Evidian

SafeKit User's Guide

High Availability Software for Critical Applications

Overview

Subject	This document covers all the phases of the SafeKit implementation: architecture, installation, tests, administration & troubleshooting, support, and command line interface.	
Intended Readers	***Architectures***	Technical overview
	Installation	Installation
	Console	The SafeKit web console Securing the SafeKit web service
	Advanced configuration	Cluster.xml for the SafeKit cluster configuration Userconfig.xml for a module configuration Scripts for a module configuration Examples of module configurations
	Administration	Mirror module administration Farm module administration Command line interface Advanced administration
	Support	Tests Troubleshooting Access to Evidian support Log Messages Index
	Other	Table of Contents Third-Party Software
Release	SafeKit 8.2	
Supported OS	Windows and Linux; for a detailed list of supported OS, see here	
Web Sites	Evidian marketing site: http://www.evidian.com/safekit Evidian support site: https://support.evidian.com/safekit	
Ref	39 A2 38MC 05	

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1. Technical overview

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1.1 Generalities, solutions, architectures

1.1.1 Introduction to SafeKit

SafeKit, developed by Evidian, is a high availability software solution designed to ensure 24/7 uptime for business-critical applications. It supports both Windows and Linux platforms and eliminates the need for shared disks, enterprise editions of databases, or advanced technical skills, making it a cost-effective alternative to traditional clustering solutions.

Key Features:

- Real-Time Synchronous Replication: Continuous data replication across nodes to prevent data loss.
- Automatic Failover and Failback: Seamless switch to a secondary system during failures and reversion once the original system is operational.
- Load Balancing: Optimizes resource use by distributing workloads across multiple servers.
- Platform Agnostic: Compatible with physical machines, virtual machines, and public cloud infrastructures.

Key Advantages:

- Zero Specific Skills: No specialized IT skills required for deployment.
- Zero Hardware Overhead: No need for specific hardware like shared disks or load balancers.
- Zero Software Overhead: Works with standard editions of Windows and Linux.

Key Solutions:

- Application Level: High availability with restart scripts per application.
- Hypervisor Level: High availability without restart scripts per application.
- Container or Pod Level: High availability without restart scripts per application.

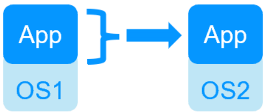
SafeKit is ideal for software publishers, resellers, and distributors looking to enhance their products with high availability features. It also offers an OEM opportunity for partners to integrate SafeKit into their own applications.

1.1.2 SafeKit solutions

See here for a list of SafeKit solutions.

Application-level HA

In this type of solution, only application data is replicated. And only the application is restarted in case of a failure.

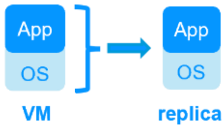


Integration tasks must be implemented: write restart scripts for the application, define folders for replication, configure software checkers, define a virtual IP address.

This solution is platform-independent and works with applications inside physical machines, virtual machines, in the cloud. Any hypervisor is supported (e.g., VMware, Hyper-V, etc.).

Virtual machine-level HA

In this type of solution, the entire virtual machine (VM) is replicated, including the application and OS. The complete virtual machine is restarted in case of a failure.



The advantage is that there are no restart scripts to write per application, and no virtual IP address to set. If you don't know how an application works, this is the simplest solution.

This solution works with Windows/Hyper-V and Linux/KVM but not with VMware. This is an active/active solution with multiple virtual machines replicated and restarted between the two nodes.

Note: Applications running in containers or pods also do not require dedicated restart scripts. SafeKit provides generic restarts and real-time replication of persistent data for these environments (see the list of SafeKit solutions).

1.1.3 SafeKit architectures

SafeKit offers two basic high availability clusters for Windows and Linux:

- the mirror cluster, with real-time file replication and failover, built by deploying a mirror module on 2 servers,
- the farm cluster, with network load balancing and failover, built by deploying a farm module on 2 servers or more.

Several modules can be deployed on the same cluster. Thus, advanced clustering architectures can be implemented:

- the farm+mirror cluster built by deploying a farm module and a mirror module on the same cluster,
- the active/active cluster built by deploying several mirror modules on 2 servers,
- the N-1 cluster built by deploying N mirror module on N+1 servers.

Specific clusters are also interesting to consider with SafeKit:

- the Hyper-V or KVM cluster with real-time replication and failover of entire virtual machines between 2 active hypervisors,
- mirror or farm clusters in the Cloud.

1.1.4 SafeKit cluster definition

A SafeKit cluster is a set of servers where SafeKit is installed and running.

All servers within a given SafeKit cluster share the same cluster configuration, which includes the list of servers and networks used. These servers communicate with each other to maintain a global view of the configurations of the SafeKit modules. A server cannot belong to multiple SafeKit clusters simultaneously.

Configuring the cluster is a prerequisite before the installation and configuration of SafeKit modules. This can be done using the SafeKit web console or through online commands.

1.1.5 SafeKit module definition

A module is a customization of SafeKit for a specific application or hypervisor. See here for a list of modules and their quick installation guides.

Types of Modules

- Generic farm and mirror modules for new applications,
- Preconfigured application modules for databases, web servers…,
- Hypervisors modules (hyperv.safe, kvm.safe) for real-time replication and restart of entire virtual machines.

Module Contents

In practice, a module is a ".safe" file (zip type) that includes:

- The configuration file userconfig.xml, which contains:
  - The virtual IP address (not necessary for a hypervisor module),
  - File directories to replicate in real time (for a mirror module),
  - Network load balancing criteria (for a farm module),
  - Configuration of software and hardware failures detectors,
- The scripts to start and stop an application or a virtual machine.

Deployment Steps

Once a module is configured and tested, deployment requires no specific IT skills:

- Install the application or the hypervisor on 2 standard servers,
- Install the SafeKit software on both servers,
- Install the module on both servers.

Configuring, deploying, and monitoring modules can be done using the SafeKit web console or through online commands.

1.1.6 SafeKit limitations

Typical usage with SafeKit			
Replication of a few Tera-bytes	Replication < 1 million files	Replication <= 32 virtual machines	1 or 10 G/s LAN or extended LAN
Limitation			

Resynchronization after a failure takes too long. On a 1 Gb/s network, 3 Hours for 1 Tera-bytes. On a 10 Gb/s network, 1 hour or less for 1 Tera-bytes (depends on write disk IO performances).	Resynchronization after a failure takes too long. Time to check each file between both nodes.	In full virtual machine replication mode, and with one virtual machine in a mirror module, the limit is 32 modules per cluster.	Failover of the virtual IP address is built-in when in the same subnet. A LAN provides adequate bandwidth for resynchronization. A LAN provides adequate latency (typically a round-trip of less than 2ms) for synchronous replication.
Alternative			
Use shared storage.	Put files in a virtual hard disk replicated by SafeKit.	Use another HA solution with shared storage.	Use backup solutions with asynchronous replication.

1.2 The SafeKit mirror cluster

1.2.1 Real time file replication and application failover

The mirror cluster is an active-passive high-availability solution, built by deploying a mirror module within a two-node cluster. The application runs on a primary server and is restarted automatically on a secondary server if the primary server fails.

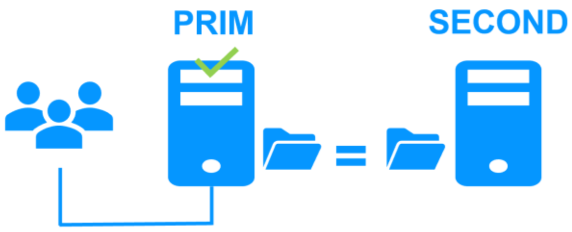
With its real-time file replication function, this architecture is particularly suited to providing high availability for back-end applications with critical data to protect against failure.

Microsoft SQL Server, PostgreSQL, MariaDB, Oracle, Milestone, Nedap, Docker, Podman, Hyper-V, and KVM solutions are examples of mirror modules. You can create your own mirror module for your application based on the generic mirror.safe module. See here for a list of modules.

Note that Hyper-V and KVM mirror modules replicate entire virtual machines, including applications and operating systems. They do not require a virtual IP, as the VM restart handles the failover of the VM physical IP address.

The mirror cluster works as follows.

1.2.2 Step 1. Normal operation



Server 1 (PRIM) runs the application.

SafeKit replicates files opened by the application. Only changes made by the application in the files are replicated in real time across the network, thus limiting traffic.

For replication, only names of file directories to replicate are configured in SafeKit. There are no pre-requisites on disk organization for the two servers. Directories to replicate may be located in the system disk.

1.2.3 Step 2. Failover

When Server 1 fails, Server 2 takes over. SafeKit switches the virtual IP address and restarts the application automatically on Server 2. The application finds the files replicated by SafeKit up-to-date on Server 2, thanks to the synchronous replication between Server 1 and Server 2. The application continues to run on Server 2 by locally modifying its files that are no longer replicated to Server 1.

The switch-over time is equal to the fault-detection time (set to 30 seconds by default) plus the application start-up time. Unlike disk replication solutions, there is no delay for remounting file systems and running recovery procedures.

1.2.4 Step 3. Failback and automatic resynchronization

Failback involves restarting Server 1 after fixing the problem that caused it to fail. SafeKit automatically resynchronizes the files, updating only the files modified on Server 2 while Server 1 was halted.

This automatic reintegration takes place without stopping the application, which can continue running on Server 2. This is a major feature that differentiates SafeKit from other solutions, which require manual operations to reintegrate Server 1 in the cluster.

1.2.5 Step 4. Return to normal operation

After reintegration, the files are once again in mirror mode, as in step 1. The system is back in high-availability mode, with the application running on Server 2 and SafeKit replicating file updates to Server 1.

If administrators want the application to run on Server 1, they can execute a 'Stop/Start' command on the PRIM server either through the console at the appropriate time or automatically by configuring a default primary server.

1.2.6 Synchronous replication versus asynchronous replication

There is a significant difference between synchronous replication, as offered by the SafeKit mirror solution, and asynchronous replication traditionally offered by other file replication solutions.

With synchronous replication, when a disk IO is performed by the application on the primary server inside a replicated file, SafeKit waits for the IO acknowledgement from the local disk and from the secondary server, before sending the IO acknowledgement to the application. This mechanism is essential for recovery of transactional applications.

The latency of a LAN (typically a round-trip of less than 2ms) between the servers is required to implement synchronous data replication, possibly with an extended LAN in two geographically remote computer rooms.

With asynchronous replication implemented by other solutions, the IOs are placed in a log on the primary server but the primary server does not wait for the IO acknowledgments of the secondary server. Thus, all data that has not been copied over the network to the second server is lost in the event of a failure of the first server.

In particular, a transactional application may lose committed data in the event of a failure. Asynchronous replication can be used for data replication over a low-speed WAN to back up data remotely, but it is not suitable for high availability with automatic failover.

SafeKit provides a semi-synchronous solution, implementing the asynchrony not on the primary server but on the secondary one. In this solution, SafeKit always waits for the acknowledgement of the two servers before sending the acknowledgement to the application. But on the secondary, there are 2 options asynchronous or synchronous. In the asynchronous case, the secondary sends the acknowledgement to the primary upon receipt of the IO and writes to disk after. In the synchronous case, the secondary writes the IO to disk and then sends the acknowledgement to the primary. The synchronous mode is required if we consider a simultaneous double power outage of two servers, with inability to restart the former primary server and requirement to re-start on the secondary.

1.2.7 Behavior in case of network isolation

A **heartbeat** is a mechanism for synchronizing two servers and detecting failures by exchanging data over a shared network. If one server loses all heartbeats, it assumes the other is down and runs the application ALONE.

SafeKit supports multiple heartbeats across shared networks. A dedicated network with a second heartbeat can prevent network isolation and also be used as the replication network.

Network Isolation:

- Upon losing all heartbeats, both servers transition to the ALONE state, running the application independently.
- After the isolation, one server stops and resynchronizes data from the other server.
- The cluster returns to PRIM-SECOND state.

Splitbrain Checker:

- Uses a witness IP (usually a router) to avoid double execution during isolation.
- Only the server with witness access goes ALONE, the other waits.
- After isolation, the WAIT server resynchronizes and becomes SECOND.

1.2.8 3-node replication

SafeKit only supports replication between two nodes. However, it is possible to implement 3-node replication by combining SafeKit with a backup solution.

An application is made highly available between 2 nodes thanks to SafeKit with its synchronous real-time replication (no data loss) and automatic failover. Additionally, a backup solution is implemented for asynchronous replication to a third node in a disaster recovery site. Since there is data loss with an asynchronous backup solution, the failover to the third node is manual and decided by an administrator.

Note that the real-time replication of SafeKit does not eliminate the need for a backup solution. For example, a ransomware attack encrypting replicated data on the primary server will also encrypt data on the secondary server in real-time with SafeKit. Only a backup solution with a retention policy can resolve a ransomware attack. The administrator must restore the backup from before the ransomware attack.

1.2.9 SafeKit on a single node to protect against software failures

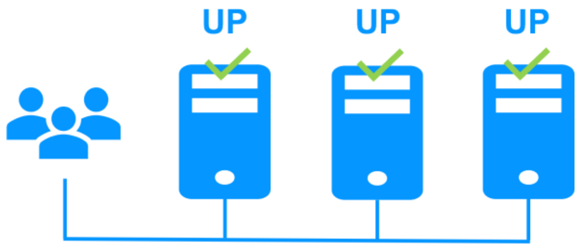
You can configure a module in "light" mode, which corresponds to a module running on a single node without synchronizing with other nodes (unlike mirror or farm modules). A light module includes the start and stop of an application, as well as SafeKit checkers that detect software errors and perform automatic restarts on a single node.

The light module interfaces with the SafeKit console, allowing an administrator to view the status of the application module and manually trigger application restarts using a button-click interface.

There is no need to define a virtual IP address or replicated directories in a light module. Note that this can also serve as a first step before transitioning to a mirror module or a farm module.

1.3 The SafeKit farm cluster

1.3.1 Network load balancing and application failover



The farm cluster is an active-active high-availability solution, built by deploying a farm module within a cluster of two or more nodes. The farm cluster provides both network load balancing, through transparent distribution of network traffic, and software and hardware failover. This architecture offers a simple solution to support the increase in system load.

The same application runs on each server, and the load is balanced by the distribution of network activity on the different servers of the farm.

Farm clusters are suited to front-end applications like web services.

Apache, Microsoft IIS, NGINX solutions are examples of farm modules. You can write your own farm module for your application, based on the generic farm.safe module. See here for a list of modules.

1.3.2 Principle of a virtual IP address with network load balancing

The virtual IP address is configured locally on each server in the farm. Input traffic for this address is distributed among all servers by a filter within each server's kernel.

The load balancing algorithm inside the filter is based on the identity of the client packets (client IP address, client TCP port). Depending on the identity of the client packet, only one filter on a server accepts the packet. Once a packet is accepted by the filter on a server, only the CPU and memory of that server are used by the application responding to the client's request. The output messages are sent directly from the application server to the client.

If a server fails, the SafeKit heartbeat protocol in a farm reconfigures the filters to re-balance the traffic among the remaining available servers.

1.3.3 Load balancing for stateful or stateless web services

With a stateful server, session affinity is required. The same client must connect to the same server across multiple TCP sessions to retrieve its context. In this scenario, the SafeKit load balancing rule is configured on the client IP address. This ensures that the same client always connects to the same server for multiple TCP sessions, while different clients are distributed across various servers in the farm. This configuration is used when session affinity is required.

With a stateless server, there is no session affinity. The same client can connect to different servers in the farm across multiple TCP sessions, as no context is stored locally on a server from one session to another. In this case, the SafeKit load balancing rule is configured on the TCP client session identity. This configuration is optimal for distributing sessions between servers but requires a TCP service without session affinity.

1.3.4 Chain high availability solution in a farm

What is a chain HA solution (also known as a cascading HA solution)?

- Multiple servers are linked in a sequence: If one server fails, the next one in the chain takes over.
- Priority-based management: A single server, the one with the highest priority in the chain and which is available, manages all requests from clients.
- Failover process: If the server with the highest priority fails, the next available server with the highest priority takes over.
- Reintegration: When a server comes back online and has the highest priority, it resumes handling all client requests.
- Quick recovery time: This solution has a quick recovery time, as the application is pre-started on all servers. The recovery time is essentially the time needed to reconfigure the priorities among the servers in the farm (a few seconds).
- Replication limitations: This solution does not support real-time replication, which is limited to mirror architecture. However, a combined farm+mirror architecture is available.

To implement a chain high availability solution, SafeKit offers a "power" variable in the load balancing rules, which is set at the level of each server in the cluster. The power variable allows you to allocate more or less traffic to a server. When the power variable is set as a multiple of 64 between servers (e.g., 1, 64, 64*64, 64*64*64, ...), the chain high availability solution is implemented.

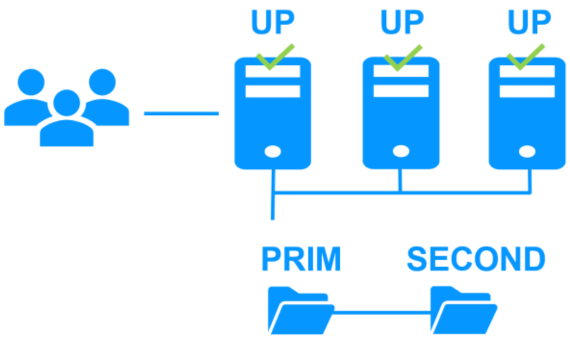
1.4 Clusters running several modules

1.4.1 The SafeKit farm+mirror cluster

Network load balancing, file replication and application failover

You can mix farm and mirror modules on the same cluster.

This option allows you to implement a multi-tier application architecture, such as apache_farm.safe (farm architecture with load balancing and failover) and postgresql.safe (mirror architecture with file replication and failover) on the same servers.

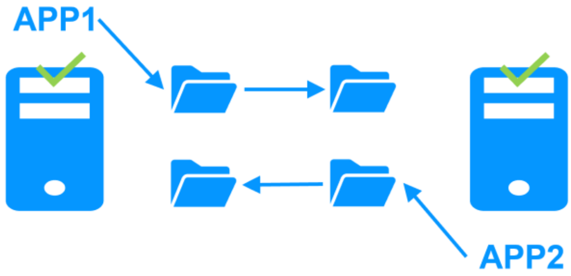


As a result, load balancing, file replication and failover are managed coherently on the same servers.

1.4.2 The SafeKit active/active cluster with replication

Crossed replication and mutual failover

In an active / active cluster with replication, there are two servers and two mirror modules in mutual failover (appli1.safe and appli2.safe). Each application server is backup of the other server.



If one application server fails, both applications will run on the same physical server. Once the failed server is restarted, its application will return to its default primary server.

A mutual failover cluster is more cost-effective than two separate mirror clusters, as it eliminates the need for backup servers that remain idle most of the time, waiting for a primary server to fail. However, in the event of a server failure, the remaining server must be capable of handling the combined workload of both applications.

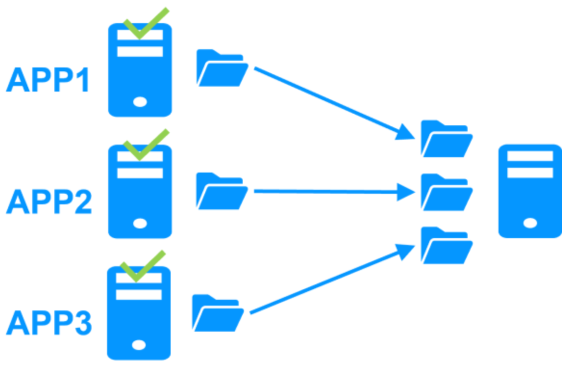
Note that:

- Both applications, Appli1 and Appli2, must be installed on each server to enable application failover.
- This architecture is not limited to just two applications; N application modules can be deployed across two servers.
- Each mirror module will have its own virtual IP address, its own replicated file directories, and its own restart scripts.

1.4.3 The SafeKit N-1 cluster

Replication and application failover from N servers to 1

In an N-1 cluster, N mirror application modules are deployed across N primary servers and a single backup server.



In the event of a failure, unlike in an active/active cluster, the backup server does not need to manage a double workload when a primary server fails. This assumes only one failure occurs at a time. While the solution can support multiple primary server failures simultaneously, in such cases, the single backup server will need to handle the combined workload of all the failed servers. In a N-1 cluster, there are N mirror application modules installed between N primary servers and one backup server.

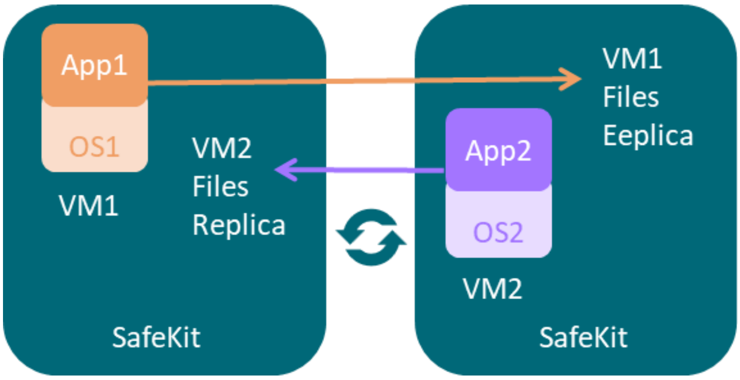
Note that:

- All applications (Appli1, Appli2, Appli3) must be installed on the single backup server to enable application failover.
- Each mirror module will have its own virtual IP address, its own replicated file directories, and its own restart scripts.

1.5 The SafeKit Hyper-V or KVM cluster

1.5.1 Load balancing, replication, failover of entire virtual machines

The Hyper-V or KVM cluster is an example of an active-active cluster. Multiple applications can be hosted in various virtual machines, which are replicated and restarted by SafeKit. Each virtual machine is managed by SafeKit within its own mirror module.



The solution has the following features:

- Real-time synchronous replication of entire virtual machines with failover capabilities.
- A centralized, user-friendly SafeKit console for managing all VMs, including the ability to migrate VMs between servers to optimize load distribution.
- A checker for each VM to detect if it has locked up, crashed, or ceased to function, and to restart the VM if necessary.
- An attractive solution that requires no application integration.
- A robust architecture suitable for high-availability solutions that cannot be integrated at the application level.

A free trial of the Hyper-V cluster with SafeKit is available here.

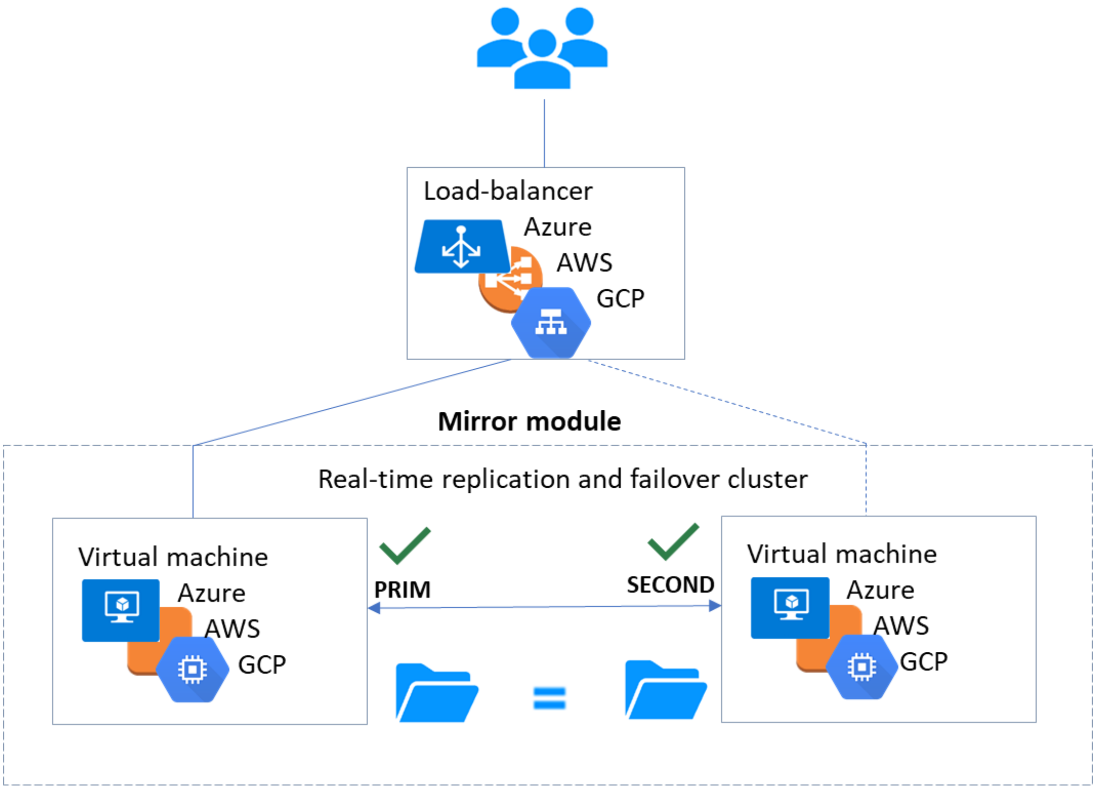
A free trial of the KVM cluster with SafeKit is available here.

1.6 SafeKit clusters in the cloud

For a full description, refer to section 16.

1.6.1 Mirror cluster in Azure, AWS and GCP

SafeKit delivers high-availability clusters with real-time replication and failover in Azure, AWS, and GCP through the deployment of a mirror module.



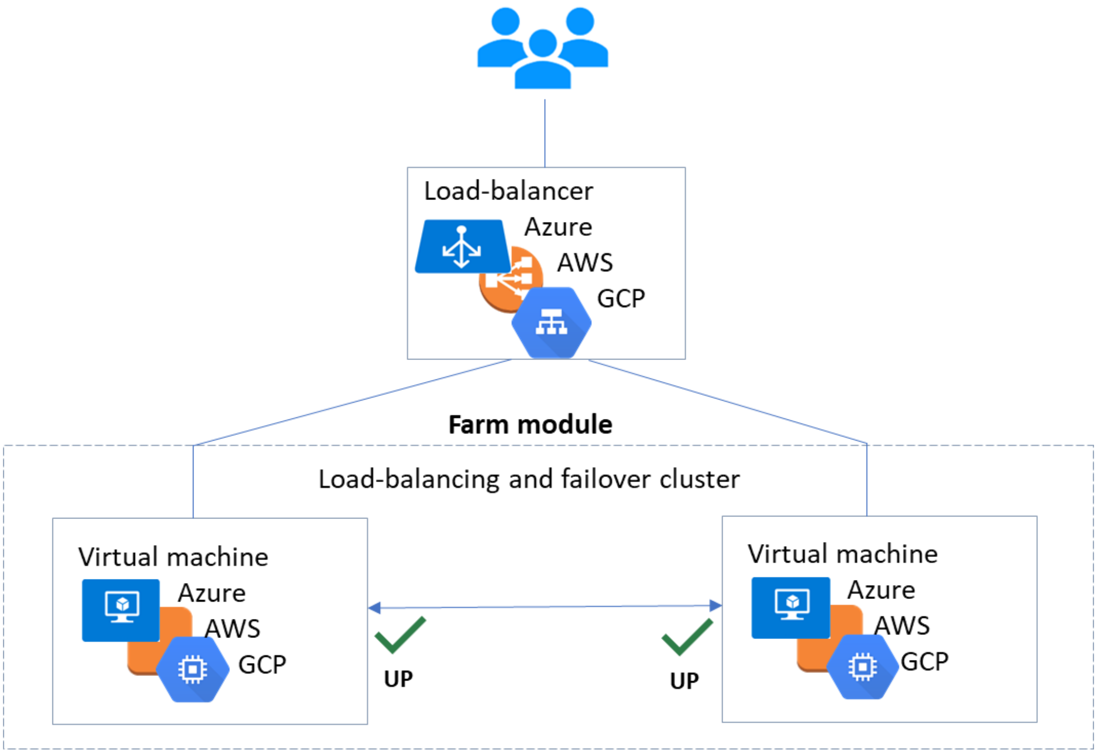
The mirror solution in the cloud is similar to the on-premise one, except that the virtual IP address must be configured at the load balancer level:

- Virtual machines are placed in different availability zones, which are in different subnets.
- The critical application runs on the primary server.
- Users connect to a primary/secondary virtual IP address managed by the cloud load balancer.
- SafeKit provides a health check configured in the load balancer. On the primary server, the health check returns OK to the load balancer, while it returns nothing on the secondary server. Thus, all requests to the virtual IP address are routed to the primary server.
- If the primary server fails or is stopped, the secondary server automatically becomes the primary one and returns OK to the health check. Thus, all requests to the virtual IP address are rerouted to the new primary server.
- SafeKit monitors the critical application on the primary server using SafeKit checkers.
- SafeKit automatically restarts the critical application in the event of software or hardware failure, thanks to restart scripts.
- SafeKit performs synchronous real-time replication of files containing critical data.

For more information, refer to mirror cluster in Azure, mirror cluster in AWS or mirror cluster in GCP.

1.6.2 Farm cluster in Azure, AWS and GCP

SafeKit delivers high-availability clusters with network load balancing and failover in Azure, AWS, and GCP through the deployment of a farm module.



The farm solution in the cloud is similar to the on-premise one, except that the virtual IP address must be configured at the load balancer level:

- Virtual machines are placed in different availability zones, which are in different subnets.
- The critical application runs on all servers.
- Users are connected to a virtual IP address managed by the cloud load balancer.
- SafeKit provides a health check configured in the load balancer. The health check returns OK on all servers running the application.
- If a server fails or is stopped, the checker returns nothing to the load balancer, which then stops routing requests to that server.
- SafeKit monitors the critical application on all servers using SafeKit checkers.
- SafeKit automatically restarts the critical application on a server when there is a software failure, thanks to restart scripts.

For more information, refer to farm cluster in Azure, farm cluster in AWS or farm cluster in GCP.

2. Installation

➾ Section 2.1 "SafeKit install"

➾ Section 2.2 "Mirror installation recommendation"

➾ Section 2.3 "Farm installation recommendation"

➾ Section 2.4 "SafeKit upgrade"

➾ Section 2.5 "SafeKit full uninstall"

➾ Section 2.6 "SafeKit documentation"

2.1 SafeKit install

2.1.1 Download the package

1. Connect to https://support.evidian.com/safekit
2. Go to <Version 8.2>/Platforms/<Your platform>/Current versions
3. Download the package
   In Windows, two packages are available:
   - A Windows Installer package (safekit_windows_x86_64_8_2_x_y.msi). It depends on the VS2022 C runtime which must be previously installed
   - A standalone executable bundle (safekit_windows_x86_64_8_2_x_y.exe), which includes the SafeKit installation and the VS2022 C runtime

   Choose one or the other package depending on whether the VS2022 C runtime is installed or not.

2.1.2 Installation directories and disk space provisioning

SafeKit is installed in:

SAFE	• in Windows SAFE=C:\safekit if %SYSTEMDRIVE%=C: • in Linux SAFE=/opt/safekit	Minimum free disk space: 97MB
SAFEVAR	• in Windows SAFEVAR= C:\safekit\var if %SYSTEMDRIVE%=C: • in Linux SAFEVAR=/var/safekit	Minimum free disk space: 20MB + at least 20MB (up to 3 GB) per module for dumps

2.1.3 SafeKit install procedure

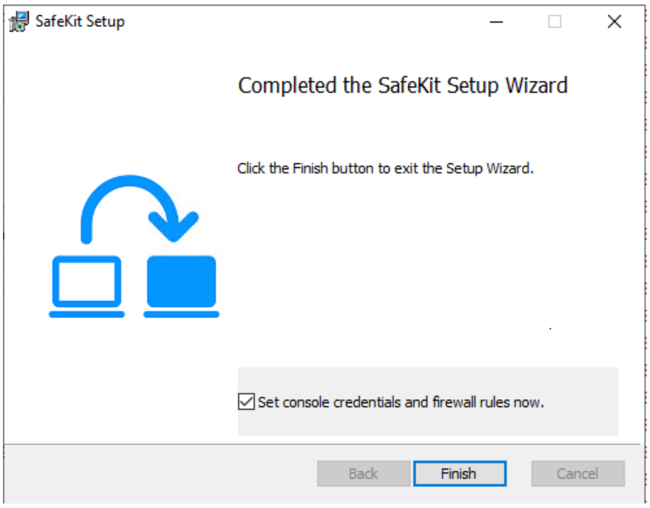
2.1.3.1 Install on Windows as administrator

2.1.3.1.1 SafeKit package install

1. Log-in as administrator on Windows server
2. Locate the downloaded file `safekit_windows_x86_64_8_2_x_y.msi` (or `safekit_windows_x86_64_8_2_x_y.exe`)
3. Install in interactive mode by double-clicking it and go through the installer wizard

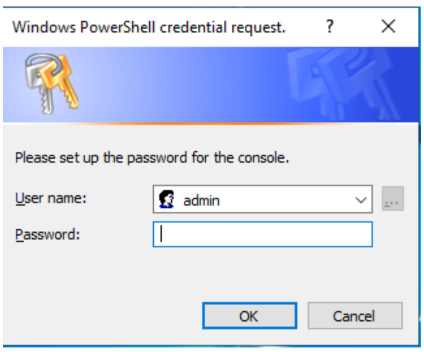
   Before SafeKit 8.2.3, after installation, you need to run the firewall configuration scripts (see section 10.3) and initialize the SafeKit web service (see section 11.2.1.2).

   Since SafeKit 8.2.3, at the end of the SafeKit Setup, you will be asked to check or uncheck " Set console credentials and firewall rules now ".



If the box is checked, when clicking the "Finish" button:

- it configures `Microsoft Windows Firewall` for SafeKit. For details or other firewalls, see section 10.3.
- it opens a window to enter the password for the `admin` user of the SafeKit web console.



This step is mandatory to initialize the default configuration of the web service that requires authentication. It is initialized with the `admin` user and the given password `pwd`, for instance. It then allows to access to all the web console's features, by logging in with `admin/pwd`, and run distributed commands. For details, see section 11.2.1.

The password must be identical on all nodes that belong to the same SafeKit cluster. Otherwise, web console and distributed commands will fail with authentication errors.

or

3. Install in non-interactive mode, by executing:

   `msiexec /qn /i safekitwindows_8_2_x_y.msi`

   Then, the firewall setup and web service initialization must be done.

2.1.3.1.2 Firewall setup

This step is mandatory to enable communication between the nodes of the SafeKit cluster and with the web console.

No action required when firewall automatic configuration has been performed during the package install. Otherwise see section 10.3.

2.1.3.1.3 Web service initialization

This step is mandatory to initialize the default configuration of the web service, which is accessed by the web console and the global safekit command. The web service requires authentication to access the service. No action required when the web service initialization has been performed during the package install. Otherwise, see section 11.2.1.2.

2.1.3.1.4 Antivirus setup

This step is only necessary if the server's antivirus interferes with the operation of SafeKit. See section 10.6 for the list of legitimate SafeKit directories and processes that should not be affected by the antivirus.

2.1.3.2 Install on Linux as root

2.1.3.2.1 SafeKit package install

1. Open a Shell console as root on Linux server
2. Go to the directory that contains the downloaded file `safekitlinux_x86_64_8_2_x_y.bin`

   auto extractible zip file
3. Run `chmod +x safekitlinux_x86_64_8_2_x_y.bin`
4. Run `./safekitlinux_8_2_x86_64_x_y.bin`

   it extracts the package and the `safekitinstall` script
5. Install in interactive mode by executing `./safekitinstall`

   During the installation:

   - reply to "Do you accept that SafeKit automatically configure the local firewall to open these ports (yes|no)?"

     If you answer `yes`, it configures `firewalld` or `iptable` Linux firewall for SafeKit. For details or other firewalls, see section 10.3.
   - reply to "Please enter a password or "no" if you want to set it later"

     This step is mandatory to initialize the default configuration of the web service. The web service requires authentication to access the service.

It initializes it with the `admin` user and the given password `pwd`, for instance. It then allows to access to all the web console's features, by logging in with `admin/pwd`, and run distributed commands. For details, see section 11.2.1.

The password must be identical on all nodes that belong to the same SafeKit cluster. Otherwise, web console and distributed commands will fail with authentication errors.

or

5. Install in non-interactive mode, by executing:

   ```
   ./safekitinstall -q
   ```

   Use the option `-nofirewall` for disabling the firewall automatic setup.

   Use the option `-passwd pwd` for initializing the web service authentication (where `pwd` is the password set for the `admin` user).

   The install log is `/tmp/safekitinstall_log`.

2.1.3.2.2 Firewall setup

This step is mandatory to enable communication between the nodes of the SafeKit cluster and with the web console.

No action required when firewall automatic configuration has been performed during the package install. Otherwise see section 10.3.

2.1.3.2.3 Web service initialization

This step is mandatory to initialize the default configuration of the web service, which is accessed by the web console and the global safekit command. The web service requires authentication to access the service. No action required when the web service initialization has been performed during the package install. Otherwise, see section 11.2.1.2.

2.1.3.2.4 Antivirus setup

This step is only necessary if the server's antivirus interferes with the operation of SafeKit. See section 10.6 for the list of legitimate SafeKit directories and processes that should not be affected by the antivirus.

2.1.4 Use the SafeKit web console or command line interface

Once installed, the SafeKit cluster must be defined. Then modules can be installed, configured, and administered. All these actions can be done with the SafeKit console or the command line interface.

2.1.4.1 The SafeKit web console

1. Start a web browser (Microsoft Edge, Firefox, or Chrome)
2. Connect it to the URL `http://host:9010` (where `host` is the name or IP address of one of the SafeKit nodes)
3. In the login page, enter `admin` as user’s name and the password you gave on initialization (e.g., `pwd`)
4. Once the console is loaded, the `admin` user can access to Monitoring and Configuration in the navigation sidebar, as he has the default `Admin` role

For details see section 3.

2.1.4.2 The SafeKit command line interface

It is based on the single safekit command located at the root of the SafeKit installation directory. Almost all safekit commands can be applied locally or on a list of nodes in the SafeKit cluster. This is called global or distributed command.

For details on the safekit command, see section 9.

To use the safekit command:

In Windows	1. Open a PowerShell console as administrator 2. Go to the root of the SafeKit installation directory SAFE (by default SAFE=C:\safekit if %SYSTEMDRIVE%=C:) cd c:\safekit 3. Run .\safekit.exe <arguments> for the local command 4. Run .\safekit.exe -H "<hosts>" <arguments> for the command distributed across multiple nodes
In Linux	1. Open a Shell console as root 2. Go to the root of the SafeKit installation directory SAFE (by default SAFE=/opt/safekit) cd /opt/safekit 3. Run ./safekit <arguments> for the local command 4. Run ./safekit -H "<hosts>" <arguments> for the command distributed across multiple nodes

For instance, to display the levels (SafeKit, OS…):

- for the local host

```
safekit level
```

- for all hosts configured in the SafeKit cluster

```
safekit -H "*" level
```

2.1.5 SafeKit license keys

License keys are determined and verified based on the Operating System (Windows or Linux) and the hostnames of machines (not the FQDN), as returned by the hostname command in a Windows command prompt or a Linux shell. They are delivered in a text file. Once the license key file is installed, there is no need for a connection to a license server.

- If you do not install any license key file, the product will stop functioning every 3 days. However, it can be restarted for another 3 days.
- You can download a one-month trial key file from the following address: https://www.evidian.com/products/high-availability-software-for-application-clustering/high-availability-and-load-balancing-cluster-key/
- When a license key expires or is incorrect (e.g., wrong OS or hostname), the system falls into the 3-day behavior.

- After placing a purchase order, you obtain a permanent key file (see section 8.2). The permanent key file can be installed without reinstalling or stopping the product.
- The key file can contain keys for multiple hostnames. SafeKit will detect the appropriate license for the correct OS/hostname on each server.
- Save the key file into the `SAFE/conf/license.txt` file (or any other file in `SAFE/conf`) on each server.
- If files in `SAFE/conf` contain more than one key file, the most favorable key will be chosen.
- Check the key conformance on each server with the command `SAFE/safekit level` or with the SafeKit web console.

2.1.6 System specific procedures and characteristics

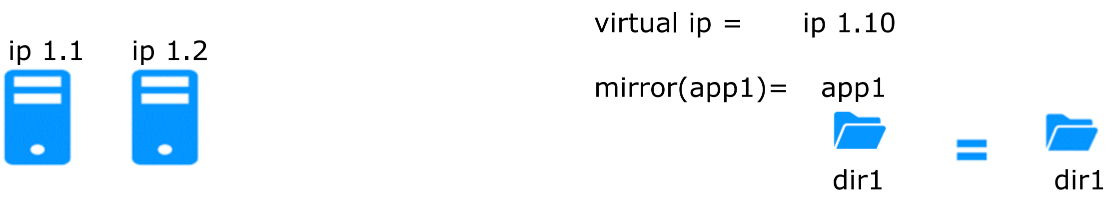
2.1.6.1 Windows

- Apply a special procedure to properly stop SafeKit modules at machine shutdown and to start `safeadmin` service at boot: see section 10.4.
- For network interfaces with teaming and with SafeKit load balancing, it is necessary to uncheck "Vip" on physical network interfaces of teaming and keep it checked only on teaming virtual interface.

2.1.6.2 Linux

- In Linux, the SafeKit package depends on other system packages. Most of them are installed automatically, except those specific to the implementation of load balancing in a farm and file replication in a mirror.
- For an updated list of required packages, see the *SafeKit Release Notes*.
- The user `safekit` and a group `safekit` are created: all users belonging to the `safekit` group, and the user `root` can execute SafeKit commands
- In a farm module with load balancing on a virtual IP address, the vip kernel module is compiled when the module is configured. To compile successfully, Linux packages must be installed. See the *SafeKit Release Notes* for an up-to-date list of the packages.
- For a farm with SafeKit load balancing on a bonding interface, no ARP should be set in the bonding configuration. Otherwise, the association <virtual IP address, invisible virtual MAC address> is broken in client ARP caches with physical MAC address of the bonding interface.
- When Secure Boot is enabled and you are using a farm module, follow the procedure described in section 10.5 to sign and enroll the SafeKit kernel modules that implement load-balancing.

2.2 Mirror installation recommendation



2.2.1 Hardware prerequisites

- 2 servers with the same Operating System
- Supported OS: https://support.evidian.com/supported_versions/#safekit
- Disk drive with write-back cache recommended for the performance of the IOs

2.2.2 Network prerequisites

- 1 physical IP address per server (ip 1.1 and ip 1.2)
- If you need to set a virtual IP address (ip 1.10), both servers must be in the same IP network with the standard SafeKit configuration (LAN or extended LAN between two remote computer rooms). For setting a virtual IP address with servers in different IP networks, see section 13.5.3.

2.2.3 Application prerequisites

- The application is installed and starts on both servers
- Application can be started and stopped using command lines
- On Linux, command lines like `service "service" start|stop` or `su -user "appli-cmd"`
- On Windows, command lines like `net start|stop "service"`
- If necessary, application with a procedure to recover after crash
- Remove automatic application start at boot and configure the boot start of the module instead

2.2.4 File replication prerequisites

- File directories that will be replicated are created on both servers
- They are located at the same place on both servers in the file tree
- It is better to synchronize clocks of both server for file replication (NTP protocol)
- On Linux, align uids/gids on both servers for owners of replicated directories/files
- See also system specific procedures and characteristics in section 2.1.6

2.3 Farm installation recommendation

ip 1.1 ip 1.2 ip 1.3

virtual IP =	ip 1.20	ip 1.20	ip 1.20
farm (app2) =	app2	app2	app2

2.3.1 Hardware prerequisites

- At least 2 servers with the same Operating System
- Supported OS: https://support.evidian.com/supported_versions/#safekit
- Linux: kernel compilation tools installed for vip kernel module

2.3.2 Network prerequisites

- 1 physical IP address per server (ip 1.1, ip 1.2, ip 1.3)

- If you need to set a virtual IP address (ip 1.20), servers must be in the same IP network with the standard SafeKit configuration (same LAN or extended LAN between remote computer rooms). For setting a virtual IP address with servers in different IP networks, see section 13.5.3.
- See also system specific procedures and characteristics in section 2.1.6

2.3.3 Application prerequisites

The same prerequisites as for a mirror module described in section 2.2.3

2.4 SafeKit upgrade

If you encounter a problem with SafeKit, see the *Software Release Bulletin* containing the list of fixes on the product.

If you want to take advantage of some new features, see the *SafeKit Release Notes*. This document also tells you if you are in the case of a major upgrade (ex. 7.5 to 8.2) which requires a different procedure from the one presented here.

The upgrade procedure consists in uninstalling the old package and then installing the new package. All nodes in the same cluster must be upgraded.

2.4.1 Prepare the upgrade

1. Note the state "on" or "off" of SafeKit services and modules started automatically at boot `safekit boot webstatus; safekit boot status -m AM` (where *AM* is the name of the module) and in Windows: `safekit boot snmpstatus;`

   The start at boot of the module can be defined in its configuration file. If so, the use of the `safekit boot` command becomes unnecessary.

2. for a mirror module

   note the server in the `ALONE` or `PRIM` status to know which server holds the up-to-date replicated files

3. optionally, take snapshots of modules

   Uninstalling/reinstalling will reset logs and dumps of each module. If you want to keep this information (logs and last 3 dumps and configurations), run the command `safekit snapshot -m AM /path/snapshot_xx.zip` (replace *AM* by the module name)

2.4.2 Uninstall procedure

On Windows as administrator and on Linux as root:

1. stop all modules using the command `safekit shutdown`

   For a mirror in the `PRIM-SECOND` status, stop first the `SECOND` server to avoid an unnecessary failover

2. close all editors, file explorers, shells, or terminal under `SAFE` and `SAFEVAR` (to avoid package uninstallation error)

3. uninstall SafeKit package

In Windows	Use the Control Panel-Add/Remove Programs applet
In Linux	Use the command `safekit uninstall`

4. undo all configurations that you have done manually for the firewall setup (see section 10.3)

Uninstalling SafeKit includes creating a backup of the installed modules in `SAFE/Application_Modules/backup`, then unconfiguring them.

2.4.3 Reinstall and postinstall procedure

1. Install the new package as described in section 2.1
2. Check with the command `safekit level` the installed SafeKit version and the validity of the license (which has not been uninstalled)

   If you have a problem with the new package and the old key, take a temporary license: see section 2.1.5
3. If you use the web console, clear the browser cache and refresh pages in the web browser
4. Since SafeKit 8.2.1, previously configured modules are automatically reconfigured on upgrade.

   However, you may still need to reconfigure module to apply any configuration changes coming with the new version (see the *SafeKit Release Notes*). Reconfigure the module either with:

   - the web console by navigating to ⚙"Configuration/Modules configuration/⚙Configure the module/"
   - the web console by directly entering the URL http://host:9010/console/en/configuration/modules/*AM*/config/
   - the command `safekit config -m` *AM*

   where *AM* is the module name
5. If necessary, reconfigure the automatic start of modules at boot

   The start at boot of the module can be defined in its configuration file. If so, skip this step. Otherwise, run the command `safekit boot -m` *AM* `on` (replace *AM* by the module name)
6. Restart the modules

Mirror module	The module must be started as primary on the node with the updated replicated files (former `PRIM` or `ALONE`) either with: • the web console by navigating to 👁 Monitoring/••• of the node/Force start/As primary • the command `safekit prim -m` *AM* (replace *AM* by the module name)

	Check that the application is working properly once the module is in `ALONE` state, before starting the other node. On the other node (former `SECOND`), the module must be started in secondary mode either with: • the web console by navigating to Monitoring/••• of the node/Force start/As secondary • the command `safekit second -m AM` (replace *AM* by the module name) Once this initial start has been performed by selecting the primary and secondary nodes, subsequent starts can be performed with: • the web console by navigating to Monitoring/••• of the node/ Start/ • the command `safekit start -m AM` (replace *AM* by the module name)
Farm module	Start the module either with: • the web console by navigating to Monitoring/••• of the module/ Start/ • the command `safekit start -m AM` (replace *AM* by the module name)

Furthermore, in cases where you have modified the setup of the SafeKit web service, SNMP monitoring or SafeKit notification agent:

1. the SafeKit web service `safewebserver`
   - If its automatic start at boot had been disabled, disable it again with the command `safekit boot weboff`
   - If you had modified configuration files and these have evolved in the new version, your modifications are saved into `SAFE/web/conf` before being overwritten by the new version. Carrying over your old configuration to the new version may require some adaptations. For details on the default setup and all predefined setups, see section 11.
   - For HTTPS and login/password configurations, certificates, and `user.conf / group.conf` generated for the previous release should be compatible.
2. The SafeKit SNMP monitoring
   - In Windows, if its automatic start at boot had been enabled, enable it again with the command `safekit boot snmpon`
   - If you had modified configuration files and these have evolved in the new version, your modifications are saved into `SAFE/snmp/conf` before being overwritten by the new version. Carrying over your old configuration to the new version may require some adaptations. For details, see section 10.10.
3. The SafeKit email notification agent

   Since SafeKit 8.2.4, SafeKit offers a notification agent to send emails for major modules events. For details, see section 10.9.

If you have enabled it, it will remain enabled after the upgrade. However, you may need to reconfigure the SafeKit notification agent, as described in section 10.9.1, if its configuration file has evolved between the two versions.

2.5 SafeKit full uninstall

For completely removing the SafeKit package, follow the procedure described below.

2.5.1 Uninstall on Windows as administrator

1. Log-in as administrator on Windows server
2. stop all modules using the command `safekit shutdown`
3. close all editors, file explorers, shells, or cmd under `SAFE` and `SAFEVAR` (to avoid package uninstallation error)

   (`SAFE=C:\safekit` if `%SYSTEMDRIVE%=C: ; SAFEVAR=C:\safekit\var` if `%SYSTEMDRIVE%=C:`)
4. uninstall SafeKit using the Control Panel-Add/Remove Programs applet
5. reboot the server
6. delete the folder `SAFE` that is the installation directory of the previous install of SafeKit
7. undo all configurations that you have done for SafeKit boot/shutdown (see section 10.4)
8. undo all configurations that you have done for firewalls rules setting (see section 10.3)

2.5.2 Uninstall on Linux as root

1. Open a Shell console as root on Linux server
2. stop all modules using the command `safekit shutdown`
3. close all editors, file explorers, shells, or terminal under `SAFE` and `SAFEVAR` (`SAFE=/opt/safekit ; SAFEVAR=/var/safekit`)
4. uninstall SafeKit using the `safekit uninstall -all` command and answer `yes` when prompted to delete all SafeKit folders
5. reboot the server
6. undo all configurations that you have done for firewalls rules setting

   See section 10.3
7. delete the user/group created by the previous install (default is `safekit`/`safekit`) with the commands:

   `userdel safekit`

   `groupdel safekit`

2.6 SafeKit documentation

SafeKit Solution	The SafeKit solution is fully described.

SafeKit Training	Refer to this online training for a quick start in using SafeKit.
SafeKit Release Notes	It presents: • latest install instructions • major changes • restrictions and known problems • migration instructions
Software Release Bulletin	Bulletin listing SafeKit 8.2 packages, with descriptions of changes and fixed issues.
SafeKit Knowledge Base	List of known SafeKit issues and restrictions. Other KBs are available on the Evidian support site, but are only accessible to registered users. For more details on the support site, see section 8.
SafeKit user's guide	This is the guide. Please refer to the guide corresponding to your SafeKit version number. It is delivered with the SafeKit package and can be accessed via the web console under ⋮ / ⓘ User's guide. The link opposite takes you to the latest version of this guide.

3. The SafeKit web console

➾ Section 3.1 "Start the web console"

➾ Section 3.2 "Configure the cluster"

➾ Section 3.3 "Configure a module"

➾ Section 3.4 "Monitor a module"

➾ Section 3.5 "Snapshots or logs of module for debug and support"

➾ Section 3.6 "Secure access to the web console"

The SafeKit 8 web console and API have evolved from earlier versions. As a result, the console delivered with SafeKit 8 can only administer SafeKit 8 servers, which cannot be administered with an older console.

3.1 Start the web console

The web console permits to administer one SafeKit cluster. A SafeKit cluster is a set of servers where SafeKit is installed and running. All servers belonging to a given SafeKit cluster share the same cluster configuration (list of servers and networks used) and communicate with each other's to have a global view of SafeKit modules configurations. The same server can not belong to many SafeKit clusters.

3.1.1 Start a web browser

- The web browser runs on any allowed SafeKit nodes or workstation that can reach the SafeKit servers over the network.
- Network, firewall and proxy configuration must allow access to all the servers that are administered with the web console
- JavaScript must be available and enabled in the web browser
- Tested browsers are Microsoft Edge, Firefox, and Google Chrome
- To avoid security popups in Microsoft Edge, you may add the SafeKit servers addresses into the Intranet or Trusted zone
- The messages in the web console are displayed in French or English languages, according to the selected language into the console
- After SafeKit upgrade, you must clear the browser's cache to get the new web console pages. A quick way to do this is a keyboard shortcut:
    1. Open the browser to any web page and hold `CTRL` and `SHIFT` while tapping the `DELETE` key
    2. A dialog box will open to clear the browser. Set it to clear everything and click Clear Now or Delete at the bottom
    3. Close the browser, stop all background processes that may be still running and re-open it fresh to reload the web console

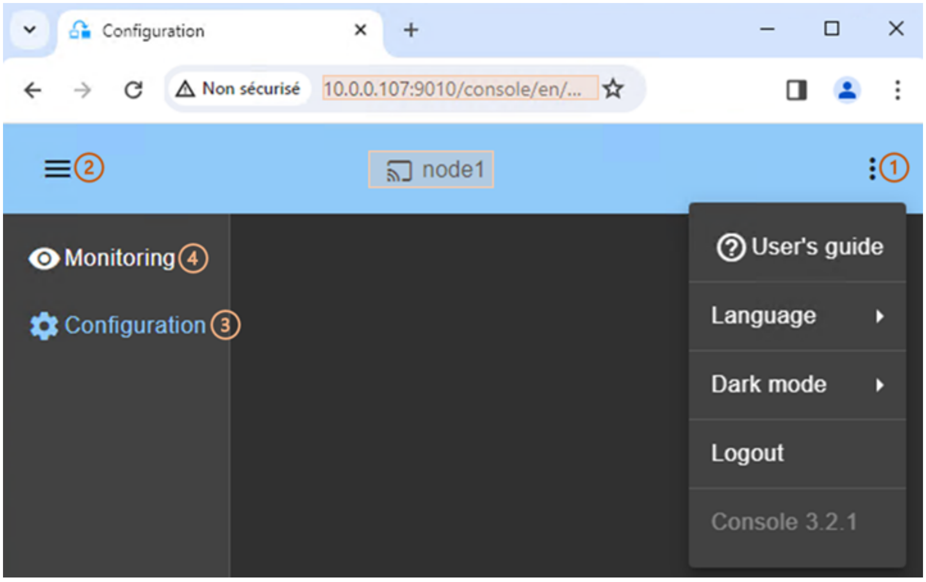
3.1.2 Connect to a SafeKit node

By default, access to the web console requires the user to authenticate himself with a name and password. On SafeKit install, you had to initialize it with the user `admin` and assign a password. This `admin` name and password are sufficient to access all the console's features. For more details on this configuration, see section 11.2.1.

1. Start a web browser (Microsoft Edge, Firefox, or Chrome)
2. Connect it to the URL http://host:9010 (where `host` is the name or IP address of one of the SafeKit servers). If HTTPS is configured, there is an automatic redirection to https://host:9453.
3. The SafeKit server to which the console is connected (`host` in the URL) is called the **connection node**. This node acts as a proxy to communicate on behalf of the console with all other SafeKit servers.

You can connect to any node of the cluster since the console offer global view and actions. On connection error with one node, connect to another node.

4. In the login page, enter `admin` as user's name and the password you gave on initialization (e.g., `pwd`).
5. The SafeKit web console is loaded



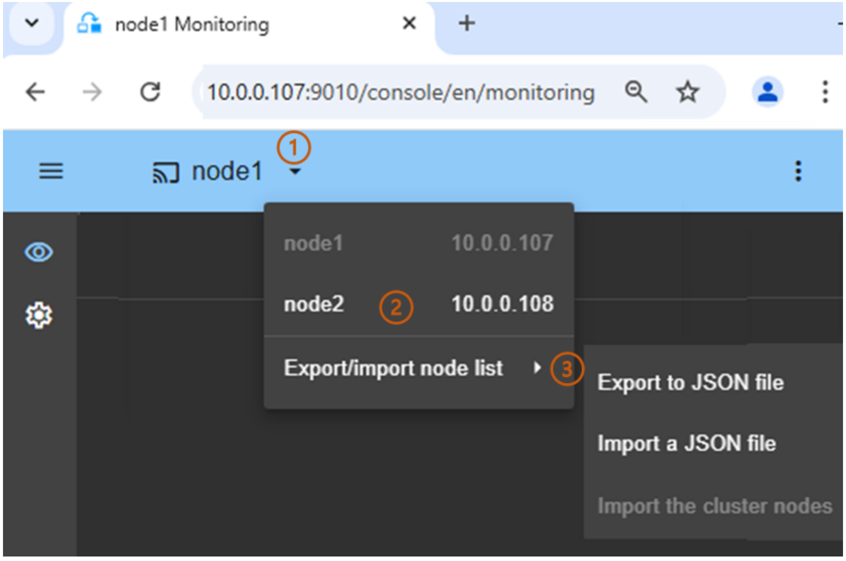
- When the console is connected to a SafeKit server on which the cluster is configured, the name of the node corresponding to the server (as defined in the cluster configuration) is displayed in the header. This is the **connection node** (`node1` in the example). If the cluster is not yet configured, no name is displayed.
- Click on ⋮ to open the menu to read the SafeKit User's Guide, select the language, enable/disable the dark mode and logout.
- Click on ≡ to collapse or expand the navigation sidebar.
- Click on ⚙ "Configuration" to configure the cluster and the modules. Configuration is only authorized to users that have Admin role. By default, the `admin` user has the Admin role.

- (4) Click on "Monitoring" to monitor and control the configured modules. Monitoring is authorized to users that have Admin, Control and Monitor roles. With Monitor role, actions on modules (start, stop…) are prohibited.

The web console offers contextual help by clicking on the ⓘ icon.

3.1.3 List of connection nodes

The console offers the ability to easily switch connection node, even if the node belongs to a different cluster.



- (1) Click on ▾ to display the list of connection nodes.

  By default, if the cluster is configured, it lists all the nodes belonging to the cluster. Otherwise, this menu is unavailable.
- (2) For example, click on node2 to connect the web console to node2. This is a shortcut for changing the URL in the browser. The web console is loaded from this node, which becomes the connection node.
- (3) Click on ▸ to open the submenu that allows to:
  - Export the list of connection nodes to a JSON file on your workstation.

    It contains the names and addresses of the nodes in the list.
  - Import the list of connection nodes from a JSON file on your workstation.

    Use the exported JSON file as a template and define your own list of connection nodes. This can be used if you wish to manage nodes belonging to different SafeKit clusters. You can also define a cluster name to which the nodes belong.
  - Import the cluster nodes

    Use this option to reset an imported list and restore the default list, which contains only the nodes defined in the cluster of the node to which the console is connected.

3.2 Configure the cluster

The SafeKit cluster must be defined before installing, configuring, or starting a SafeKit module. A Safekit cluster is defined by a set of networks and the addresses, on these networks, of a group of SafeKit servers, named nodes. These nodes implement one or more modules. Each server is not necessarily connected to all the networks, but at least one.

The cluster configuration is saved on the servers' side into the `cluster.xml` file (see section 12). For a correct behavior, it is required to apply the same cluster configuration on all the nodes.

> You must fully define the cluster configuration before installing and configuring modules since the modification of the cluster can affect the configuration or the execution of installed modules.

The cluster configuration home page is available :

- Directly via the URL http://host:9010/console/en/configuration/cluster

Or

- By navigating the console via "Configuration/Cluster configuration"

If the cluster is not yet configured, the cluster configuration wizard is automatically opened.

3.2.1 Cluster configuration wizard

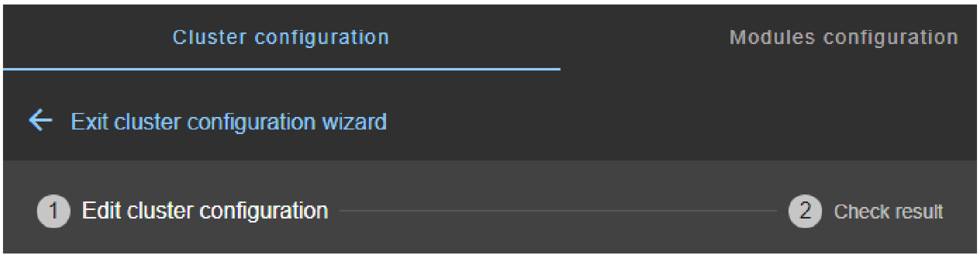
Open the configuration wizard:

- Directly via the URL http://host:9010/console/en/configuration/cluster/config

Or

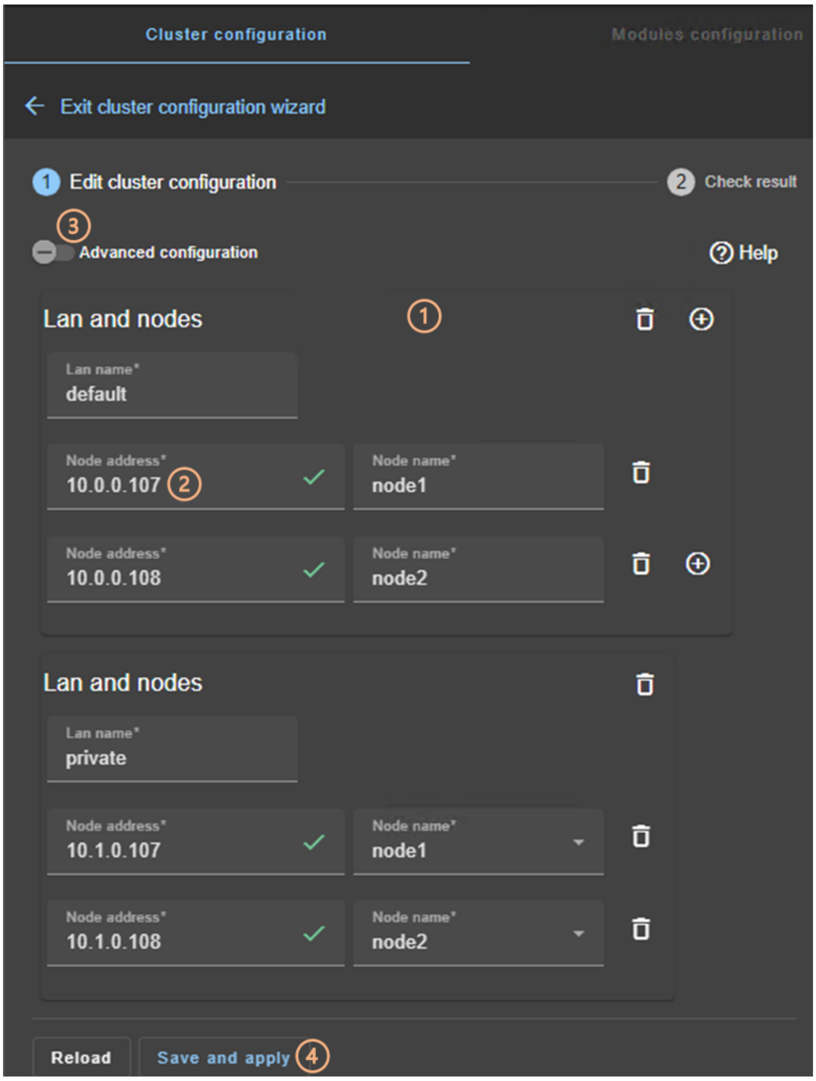
- Navigate in the console via "Configuration/Cluster configuration/ Configure the cluster/"

The cluster configuration wizard is a step-by-step guided form:



1. "Edit cluster configuration" described in section 3.2.1.1
2. "Check result" described in section 3.2.1.2
3. ← to "Exit cluster configuration wizard"

3.2.1.1 Edit cluster configuration



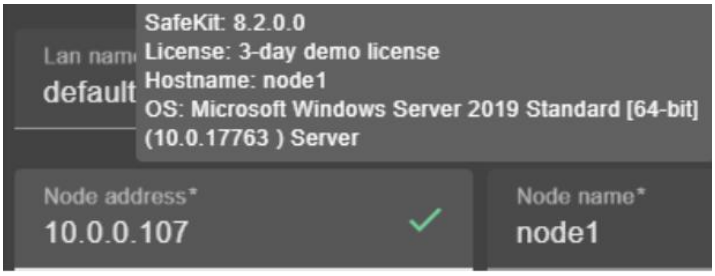
- (1) Fill in the form to first assign a user-friendly name for the network. This name is used for configuring heartbeat networks used by a module.

  Click on ⊕ to add another node/lan or on 🗑 to remove the node/lan from the cluster.

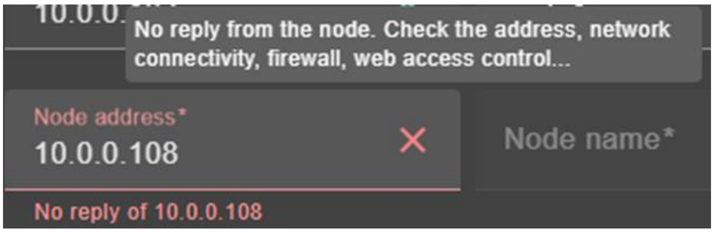
When a node/lan is removed from the cluster, all modules using it in its configuration may become unusable.

- (2) Fill in the IP address of the node and then press the Tab key to check the server connectivity and automatically insert the server hostname.

The icon next to the address reflects the reachability of the node.



means that the SafeKit server is available. The tooltip gives information on the server.



means that there was no reply from the server within the timeout delay. Fix the problem to be able to administer this node. It may be a bad address, a network or host failure, a bad configuration of the web browser or the firewall, the stop of the SafeKit web service on the node. For solving the problem, refer to the section 7.1.

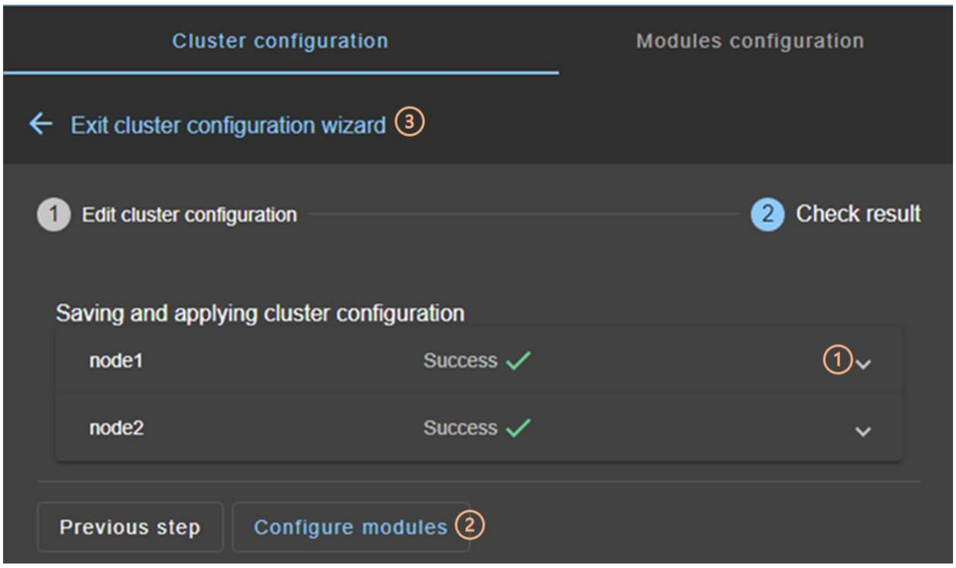
- Change the node name if necessary. This name is the one that will be used by the SafeKit administration service for uniquely identifying a SafeKit node. It is also the one displayed into the SafeKit web console.
- (3) If you prefer, click on "Advanced configuration" to switch to XML cluster editing.

  Click on ⓘ to open the SafeKit User's Guide on the configuration description in the `cluster.xml` file.
- Click on "Reload" to discard your current modifications and reload the original configuration.
- (4) Once the edition is completed, click on "Save and Apply" to save and apply the edited configuration to all nodes in the cluster.

If required, you can reapply the configuration to all nodes without modifying it.

For examples of cluster configurations with two networks refer to section 15.1.1; with three nodes refer to section 15.2.1.

3.2.1.2 Check result



- (1) Read the result of the operation on each node:
  - "Success" means the configuration was successful.
  - "Failure" means the configuration has failed. Click to read the output of commands executed on the node and search for the error. You may need to modify the parameters entered or connect to the node to correct the problem. Once the error has been corrected, "Save and apply" again.
- (2) Click on "Configure modules" to exit the cluster configuration wizard and navigate to modules configuration.

Or

- (3) Click on ← to "Exit the cluster configuration wizard" and navigate to the cluster configuration home page

3.2.2 Cluster configuration home page

When the cluster is configured, the cluster configuration home page is available.

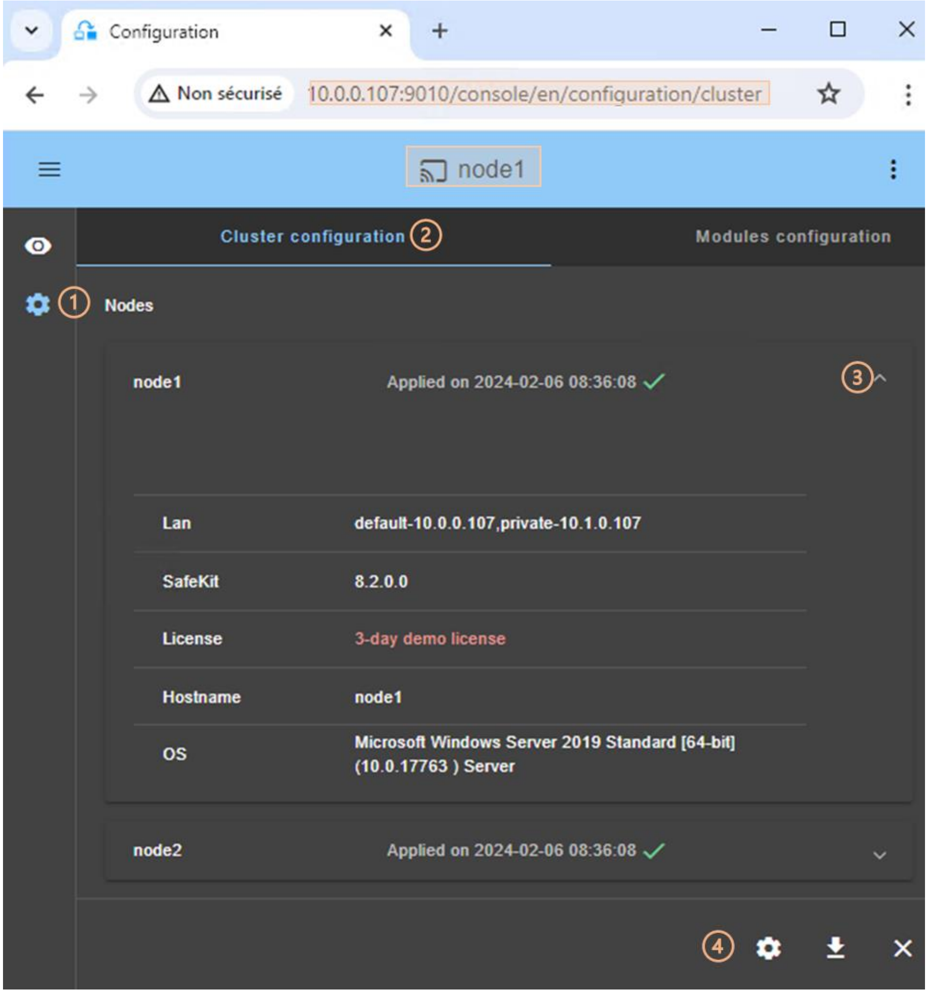
Open it:

- Directly via the URL http://host:9010/console/en/configuration/cluster

Or

- By navigating the console via "Configuration/Cluster configuration"

In this example, the console is loaded from `10.0.0.107`, which corresponds to `node1` in the existing cluster. This is the connection node.



- (1) Click on ⚙"Configuration" in the navigation sidebar
- (2) Click on "Cluster configuration" tab

  Nodes configured in the cluster are listed with their configuration date.
- (3) Click on ﹀ to display details about the node: networks name and addresses defined in the cluster configuration, SafeKit version, license key, hostname, OS.
- (4) Click on one of the buttons:
  - ⚙ to modify the cluster configuration and/or re-apply it. This opens the cluster configuration wizard and loads the cluster configuration from the connection node.
  - ⤓ to download the cluster configuration in XML format from the connection node.
  - ✕ to unconfigure the cluster on one or more nodes

3.3 Configure a module

Once the cluster has been set up, you can configure a new module on the cluster. The module configuration home page is accessible :

- Directly via the URL http://host:9010/console/en/configuration/modules

Or

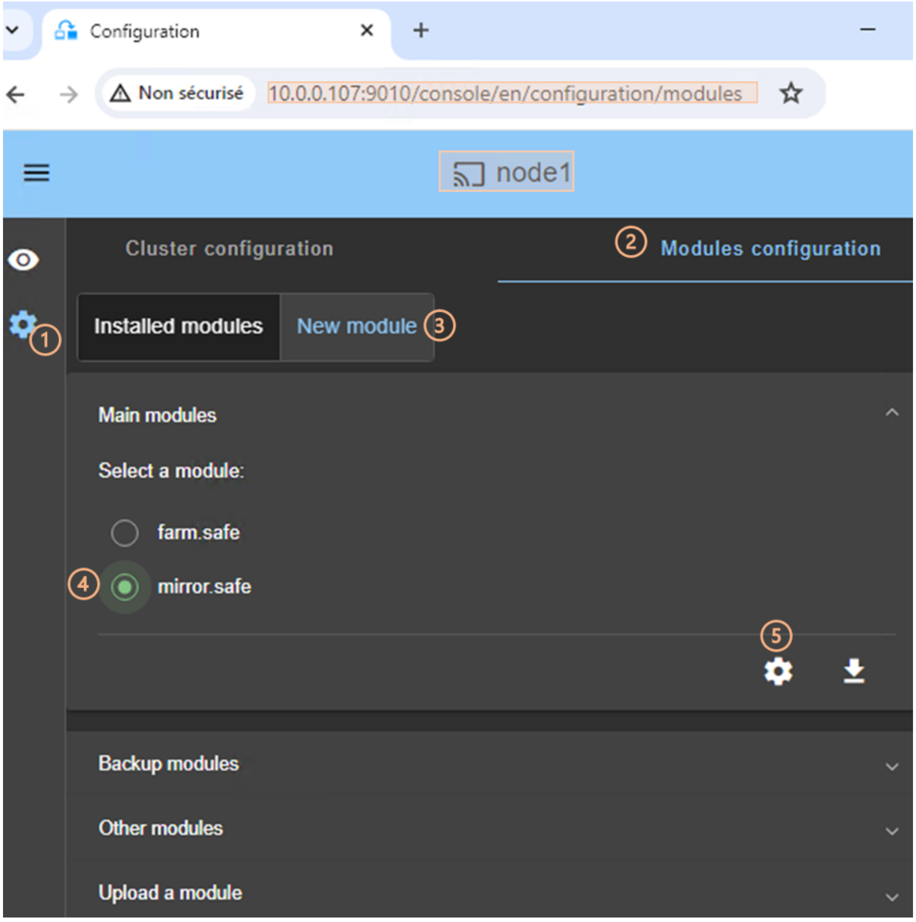
- By navigating the console via ⚙"Configuration/Modules configuration"

If no module has been configured, the console automatically presents the page for configuring a "New module".

For module configuration examples refer to section 15.

3.3.1 Select the new module to configure

In this example, the console is loaded from `10.0.0.107`, which corresponds to `node1` in the existing cluster. This is the connection node.



- (1) Click on "Configuration" in the navigation sidebar
- (2) Click on "Modules configuration" tab
- (3) Click on "New Module"

  The page proposes to select a new module among several proposals visible by clicking on :

  - the "Main modules", including the generic `mirror.safe` (refer to section 15.1.2) and `farm.safe` (refer to section 15.2.2) modules for integrating a new application into a mirror or farm architecture.

    Here are the modules stored on the connection node, `node1`, under `SAFE/Application_Modules/generic`, `SAFE/Application_Modules/demo` and `SAFE/Application_Modules/published`.

- o "Backup modules" archived on the connection node, which are saved when a module is uninstalled on this node.

  They are loaded from `node1` under `SAFE/Application_Modules/backup`.

- o "Other modules" which are examples of SafeKit features used in modules supplied for testing purposes only. Refer to section 15 for the description some of them.

  They are loaded from `node1` under `SAFE/Application_Modules/other`.

- o A locally stored module accessible from "Upload module".

  This feature can be used to configure a module for a given application (e.g., Microsoft SQL Server, PostgreSQL…) downloaded from one of the SafeKit quick installation guides.

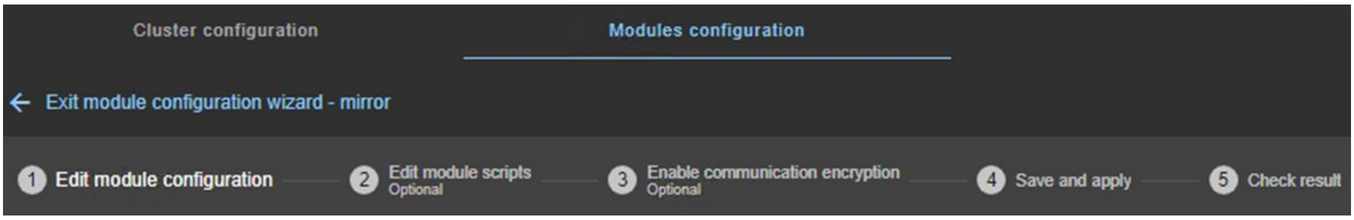
- (4) Select a module to configure from those listed above. In the example, `mirror.safe`.
- (5) Click on the button ⚙Configure the new module.
- A dialog opens to give the new module name

- (6) Enter the name of the new module.
- (7) Click on "Confirm"

The module configuration wizard is opened. This is described below.

3.3.2 Module configuration wizard

The module configuration wizard is a step-by-step guided form.:



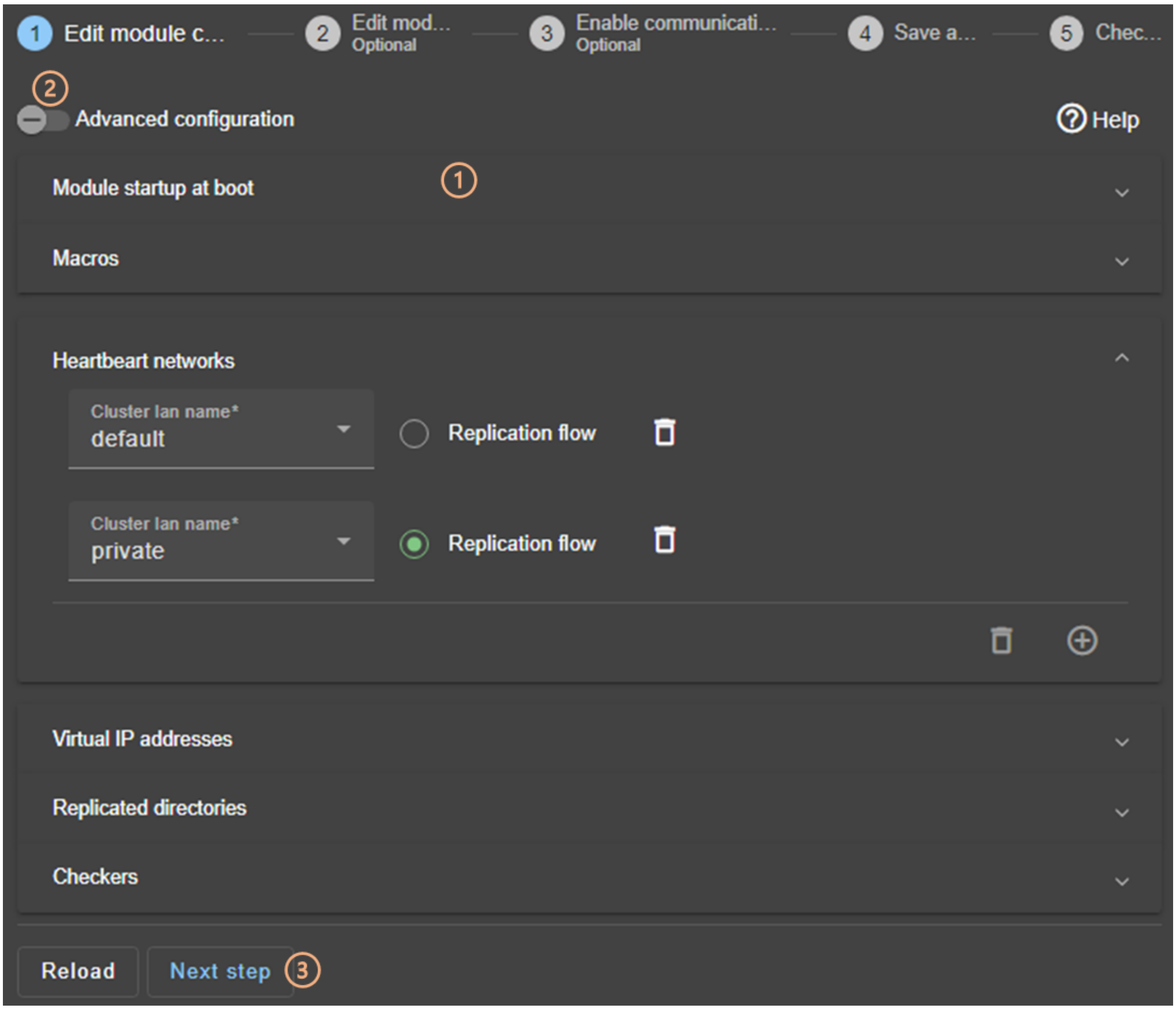
1. "Edit module configuration" described in section 3.3.2.1
2. "Edit module scripts (Optional)" described in section 3.3.2.2
3. "Enable communication encryption (Optional) " described in section 3.3.2.3
4. "Save and apply" described in section 3.3.2.4
5. "Check result" described in section 3.3.2.5
6. ← to "Exit module configuration wizard"

Note that module reconfiguration can only be applied to nodes on which the module in question is not started. Therefore, stop the module before starting the configuration wizard.

If needed, you can reapply the module configuration on all nodes without modifying it.

3.3.2.1 Edit module configuration

Below is an example of editing the `mirror.safe` module configuration.



- (1) Fill in the form to assign values to the various components, add or remove them. Click on ⌄ to open the detailed panel for each component.

  This form is used to enter only the main module configuration parameters.

The names of the "Heartbeat networks" proposed are the names of the lans entered during cluster configuration.

- (2) For advanced module configuration, exhaustive compared to the form, click on "Advanced configuration". This switches to editing the module configuration file in XML format, `userconfig.xml`.

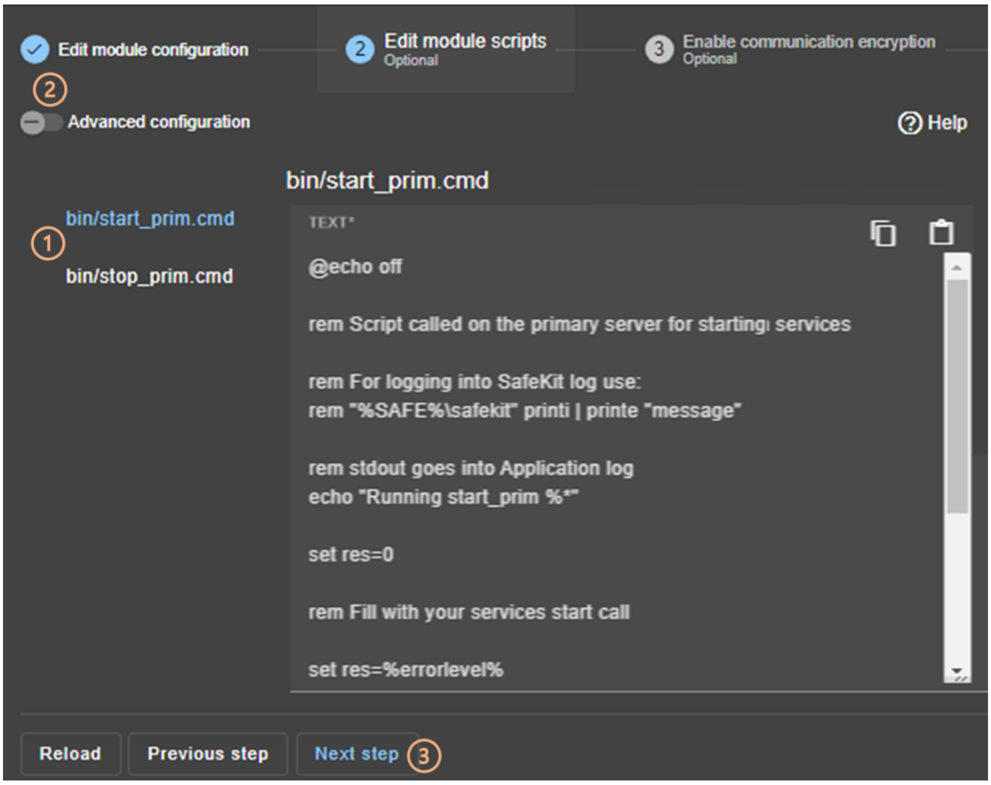
Click on ⓘ to open the SafeKit User's Guide describing the configuration of the various components in the `userconfig.xml` file.

- If necessary, click on "Reload" to discard your modifications and reload the complete original configuration (including scripts if these were modified in the next step).
- (3) Once you have finished editing the module configuration, click on "Next step".

For examples of mirror module configuration, refer to section 15.1.2 ; of farm module configuration, refer to section 15.2.2.

3.3.2.2 Edit module scripts

Below is an example of editing the `mirror.safe` module scripts.



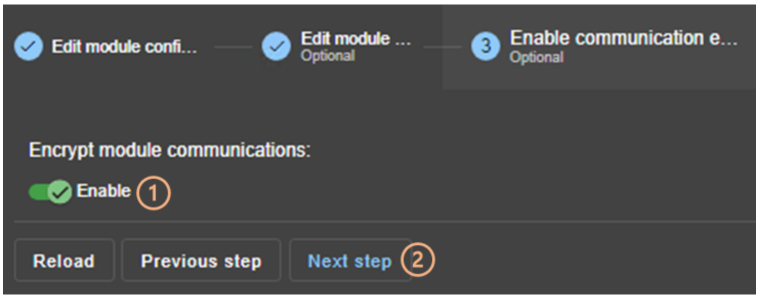
- (1) Click on "start_prim" or "stop_prim" to edit it and insert your application start/stop.

  Click on ⧉ to copy the content and edit it with your favorite syntax editor. Once done, paste the modified content into the input field with 📋.
- (2) If necessary, click on "Advanced configuration" to list the other module's scripts and edit them (`prestart`, `poststop`, scripts for checkers…).
- Click on ⓘ to open the SafeKit User's Guide describing the module scripts.
- If necessary, click on "Reload" to discard your modifications and reload the complete original configuration (including the module configuration if it was modified in the previous step).
- (3) Once you have finished editing the module scripts, click on "Next step".

For examples of mirror module scripts, refer to section 15.1.3 ; of farm module scripts, refer to section 15.2.3.

3.3.2.3 Enable communication encryption

Encryption of internal module communications between cluster nodes is enabled by default. For details, see section 10.7.



- (1) Click "Enable" to enable or disable encryption of module communications.

When the module's encryption key is not identical on all nodes, internal communication is impossible. The configuration must be reapplied to all nodes to propagate the same key.

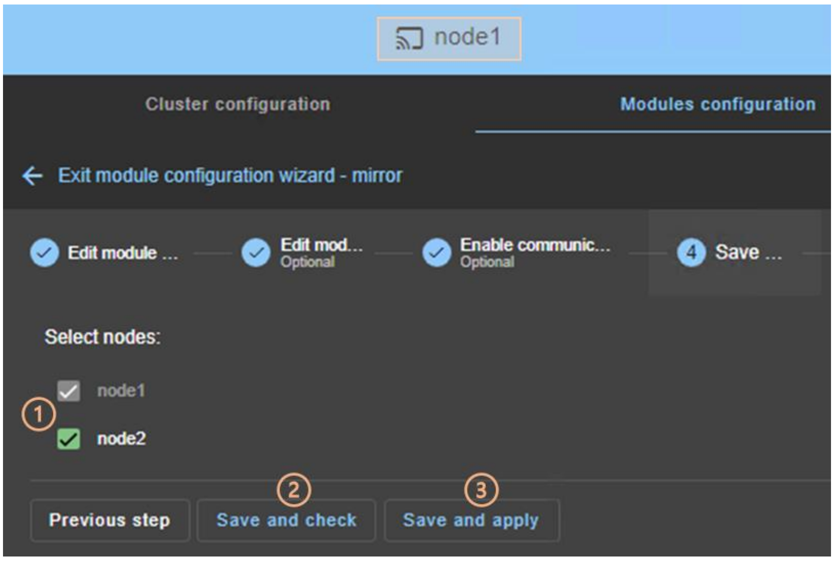
To generate new encryption keys, you need to:

1. disable encryption, then "Save and apply" configuration to all nodes
2. enable encryption, then "Save and apply" configuration to all nodes

- If necessary, click on "Reload" to discard your modifications and reload the complete original configuration (including the module configuration and scripts if these were modified in the previous steps).
- (2) Once this step is complete, click on "Next step".

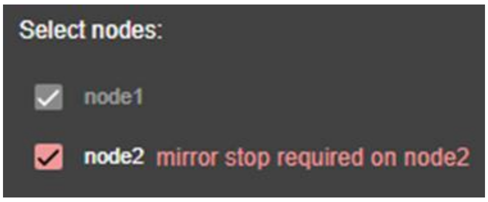
3.3.2.4 Save and apply

Step to select the nodes affected by the configuration.

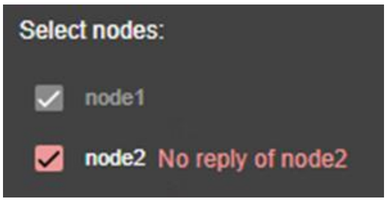


- (1) Check/uncheck to select/unselect nodes. Please note that the connection node (`node1` in the example) is mandatory.

  There are 2 cases where "Save and Apply" is disabled:



The module on the selected node is started and, in a state, other than `STOP` (`NotReady`).



There was no reply from the node within the timeout delay. It may be a bad address, a network or host failure, a bad configuration of the web browser or the firewall, the stop of the SafeKit web service on the node. For solving the problem, refer to the section 7.1.

  In both cases, uncheck the node or click on "Save and check" to apply it later, after stopping the module or solving the communication problem.

- (2) Click on "Save and check" to save the edited configuration on the connection node and check its consistency. It then proceeds to the next step to display the result of this operation.

  Once this operation has been completed, any changes are saved on the connection node. The configuration wizard can be exited and relaunched later to apply the saved configuration. Until the saved configuration is applied, the last applied configuration of the module remains active.

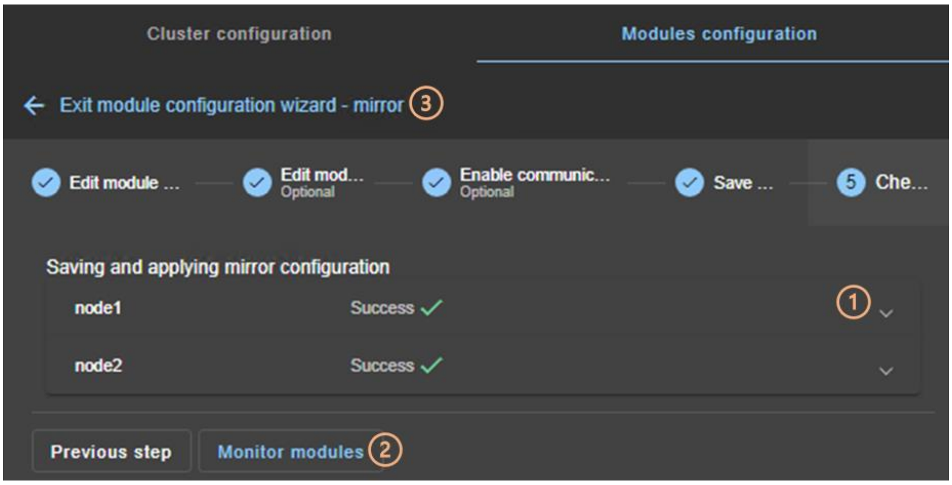
- (3) Click on "Save and apply" to save and apply the edited configuration on selected nodes. It then proceeds to the next step to display the result of this operation.

  If this operation is successful, the applied configuration becomes the active one for the module.

> On the server side, the module configuration is saved under `SAFE/modules/`*`AM`*(where *AM* is the module name). When reconfiguring a module, this directory is deleted and overwritten with the changes made in the console. Thus, on the servers' side, you must close all editors, file explorers, shells or cmd under `SAFE/modules/`*`AM`* before applying the configuration (otherwise there is a risk that the apply fails).

3.3.2.5 Check result

The example below shows the result of the "Save and Apply" operation. The layout for "Save and Verify" is similar.



- (1) Read the result of the operation on each node:
  - "Success"✓ means the operation was successful.
  - "Failure"✗ means the operation has failed.

    Click to read the output of commands executed on the node and search for the error. You may need to modify the parameters entered or connect to the node to correct the problem. Once the error has been corrected, repeat the operation from the previous step.
- (2) Click on "Monitor modules" to exit the module configuration wizard and navigate to modules monitoring.

Or

- (3) Click on ← to "Exit the module configuration wizard" and navigate to the modules configuration home page.

3.3.3 Modules configuration home page

Once the first module has been configured, the module configuration home page is available. It allows you to view the modules installed on the cluster and to access the configuration of a new module.

Open it:

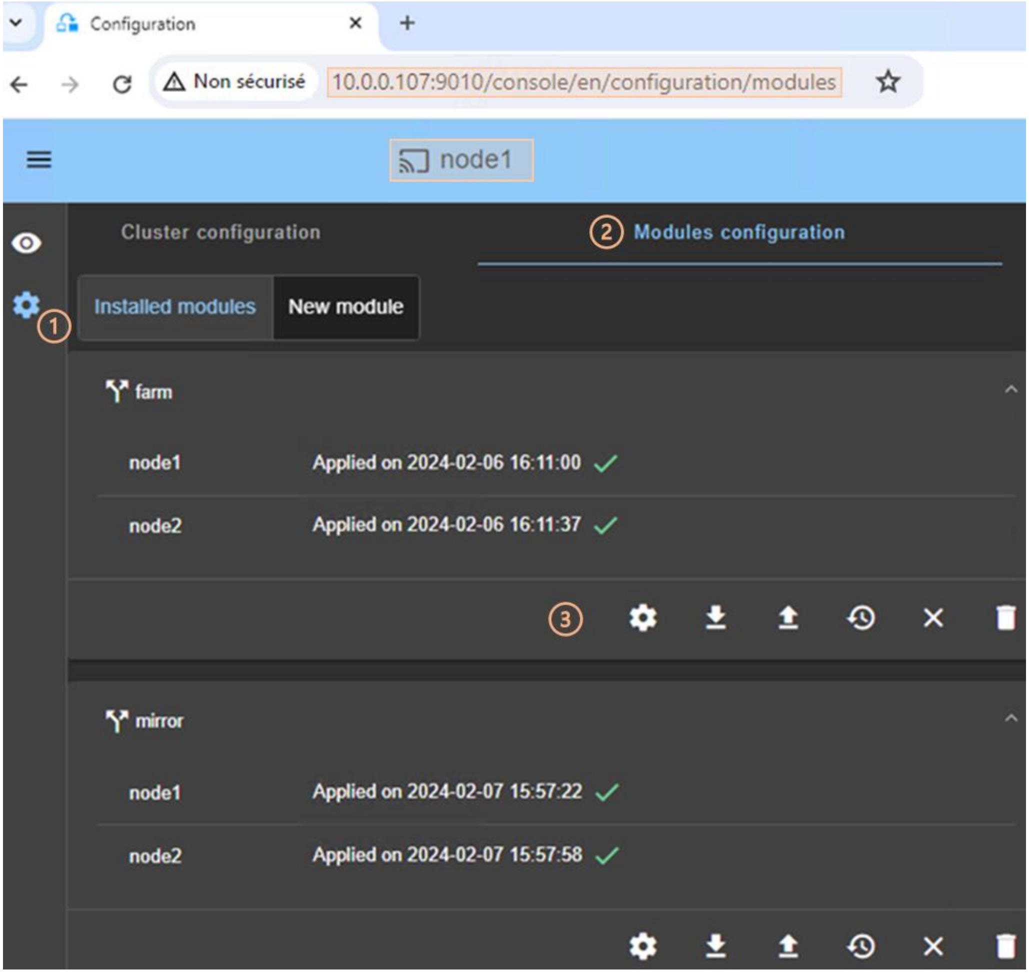
- Directly via the URL http://host:9010/console/en/configuration/modules

Or

- By navigating the console via "Configuration/Modules configuration"

Before each reconfiguration, deconfiguration and uninstallation, on each node, close all editors, file explorer, shells or cmd under `SAFE/modules/`*`AM`* (or risk the operation failing).

In the following example, the console is loaded from `10.0.0.107`, which corresponds to `node1` in the existing cluster. This is the connection node.



- (1) Click on ⚙"Configuration" in the navigation sidebar.
- (2) Click on "Modules configuration" tab.
- Modules installed on the cluster are listed with the date the configuration was applied and, if applicable, the date the configuration was saved but not yet applied.
- (3) Click on one of the buttons associated with the module:
  - ⚙ to modify its configuration or reapply its current configuration. This opens the module configuration wizard and loads its current configuration from the connection node.
  - ⤓ to download the `.safe`, consisting of all module files (`userconfig.xml`, scripts) from the connection node.
  - ⤒ to reconfigure the module from the contents of a locally stored `.safe`.
  - ⟲ to restore a previous module configuration.
  - SafeKit keeps a copy of the last three successful configurations (stored under `SAFE/modules/lastconfig` on the server side). All module configuration files are packaged in a `.safe` file, whose name is of the type of *`AM`*`_<date>_<time>` (where *`AM`* is the module name).
  - ✕ to remove internal files for the module on one or more nodes, without uninstalling it. The user configuration files are kept for later re-application.
  - 🗑 to completely uninstall the module on one or more nodes.

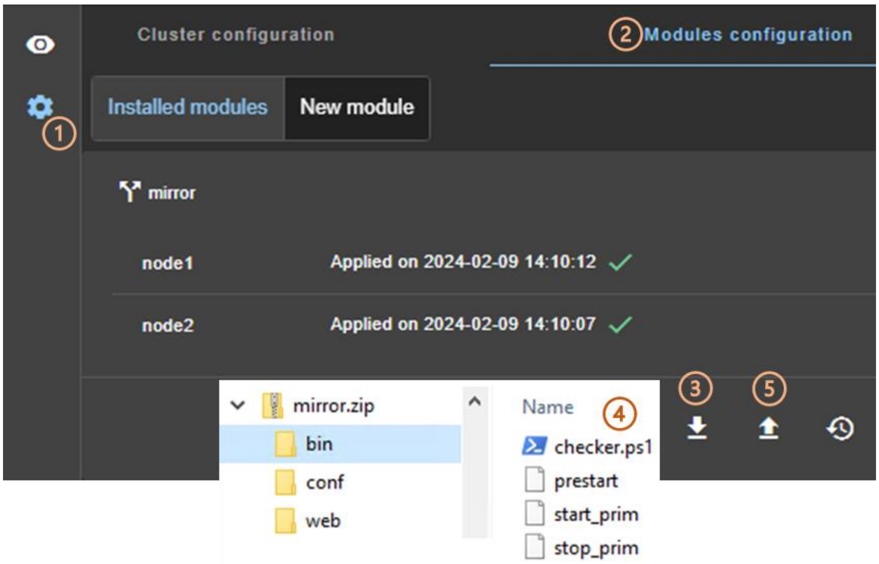
All module configuration files are packaged in a `.safe` file, which is archived on the server side under `SAFE/Application_Modules/backup`.

- To configure a new module, click on "New module"

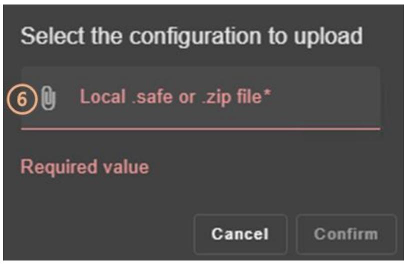
3.3.4 Edit the module configuration locally and then apply it

You may prefer to use your favorite editor to modify the module's configuration file and scripts or may need to add module scripts, such as custom checkers.

Follow the procedure below to modifye the module's configuration on your workstation and then apply it.



- (1) Click on "Configuration" in the navigation sidebar.
- (2) Click on "Modules configuration" tab.
- (3) Click on to download the `mirror.safe` on your workstation.
- (4) Extract the content of `mirror.safe`, that is a zip file, to edit `userconfig.xml`, add/delete/edit module scripts into the `bin` directory (add a custom checker for instance).
- (5) Compress the modified directory into `xx.safe` (or `xx.zip`) then upload it with (.safe and .zip extension are accepted).



- (6) Click on to select the file to be uploaded then "Confirm".

The module configuration wizard is launched with the contents of this file. The new contents are visible into the wizard. Got to step 4 to "Save and apply" this new configuration.

3.4 Monitor a module

Once a module is configured, you can monitor its state and run actions on it (start, stop…).

The modules monitoring home page is accessible :

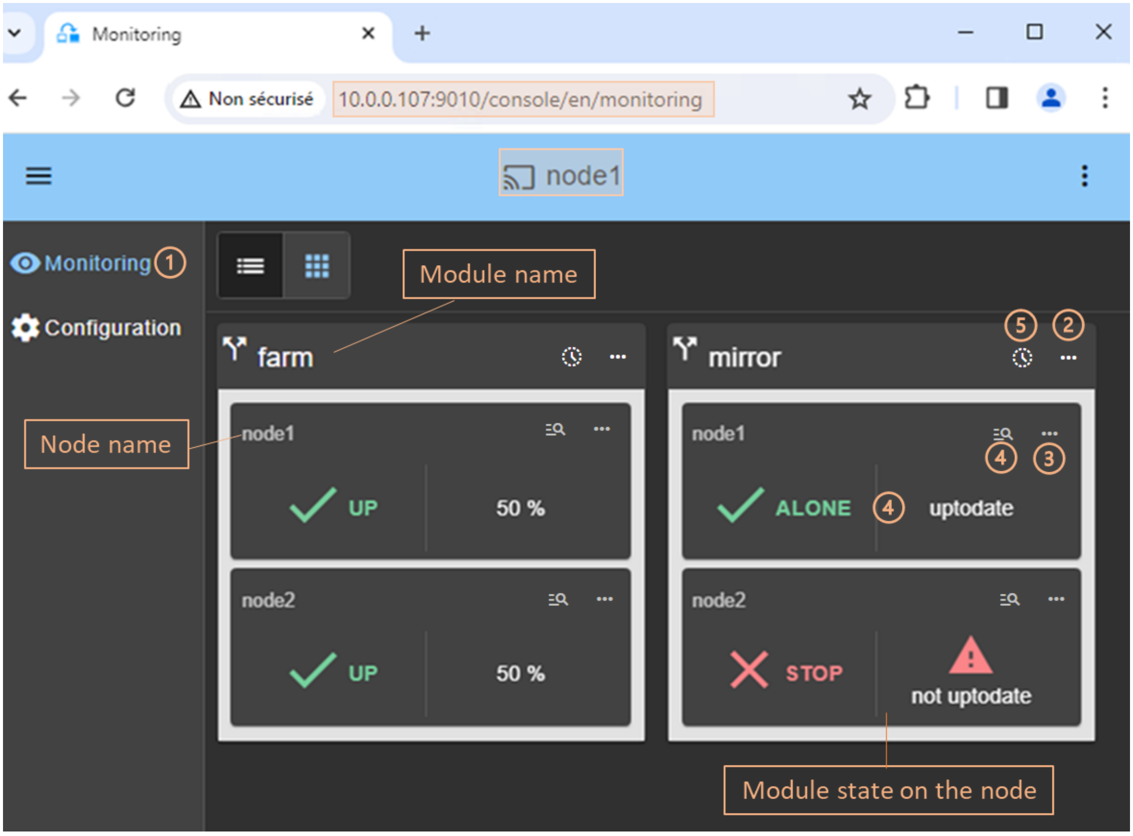
- Directly via http://host:9010/console/en/monitoring

Or

- By navigating the console via “Monitoring”

3.4.1 Monitoring home page

In this example, the console is loaded from `10.0.0.107`, which corresponds to `node1` in the existing cluster. This is the connection node. Two modules are configured: `farm` and `mirror`.



- (1) Click on “Monitoring” in the navigation sidebar

  For each installed module, it displays:
  - the module name and nodes name on which it is installed
  - the module state on the node
  - a notification on state change if the user has allowed them, and the URL is https or http://localhost

  For a description, see section 3.4.2.

- (2) Click on ••• to open the menu of global actions (start, stop…) on the module that apply on all nodes (`node1`, `node2` in the example).

For a description, see section 3.4.3.1.

- (3) Click on ••• to open menu of actions (start, stop…) on the module that applies only to the node (`node1` in the example).

  For a description, see section 3.4.3.2.

- (4) Click on the node panel (`mirror>node1` in the example) to open details for the module on this node (logs, resources…). Since SafeKit 8.2.2, Click instead on to open/close the details.

  For a description, see section 3.4.4.

- (5) Click on to open/close the module states timeline on all nodes where it is installed. Available since SafeKit 8.2.2.

  For a description, see section 3.4.5.

3.4.2 Module state

The module is represented real-time display of its synthetic and detailed states on the left and right panels.

3.4.2.1 Synthetic state

The console displays one of the following synthetic states for the module on the node:

`STOP (NotReady)(red)`	Module stopped (ready for starting)
`WAIT (Transient)(orange)`	Transient state of the module
`ALONE (Transient)(orange)`	Transient state of a mirror module, primary without secondary
`ALONE (Ready)(green)`	Stable state of a mirror module, primary without secondary
`PRIM (Transient)(orange)`	Transient state of a mirror module, primary with secondary
`PRIM (Ready)(green)`	Stable state of a mirror module, primary with secondary
`SECOND (Transient)(orange)`	Transient state of a mirror module, secondary with primary, during the synchronization of replicated directories
`SECOND (Ready)(green)`	Stable state of a mirror module, secondary with primary
`UP (Transient)(orange)`	Transient state of a farm module

✓ `UP (Ready)` (green)	Stable state of a farm module
`WAIT (NotReady)` (red)	Blocked state of the module, waiting for one or more resources
`NOT CONFIGURED (grey)`	Installed module but not configured
! `ERROR` (red)	The node did not respond within the given time limit.

This may be due to an incorrect address, a network or server failure, a misconfigured web browser or firewall, or the SafeKit web service being stopped on the node (see section 7.1). It may also be due to the temporary unavailability of the connection node. In this case, reload the console from another SafeKit node.

For details on state changes of a mirror module, see section 5.2.

For details on state changes of a farm module, see section 6.2.

3.4.2.2 Detailed state

It is the state of the main resources or failover rules.

`uptodate`	Replicated directories of the mirror module are uptodate
`not uptodate`	Replicated directories of the mirror module are not uptodate
`degraded`	The mirror module is in degraded mode described in section 7.6
`50%, 100%`	The network load share of the farm module (e.g. `50%` or `100%` with 2 nodes)
`0%`	No load share taken by the farm module
`c_checkfile`	The module applied the failover rule (e.g., the rule named `c_checkfile`) which triggers the actions `restart`, `stop`, `stopstart`, or `wait` on the module due to a resource going `down`. View section 13.18.4.2 for details on failover rules. To analyze the issue, read the logs and resource statuses as described below.

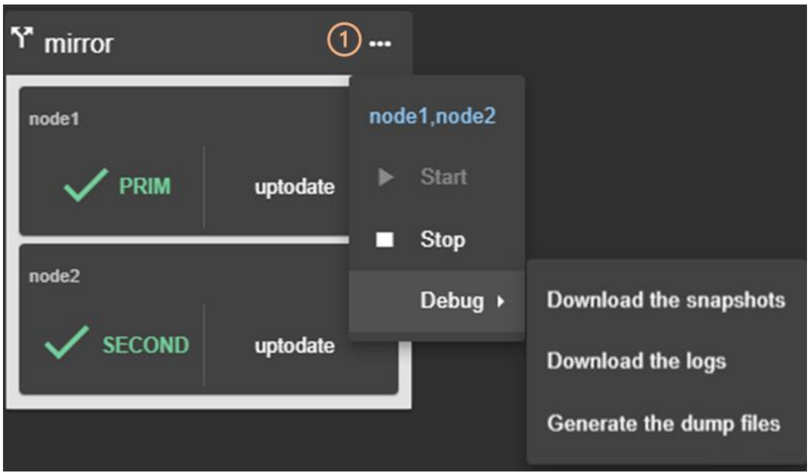
HTTP connection error	The module is in state ERROR (red) The node did not respond within the given time limit

3.4.3 Module control menus

3.4.3.1 Global menu

The actions of global menu apply to all nodes where the module is configured.

In the example below, actions apply to the module mirror on node1 and node2.



- (1) Click on ••• to open the module's global actions menu.
- Click on "Start" to start the module on all nodes.

  For mirror module, the node with the up-to-date replicated data is started as primary.
- Click on "Stop" to stop the module on all nodes.

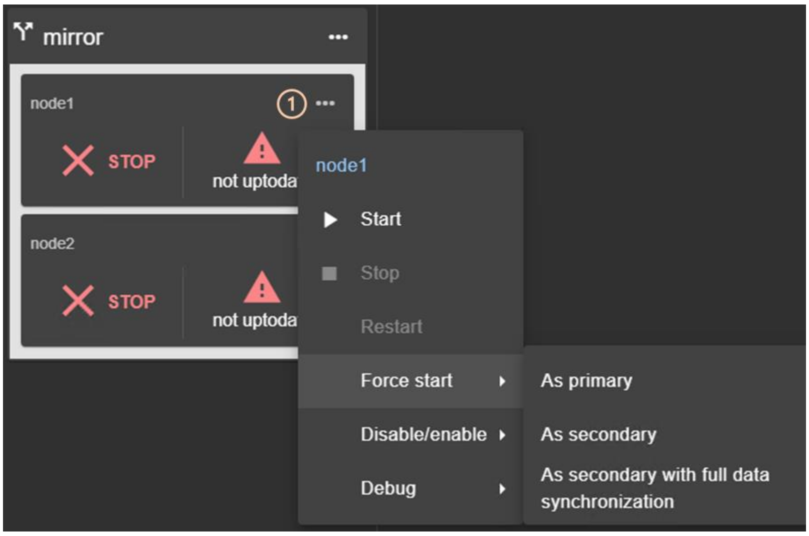
  For mirror module, the node that is secondary is stopped first to avoid unnecessary failover.
- Click on "Debug" for debug and support as described in section 3.5.

3.4.3.2 Local menu

The actions of local menu apply only to the selected node.

3.4.3.2.1 Control a mirror module

In the example below, actions apply to the module mirror on node1.



- (1) Click on ••• to open module's local actions menu on the desired node (e.g. `node1`).
- Click on "Start" to start the module on the node.

  For mirror module, the node is started as primary when replicated data are up-to-date. Otherwise, it is started as secondary. For details, see section 5.5.
- Click on "Stop" to stop the module on the node.
- Click on "Restart" to restart the module on the node.

  It only executes only stop then start scripts to locally restart the application without leading to a failover.
- Use "Force start" submenu when you need to decide if the node should start primary or secondary:
  - Select "Force start As Primary" to force the module to start as primary on this node.

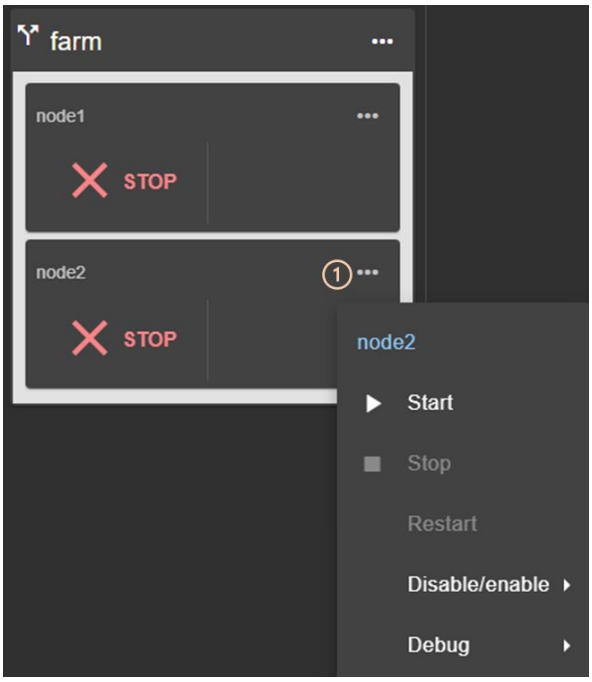
    For instance, on the 1st start of a mirror module as described in section 5.3, you must "Force start As primary" the node which has the up-to-date replicated folders.
  - Select "Force Start As secondary" to force the module to start as secondary on this node.

    Data synchronization can be optimized based on the module's last internal state.
  - Select "Force Start As secondary with full data synchronization" to start the module on this node as a secondary and to force a complete copy of the replicated data.
- Click on "Disable/enable" to control error detection as described in section 3.4.3.2.3.
- Click on "Debug" to download module logs or snapshots from this node rather than from all nodes as described in section 3.5.

To understand and check the correct behavior of a mirror module, see section 5. To test it, see section 4.

3.4.3.2.2 Control farm module

In the example below, actions apply to the module `farm` on `node2`.



- (1) Click on ••• to open module's local actions menu on the desired node (e.g. `node2`).
- Click on "Start" to start the module on the node.
- Click on "Stop" to stop the module on the node.
- Click on "Restart" to restart the module on the node.

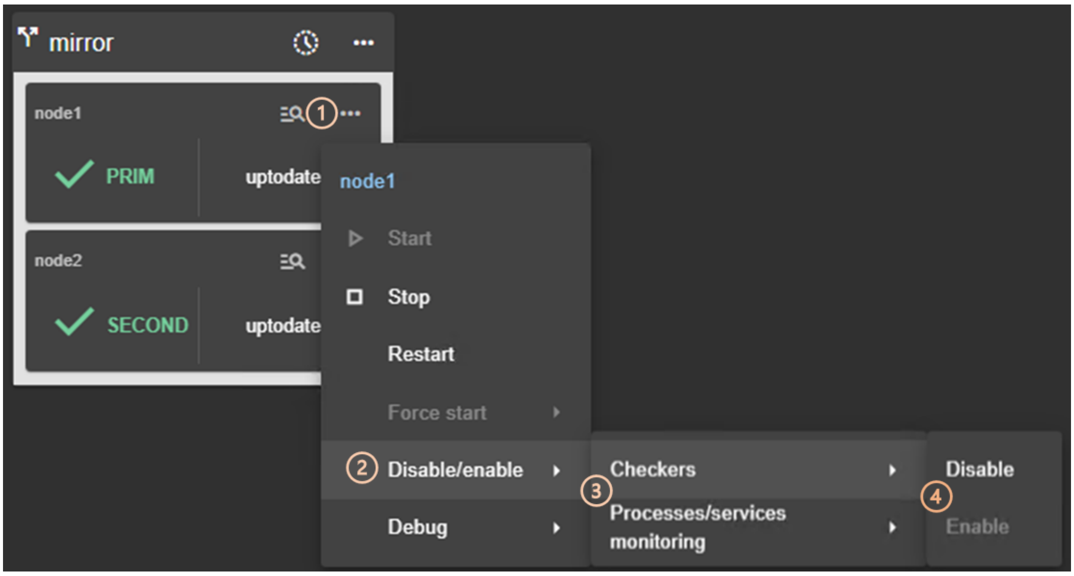
  It only executes only stop then start scripts to restart the application without leading to a failover.
- Click on "Disable/enable" to control error detection as described in section 3.4.3.2.3.
- Click on "Debug" to download module logs or snapshots from this node rather than from all nodes as described in section 3.5.

To understand and check the correct behavior of a farm module, see section 6. To continue the tests, see section 4.

3.4.3.2.3 Control checkers or processes/services monitoring

To avoid false error detection and automatic failover on application maintenance, you can disable configured checkers (TCP, ping, custom….) or processes/services monitoring. Once the maintenance is completed, they can be safely re-enabled. These actions can be applied while the module is started/stopped and are not reset when the module stops-starts.

In the example below, actions apply to the module `mirror` on `node1`.



- (1) Click on ••• to open the module's local actions menu on the desired node (e.g. `node1`).
- (2) Click on "Disable/enable" to open the submenu.
- (3) Click on "Checkers" or "Processes/services monitoring" to open the submenu.
- (4) Click on "Disable" to disable the error detection

  This disables all checkers (TCP, ping, custom….) or processes/services monitoring configured for the module.
- (4) Click on "Enable" to re-enable error detection by checkers or processes/services monitoring.

3.4.4 Module details

You can display details for a module on one node:

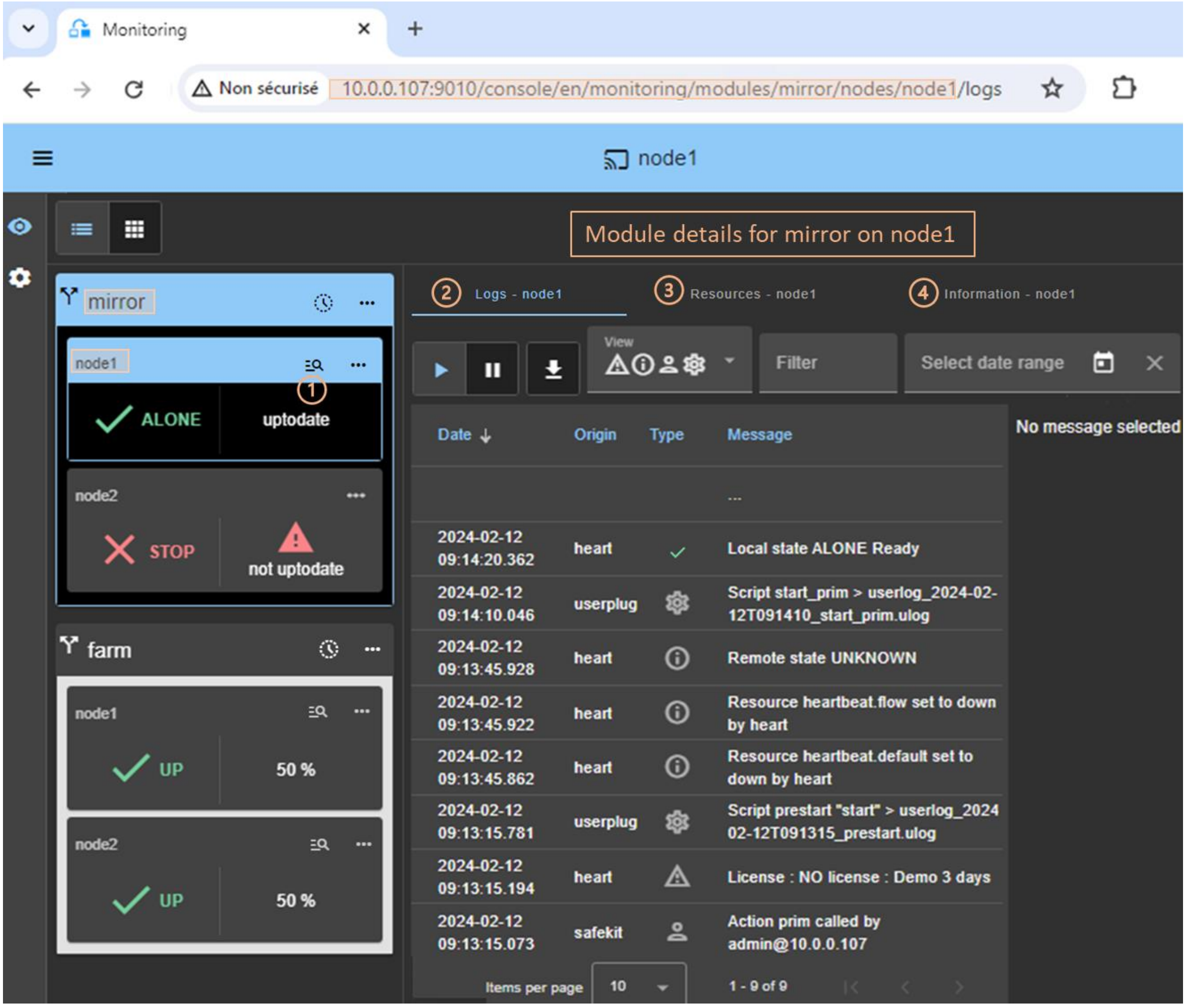
- Directly via the URL http://host:9010/console/en/monitoring/modules/*AM*/nodes/*node* (replace *AM* by the module name and *node* by the node name)

Or

- By navigating the console via "Monitoring/Click on for the module>node"

The selected module>node is highlighted with a blue color.

In the example, the detail for the module `mirror` on `node1` is displayed.



- Click on ≡Q to open/close details for the module on this node (logs, resources…).
- Click on "Logs" tab to visualize the module logs.
- Click on "Resources" tab to visualize the module resources.
- Click on "Information" tab to visualize information on the node: networks name and addresses defined in the cluster configuration, SafeKit version, license key, hostname, OS.

3.4.4.1 Module logs

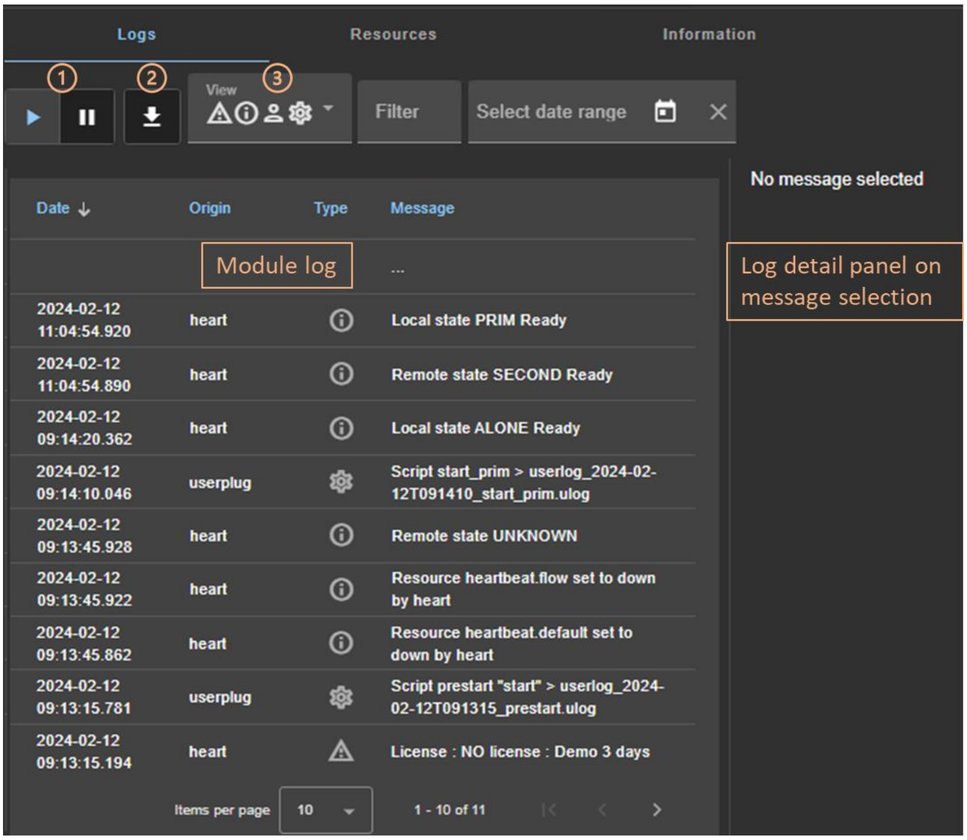
You can display logs of a module on one node:

- Directly via the URL http://host:9010/console/en/monitoring/modules/*AM*/nodes/*node*/logs (replace *AM* by the module name and *node* by the node name)

Or

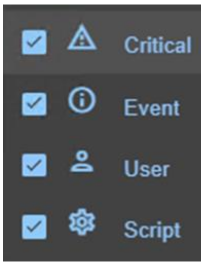
- By navigating the console via "Monitoring/Click on the module>node/Logs tab"

The left panel displays in real-time the non verbose module log for the selected module>node.



- Click on ▶II to resume/suspend the view in real time of the module log.

  Refer to section 7 for an explanation of main messages.
- Click on ⤓ to download the module log (verbose or not verbose).
- Select the message type to view:

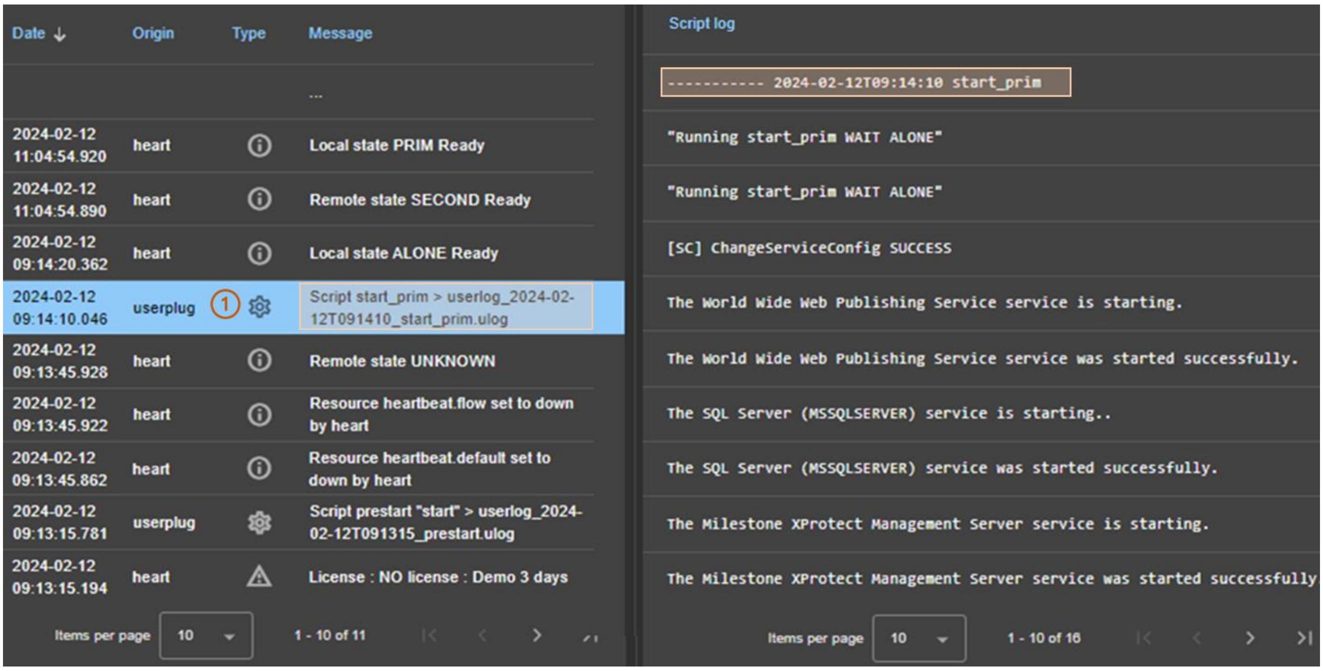


- C(ritical) messages such as error detection
- E(vent) messages such as local and remote states
- U(ser) messages when the user run action on the module
- S(cript) messages when module scripts are executed

- Click on a message to display the verbose module log or the script log (output of scripts) into the log detail into the right panel.

3.4.4.1.1 Script log

To display the script log, click on the ⚙S(cript) message whose output you want to view.

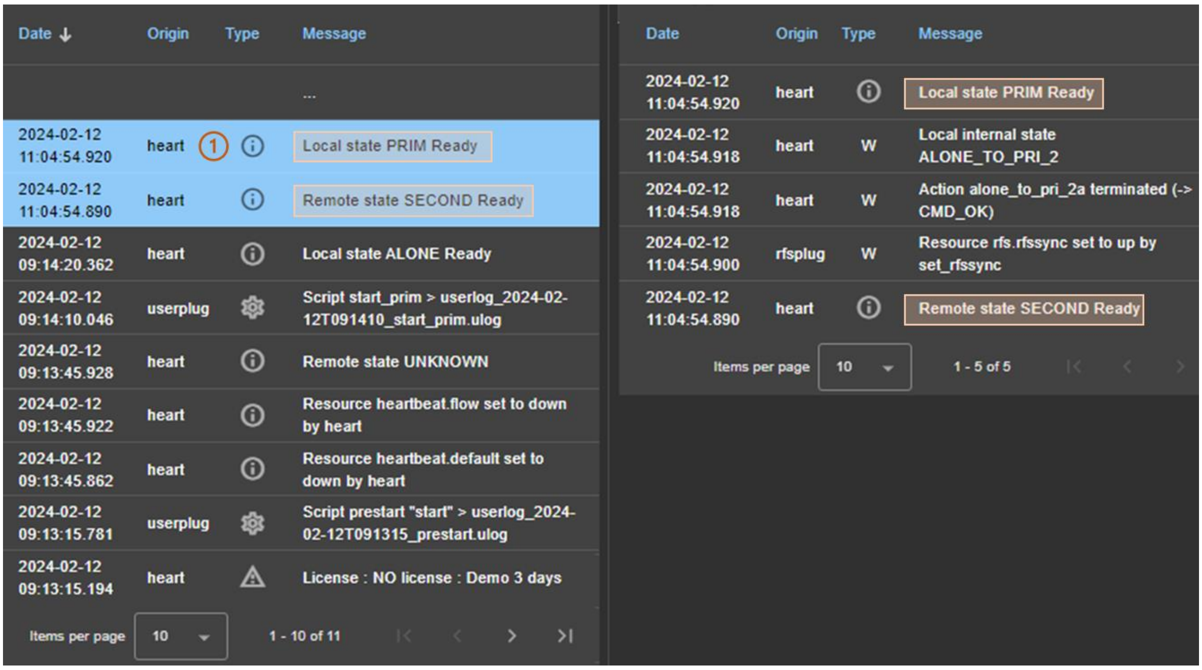


- (1) Click the S(cript) message consisting of:
    - the date and time of the execution of the script
    - the name of the script executed
    - the name of the name of the corresponding `userlog` file

The `userlog` file content is displayed into the right panel. In the example, it is the content of the file `SAFEVAR/modules/`*`AM`*`/userlog_2024-02-12T091410_start_prim.ulog` (where *`AM`* is the module name)

3.4.4.1.2 Verbose log

To display the verbose module log, click on a message other than S(cript).



- (1) Click the message consisting of:
  - the date and time of the event
  - the module message
- All verbose messages between the selected message and the previous one in the table are displayed in the right-hand panel.

3.4.4.2 Module resources

You can display resources of a module on one node:

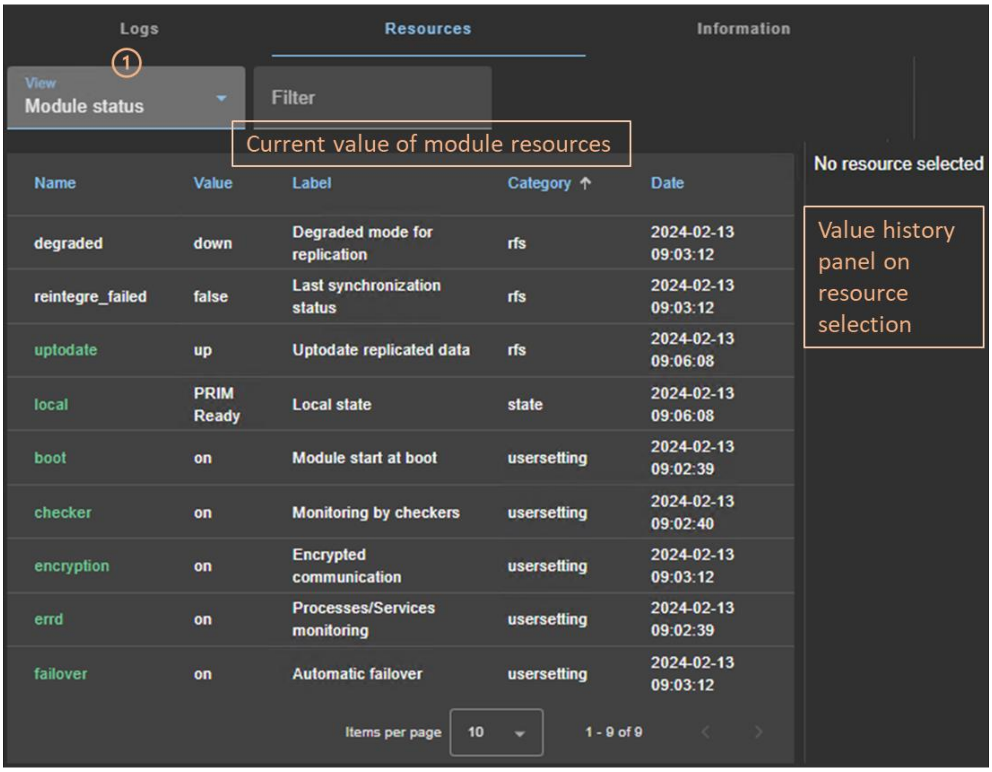
- Directly via the URL http://host:9010/console/en/monitoring/modules/*AM*/nodes/*node*/resources (replace *AM* by the module name and *node* by the node name)

Or

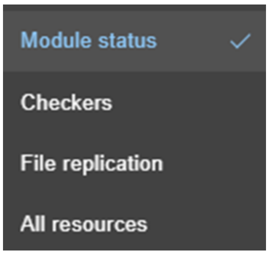
- By navigating the console via "Monitoring/Click on the module>node/Resources tab"

3.4.4.2.1 Ressources state

The left panel displays in real-time the current state of the resources for the selected module>node.



- (1) Select the group of resources to view:



- Module status

  Main resources, especially the ones of files replication for a mirror module
- Checkers

  Ressources set by checkers
- File replication

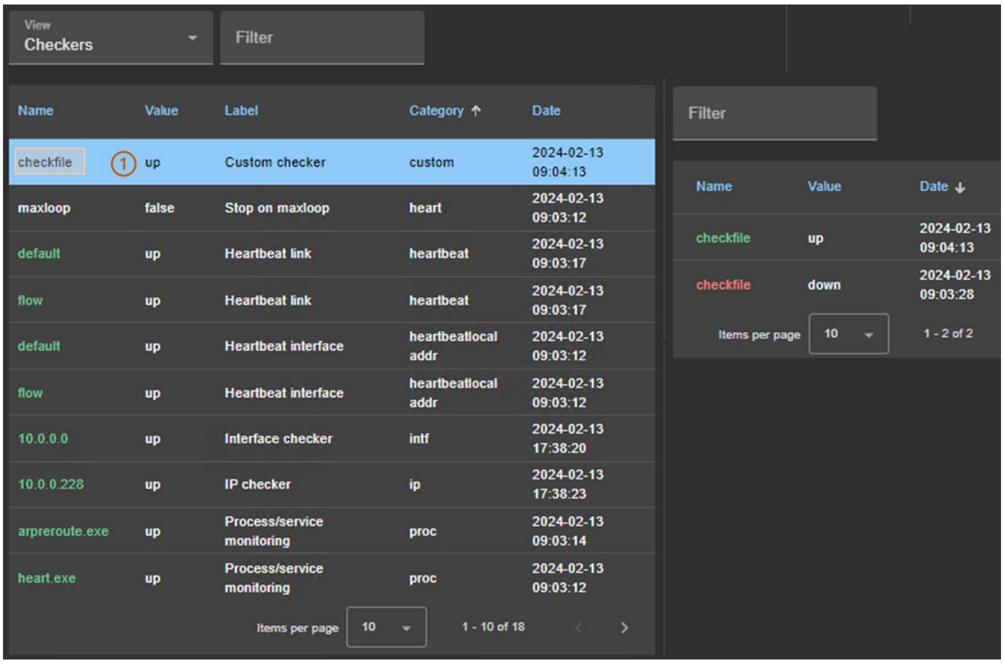
  File replication-specific resources that demonstrate synchronization progress
- All resources

- Click on a resource to display its value over time in the right panel. This history may be empty for some resources (unassigned or cleaned).

Resource's state is controlled by the failover machine to trigger a failover on failures (see section 13.18).

3.4.4.2.2 Resource's state value history

To display a resource's value history, click on the resource you're interested in.



- (1) Click on the line consisting of:
  - the last date the resource was assigned
  - the name and category of the resource. The full resource name is like `*category.name*` (`custom.checkfile` in the example).

The history of resource values is displayed in the right panel. In the example, this is the `custom.checkfile` resource corresponding to a resource assigned by a custom checker.

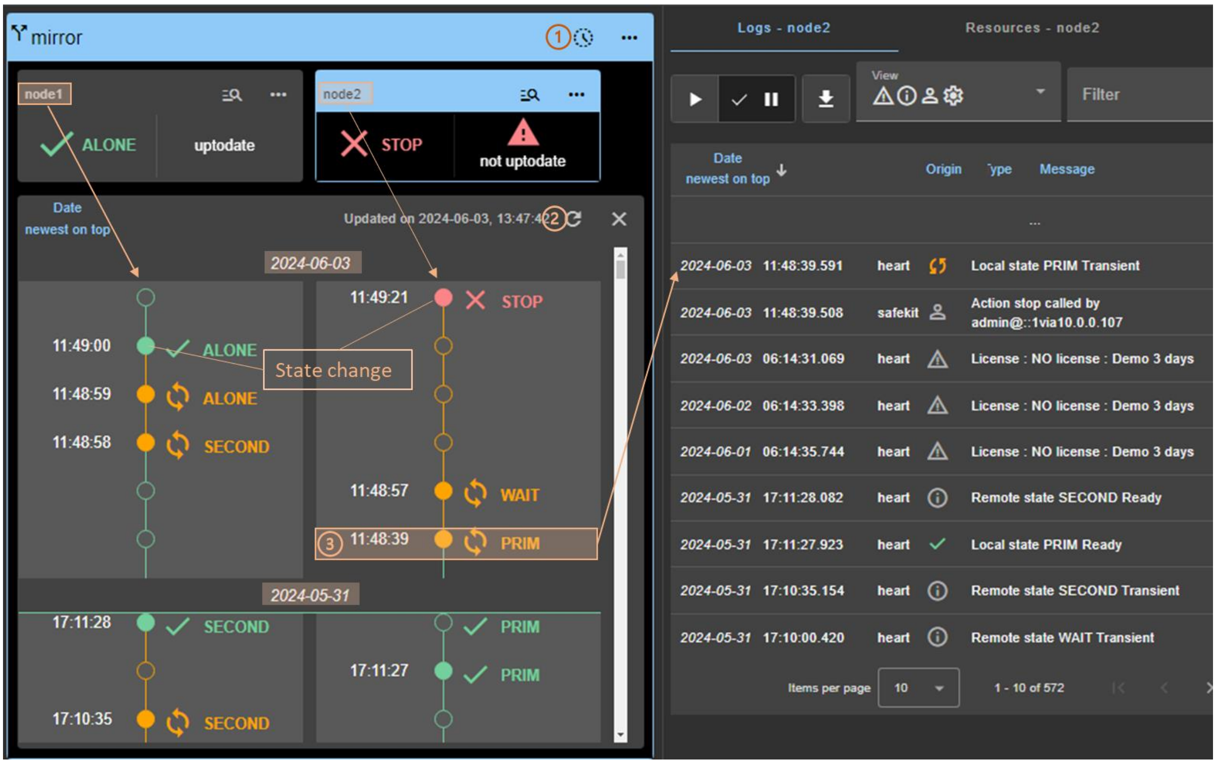
3.4.5 Module states timeline

Since SafeKit 8.2.2, you can display the module states timeline:

- By navigating the console via "Monitoring/Click on for the module"

This provides a global view of the module's state on the cluster. Be aware:

- that the clocks of the two nodes must be synchronized for the mapping of state changes to be meaningful
- it displays a reverse timeline of the module states on all nodes over time, by starting by the newest date.

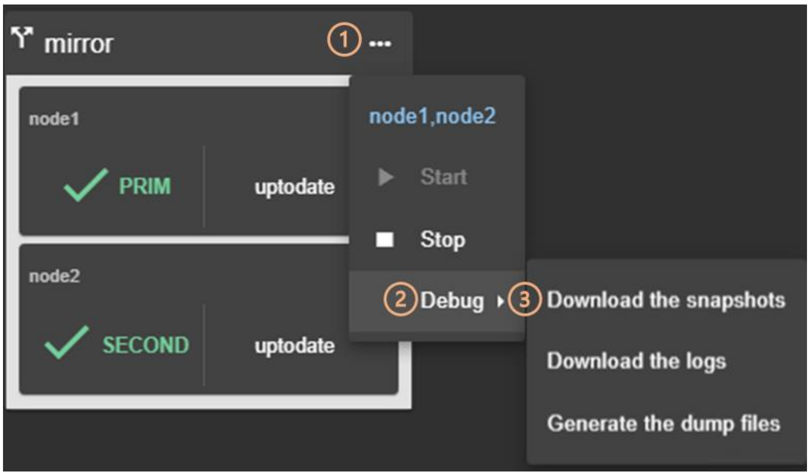


- Click on to open/close the timeline. The timeline displayed is the one available at the time of loading.
- Click on to refresh the timeline with the latest state changes.
- Click on a state change event to display the module log for the node starting at this date

3.5 Snapshots or logs of module for debug and support

When the problem is not easily identifiable, it is recommended to download logs or snapshots of the module on all nodes as described below. Snapshots allows an offline and in-depth analysis of the module and node status as described in section 7.17. If this analysis fails, send snapshots to support as described in section 8.

In the following example, the module `mirror` is configured on `node1` and `node2`. Note that a snapshot can be downloaded in any state of the module.



- (1) Click on ••• to open the global menu of the module.
- (2) Click on "Debug" to open the debug submenu.
- (3) Click on "Download the snapshots" to create and download the snapshot of the module for each node.

  The web console relies on the web browser's download settings to save the snapshot on the workstation. Some browsers may ask confirmation to download many files and zip files.

  The snapshot generation command generates a new dump and creates a .zip file containing the last 3 dumps and the last 3 module configurations.

  In this example, it downloads 2 snapshots : `snapshot_node1_mirror.zip` and `snapshot_node2_mirror.zip`.
- Click on "Download the logs" to download the module log (verbose or not) for each node.
- In case of file replication issues, click on "Generate the dump files" at the time the problem occurs.

  The dump contains the module logs and information on the system and SafeKit state at the time of the dump. It is generated on the server side into `SAFEVAR/snapshot/modules/`*`AM`*`/dump_AAAA_MM_DD_hh_mm_ss`.

Since SafeKit 8.2.4, the zips generated for snapshots are protected by the password `safekit`. This allows the snapshot to be received in its entirety when sent via email.

3.6 Secure access to the web console

SafeKit offers different security policies for the web console that are implemented by modifying the SafeKit web service configuration. These configurations also offer role management:

Admin role	This role grants all administrative rights by allowing access to Configuration and Monitoring in the navigation sidebar
Control role	This role grants monitoring and control rights by allowing access only to Monitoring in the navigation sidebar

Monitor role	This role grants only monitoring rights, prohibiting actions on modules (start, stop…) in Monitoring in the navigation sidebar.

SafeKit provides different setups for the web service to enhance the security of the SafeKit web console. The predefined setups are listed below from least secure to most secure:

- HTTP. Same role for all users without authentication

  This solution can only be implemented only in HTTP and is not compatible with user authentication methods. It is intended to be used for troubleshooting only.

- HTTP/HTTPS with user authentication based on Apache files and optional role management

  It relies on Apache files to store username/password for authenticating users and, optionally, to store the associated role for restricting their access. To connect to the console, the user must enter the username and password as configured with the Apache mechanisms.

  This is the default active configuration, applied for HTTP and initialized with a single `admin` user with the Admin role. The default setup can be extended to add users or to switch to HTTPS.

- HTTP/HTTPS with user authentication based on LDAP/AD authentication. Optional role management

  It relies on LDAP/AD authentication server to authenticate users and, optionally, restricts their access based on roles. To connect to the console, the user must enter the username and password as configured into the LDAP/AD server. It supports HTTP or HTTPS.

- HTTPS with user authentication based on OpenId Connect authentication. Optional role management

  It relies on OpenID Identity Provider server to authenticate users and, optionally, restricts their access based on roles. To connect to the console, the user must enter the username and password as configured into the Identity Provider server. Since SafeKit 8.2.3, it supports only HTTPS.

To implement them, refer to the section 11.

4. Tests

- ➩ Section 4.1 "Installation and tests after boot"
- ➩ Section 4.2 "Tests of a mirror module"
- ➩ Section 4.3 "Tests of a farm module"
- ➩ Section 4.4 "Tests of checkers common to mirror and farm"

The following tests help to better understand how SafeKit works and ensure that the deployed solution returns the expected results. They can be used as a basis for the acceptance testing at a client's site.

Subsequently, analysis of test results may require consulting the module log, the scripts log (which contains the output of module scripts) and the state of module resources. To read these logs and resources, see section 7.3.

4.1 Installation and tests after boot

4.1.1 Test package installation

Replace below `node1` by the node name and *`AM`* by the module name.

- `safekit -p` executed on the nodes returns among other values, the value of `SAFE`, the SafeKit root installation path, and `SAFEVAR`, the SafeKit working directory:
  - in Windows

    `SAFE=C:\safekit` if `%SYSTEMDRIVE%`=C:
    `SAFEVAR=C:\safekit\var`
  - in Linux
    `SAFE="/opt/safekit"`

    `SAFEVAR="/var/safekit"`

  For details, see section 10.1.
- Editing **`userconfig.xml`** of a mirror(/farm) module and its scripts **`start_prim/start_both`**, **`stop_prim/stop_both`** is made with:
  - the web console at /console/en/configuration/modules/*AM*/config
  - under the directory `SAFE/modules/`*`AM`* on the node1
- Module log and scripts log (that contains module scripts output) for the module on one node may be analyzed with :
  - the web console at /console/en/monitoring/nodes/node1/modules/*AM*/logs
  - the command executed on `node1`
    `safekit logview -m` *`AM`* for the module log
  - on node1, into files
    `SAFEVAR/modules/`*`AM`*`/userlog_<year>_<month>_<day>T<time>_<script name>.ulog` for the scripts logs (output messages of the scripts)

4.1.2 Test license and version

`safekit level` returns:

```
Host : <hostname>
OS : <OS version>
SafeKit : <SafeKit version>
License : Demo (No license)| Invalid Product | Invalid Host | … Expiration… | <license id> for
<hostname>…
or License : Expired license
```

- "Demo (No license)"

  means no license into `SAFE/conf/` ; the product stops every 3 days
- "Invalid Product"

  means an expired license in `SAFE/conf/license.txt`
- "Invalid Host"

  means no valid hostname in `SAFE/conf/license.txt`
- " ...Expiration..."

  means a temporary key
- "<license id> for <hostname>"

  means a permanent license

Go to http://www.evidian.com/safekit/requestevalkey.php to get a temporary key of one month for any OS or any hostname.

Go to https://support.evidian.com to get a permanent key based on the hostname and OS.

4.1.3 Test SafeKit services and modules after boot

In Windows, see also section 10.4.

Test `safeadmin` service

`safeadmin` service must be automatically started at boot. To check its state:

In Windows	1. Open a PowerShell console as administrator 2. Run `Get-Service -name safeadmin` `Status   Name          DisplayName` `------   ----          -----------` `Running  safeadmin     safeadmin`
In Linux	1. Open a Shell console as root 2. Run `systemctl status safeadmin` Redirecting to /bin/systemctl status safeadmin.service ● safeadmin.service - The SafeKit Administration Daemon Loaded: loaded (/usr/lib/systemd/system/safeadmin.service; enabled; vendor preset: disabled) Active: active (running) since Tue 2024-11-12 17:30:56 CET; 20h ago …

When `safeadmin` service is not running, all `safekit` commands fail and return for example:

`safekit level`

```
Waiting for safeadmin ..........
Error: safeadmin administrator daemon not running
```

Refer to section 9.1.1, for starting `safeadmin` service.

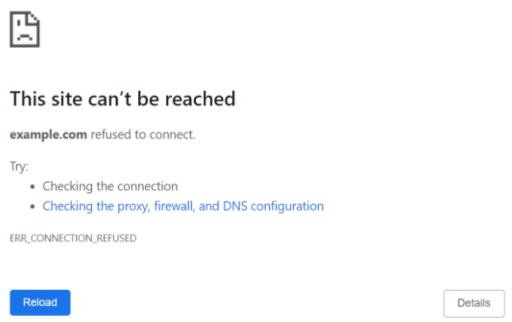
Test `safewebserver` service

By default, `safewebserver` service must be automatically started at boot. To check its state:

<table>
<tr><td>In Windows</td><td>1. Open a PowerShell console as administrator
2. Run <code>Get-Service -name safewebserver</code><pre>Status   Name   DisplayName
------   ----   -----------
Running safewebserver   safewebserver</pre></td></tr>
<tr><td>In Linux</td><td>1. Open a Shell console as root
2. Run <code>systemctl status safewebserver</code><pre>systemctl status safewebserver
Redirecting to /bin/systemctl status safewebserver.service
● safewebserver.service - SafeKit Apache Server
   Loaded: loaded (/usr/lib/systemd/system/safewebserver.service; enabled; vendor preset: disabled)
   Active: active (running) since Wed 2024-11-13 11:01:31 CET; 2h 58min ago
…</pre></td></tr>
</table>

When `safewebserver` service is not running, the following features are unavailable:

- the SafeKit web console that displays:



- the module checker
- the distributed command line interface that returns for example:

  `safekit -H "*" level`

```
--------------- Server=https://10.0.0.107:9453 ---------------
curl: (7) Failed to connect to 10.0.0.107 port 9453 after 1022 ms: Couldn't connect to server
```

```
---------------- Server=https://10.0.0.108:9453 ----------------
curl: (28) Failed to connect to 10.0.0.108 port 9453 after 21024 ms: Couldn't connect to server
```

Refer to section 9.1.2, for starting `safewebserver` service.

Test SNMP service

SNMP monitoring is not enabled by default. Refer to section 10.10, to enable it.

In Windows, it relies on `Net-SNMP Agent` service. In Linux, it relies on the standard `snmpd` service. To check its state:

In Windows	1. Open a PowerShell console as administrator 2. Run `Get-Service -name "Net-SNMP Agent"` Status Name DisplayName ------ ---- ----------- Running Net-SNMP Agent Net-SNMP Agent
In Linux	1. Open a Shell console as root 2. Run `systemctl status snmpd` systemctl status snmpd Redirecting to /bin/systemctl status snmpd.service ● snmpd.service - … Active: active (running) since Wed 2024-11-13 11:01:31 CET; 2h 58min ago …

When the service is not running, the SNMP monitoring is unavailable.

Refer to section 9.1.4, for starting the service.

Test modules

- `safekit boot status` displays start-up ("on") or not ("off") of modules at boot
- `safekit state` displays state of all configured modules: `STOP` (mirror or farm), `WAIT` (mirror or farm), `ALONE` (mirror), `PRIM` (mirror), `SECOND` (mirror), `UP` (farm)
- check processes of a module: see section 10.2.

  To list the processes of the AM module, execute:

  `safekit -r processtree list all` *`AM`*

  This command returns all processes with *`AM`* in arguments.
- `safekit module listid` displays name of installed modules with their ids: id of a module must be the same on all servers

4.1.4 Test start of SafeKit web console

For details on the web console, refer to section 3.

- connect a web browser to http://<server IP>:9010
- the web console home page is displayed

4.2 Tests of a mirror module

4.2.1 Test first start of a mirror module on 2 servers `STOP (NotReady)`

On the first start of the module after its configuration:

- message in the logs of both servers (to read logs, see section 7.3)

"Action start called by admin@<IP>via<IP>/SYSTEM/root"

- the module goes to state `WAIT (NotReady)` and `WAIT (NotReady)` on both servers with in the log

"Action wait from failover rule rfs_notuptodate_server"
"Data may be not uptodate for replicated directories (wait for the start of the remote server)"
"If you are sure that this server has valid data, run safekit stop, then safekit prim to force start as primary"

For the first start of a mirror module with replicated directories, the user must force the start as primary the node with the uptodate data. Refer to section 5.3.

4.2.2 Test start of a mirror module on 2 servers `STOP (NotReady)`

For subsequent starts:

- message in the logs of both servers (to read logs, see section 7.3)

"Action start called by admin@<IP>via<IP>/SYSTEM/root"

- the module goes to the stable state `PRIM (Ready)` and `SECOND (Ready)` on both servers with in the first log

"Remote state SECOND Ready"
"Local state PRIM Ready "

- and in the other log

"Local state SECOND Ready "
"Remote state PRIM Ready "

- application is started in the `start_prim` script of the module on the `PRIM` server with message in the log

"Script start_prim"

4.2.3 Test stop of a mirror module on the server `PRIM (Ready)`

On the stopping node:

- message in the log of the stopped node (to read logs, see section 7.3)

"Action stop called by admin@<IP>/SYSTEM/root"

- the stopped node runs the `stop_prim` script of the module which stops the application on the server with message in the log:

"Script stop_prim"

- the module becomes `STOP (NotReady)` with messages in the log:

"Local state STOP NotReady"

On the other node:

* the node runs a failover with the message in the log:

  "Action alone called by heart : remote stop"

* the application is started with the `start_prim` script with the message in the log:

  "Script start_prim"

* the module becomes ✓ `ALONE (Ready)` with the message in the log:

  "Local state ALONE Ready"

4.2.4 Test start of a mirror module on the server ✗ `STOP (NotReady)`

Start the module on a node while the other node is ✓ `ALONE (Ready)`.

* message in the log of the starting module (to read logs, see section 7.3)

  "Action start called by admin@<IP>/SYSTEM/root"

* the ✗ `STOP (NotReady)` module becomes ✓ `SECOND (Ready)`
* the module ✓ `ALONE (Ready)` becomes ✓ `PRIM (Ready)` and continues to execute the application

4.2.5 Test restart of a mirror module on the server ✓ `PRIM (Ready)`

* message in the log of the server where the restart command is passed (to read logs, see section 7.3)

  "Action restart called by admin@<IP>/SYSTEM/root"

* the `PRIM` module becomes ↻ `PRIM (Transient)` and then becomes ✓ `PRIM (Ready)`
* the scripts of the module `stop_prim/start_prim` are executed on the `PRIM` and restarts locally the application on the server with messages in the log:

  "Script stop_prim"
  "Script start_prim"

* the other module on the other server stays ✓ `SECOND (Ready)`

4.2.6 Test virtual IP address of a mirror module

Mirror module in the state ✓ `PRIM (Ready)` on node1 and ✓ `SECOND (Ready)` on node2.

`userconfig.xml`:

```
<vip>
 <interface_list>
 <interface check="on">
 <real_interface>
   <virtual_addr addr="virtip"
              where="one_side_alias"
              check="on"/>
  </real_interface>
  </interface>
 </interface_list>
</vip>
```

1. On node1, `ipconfig /all` (Windows) or `ip addr show` (Linux) returns `virtip` as an alias on the network interface.

   On the external workstation (or server), the 3 pings respond.

   On the external workstation (or server) in the same LAN, `virtip` is mapped to the same MAC address as node1_ip_address

   ```
   arp -a
   node1_ip_address      00-0c-29-0a-5c-fc
   node2_ip_address      00-0c-29-26-44-93
   ```

1. On an external workstation (or server) in the same LAN, ping both physical IP addresses + virtual IP address: ping node1_ip_address ping node2_ip_address ping virtip arp -a 2. `safekit stopstart -m AM` on the primary server (where *AM* is the module name) 3. On the external workstation (or server) ping node1_ip_address ping node2_ip_address ping virtip arp -a Note: redo the ping to `virtip` before looking at the ARP table because the entry may be marked obsolete and refreshes only after ping	virtip 00-0c-29-0a-5c-fc 2. After the `stopstart`, ✓ `SECOND (Ready)` on node1 server and ✓ `PRIM (Ready)` on node2 server In the verbose log of new primary, message: "Virtual IP <virtip of mirror> set" 3. On node2, `ipconfig /all` (Windows) `or ip addr show` (Linux) returns `virtip` as an alias on the network interface On the external workstation (or server), the 3 pings respond. On the external workstation (or server), `virtip` is mapped to the same MAC address as node2_ip_address arp -a node1_ip_address 00-0c-29-0a-5c-fc node2_ip_address 00-0c-29-26-44-93 virtip 00-0c-29-26-44-93

4.2.7 Test file replication of a mirror module

Mirror module in the state ✓ `PRIM (Ready)` on node1 server and ✓ `SECOND (Ready)` on node2 server. `userconfig.xml` in Windows: `<rfs>` `  <replicated dir="c:\replicated" mode="read_only" />` `</rfs>` `userconfig.xml` in Linux: `<rfs>` `  <replicated dir="/replicated" mode="read_only" />` `</rfs>` 1. On the server ✓ `PRIM (Ready)`, go to /replicated and create a file file1.txt 2. On the server ✓ `SECOND (Ready)`, go to /replicated and try to delete file1.txt	1. file1.txt has been replicated on ✓ `SECOND (Ready)` under /replicated 2. Failure because the /replicated directory is read-only on the server ✓ `SECOND (Ready)` 3. file2.txt is not replicated in /replicated of the server ✗ `STOP (NotReady)` 4. file2.txt is reintegrated on the restarted server. During the phase of reintegration, the server is ↻ `SECOND (Transient)` In the log of reintegrated Linux server, message: "Updating directory tree from /replicated_For_SafeKit_Replication" In the log of reintegrated Windows server, message: "Updating directory tree from c:\replicated"

3. Stop the server `PRIM (Ready)` and wait for `STOP (NotReady)`. Then go to the other server which is `ALONE (Ready)` and create a new file file2.txt
4. Restart the server `STOP (NotReady)` and wait for `SECOND (Ready)`.

And at the end of /replicated reintegration, if at least 1 file with modified data has been reintegrated from primary server to secondary server, message

"Copied <reintegration statistics>"
"Reintegration ended (synchronize)"

This message gives statistics for the reintegrated directory: reintegrated size, number of files, time, and throughput on the network in KB/sec.

Note: reintegrate a file larger than 100 MB to have reliable statistics

At the end of reintegration, the server is `SECOND (Ready)`.

4.2.8 Test shutdown of the server `PRIM (Ready)`

- on Windows, check that the special procedure to stop modules at shutdown has been applied. Refer to section 10.4.
- make a shutdown of the server `PRIM (Ready)`
- check in the log of server `SECOND (Ready)`, message

"Action alone called by heart : remote stop"

- the server `SECOND (Ready)` becomes `ALONE (Ready)`; application in the `start_prim` script of the module is started on the `ALONE` server with the message in the log

"Script start_prim"

- on timeout in the SafeKit console, the old server `PRIM (Ready)` becomes `ERROR (connection error)`
- after reboot of the stopped server, check that the OS shutdown has really called a shutdown of the module

"Action shutdown called by SYSTEM/root"

- Check that the application `stop_prim` script has been executed with the message

"Script stop_prim"

- And check that the module has been completely stopped before shutting down the server with the last message

"Local state STOP NotReady"

- after reboot of stopped server, if the module is started automatically at boot (`safekit boot status`), message in the log

"Action start called at boot time"

- after a start of the module on the stopped server, the module becomes `SECOND (Ready)` on this server and `PRIM (Ready)` on the other server

4.2.9 Test power-off of the server PRIM (Ready)

In the event of a power outage, the module is not stopped properly as it would be during a server shutdown. Failover is triggered by the loss of heartbeats rather than by detecting the module stop.

`userconfig.xml` with 2 heartbeats:

```
<heart>
 <heartbeat name="default" />
 <heartbeat name="private"
            ident="flow" />
</heart>
```

Note: If you want to make a test with double simultaneous electrical fault on both servers, check that `<rfs async="none">` is set in `userconfig.xml`. For more information, see section 13.6.3.

- in the log of the server `SECOND (Ready)`, message

  "Resource heartbeat.default set to down by heart"
  "Resource heartbeat.flow set to down by heart"
  "Remote state UNKNOWN"
  "Action alone called by heart : no heartbeat"

- messages appear within 30 seconds after the power-off (if no specified timeout configured for `<heart>`)
- the server `SECOND (Ready)` becomes `ALONE (Ready)`; the application in the `start_prim` script of the module is restarted on the `ALONE` server with the message in its log

  "Script start_prim"

- on SafeKit console timeout, the former server `PRIM (Ready)` becomes `ERROR (connection error)`
- after reboot of stopped server, if the module is started automatically at boot (`safekit boot status`), message in the log

  "Action start called at boot time"

- after restart of the module on the stopped server, the module becomes `SECOND (Ready)` on this server and `PRIM (Ready)` on the other server

4.2.10 Test split-brain with a mirror module

Split-brain occurs in situation of network isolation between two SafeKit servers. Each server becomes primary `ALONE` and runs the application. At return of split-brain, a sacrifice must be made by shutting down the application on one of the two servers.

Mirror module in the state `PRIM (Ready)` and `SECOND (Ready)`

`userconfig.xml`:

```
<heart>
 <heartbeat name="default" />
 <heartbeat name="repli" ident="flow"
```

1. After network isolation of both servers, all heartbeats are lost. In the logs of both servers,

   "Resource heartbeat.default set to down by heart"
   "Resource heartbeat.flow set to down by heart"

```
/>
</heart>
```

+
on Windows to manage the IP conflict on the virtual IP address virtip

```
<vip>
 <interface_list>
  <interface check="on"
arpreroute="on">
   <real_interface>
    <virtual_addr addr="192.168.1.10"
       where="one_side_alias"/>
   </real_interface>
  </interface>
 </interface_list>
</vip>
```

To obtain the split-brain, check that there are no checkers in `userconfig.xml` that can detect the network isolation: no <interface check="on">, no <ping> checker

1. disconnect at the same time, networks `default` and `repli`
2. reconnect networks

```
"Remote state UNKNOWN"
"Local state ALONE Ready "
```

Split-brain case: both servers are `ALONE (Ready)` and run the application.

2. When reconnecting networks, sacrifice of one `ALONE` server: the former `SECOND` server

   Log of the former `PRIM` not sacrificed:

   ```
   "Remote state ALONE Ready"
   "Split brain recovery: staying alone"
   ```

   Log of the former `SECOND` sacrificed:

   ```
   "Remote state ALONE Ready"
   "Split brain recovery: exiting alone"
   "Script stop_prim"
   ```

   The server performs a `stopstart`: stop of the application with stop_prim then reintegration of replicated files from the other server.

   In Windows, upon reconnection, a conflict may occur with the virtual IP address, leading to the stop-start of the module.

3. Come back to the stable state `PRIM (Ready)` and `SECOND (Ready)` on both servers as it was before split-brain

Note: situation of split-brain in a mirror module with file replication is not good. Indeed, the sacrifice of the former secondary server causes file reintegration of this server from the primary one and the loss of data stored on the secondary during the split-brain situation.

For this reason, 2 heartbeats on two physically separate networks are recommended. Typically, a cable between the two servers will allow (1) to avoid split-brain with an additional heartbeat network and (2) set the replication flow on a separate network

4.2.11 Continue your mirror module tests with checkers

Go to section 4.4 for tests of checkers.

4.3 Tests of a farm module

4.3.1 Test start of a farm module on all servers `STOP (NotReady)`

- message in the logs of all servers (to read logs, see section 7.3)

"Action start called by admin@<IP>/SYSTEM/root"

- the module goes to `UP (Ready)` on all servers
- the application is started in the `start_both` script of the module on all servers with the message in the log

"Script start_both"

4.3.2 Test stop of a farm module on one server `UP (Ready)`

- message in the log of the stopped server (to read logs, see section 7.3)

"Action stop called by admin@<IP>/SYSTEM/root"

- the stopped module runs the `stop_both` script which stops the application on this server and with message in the log

"Script stop_both"

- the stopped module becomes `STOP (NotReady)` with messages in the log:

"Local state STOP NotReady"

- the other servers stay `UP (Ready)` and continue to run the application
- restart the module `STOP (NotReady)` with the start command

4.3.3 Test restart of a farm module on one server `UP (Ready)`

- message in the log of the module where the restart command is passed (to read logs, see section 7.3)

"Action restart called by admin@<IP>/SYSTEM/root"

- the restarted module becomes `UP (Transient)` then becomes `UP (Ready)`
- the module scripts `stop_both`/`start_both` are executed on the server to locally restart the application with messages in the log

"Script stop_both"
"Script start_both"

4.3.4 Test virtual IP address of a farm module

4.3.4.1 Configuration with vmac_directed

Farm module in the `UP (Ready)` state on 2 servers node1 and node2

`userconfig.xml` with load balancing on the `safewebserver` service (TCP port 9010):

```
<farm>
<lan name="default" />
</farm>
```

- In the verbose log of all servers:

"Virtual IP <virtip of farm> set"

- On the 2 servers, `ipconfig /all` (Windows) or `ip addr show` (Linux) returns `virtip` as an alias on the network interface.
- On a remote workstation (or server), the pings respond, and

```
<vip>
 <interface_list>
  <interface check="on">
  <virtual_interface type="vmac_directed">
    <virtual_addr addr="virtip"
where="alias" check="on"/>
  </virtual_interface>
  </interface>
 </interface_list>

<loadbalancing_list>
<group name="FarmProto">
  <rule port="9010" proto="tcp"
filter="on_port"/>
</group>
</loadbalancing_list>
</vip>
```

On a remote workstation (or server) in the same LAN, ping of the 2 physical IP addresses + virtual IP + arp -a

ip1.20 is mapped with the MAC address of one of the 2 servers:

```
ping node1_ip_address
ping node2_ip_address
ping virtip

arp -a
node1_ip_address      00-0c-29-0a-5c-fc
node2_ip_address      00-0c-29-26-44-93
virtip    00-0c-29-26-44-93
```

4.3.4.2 Configuration with vmac_invisible

Farm module in the UP (Ready) state on 2 servers node1 and node2

userconfig.xml with load balancing on the safewebserver service (TCP port 9010):

```
<farm>
<lan name="default" />
</farm>

<vip>
 <interface_list>
  <interface check="on">
  <virtual_interface type="vmac_invisible"
>
    <virtual_addr addr="virtip"
where="alias" check="on"/>
  </virtual_interface>
  </interface>
 </interface_list>

<loadbalancing_list>
<group name="FarmProto">
  <rule port="9010" proto="tcp"
filter="on_port"/>
</group>
</loadbalancing_list>
</vip>
```

On a remote workstation (or server) in the same LAN, ping of the 2 physical IP addresses + virtual IP + arp -a

- In the verbose log of all servers:

```
"Virtual IP <virtip of farm> set"
```

- On the 2 servers, `ipconfig /all` (Windows) or `ip addr show` (Linux) returns `virtip` as an alias on the network interface.
- On a remote workstation (or server), the pings respond. And virtip is mapped with the invisible virtual MAC address:

```
ping node1_ip_address
ping node2_ip_address
ping virtip

arp -a
node1_ip_address      00-0c-29-0a-5c-fc
node2_ip_address      00-0c-29-26-44-93
virtip     5a-fe-c0-a8-38-14
```

- Note: by default, the virtual MAC address is a unicast Ethernet address built with 5A:FE (SAFE) and the virtual IP address in hexadecimal

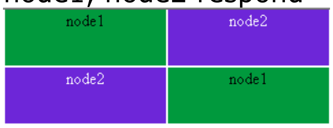
4.3.5 Test TCP load balancing on a virtual IP address

Farm module in the state ✓UP (Ready) on the 2 servers node1, node2.

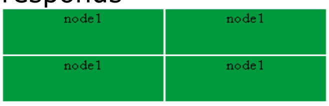
Same load balancing configuration in `userconfig.xml` as the previous test.

On a remote workstation:

1. Connect a browser to http://virtip:9010/safekit/mosaic.html, then fill the module name and on Mosaic Test. node1, node2 respond



2. `safekit stop -m AM` on node2 (where *AM* is the module name). Reload the URL: node1 responds



Special command to check the load balancing bitmap for port 9010 on each node ✓UP (Ready):

`safekit -r vip_if_ctrl -l`

An entry in the bitmap of 256 bits must be 1 on a single server.

Furthermore, the 256 bits are fairly distributed in the bitmaps of all servers ✓UP (Ready) (if no definition of `power` inside `userconfig.xml`)

1. ✓UP (Ready) on the 2 servers: load balancing of TCP sessions between node1, node2 when loading the URL
   - In the resources of the module, for node1 and node2: `FarmProto_0 50%`
   - In the verbose logs of node1 and node2:

     "farm membership: **node1 node2** (group FarmProto_0)"
     "farm load: **128/256** (group FarmProto_0)"

     128/256: 128 bits on 256 are managed by each server
   - `safekit -r vip_if_ctrl -l` on node1 and node2.

     With `type="vmac_directed"`

     Bitmap node1:
     01010101:01010101:01010101:01010101:ffffffff:ffffffff:ffffffff:ffffffff
     Bitmap node2:
     ffffffff:ffffffff:ffffffff:ffffffff:02020202:02020202:02020202:02020202

     01 and 02 corresponds to the node numbers that reply.

     With `type="vmac_invisible"`

     Bitmap node1:
     00000000:00000000:00000000:00000000:ffffffff:ffffffff:ffffffff:ffffffff
     Bitmap node2:
     ffffffff:ffffffff:ffffffff:ffffffff:00000000:00000000:00000000:0000000

     Bits are fairly distributed between both servers
2. ✗STOP (NotReady) on node2: TCP sessions served only by node1 when loading the URL
   - In the resources of the module, for node1: `FarmProto_0 100%`
   - In the verbose log of node1:

     "farm membership: **node1** (group FarmProto_0)"
     "farm load: **256/256** (group FarmProto_0)"

     256/256: all the bits are managed by node1
   - `safekit -r vip_if_ctrl -l` on node1:

     Bitmap:
     ffffffff:ffffffff:ffffffff:ffffffff:ffffffff:ffffffff:ffffffff:ffffffff

	All the bits are managed by node 1

4.3.6 Test split-brain with a farm module

Split-brain occurs in case of network isolation between SafeKit servers.

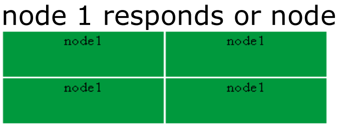
Farm module is ✓ `UP (Ready)` on the servers node1 and node2.

Same configuration of load balancing in `userconfig.xml` as the previous test. To get the split-brain, check in `userconfig.xml` that there are no checkers that can detect isolation: no `<interface check="on">` or `<ping>` checker

On the external workstation:

1. Connect a browser to http://virtip:9010/safekit/mosaic.html, then click on Mosaic Test. node1 and node2 respond

2. disconnect the network between node1 and node2. Depending on the location where the external console is, node 1 responds or node 2



or

3. reconnect the network and connect to URL

Same special command as in the previous test to check the load balancing bitmap for port 9010 on each node ✓ `UP (Ready)`

1. before split-brain, state ✓ `UP (Ready)` on node1 and node2:
   - In the resources of the module, for node1 and node2: `FarmProto_0 50%`
   - In the verbose logs of node1 and node2:

     "farm membership: **node1 node2** (group FarmProto_0)"
     "farm load: **128/256** (group FarmProto_0)"

     128/256: 128 bits on 256 are managed by each server.
   - `safekit -r vip_if_ctrl -l` on node1 and node2:

     With `type="vmac_directed"`

     Bitmap node1:
     01010101:01010101:01010101:01010101:ffffffff:ffffffff:ffffffff:ffffffff
     Bitmap node2:
     ffffffff:ffffffff:ffffffff:ffffffff:02020202:02020202:02020202:02020202

     01 and 02 corresponds to the node numbers that reply.

     With `type="vmac_invisible"`

     Bitmap node1:
     00000000:00000000:00000000:00000000:ffffffff:ffffffff:ffffffff:ffffffff
     Bitmap node2:
     ffffffff:ffffffff:ffffffff:ffffffff:00000000:00000000:00000000:0000000

     Bits are fairly distributed between both servers
2. after isolation of servers, split-brain:
   - In the resources of the module, for node1 and node2: `FarmProto_0 100%`
   - In the verbose log of node1:

     "farm membership: **node1** (group FarmProto_0)"
     "farm load: **256/256** (group FarmProto_0)"

     256/256: all the bits are managed by node1
   - In the verbose log of node2:

     "farm membership: **node2** (group FarmProto_0)"
     "farm load: **256/256** (group FarmProto_0)"

256/256: all the bits are managed by node2

- `safekit -r vip_if_ctrl -l` on node1 and node2:

```
Bitmap:
ffffffff:ffffffff:ffffffff:ffffffff:ffffffff:ffffffff:ffffffff:ffffffff
```

3. after split-brain when network is reconnected, the same messages can be found in the log and the same bitmaps as those before split-brain.

Note: the default behavior of farm in situation of split-brain is good. The recommendation is to put in `userconfig.xml` a monitoring network `<lan></lan>` where the virtual IP address is.

The messages in the log and the result of vip_if_ctrl are slightly different depending on the type `vmac_directed` or `vmac_invisible`.

4.3.7 Test compatibility of the network with invisible MAC address (vmac_invisible)

Network prerequisite

A unicast MAC Ethernet address 5a-fe-xx-xx-xx-xx is associated with the virtual IP address `virtip` of a farm module. It is never presented by SafeKit servers as source Ethernet address (invisible MAC). Switches cannot locate this address. When they follow a packet to the destination MAC address 5a-fe-xx-xx-xx-xx, they must broadcast the packet on all ports of the LAN or VLAN where the virtual IP address is (flooding). All servers in the farm therefore receive packets destined to the virtual MAC address 5a-fe-xx-xx-xx-xx.

Note that this prerequisite does not exist for a mirror module (see section 4.2.6)

Server prerequisite

The packets are captured by Ethernet cards set in promiscuous mode by SafeKit. And the packets are filtered by the module kernel <vip> according to the load balancing bitmap. To make a test, you need network monitor tool.

1. all servers are `UP (Ready)`
2. the network monitoring is started on each server with a filter on `virtip`
3. an external workstation sends a single ping to the virtual IP address with `ping -n (or -c) 1 virtip`
   - 1 packet sent and received by all servers

     ```
     "ICMP: Echo: From extip To virtip"
     ```

   - there must be as many packets

     ```
     "ICMP: Echo Reply: To extip From virtip"
     ```

     as there are servers `UP (Ready)`
4. if it is not the case, check if options restrict the "port flooding" in switches and prevent the broadcast of "ICMP: Echo" to all servers
5. be careful: the "port flooding" restriction in switches can occur after a certain number of flooding (time, number of KB flooded): the ping test must be repeated during several hours by creating flooding to the virtual IP address
6. Note: to avoid network monitoring tools, an external Linux console can be used. The Linux ping prints duplicate packets coming from the 2 servers `UP (Ready)`:

   ```
   ping virtip
   64 bytes from ip1.20 icmp_seq=1
   ```

Network monitoring on Windows 2003 (CD2): 1. install "Network Monitor Tools" in "Management and Monitoring Tools" (capture only packets in source or destination of the server) 2. Start / Network Monitor then Capture Filter / Address Pairs / virtip then Capture / Start then "Stop and View" at the end of capture Network monitoring on Linux: 1. `tcpdump host virtip` capture all network packets	64 bytes from ip1.20 icmp_seq=1 (DUP!) 64 bytes from ip1.20 icmp_seq=2 64 bytes from ip1.20 icmp_seq=2 (DUP!)... This test may be carried out for several minutes by storing the output of the ping in a file and then ensuring that there was (DUP!) all the time: `date > /tmp/ping.txt ; ping virtip >> /tmp/ping.txt`

4.3.8 Test shutdown of a server ✓UP (Ready)

- on Windows, check that the special procedure to stop modules at shutdown has been performed. Refer to section 10.4.
- make a shutdown of a ✓`UP (Ready)` server
- the other servers stay ✓`UP (Ready)` and continue to run the application
- on timeout in the SafeKit console, the old server ✓`UP (Ready)` becomes !`ERROR (connection error)`
- after reboot, check that shutdown of the OS has called a shutdown of the module

```
"Action shutdown called by SYSTEM"
```

- Check that the `stop_both` script which stops the application has been executed with the message

```
"Script stop_both"
```

- And check that the module has been completely stopped before stopping the server with the last message

```
"Local state STOP NotReady"
```

- after reboot of the stopped server, if the module is started automatically at boot (`safekit boot status`), message in the log

```
"Action start called at boot time"
```

- after start-up of the module on the stopped server, the module becomes ✓`UP (Ready)` and it executes the `start_both` script which restarts the application on this server with the message in the log

```
"Script start_both"
```

4.3.9 Test power-off of a server ✓UP (Ready)

In the event of a power outage, the module is not stopped properly as it would be during a server shutdown. Failover is triggered by the loss of heartbeats rather than by detecting the module stop.

- the other servers stay ✓UP (Ready) and continue to run the application
- on timeout in the SafeKit console, the old server ✓UP (Ready) becomes ! ERROR (connection error)
- after reboot of the stopped server, if the module is started automatically at boot (safekit boot status), message in the log

  "Action start called at boot time"
- after start-up of the module on the stopped server, the module becomes ✓UP (Ready) and it executes the start_both script which restarts the application on this server with the message in the log

  "Script start_both"

4.3.10 Continue your farm module tests with checkers

Go to section 4.4 for tests of checkers.

4.4 Tests of checkers common to mirror and farm

4.4.1 Test <errd> checker with action restart or stopstart

For a description of process/service monitoring, refer to section 13.9.

In userconfig.xml:

```
<errd>
  <proc name="appli.exe" atleast="1"
action="restart" class="prim"/>
</errd>
```

The checker monitors the process named appli.exe.

- name="appli.exe" atleast="1": at least one process appli.exe must run
- class
  - class="prim" for mirror module

    checker started/stopped on the server in state ✓PRIM or ALONE (Ready), after/before the application (start_prim/stop_prim)
  - class="both" for farm module

    checker started/stopped on all servers ✓UP (Ready) after after/before the application (start_both/stop_both)
- action

  If appli.exe is not running, the checker set the resource

1. Kill of process appli.exe on the server in ✓ (Ready) state. That is in states PRIM or ALONE for a mirror module, UP for a farm module.
   - messages in the log:

     "Process appli.exe not running"
     "Action restart|stopstart called by errd"
   - the module becomes (Transient), respectively in state PRIM, ALONE or UP
   - in the restart case, the module becomes ✓ (Ready), respectively in state PRIM, ALONE or UP
   - in the stopstart case, the module becomes ✓ (Ready), respectively in state SECOND, ALONE or UP

     message in the log:

     "Action start called automatically"

     Note: a stopstart on ✓PRIM (Ready) causes a failover
2. Repeat the test on the same server if it still runs the application (i.e., ✓ (Ready) in state ALONE, PRIM or UP).

   By default, on the 4th error detection within 24 hours (see maxloop and proc.appli.exe to down. Then, it executes a `restart` or `stopstart`.

- o `action="restart"`

  it restarts locally the application (`stop_xx; start_xx`)

- o `action="stopstart"`

  it stops the module, as well as the application, and then automatically starts it

`loop_interval` described in section 13.2.3), the module becomes `STOP (NotReady)`. In the log, message before stopping:

"Action stop called by maxloop"

4.4.2 Test <tcp> checker with action restart or stopstart

For a description of TCP checker, refer to section 13.11.

In `userconfig.xml`:

```
<check>
  <tcp ident="id" when="prim"
action="restart" >
    <to addr="addr" port="port"/>
  </tcp>
</chek>
```

The checker checks that the application responds to connection requests.

- `addr="addr" port="port"`

  test TCP connections on `addr:port`

- `when`
  - o `when="prim"` for mirror module

    checker started/stopped on the server in state `PRIM` or `ALONE (Ready)`, after/before the application (`start_prim/stop_prim`)

  - o `when="both"` for farm module

    checker started/stopped on all servers `UP (Ready)` after after/before the application (`start_both/stop_both`)

- `action`

  If the connection fails, the checker sets the resource `tcp.id` to `down`. The associated failover rule, named `t_id`, executes a `restart` or `stopstart`.

  - o `action="restart"`

    It restarts locally the application (`stop_xx; start_xx`)

1. Stop the application listening `addr:port` on the server in state `(Ready)`. That is in states `PRIM` or `ALONE` for a mirror module, `UP` for a farm module:
   - o messages in the log:

     "Resource tcp.id set to down by tcpcheck"
     "Action restart|stopstart from failover rule t_id"

   - o the module becomes `(Transient)`
   - o in case of `restart`, the module becomes `(Ready)`, respectively in state `PRIM`, `ALONE` or `UP`
   - o in case of `stopstart`, the module becomes `(Ready)`, respectively in state `SECOND`, `ALONE` or `UP`

     Message in the log:

     "Action start called automatically"

     Note: a `stopstart` on `PRIM (Ready)` causes a failover.

2. Repeat the test on the same server if it still runs the application (i.e., `(Ready)` in state `ALONE`, `PRIM` or `UP`).

   By default, on the 4th error detection within 24 hours (see `maxloop` and `loop_interval` in section 13.2.3), the module becomes `STOP (NotReady)`. In the log, message before stopping:

   "Action stop called by maxloop"

- action="stopstart"

  It stops completely the module and then automatically starts it.

4.4.3 Test <tcp> checker with action wait

For a description of TCP checker, refer to section 13.11.

In `userconfig.xml`:

```
<check>
  <tcp ident="id" when="pre"
action="wait" >
    <to addr="addr" port="port"/>
  </tcp>
</check>
```

The checker checks that an application, external to the module, responds to connection requests.

- `addr="addr" port="port"`

  It checks TCP connections on `addr:port`

- `when="pre"`

  The checker starts before, stops after, the application integrated into the module (in `start_xx` /`stop_xx`).

- `action="wait"`

  If the connection fails, the checker sets the resource `tcp.id` to `down`. The associated failover rule, named **t**_`id`, executes a `wait`.

  It stops the module, and its application, then puts it in the state `WAIT`, waiting for `tcp.id` reset to `up` by the checker.

1. Stop the external application listening on `addr:port`, when the server is in ✓ `(Ready)` state.
   - messages in the log:

     "Resource tcp.id set to down by tcpcheck"
     "Action wait from failover rule t_id"

   - the module becomes ○ `WAIT (NotReady)` on all nodes

     Note: a `wait` on ✓ `PRIM (Ready)` causes a failover
2. Restart the application listening on `addr:port`.
   - messages in the verbose log

     "Resource tcp.id set to up by tcpcheck"
     " Action wakeup from failover rule Implicit_wakeup "

   - the module becomes ✓ `(Ready)`, respectively in state `SECOND`, `ALONE`, or `UP`
3. Repeat the test.

   By default, on the 4th error detection within 24 hours (see `maxloop` and `loop_interval` in section 13.2.3), the module becomes ✗ `STOP (NotReady)`. In the log, message before stopping:

   "Action stop called by maxloop"

Note: This test allows testing of connectivity to an external service. But if the external service is down or is unreachable on all servers, all servers are in state ○ `WAIT (NotReady)` and the application is unavailable.

4.4.4 Test <interface check="on"> with action wait

For a description of interface checker, refer to section 13.13. For its automatic configuration with `<interface check="on">`, see section 13.5.5.

In `userconfig.xml`:

```
<vip>
 <interface_list>
 <interface check="on">
 <real_interface>
   <virtual_addr addr="172.17.0.20"
             where="one_side_alias"
             check="on"/>
</real_interface>
  </interface>
 </interface_list>
</vip>
```

The checker checks that the Ethernet cable is connected in the interface where the virtual IP address is set.

- If the cable is disconnected, the checker set the associated resource `intf.172.17.0.0` to `down`. The prefix is `intf` and the suffix is the network corresponding to the virtual IP.
- The default failover rule, named `interface_failure`, executes a `wait`.

  It stops the module, and its application, then puts it in the state `WAIT`, waiting for `intf.172.17.0.0` reset to `up` by the checker.

Note: do not use `check="on"` on bonding or teaming interface because these interfaces bring their own failover mechanisms from interface to interface

1. Remove the Ethernet cable from the network card (on which the virtual IP is configured) on the server in `(Ready)` state. That is in state `PRIM` or `ALONE` for a mirror module, `UP` for a farm module.
   - messages in the log:

     "Resource intf.172.17.0.0 set to down by intfcheck"
     "Action wait from failover rule interface_failure"

   - the module becomes `WAIT (NotReady)`

     Note: a `wait` on `PRIM (Ready)` causes a failover
2. Plug the cable again
   - messages in the log

     "Resource intf.172.17.0.0 set to up by intfcheck"
     "Action wakeup from failover rule Implicit_wakeup"

   - the module becomes `(Ready)`, respectively in state `SECOND`, `ALONE` or `UP`
3. Repeat the test on the same server

   By default, on the 4th error detection within 24 hours (see `maxloop` and `loop_interval` in section 13.2.3), the module becomes `STOP (NotReady)`. In the log, message before stopping:

   "Action stop called by maxloop"

Note: disabling the interface (instead of unplugging the ethernet cable) leads to `STOP (NotReady)` if this network is also used for heartbeat. The reason is that the module cannot start (or restart) without local IP address.

4.4.5 Test <ping> checker with action wait

For a description of ping checker, refer to section 13.12.

In userconfig.xml:

```
<check>
  <ping ident="id" when="pre"
action="wait">
    <to addr="extip"/>
  </ping>
</check>
```

The checker checks that the external device (ex.: a router) with address extip responds to ping.

- when="pre"

  The checker starts before, stops after, the application integrated into the module (in start_xx /stop_xx).

- action="wait"

  If the ping fails, the checker sets the resource ping.id to down. The associated failover rule, named p_id, executes a wait.

  It stops the module, and its application, then puts it in the state WAIT, waiting for ping.id reset to up by the checker.

1. Break the link between the pinged external device and the server the server in (Ready) state. That is in state PRIM, ALONE or SECOND for a mirror module, UP for a farm module
   - messages in the log:

     "Resource ping.id set to down by pingcheck"
     "Action wait from failover rule p_id"

   - the module becomes WAIT (NotReady) on all nodes

     Note: a wait on PRIM (Ready) causes a failover

2. Restore the network connection
   - messages in the verbose log

     "Resource ping.id set to up by pingcheck"
     " Action wakeup from failover rule Implicit_wakeup "

   - the module becomes (Ready), respectively in state SECOND, ALONE, PRIM or UP

4. Repeat the test

   By default, on the 4th error detection within 24 hours (see maxloop and loop_interval in section 13.2.3), the module becomes STOP (NotReady). In the log, message before stopping:

   "Action stop called by maxloop"

Note: This test allows testing of connectivity to an external device. But if this one is down or is unreachable on all servers, all servers are in state WAIT (NotReady) and the application is unavailable.

4.4.6 Test <module> checker with action wait

For a description of module checker, refer to section 13.16.

In userconfig.xml of AM module:

```
<check>
  <module name="othermodule">
    <to addr="ip" addr="9010"/>
  </module>
</check>
```

1. Stop the module othermodule. And start the module AM on all servers.
   - messages in the log of module AM

   "Resource module.othermodule_ip set to down by modulecheck"

The checker in AM checks the module othermodule on its virtual IP address ip.

- If the module othermodule is not started, the checker set the associated resource module.othermodule_ip to down. The prefix is module, and the suffix is the other module name and address.
- The default failover rule, named module_failure, executes a wait.

  It stops the module AM, and its application, then puts it in the state WAIT, waiting for module.othermodule_addr reset to up by the checker.
- If the module othermodule is restarted, the checker executes a stopstart on AM.

Note: if the module AM is a mirror module using file replication and because of rule notuptodate_server, you may experience a wrong behavior with module AM blocked in a WAIT state, if the stopstart action happens when AM in the transition SECOND to ALONE

"Action wait from failover rule module_failure"

  - the module AM becomes WAIT (NotReady) on all servers

2. Start the module othermodule
   - messages in the verbose log of module AM

     "Resource module.othermodule_ip set to up by modulecheck"
     "Action wakeup from failover rule Implicit_wakeup"

   - the module AM goes (Ready) on all nodes
3. Run a restart on othermodule
   - messages in the log of module AM

     "Action stopstart called by modulecheck"

   - the module AM stops and then automatically starts
4. Repeat the test on the same server

   By default, on the 4th error detection within 24 hours (see maxloop and loop_interval in section 13.2.3), the module becomes STOP (NotReady). In the log, message before stopping:

   "Action stop called by maxloop"

4.4.7 Test <custom> checker with action wait

For a description of custom checker, refer to section 13.15.

In userconfig.xml:

```
<check>
  <custom ident="id" when="pre"
exec="customscript" action="wait" />
  </custom>
</check>
```

The custom checker is an infinite loop that performs a test and assigns the associated resource as up or down based on the test result.

- when="pre"

  The checker starts before, stops after, the application integrated into the module (in start_xx /stop_xx).

1. Cause the failure of the custom checker test when the server is in state (Ready). That is in state PRIM, ALONE or SECOND for a mirror module, UP for a farm module:
   - messages in the log:

     "Resource custom.id set to down by customscript"
     "Action wait from failover rule c_id"

   - the module becomes WAIT (NotReady) on all nodes

     Note: a wait on PRIM (Ready) causes a failover

<table>
<tr>
<td>

- `exec="customscript"`

  Script located under *AM*/bin/customscript that sets the resource custom.id:

  - on error

    ```
    SAFE/safekit set -r custom.id -v down  -i customscript
    ```

  - on success

    ```
    SAFE/safekit set -r custom.id -v up  -i customscript
    ```

- `action="wait"`

  When the custom.id is down, the associated failover rule, named c_id, executes a wait.

  It stops the module, its application, and the checker, then puts it in the state WAIT, waiting for custom.id reset to up by the checker.

</td>
<td>

2. Fix the error tested by the custom checker
   - messages in the verbose log

     "Resource custom.id set to up by customscript"
     "Action wakeup from failover rule Implicit_wakeup"

   - the module becomes (Ready), respectively in state SECOND, ALONE, PRIM or UP
3. Repeat the test on the same server.

   By default, on the 4th error detection within 24 hours (see maxloop and loop_interval in section 13.2.3), the module becomes STOP (NotReady). In the log, message before stopping:

   "Action stop called by maxloop"

</td>
</tr>
</table>

The action associated with the custom checker can be defined through an explicit failover rule instead of the action attribute, which in this case is set to noaction. The following example is equivalent to the previous one, except for the name of the failover rule, which is customid_failure:

```
<check>
  <custom ident="id" when="pre" exec="customscript" action="noaction" />
  </custom>
</check>
<failover>
  <![CDATA[
   customid_failure: if (custom.id == down) then wait();
  ]]>
</failover>
```

This syntax is the one supported before SafeKit 8.

4.4.8 Test <custom> checker with action restart or stopstart

For a description of custom checker, refer to section 13.15.

4.4.8.1 Action through a failover rule

<table>
<tr>
<td>

In userconfig.xml:

```
<check>
  <custom ident="id" when="prim"
exec="customscript" action="restart"
/>
  </custom>
</check>
```

</td>
<td>

1. Cause the failure of the custom checker test when the server is in state (Ready). That is in state PRIM, ALONE or SECOND for a mirror module, UP for a farm module:
   - messages in the verbose log:

     "Resource custom.id set to down by customscript"

</td>
</tr>
</table>

The custom checker is an infinite loop that performs a test and assigns the associated resource as `up` or `down` based on the test result.

- `when`
  - o `when="prim"` for mirror module

    checker started/stopped on the server in state ✓ `PRIM` or `ALONE (Ready)`, after/before the application (`start_prim/stop_prim`)
  - o `when="both"` for farm module

    checker started/stopped on all servers ✓ `UP (Ready)` after after/before the application (`start_both/stop_both`)
- `exec="customscript"`

  Script located under `AM/bin/customscript` that sets the resource `custom.id`:
  - o on error

    `SAFE/safekit set -r custom.id -v down -i customscript`
  - o on success

    `SAFE/safekit set -r custom.id -v up -i customscript`
- `action`

  When the `custom.id` is down, the associated failover rule, named `c_id`, executes a `restart` or `stopstart`.
  - o `action="restart"`

    It restarts locally the application (`stop_xx; start_xx`).
  - o `action="stopstart"`

    It stops completely the module, its application, and the checker, and then automatically starts it.

    and

    "Action restart from failover rule c_id "

    or

    "Action stopstart from failover rule c_id "
  - o the module becomes `(Transient)`.
  - o in case of `restart`, the module becomes ✓ `(Ready)`, respectively in state `PRIM`, `ALONE` or `UP`
  - o in case of `stopstart`, the module becomes ✓ `(Ready)`, respectively in state `SECOND`, `ALONE` or `UP`

    Message in the log:

    "Action start called automatically"

    Note: a `stopstart` on ✓ `PRIM (Ready)` causes a failover.

2. Repeat the test on the same server.

   By default, on the 4th error detection within 24 hours (see `maxloop` and `loop_interval` in section 13.2.3), the module becomes ✗ `STOP (NotReady)`. In the log, message before stopping:

   "Action stop called by maxloop"

The action associated with the custom checker can be defined through an explicit failover rule instead of the `action` attribute, which in this case is set to `noaction`. The following example is equivalent to the previous one, except for the name of the failover rule, which is `customid_failure`:

```
<check>
  <custom ident="id" when="pre" exec="customscript" action="noaction" />
  </custom>
</check>
<failover>
  <![CDATA[
   customid_failure: if (custom.id == down) then restart();
  ]]>
</failover>
```

This syntax is the one supported before SafeKit 8.

4.4.8.2 Action through a command in the custom checker

In `userconfig.xml`:

```
<check>
  <custom ident="id" when="prim"
exec="customscript"
action="noaction" />
  </custom>
</check>
```

The custom checker is an infinite loop that performs a test and execute `restart` or `stopstart` based on the test result.

- `when`
  - `when="prim"` for mirror module

    checker started/stopped on the server in state `PRIM` or `ALONE` `(Ready)`, after/before the application (`start_prim/stop_prim`)
  - `when="both"` for farm module

    checker started/stopped on all servers `UP (Ready)` after after/before the application (`start_both/stop_both`)
- `action="noaction"`

  No failover rule generated.
- `exec="customscript"`

  Script located under *`AM`*`/bin/customscript` that sets the resource `custom.id`:
  - on error

    `SAFE/safekit restart -i customscript`

1. Cause the failure of the custom checker test when the server is in state `(Ready)`. That is in state `PRIM`, `ALONE` or `SECOND` for a mirror module, `UP` for a farm module:
   - messages in the verbose log:

     "Action restart called by customscript"

     ou

     "Action stopstart called by customscript"
   - the module becomes `(Transient)`.
   - in case of `restart`, the module becomes `(Ready)`, respectively in state `PRIM`, `ALONE` or `UP`
   - in case of `stopstart`, the module becomes `(Ready)`, respectively in state `SECOND`, `ALONE` or `UP`

     Message in the log:

     "Action start called automatically"

     Note: a `stopstart` on `PRIM (Ready)` causes a failover.
2. Repeat the test on the same server.

   By default, on the 4th error detection within 24 hours (see `maxloop` and `loop_interval` in section 13.2.3), the module becomes `STOP (NotReady)`. In the log, message before stopping:

   "Action stop called by maxloop"

Note: on a direct action in the custom checker, the `maxloop` counter is incremented only if `-i identity` is passed to the command restart or stopstart. Without identity, SafeKit considers the command is as an administrative

It restarts locally the application (`stop_xx`; `start_xx`). or o on error `SAFE/safekit stopstart -i customscript` It stops completely the module, its application, and the checker, and then automatically starts it.	operation. The counter is reset and there is no stop after 4 restarts.

5. Mirror module administration

➾ Section 5.1 "Operating mode of a mirror module"

➾ Section 5.2 "State automaton of a mirror module (STOP, WAIT, ALONE, PRIM, SECOND - NotReady, Transient, Ready)"

➾ Section 5.3 "First start-up of a mirror module (`safekit prim` command)"

➾ Section 5.4 "Different reintegration cases (use of bitmaps)"

➾ Section 5.5 "Start-up of a mirror module with the up-to-date data `STOP (NotReady)` - `WAIT (NotReady)`"

➾ Section 5.6 "Degraded replication mode (`ALONE (Ready)` degraded)"

➾ Section 5.7 "Automatic or manual failover"

➾ Section 5.8 "Default primary server (automatic swap after reintegration)"

➾ Section 5.9 "Prim command fails: why? (`safekit primforce` command)"

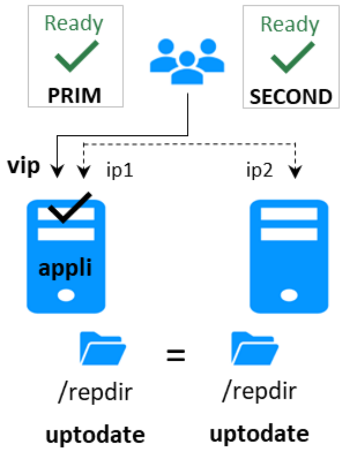
To test a mirror module, see section 4.2.

To analyze a problem, see section 7.

5.1 Operating mode of a mirror module

1. Normal operation

Stable state: primary with secondary.



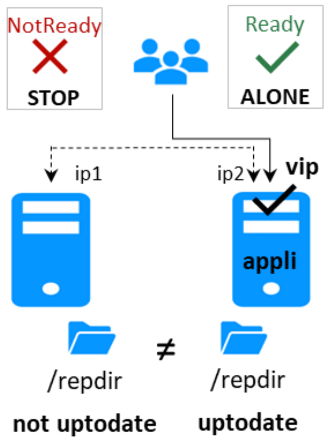
On the primary:

- Virtual IP is set
- Application is running
- Real-time file replication

The secondary is ready to run a failover and become primary.

2. Automatic failover

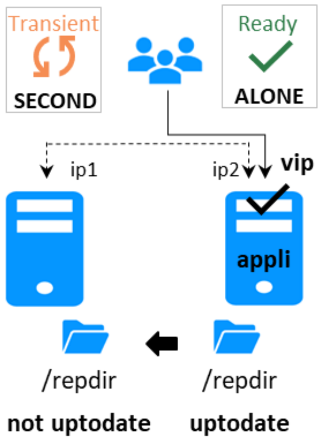
Stable state: primary without secondary.



On primary stop, automatic failover of the virtual IP and application.

3. Failback and reintegration

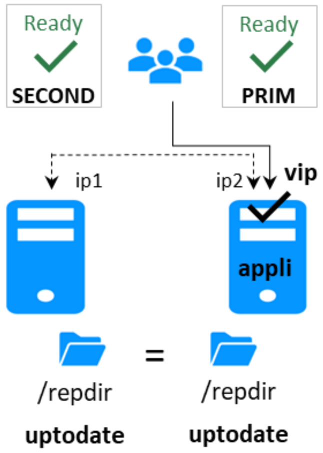
Transient state: secondary reintegrating.



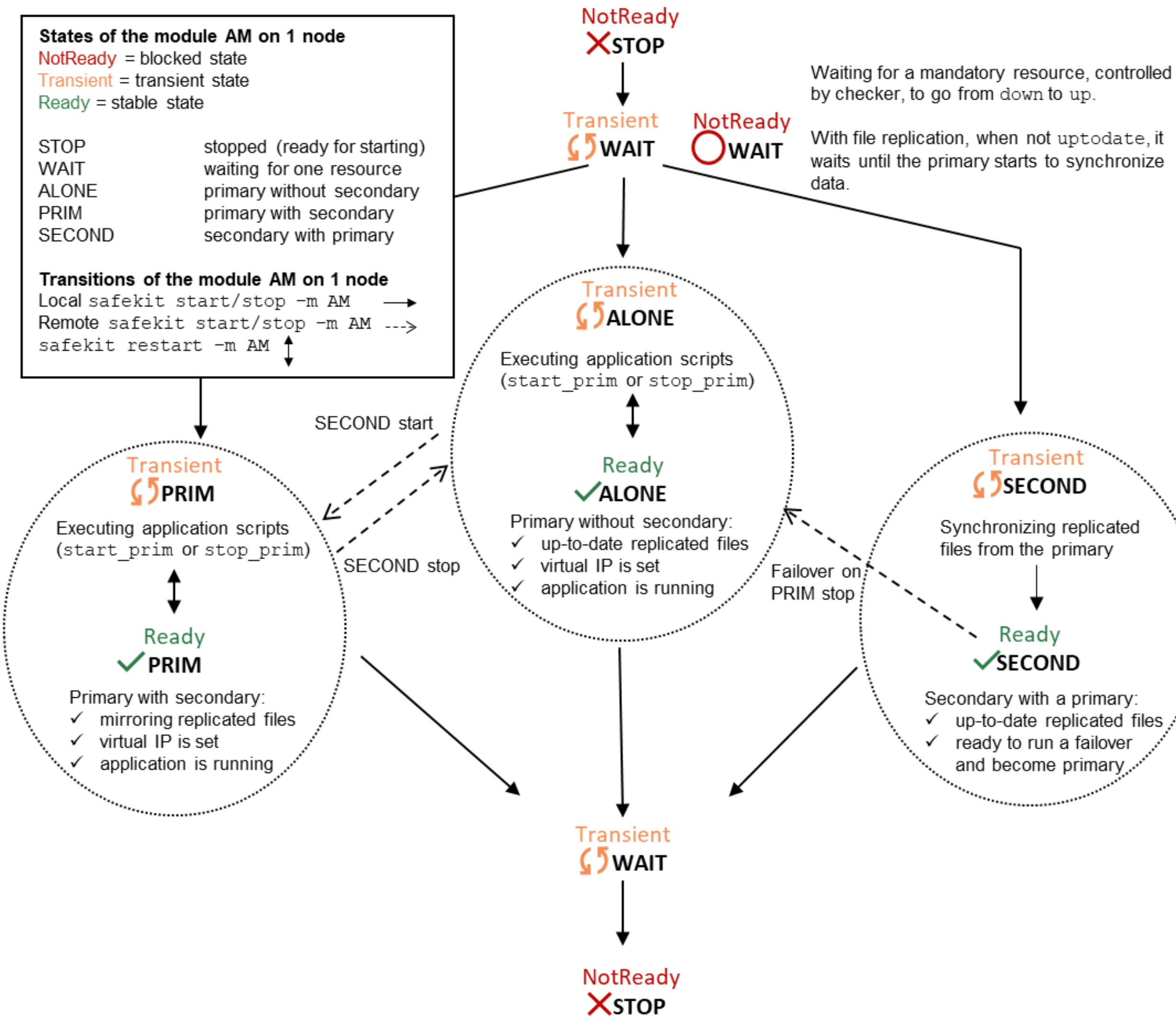
Automatic file synchronization without application shutdown and updating only the files that were modified on the primary while the other node was stopped.

4. Back to normal operation

Stable state: primary with secondary.



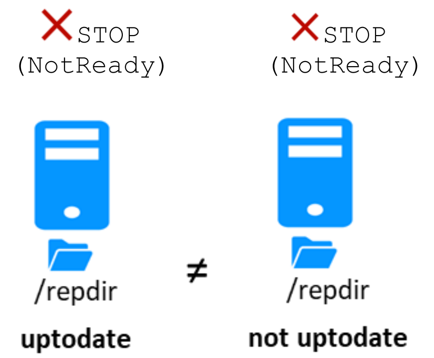
5.2 State automaton of a mirror module (STOP, WAIT, ALONE, PRIM, SECOND - NotReady, Transient, Ready)



5.3 First start-up of a mirror module (`safekit prim` command)

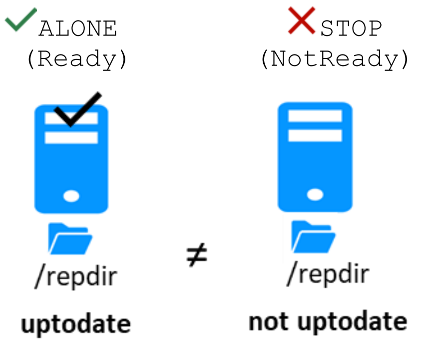
At first start-up of a mirror module, if both servers are started with the start command, both go into `WAIT (NotReady)` state with the message "Data may be not uptodate for replicated directories (wait for the start of the remote server)" in the log.
At first start-up of a mirror module, use the special `prim` command on the server with the up-to-date directory, and the second command on the other one. Data is synchronized from the primary server to the secondary one.
For next start-up, use the start command on both servers.

1. **initial state**
   - the mirror module has just been configured with a new directory to replicate between node1 and node2
   - node1 has the up-to-date directory
   - node2 has an empty directory



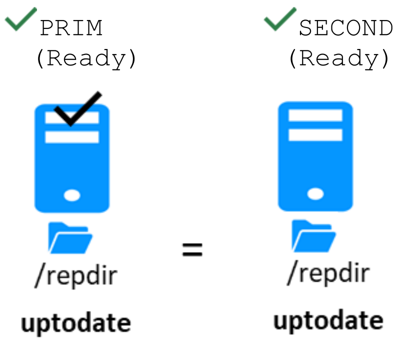
2. **command `prim` on node1**
   - use the special `prim` command to force node1 to become primary
   - for following start-ups, always prefer start: see section 5.5
   - message in the log:

   "Action prim called by admin@<IP>/SYSTEM/root"



3. **command `second` on node2**
   - start the other server as secondary
   - the secondary reintegrates replicated directory from primary
   - message in the log:

   "Action second called by admin@<IP>/SYSTEM/root"



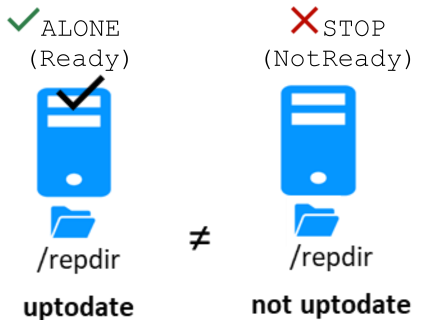
5.4 Different reintegration cases (use of bitmaps)

To optimize file reintegration, different cases are considered:

1. The module must have completed the reintegration (on the first start of the module, it runs a full reintegration) before enabling the tracking of modification into bitmaps
2. If the module was cleanly stopped on the server, then at restart of the secondary, only the modified zones of modified files are reintegrated, according to a set of modification tracking bitmaps.
3. If the server crashed (power off) or was incorrectly stopped (exception in nfsbox replication process), or if files have been modified while SafeKit was stopped, the modification bitmaps are not reliable, and are therefore discarded. All the files bearing a modification timestamp more recent than the last known synchronization point minus a grace delay (typically one hour) are reintegrated.
4. A call to the special `second fullsync` command triggers a full reintegration of all replicated directories on the secondary when it is restarted.

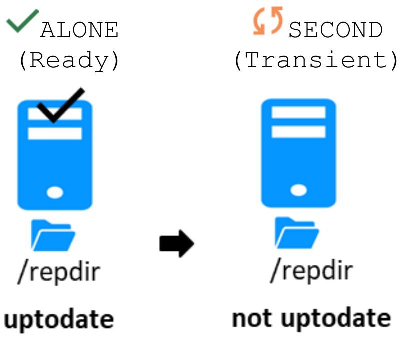
1. secondary server2 has been stopped

- data is desynchronized



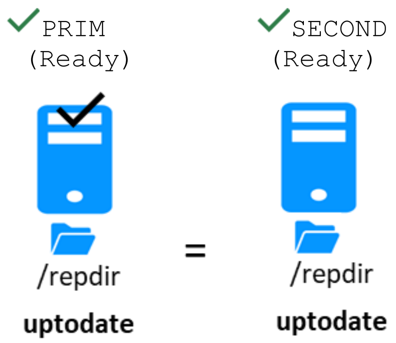
2. `start` command on node2

- data is reintegrated with bitmap optimization (see above)



3. end of reintegration

- data is the same on both servers
- only modifications inside files are replicated with a real-time synchronous replication



The replication system also keeps track of the last date on which data was synchronized on each node. This synchronization date, named `synctimestamp`, is assigned at the end of the reintegration and changes in the ✓`PRIM (Ready)` and ✓`SECOND (Ready)` states. When the module is stopped on the secondary node and then restarted, the `synctimestamp` is one of the reintegration criteria: all files modified around this date are potentially out of date on the secondary and must be reintegrated. Since SafeKit 7.4.0.50, the synchronization date is also used to implement an additional security. When the difference between the synchronization date stored on the primary and on the secondary is greater than 90 seconds, the replicated data is considered unsynchronized in its entirety. The reintegration is interrupted with the following message in the module log:

"| 2021-08-06 08:40:20.909224 | reintegre | E | Automatic synchronization cannot be applied due to an abnormal delta between the dates of the last synchronization"

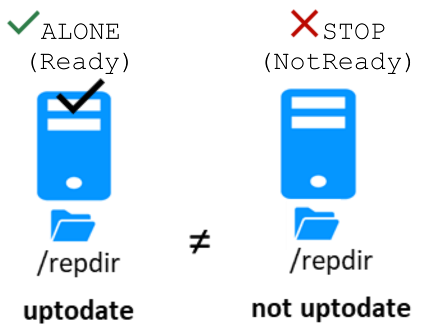
If the administrator considers that the server is valid, he can force the start in secondary with full synchronization of the data, by executing the command: `safekit second fullsync -m` *`AM`*.

5.5 Start-up of a mirror module with the up-to-date data ✗`STOP (NotReady)` - ○`WAIT (NotReady)`

SafeKit determines which server must start as primary or not. SafeKit retains the information on the server with the up-to-date replicated directories. To take advantage of this feature, use the command start and NOT the command prim

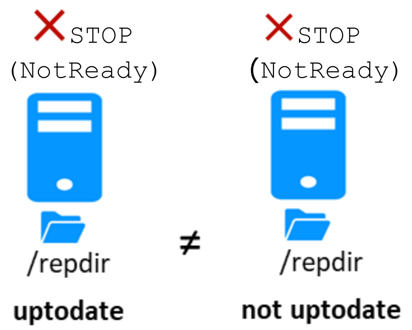
1. initial state

- server1 is primary `ALONE`
- directories are up-to-date on this server
- the module is stopped on node2
- node2 has desynchronized replicated directories



2. command `stop` on node1

- stop of the server with the up-to-date directories

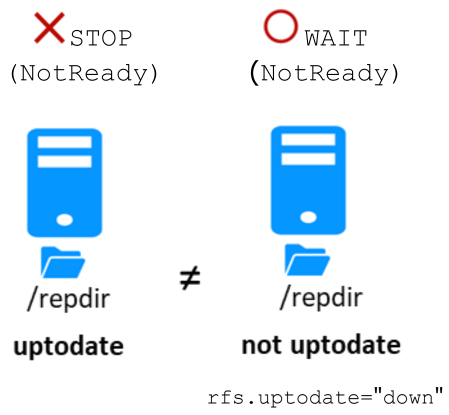


3. command `start` on node2

- the module is put in the `WAIT` state waiting for the start of the other server and within its log of messages:

  "Data may be not uptodate for replicated directories (wait for the start of the remote server)"
  "Action wait from failover rule notuptodate_server"
  "If you are sure that this server has valid data, run safekit prim to force start as primary"

- in this case, you must start server1 to resynchronize data of server2
- if you really want to sacrifice the up-to-date data and start node2 as primary with the data not up-to-date: issue a stop command then a prim command on node2



See also section 5.9.

5.6 Degraded replication mode (✓`ALONE (Ready)` degraded)

If the replication process nfsbox fails on the primary server (for instance because of an unrecoverable replication problem), the application is not swapped on the secondary server

The primary server goes to the `ALONE` state in a degraded replication mode.

Degraded is displayed in the web console. A message is emitted in the log:

"Resource rfs.degraded set to up by nfsadmin"

`safekit state -v -m` *`AM`* returns resource `rfs.degraded` up (replace *`AM`* by the module name)

The primary server continues in `ALONE` state with a nfsbox process which does not replicate anymore.

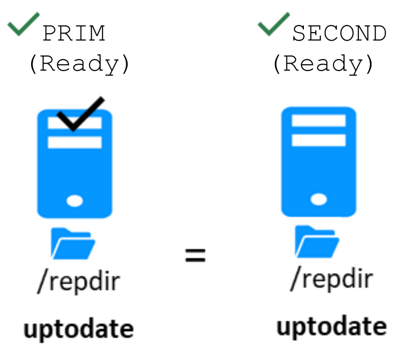
You must stop and start the `ALONE` server to come back to a `PRIM` - `SECOND` state with replication

1. initial state

the mirror is in a stable state:

node1 ✓`PRIM (Ready)`

node2 ✓`SECOND (Ready)`



2. failure of replication process nfsbox on node1

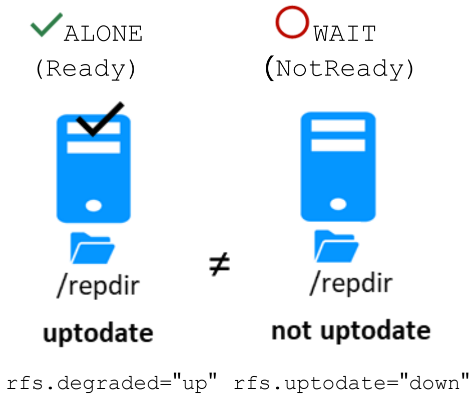
- node1 becomes ALONE (Ready) degraded with the message in its log

  "Resource rfs.degraded set to up by nfsadmin".

- `safekit state -v AM` returns resource rfs.degraded=up (where *AM* is the module name)
- node1 `ALONE` continues to execute the application without replication
- node2 is in `WAIT (NotReady)` waiting for the replication process with the message in its log

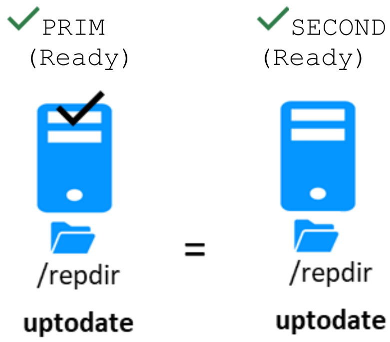
  "Action wait from failover rule degraded_server"

  and with rfs.uptodate="down"



3. come back to replication

- administrator makes stop command and start command on node1 `ALONE`
- the nfsbox replication process is restarted on node1
- node2 reintegrates replicated directories before becoming `SECOND (Ready)`
- node1 becomes `PRIM (Ready)`



5.7 Automatic or manual failover

Automatic or manual failover on the secondary server is defined in `userconfig.xml` by `<service mode="mirror" failover="on"|"off">`. By default, if the parameter is not defined, `failover="on"`

The `failover="off"` mode is useful when the failover must be controlled by an administrator. This mode ensures that an application runs always on the same primary server whatever operations are made on the server (reboot, temporary stop of the module for maintenance...). Only an explicit administrative action (`prim` command) may promote the other server as primary.

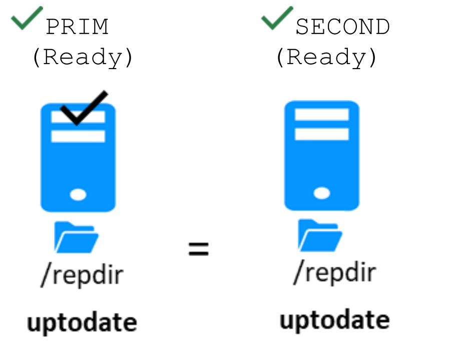
Failover mode could be set dynamically with the `safekit failover on|off -m AM` (replace *AM* by the module name).

1. initial state

the mirror is in a stable state:

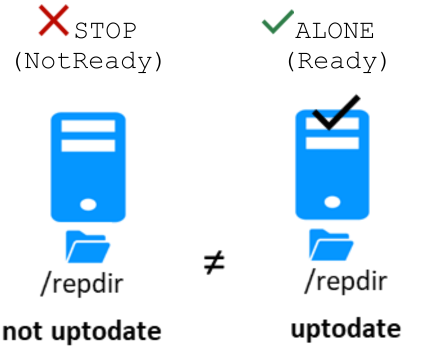
node1 ✓`PRIM (Ready)`

node2 ✓`SECOND (Ready)`



2. restart with `failover="on"`

- if node1 former `PRIM` fails and stops, node2 becomes automatically ✓`ALONE (Ready)` (default mode)



3. behavior with `failover="off"`

- if node1 former `PRIM` fails and stops, node2 goes to ○`WAIT (NotReady)` state with message in its log

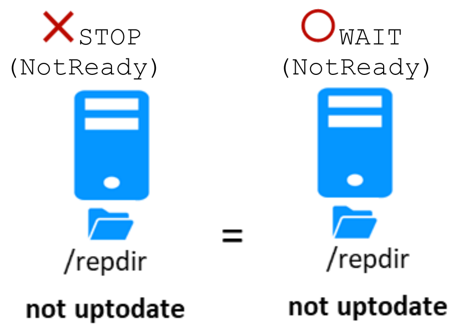
  "Failover-off configured"
  "Action stopstart called by failover-off"
  "Transition STOPSTART from failover-off"
  "Local state `WAIT NotReady` "

- the administrator in this situation can restart node1: the mirror restarts in its former stable state

  node1 ✓`PRIM (Ready)`

  node2 ✓`SECOND (Ready)`

- the administrator can decide to force node2 to become primary with the command: `stop` then `prim` on node2



See also section 5.9

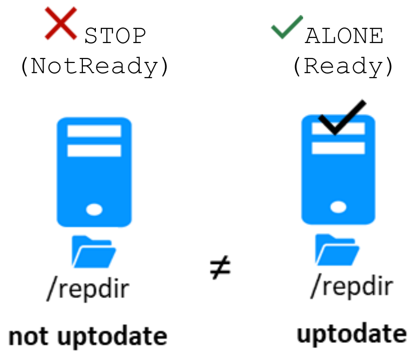
5.8 Default primary server (automatic swap after reintegration)

After reintegration at failback, a server becomes by default secondary. The administrator may choose to swap the application back to the reintegrated server at an appropriate time with the `swap` command. This is the default behavior when `userconfig.xml` <service> is defined without the `defaultprim` variable

If the application must automatically swap back to a preferred server after reintegration, specify a defaultprim server in `userconfig.xml`: `<service mode="mirror" defaultprim="hostname node1">`

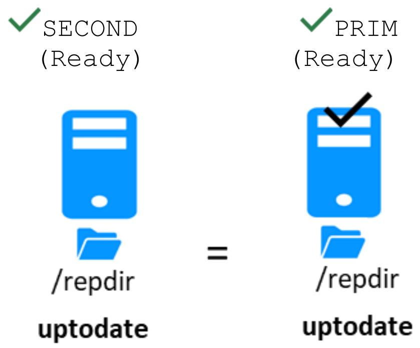
1. initial state

- node1 (former `PRIM`) fails and stops
- node2 secondary becomes automatically `ALONE`



2. failback without `defaultprim`

- node1 is restarted with command start
- it reintegrates replicated directories and then becomes secondary
- an administrator can swap the primary to node1 with the command `swap` in a timely manner
- swap stops the application on node2 and restarts it on node1

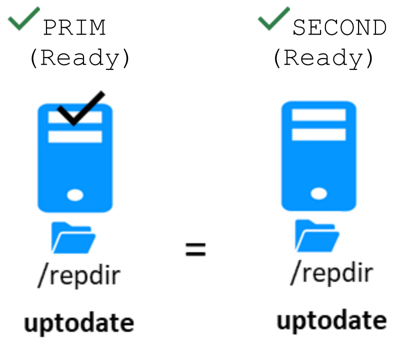


3. **failback with `defaultprim="hostname node1"`**

   - node1 in `STOP (NotReady)` at step 1 (initial state) is restarted by command start
   - it reintegrates replicated directories
   - just after reintegration, an automatic swap is made on node1 with the message in its log:

     "Transition SWAP from defaultprim"
     "Begin of Swap"

   - the application is then automatically stopped on node2 and restarted on node1
   - at the end, node1 is `PRIM`

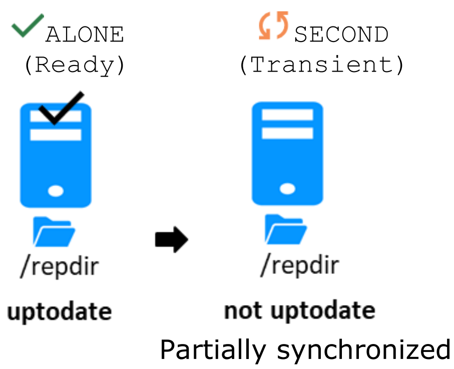


5.9 Prim command fails: why? (`safekit primforce` command)

A prim command may fail to start a server as primary: after trying a start-up, the server goes back to `STOP (NotReady)`.

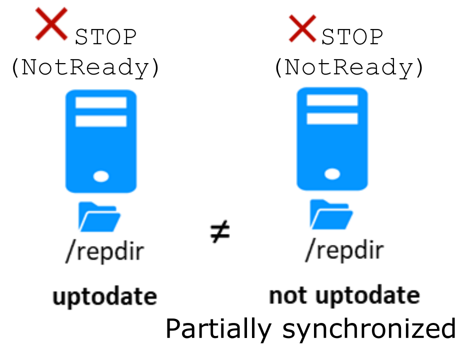
1. **initial state**

   - node1 `ALONE` has the up-to-date directory
   - node2 is in the process of reintegrating files from node1



2. **command `stop` on node2 then on node1**

   - stop of node2 during its reintegration: stop of node2 can be made while a file that is half copied (corrupted file)
   - node1 is also stopped



3. command prim on node2

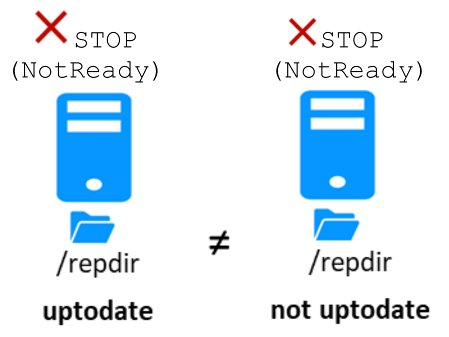
- fails with messages in the log described above

  "Data may be inconsistent for replicated directories (stopped during reintegration)"
  "If you are sure that this server has valid data, run safekit primforce to force start as primary"

- in this case, you must start node1 with start command or prim command. And to restart node2 with start command to finish reintegration of files. While node2 is not in the state `SECOND (Ready)`, its data may be corrupted

- if you absolutely want to start as primary on node2 partially reintegrated and with data potentially corrupted, use the command `safekit primforce -m` *`AM`* on node2 (command line only, where *`AM`* is the module name). Message in the log:

  "Action primforce called by SYSTEM/root"



Partially synchronized

The command prim fails since the data may be corrupted

Note: The `safekit primforce -m` *`AM`* command forces a full reintegration of replicated directories on the secondary when it is restarted.

6. Farm module administration

➩ Section 6.1 "Operating mode of a farm module"

➩ Section 6.2 "State automaton of a farm module (STOP, WAIT, UP - NotReady, Transient, Ready)"

➩ Section 6.3 "Start-up of a farm module"

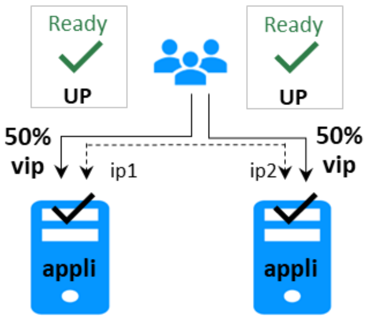
To test a farm module, see section 4.3.

To analyze a problem, see section 7.

6.1 Operating mode of a farm module

1. Normal operation

Stable state: 2 active nodes.



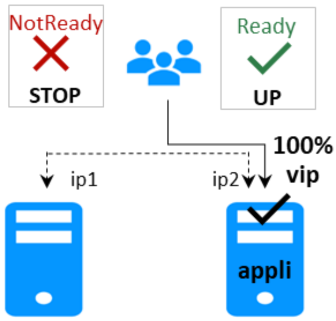
On all nodes:

- Virtual IP is set
- Application is running
- Network load sharing is distributed among all nodes

Each node is ready to run a failover and take 100% of the load.

2. Automatic failover

Stable state: 1 active node.

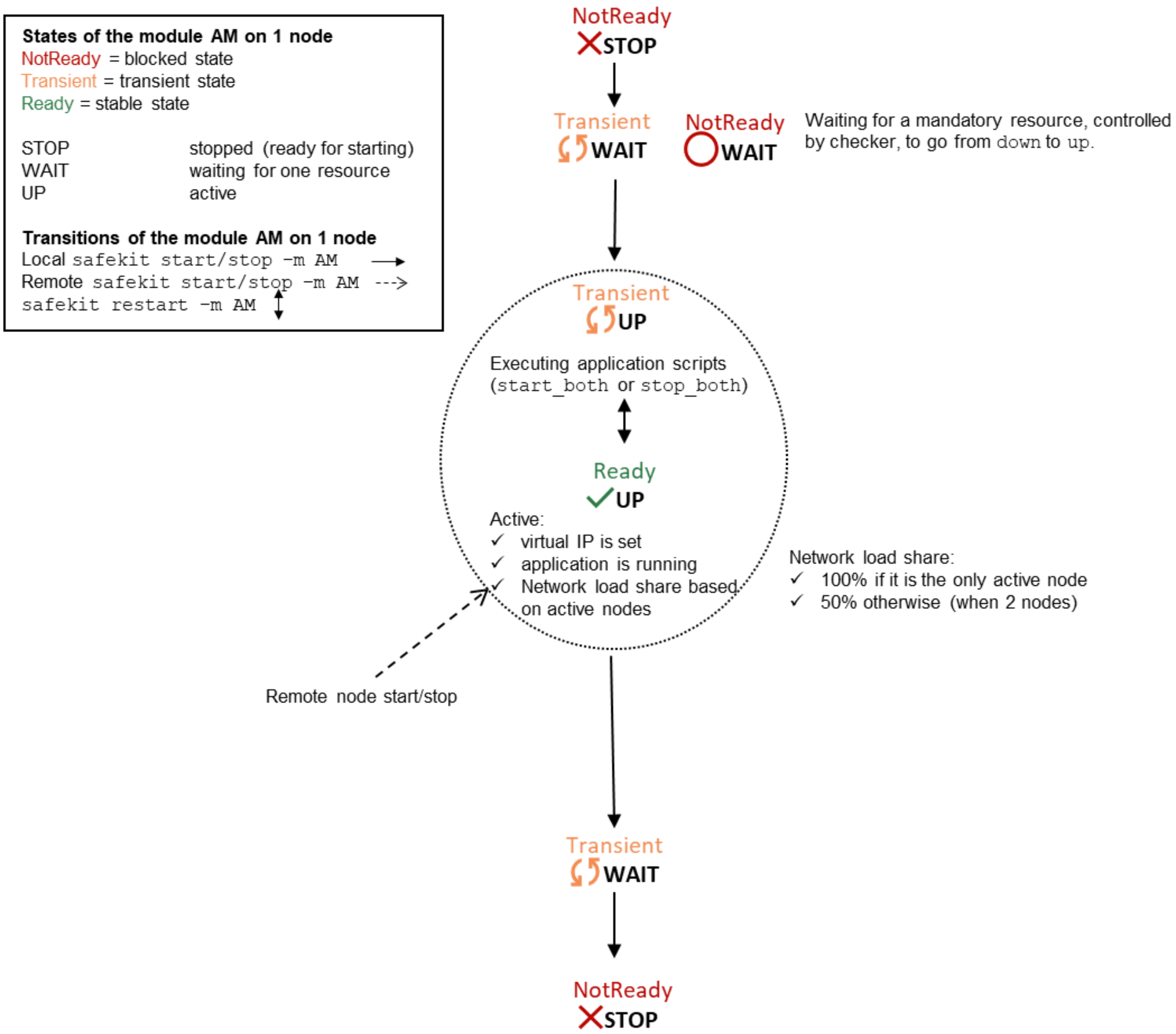


On remote node stop, automatic failover of the network load sharing.

3. Back to normal operation

Stable state: 2 active nodes.

6.2 State automaton of a farm module (STOP, WAIT, UP - NotReady, Transient, Ready)



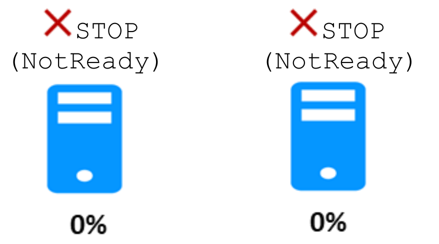
Note: This is also the state automation of a light module. A light module is identified by `<service mode="light">` in `userconfig.xml` file under `SAFE/modules/`*`AM`*`/conf` (where *`AM`* is the module name). The light type corresponds to a module that runs on one node without synchronizing with other nodes (as can-do mirror or farm modules). A light module includes the start and stop of an application as well as the SafeKit checkers that can detect errors.

6.3 Start-up of a farm module

Use the start command on each node running the module. An example with a farm of 2 servers is presented below.

1. initial state

- the farm module has just been configured on node1 and node2

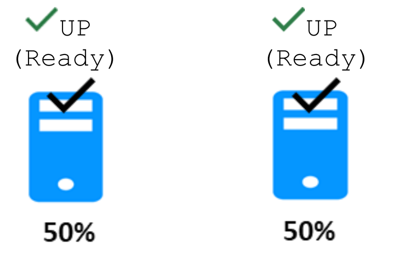


2. command `start` on node1 and node2

- message in the log of both servers:

  "farm membership: **node1 node2** (group FarmProto_0)"
  "farm load: **128/256** (group FarmProto_0)"
  "Local state `UP` Ready"

- resource of the module instance on both nodes: `FarmProto_0 50%`



7. Troubleshooting

- Section 7.1 "Connection issues with the web console"
- Section 7.2 "Connection issues with the HTTPS web console"
- Section 7.3 "How to read logs and resources of the module?"
- Section 7.4 "How to read the commands log of the server?"
- Section 7.5 "Stable module (Ready) and (Ready)"
- Section 7.6 "Degraded module (Ready)and / (NotReady)"
- Section 7.7 "Out of service module / (NotReady) and / (NotReady)"
- Section 7.8 "Module STOP (NotReady): start the module"
- Section 7.9 "Module WAIT (NotReady): repair the resource="down""
- Section 7.10 "Module oscillating from (Ready) to (Transient)"
- Section 7.11 "Message on stop after maxloop"
- Section 7.12 "Module (Ready) but non-operational application"
- Section 7.13 "Mirror module ALONE (Ready) - WAIT/STOP (NotReady)"
- Section 7.14 "Farm module UP(Ready)but problem of load balancing in a farm"
- Section 7.15 "Problem with the virtual IP after failover"
- Section 7.16 "Problem after Boot"
- Section 7.17 "Analysis from snapshots of the module"
- Section 7.18 "Problem with the size of SafeKit databases"
- Section 7.19 "Problem for retrieving the certification authority certificate from an external PKI"
- Section 7.20 "Issue with email sending by the SafeKit notification agent"
- Section 7.21 "Still in Trouble"

7.1 Connection issues with the web console

If you encounter problems for connecting to the SafeKit web console to SafeKit node, such as no reply or connection error, run the following checks and procedures:

- section 7.1.1 "Browser check"
- section 7.1.2 "Browser state clear"
- section 7.1.3 "Server check"

Then, it may be necessary to reload the console into the browser.

7.1.1 Browser check

For the web browser:

1. check that it is a supported browser and its level
2. change the proxy settings for direct or indirect connection to the server

3. with Microsoft Edge, change the security settings (add the URL into the trusted zones)
4. clear the browser's state on upgrade as described below
5. check that the web console and the server are at the same level (backward compatibility may not be fully preserved)

7.1.2 Browser state clear

1. Clear the browser cache

   A quick way to do this is a keyboard shortcut that works on IE, Firefox, and Chrome. Open the browser to any web page and hold CTRL and SHIFT while tapping the DELETE key. (This is NOT CTRL, ALT, DEL). The dialog box will open to clear the browser. Set it to clear everything and click Clear Now or Delete at the bottom

2. Clear the browser SSL cache if HTTPS is used

   Look at advanced settings for the browser and search for SSL cache.

Finally close all windows for the browser, stop the browser process still running in the background if necessary, and re-open it fresh to test what wasn't working for you previously.

7.1.3 Server check

On each SafeKit cluster node check:

1. the firewall

   If this has not yet been done, run the `SAFE/private/bin/firewallcfg add` command which configures the operating system firewall. For other firewalls, add an exception to allow connections between the web browser and the server. For details, see section 10.3.

2. the web server configuration

   HTTP access to the web console requires authentication. If it has not yet been done, run the `SAFE/private/bin/webservercfg -passwd pwd` to initialize (or reinitialize) this configuration with the password of the user `admin`. For details, see section 11.2.1.

3. the network and the server availability
4. the `safeadmin` and `safewebserver` services

   They must be started.

5. the SafeKit cluster configuration

   Run the command `safekit cluster confinfo` (see section 9.2). This command must return on all nodes, the same list of nodes and the same value for the configuration signature. If not, reapply the cluster configuration on all nodes (see section 12.2).

7.2 Connection issues with the HTTPS web console

If you encounter problems for connecting the secure SafeKit web console to SafeKit nodes, you can run the following checks and procedures:

- ⇨ section 7.1 “Connection issues with the web console”
- ⇨ section 7.2.1 “Check server certificate”

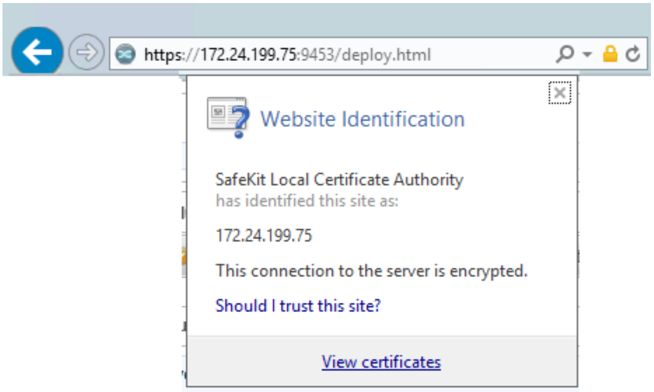
➾ section 7.2.2 "Check certificates installed in SafeKit"

➾ section 7.2.3 "Revert to HTTP configuration"

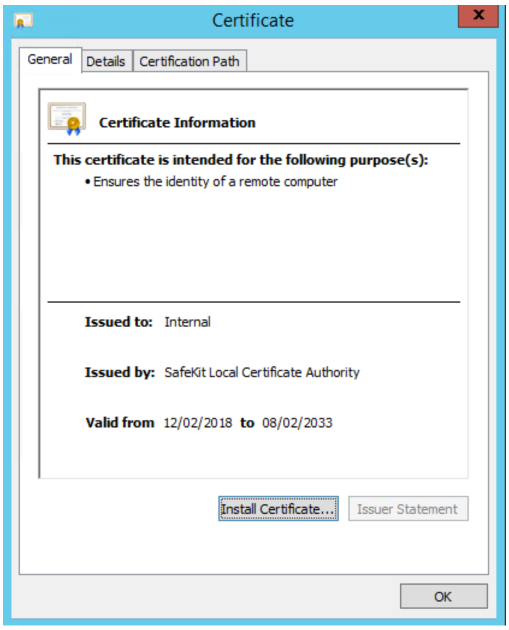
7.2.1 Check server certificates

The SafeKit web console connects to a SafeKit node that is identified by a certificate. To get the SafeKit node certificate content with Internet Explorer or Chrome, run the following:

1. Click on the lock next to the URL to open the security report
2. Click on the View certificates link. It opens a window that displays the certificate content



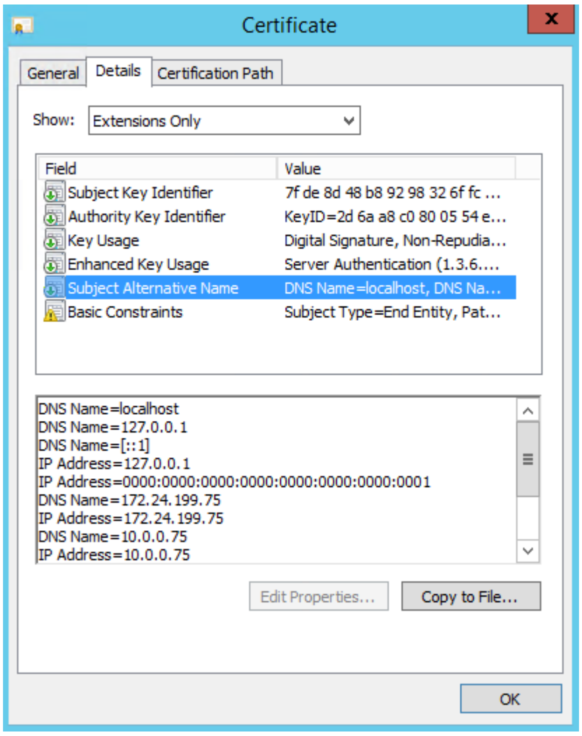
3. Check the issuer that must be the appropriate certification authority
4. Check the validity date and the workstation date. If necessary, change the workstation date
5. Check the validity date. If the certificate is expired, you must renew. For certificate generated with the SafeKit PKI, see section 11.3.1.9.1



6. Click on Details tab
7. Select Subject Alternate Name field. Its content is displayed into the bottom panel. The location set into the URL for connecting the SafeKit web console must be included into this list. Change the URL if necessary
8. The address value for the node, set into the SafeKit cluster configuration, must be one of the values listed. If it is not, change the cluster configuration as described in section 12.2.

   When using DNS name, you must use lower case.

With SafeKit <= 7.5.2.9, the server's name must be included.



7.2.2 Check certificates installed in SafeKit

You can use the `checkcert` command for checking all the certificates.

On each SafeKit nodes:

1. Log as administrator/root and open a command shell window
2. Change directory to `SAFE/web/bin`
3. Run `checkcert -t all`

   It checks all installed certificates and returns a failure if an error is detected
4. You can check that the server certificate contains some DNS name or IP address with:

   `checkcert -h "DNS name value"`

   `checkcert -i "Numeric IP address value"`

The server certificate must contain all DNS names and/or IP addresses used for HTTPS connection. These ones must also be included into the SafeKit cluster configuration file.

If the command fails, it may be due to an incorrect file format.

The content of a .crt file looks like:


```
-----BEGIN CERTIFICATE-----
MIID+DCCAuCgAwIBAgIFAJNuUj4wDQYJKoZIhvcNAQELBQAwUjEQMA4GA1UEChMH
RXhhbXBsZTEQMA4GA1UECxMHU2FmZUtpdDEsMCoGA1UEAxMjU2FmZUtpdCBMb2Nh
bCBDZXJ0aWZpY2F0ZSBBdXRob3JpdHkwHhcNMjQwNTI5MDYzMzIxWhcNNDQwNTI0
…
H/kG9pfzpnCEtZeyRCxGiowQpEmKtqOS51Xzg+q2tI7uiOAf5SVxHbqj/8c5RNZi
/iYlZg3itzIxLTPBEn3BD6pSVmRU33yU2cHo6HMsXXwFvo/LMOWNhVrj9I33d7u6
0fooCyU3aFbFCwGx
```

```
-----END CERTIFICATE-----
```

The content of a .key file looks like:


```
-----BEGIN PRIVATE KEY-----
MIIEvQIBADANBgkqhkiG9w0BAQEFAASCBKcwggSjAgEAAoIBAQCbSAP0f28TR3lj
jMRNabVP6725NQoH6Wt3O238aH8uXKKiI2byzWGXVjnrvT8AK+3lraQ4yLoAGtO3
LTsxsbuOQi90kwfelKNlQsIh3WJ7V6bGltLoQhT+bDdLJAPmLH1nFHKe19Tkvqr/
..
SUl5Ap71plSqrYlvNhkiOB50Hs34r+iNtPB6GaKtnTHicBjI1i95zrU/J5JKHxBV
uRY4ghOgtJyq9LuZXb2aTOht7K7QTjLRqHS5rdy+alSByhKpD2wR6oqX44mw1w1s
eOCnWlvhpFarc9As9BIVGsw=
-----END PRIVATE KEY-----
```


7.2.3 Revert to HTTP configuration

If the problem cannot be solved, you can revert to the HTTP configuration (where SAFE=C:\safekit in Windows if System Drive=C: ; and SAFE=/opt/safekit in Linux).

On S1 and S2:

1. remove the file SAFE/web/conf/ssl/httpd.webconsolessl.conf
2. run safekit webserver restart
3. clear the browser cache as described in section 7.1.2

7.3 How to read logs and resources of the module?

Module log and **Scripts log** for the module on one node may be analyzed with (replace below node1 by the node name and *AM* by the module name):

- the web console at URI /console/en/monitoring/modules/*AM*/nodes/node1/logs
- the command executed on node1 safekit logview -m *AM* for the module log
- on node1, into files SAFEVAR/modules/*AM*/userlog_<year>_<month>_<day>T<time>_<script name>.ulog for the scripts log

With the module log, you can understand why the module is no longer in its stable state (Ready).

With the scripts log, you can see the output messages of module scripts (start_xxx and stop_xxx).

Note that a module can leave its stable (Ready) because of an administrator command: safekit stop | restart | swap | stopstart | forcestop… -m *AM*

- You will find a list of SafeKit log messages in Log Messages Index.
- Messages in the log after an administrator command are:

```
"Action start called by admin@<IP>/SYSTEM/root"
"Action stop called by admin@<IP>/SYSTEM/root"
"Action restart called by admin@<IP>/SYSTEM/root"
"Action swap called by admin@<IP>/SYSTEM/root"
"Action stopstart called by admin@<IP>/SYSTEM/root"
"Action forcestop called by admin@<IP>/SYSTEM/root"
```

admin@<ip>: via the SafeKit console
SYSTEM: command on Windows
root: command on Linux

- If "Action stop called by maxloop" appears in the module log, see section 7.11

Resources state of the module on one node may be analyzed with (replace below `node1` by the node name and *AM* by the module name): • the web console at URI /console/en/monitoring/modules/*AM*/nodes/node1/resources • the command executed on `node1` `safekit state -m AM -v`	• Module status state.local, state.remote usersetting.errd, usersetting.checker, usersetting.encryption • Checkers proc.xxx, intf.xxx, custom.xxx • File replication rfs.uptodate, rfs.degraded, rfs.reintegre_failed

7.4 How to read the commands log of the server?

There is a log of the `safekit` commands ran on the server.

Commands log may be displayed using the command `safekit cmdlog`

See section 10.11 for more details

7.5 Stable module ✓ (Ready) and ✓ (Ready)

- A stable mirror module on 2 servers is in the state ✓`PRIM (Ready)` - ✓`SECOND (Ready)`: the application is running on the `PRIM` server; on failure, the `SECOND` server is ready to resume the application.
- A stable farm module is in the state ✓`UP (Ready)` on all servers of the farm: the application is running on all servers.

7.6 Degraded module ✓ (Ready) and ✗/○ (NotReady)

A degraded mirror module is in the state ✓`ALONE (Ready)` - ✗`STOP`/○`WAIT (NotReady)`. There is no recovery server, but the application is running on the `ALONE` server.

A degraded farm module is in the state ✓`UP (Ready)` on at least one server of the farm, the other servers being in the state ✗`STOP`/○`WAIT (NotReady)`. The application is running on the `UP` server.

In the degraded case, there is no emergency procedure to implement. Analysis of the state ✗`STOP`/○`WAIT (NotReady)` can be done later. However, you can attempt to restart the module in a stable state:

➩ See section 7.8 "Module ✗ `STOP (NotReady)`: start the module"

➩ See section 7.9 "Module ○ `WAIT (NotReady)`: repair the `resource="down"`"

7.7 Out of service module ✗/○ (NotReady) and ✗/○ (NotReady)

An out of service mirror or farm module is in the state ✗`STOP`/○`WAIT (NotReady)` on all servers. In this case, the application is not operational on any server anymore. You must restore the situation and restart the module in ✓ `(Ready)` on at least one server:

➾ See section 7.8 “Module ✕ `STOP (NotReady)`: start the module”

➾ See section 7.9 “Module ◯ `WAIT (NotReady)`: repair the `resource="down"`”

7.8 Module ✕ `STOP (NotReady)`: start the module

1. Start the stopped module (replace below *AM* by the module name) with:
    - the web console via Monitoring/••• on the node/ ▷ Start/
    - the command `safekit start -m AM` executed on the node
2. Check that the module becomes ✓ `(Ready)`.
3. Analyze results of start in the module and scripts logs (replace below `node1` by the node name and *AM* by the module name) with:
    - the web console at URI /console/en/monitoring/modules/*AM*/nodes/node1/logs
    - the command `safekit logview -m AM` on `node1`, for the module log
    - the files `SAFEVAR/modules/AM/userlog_<year>_<month>_<day>T<time>_<script name>.ulog` on `node1`, for the scripts log

7.9 Module ◯ WAIT (NotReady): repair the resource="down"

If the module is in the state ◯ `WAIT (NotReady)`, it waits for the state of a resource to become `up`. You must identify and fix the problem that caused the resource state to go `down`. To determine the resource involved, analyze the module log and resources (see section 7.3). **Notes:** A wait checker is started after the `prestart` script and stopped before `poststop`. The checker is active on all servers ✓ `ALONE/PRIM/SECOND/UP (Ready)`. The action of the checker upon detecting an error is to set a resource to `down`. A failover rule referencing the resource performs the `wait` action. The module is locally in state ◯ `WAIT (NotReady)` while the resource stays `down`.	Messages from wait checkers: • files not up-to-date locally: see section 5 "Data may be not uptodate for replicated directories (wait for the start of the remote server)" "Action wait from failover rule notuptodate_server" "If you are sure that this server has valid data, run safekit prim to force start as primary" • `<interface check="on">` checker of a local network interface "Resource intf.ip.0 set to down by intfcheck" "Action wait from failover rule interface_failure" • `<ping>` checker of an external IP "Resource ping.id set to down by pingcheck" "Action wait from failover rule ping_failure" • `<module>` checker of another module "Resource module.othermodule_ip set to down by modulecheck" "Action wait from failover rule module_failure" • `<tcp ident="id" when="pre">` checker of an external TCP service "Resource tcp.id set to down by tcpcheck" "Action wait from failover rule t_id"

The module exits the WAIT (NotReady) state as soon as the checker sets the resource back to up.	• <custom ident="id" when="pre"> customized checker "Resource custom.id set to down by customscript" "Action wait from failover rule customid_failure" <splitbrain> checker "Resource splitbrain.uptodate set to down by splitbraincheck" … "Action wait from failover rule splitbrain_failure" • Files not up-to-date locally due to split-brain: see section 13.17

7.10 Module oscillating from (Ready) to (Transient)

If a module oscillates from state (Ready) to state (Transient), it is probably a victim of a restart or stopstart checker which detects a constant error. By default, after the 4th unsuccessful restart on a server, the module stops, and the server stabilizes in STOP (NotReady). Use the module log to determine which checker is the source of the logs (to read logs, see section 7.3). **Notes:** A restart or stopstart checker is defined in userconfig.xml by: • when="prim" for a mirror module The checker is started on the node PRIM/ALONE (Ready) after script start_prim (stopped before stop_prim). It checks the application started in start_prim. • when="both" for a farm module The checker is started on all nodes UP (Ready) after script start_both (stopped before stop_both). It checks the application started in start_both. The action of a checker on an error is to restart or stopstart the module. stopstart on PRIM (Ready) leads to a failover of the primary on the other node.	Messages from restart or stopstart checkers: • <errd> in userconfig.xml checker of processes "Process appli.exe not running" "Action restart|stopstart called by errd" • <tcp ident="id" when="prim"|"both"> in userconfig.xml TCP checker of the application "Resource tcp.id set to down by tcpcheck" "Action restart|stopstart from failover rule tcp_failure" • <custom ident="id" when="prim"|"both"> in userconfig.xml custom checker "Resource custom.id set to down by customscript" "Action restart|stopstart from failover rule customid_failure" or "Action restart|stopstart called by customscript"

The module is in the state PRIM/UP (Transient) during the application restart. After several oscillations, the module stops with "Action stop called by maxloop" in the module log: see section 7.11.	

7.11 Message on stop after maxloop

If an error detected by a checker repeats itself several times and successively, the module is stopped on the server in STOP (NotReady) : because the error is permanent, and the action of the checker cannot correct it If in userconfig.xml, there is no parameter maxloop / loop_interval in <service>, by default, maxloop="3" loop_interval="24" if the checkers generate more than 3 unsuccessful restarts (restart, stopstart, wait) in less than 24H, then stop of module: STOP (NotReady). The counter is reset to 0 if an administrator executes an action on the module such as safekit start -m *AM* (replace *AM* by the module name) or safekit stop -m *AM* (without the option -i <identity>)	Message on stop after maxloop "Action stop called by maxloop"

7.12 Module (Ready) but non-operational application

If a server has a status of PRIM (Ready) or ALONE (Ready) or UP (Ready), the application can be non-operational because of undetected errors on start-up. In the following, replace node1 by the node name and *AM* by the module name.

1. Check the output messages of application scripts coming from start_prim/start_both and stop_prim/stop_both. They are visible in (replace below node1 by the node name and *AM* by the module name) with:

   - the web console at URI /console/en/monitoring/modules/*AM*/nodes/node1/logs
   - the files SAFEVAR/modules/*AM*/userlog_<year>_<month>_<day>T<time>_<script name>.ulog, on node1, for the scripts log

   Check if there are errors during start or stop of the application. Be careful, sometimes the userlog is disabled because it is too large with <user logging="none"> in userconfig.xml of the module.

2. Check application scripts start_prim(/both) and stop_prim(/both) of a mirror(/farm) and userconfig.xml with:

- the web console at URI /console/en/configuration/modules/*AM*/config
- under the directory `SAFE/modules/`*AM* on the node1

3. Execute a restart of the ✓`PRIM/ALONE/UP(Ready)` node to stop and restart locally the application (without failover) with:
   - the web console via Monitoring/••• on the node/Restart/
   - the command `safekit restart -m` *AM* executed on the node (replace *AM* by the module name)
4. If the application is still non-operational, apply a stop ✓`PRIM/ ALONE / UP(Ready)` node to stop and the application (stopstart makes a failover if the other node is `Ready`) with:
   - the web console via Monitoring/••• on the node/ Stop/
   - the command `safekit stop -m` *AM* executed on the node

7.13 Mirror module ✓ALONE (Ready) - ○WAIT/✗STOP (NotReady)

If a mirror module stays in state ✓`ALONE(Ready)` - ○`WAIT(NotReady)`, check the resource `state.remote` on each node (to read resources, see section 7.3). If this state is `UNKNOWN` on the two nodes, there is probably a communication problem between the nodes. This problem may also lead to ✓`ALONE(Ready)` -✗`STOP (NotReady)`.

Possible root causes are:

1. Real network problem

   Check your network configurations on the two nodes.
2. Firewall rules on one or the two nodes

   For details, see section 10.3
3. Not the same SafeKit cluster configuration or cluster cryptographic keys

   To communicate, cluster nodes must belong to the same cluster and have the same configuration (see section 12):
   - The web console warns if nodes in the cluster nodes list have not an identical configuration
   - The command: `safekit cluster confinfo` on any nodes of the cluster must report an identical configuration signature for all nodes of the cluster (see section 9.2)

   If the cluster configuration is not identical, re-apply the cluster configuration on all cluster nodes as described in section 3.2.2.
4. Not the same module cryptographic keys

   When cryptographic has been enabled for the module, the resource `usersetting.encryption` is "`on`" (to check the state of resources, see section 7.3). If the nodes do not have the same keys for the module, the nodes will not be able to communicate for the internal module communications.

   To distribute the same module cryptographic keys, re-apply the module configuration on all nodes.

See section 10.7 for details.

5. Expired cryptographic keys

   In SafeKit <= 7.4.0.31, the key for encrypting the module communication has a validity period of 1 year. When it expires in a mirror module with file replication, the secondary fails to reintegrate and the module stops with an error message into the log:

   ```
   reintegre | D | XXX clnttcp_create: socket=7 TLS handshake failed
   ```

   In SafeKit > 7.4.0.31, the message is:

   ```
   reintegre | D | XXX clnttcp_create: socket=7 TLS handshake failed. Check server time and module certificate (expiration date, hash)
   ```

   To solve this problem, see section 10.7.3.1

7.14 Farm module ✓`UP (Ready)` but problem of load balancing in a farm

Even though all servers in the farm are ✓`UP (Ready)`, load balancing is not working.

7.14.1 Reported network load share are not coherent

In a farm module, the sum of the network load share of all ✓`UP (Ready)`, module nodes must be equal to 100%.

If it's not the case, there is probably a communication problem between module nodes. Possible root causes are the same as for a mirror module. See section 7.12 for possible solutions.

See also section 4.3.6.

7.14.2 virtual IP address does not respond properly

If the virtual IP does not respond properly to all requests for connections:

1. choose a node in the farm that receives and processes connections on the virtual IP address (established TCP connections):
   - in Windows, use the command `netstat -an | findstr <virtual IP address>`
   - in Linux, use the command `netstat -an | grep <virtual IP address>`
2. stop the farm module on all nodes except the one that receives connections and that remains ✓`UP (Ready)` with:
   - the web console via Monitoring/••• on the node/ Stop/
   - the command `safekit stop -m AM` (replace *AM* by the module name)
3. check that all connections to the virtual IP address are handled by the single server ✓`UP (Ready)`

For a more detailed analysis on this topic, see next section and:

⇨ section 4.3.4 "Test virtual IP address of a farm module"

⇨ section 4.3.5 "Test TCP load balancing on a virtual IP address"

⇨ section 4.3.7 "Test compatibility of the network with invisible MAC address"

7.15 Problem with the virtual IP after failover

Sometimes, external devices function correctly when the primary server is node1, but they do not work properly after failover on the other node, node2.

It may be a problem with the configuration of external devices. Two types of TCP connections must be considered at the level of external devices:

- Outgoing TCP connections issued by the external devices to the SafeKit cluster.
- Incoming TCP connections issued by the SafeKit cluster to the external device.

The outgoing TCP connections, issued by the external devices to the SafeKit cluster, must be configured with the virtual IP address and not the physical IP address of node1. Otherwise, they will remain stuck to node1 in case of a failover to node2. Note that on the node side, the application must listen on the virtual IP address to accept connections from external devices. You can check the listening TCP sockets using the `netstat` command. Generally, a listening TCP socket is bound to all IP addresses (0.0.0.0), and in this case, there is no problem.

For incoming TCP connections, if the application initiates a TCP connection on node1 to an external device, this connection will start with the physical IP address of node1 as the source IP address. After a failover to node2, the connection will start with the physical IP address of node2. This is because the virtual IP address is set as an alias on the network interface of the primary node, and the primary IP address of the network interface remains the physical IP address of the node.

Therefore, if the external devices perform a check on their incoming connections, it is necessary to configure them to accept connections from the two physical IP addresses of the two nodes in the cluster.

Now, if the external devices can only be configured with a single IP address, then you need to reconfigure in the `userconfig.xml`:

```
<virtual_addr where="one_side_alias">
```

to

```
<virtual_addr where="one_side">
```

This way, the primary IP address will be the virtual IP address, and the connections from the primary node to the external devices will use the virtual IP address as the source IP address. Consequently, the external devices must be configured to accept incoming connections on a single IP: the virtual IP address.

The same issue may occur if external devices communicate with the cluster using UDP. In this case, it may be preferable to configure `one_side`.

The final possibility is that an external device only accepts communications to a unique Ethernet MAC address of a server. In this very specific and rare case, you need to configure the virtual IP address with a `'vmac_invisible'` MAC address. For example, it can start with '5A:FE':

```
<virtual_interface type="vmac_invisible" addr="5A:FE:01:02:03:04">
```

When configured as `'vmac_invisible'`, a virtual MAC address is associated with a virtual IP address, but this MAC address is never visible in Ethernet headers. This configuration allows packets directed to the virtual IP address to be received by all servers within the system without revealing the virtual MAC address to switches, which would typically be able to locate it. Since switches cannot detect this address, they broadcast packets intended for it across all ports in the local area network (LAN). All nodes receive these packets, particularly both nodes of the cluster. Therefore, the primary server can be on node 1 or node 2. vmac_invisible requires promiscuous mode on the physical Ethernet cards of both nodes. Additionally, it necessitates the 'vip' kernel module, which must be compiled on Linux.

Preferably, configure a virtual IP address with `'one_side_alias'`, and only use `'one_side'` or `'vmac_invisible'` if necessary.

Note that none of these issues arise with a complete virtual machine replication and restart solution. In this case, there is no virtual IP address involved. The VM is relaunched on the secondary node with the same primary IP address and the same MAC address. To avoid the aforementioned issues, you can use SafeKit solutions for Hyper-V or KVM.

7.16 Problem after Boot

If you encounter a problem after boot, see section 4.1.

Note that by default, modules are not automatically started at boot. For this, you must setup the boot start into the module’s configuration with:

- the web console at /console/en/configuration/modules/*AM*/config
- in file `SAFE/modules/`*AM*`/conf/userconfig.xml` on the node1, with the `boot` attribute of the `service` tag (see section 13.2.3)

Then apply the new configuration on all nodes.

7.17 Analysis from snapshots of the module

When the problem is not easily identifiable, it is recommended to take a snapshot of the module on all nodes as described in section 3.5. A snapshot is a zip file that collects, for one module, the configuration files, dumps… Its content allows an offline and in-depth analysis of the module and node status.

The structure and content of the snapshot varies depending on the version of SafeKit.

Since SafeKit 8.1, the structure of the snapshot is as follows:

`snapshot_centos7_test3_mirror/`	Directory `snapshot_nodename_`*AM* Snapshot for the module *AM* get from the node named `nodename`
`mirror/`	Directory *AM* Application module name
`config_2021_05_05_14_15_42/` `config_2021_07_08_10_05_02/` `config_2021_08_18_16_15_25/`	Directories `config_year_month_day_hour_mn_sec` Last 3 configurations for the module, including the current one
`dump_2021_05_15_10_15_40/` `dump_2021_07_20_11_05_35/` `dump_2021_08_28_08_11_45/`	Directories `dump_year_month_day_hour_mn_sec` Last 3 dumps for the module, including the last one

tmp/	Directory for the level 3 support

7.17.1 Module configuration files

The module configuration files are saved as follows:

config_2021_08_18_16_15_25/	Directory for the module's configuration files
module/ bin/ conf/ web/ private/	Directory module It contains the user configuration files • bin directory scripts start_xx, stop_xx, … • conf directory XML configuration userconfig.xml

Check the user configuration file and scripts for troubleshooting with the application integration into SafeKit.

7.17.2 Module dump files

The dump contains the state of the module and the SafeKit node as it was at the time of the dump.

dump_2021_08_28_08_11_45/	Directory for the module's dump files
csv/ licenses/ notifications/ userlog/ var/ web/	• csv directory Logs and status in csv format • licences directory SafeKit licenses get from SAFE/conf directory • notifications directory Email notification agent configuration gets from SAFE/web/notifications directory • userlog directory Module scripts logs • var directory Extract of the SAFEVAR directory • web directory Web server configuration gets from SAFE/web/conf directory
log.txt logverbose.txt	Module log files (not verbose and verbose)
heartplug	Information file

	Various information about the node (list and status of installed modules, OS version, disk, and network configuration…)
last.txt systemevt.txt Or applicationevt.txt systemevt.txt	System logs • last.txt and systemevt.txt in Linux Or • applicationevt.txt and systemevt.txt in Windows
commandlog.txt	Commands log for the node
heart heart.trc nfsbox nfsbox.trc	Trace files for level 3 support

- Check the license file(s) into `licenses` directory for troubleshooting with the SafeKit license check
- Check the Apache configuration files into `web` directory for troubleshooting with the SafeKit web service
- Check the module logs, in `log.txt` and `logverbose.txt`, for troubleshooting with the module behavior
- Check the module scripts logs `userlog/userlog_<year>_<month>_<day>T<time>_<script name>.ulog` for troubleshooting with application start/stop
- If necessary, look at `heartplug` file for some information on the node and search the system logs for events that occurred at the same time as the problem being analyzed
- Check the commands log `commandlog.txt` for troubleshooting with cluster management or distributed commands

7.17.2.1 `var` directory

The `var` directory is mainly for the level 3 support. It is a copy of some part of the `SAFEVAR` directory. In the `var/cluster` directory:

- look at the `cluster.xml` file for checking the cluster configuration
- look at the `cluster_ip.xml` file for checking the DNS name resolution of names into the cluster configuration

7.17.2.2 `csv` directory

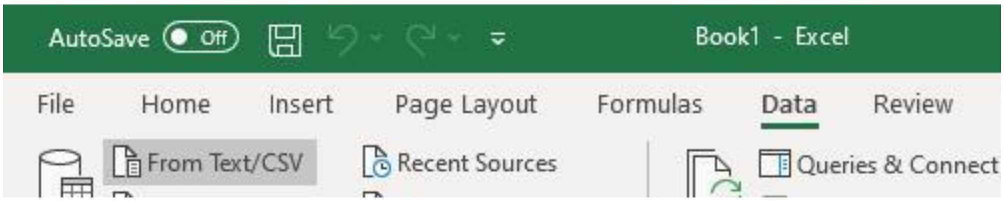
The logs and reports are also exported into csv format in the `csv` directory:

csv/	csv directory
logverbose.csv	Logs and status of the module • Verbose log

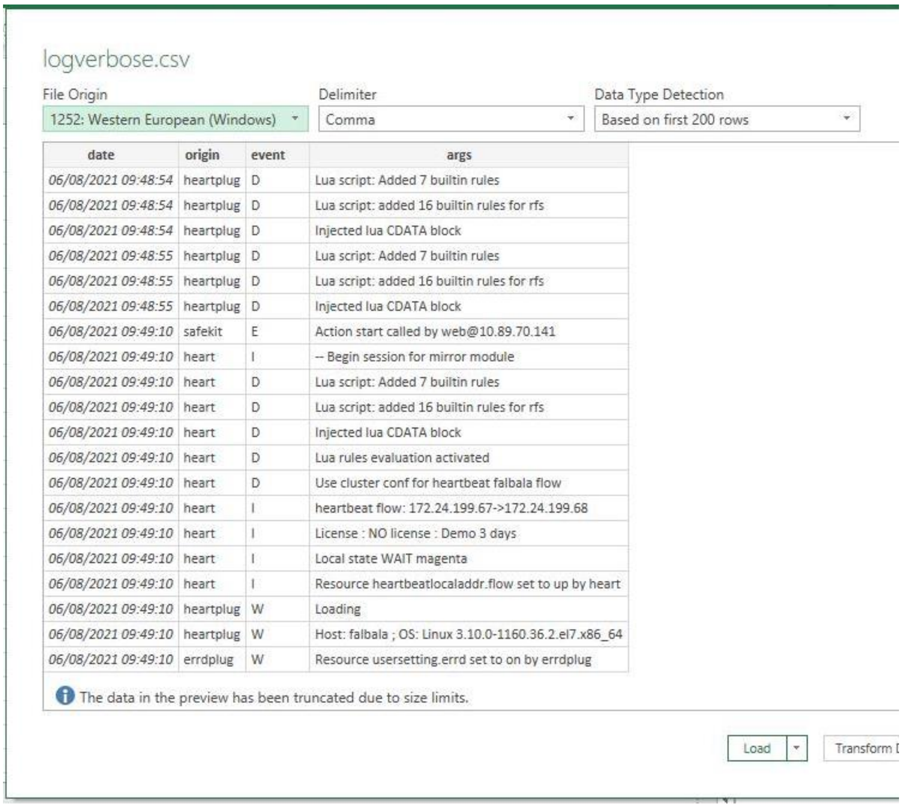
`resource.csv` `resourcelog.csv`	• Resources status and history
`commandlog.csv` `modules.csv` `moduleslog.csv` `clusterstate.csv`	Logs and status of the node • Commands log • List of installed modules • For the level 3 support

Import the csv files into an Excel sheet to facilitate their analysis. To import a file:

1. Create a new sheet
2. From the Data tab, import From Text/CSV



3. In the dialog box, locate and double-click the csv file to import, then click Import
4. Then click on Load



date	origin	event	args
06/08/2021 09:48:54	heartplug	D	Lua script: Added 7 builtin rules
06/08/2021 09:48:54	heartplug	D	Lua script: added 16 builtin rules for rfs
06/08/2021 09:48:54	heartplug	D	Injected lua CDATA block
06/08/2021 09:48:55	heartplug	D	Lua script: Added 7 builtin rules
06/08/2021 09:48:55	heartplug	D	Lua script: added 16 builtin rules for rfs
06/08/2021 09:48:55	heartplug	D	Injected lua CDATA block
06/08/2021 09:49:10	safekit	E	Action start called by web@10.89.70.141
06/08/2021 09:49:10	heart	I	-- Begin session for mirror module
06/08/2021 09:49:10	heart	D	Lua script: Added 7 builtin rules
06/08/2021 09:49:10	heart	D	Lua script: added 16 builtin rules for rfs
06/08/2021 09:49:10	heart	D	Injected lua CDATA block
06/08/2021 09:49:10	heart	D	Lua rules evaluation activated
06/08/2021 09:49:10	heart	D	Use cluster conf for heartbeat falbala flow
06/08/2021 09:49:10	heart	I	heartbeat flow: 172.24.199.67->172.24.199.68
06/08/2021 09:49:10	heart	I	License : NO license : Demo 3 days
06/08/2021 09:49:10	heart	I	Local state WAIT magenta
06/08/2021 09:49:10	heart	I	Resource heartbeatlocaladdr.flow set to up by heart
06/08/2021 09:49:10	heartplug	W	Loading
06/08/2021 09:49:10	heartplug	W	Host: falbala ; OS: Linux 3.10.0-1160.36.2.el7.x86_64
06/08/2021 09:49:10	errdplug	W	Resource usersetting.errd set to on by errdplug

You can use the Excel features to filter rows according to the level of the messages, ... and load in different sheets the csv of each node.

For the exact date, format cells with Number/Custom `jj/mm/aaaa hh:mm:ss,000`.

7.18 Problem with the size of SafeKit databases

SafeKit uses SQLite3 storage to save:

1. The log and the status of the node
   - `SAFEVAR/log.db` contains the commands log
   - `SAFEVAR/resource.db` contains the list of installed modules and its history

   These are referred to as node databases.
2. The log and the resources of the module
   - `SAFEUSERVAR/log.db` contains the module log
   - `SAFEUSERVAR/resource.db` contains the state of the module resources and its history

   These are referred to as module databases.

The size of the logs and histories increases as events occur on the SafeKit node and modules. Therefore, they should be purged regularly by deleting the oldest entries. This is automatically done thanks to a periodic job (task scheduler in Windows; crontab in Linux) that is controlled by the `safeadmin` service. The clean of the node databases is always active. The clean of the module databases is active only when the module is running.

To check that the jobs are ready:

1. Job for cleaning node databases
   - In Windows, run `schtasks /QUERY /TN safelog_clean`
   - In Linux, run `crontab -u safekit -l`

     The output of this command must contain the `safelog_clean` entry
2. Job for cleaning *AM* module databases (where *AM* is the module name)
   - In Windows, run `schtasks /QUERY /TN safelog_AM`
   - In Linux, run `crontab -u safekit -l`

     The output of this command must contain the `safelog_clean_AM` entry

The clean-up is implemented by a script located into `SAFEBIN` (in Linux, `SAFEBIN=/opt/safekit/private/bin`; in Windows, `SAFE=C:\safekit\private\bin` - if `%SYSTEMDRIVE%`=C:):

`dbclean.ps1` in Windows and `dbclean.sh` in Linux	Clean the log and history in the node databases
`dbclean.ps1 AM` in Windows and	Clean the log and history in the databases of the module named *AM*

`dbclean.sh` *`AM`* in Linux	

If necessary, you can run this script outside the scheduled period to force the databases clean-up.

7.19 Problem for retrieving the certification authority certificate from an external PKI

When using an external PKI, you must provide the certificate of the certification authority `CA` used to issue server certificates (`cacert.crt` file containing the chain of certificates for the root and intermediates Certification Authorities)

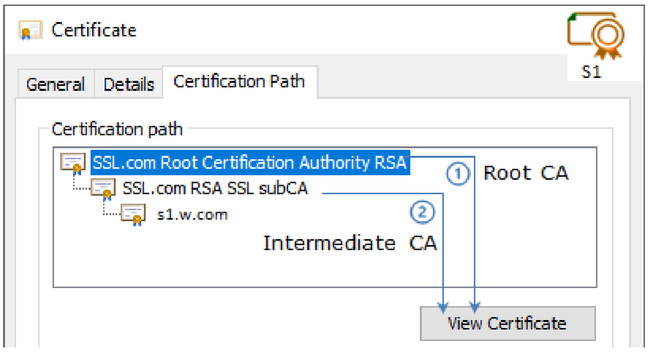
If you have trouble retrieving these files from an external PKI, you can build them using the procedure described below.

7.19.1 Export CA certificate(s) from public certificates

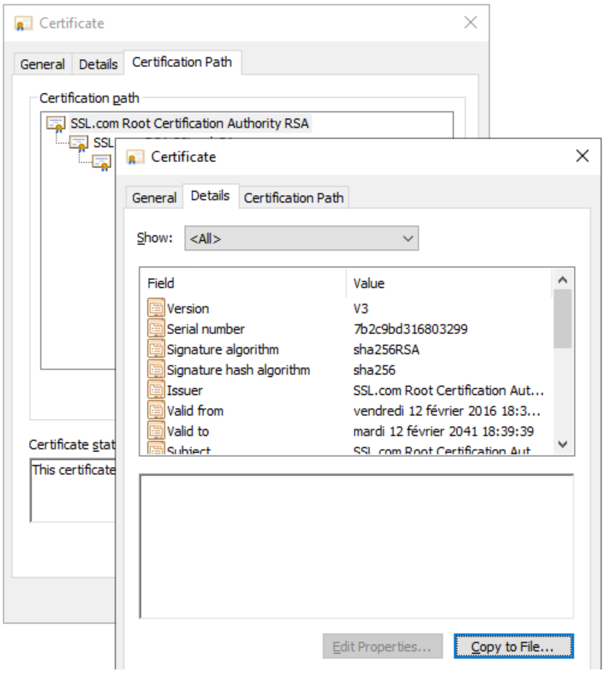
The following procedure explains how to build from a public certificate, the chain of certificates for the root and intermediates Certification Authorities, into the file `combined.cer`.

When you have the public certificate (.crt or .cer file in Base-64 encoded X.509 format) generated by the PKI:

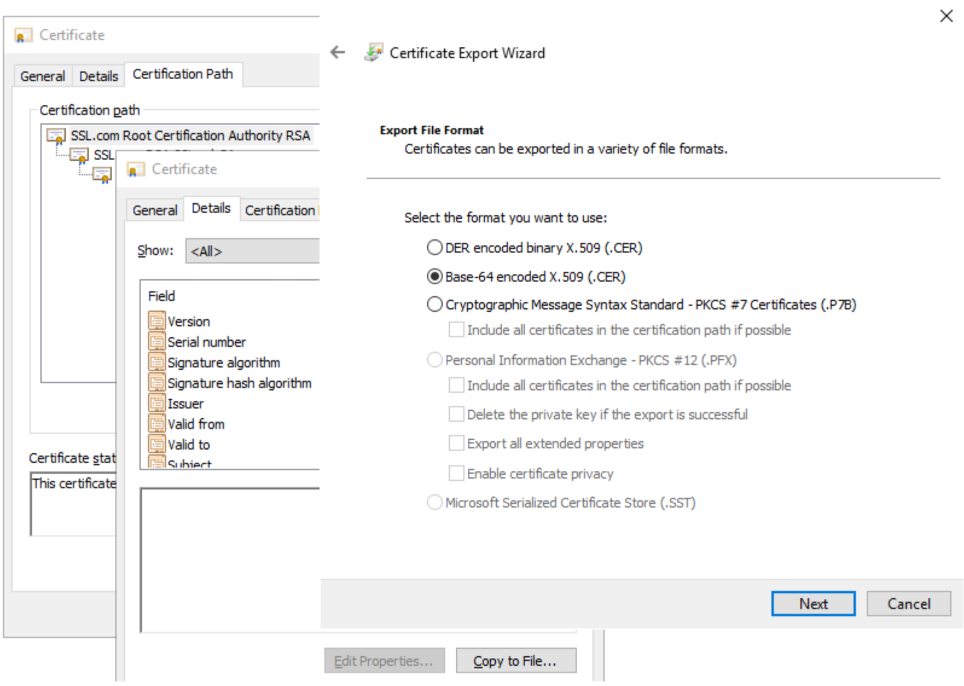
1. Copy the .crt (or .cer) file on a Windows workstation
2. Double click on this file to open it with "Crypto Shell Extensions"
3. Select the "Certification Path" tab to view the tree of certification authorities
4. Select an entry (from top to down except the leaf)



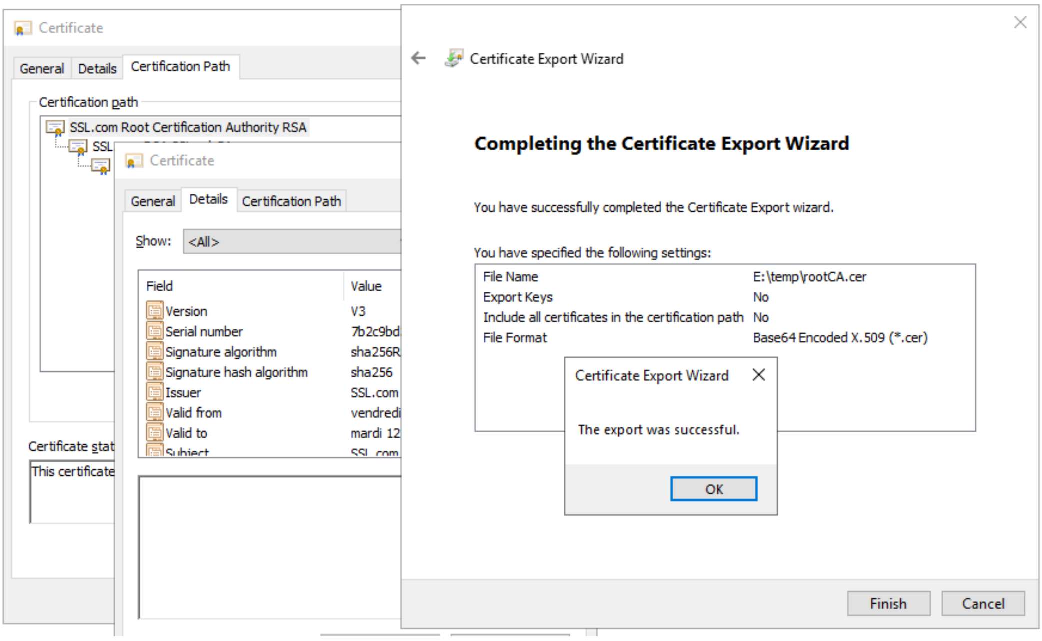
5. Click on "View Certificate". A new window is opened with details for the selected certificate
6. In this new window, select the "Details" tab and click "Copy to File"



7. It opens the Certificate Export Wizard:
   a. Click on "Next" to continue
   b. On the "Export File Format" page, select "Base-64 encoded X.509 (.CER).", and then click "Next"



   c. For "File to Export", "Browse" to the location to which you want to export the certificate. Fill "File name" with the name of the certificate file. Then, click "Next"
   d. Click "Finish" to export the certificate
   e. Your certificate is successfully exported



8. Now repeat steps 4-7 for all entries (except the last one) to export all intermediate CA certificates in the Base-64 encoded X.509(.CER) format. For the example, you would repeat steps 4-7 on SSSL.com RSA subCA intermediate CA to extract it as its own certificate.
9. Concatenate all your CA certificates into one file `combined.cer`

   Run the following command with all the CA certificates you extracted earlier:

   - In Windows

     `type intermediateCA.cer rootCA.cer > combined.cer`

   - In Linux

     `cat intermediateCA.cer rootCA.cer >> combined.cer`

   The resulting combined certificate should look something like the following:

```
-----BEGIN CERTIFICATE-----
MIIGbzCCBFegAwIBAgIICZftEJ0fB/wwDQYJKoZIhvcNAQELBQAwfDELMAkGA1UE
BhMCVVMxDjAMBgNVBAgMBVRleGFzMRAwDgYDVQQHDAdIb3VzdG9uMRgwFgYDVQQK

bRbjaT7JD6MBidAWRCJWC1R/5etTZwWwWrRCzrvIHC7WO6rCzwu69a+l7ofCKlWs
y702dmPTKEdEfwhgLx0LxJr/Aw==
-----END CERTIFICATE-----
-----BEGIN CERTIFICATE-----
MIIF3TCCA8WgAwIBAgIIeyyb0xaAMpkwDQYJKoZIhvcNAQELBQAwfDELMAkGA1UE
BhMCVVMxDjAMBgNVBAgMBVRleGFzMRAwDgYDVQQHDAdIb3VzdG9uMRgwFgYDVQQK

oYYitmUnDuy2n0Jg5GfCtdpBC8TTi2EbvPofkSvXRAdeuims2cXp71NIWuuA8ShY
Ic2wB1X7Jz9TkHCpBB5XJ7k=
-----END CERTIFICATE-----
```

This file can be used as the `SAFE/web/conf/cacert.crt`

7.20 Issue with email sending by the SafeKit notification agent

Since SafeKit 8.2.4, SafeKit offers a notification agent that sends emails for major events on modules. It is described in section 10.9.

This section describes how to troubleshoot the SafeKit notification agent thanks to the e-mail sending test command:

1. Open a PowerShell/shell window as administrator/root

2. Change directory to `SAFE`

   where `SAFE=C:\safekit` in Windows (if `%SYSTEMDRIVE%=C:`), and `SAFE=/opt/safekit` in Linux

3. Run `./private/bin/safenotif -testemail`

This command may fail due the issues described below.

If the email test is successful and you still encounter issues, please check the SafeKit notification agent log for further investigation. The log is located at `SAFEVAR/notifications/safenotif.log`. This file has a limited size and is truncated in case the limit size is reached. Consequently, it is recommended to make a copy of it if you analyze it, or if you want the Evidian support to analyze it.

7.20.1 Failed to read or parse the configuration file

The e-mail sending test command may fail with the following error:

```
Failed to read or parse the configuration file.
Please verify the "SAFE/conf/notifications/safenotif_conf.json" file exists and
is properly formatted as a JSON file.
```

This is due either to:

- `SAFE/conf/notifications/safenotif_conf.json` file does not exist

  You need to configure the agent as described in section 10.9.1

- `SAFE/conf/notifications/safenotif_conf.json` file is not properly formatted in the JSON format

  Use a tool (in your machine or online) to verify the JSON syntax.

- `SAFE/conf/notifications/safenotif_conf.json` contains paths

  For instance, `smtp.expert.caCertificateFile` property accepts a path. In Windows, paths contain backslashes (`\`); they must be escaped with another backslash (`\\`, e.g. `C:\\Users\\Administrator\\certfile.pem`).

7.20.2 Curl errors

The notification agent uses the `curl` SMTP client. Consequently, when an email sending error occurs, examining the `curl` error is the key to understanding the cause of the failure. The following non-trivial curl errors may occur. For other errors, refer to the curl documentation.

- Recipient address rejected

  The recipient's address is rejected by the SMTP server with the following error:

  ```
  curl error: curl: (55) RCPT failed: 550
  ```

  To resolve this issue, modify the file `SAFE/conf/notifications/safenotif_conf.json` to set the correct recipient address in `emailNotifications.recipients`.

- Protocol mismatch

  When the protocol used by the notification agent does not align with the one required by the SMTP server, you may have the following `curl` errors:

  ```
  curl: (35) OpenSSL/3.2.1: error:0A00010B:SSL routines::wrong version number
  ```

```
curl: (55) MAIL failed: 530
curl: (64) STARTTLS not supported
```

To resolve these problems, edit `SAFE/conf/notifications/safenotif_conf.json` file, to set the appropriate value for `smtp.protocol` property.

- Authentication mismatch

```
o   curl: (35) OpenSSL/3.2.1: error:0A0000C6:SSL routines::packet length too
    long
```

The notification agent tried to connect to the SMTP server by being authenticated, whereas no authentication is required.

To resolve this issue, reset the SMTP client credentials as described in section 10.9.2.

```
o   curl: (55) RCPT failed: 554
```

The notification agent attempted to connect to the SMTP server without authentication, whereas authentication is required.

To resolve this issue, set the SMTP client credentials as described in section 10.9.2.

- Certificate issue

```
curl: (60) SSL certificate problem: self-signed certificate
```

This error can occur when the SMTP server is configured for SMTPS or SMTP+STARTTLS. It means that the server uses a self-signed certificate, rather than a certificate signed by a trusted certification authority (CA). The Certificate Authority (CA) certificate that issued the SMTP server's certificate is needed to verify it.

To resolve this issue:

1. ask your PKI provider to supply the CA certificate, which must include the certificate chain for the root and intermediate CAs. It should be Base-64 encoded X.509 certificate file (PEM format), with a `.pem` or `.crt` suffix
2. copy it to your SafeKit server
3. edit `SAFE/conf/notifications/safenotif_conf.json` file to fill in the `smtp.expert.caCertificateFile` property to the path of the CA certificate using '\\' in the string,
   e.g. "`C:\\Users\\Administrator\\cacert.crt`".

7.21 Still in Trouble

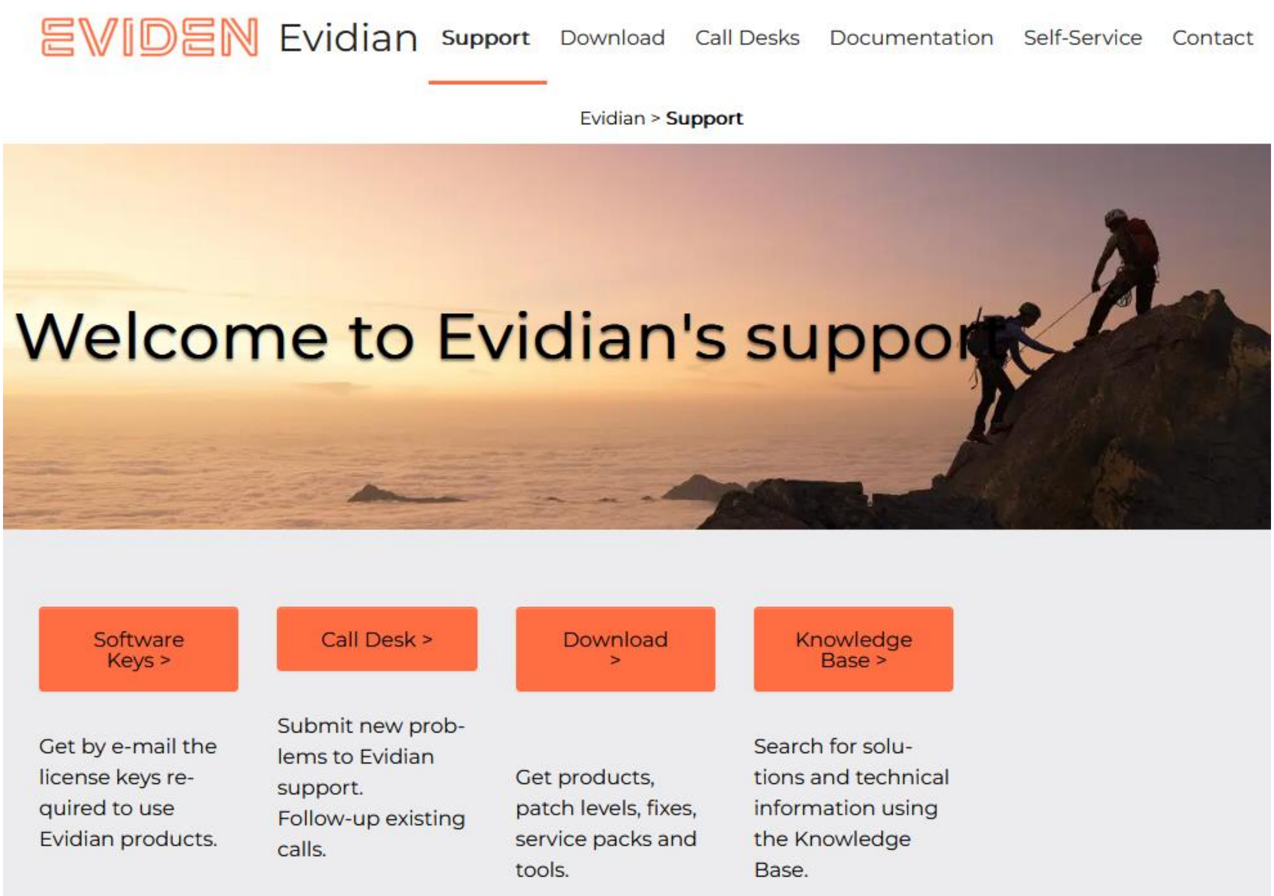
➩ See Messages Index

➩ See section 8.5 for opening a ticket at the call desk

8. Access to Evidian support

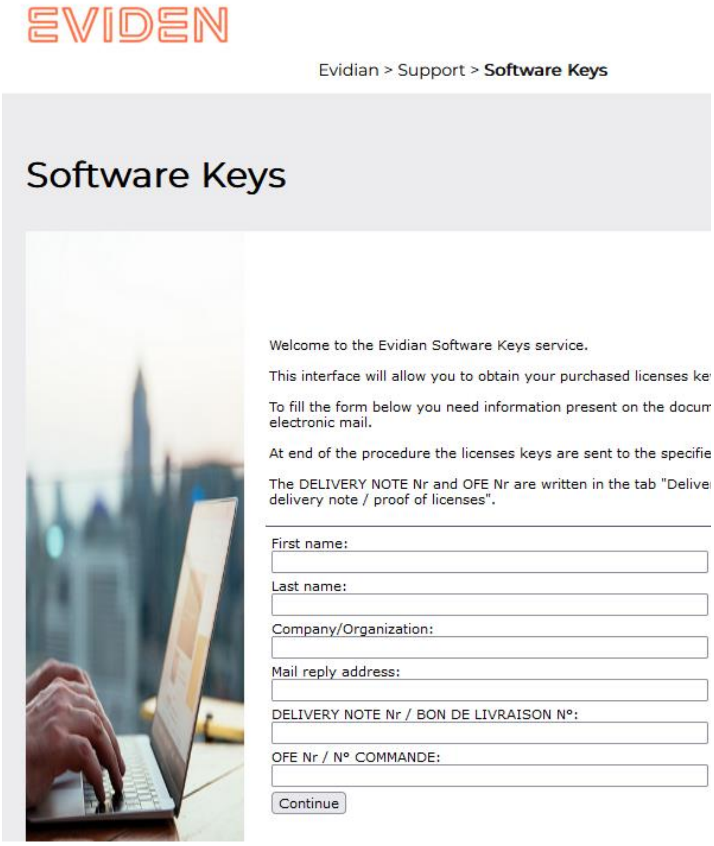
- ➪ Section 8.1 Home page of support site”
- ➪ Section 8.2 “Permanent license keys”
- ➪ Section 8.3 “Create an account”
- ➪ Section 8.4 “Access to your account”
- ➪ Section 8.5 “Call desk to open a trouble ticket”
- ➪ Section 8.6 “Download and upload area”
- ➪ Section 8.7 “Knowledge base”

8.1 Home page of support site



- https://www.evidian.com/support
- Software Keys: get permanent keys
- Subscription Request: create an account
- Download: download product or upload snapshots
- Call desk: tool for opening a call on problem
- Knowledge Base: base of KB

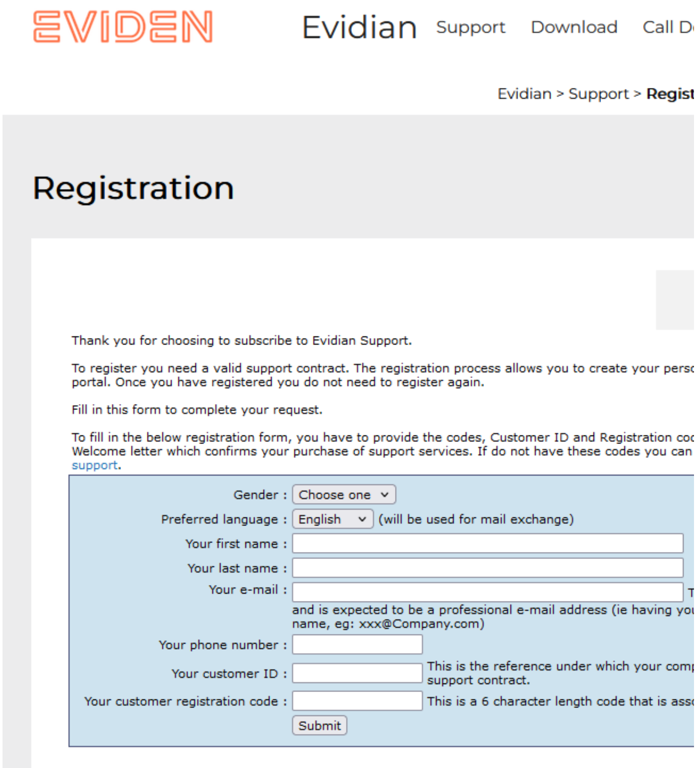
8.2 Permanent license keys



- https://www.evidian.com/support/software-keys/
- Software Keys: get permanent keys
- Fill-in the form with the delivery note sent after a purchase order
- Take "hostname" and OS of your servers
- To obtain a temporary key for any hostname and any OS, for details see section 2.1.5

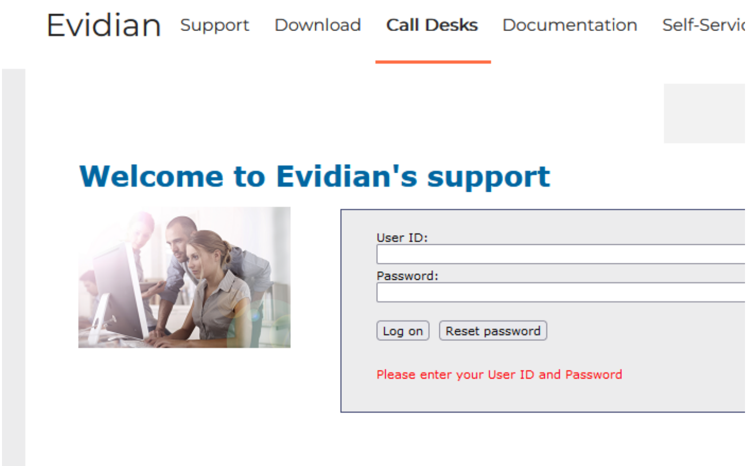
8.3 Create an account

- https://www.evidian.com/support/registration/
- Subscription Request: create an account
- The procedure must be executed once with:
  - Your client identity
  - Your confidential identity
  - A unique e-mail address
- Note: your identities are sent by mail if you take an Evidian support contract
- What you will obtain: a user account and a private password on the site



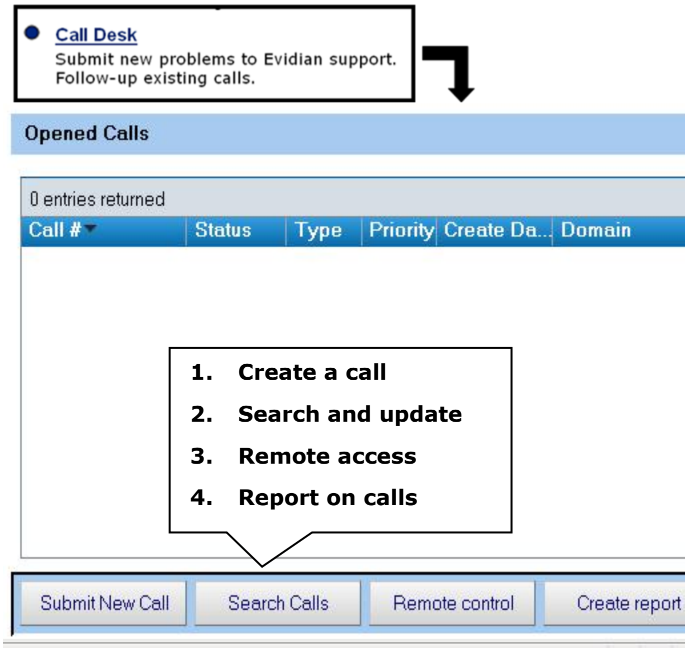
8.4 Access to your account

- https://www.evidian.com/support/call-desk/
- Login on top at right with your identity and password
- Then you have access to all services of support site



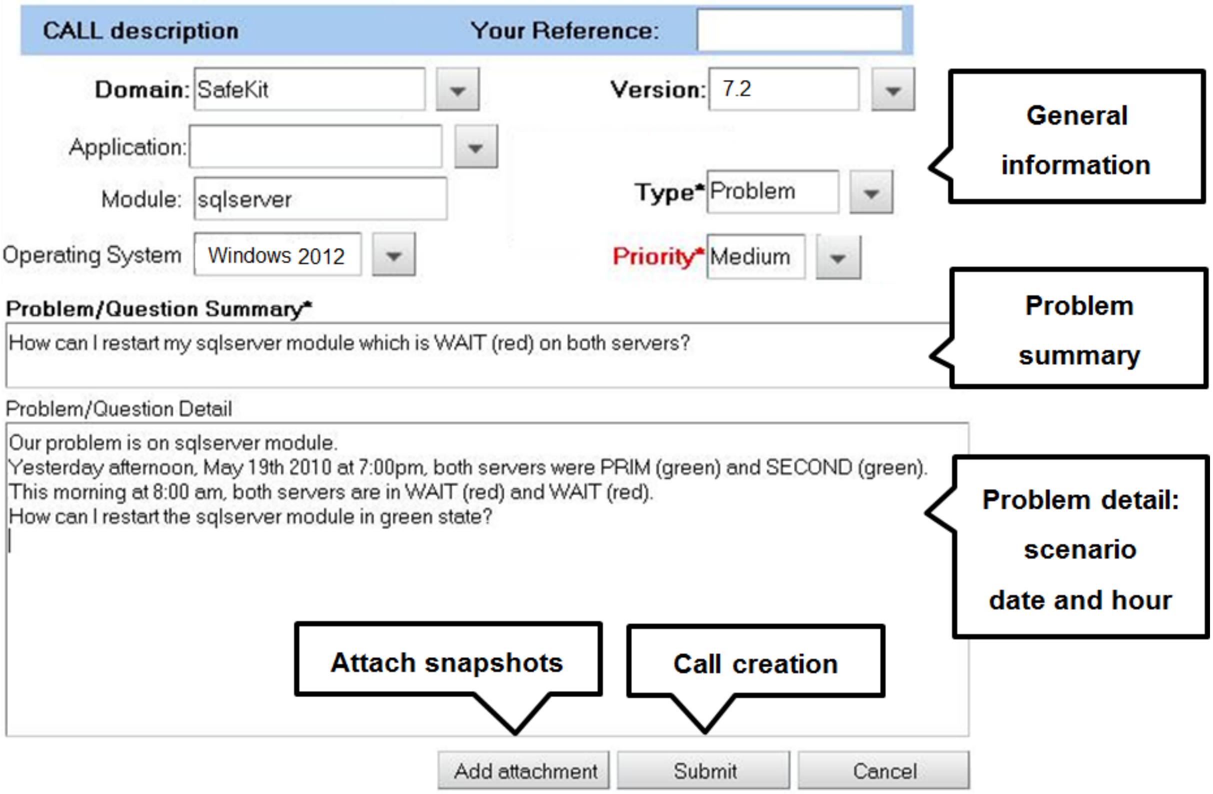
8.5 Call desk to open a trouble ticket

8.5.1 Call desk operations



- https://www.evidian.com/support/call-desk/
- Call desk: tool to open a trouble ticket on problem with 2 main operations
- Create a call
- Search for a Call and exchange with support on a Call

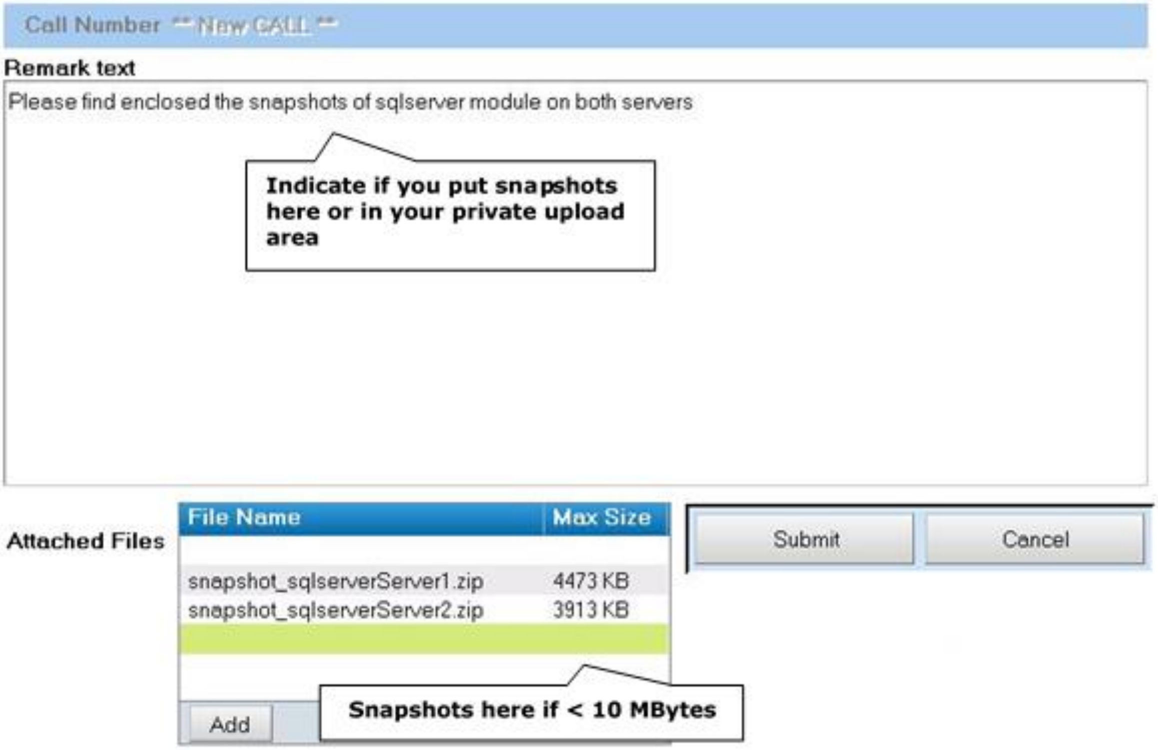
8.5.2 Create a call



1. In the header, specify the SafeKit version, problem type and priority as well as the module name and the OS

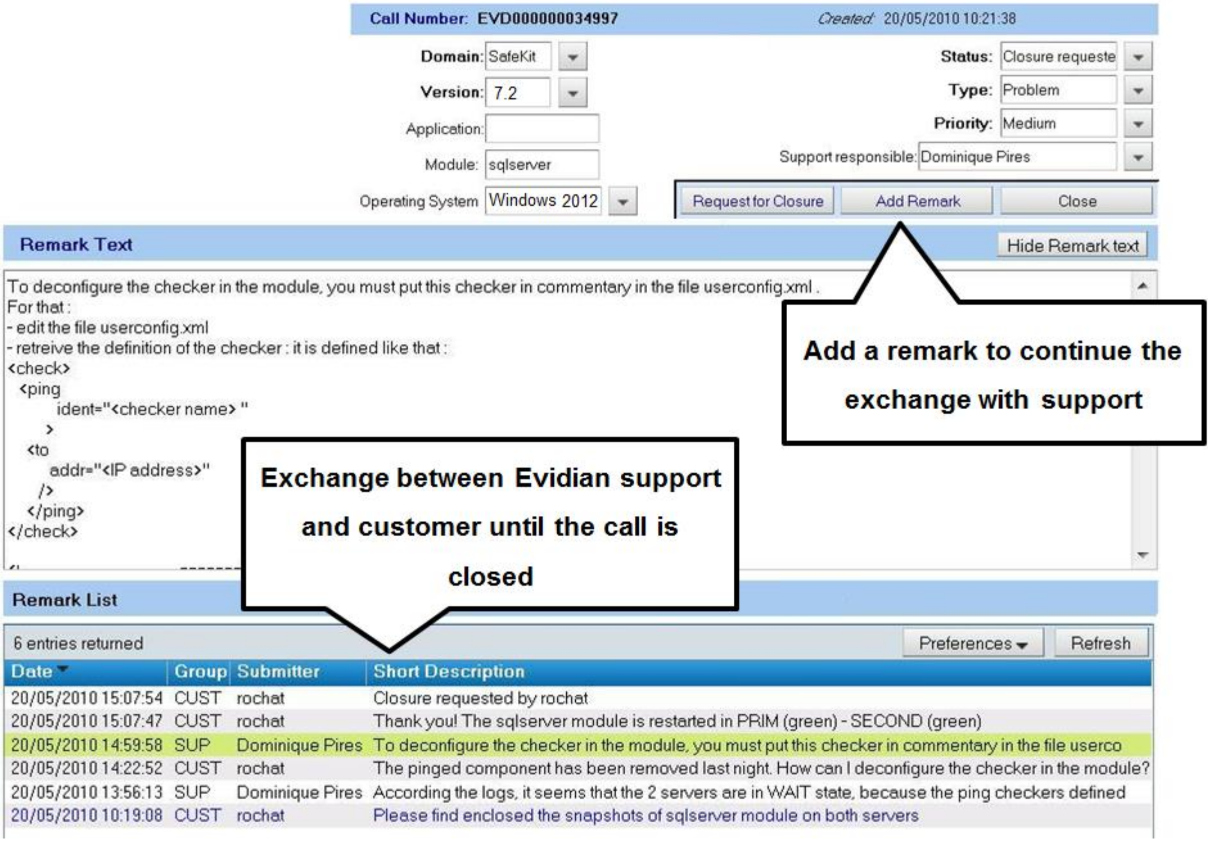
2. Summarize the problem and then describe with more details the scenario and the date and time of the problem
3. Snapshots of the SafeKit module causing problem are necessary for the analysis. See next page for attaching snapshots
4. Create the call by pressing "Submit"

8.5.3 Attach the snapshots



- When there is a problem on a SafeKit module, snapshots of the module on all servers are necessary for analysis
- To get snapshots, see section 3.5
- If the snapshots size is smaller than 10 MBytes, you can attach them with the opening of the call by clicking on "Add"
- Otherwise, downloading snapshots on the support site may take several minutes. In this case indicate in "Remark text" that you download them into your private upload area: see section 8.6.3

8.5.4 Answers to a call and exchange with support

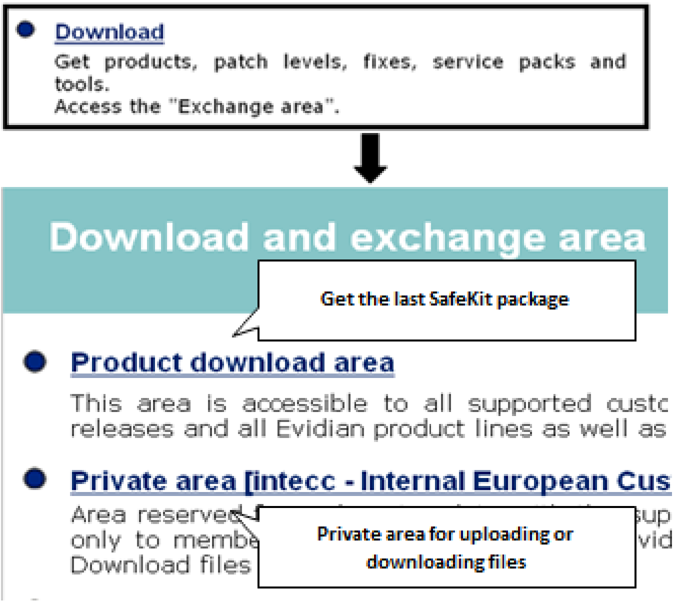


- All exchanges between the support and the customer are made with "Remarks"
- When support adds a remark on a call, the customer is notified by mail. This is the case for first response of the support after the opening of the call
- After consultation of the last remark of support, the customer can add a new remark in turn
- The exchange takes place until the closure of the call by agreement between the customer and Evidian support

8.6 Download and upload area

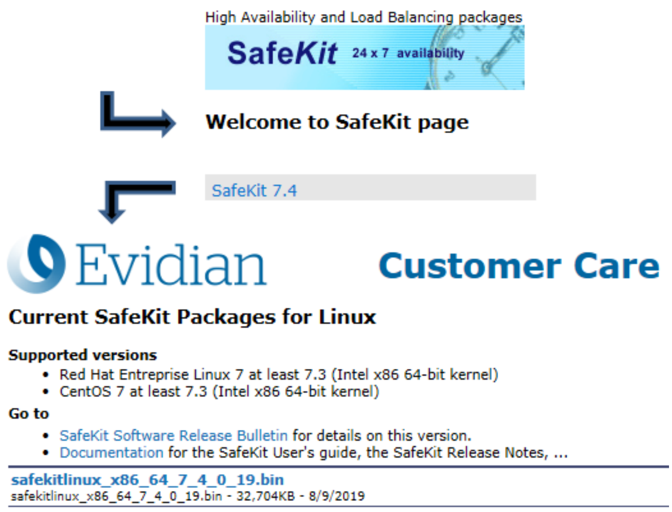
8.6.1 Two areas of download and upload

- https://www.evidian.com/support/download/
- Product download area: area for downloading SafeKit packages
- Private area [client identity]: private area to upload files



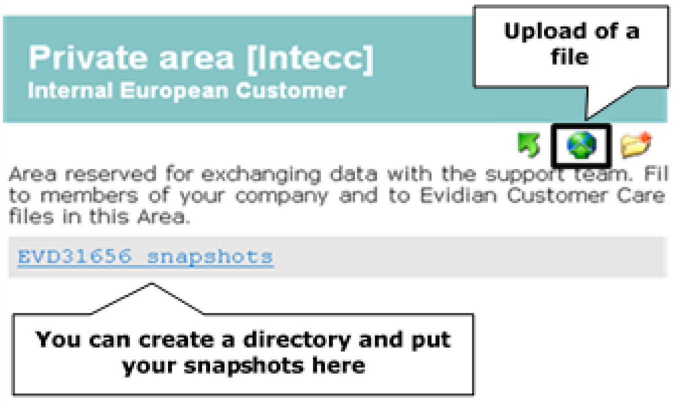
8.6.2 Product download area

- Go to <Version 8.2>/Platforms/<Your platform>/Current versions
- Download the SafeKit package
- For more information on installation, documentation, upgrade, see section 2



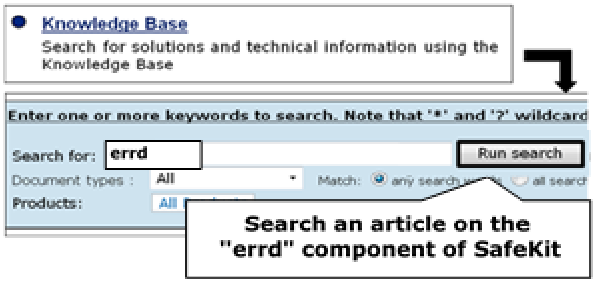
8.6.3 Private upload area

- Create a directory for a problem
- Upload snapshots in this directory with
- For building snapshots, see section 3.5
- For attaching snapshots, see section 8.5.3



8.7 Knowledge base

- https://support.evidian.com/knowledge_base/
- Knowledge Base: base of KB
- Search for example all articles on the errd component of SafeKit



9. Command line interface

- Section 9.1 "Commands to control and setup SafeKit"
- Section 9.2 "Command lines to configure and monitor the cluster"
- Section 9.3 "Command lines to control modules"
- Section 9.4 "Command lines to monitor modules"
- Section 9.5 "Command lines to configure Modules"
- Section 9.6 "Command lines for support"
- Section 9.7 "Command lines during the maintenance of the module application"
- Section 9.8 "Command lines distributed across multiple SafeKit servers"
- Section 9.9 "Examples"

The SafeKit command-line interface is provided by the safekit command. To use it:

In Windows	1. Open a PowerShell console as administrator 2. Go to the root of the SafeKit installation directory SAFE (by default SAFE=C:\safekit if %SYSTEMDRIVE%=C:) cd c:\safekit 3. Run .\safekit.exe <arguments> for the local command 4. Run .\safekit.exe -H "<hosts>" <arguments> for the command distributed across multiple nodes
In Linux	1. Open a Shell console as root 2. Go to the root of the SafeKit installation directory SAFE (by default SAFE=/opt/safekit) cd /opt/safekit 3. Run ./safekit <arguments> for the local command 4. Run ./safekit -H "<hosts>" <arguments> for the command distributed across multiple nodes

This section presents other commands that also must be run as administrator/root.

9.1 Commands to control and setup SafeKit

Use the following commands for starting/stopping SafeKit services and their automatic boot start.

9.1.1 safeadmin service

SafeKit main service mandatory and started automatically at boot.

In Windows `net start safeadmin` `net stop safeadmin`	`safeadmin` can also be controlled using the Windows Services Control Panel applet. To check the service status, run: • In command prompt `sc query safeadmin` • In PowerShell: `Get-Service -name safeadmin`
In Linux `systemctl start safeadmin` `systemctl stop safeadmin`	To check the service status, run: `systemctl status safeadmin`

9.1.2 safewebserver service

This service is used by the web console, module checkers and distributed command line interface. By default, it is started automatically at boot. For details, refer to section 10.8. The following commands are used to control this service:

`safekit webserver start` `safekit webserver restart` `safekit webserver stop`	Control the service via the `safekit` command.
In Windows `net start safewebserver` `net stop safewebserver`	Control the service via the `net` command. To check the service status, run: • In command prompt `sc query safewebserver` • In PowerShell: `Get-Service -name safewebserver`
In Linux `systemctl start safewebserver` `systemctl restart safewebserver` `systemctl stop safewebserver`	Control the service via the `systemctl` command. To check the service status, run: `systemctl status safewebserver`
`safekit boot [webon | weboff | webstatus]`	Controls the automatic start at boot of the `safewebserver` service ("on" or "off") By default: "on"

The default configuration of the SafeKit web service is HTTP with file-based authentication. During the setup initialization, described in section 11.2.1, two users are created by default:

- the `admin` user to authenticate access to the SafeKit web console
- the private `rcmdadmin` user to authenticate access to the `safekit` distributed command

The following commands are used to change the usernames and passwords for these users when necessary:

`safekit webservercfg -passwd` *`pwd`* `[-user` *`username`*`]`	Setup the password *`pwd`* for the user who accesses the web console. Optionally, setup its *`username`* that is *`admin`* by default.
`safekit webservercfg -rcmdpasswd` *`pwd`* `[-rcmduser` *`username`*`]`	Setup the password *`pwd`* for the private user who accesses the distributed command. Optionally, setup its *`username`* that is `rcmdadmin` by default.

- The script `SAFE/private/bin/webservercfg` can also be called directly
- Options `-user` and `-rcmduser` are available since SafeKit 8.2.4

9.1.3 Email notification agent

Since SafeKit 8.2.4, SafeKit offers a notification agent to send emails for major modules events. The notification agent is not enabled by default. To configure and enable it, refer to the section 10.9.

The following commands are used to control this agent:

`safekit notification enable` `safekit notification disable`	Enable/disable the notification agent.
`safekit notification status`	Display the status of the notification agent.

9.1.4 SNMP service

`Net-SNMP Agent` service in Windows

SNMP monitoring for SafeKit is not enabled by default. To enable and configure it, refer to the section 10.10.

In Windows, SNMP monitoring is provided by `Net-SNMP Agent` service.

`safekit safeagent [start | stop | restart | check]`	Control the service via the `safekit` command.
`net start "Net-SNMP Agent"` `net stop "Net-SNMP Agent"`	Control the service via the `net` command. To check the service status, run: • In command prompt `sc query "Net-SNMP Agent"` • In PowerShell:

	`Get-Service -name "Net-SNMP Agent"`
`safekit boot [snmpon | snmpoff | snmpstatus]`	Controls the automatic start at boot of the `Net-SNMP Agent` service ("on" or "off") By default: "off"

Standard `snmpd` service in Linux

SNMP monitoring for SafeKit is not enabled by default. To enable and configure it, refer to the section 10.10.

In Linux, SNMP monitoring is provided by the standard `snmpd` Linux agent.

`systemctl start snmpd` `systemctl stop snmpd`	To check the service status, run: `systemctl status snmpd`

9.2 Command lines to configure and monitor the cluster

`safekit cluster config [`*`filepath .xml or .zip`*`] [lock | unlock]`	Apply the new SafeKit cluster configuration with the content of the file passed as argument, `cluster.xml` or `cluster.zip`: • `cluster.xml` Configure with new `cluster.xml` and generate new cryptographic keys • `cluster.zip` Configure with the new `cluster.xml` and cryptographic keys stored into the zip file When called with no argument, this command keeps the current configuration but generates new cryptographic keys. Ex: `safekit cluster config /tmp/newcluster.xml` Use with great care: the new cluster configuration and cryptographic key must then be copied to all cluster nodes to have the same cluster configuration on all nodes. If the command is called with the parameter `lock`, future `safekit cluster config` commands will not be granted until they are called with the `unlock` parameter.
`safekit cluster confcheck `*`filepath`*	Check the cluster configuration, with the content of the xml file passed as argument, without applying it

<table>
<tr>
<td><code>safekit cluster confinfo</code></td>
<td>
Return, for each active cluster node:

the date of last cluster configuration,
the digital signature of last cluster configuration
the state: locked (1) or unlocked (0) status for the cluster configuration

This command allows checking if all node of a cluster have the same configuration.
Ex:
<pre>
safekit cluster conf info
Node   Signature   Date
Lock
rh6server7 6f1032b11a7b2 … 33e67c 2016-05-
20T17:06:45 0
rh7server7 6f1032b11a4e0 … 33e67c 2016-05-
20T17:06:45 0
</pre>
The SafeKit cluster configuration must be the same on all nodes of a cluster. Asymmetric cluster configurations are not supported.
</td>
</tr>
<tr>
<td><code>safekit cluster deconfig</code></td>
<td>Remove the cluster configuration and the cryptographic key.</td>
</tr>
<tr>
<td><code>safekit cluster state</code></td>
<td>
Return the global SafeKit modules configuration state
For each installed module on each cluster node, this commands list:

the node name,
module name,
module mode (farm or mirror)
internal module id number,
date of last module configuration,
digital signature of last configuration

This command list which modules are installed on which nodes of the cluster. Signature and date of last configuration on each node allow checking that a module has the same configuration on all nodes, and if not, which node has the most recent configuration.
</td>
</tr>
<tr>
<td><code>safekit cluster genkey</code></td>
<td>Create cryptographic key for global SafeKit communication (implemented in the <code>safeadmin</code> process). The cluster configuration must be deployed again (with <code>safekit -G</code>) for this command to take effect.</td>
</tr>
<tr>
<td><code>safekit cluster delkey</code></td>
<td>Suppress cryptographic keys for global SafeKit communication. The cluster configuration must be applied again (with <code>safekit -G</code>) for this command to take effect.</td>
</tr>
</table>

`safekit -H "*" -G`	Distributes the local cluster configuration and associated cryptographic key if it exists, on all cluster nodes. Redo a name resolution for all names specified in `cluster.xml` and `userconfig.xml` of modules, without stopping modules (when possible). See section 9.8 for details on this distributed command.

9.3 Command lines to control modules

The commands apply to the module named *AM*, passed as an argument with the `-m` option.

When the `SAFEMODULE` environment variable is set with the module name, `-m` argument not required. It is set during the execution of the module scripts (see section 14.2).

`safekit start -m` *AM*	Starts the module
`safekit waitstart -m` *AM*	Waits for the end of the module start
`safekit stop -m` *AM*	Stops the module
`safekit shutdown`	Stops all running modules
`safekit waitstop -m` *AM*	Waits for the end of the module stop
`safekit waitstate -m` *AM* `STOP | ALONE | UP | PRIM | SECOND`	Wait for the required stable state (`NotReady` or `Ready`).
`safekit restart -m` *AM*	Executes only application stop and start scripts • For a mirror module equivalent to `stop_prim ; start_prim` • For a farm module equivalent to `stop_both ; start_both`
`safekit stopstart -m` *AM*	Unlike the `restart`, the `stopstart` causes a complete stop of the module followed by an automatic start. If the module was `PRIM`, there is a failover of the `PRIM` module on the other server. Equivalent to `safekit stop -m` *AM*; `safekit start -m` *AM*.

`safekit swap [nosync] -m` *`AM`*	Mirror modules only Swaps the roles of primary and secondary nodes. Use `nosync` to swap without synchronizing the replicated directories.
`safekit prim -m` *`AM`*	Mirror modules only Forces the module to start as primary. It fails if the other server is already primary. The main use case of this command is described in section 5.3
`safekit second [fullsync] -m` *`AM`*	Mirror modules only Forces the module to start as secondary. It fails if the other server is not primary. Use `fullsync` to force the full synchronization of the replicated directories.
`safekit forcestop -m` *`AM`*	Forces the module stop to use when the `stop` has no effect
`safekit set -m` *`AM`* `-r` *`resource`* `-v` *`state`* `[-n] [-l]` `[-i identity]`	This command sets the state of one resource: `safekit set -r custom.myresource -v up` `safekit set -r custom.myresource -v down` Each assignment of the main resources is stored in a log to keep track of their status. Use `-n` to disable this logging or `-l` to force it. Use `-i` to specify the identity of the component, which affects the resource, in the logged message

The commands `restart`, `stop`, `stopstart` and `swap` also accept the argument `-i identity`. This argument is set when the action is called by checkers or the failover machine for logging purpose and to increment the `maxloop` counter. When not set, the `maxloop` counter is reset.

9.4 Command lines to monitor modules

The commands apply to the module named *`AM`*, passed as an argument with the `-m` option.

When the `SAFEMODULE` environment variable is set with the module name, `-m` argument not required. It is set during the execution of the module scripts (see section 14.2).

`safekit level [-m AM]`	Indicates the version of SafeKit and the license With the *AM* parameter, the module script `level` is called if exists, and its results displayed
`safekit state`	Displays the status of all modules
`safekit state -m AM [-v | -lq]`	Displays the status of the *AM* module With the verbose option `-v`, status of all the module resources are listed: see the usefulness of resources in section 7.9. With the option `-lq`, the command returns status (and exit code): `STOP (0), WAIT (1), ALONE (2), UP (2), PRIM (3), SECOND (4)`
`safekit log -m AM [-s nb] [ -A ] [-l en|fr]`	Displays the last `nb` messages of the *AM* module log. Use `-A` for displaying the verbose log (all messages including debug ones). Use `-l` option for choosing the language, `en`(glish) or `fr`(ench). Default: `-s 300`
`safekit logview -m AM [-A] [-l en|fr]`	View in real time the last main messages of the *AM* module log. Use `-A` for displaying all messages (including debug ones). Use `-l` option for choosing the language, `en`(glish) or `fr`(ench).
`safekit logview -m AM -s 300 [-A ] [-l en|fr]`	View in real time the *AM* module log messages starting from the last 300 messages
`safekit logsave -m AM [-l en|fr] [-A] /tmp/f.txt`	Save main messages of the *AM* module log in */tmp/f.txt* (absolute path mandatory). Use `-A` for saving all messages (including debug ones). Use `-l` option for choosing the language, `en`(glish) or `fr`(ench).
`safekit printi|printe -m AM "message"`	Application start/stop scripts can write messages in the module log with I or E level.

9.5 Command lines to configure modules

The commands apply to the module named *AM*, passed as an argument with the `-m` option.

When the `SAFEMODULE` environment variable is set with the module name, `-m` argument not required. It is set during the execution of the module scripts (see section 14.2).

`safekit config -m AM`	Apply changes made in files under `SAFE/modules/AM` in such as `userconfig.xml`, `start_prim/both` or `stop_prim/both` (mirror/farm). It is recommended to run this command when the module is stopped. However, it is allowed in stable states `ALONE (Ready)` or `WAIT (NotReady)`. But only some configuration parameters can be changed while the module is in these states. This feature is called *dynamic configuration*. Parameters that could be dynamically changed are reported into section 13 that describes all configuration parameters.
`safekit module genkey -m AM`	Generates cryptographic keys for the module instances network exchanges encryption. Considered after the next configuration of the module.
`safekit module delkey -m AM`	Erase cryptographic keys associated with the module. After the next configuration, module instances network exchanges will be performed without encryption.
`safekit "*" -E AM`	Distributes the local configuration for the module *AM* and associated cryptographic key if it exists, to all cluster nodes. See section 9.8 for details on this distributed command.
`safekit confinfo -m AM`	Display information on the active and current configuration of the module *AM*. • the active configuration is the last configuration successfully applied. It is in `SAFE/private/modules/AM` • the current configuration is the one located in `SAFE/modules/AM`. It may be different from the active one when it has been modified and not yet been applied This command is useful for checking the configuration of the module. It displays: • the signature value and a last modification date (Unix timestamp) for the active configuration • the signature value and last modification date (Unix timestamp) for the current configuration When the signature values are different, it means that the configurations are not identical and that you may have to apply the current configuration. You can run this command on all the cluster nodes that implement the module to check that the configuration of the module is identical on all nodes.
`safekit confcheck -m AM`	Check the module configuration under `SAFE/modules/AM` without applying

`safekit module install -m` *AM* `[-M id] [-r] [`*AM.safe*`]`	Installs the *AM*`.safe` module file under the *AM* name `[-r]` force reinstallation of the module `[-M id]` forces the installation of the module with the `id` specified as module id • *AM*`.safe` default location is `SAFE/Application_Modules/` and its subdirectories • An absolute path could be used too • If no *AM.safe* is given, the command search for file *AM*`.safe` in `/Application_Modules/` and its subdirectories
`safekit module package -m` *AM* */…/newAM.safe*	Packages the *AM* module in */…/newAM.safe* (absolute path mandatory) Used by the console to create a backup in `SAFE/Application_Modules/backup/`
`safekit module uninstall -m` *AM*	Uninstalls the *AM* module. Deletes the module configuration directory `SAFE/modules/`*AM*
`safekit module list`	Lists the names of the installed modules
`safekit module listid`	Lists the names and ids of the installed modules
`safekit module getports -m` *AM* `(or -i id)`	Lists the communication ports used by the module to communicate between servers

9.6 Command lines for support

The commands apply to the module named *AM*, passed as an argument with the `-m` option.

When the `SAFEMODULE` environment variable is set with the module name, `-m` argument not required. It is set during the execution of the module scripts (see section 14.2).

`safekit snapshot -m` *AM* */tmp/snapshot_xx.zip*	Saves the snapshot of the *AM* module in */tmp/snapshot_xx.zip* (absolute path mandatory) A snapshot creates a dump and gathers under `SAFEVAR/snapshot/modules/`*AM* the last 3 dumps and last 3 configurations to collect them in a .zip file To analyze snapshots, see section 7.17. To send snapshots to Evidian support, see section 8. Since SafeKit 8.2.4, the zips generated for snapshots are protected by the password `safekit`. This allows the snapshot to be received in its entirety when sent via email.

`safekit dump -m AM`	To solve a problem in real time on a server, make a dump of the *AM* module A dump creates a directory `dump dump_year_month_day_hour_mn_sec` on the server side under `SAFEVAR/snapshot/modules/AM`. The `dump` directory contains the module log and status, as well as information on the system state and SafeKit processes at the time of the dump
`safekit -r "specialcommand"`	Calls the special command in `SAFEBIN` with SafeKit environment variables set.
`safekit clean [all | log | process | resource] [-m AM]`	Clean the logs, the resource file, and the main processes of the module *AM*. This command must be used with caution since it deletes working files and kills processes. • `safekit clean log -m AM` Clean the logs (verbose and not verbose logs) of the module. To be used when these logs are corrupted (e.g.: errors in log view). • `safekit clean resource -m AM` Reinitialize the resource file of the module. To be used when this file is corrupted (e.g.: errors in resources display) • `safekit clean process -m AM` Kill the main processes (`heart`) of the module. To be used when the `stop` and `forcestop` of the module did not achieve to kill these processes. • `safekit clean all -m AM` Default value. Clean log, resource, and process.

9.7 Command lines during the maintenance of the module application

During maintenance or testing of the application, it may be necessary to stop or restart the associated services. But if the module is configured to monitor the application (processes/services monitoring, checkers), these operations will cause false error detection and automatic restart or failover. To avoid this, follow one of the two solutions described below.

9.7.1 Module control for maintenance

The following commands allow the module's behavior to be dynamically modified without the need for reconfiguration. They apply to the module named *AM*, passed as an argument with the `-m` option.

When the `SAFEMODULE` environment variable is set with the module name, `-m` argument not required. It is set during the execution of the module scripts (see section 14.2).

`safekit errd off -m` *AM* `safekit errd on -m` *AM*	Disable/enable the processes/services monitoring defined in the module configuration. The resource variable *usersetting.errd* reflects the current setting. With SafeKit < 8.2, use `safekit errd suspend|resume -m` *AM*
`safekit checker off -m` *AM* `safekit checker on -m` *AM*	Disable/enable all checkers (interface, TCP, IP, custom, etc.) defined in the module configuration. The resource variable *usersetting.checker* reflects the current setting.
`safekit boot off -m` *AM* `safekit boot on -m` *AM* `safekit boot status [-m` *AM]*	Disable/enable the automatic startup at boot of the module. The resource variable *usersetting.boot* reflects the current setting. Without the option `-m` *AM*, lists the boot status of all modules.
`safekit failover off -m` *AM* `safekit failover on -m` *AM*	Disable/enable the module automatic failover (see section 13.2.3). The resource variable *usersetting.failover* reflects the current setting. This command must be issued on all nodes belonging to the same cluster to not have unexpected results.

To check the state of resources, see section 7.3.

If the module is running, a side effect of these commands (except `safekit boot`) is the execution of the update of the module to apply the new setting.

With SafeKit < 8.2, these commands (except `safekit boot`) could only be executed when the module was started and in a stable state. Additionally, the module's configuration options were restored once the module was stopped and then restarted.

Since SafeKit 8.2, these commands can be performed while the module is stopped and are not reset when the module stops then starts. To restore the initial state, you must either execute the corresponding command or reapply the module configuration.

9.7.2 Running the application without the module

Rather than starting the module and disabling the checkers, you might want to launch only the application without the module processes. For this, stop the module and run the following scripts, called wrappers:

`SAFE/private/modules/AM/bin/AM_start_wrapper`	Start the application
`SAFE/private/modules/AM/bin/AM_stop_wrapper`	Stop the application

The wrappers, generated during each configuration of the module:

- start/stop the application with the `start_prim/stop_prim` or `start_both/stop_both` scripts
- set/reset the virtual IP address if it is defined into the module configuration

Wrappers filename extension is `.ps1` in Windows; `.sh` in Linux.

9.8 Command lines distributed across multiple SafeKit servers

SafeKit provides a command-line interface for running it on multiple SafeKit servers. Each server must be running the SafeKit web service (see section 10.8).

The password assigned during the initialization of the SafeKit web service must be the same on all servers, even if they do not belong to the same SafeKit cluster.

The distributed command applies to the servers specified with the `-H "<hosts>"` argument described below.

`-H "*"` `-H "<cluster node names list>"`	Apply the command on nodes defined into the local cluster configuration (see section 12). The protocol and port are those defined in the local configuration of the SafeKit web service. By default, the protocol is `http` and the port is `9010`. • `-H "*"` for all cluster nodes • `-H "<cluster node names list>"` list of node names as defined in the cluster configuration, separated by coma. For example: `-H "node1,node2"`
`-H "[[protocol:port],]<servers list>"`	Apply the command to the listed servers, which may not necessarily belong to the local cluster. • Optional specification of the protocol (`http` or `https`) and the port to use. If not specified, the protocol and port are those defined in the local configuration of the SafeKit web

	service. By default, the protocol is `http` and the port is `9010`. • List of SafeKit servers (IP address or name) with a comma as the separator. Examples: `-H "[http:9500],10.0.0.107,10.0.0.108"` `-H "[https],S1.company.com,S2.company.com"`
`-H "<urls list>"`	Apply the command to the listed URLs, which may not necessarily belong to the local cluster. Example: `-H "http://192.16.0.2:9010,http://192.16.0.3:9010"`

The distributed commands are as follows.

`safekit -H "<hosts>" <safekit command arguments>`	Executes the safekit command on the servers specified by `-H`. Almost all `safekit` commands can be applied on a list of cluster nodes. Exceptions are `safekit logview`, `safekit -p` and `safekit -r` commands which can be used only locally. Examples: `safekit -H "http://192.168.0.2:9010,http://192.168.0.3:9010" level` `safekit -H "*" cluster confinfo` `safekit -H "node2" module list` `safekit -H "[http:9500],server1,server2" start -m AM`
`safekit -H "<hosts>" -E` *`AM`*	Exports the configuration of the module named AM on the servers specified by `-H`. The *AM* module must be installed locally. This command performs the following actions: • creates *AM*`.safe` from local `SAFE/modules/`*AM* • transfers and installs *AM*`.safe` on the list of servers • installs the module on remote servers with the local module id • if the module was configured locally, configures it on remote servers See the usage example in section 9.9.3.

`safekit -H "<hosts>" -G`	Exports the local cluster configuration on the servers specified by `-H`. This command performs the following actions: • collect the content of the `SAFEVAR/cluster` directory • transfer and copy the collected files into the target servers' `SAFEVAR/cluster` directory • trigger `safeadmin` configuration reload See the usage example in section 12.2.2

9.9 Examples

9.9.1 Local and distributed command

For instance, to display the levels (SafeKit, OS…):

- for the local host

```
safekit level
```

- for all hosts configured in the SafeKit cluster

```
safekit -H "*" level
```

9.9.2 Cluster configuration with command line

See section 12.2.2.

9.9.3 Module configuration with command line

In the following, replace *AM* by your module name; replace `node1` and `node2` by the name of your cluster nodes set during the SafeKit cluster configuration.

1. Log as administrator/root and open a command shell window on one node

   For instance, log-in `node1`

2. Optional

   Only during the first configuration, run `safekit module install -m AM SAFE/Application_Modules/generic/mirror.safe`

   to install a new module named *AM*, from `mirror.safe` template.

   This is not necessary when reconfiguring an already installed module.

3. Edit the module configuration and scripts in `SAFE/modules/AM/conf` and `SAFE/modules/AM/bin`

4. Optional

   Run `safekit module genkey -m AM` or `safekit module delkey -m AM`

   to create or delete cryptographic key for the module.

   You do not have to create new cryptographic key on each reconfiguration of the module.

5. Run `safekit -H "node1,node2" -E AM`

to (re)install the module `AM` and apply its configuration, which is get from the node running the command (`node1` in this example). It applies it on all listed nodes (`node1` and `node2`).

9.9.4 Module snapshot with command line

The command line the module snapshot is described below. Replace *AM* by your module name.

1. Log as administrator/root and open a command shell window on one node

   For instance, log-in `node1`

2. Run `safekit snapshot -m AM /tmp/snapshot_node1_AM.zip`

   To save the snapshot of the *AM* module in `/tmp/snapshot_node1_AM.zip` (absolute path mandatory) locally (that is on `node1`).

Repeat all these commands on the other nodes in the cluster.

10. Advanced administration and setup

- Section 10.1 “SafeKit environment variables and directories”
- Section 10.2 “SafeKit services”
- Section 10.3 “Firewall settings”
- Section 10.4 “Boot and shutdown setup in Windows”
- Section 10.5 “Linux Secure boot settings for SafeKit kernel modules”
- Section 10.6 “Antivirus settings”
- Section 10.7 “Encryption of module communications”
- Section 10.8 “SafeKit web service”
- Section 10.9 “SafeKit email notification agent”
- Section 10.10 “SNMP monitoring”
- Section 10.11 “Commands log of the SafeKit server”

10.1 SafeKit environment variables and directories

10.1.1 Global

Variable	Description
`SAFE` (given by `safekit -p`)	SafeKit installation directory: • In Windows `C:\safekit` on Windows if `SystemDrive=C:` • In Linux `/opt/safekit`
`SAFEVAR` (given by `safekit -p`)	SafeKit working files directory: **`SAFEVAR=C:\safekit\var`** on Windows and **`SAFEVAR=/var/safekit`** on Linux
`SAFEBIN` (given by `safekit -p`)	SafeKit binary installation directory: **`C:\safekit\private\bin`** on Windows and **`/opt/safekit/private/bin`** on Linux. Useful to access SafeKit special commands (see section 14.5)
`SAFE/Application_Modules`	Installable .safe modules directory. Once a module has been installed, the module is located under **`SAFE/modules`**
`SAFE/conf`	Contains the SafeKit license file.

10.1.2 Module

Variable	Description

SAFEMODULE	The name of the module. The `safekit` command no longer needs the module name parameter (`-m` *AM* `= -m SAFEMODULE`)
SAFE/modules/*AM* and SAFEUSERBIN	Editing a module, named *AM*, and its scripts is made inside directory SAFE/modules/*AM*. There are **userconfig.xml** file and application start and stop scripts **start_prim**, **stop_prim** for a mirror, **start_both**, **stop_both** for a farm (online edition or through the SafeKit console) After a module configuration, scripts are copied to the runtime directory **SAFE/private/modules/*AM*/bin**: this is the value of SAFEUSERBIN (do not modify scripts at this place)
SAFEVAR/modules/*AM* and SAFEUSERVAR	Module, named *AM*, working files directory (SAFEUSERVAR=**SAFEVAR/modules/*AM***) Output messages of application scripts are in SAFEVAR/modules/*AM*/userlog_*year-month-date_striptname*.ulog. To check if there are errors during start or stop of the application. the userlog could disabled with <user logging="none"> in userconfig.xml.
SAFEVAR/snapshot/modules/*AM*	Directory of dumps and configurations put in a snapshot of the module named *AM*. See section 9.6 that describes command lines for support.

The module tree (packaged into a .safe or installed into SAFE/modules/*AM*) is the following:

AM	Application module name
conf	
userconfig.xml	User XML configuration file
userconfig.xml.template	Internal use only
modulekey.p12	Optional. Internal use only (encryption of the module internal communications)
modulekey.dat	Optional. Internal use only (encryption of the module internal communications)

bin	
prestart	Module script executed on module start
start_prim or start_both	Module script to start the application in mirror or farm module
stop_prim or stop_both	Module script to stop the application in mirror or farm module
poststop	Module script executed on module stop
web	
index.html	Obsolete (for the web console < SafeKit 8)
manifest.xml	Internal use only

Since SafeKit 8, you cannot anymore customize the module quick configuration display (since index.html is obsolete).

10.2 SafeKit services and daemons

See section 10.3.3.1 and section 10.3.3.2 for full details on SafeKit processes name and ports used.

10.2.1 SafeKit services

In Windows, processes names have the `.exe` extension.

safeadmin (`safeadmin` process)	SafeKit main service mandatory and started automatically at boot.
safewebserver (`httpd` process)	Service used by the web console, module checkers and distributed command line interface.
Net-SNMP Agent (`safeagent` process)	In Windows Service that implements the SafeKit SNMP agent

For the commands to control SafeKit services, refer to section 9.1.

10.2.2 SafeKit daemons per module

In Windows, processes names have the `.exe` extension.

`heart`	Manages the state automaton of the module and the recovery procedures
`errd` `ipcheck` `intfcheck` `tcpcheck` `pingcheck` `modulecheck`	Checkers that manage error detection
`vipd`	Synchronizes a farm of servers
`arpreroute`	Manages arp requests for the virtual IP address (sends ARP packet)
`nfsadmin` `nfsbox` `reintegre`	Manages the real-time replication and data synchronization

10.3 Firewall settings

If a firewall is active on the SafeKit server, you must add rules to allow network traffic:

- between servers for internal communication (global runtime and module specific)
- between servers and workstations running the SafeKit console

See below the command to configure the `Microsoft Windows Firewall` in Windows ; `firewalld`/`iptables` in Linux. If you opted for automatic firewall configuration during the SafeKit installation, this command has already been executed.

`SAFE/private/bin/firewallcfg add` where `SAFE=C:\safekit` (if `%SYSTEMDRIVE%`=C:) in Windows `SAFE=/opt/safekit` in Linux	On all SafeKit servers: 1. Open a PowerShell/shell window as administrator/root 2. Run `SAFE/private/bin/firewallcfg add` This configures the operating system firewall for SafeKit.

For configuring other firewalls, refer to section 10.3.3 that details SafeKit processes name and ports used.

10.3.1 Firewall settings in Linux

If you opted-in for automatic firewall configuration during SafeKit installation, you do not have to apply the following procedure.

If you opted-out for automatic firewall configuration, you must configure the firewall.

When using the operating system firewall (firewalld/iptables), you may use the `firewallcfg` command. It inserts (or remove) the firewall rules required by the SafeKit services and modules.

Administrators should review conflicts with local policy before applying it.

`SAFE/private/bin/firewallcfg add` `SAFE/private/bin/firewallcfg del` where `SAFE=/opt/safekit`	Add (or delete) the firewalld or iptable firewall rules for the SafeKit `safeadmin` and `safewebserver` services. • `SAFE/private/bin/firewallcfg add` Add firewall rules for `safeadmin` and `safewebserver` • `SAFE/private/bin/firewallcfg del` Delete firewall rules for `safeadmin` and `safewebserver`
`SAFE/private/bin/firewallcfg add` *`AM`* `SAFE/private/bin/firewallcfg del` *`AM`* where `SAFE=/opt/safekit`	Add (or delete) the firewalld or iptable firewall rules for the SafeKit modules. • `SAFE/private/bin/firewallcfg add` *`AM`* Add firewall rules for the module named *`AM`* This command must be applied after the first configuration of the module, and on next configurations if used ports have changed (check it with the command `safekit module getports -m` *`AM`*). • `SAFE/private/bin/firewallcfg del` *`AM`* Delete firewall rules for the module named *`AM`*

10.3.2 Firewall settings in Windows

If you opted-in for automatic firewall configuration during SafeKit installation, you do not have to apply the following procedures.

If you opted-out for automatic firewall configuration, you must configure the firewall.

When using the operating system firewall (Microsoft firewall), you may use the `firewallcfg` command. It inserts (or remove) the firewall rules required by the SafeKit services (`safeadmin`, `safewebserver`, `safeacaserv and Net-SNMP Agent`) and modules.

Administrators should review conflicts with local policy before applying it.

`SAFE/private/bin/firewallcfg add` `SAFE/private/bin/firewallcfg del`	Add (or delete) the Microsoft firewall rules. • `SAFE/private/bin/firewallcfg add`

where `SAFE=C:\safekit` (if `%SYSTEMDRIVE%`=C:)	Add firewall rules for SafeKit core and modules processes. • `SAFE/private/bin/firewallcfg del` Delete firewall rules for SafeKit core and modules processes.

10.3.3 Other firewalls

If you use another firewall or want to check rules against local policy, the following lists processes and ports used by SafeKit services and modules that may be useful to configure the firewall.

10.3.3.1 List of processes

10.3.3.1.1 Processes performing local-only network exchanges

Processes for a mirror module

- `errd`: manages detection of process death
- `nfsadmin`, `nfscheck`: manage the file replication

Processes for a farm module

- `errd`: manages detection of process death
- `heart`: manages the recovery procedures

10.3.3.1.2 Processes performing external network exchanges

Processes common to all the SafeKit servers, one process by server, started at boot:

- `safeadmin` service (`safeadmin` process): main and mandatory administration service
- `safewebserver` service (`httpd` process): web service for the console, for <module> checkers and the distributed commands
- `safecaserv` (`httpd` process): web service for securing the web console with the SafeKit PKI (optional)
- In Windows, `Net-SNMP Agent` service (`safeagent` process): SafeKit SNMP v2 agent (optional)

Processes for a mirror module (depending on its configuration):

- `heart`: manages the recovery procedures
- `arpreroute`: manages arp requests (sends ARP packet)
- `nfsadmin`, `nfsbox`, `reintegre`: manage the file replication and reintegration
- `splitbraincheck`: manage the split-brain detection (sends ICMP ping packets)

Processes for a farm module (depending on its configuration):

- `vipd`: synchronizes a farm of servers
- `arpreroute`: manages arp requests (sends ARP packet)

Processes for a mirror or a farm module depending on checkers configuration:

- `intfcheck`: for checking interface (interface checker configuration automatically generated when <interface check=on>)
- `pingcheck`: for pinging an address (<ping> configuration)
- `ipcheck`: for checking a locally defined ip address (virtual ip checker automatically generated when `<virtual_addr check=on>`)
- `modulecheck`: for checking a SafeKit module `(<module>` configuration)
- `tcpcheck`: for checking a TCP connection (`<tcp>` configuration)

10.3.3.2 List of ports

The following list ports used by SafeKit services and modules.

10.3.3.2.1 Ports used by services

- `safeadmin`

  By default, remote access on UDP port 4800 (to communicate with `safeadmin` instances on other SafeKit servers)

  For changing this value , see section 12.1.3.

- `safewebserver`

  Local and remote TCP access, by default, on port 9010 for HTTP or port 9453 for HTTPS. For the ports value definition, see section 10.8.

  This service is accessed locally and from remote SafeKit servers and remote workstation running the SafeKit console.

- `safecaserv` (optional)

  Local and remote access on TCP port 9001 by default. For the port value definition, see section 11.3.1.9.5.

  This service is accessed locally, and from remote SafeKit servers and remote workstation running the HTTPS configuration wizard with the SafeKit PKI.

- `Net-SNMP Agent` (Windows only, optional)

  Local and remote access on UDP port 3600 by default. For the port value definition, see section 10.10.

10.3.3.2.2 Ports used by modules

When a module is configured on a SafeKit server, you can run the command `safekit module getports -m` *`AM`* to list the external ports used by the module *AM*. For firewall configuration, you must configure all SafeKit servers to enable communications targeted at these ports.

The ports values for one module are automatically computed depending on its module id. Run the command `safekit module listid` to list all the installed modules with their name and id.

The following gives rules for computing ports values depending on the module id. When checkers are configured for the module, you may also need to change the firewall configuration according to the checkers configuration. You must enable all communications on localhost between SafeKit processes.

For a mirror module

- Port used by heart
  UDP port used for sending heartbeats between SafeKit servers
  port=8888 +(id-1)

- Ports used by rfs (file replication)
  TCP port used for replications requests between SafeKit servers
  safenfs_port=5600 +(id-1)x4

To list ports used by the mirror module with id 1, run `safekit module getports -m mirror`. It returns:

```
List of the ports used by SafeKit

Process        Ports
safeadmin
        port    UDP 4800

webconsole
        port    TCP 9010
heart
        port    UDP 8888
rfs
        safenfs_port    TCP 5600
```

For a farm module

- Port used by farm: UDP port used for communications between all SafeKit nodes
  port   4803 + (id-1)x3

To list ports used by the farm module with id 2, run `safekit module getports -m farm`. It returns:

```
List of the ports used by SafeKit

Process        Ports
safeadmin
        port    UDP 4800
webconsole
        port    TCP 9010
farm
        port    UDP 4806
```

For configured checkers

- Ping checker for mirror or farm module
  Change ICMP settings to allow ping at destination to the address defined into the configuration.
- TCP checker for mirror or farm module
  Allow TCP connections at destination to the address defined into the <tcp> configuration if this address is not local.
- Module checker
  Allow TCP connections at destination to 9010 port of the node running the module that is checked.
- Split-brain checker
  Change ICMP settings to allow ping at destination to the witness defined into the <splitbrain> configuration.

10.4 Boot and shutdown setup in Windows

`safeadmin` service is configured for automatically starting on boot and stopping on shutdown. In turn, this service starts modules configured for starting at boot and shutdown all modules.

On some Windows platforms, the `safeadmin` boot start fails because the network configuration is not ready, and the modules shutdown does not have time to complete since the timeout for services shutdown is too short. If you encounter such problems, apply one of the following procedures.

When using the SNMP agent, adapt the following procedures to set the manual start of the `Net-SNMP Agent` service and include its start/stop into SafeKit start-up (`safekitbootstart.cmd`) and shutdown (`safekitshutdown.cmd`) scripts.

10.4.1 Automatic procedure

You can run the script as follow:

1. open a PowerShell window as administrator
2. `cd SAFE\private\bin`
3. run `addStartupShutdown.cmd`

This script sets the manual start for `safeadmin` service and adds default SafeKit start-up (`safekitbootstart.cmd`) and shutdown (`safekitshutdown.cmd`) scripts as part of the computer group policy start-up/shutdown scripts. If the script fails, apply the manual procedure below.

10.4.2 Manual procedure

You must apply the following procedure that uses the Group Policy Object Editor.

1. set manual start for `safeadmin` service
2. start the MMC console with the `mmc` command line
3. File - Add/Remove Snap-in Add - "Group Policy Object Editor" - OK
4. under "Console Root"/"Local Computer Policy"/"Computer Configuration"/"Windows Settings"/"Scripts (Start-up/Shutdown)", double click on "Start-up". Click on Add

then set for "Script Name:" `c:\safekit\private\bin\safekitbootstart.cmd`. This script launches the `safeadmin` service.

5. under "Console Root"/"Local Computer Policy"/"Computer Configuration"/"Windows Settings"/"Scripts (Start-up/Shutdown)", double click on "Shutdown". Click on Add then set for "Script Name:" `c:\safekit\private\bin\safekitshutdown.cmd`. This script shutdowns all running modules.

10.5 Linux Secure boot settings for SafeKit kernel modules

When Secure Boot is enabled in Linux, any kernel module must be signed, and the signing key must be enrolled in UEFI. Since SafeKit relies on `vip` and `tcpseq` kernel modules to implement load-balancing for farm modules, these kernel modules must also be signed and enrolled. Otherwise, the kernel modules will fail to load during the module startup with the following message into the module log:

| vipplug | E | Unable to load vip kernel extension

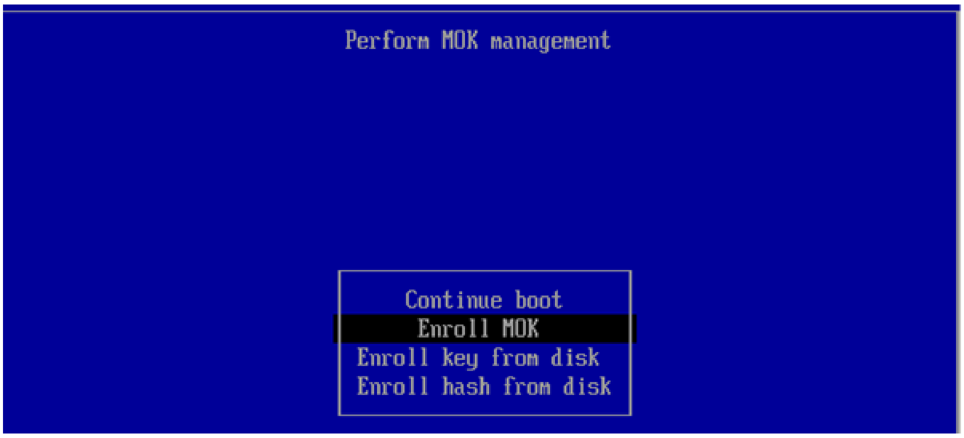
Moreover, when trying to load the vip module for instance, you'll get the following error:

```
modprobe vip
modprobe: ERROR: could not insert 'vip': Required key not available
```

Since SafeKit 8.2.4, to use farm module with load-balancing with Secure Boot enabled, follow the procedure described below. This procedure must be applied on all SafeKit nodes and can be done before or after the farm module configuration.

1. Log as root and open a command shell window
2. Change to the directory `/opt/safekit/kernel`
3. Run the command `make enroll`

   It will ask for the creation of a password. Remember this password for the step 5.
4. Reboot the server
5. At boot start, UEFI will ask for the enrolling of the new SafeKit signing key:



   Accept and give the password created in step 3.
   The procedure is needed only after the first reboot.
6. Once the reboot is completed, you can check that the SafeKit key has been enrolled by running:

```
mokutil --list-enroll | grep SafeKit
     … SafeKit …
```

You can also check that the SafeKit vip kernel module can be loaded without errors by running:

```
modprobe vip
```

For SafeKit < 8.2.4, follow the procedure described in Q009176.

10.6 Antivirus settings

Antiviruses may face detection challenges with SafeKit due to its close integration with the OS, virtual IP mechanisms, real-time replication, and restart of critical services. It may then be necessary to configure the antivirus to exclude certain directories and processes. The list of directories and processes is provided below.

Directories

`SAFE`	SafeKit installation directory: • In Windows `C:\safekit` on Windows if `SystemDrive=C:` • In Linux `/opt/safekit`
`SAFEVAR`	SafeKit working files directories: • In Windows `C:\safekit\var` if `SystemDrive=C:` • In Linux `/var/safekit`
Replicated folders	All replicated folders defined into mirror modules

Processes

The SafeKit processes for services and daemons are listed into the section 10.2.

Executables are in:

`SAFE`	`safekit` command
`SAFE/private/plugin/*/*`	Executables that are run on module state changes
`SAFE/private/bin`	SafeKit executables
`SAFE/web/bin`	SafeKit web service executables

10.7 Encryption of module communications

You can secure internal communications for the module, such as heartbeats and replication, by creating cryptographic keys associated with the module. By default, these keys are generated by SafeKit with a "private" certification authority (SafeKit PKI). In SafeKit <= 7.4.0.31, the generated key has a validity period of 1 year. See section 10.7.3.1 for solutions when the key expires.

Since SafeKit 7.4.0.16, you can also provide your own certificates generated with your trusted certification authority (enterprise PKI or commercial PKI). See section 10.7.3.2 for details.

Since SafeKit 7.4.0.32, the module can be reconfigured with new keys while it is in ALONE state (dynamic update).

When encryption is not properly configured (e.g.: not the same key on all cluster nodes of the module), the module internal communications between nodes are rejected. In this case, the module configuration is not identical on all nodes. You must apply it again on all nodes. Then, you can check it by running on each node the command `safekit confinfo -m AM` where *AM* is the module name (see section 9.5).

The **`encryption`** resource reflects the current communication mode of the module: "on"/"off" when encryption is active/not active. The resource name is `usersetting.encryption`. To check the state of resources, see section 7.3.

10.7.1 Configuration with the SafeKit Web console

When configuring the module with the SafeKit web console, communication encryption is enabled in the step 3 of the module configuration wizard (see section 3.3.2).

10.7.2 Configuration with the Command Line Interface

The commands line equivalent for configuring a module, named *AM*, with cryptographic key are:

1. Stop the *AM* module on all nodes
2. On one node, log as administrator/root and open a command shell window
3. Run `safekit module genkey -m AM`
4. Run `safekit -H "server1,server2" -E AM`

   where server1 and server2 are the nodes that implement the module

The commands line equivalent for re-configuring a module without cryptographic key are:

1. Stop the *AM* module on all nodes
2. On one node, log as administrator/root and open a command shell window
3. Run `safekit module delkey -m AM`
4. Run `safekit -H "server1,server2" -E AM`

   where server1 and server2 are the nodes that implement the module

For more details on commands, refer to section 9.5.

10.7.3 Advanced configuration

10.7.3.1 Advanced configuration with the SafeKit PKI

In SafeKit <= 7.4.0.31, the key for encrypting the module communication has a validity period of 1 year. When it expires in a mirror module with file replication, the secondary fails to reintegrate. You must re-configure the module with a new key, as explained in SK-0084, for reverting to normal behavior. In SafeKit > 7.4.0.31, the validity period has been set to 20 years.

If you cannot upgrade SafeKit, you can generate new keys with a longer validity period. For this apply the following procedure:

1. Stop the *AM* module on all nodes
2. On one node, log as administrator/root and open a command shell window
3. Run `safekit module genkey -m AM`
4. Delete the file `SAFE/modules/AM/conf/modulekey.p12`
5. Change to the directory `SAFE/web/bin`
6. Run `./openssl req -config ../conf/ssl.conf -subj "/O=SafeKiModule/CN=mirror" -new -x509 -sha256 -nodes -days 3650 -newkey rsa:2048 -keyout pkey.key -out cert.crt`

   Set the `-days` value to the validity period you want
7. Run `./openssl pkcs12 -export -inkey ./pkey.key -in ./cert.crt -name "Module certificate" -out modulekey.p12`

   This command requires to fill a password. Contact Evidian support to get the correct value for the password
8. Delete the files `pkey.key` and `cert.crt`
9. Move the file `modulekey.p12` into `SAFE/modules/AM/conf`
10. Run `safekit -H "server1,server2" -E AM`

    where server1 and server2 are the nodes that implement the module

The module is configured, on the 2 nodes, with the new key and ready to start.

10.7.3.2 Advanced configuration with an external PKI

Since SafeKit 7.4.0.16, you can provide your own key generated with your trusted certification authority (enterprise PKI or commercial PKI). For this apply the following procedure:

1. Stop the *AM* module on all nodes
2. On one node, log as administrator/root and open a command shell window
3. Run `safekit module genkey -m AM`
4. Delete the file `SAFE/modules/AM/conf/modulekey.p12`
5. Append the Base-64 encoded X.509 certificate file (PEM format), for your certification authority (certificate of the CA or certificate bundle of all the certificate authorities) to the file `SAFE/web/conf/cacert.crt`

6. Change to the directory `SAFE/web/bin`
7. Generate your certificate with the PKI with the subject set to `"/O=SafeKiModule/CN=mirror"`
8. Copy the generated files `pkey.key` and `cert.crt` into the directory `SAFE/web/bin`
9. Run `./openssl pkcs12 -export -inkey ./pkey.key -in ./cert.crt -name "Module certificate" -out modulekey.p12`

   This command requires to fill a password. Contact Evidian support to get the correct value for the password
10. Delete the files `pkey.key` and `cert.crt`
11. Move the file `modulekey.p12` into `SAFE/modules/`*`AM`*`/conf`
12. Run `safekit -H "server1,server2" -E` *`AM`*

    where server1 and server2 are the nodes that implement the module

The module is configured, on the 2 nodes, with the new key and ready to start.

10.8 SafeKit web service settings

SafeKit comes with a web service, `safewebserver`, which runs on each SafeKit server. It is a standard Apache web service that is **mandatory** for running:

- the web console (see section 3)
- the distributed command line interface (see section 9.8)
- the `<module>` checkers (see section 13.16)

`safewebserver` starts automatically at the end of SafeKit package install and on server reboot. If you do not need the SafeKit web service and want to remove the automatic boot start, refer to section 9.1.2.

The default configuration is HTTP with file-based authentication, initialized with:

- a single `admin` user that got the Admin role for the web console. The role can be changed via configuration files
- a private `rcmdadmin` user to execute the distribute safekit command

The usernames and passwords for these users can be changed, if necessary, as described in section 9.1.2.

10.8.1 Configuration files

The configuration of an instance of `safewebserver` on a SafeKit server is contained in the `SAFE/web/conf` directory. It consists in standard Apache configuration files (see http://httpd.apache.org). The configuration is split into many files, but for most common configurations, only the main configuration file `httpd.conf` need to be modified.

- After changes, you must restart the service with the command: `safekit webserver restart` (see section 9.1).
- Do not edit `.default` files since they are backups of delivered configuration files.

The `httpd.conf` file consists essentially in a set of `Define` statements. Comment character # disables the definition.

The mains `Define` are:

Connection port definition:

```
Define httpport 9010
Define httpsport 9453
```

Set the listening port in http and https mode. (See section 10.8.2 for usage).

User authentication definition:

```
Define usefile
# Define useldap
# Define useopenid
…
```

Select which user authentication to use. At most one must be defined. `usefile` is the default. (See section 11.4 for details.)

Apache logging definition:

```
#Define Loglevel info
#Define accesslog
```

Uncomment these lines to enable the logging for debug purposes. Logging files `httpd.log` and `access.log` are in `SAFEVAR`.

Session validity period definition:

```
Define SessionMaxAge 28800
```

Since SafeKit 8.2.1, the user is automatically logged out after 8 hours of inactivity (28800 seconds). If necessary, adjust this value.

Other `Define` are self-documented in the `httpd.conf file`.

The other configuration files are listed below. Modifying one of them may cause problems when upgrading SafeKit :

Global configuration	**httpd_main.conf**
File based authentication and role mapping	**httpd.webconsolefileauth.conf**
Form authentication configuration	**httpd.webconsoleformauth.conf**
LDAP/AD authentication configuration	**httpd.webconsoleldap.conf** using a LDAP/AD server
OpenID Connect authentication configuration	**httpd.webconsoleopenidauth.conf** using an OpenID connect identity provider
HTTPS configuration	**httpd.webconsolessl.conf** in `SAFE/web/conf/ssl`

User authentication configurations may optionally use `group.conf` (for HTTP) or `sslgroup.conf` (for HTTPS) files in `SAFE/web/conf` for user to role mapping.

10.8.2 Connection ports configuration

By default, connect the web console with the URL `http://host:9010`. The SafeKit web server will redirect to the appropriate section according to your security settings.

If you need to change the default value:

1. Edit `SAFE/web/conf/httpd.conf` and change the value of `httpport` or `httpsport` variables.
2. Restart the service using the command `safekit webserver restart`.

The HTTP and HTTPS configurations cannot be active simultaneously. See section 11.3 for how to configure HTTPS.

The port value `9010(HTTP)/9453(HTTPS)` is also used by the module checker. Therefore, if the configuration of a module defines a `<module>` checker:

1. Edit the module configuration file `userconfig.xml`
2. Edit the `port` attribute and assign it to the new port value

```
<check>
    <module name="mirror">
     <to addr="192.168.1.31" port="9010"/>
    </module>
  </check>
```

3. Apply the new configuration of the module

10.8.3 HTTP/HTTPS and user authentication configuration

- The default configuration is for HTTP.

The default configuration is also set with file-based authentication, initialized with a single `admin` user that got the Admin role.

- The HTTPS configuration requires the installation of certificates and the definition of user authentication.

For a detailed description, see section 11.

To re-enable the HTTP configuration if it has been changed to HTTPS see section 11.2.1.1.

10.8.4 SafeKit API

Use Swagger UI to visualize and interact with the SafeKit API provided by the SafeKit web service. For this, connect a browser at the URL http://host:9010/swagger-ui/index.html. It may be useful to debug issues with the SafeKit web console and/or API.

10.9 SafeKit email notification agent

Since SafeKit 8.2.4, SafeKit offers a notification agent that sends emails for major events on modules. These events are extracted from the system log (see section 10.12), which is populated by the log messages of modules configured on the SafeKit server. Using this feature requires that your company's IT team has set up an SMTP server that can be accessed by the agent running on SafeKit nodes.

During the SafeKit installation, the notification agent is installed but disabled by default.

The following procedure is required to configure and enable it. Apply it on all SafeKit nodes:

➪ SafeKit notification agent configuration described in section 10.9.1

It allows you to define the SMTP server, the email recipients, the selection of events to be sent…

➪ Optional SMTP client credentials setup described in section 10.9.2

It allows you to define the username and password needed to send an email if authentication is required by the SMTP server.

➪ Email sending test described in section 10.9.3

This allows you to verify that your configuration is functional for sending emails.

➪ SafeKit notification agent activation described in section 10.9.4

Once activated, major events from modules on this server will be automatically sent by email to the configured recipients.

In Windows, PowerShell 5 is required, which is the default version, as it is not compatible with PowerShell 7.

Below is an example of an email sent by the SafeKit notification agent set up on node1:

node1: New SafeKit message(s)

The following 5 noteworthy messages have been emitted on `node1`:

Node	Module	Timestamp	Origin	Level	Message	Message key
node1	mirror	2025-03-07T11:28:35.598077+01:00	heart	E	Local state WAIT Transient	512
node1	mirror	2025-03-07T11:28:35.582446+01:00	heart	C	License : NO license : Demo 3 days	537
node1	mirror	2025-03-07T11:28:19.156327+01:00	heart	E	Local state STOP NotReady	512
node1	mirror	2025-03-07T11:28:00.195159+01:00	heart	E	Local state WAIT Transient	512
node1	mirror	2025-03-07T11:27:41.183999+01:00	heart	E	Local state PRIM Transient	512

With the default agent configuration, when a module critical or state change event occurs on node1, the agent gathers all other events within the following minute and sends them in a single email.

In case of issues, refer to the section 7.20 for assistance.

10.9.1 SafeKit notification agent configuration

Follow the steps below to configure the SafeKit notification agent:

1. Open a PowerShell/shell window as administrator/root
2. Change directory to `SAFE/notifications`

   where `SAFE=C:\safekit` in Windows (if `%SYSTEMDRIVE%`=C:), and `SAFE=/opt/safekit` in Linux
3. Copy `safenotif_conf.json.default` to `safenotif_conf.json`
4. Edit `safenotif_conf.json` to set up your configuration

`safenotif_conf.json` is a self-documented configuration file in which you must at least configure the fields in the following excerpt:

```
{
    // ...
    "emailNotifications": {
        // ...
        "sender": "noreply@it-smtp-server.my.company.com",
        "recipients": [
            "my.name@my.company.com"
        ],
        // ...
    },
    "smtp": {
        "host": "it-smtp-server.my.company.com",
        "port": 25,
        "protocol": "smtp+starttls"
        // ...
    }
}
```

Where:

- "`sender`" is the email address to send emails from
- "`recipients`" is the list of email addresses to send emails to

- "`host`" is the hostname or IP address of the SMTP server
- "`port`" is the port the SMTP server listens on
- "`protocol`" is the protocol to use to connect to the SMTP server. In this example, it is set to an encrypted connection, initiated from a STARTTLS command.

By default, only critical messages and local state changes of the module are sent by emails. See `safenotif_conf.json` to select other messages, if necessary, change the sending delay or for other configuration options.

After upgrading SafeKit, you may need to reconfigure the notification agent if its configuration file format has changed between versions.

You can check the `safenotif_conf.json` for common logic errors with:

```
SAFE/private/bin/safenotif -testconfiguration
```

It returns a failure if an error is detected. Fix it before proceeding to the next step.

10.9.2 SMTP client credentials setup for authentication

SMTP servers are usually configured to require SMTP clients to specify credentials (username, password). The SafeKit notification agent (which embeds a SMTP client) stores such credentials in the file system in a secure, encrypted way. For this follow the steps below:

1. Open a PowerShell/shell window as administrator/root
2. Change directory to `SAFE`

   where `SAFE=C:\safekit` in Windows (if `%SYSTEMDRIVE%`=C:), and `SAFE=/opt/safekit` in Linux
3. Run `./private/bin/smtpcfg credentials set`

   This command prompts you to enter the username and password that correspond to the email sender account.

These credentials will then be used by the SafeKit notification agent to send mails.

To reset the credentials, and consequently disable the authentication, run:

```
SAFE/private/bin/smtpcfg credentials none
```

10.9.3 Email sending test

Once the SafeKit notification agent configured (see section 10.9.1), and the SMTP credentials set if authentication is required (see section 10.9.2), the following procedure can be used to send a test e-mail, using this configuration:

1. Open a PowerShell/shell window as administrator/root
2. Change directory to `SAFE`

   where `SAFE=C:\safekit` in Windows (if `%SYSTEMDRIVE%`=C:), and `SAFE=/opt/safekit` in Linux
3. Run `./private/bin/safenotif -testemail`

Here is a sample output of this command:

```
Sending email from noreply@it-smtp-server.my.company.com to
my.name@my.company.com with SMTP account noreply on server it-smtp-
server.my.company.com...
Email sending successful, check your mailbox(es).
```

Although the command is successful, it’s advisable to check the recipient’s mailbox that you configured to ensure the email was properly received.

If the email test fails, resolve the issue before proceeding to the next step. Refer to the section 7.20 for assistance.

10.9.4 SafeKit notification agent activation

Once you have ensured that your configuration is functional, apply the following procedure to enable the notification agent:

1. Open a PowerShell/shell window as administrator/root
2. Change directory to `SAFE`

   where `SAFE=C:\safekit` in Windows (if `%SYSTEMDRIVE%`=C:), and `SAFE=/opt/safekit` in Linux
3. Run `./safekit notification enable`

Once activated, major events from modules on this server will be automatically sent by email to the configured recipients.

To deactivate the notification, run:

`SAFE/safekit notification disable`

To check the status of the notification agent, run:

`SAFE/safekit notification status`

10.10 SNMP monitoring

SafeKit could be monitored by snmp. Since version 8, snmp monitoring implementation differs in Windows and Linux : In Windows, SafeKit use its own snmp agent service, when in Linux, the operating system’s snmp agent is used.

10.10.1 SNMP monitoring in Windows

For using the SafeKit SNMP agent, you must:

1. configure it to start on boot, with the command

`safekit boot [snmpon | snmpoff | snmpstatus]`	Controls the automatic start at boot of the `Net-SNMP Agent` service ("on" or "off"; by default, "off")

2. add the corresponding firewall rule

   When using the operating system firewall, the firewall has already been configured for `Net-SNMP Agent` if you have applied the command:

   `SAFE/private/bin/firewallcfg add`
3. start it with the command

`safekit safeagent [start | stop | restart | check]`	Controls start/stop of the `Net-SNMP Agent` service that implements the SafeKit SNMP agent.

The configuration of the `Net-SNMP Agent` is defined in the self-documented **`SAFE/snmp/conf/snmpd.conf`** file. It is a standard net-snmp configuration file as described in http://net-snmp.sourceforge.net. By default, the service is listening on UDP **`agentaddress`** port `3600` and accepts read request from the public community and write requests from the private community. Read requests are used to get module status and write requests to run actions on the module.

You can change the default configuration according to your needs. When you modify `snmpd.conf`, you must manually change the firewall rule and restart the service to load the new configuration with: `safekit safeagent restart`.

Since SafeKit 8, the service name is `Net-SNMP Agent` instead of `safeagent` in previous releases.

10.10.2 SNMP monitoring in Linux

Since SafeKit 8, Safekit did not come with its own snmp agent anymore, so the following safekit commands are obsoleted in Linux**:** `safeagent install, safeagent start, safeagent stop, boot snmpon, boot snmpoff, boot snmpstatus.`

Instead, it is possible to configure the standard snmpd Linux agent to access safekit mib:

1. Install net-snmp
   ```
   dnf install net-snmp net-snmp-utils
   ```
2. If selinux is in enforced mode, you have to set snmpd in permissive mode for snmp by :
   ```
   semanage permissive -a snmpd_t
   ```
3. If firewall is active, you have to open the snmp ports with:
   ```
   firewall-cmd --permanent --add-service snmp

   firewall-cmd --reload
   ```
4. Edit `/etc/snmp/snmpd.conf`
   Add the following lines :
   ```
   pass .1.3.6.1.4.1.107.175.10 /opt/safekit/snmp/bin/snmpsafekit
   view systemview included .1.3.6.1.4.1.107.175.10
   ```

   Note : the "view systemview" line set the access rights. You could have to adapt it to your general snmpd configuration.
5. Enable and Start the snmp agent
   ```
   systemctl enable snmpd
   systemctl start snmpd
   ```

10.10.3 The SafeKit MIB

The SafeKit MIB is common to Windows and Linux implementation. It is delivered in **`SAFE/snmp/mibs/safekit.mib`** .

The SafeKit MIB is accessed with the following identifier (OID, prefix of SafeKit SNMP variables): **`= enterprises.bull.safe.safekit (1.3.6.1.4.1.107.175.10).`**

The SafeKit MIB defines:

- The module table: **`skModuleTable`**

  The index on the module table is the ID of the application module as returned by the command `safekit module listid`.

  Through the MIB, you can read and display the status of an application module on a server (`STOP, WAIT, ALONE, UP, PRIM, SECOND`) or you can take an action on the module (`start`, `stop`, `restart`, `swap`, `stopstart`, `prim`, `second`).

  For example, the status of the module with ID 1 is read by an SNMP get to the variable:
  `enterprises.bull.safe.safekit.skModuleTable.skModuleEntry.skModuleCurrentState.1 = stop (0)`

  Use the `snmpwalk` command to check all MIB entries.

- The resource table: **`skResourceTable`**

  Each element defines a resource as for instance the one corresponding to the network interface checker `"intf.192.168.0.0"` and its status (`unknown`, `init`, `up`, `down`).

  Example: SNMP get request to
  `enterprises.bull.safe.safekit.skResourceTable.skResourceEntry.skResourceName.1.2` means name of resource 2 in application module 1.

10.11 Commands log of the SafeKit server

There is a log of the `safekit` commands ran on the server. It allows auditing the actions performed on the server to help support for instance. The log records all the `safekit` commands that are run and that modify the system such as a module install and configuration, a module start/stop, the `safekit webserver start/stop`, …

The command log is stored in the `SAFEVAR/log.db` file in SQLite3 format. For viewing its content:

- run the command `safekit cmdlog`

or

- click on the commands log tab into the web console

Below is the raw extract of this log:

```
| 2021-07-27 14:37:33.205122 |   safekit |   mirror |  6883 | START | config -m mirror
| 2021-07-27 14:37:33.400513 |   cluster |   mirror |     0 |     I | update cluster state
| 2021-07-27 14:37:33.405597 |   cluster |   mirror |     0 |     I | module state change on node centos7-
test3
| 2021-07-27 14:37:34.193280 |           |          |  6883 |   END | 0
| 2021-07-27 14:37:34.718292 |   cluster |   mirror |     0 |     I | update cluster state
| 2021-07-27 14:37:34.722080 |   cluster |   mirror |     0 |     I | module state change on node centos7-
test4
| 2021-07-27 14:37:37.510971 |           |          |  6871 |   END | 0
| 2021-07-27 14:38:05.092924 |   safekit |   mirror |  7017 | START | prim -m mirror -u
admin@10.0.0.103
| 2021-07-27 14:38:05.109368 |           |          |  7017 |   END | 0
```

Each field has the following meaning:

- The 1st field in the log entry is the date and time of the message

- The next one is the type of the action
- The next one is the module name when the action is not global
- The next one is the pid of the process that runs the command. It is used as the identifier of the log entry
- The next ones are `START` when the command starts and the command's arguments; or `END` when the command has finished with the return value.

10.12 SafeKit log messages in system log

Since SafeKit 8, SafeKit modules log messages are sent to system log too. To view them:

- In Windows, open a PowerShell window and run

  `Get-EventLog -Logname Application -Source Evidian.SafeKit` that returns:

```
  47086 Nov 23 11:27  Information Evidian.SafeKit       1073873154 mirror | heart | Remote
state UNKNOWN Unknown...
  47085 Nov 23 11:27  Information Evidian.SafeKit       1073873154 mirror | heart | Resource
heartbeat.flow set to down by heart...
  47084 Nov 23 11:26  Information Evidian.SafeKit       1073873154 mirror | heart | Local
state ALONE Ready...
  47082 Nov 23 11:26  Warning     Evidian.SafeKit       2147614977 mirror | heartplug | Action
alone called by heart : remote stop...
  47081 Nov 23 11:25  Information Evidian.SafeKit       1073873154 mirror | heart | Remote
state PRIM Ready...
  47080 Nov 23 11:25  Information Evidian.SafeKit       1073873154 mirror | heart | Local
state SECOND Ready...
  47079 Nov 23 11:25  Information Evidian.SafeKit       1073873154 mirror | rfsplug |
Reintegration ended (default)...
```

- In Linux, open a shell window and run
  `journalctl -r -t safekit` that returns:

```
Nov 23 15:22:43 localhost.localdomain safekit[3689940]: mirror | heart | Local state ALONE
Ready
Nov 23 15:22:43 localhost.localdomain safekit[3689940]: mirror | heart | Local state PRIM
Ready
Nov 23 15:16:48 localhost.localdomain safekit[3689940]: mirror | heart | Local state ALONE
Ready
Nov 23 15:16:48 localhost.localdomain safekit[3690096]: mirror | userplug | Script start_prim >
userlog_2023-11-23T151648_start_prim.ulog
Nov 23 15:16:48 localhost.localdomain safekit[3690066]: mirror | rfsplug | Uptodate replicated
file system
Nov 23 15:16:24 localhost.localdomain safekit[3689940]: mirror | heart | Remote state
UNKNOWN Unknown
```

11. Securing the SafeKit web service

➪ Section 11.1 "Overview"

➪ Section 11.2 "HTTP setup"

➪ Section 11.3 "HTTPS setup"

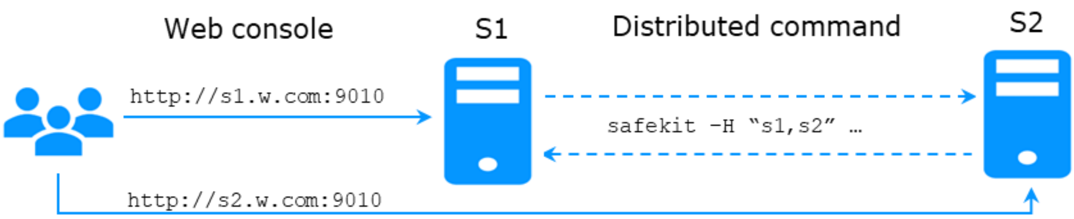
➪ Section 11.4 "User authentication setup"

11.1 Overview

The SafeKit web service is mainly used by:

- the web console (see section 3)
- the distributed command line interface (see section 9.8)

SafeKit provides different setups for this web service to enhance the security of the SafeKit web console and distributed commands.



Protocol	Authentication	Role management
✓ HTTP ✓ HTTPS	✓ None (http only) ✓ File based ✓ LDAP/AD ✓ OpenID Connect	✓ Admin ✓ Control ✓ Monitor

The most secure setups are based on HTTPS and user authentication. SafeKit provides a "private" certification authority (the SafeKit PKI). This allows SafeKit to be quickly secured without the need for an external PKI (enterprise PKI or commercial PKI) that provides trusted certification authority.

SafeKit offers also optional role management based on 3 roles:

Admin role	This role grants all administrative rights by allowing access to Configuration and Monitoring in the navigation sidebar
Control role	This role grants monitoring and control rights by allowing access only to Monitoring in the navigation sidebar
Monitor role	This role grants only monitoring rights, prohibiting actions on modules (start, stop…) in Monitoring in the navigation sidebar.

11.1.1 Default setup

The default setup is the following:

Setup	Protocol	Authentication Role management
Default	✓ HTTP	✓ File-based authentication (username/password stored in an Apache file) ✓ Initialization with a single user named `admin` with the Admin role ➩ To configure, see section 11.2.1

11.1.2 Predefined setups

The predefined setups are as follows:

Setup	Protocol	Authentication Role management
Unsecure	✓ HTTP	✓ No authentication ✓ Same role for all users For troubleshooting purpose only. ➩ To configure, see section 11.2.2
File-based	✓ HTTP ✓ HTTPS To configure HTTPS with: ➩ the SafeKit PKI, see section 11.3.1 ➩ an external PKI, see section 11.3.2	✓ username/password stored in a local Apache file ✓ Optional role management stored in a local Apache file ➩ To configure, see section 11.4.1
LDAP/AD	✓ HTTP ✓ HTTPS To configure HTTPS with: ➩ the SafeKit PKI, see section 11.3.1	✓ LDAP/AD authentication ✓ Optional role management ➩ To configure, see section 11.4.2

	➾ an external PKI, see section 11.3.2	
OpenID Connect	✓ HTTPS To configure HTTPS with: ➾ the SafeKit PKI, see section 11.3.1 ➾ an external PKI, see section 11.3.2	✓ OpenID Connect authentication ✓ Optional role management ➾ To configure, see section 11.4.3

On Linux, for all files added under `SAFE/web/conf`, change their rights with:

```
chown safekit:safekit SAFE/web/conf/<filename>
chmod 0440 SAFE/web/conf/<filename>.
```

11.2 HTTP setup

By default, after the SafeKit install, the web service is configured for HTTP with file-based authentication that must be initialized.

This default configuration can be extended as described in section 11.2.1.

It can also be replaced by the unsecure setup described in section 11.2.2 or anyone of the predefined setups.

11.2.1 Default setup

The default setup relies on HTTP with file-based authentication. It requires some initialization described below. It is a mandatory step.

This default configuration can be extended:

- to add users and assign them a role as described in section 11.4.1.1
- to switch to HTTPS with:
  - ➾ the SafeKit PKI described in section 11.3.1
  - ➾ an external PKI described in section 11.3.2

After the installation of SafeKit, the configuration and restart of the web service is not necessary since this is the default configuration and the web service has been started with it.

11.2.1.1 Reset to default HTTP Setup

If you have changed the default user authentication configuration and want to revert to it, see section 11.4.1.

If you want to revert to HTTP from HTTPS, on all SafeKit servers:

1. Remove `SAFE/web/conf/ssl/httpd.webconsolessl.conf`
2. Run `safekit webserver restart`

(where `SAFE=C:\safekit` in Windows if System Drive=C: and `SAFE=/opt/safekit` in Linux).

You can also run the command `SAFE/web/bin/rmcerts`, which, in addition to performing the previous operations, deletes all files related to certificates.

11.2.1.2 Initialization for the web console and distributed command

SafeKit provides a command to get the web console and distributed commands up and running quickly.

If you opted-in for automatic configuration during SafeKit package installation, the initialization has already been done.

If you opted-out for automatic configuration, you must execute this command.

In both cases, you will have to give the password value, *pwd* for the `admin` user.

`SAFE/private/bin/webservercfg -passwd` *pwd* where `SAFE=C:\safekit` (if `%SYSTEMDRIVE%`=C:) in Windows `SAFE=/opt/safekit` in Linux	On all nodes: 1. Open a PowerShell/shell window as administrator/root 2. Run `SAFE/private/bin/webservercfg -passwd` *pwd* `pwd` is the password value You must set the same password on all nodes.

The password must be identical on all nodes that belong to the same SafeKit cluster. Otherwise, web console and distributed commands will fail with authentication errors.

Once this initialization is done on all the cluster nodes:

- you can authenticate in the web console with the name `admin` and the password you provided. The role is Admin by default (unless you change the default behavior by providing the `group.conf` file as described in section 11.4.1.1)

  On authentication failure in the web console, you may need to reinitialize the `admin` password. For this, run again `SAFE/private/bin/webservercfg -passwd` *pwd* on all nodes.

- you can run distributed commands. It is based on a dedicated user `rcmdadmin` with the Admin role. It is managed in a different, private user file that you do not have to change.

  On authentication failure for distributed commands, you may need to reset `rcmdadmin` password. To reset only this one, without changing the `admin` password, run `SAFE/private/bin/webservercfg -rcmdpasswd` *pwd* on all nodes.

11.2.1.3 Test the web console and distributed command

The setup is complete; you can now test that it is operational.

- Test the web console
  1. Start a browser on the user's workstation
  2. Connect it to the default URL `http://host:9010` (where `host` is the name or Ip address of one of the SafeKit nodes)
  3. In the login page, enter `admin` as user's name and the password you gave on initialization (the value for *`pwd`*)
  4. The loaded page authorizes accesses that corresponds to the Admin role by default

- Test the distributed command
  1. Connect on S1 or S2 as administrator/root
  2. Open a system console (PowerShell, shell, …)
  3. Change directory to `SAFE`
  4. Run `safekit -H "*" level`

     that should return the level for all nodes

11.2.2 Unsecure setup based on identical role for all

It is based on the configuration of a single role that is applied to all users without requiring authentication. This solution can only be implemented in HTTP and is incompatible with user authentication methods. It is intended to be used for troubleshooting only.

11.2.2.1 Configure and restart the web service

To configure where `SAFE=C:\safekit` in Windows if System Drive=C: ; and `SAFE=/opt/safekit` in Linux):

httpd.conf

On S1 and S2:

1. edit `SAFE/web/conf/httpd.conf` file
2. comment all authentication variants (`usefile`, `useldap`, `useopenid`)

```
#Define usefile
…
#Define useldap
…
#Define useopenid
```

3. select the desired role by uncommenting the associated line (`httpadmin` for Admin role, `httpcontrol` for Control role) ; if both lines are commented, the default role is **Monitor.**

```
Define httpadmin
#Define httpcontrol
```

	On S1 and S2, disable HTTPS if you had configured it: 4. remove the file `SAFE/web/conf/ssl/httpd.webconsolessl.conf`
	On S1 and S2: 5. run `safekit webserver restart`

11.2.2.2 Test the web console and distributed command

The setup is complete; you can now test that it is operational.

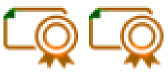
- Test the web console
  1. Start a browser on the user's workstation
  2. Connect it to the default URL `http://host:9010` (where `host` is the name or Ip address of one of the SafeKit nodes)
  3. The loaded page authorizes only the actions corresponding to the selected role

- Test the distributed command
  1. Connect on S1 or S2 as administrator/root
  2. Open a system console (PowerShell, shell, …)
  3. Change directory to `SAFE`
  4. Run `safekit -H "*" level`

     that should return the level for all nodes

11.3 HTTPS setup

The HTTPS web service relies on the existence of a set of certificates listed below:

 CA	The certificate of the Certification Authority CA used to issue the server certificate for S1 and S2
 S1 S2	The server certificate of S1 and S2 used to assert the nodes' identity

Apply one of the following 2 procedures to configure HTTPS and associated certificates:

➩ section 11.3.1 "HTTPS setup using the SafeKit PKI"

Go to this section to quickly setup HTTPS with the SafeKit "private" certification authority.

➩ section 11.3.2 "HTTPS setup using an external PKI"

Go to this section to setup HTTPS with an external PKI (enterprise PKI or commercial PKI) that provides trusted certification authority.

At the end of HTTPS setup, you must implement one of the authentication methods described in section 11.4.

11.3.1 HTTPS setup using the SafeKit PKI

Verify that the system clock is set to the current date and time on all SafeKit nodes and workstations that will run the HTTPS SafeKit web console. Certificates are timestamped, and a time difference between systems may have an impact on certificate validity.

11.3.1.1 Choose the Certificate Authority server

First, choose one SafeKit node to act as the Certificate Authority server. The selected node will be hereafter called the `CA server`. The other cluster nodes are called `non-CA server`. Then go through all the next subsections to activate the HTTPS configuration with the SafeKit PKI.

11.3.1.2 Start the CA web service on the CA server

On the CA server:

1. Log as administrator/root and open a command shell window
2. Change to the directory `SAFE/web/bin`
3. Run the command `./startcaserv`

   When prompted, enter a password to protect the access to this service for the `CA_admin` user (for instance, `PasW0rD)`. This command starts the `safecaserv` service.

Remember this password since it will be required to connect to this service in next steps.

The CA web service running on the first server is also accessed by the additional non-CA servers.

Since the service listens to TCP port 9001, make sure TCP port 9001 is not used, and is allowed in the firewall configuration. On Linux, the TCP 9001 port is automatically opened in local firewall by the `startcaserv` command. In Windows, the `SAFE/private/bin/firewallcfg add` command opens `safecaserv` service communications.

11.3.1.3 Generate Certificates on the CA server

During this step, the environment for generating certificates is set up: certificate authority, local server and client certificates are created; and server-side certificates are installed in their expected location.

On the CA server:

1. Log as administrator/root and open a command shell window
2. Change to the directory `SAFE/web/bin`
3. List server DNS names and IP addresses

By default, the server certificate includes all the locally defined IP addresses, DNS names and host name. They are listed into the files: SAFE/web/conf/ipv4.json and SAFE/web/conf/ipv6.json and SAFE/web/conf/ipnames.json.

For building these files, run the command:

- In Linux

```
./getipandnames
```

- In Windows

```
./getipandnames.ps1
```

If the service will be accessed using another DNS name or IP address, edit the corresponding file to insert the new value before executing the initssl command. This is required for instance in the clouds using NAT, where the server has a public address mapped on a private address.

4. Run the command:

```
./initssl sca
```

This command :

- Create a CA certificate conf/ca/certs/cacert.crt and its associated key conf/ca/private/cacert.key
- Create server certificate conf/ca/certs/server_<HOSTNAME>.crt and its corresponding key conf/ca/private/server_<HOSTNAME>.key
- Install the CA certificate, server certificate and key in the conf directory

This command creates a Certificate Authority certificate with the default subject name (that is "SafeKit Local Certificate Authority"). To customize the subject name, run the command with an extra parameter:

```
./initssl sca "/O=My Company/OU=My Entity/CN=My Company Private
Certificate Authority".
```

11.3.1.4 Generate certificates on non-CA server

During this step, on non-CA servers, local certificate requests are created, signed certificates are retrieved from the CA server, and finally certificates are installed at their expected locations.

Apply the following procedure sequentially on each non-CA servers:

1. Log on as administrator/root and open a command shell window
2. Change to the directory SAFE/web/bin
3. List server DNS names and IP addresses

By default, the server certificate includes all the locally defined IP addresses, DNS names and host name. They are listed into the files: SAFE/web/conf/ipv4.json, SAFE/web/conf/ipv6.json and SAFE/web/conf/ipnames.json. For building these files, run the command:

- In Linux

```
./getipandnames
```

- In Windows

```
./getipandnames.ps1
```

If the service will be accessed using another DNS name or IP address, edit the corresponding file to insert the new value before executing the `initssl` command. This is required for instance in the clouds using NAT, where the server has a public address mapped on a private address.

4. Run the command:

   ```
   ./initssl req https://CAserverIP:9001 CA_admin
   ```

   where `CAserverIP` is the DNS name or IP address of the CA server.

   Then enter, each time it is required, the password you specified when you started the CA web service on the CA server (for instance, `PasW0rD`)

   Or

   ```
   ./initssl req https://CAserverIP:9001 CA_admin:PasW0rD
   ```

If necessary, set the environment variables `HTTPS_PROXY` and `HTTP_PROXY` to adequate values.

If you get the error "Certificate is not yet valid", it means the system clock of the server is not synchronized with the system clock of the CA server. You should synchronize your server clocks and re-run the `initssl` command if the time difference is not acceptable.

11.3.1.5 Enable HTTPS on CA server and non-CA server

To enable HTTPS, on all SafeKit servers:

1. copy `SAFE/web/conf/httpd.webconsolessl.conf` to `SAFE/web/conf/ssl/httpd.webconsolessl.conf`
2. On Linux run :
   `chown safekit:safekit SAFE/web/conf/ssl/httpd.webconsolessl.conf`
   a. `chmod 0440 SAFE/web/conf/ssl/httpd.webconsolessl.conf`
3. run `safekit webserver restart`

(where `SAFE=C:\safekit` in Windows if System Drive=C: and `SAFE=/opt/safekit` in Linux)

11.3.1.6 Configure the firewall on CA server and non-CA server

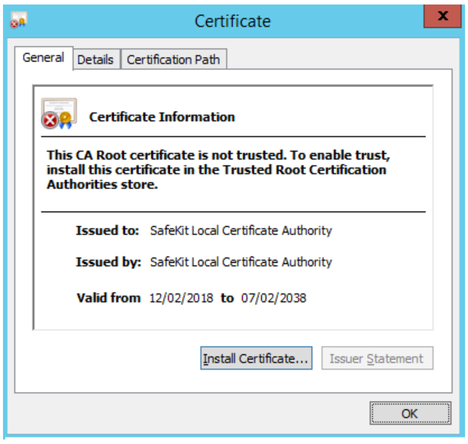
When the SafeKit web service runs in HTTPS mode, it is safe to allow network communication with this server and configure the firewall. For this, apply the instructions described in section 10.3.

11.3.1.7 Set the HTTPS SafeKit Web console

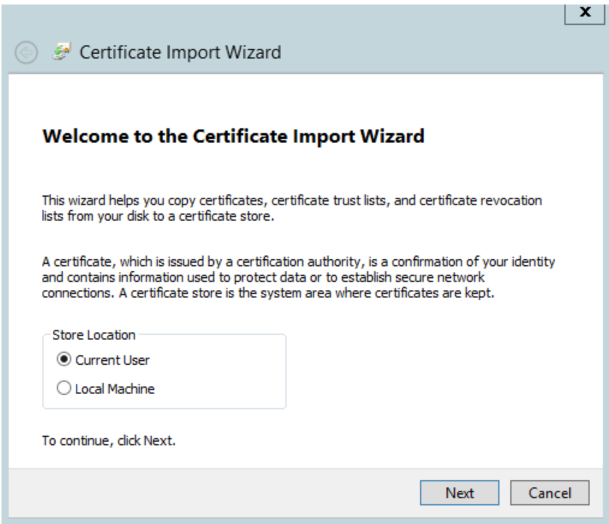
If the CA certificate has not been imported, the browser issues security alerts when the user connects to the web console with his client certificate. If the import has not already been done, apply the procedure below in Windows:

1. Log-in the user’s workstation
2. Download from the CA server the CA certificates (`cacert.crt` file) located into `SAFE/web/conf/ca/certs`.

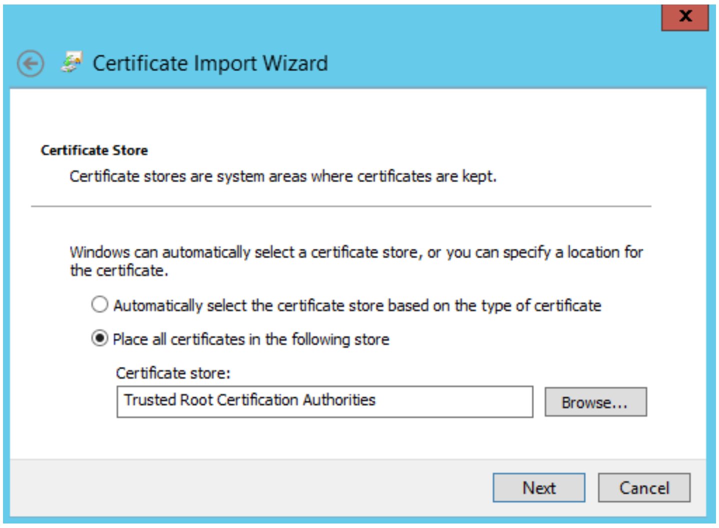
3. Click on the downloaded `cacert.crt` file for opening the certificate window. Then click on Install Certificate button



4. It opens the Certificate Import Wizard. Select Current User and click on the Next button



5. Browse stores to select the Trusted Root Certification Authorities store. Then click on Next button



6. Then complete the certificate import.

11.3.1.8 Stop the CA web service on CA server

Once all SafeKit servers have been configured, it is recommended to bring the CA web service (`safecaserv` service) offline on the CA server, to limit the risk of accidental or malicious access.

For stopping the SafeKit CA web service with the command line:

1. Log as administrator/root and open a command shell window
2. Change to the directory `SAFE/web/bin`
3. Run the command `./stopcaserv`

On Windows, this command also removes the service entry to prevent any accidental start of the service afterwards. On Linux, the 9001 port is automatically closed on local firewall.

When all foreseeable certificate generation and installation is done, it is a good practice to make sure files unnecessary at production time are not accessible. This step is not mandatory.

The files that constitute the CA, i.e., the `SAFE/web/conf/ca` file tree (especially the private keys stored under `SAFE/web/conf/ca/private/*.key`s) should be stored for future use on a removable storage media and removed from the server. Store the removable media in a secure place (i.e., a vault). This also applies to the files located under the `SAFE/web/conf/ca` directory of non-CA servers. The CA files should be restored into the same location before using the CA again (for example, if adding a new SafeKit cluster node).

11.3.1.9 SafeKit PKI advanced configuration

11.3.1.9.1 Removing certificates

If you want to revert to HTTP from HTTPS and remove all files related to certificates, on all SafeKit servers, run `SAFE/web/bin/rmcerts`(where `SAFE=C:\safekit` in Windows if System Drive=C: and `SAFE=/opt/safekit` in Linux). This command also restarts the `safewebserver` service.

11.3.1.9.2 Renewing certificates

Every certificate has an expiration date. The default expiration date of the CA certificate is set to 20 years after the CA installation date. The default expiration date of the server certificates is set to 20 years after the certificate request date.

Expired server certificates will trigger warnings when the browser connects to the server. Expired CA certificates cannot be used to validate issued certificates.

It is possible to renew certificates using the original certificate requests and the private keys stored under the `SAFE/web/conf/ca` directory tree. You may also create a new certificate request using the existing private key. The procedure to do so is beyond the scope of this document, see openssl (or your certificate authority) documentation.

Creating a new set of certificates (and private keys) will have the side effect of renewing all certificates. To create a new set of certificates:

1. Erase the `web/conf/ca` directory on all SafeKit servers related to the CA, including the CA SafeKit server itself
2. Suppress existing certificates from the client machines certificate stores

3. Apply the full procedures described in section 11.3

11.3.1.9.3 Revoking certificates

It is possible to modify the SafeKit web service configuration to use a CRL containing the revoked certificates list. Setting up such a configuration is beyond the scope of this document. Refer to the Apache and openssl documentation.

Creating a new set of certificates and replacing the old set with the new one will have the side effect of effectively revoking the previous certificate set, since the CA certificate is different.

11.3.1.9.4 Commands for certificate generation

These commands are located, and must be run from, the `SAFE/web/bin` directory.

All paths below are relative to `SAFE/web` directory.

`initssl sca [<subject>]`

Parameters

`<Subject>`: the optional CA certificate subject, that identify in human readable form the owner of the CA.

Examples

```
initssl sca "/O=My Company/OU=My Unit/CN=My Company Private Certificate
Authority"
```

Description

This command :

- Create a CA certificate `conf/ca/certs/cacert.crt` and its associated key `conf/ca/private/cacert.key`
- Create server certificate `conf/ca/certs/server_<HOSTNAME>.crt` and its corresponding key `conf/ca/private/server_<HOSTNAME>.key`
- Install the CA certificate, server certificate and key in the conf directory

It initializes a conf/ca file tree needed for the SafeKit PKI related commands.

Note that the best practice is to protect private keys with a password, but it needs more complex configuration on the server and is beyond the scope of this document. See the Apache and OpenSSL documentation for more information.

`initssl rca`

Description

As `initssl sca`, but reuse the existing CA infrastructure to reissue the server certificate and key (re)install the CA certificate , server certificate and key in the conf directory

`initssl req <url> <user>[:<password>]]`

Parameters

- `<url>`: URL of the CA service. (https://CA_server:9001)
- `<user>,<password>`: user and password used to authenticate against the CA web service.

<user> preconfigured value is CA_admin. <password> is the one entered by the administrator at the start of CA web service. If these optional field are not present, the password will be asked interactively several times, when needed.

Example

```
initssl req https://192.168.0.1:9001 CA_admin:PasW0rD
```

Description

This command :

- Creates a certificate request for a server certificate that includes all the locally defined IP addresses and DNS names. The certificate request is stored in `conf/ca/private/server_<hostname>.csr`. The corresponding key is stored in `conf/ca/private/server_<hostname>.key`.
- Creates a certificate request for a client certificate with the Admin role (to be used by the distributed commands). The certificate request is stored in `conf/ca/private/user_Admin_<hostname>.csr`. The corresponding key is stored in `conf/ca/private/user_Admin_<hostname>.key`.
- Retrieves the CA certificate from the CA server
- Retrieves signed certificates corresponding to the certificate requests above, from the CA server (using provided login)
- Installs certificates and keys in the conf directory
- Checks certificates are OK

If no <url> is given, the command stops after having generated the certificate requests corresponding to:

- The local server, in the `conf/ca/private/server_<hostname>.csr`
- An Admin role client certificate, in `conf/ca/private/user_Admin_<hostname>.csr`

Those certificate requests are stored in a base64 encoded file ready to be submitted to an external certificate authority such as Microsoft Active Directory Certificate Services (refer to the Microsoft documentation on how to submit a base64 encoded certificate request file).

makeusercert <name> <role>

Parameters

<name> is the subject's CN name of the certificate, usually the subject's username.

<role> is subject's role as a console user. The valid value is Admin or Control or Monitor.

Examples

```
makeusercert administrator Admin
makeusercert manager Control
makeusercert operator Monitor
```

Description

Creates a client certificate request (and certificate + pkcs12 file containing certificate and key if started on the CA SafeKit server) for the <name> and <role>.

When the pkcs12 file is generated, the command asks twice for a password to protect the file. The generated unencrypted private key is stored into `conf/ca/private/user_<role>_<name>.key` file. If applicable, the generated certificate and pkcs12 files are stored into `conf/ca/certs/user_<role>_<name>.crt` and `conf/ca/private/user_<role>_<name>.p12` files respectively.

Client certificates could be used as an authentication method on an HTTPS server. They are transmitted to the web service by the browser and verified on the server as part of the HTTPS connection handshake. A certificate corresponding to the desired role must be installed in the browser certificate store before the SafeKit web console can be used.

11.3.1.9.5 SafeKit CA web service

The SafeKit CA web service configuration is stored in `SAFE/web/conf/httpd.caserv.conf` file.

This service implements limited PKI.

CA certificates are accessible at the https://CAserverIP>:9001/certs/<certificate name>.crt URL.

For example, the CA certificate is accessible at https://CAserverrIP>:9001/certs/cacert.crt.

Certificate signature requests are processed by posting a form at the URL: https://<CA server IP>:9001/caserv .

The form takes the following parameters:

- action = signrequest
- name = <certificate name>
- servercsr = <file content of the server certificate request>

  Or
- usercsr = <file content of the client certificate request>

11.3.2 HTTPS setup using an external PKI

Apply steps below to setup HTTPS with your trusted certification authority (your enterprise PKI or commercial PKI).

11.3.2.1 Get and install server certificates

11.3.2.1.1 Get certificate files

You must get server certificates from the PKI with the expected format.

	The certificate of the Certification Authority CA used to issue the server certificates
	The server certificate to assert the S1 identity.
	The server certificate to assert the S2 identity.

	Base-64 encoded X.509 certificate file (PEM format). The subfield `CN` (`Common Name`) into the `subject` field, or the `Subject Alternative Name` field of the certificate, must contain : • S1 name(s) and/or IP address(es) for `s1.crt` • S2 names and/or IP address(es) for `s2.crt`
`s1.crt` `s2.crt`	See the example in section 11.3.2.1.3. Be aware that you must provide all names and/or IP addresses, for S1 and S2, which are used for HTTPS connections: • those included into the SafeKit cluster configuration file • Those used in the browser URL to load the web console from a cluster node, and which are not present into the cluster configuration
`s1.key` `s2.key`	The private, *unencrypted* key corresponding to the certificates `s1.crt` and `s2.crt`

11.3.2.1.2 Install files in SafeKit

Install the certificates as follow (where `SAFE=C:\safekit` in Windows if System Drive=C: ; and `SAFE=/opt/safekit` in Linux):

 `s1.crt` `s1.key`	On S1: 1. copy `s1.crt` to `SAFE/web/conf/server.crt` 2. copy `s1.key` to `SAFE/web/conf/server.key`
 `s2.crt` `s2.key`	On S2: 3. copy `s2.crt` to `SAFE/web/conf/server.crt` 4. copy `s2.key` to `SAFE/web/conf/server.key`

5. On Linux, on S1 and S2, run:

```
chown safekit:safekit SAFE/web/conf/server.crt SAFE/web/conf/server.key
chmod 0440 SAFE/web/conf/server.crt SAFE/web/conf/server.key
```

You can check the installed certificates with:

```
cd SAFE/web/bin
checkcert -t server
```

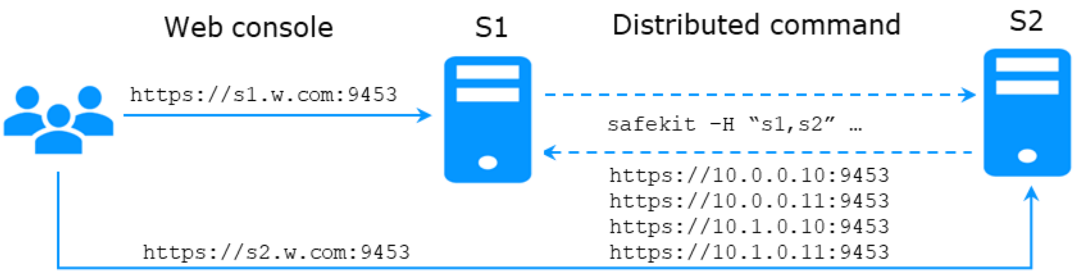
It returns a failure if an error is detected.

You can check that the certificate contains some DNS name or IP address with:

```
checkcert -h "DNS name value"
checkcert -i "Numeric IP address value"
```

11.3.2.1.3 Example

Consider the following architecture:



The corresponding SafeKit cluster configuration file, `SAFEVAR/cluster/cluster.xml` must contain these values into `addr` field:

```
<?xml version="1.0"?>
<cluster>
<lans>
  <lan name="default">
    <node name="s1" addr="10.0.0.10"/>
    <node name="s2" addr="10.0.0.11"/>
  </lan>
  <lan name="private">
    <node name="s1" addr="10.1.0.10"/>
    <node name="s2" addr="10.1.0.11"/>
  </lan>
</lans>
</cluster>
```

The server certificates must contain the same values (DNS names and/or IP addresses) as those in the cluster configuration and the values used to connect the web console. If not, the SafeKit web console and distributed commands will not work properly.

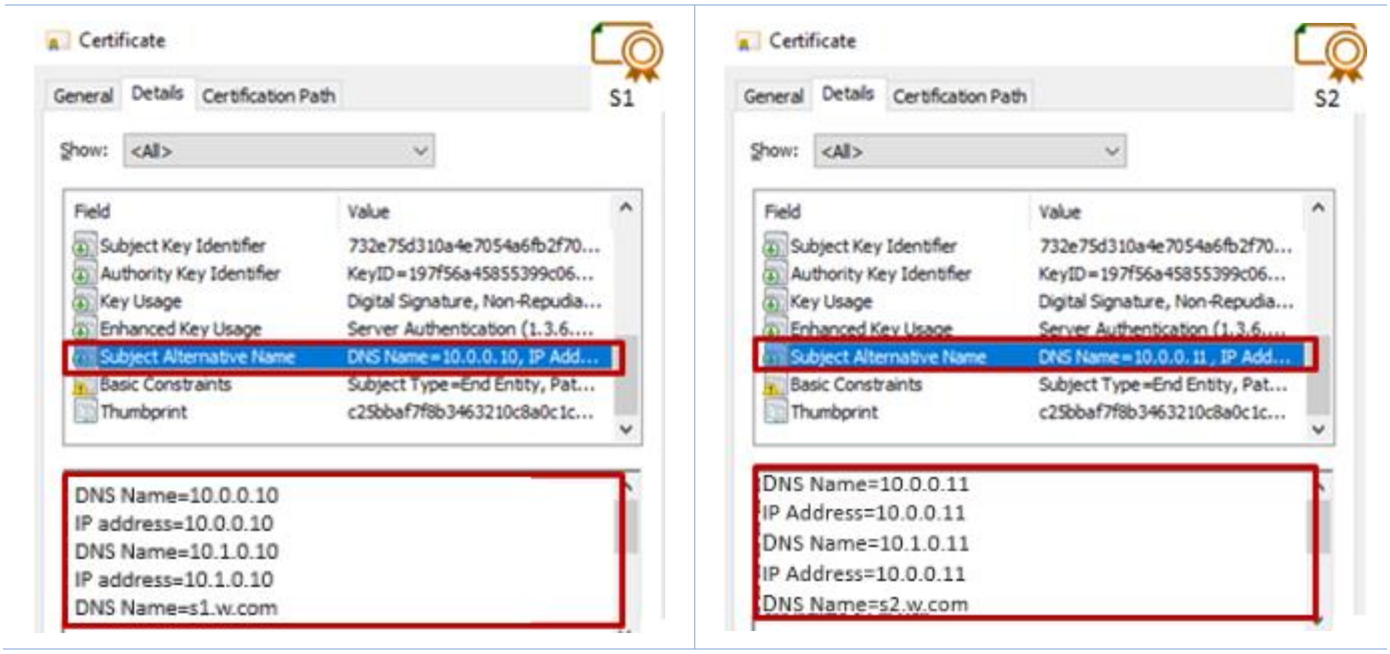
To check that the certificate file is correct:

1. Copy the `.crt` (or `.cer`) file on a Windows workstation
2. Double click on this file to open it with Crypto Shell Extensions
3. Click on the Details tab
4. Verify the `Subject Alternative Name` field

If you prefer the command line interface, you can run on each the SafeKit node:

```
SAFE/web/bin/openssl.exe x509 -text -noout -in
SAFE/web/conf/server.crt
```

and look for the value after `Subject Alternative Name`.



11.3.2.2 Get and install the CA certificate

11.3.2.2.1 Get certificate file

You must get these certificates from the PKI with the expected format.

 cacert.crt	The Certification Authority CA certificate used to issue the server certificates. Base-64 encoded X.509 certificate file (PEM format). The chain of certificates for the root and intermediates CA	 Server certificates for S1 and S2

If you have trouble retrieving this file from the PKI, you can build it using the procedure described in section 7.19.

11.3.2.2.2 Install file in SafeKit

Install certificates files as follow (where `SAFE=C:\safekit` in Windows if System Drive=C: ; and `SAFE=/opt/safekit` in Linux):

 cacert.crt	On S1 and S2: 1. copy `cacert.crt` to `SAFE/web/conf/cacert.crt` 2. On Linux, run: `chown safekit:safekit SAFE/web/conf/cacert.crt` `chmod 0440 SAFE/web/conf/cacert.crt`

You can check the installed certificates with:

```
cd SAFE/web/bin
checkcert -t CA
```

It returns a failure if an error is detected.

You must also check that the `cacert.crt` contains the chain of certificates for the root and intermediates Certification Authorities.

11.3.2.3 Configure and restart the web service

To enable HTTPS, on all servers :

1. copy `SAFE/web/conf/httpd.webconsolessl.conf` to `SAFE/web/conf/ssl/httpd.webconsolessl.conf`
2. On Linux, run :

   `chown safekit:safekit SAFE/web/conf/ssl/httpd.webconsolessl.conf`

   `chmod 0440 SAFE/web/conf/ssl/httpd.webconsolessl.conf`
3. run `safekit webserver restart`

where `SAFE=C:\safekit` in Windows if System Drive=C: ; and `SAFE=/opt/safekit` in Linux

11.3.2.4 Change the firewall rules

You can run the `firewallcfg` command to change the firewall rules. It set SafeKit rules into the operating system default firewall (in Windows, `Microsoft Windows Firewall` ; in Linux, `firewalld` or `iptables`).

Firewall	On S1 and S2: 1. run `SAFE/private/bin/firewallcfg add` where `SAFE=C:\safekit` in Windows if System Drive=C: ; and `SAFE=/opt/safekit` in Linux

Don't run this command if you want to configure the firewall yourself or if you use a different firewall than the system one. For the list of SafeKit processes and ports, see section 10.3.

11.4 User authentication setup

Setup one of the following user authentication methods:

➪ section 11.4.1 "File-based authentication setup"

➪ section 11.4.2 "LDAP/AD authentication setup"

➪ section 11.4.3 "OpenID authentication setup"

At the end of this setup, you can start using the secure SafeKit web console.

11.4.1 File-based authentication setup

File-based authentication setup can be applied in HTTP or HTTPS. It relies on the following files:

user.conf	User file configuration that defines authorized users
Admin Control Monitor group.conf	Optional file to restrict the user's role. If the `group.conf` file is not present, all authenticated users will have the Admin role.

11.4.1.1 Manage users and groups

The users and groups must be identical on S1 and S2, as well as passwords. It is defined by the files `user.conf` and `group.conf` into `SAFE/web/conf` directory (`SAFE=C:\safekit` in Windows if System Drive=C: ; and `SAFE=/opt/safekit` in Linux).

During the default setup initialization, described in section 11.2.1, the user named `admin` has been created and thus is present into `user.conf`. You can decide to remove this user if you create others.

1. Create a new user

   Users are created with the `SAFE/web/bin/htpasswd` command.

   For instance, to add the new user `manager` and set its password `managerpassword`, run:

```
SAFE/web/bin/htpasswd -bB SAFE/web/conf/user.conf manager managerpassword
```

   The new user is inserted into `SAFE/web/conf/user.conf` the file.

user.conf	admin:$2y$05$oPquL6Z2Y78QcXpHIako.O58Z6lWfa5A86XD.eCbEnbRcguJln9Ce **manager**:$apr1$U2GLivF5$x39WKmSpq6BGmLybESgNV1 operator1:$apr1$DetdwaZz$hy5pQzpUlPny3qsXrIS/z1 operator2:$apr1$ICiZv2ru$wRkc3BclBhXzc/4llofoc1

2. Assign the role of the users (optional)

   By default, all users have the Admin role. If you want to assign distinct roles to different users, you must create the `SAFE/web/conf/group.conf` file and assign user's role. The group file can contain the 3 groups Admin, Control, Monitor. Users in these groups will have the corresponding roles.

Each line of the group file must contain the group name followed by a colon, followed by the member users name separated by spaces. See the example above.

   For instance, assign the Control role to the new user `manager`:

 group.conf	`Admin : admin` `Control : manager` `Monitor : operator1 operator2`

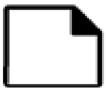
Each line of the group file must contain the group name followed by a colon, followed by the member users name separated by spaces. See the example above.

3. Delete a user, …

   Use `htpasswd -?` for all user management commands (add/delete, ...).

11.4.1.2 Install files

Install the files as follow (where `SAFE=C:\safekit` in Windows if System Drive=C: ; and `SAFE=/opt/safekit` in Linux):

 user.conf	On S1 and S2: 1. copy `user.conf` to `SAFE/web/conf/user.conf`
 group.conf	On S1 and S2 if groups are set: 2. copy `group.conf` to `SAFE/web/conf/group.conf`

3. On Linux, on S1 and S2, run:

```
chown safekit:safekit SAFE/web/conf/user.conf SAFE/web/conf/group.conf
chmod 0440 SAFE/web/conf/user.conf SAFE/web/conf/group.conf
```

These files must be identical on all nodes.

11.4.1.3 Configure and restart the web service

To configure the file-based authentication (where `SAFE=C:\safekit` in Windows if System Drive=C: ; and `SAFE=/opt/safekit` in Linux):

 httpd.conf	On S1 and S2: 1. edit `SAFE/web/conf/httpd.conf` file 2. if necessary uncomment `usefile` `Define usefile`
	On S1 and S2: 3. run `safekit webserver restart`

This is the default content of `httpd.conf`.

11.4.1.4 Test the web console and distributed command

The setup is complete; you can now test that it is operational.

- Test the web console

1. Start a browser on the user’s workstation
2. Connect it to the default URL `http://host:9010` (where `host` is the name or Ip address of one of the SafeKit nodes). If HTTPS is configured, there is an automatic redirection to `https://host:9453`
3. In the login page, specify in the user’s name and password

   With the SafeKit default configuration, you can log-in with the user `admin` by giving the password you assigned during initialization.
4. The loaded page only allows access authorized by the user's role. If the groups have not been defined, all users have the Admin role.

- Test the distributed command

4. Connect on S1 or S2 as administrator/root
5. Open a system console (PowerShell, shell, …)
6. Change directory to `SAFE`
7. Run `safekit -H "*" level`

   that should return the level for all nodes

11.4.2 LDAP/AD authentication setup

LDAP/AD authentication setup can be applied in HTTP or HTTPS. It requires:

	LDAP/Active Directory account configuration used to assert the user identity
	Optional LDAP/Active Directory group configuration to restrict the user’s role. When groups are not defined, all authenticated users have the Admin role.

On some Linux distributions (such as RedHat 8 and CentOS 8), the web server start fails when it is configured with LDAP/AD authentication. In this case, apply the solution described in SK-0092.

Apply the steps described below after verifying that S1 and S2 can connect to the LDAP controller domain port (default is 389).

11.4.2.1 Manage users and groups

If necessary, ask your LDAP administrator to create users of the SafeKit web console.

If you want to define user’s role, ask your LDAP administrator to create groups for Admin, Control, Monitor roles and assign users to groups. When groups are not defined, all users will have the Admin role.

11.4.2.2 Configure and restart the web service

To configure the LDAP/AD authentication (where `SAFE=C:\safekit` in Windows if `%SYSTEMDRIVE%=C:` ; and `SAFE=/opt/safekit` in Linux):

On S1 and S2:

Initialize the authentication for the distributed command. This may have already been done if you initialized the default configuration after SafeKit installation. Otherwise:

1. Run `SAFE/private/bin/webservercfg -rcmdpasswd` *`pwd`*

   where *`pwd`* is the password for the private user `rcmdadmin`. You don't need to memorize it.

On S1 and S2:

2. edit `SAFE/web/conf/httpd.conf` file
3. uncomment `useldap`

```
Define useldap
```

4. Locate the following lines and replace bold values according to your LDAP/AD service configuration:

```
Define binddn "CN=bindCN,OU=bindOU1,OU=bindOU2,DC=domain,DC=fq,DC=dn"
Define bindpwd "Password0"
Define searchurl "ldap://ldaporad.fq.dn:389/OU=searchou, DC=domain, DC=fq,
DC=dn?sAMAccountName, memberOf?sub?(objectClass=*)"
```

   the `binddn` and `bindpwd` variables must contain the credentials of an account with search rights on the directory.

   the `searchurl` variable defines the RFC2255 search URL to authenticate the user.

httpd.conf

   `CN`: common name

   `OU`: organization unit

   `DC`: domain component (one field for each part of the FQDN).

If the group configuration is not enabled, all authenticated users will have the Admin role.

On S1 and S2

To enable group management (optional):

5. edit `SAFE/web/conf/httpd.conf` file
6. uncomment the following lines and replace bold values according to your LDAP/AD service configuration:

```
Define admingroup
"CN=Group1CN,OU=Group1OU1,OU=Group1OU2,DC=domain,DC=fq,DC=dn"
Define controlgroup
"CN=Group2CN,OU=Group2OU1,OU=Group2OU2,DC=domain,DC=fq,DC=dn"
Define monitorgroup
"CN=Group3CN,OU=Group3OU1,OU=Group3OU2,DC=domain,DC=fq,DC=dn"
```

	Users set into the LDAP/AD groups associated to `admingroup`, `controlgroup` and `monitorgroup`, will respectively have Admin, Control and Monitor roles. For more sophisticated authentication, read Apache web service documentation (see http://httpd.apache.org).
	On S1 and S2: 7. run `safekit webserver restart`

11.4.2.3 Test the web console and distributed command

The setup is complete; you can now test that it is operational.

- Test the web console
  1. Start a browser on the user's workstation
  2. Connect it to the default URL `http://host:9010` (where `host` is the name or Ip address of one of the SafeKit nodes). If HTTPS is configured, there is an automatic redirection to `https://host:9453`
  3. In the login page, specify in the user's name and password
  4. The loaded page only allows access authorized by the user's role. If the groups have not been defined, all users have the Admin role.

- Test the distributed command
  1. Connect on S1 or S2 as administrator/root
  2. Open a system console (PowerShell, shell, …)
  3. Change directory to `SAFE`
  4. Run `safekit -H "*" level`

     that should return the level for all nodes

11.4.3 OpenID authentication setup

Since SafeKit 8.2.3, OpenID authentication works only with HTTPS. To setup HTTPS, refer to section 11.3.

OpenID authentication relies on the `mod_auth_openidc` Apache module. It must be set with HTTPS. It requires:

	OpenID Identity provider client application registration and account configuration used to assert the user identity
	Optional OpenID claims configuration to restrict the user's role. When claims are not defined, all authenticated users have the Admin role.

On some Linux distributions you may need to install the `mod_auth_openidc` module from the distribution repository.

Apply the steps described below after verifying that S1 and S2 can connect to the OpenID Identity Provider. You may need to setup a proxy configuration, see relevant `httpd.conf` section and `mod_auth_openidc` documentation for details.

11.4.3.1 Manage app, users and groups

If necessary, ask your OpenID administrator to create users of the SafeKit web console.

Ask your OpenID administrator to register the webconsole App into the OpenID provider (OP) and retrieve the assigned credentials (ClientID and ClientSecret) values (you will need those values during the httpd.conf configuration step below).

Set the app’s redirect URI to https://host:9453/openid. If you plan to connect to more than one server, enter the URL of each connection server.

If you want to define user’s role on the Identity Provider, ask your OpenID administrator to create groups or roles for Admin, Control, Monitor roles and assign users to the created groups or roles, then fill in the `AdminClaim`, `ControlClaim` and `MonitorClaim` variables in `httpd.conf` with the corresponding claims. When the above is not defined, all authenticated users will have the Admin role.

You may also define the groups on the SafeKit Web Server by filling in the `group.conf` file as in the File-based authentication case (see “Assign the role of the users” in section 11.4.1.1).

11.4.3.2 Configure and restart the web service

To configure the OpenID authentication (where `SAFE=C:\safekit` in Windows if `%SYSTEMDRIVE%`=C: ; and `SAFE=/opt/safekit` in Linux):

On S1 and S2:

Initialize the authentication for the distributed command. This may have already been done if you initialized the default configuration after SafeKit installation. Otherwise:

1. Run `SAFE/private/bin/webservercfg -rcmdpasswd` *pwd*

   where *pwd* is the password for the private user `rcmdadmin`. You don’t need to memorize it.


httpd.conf

On S1 and S2:

2. edit `SAFE/web/conf/httpd.conf` file
3. uncomment `useopenid`

```
Define useopenid
```

4. Locate the following lines and replace values according to your OpenID service configuration:

```
OIDCProviderMetadataURL <Your OpenId provider metadata URL>
OIDCClientID <Your OpenID client ID>
OIDCClientSecret <Your OpenID client secret>
OIDCRemoteUserClaim <The Claim in ID token that identifies the user, if not set, defaults to sub>
```

```
## openid connect scope request; this defines which claims are returned by
the IDP.
OIDCScope "openid email"
```

- the `OIDCClientID` and `OIDCClientSecret` variables must contain the credentials of the registered app in the OpenID Identity Provider.
- the `OICDScope` variable defines the scopes needed to return the `RemoteUser` and optionally roles claims. `openid` should always be specified.

If neither the `AdminClaim`, `ControlClaim` and `MonitorClaim` configuration nor the group.conf configuration is enabled, all authenticated users will have the Admin role.

On S1 and S2

To enable role claim management:

5. edit `SAFE/web/conf/httpd.conf` file
6. uncomment the following lines and replace the values according to your OpenID service configuration:

```
# Define AdminClaim roles:SKAdmin
# Define ControlClaim roles:SKControl
# Define MonitorClaim roles:SKMonitor
```

Users' tokens bearing the claims defined by the AdminClaim, ControlClaim and MonitorClaim, will respectively have Admin, Control and Monitor roles.

For more details, see the `mod_auth_openidc` documentation (GitHub - OpenIDC/mod_auth_openidc: OpenID Certified™ OpenID Connect Relying Party implementation for Apache HTTP Server 2.x).

On S1 and S2:

7. run `safekit webserver restart`

11.4.3.3 Test the web console and distributed command

The setup is complete; you can now test that it is operational.

- Test the web console
  1. Start a browser on the user's workstation
  2. Connect it to the default URL `http://host:9010` (where `host` is the name or Ip address of one of the SafeKit nodes). Since HTTPS must be configured, there is an automatic redirection to `https://host:9453`
  3. In the login page, specify in the user's name and password
  4. The loaded page only allows access authorized by the user's role. If the groups have not been defined, all users have the Admin role.

- Test the distributed command
  1. Connect on S1 or S2 as administrator/root
  2. Open a system console (PowerShell, shell, …)

3. Change directory to `SAFE`
4. Run `safekit -H "*" level`

   that should return the level for all nodes

12. Cluster.xml for the SafeKit cluster configuration

➪ Section 12.1 “Cluster.xml file”

➪ Section 12.2 “SafeKit cluster Configuration”

SafeKit uses the configuration file `cluster.xml`. This file defines all the servers that make up the SafeKit cluster as well as the IP address (or name) of these servers on the networks used to communicate with the cluster nodes. These are global cluster and module internal communications; these communications are encrypted. This network is also used for executing the global `safekit` command (with argument `-H`).

You must define at least one network that includes all nodes in the cluster. It is recommended to define several networks to tolerate at least one network failure.

The cluster can be configured:

- Either via the cluster configuration wizard in the SafeKit web console
- Or by directly editing the cluster configuration file and applying the configuration via command line

Both methods are described in section 12.2.

For full examples of cluster configurations refer to section 15.1.1 and section 15.2.1. It presents the configuration via the web console along with the corresponding `cluster.xml`.

12.1 Cluster.xml file

Each network (`lan`) has a logical name that will be used in the configuration of the modules to name the monitoring networks:

- into the heartbeat section for a mirror module (for details, see section 13.3)
- into the lan section for a farm module (for details, see section 13.4)

The node name is the one that is used by the SafeKit administration service (`safeadmin`) for uniquely identifying a SafeKit node. You must always use the same name for designing a given server on different networks. This name is also used by the SafeKit web console when displaying the node’s name.

12.1.1 Cluster.xml example

- In the example below, two networks are defined. One of them can be dedicated to file replication in a mirror module.

```
<cluster>
<lans>
      <lan name="default">
         <node name="node1" addr="192.168.1.67"/>
         <node name="node2" addr="192.168.1.68"/>
      </lan>
      <lan name="repli">
         <node name="node1" addr="10.0.0.1"/>
```

```
        <node name="node2" addr="10.0.0.2"/>
     </lan>
   </lans>
</cluster>
```

- In the example below, a unique network is used, but in a Network address translation (NAT) configuration. For each node two addresses must be defined: the local one `laddr` (defined on local interface) and the external one `addr` (as seen by other servers).

  All nodes must be able to communicate to the others via the NATted addresses.

```
<cluster>
   <lans>
      <lan name="default">
         <node name="node1" addr="server1.dns.name" laddr="10.0.0.1"/>
         <node name="node2" addr="server2.dns.name" laddr="10.0.0.2"/>
      </lan>
   </lans>
</cluster>
```

12.1.2 Cluster.xml syntax

```
<cluster>
  <lans [port="4800"]>
    <lan name="lan_name" [command="on|off"] >
      <node name="node1 name" addr="node1 IP address or name"
           [ laddr="local_IP1_address" ]/>
      <node name="node2 name" addr="node2 IP address or name"
           [ laddr="local_IP2_address" ] />
      …
    </lan>
    …
  </lans>
</cluster>
```

12.1.3 <lans>, <lan>, <node> attributes

`<lans`	Begin the definition of the cluster nodes and network topology.
`[port="xxxx"]`	Defines the UDP port with which the membership protocol is exchanged. Default: `4800`
`[pulse="xxxx"]`	Defines the period of the membership protocol messages emission. Longer pulse makes the membership protocol use less bandwidth but react more slowly.
`[mlost_count="xx"]`	Defines the number of periods elapsed without message before electing a new leader.
`[slost_count="xx"]`	Defines the number of periods elapsed without messages before declaring a follower node offline.

`<lan`	Definition of a LAN (i.e., IPv4 broadcast domain, IPv6 link) on which the membership protocol will be transmitted. At least one LAN must be defined. Define one such tag per used LAN.
`name="`*`lan name`*`"`	Single logical name for the lan. This name is used into module configuration to name networks used by the module.
`command="on"|"off"`	Set `command="on"` to use this network for running distributed commands on the cluster. In this case, this `<lan>` section must include all nodes in the cluster. You can set only one `<lan>` section with `command="on"`. When this attribute is not set, it is the first `<lan>` section that is used for running distributed commands on the cluster. Default: `off`
`<node`	Definition of one node in the SafeKit cluster. Define as many <node> tags as there are nodes in the cluster (at least 2).
`name="`*`node name`*`"`	Single logical name to the SafeKit server. You must always use the same name for designing a given server on different lans.
`addr=` `"`*`IP address or name`*`"`	IPv4 or IPv6 address, or name of the node as it is known by other nodes on this LAN (IP address recommended to be independent from a DNS server). On NAT configuration, it must be the external address. When defining an IPv6 address, use literal format: the address is enclosed in square brackets (e.g. `[2001::7334]`)
`laddr=` `"`*`local IP address`*`"`	Local IP address on this LAN. To be used only on NAT configurations, where local address is different from external one. IPv4 address or literal IPv6 address.

In SafeKit < 8.2, the cluster configuration had attributes `console` and `framework` on `<lan>` tag. These attributes were necessary for the legacy web console and are obsolete with the new one. If presents, these attributes are ignored in SafeKit 8.2.

12.2 SafeKit cluster Configuration

12.2.1 Configuration with the SafeKit web console

The SafeKit web console provides a configuration wizard for editing the `cluster.xml` file and applying the configuration on all the cluster nodes.

- The cluster configuration requires to log in the web console with a user having Admin role
- If the cluster is not configured, the web console automatically opens the Cluster configuration wizard
- When the cluster is configured, the current cluster configuration is loaded from the connection node specified in the browser URL

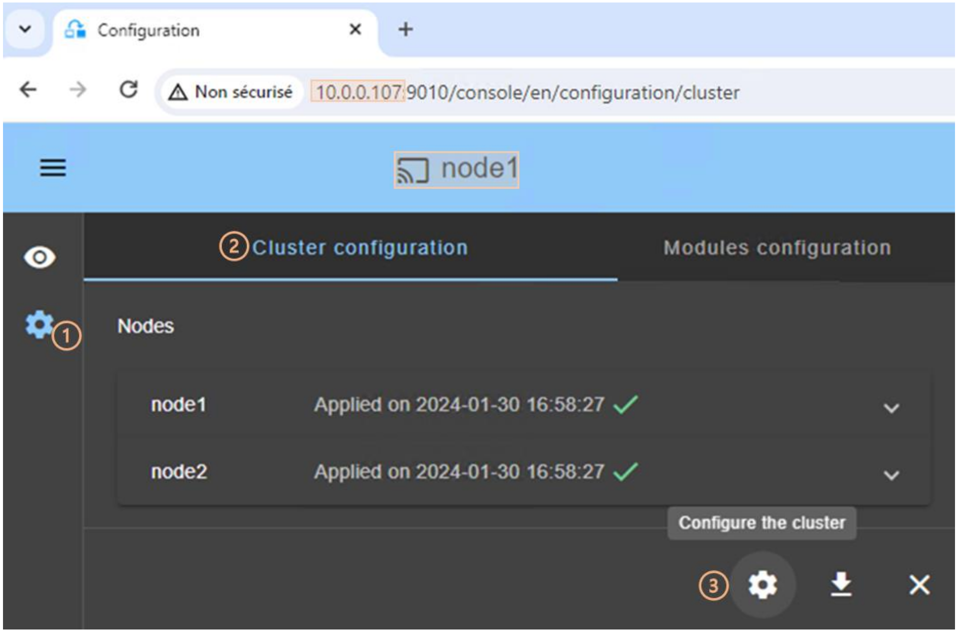
Open the cluster configuration wizard:

- Directly via the URL http://host:9010/console/en/configuration/cluster/config

Or

- Navigate in the console

In this example, the console is loaded from `10.0.0.107`, which corresponds to `node1` in the existing cluster. This is the connection node.



- Click on "Configuration" in the navigation sidebar
- Click on "Cluster configuration" tab
- Click on "Configure the cluster" button

For details on the cluster configuration wizard, see section 3.2.1.

12.2.2 Configuration with command line

- (1) Log as administrator/root
- (2) Edit the file `SAFEVAR/cluster/cluster.xml`

  In Windows, `SAFEVAR= C:\safekit\var` if `%SYSTEMDRIVE%`=C:

  In Linux, `SAFEVAR=/var/safekit`
- (3) Apply the cluster configuration with a new encryption key by executing:
  1. `safekit cluster config`

     Configure locally, from the `cluster.xml` file, and generate a new encryption key for communication between the nodes.
  2. `safekit -H "*" -G`

     It applies the local configuration, defined into `cluster.xml`, on all cluster nodes.

To re-configure the cluster without cryptographic key, execute :

1. `safekit cluster delkey`
2. `safekit -H "*" -G`

To regenerate encryption keys and propagate them on cluster nodes:

1. `safekit cluster genkey`
2. `safekit -H "*" -G`

For the full description of commands, refer to section 9.2.

12.2.3 Configuration changes

When changing the cluster configuration, the new configuration must be applied on all cluster nodes. When the configuration is applied only on a subset of the nodes present into the cluster configuration, only this subset will be able to communicate with each other. This is also the case when the cryptographic key is not identical on all nodes. This can have the effect of disrupting the operation of the modules installed on servers.
For a correct behavior, you must re-apply the configuration on all the nodes that belong to the cluster as described above.

You can check the configuration by running the command `safekit cluster confinfo` on each node (see section 9.2). When the configuration is operational, this command must return on all nodes, the same list of nodes and the same value for the configuration signature.

Changing the cluster configuration could have important impact on module configurations since the lan names set into the cluster configuration are used into the module's configuration. Any change in the cluster configuration, will trigger modules updates: each module will reload its configuration to adapt the changes. Such changes could lead to module stop in case of incompatibility (for example if a lan used by a module is removed from the cluster configuration). So, great care must be taken when modifying cluster configuration when modules are running.

13. Userconfig.xml for a module configuration

- Section 13.1 "Macro definition - <macro>"
- Section 13.2 "Farm or mirror module - <service>"
- Section 13.3 "Heartbeats - <heart>, <heartbeat >"
- Section 13.4 "Farm topology - <farm>, <lan>"
- Section 13.5 "Virtual IP address - <vip>"
- Section 13.6 "File replication - <rfs>, <replicated>"
- Section 13.7 "Enable module scripts - <user>, <var>"
- Section 13.8 "Virtual hostname - <vhost>, <virtualhostname>"
- Section 13.9 "Process or service monitoring - <errd>, <proc>"
- Section 13.10 "Checkers - <check>"
- Section 13.11 "TCP checker - <tcp>"
- Section 13.12 "Ping checker - <ping>"
- Section 13.13 "Interface checker - <intf>"
- Section 13.14 "IP checker - <ip>"
- Section 13.15 "Custom checker - <custom>"
- Section 13.16 "Module checker - <module>"
- Section 13.17 "Splitbrain checker - <splitbrain>"
- Section 13.18 "Failover machine - <failover>"

Each time you modify `userconfig.xml`, the configuration must be applied to all the nodes of the cluster onto which the module is installed, to become the active configuration.

To apply the new configuration modified on `node1`, on all cluster nodes, follow the procedure below (replace `node1`, `node2` by the nodes name and *AM* by the module name).

- the web console, connected to `node1`, by navigating to "Configuration/Modules configuration/ Configure the module/"
- or the web console, connected to `node1`, by directly entering the URI /console/en/configuration/modules/*AM*/config/
- or the command `safekit config -H "node1,node2" -E AM` executed on `node1`

Example of `userconfig.xml`:

```
<safe>
  <!-- Insert below <macro> <service> tags -->
</safe>
```

With the web console, the module must be stopped before applying the configuration.

With command line, it is possible to apply a new configuration while the module is running, but only in ✓ `ALONE (Ready)` or `WAIT (NotReady)` states. This feature is called *dynamic configuration*. Only a restricted subset of parameters could be changed. If the new configuration cannot be deployed, an error message is displayed. The attributes that can be dynamically modified are reported hereafter.

13.1 Macro definition - <macro>

Use a macro to associate a name with a value. In the `userconfig.xml`, the name, enclosed by the `%` character, is replaced by the value of the corresponding macro.

The syntax `%identifier%` can also be used in `userconfig.xml` to represent the value of an environment variable named `identifier`. In case of conflict, it is the macro value that is expanded.

13.1.1 <macro> example

In the example below, `%PATH%` is replaced by `e:\path`.

```
<macro name="PATH" value="e:\path"/>
<service>
  …
  <rfs>
   <replicated dir="%PATH%" />
  </rfs>
</service
```

For an example of macro usage, refer to section 15.3. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.1.2 <macro> syntax

```
<macro
     name="identifier"
     value="value"
/>
```

13.1.3 <macro> attributes

`<macro`	
`name="`*`identifier`*`"`	A character string that identifies the macro.
`value="`*`value`*`"`	The value that will replace each occurrence of %`identifier`% in the rest of `userconfig.xml`.
`/>`	

13.2 Farm or mirror module - <service>

13.2.1 <service> example

- Example for a mirror module

```
<service mode="mirror" defaultprim="alone" maxloop="3" loop_interval="24"
failover="on">
  <!-- Insert below <hearbeat> <rfs> <vip> <user> <vhost> <errd> <check>
<failover> tags -->
</service>
```

For a full example of a mirror module, refer to section 15.1. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

- Example for a farm module

```
<service mode="farm" maxloop="3" loop_interval="24">
  <!-- Insert below <farm> <vip> <user> <vhost> <errd> <check> <failover> tags --
>
</service>
```

For a full example of a farm module, refer to section 15.2. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.2.2 <service> syntax

```
<service mode="mirror"|"farm"|"light"
  [boot="off"|"on"|"auto"|"ignore"]
  [boot_delay="0"]
  [failover="on"|"off"]
  [defaultprim="alone"|"server_name"|"lastprim"]
  [maxloop="3"] [loop_interval="24"]
  [automatic_reboot="off"|"on"]>
</service>
```

Only `boot`, `maxloop`, `loop_interval` and `automatic_reboot` attributes can be changed with a dynamic configuration.

13.2.3 <service> attributes

`<service`	Top level section of `userconfig.xml`
`mode=` `"mirror"|` `"farm"|` `"light"`	• `mode="mirror"` for mirror module (section 1.2) The synchronization protocol between the 2 servers is defined in section 13.3. For a full example of a mirror module, refer to section 15.1. • `mode="farm"` for farm module (see section 1.3) The synchronization protocol between the 2 servers is defined in section 13.4.

	For a full example of a farm module, refer to section 15.2. • `mode="light"` for light (see section 1.2.9) It is a module set to the minimum needed for one server with error detection and local restart only (no failover).
`[boot= "on"| "off"| "auto"| "ignore"]`	• `boot="on"` the module is automatically started at boot time. • `boot="off"` the module is not started at boot time. • `boot="auto"` the module is automatically started at boot time if it was started before the reboot. • `boot="ignore"` Before SafeKit 7.5, the configuration to start the module at boot was done with the command `safekit boot -m` *`AM`* `on | off` (which had to be executed on each node). If you prefer to continue using this command, remove the `boot` attribute or set it to `ignore` (the default). The module will not be started at boot time unless the `safekit boot -m` *`AM`* `on` command is executed. The state of the boot configuration is visible in the `usersetting.boot` resource. To check the state of resources, see section 7.3. Default value: `ignore`
`[boot_delay="0" ]`	The delay, in seconds, before starting the module at boot. Default value: `0` (no delay)
`[failover= "on"| "off"]`	For mirror module only. • `failover="on"` An automatic failover on the secondary server is triggered if the primary fails or stops. • `failover="off"` When the primary server fails or stops, the secondary server waits (no automatic failover is triggered). Only the `prim` command can start the secondary server as primary. See description in section 5.7. Default value: `on`
`[defaultprim= "alone"|`	For mirror module only.

"*server_name*"| "lastprim"]	`defaultprim` specifies which server among two servers is the default primary server for an application module. This option is useful when a module is `ALONE` on a server and the module is started on the other server. • `defaultprim="alone"` The `ALONE` module becomes `PRIM` while the module on the other server becomes `SECOND`. Value recommended avoiding swap of application after reintegration. • `defaultprim="`*`server_name`*`"` When the module is running on two servers, the primary server among the two servers is the one set in `defaultprim`. This value can be useful for active/active (see section 1.4.2) or N-1 active (see section 1.4.3) architectures. • `defaultprim="lastprim"` The restarted module becomes `PRIM` if it was `PRIM` before its last stop. Default value: `alone`
[maxloop="3"]	Number of consecutive error detections before stopping. This attribute defines the maximum number of actions (`restart`, `stopstart`, `wait`) that can be executed following an error detection issued by `<errd>` or a `<checker>`, before locally stopping the module. The counter is reset at the expiration of the `loop_interval` timeout and upon `safekit start, restart, swap, stopstart…` administrative commands execution. Note that a `safekit` command sent by a detector passes the `-i identity` parameter and increments the counter, whereas administrator issued commands reset it. This attribute's value can be changed with a dynamic configuration. The `maxloop` is represented by the resource `heart.stopstartloop`. Its current value corresponds to the date on which the counter was initialized (in the form of a Unix Epoch timestamp); and its assignment date corresponds either to its initialization or to a `stopstart`, `restart`. View the resource history to see each increment of the `maxloop` counter. Default value: `3`
[loop_interval ="24"]	Time interval during which `maxloop` applies. If set to 0, the `maxloop` counter becomes inactive. Default value: 24 hours.

	This attribute’s value can be changed with a dynamic configuration.
`[automatic_reboot ="off"| "on"]`	If set to `on`, `stopstart` triggers a reboot instead of stopping and restarting the module. Default value: `off` This attribute’s value can be changed with a dynamic configuration.

13.3 Heartbeats - <heart>, <heartbeat >

Heartbeats must be used only for mirror architecture. For farm architecture, see section 13.4.

The basic mechanism for synchronizing two servers and detecting server failures is the heartbeat, which is a monitoring data flow on a network shared by a pair of servers. Normally, there are as many heartbeats as there are networks shared by the two servers. In normal operation, the two servers exchange their states (`PRIM`, `SECOND`, the resource states) through the heartbeat mechanism and synchronizes their application start and stop procedures.

If all heartbeats are lost, it is interpreted as if the other server was down, and the local server switches to the `ALONE` state. Although not mandatory, it is better to have two heartbeat channels on two different networks for synchronizing the two servers to avoid the split-brain case.

The network used by the heartbeat is defined by the logical name of a network set into the SafeKit cluster configuration (for details, see section 12).

13.3.1 <heart> example

For a full example of in a mirror module, refer to section 15.1. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

- Basic example to configure heartbeat on the cluster network named `default`

```
<heart>
   <heartbeat name="default" />
</heart>
```

- Example with 2 heartbeats, one dedicated replication network configured with `ident="flow"` on the cluster network named `private`

```
<heart>
   <heartbeat name="default" />
   <heartbeat name="private" ident="flow"/>
</heart>
```

13.3.2 <heart> syntax

```
<heart
  [port="xxxx"] [pulse="700"] [timeout="30000"]
  [permanent_arp="on"]
>
 <heartbeat
```

```
  [port="xxxx"] [pulse="700"] [timeout="30000"] name="network" [ident="name"]
 >
</hearbeat>
 …
</heart>
```

The `<heart>` tag and full subtree can be changed with a dynamic configuration.

13.3.3 <heart>, <heartbeat > attributes

`<heart`	
`[port="xx"]`	UDP port on which all the heartbeats are exchanged. Default: depends on the id of the application module. Returned by the `safekit module getports` command.
`[pulse="700"]`	The delay, in milliseconds, between two heartbeat packets. Default value: `700` ms
`[timeout="30000"]`	Timeout value for heartbeat loss detection. Default value: `30 000` ms
`<heartbeat`	Definition of one heartbeat. There are as many `<heartbeat>` tags as there are networks used to probe servers' mutual connectivity. At least one heartbeat must be defined.
`[port="xx"]`	Redefines the UDP port for the heartbeat. Default value is the same as the one defined in <heart> tag.
`[pulse="700"]`	Redefines the delay in milliseconds between two heartbeat packets. Default value is the same as the one defined in `<heart>` tag.
`[timeout= "30000"]`	Redefines the timeout value for heartbeat loss detection. Default value is the same as the one defined in <heart> tag.
`name="network"`	Network named used by the heartbeat. *`network`* must be the name of a network set into the SafeKit cluster configuration (for details, see section 12). This attribute is mandatory in new config syntax (since SafeKit 7.2).
`[ident="name"]`	Set how the heartbeat will be labelled in the web console and in internal resources. The associated resource name `heartbeat.name`. If no ident attribute is present the value of the name attribute will be used.

	ident="flow" is a reserved name associated with a heartbeat declared for a replication flow. If you set a heartbeat with ident="flow", automatically the replication flow will be set on the same network. If you set ident="flow" without <rfs> configuration, the module start blocks in WAIT state.
[permanent_arp= "on"|"off"]	Regularly, heart sets a permanent ARP entry for the ip addresses associated with the heartbeats. On some Linux systems, it may cause heart to freeze. Set this parameter to off in this case and manually set permanent arp for the remote server on boot. On Linux, this can be done by inserting the following line into a script that is executed at boot: arp -s hostname hw_addr Default value: on
[<server addr= "IP1_address />]	**Legacy** definition of the server address in the heartbeat. The <server> tag is a legacy syntax used in previous SafeKit version (before SafeKit 7.2). It's supported for compatibility reason but must not be used for new modules. In the same userconfig.xml, you must not use the syntax for SafeKit 7.1 and the one for SafeKit 7.2.

13.4 Farm topology - <farm>, <lan>

The basic mechanism to synchronize a farm of servers is a group communication protocol which automatically detects the available members of the farm. Normally, the membership protocol is configured on all networks connecting the N servers.

The network used by the protocol is defined by the logical name of a network set into the SafeKit cluster configuration (for details, see section 12).

13.4.1 <farm> example

Basic example to use the cluster network named default.

```
<farm>
   <lan name="default" />
</farm>
```

For full examples in a farm module, see section 15.2. It presents the configuration via the web console along with the corresponding userconfig.xml.

13.4.2 <farm> syntax

```
<farm [port="xx"]>
   <lan name="network"></lan>
   …
```

```
</farm>
```

The `<farm>` tag and subtree **cannot** be changed with a dynamic configuration.

13.4.3 <farm>, <lan> attributes

`<farm`	Begin the definition of a farm topology.
`[port="`*xx*`"]`	UDP port with which the membership protocol is exchanged. Default: depends on the id of the application module. Returned by `safekit module getports` command.
`[pulse="`*xx*`"]`	The period of the membership protocol messages emission. Longer pulse makes the membership protocol use less bandwidth but reacts more slowly.
`[mlost_count="`*xx*`"]`	Number of periods elapsed without message before electing a new leader.
`[slost_count="`*xx*`"]`	Number of periods elapsed without messages before declaring a follower node offline.
`<lan`	Definition of a LAN (i.e., IPv4 broadcast domain, IPv6 link) on which the membership protocol will be transmitted. At least one LAN must be defined. Define one such tag per used LAN.
`name="`*network*`"`	Define the name of network used. `network` must be the name of a network set into the SafeKit cluster configuration (see section 12). This attribute is mandatory in new config syntax (since SafeKit 7.2).
`[<node name="identity" addr= "IP1_address" />]`	**Legacy** address and name of the node on this lan. The node tag is a legacy syntax used in previous SafeKit version (before SafeKit 7.2). It's supported for compatibility reason but must not be used for new modules. In the same `userconfig.xml`, you must not use the syntax for SafeKit 7.1 and the one for SafeKit 7.2.

13.5 Virtual IP address - <vip>

If you install and run several application modules on the same server, the virtual IP addresses must be different for each application module.

13.5.1 <vip> example in a mirror module

The following example configures the virtual IP address on the primary node of an on-premises cluster.

```
<vip>
    <interface_list>
        <interface check="off" arpreroute="on">
           <real_interface>
               <virtual_addr addr="192.168.1.222" where="one_side_alias"
check="on"/>
          </real_interface>
        </interface>
    </interface_list>
  </vip>
```

See also the full example in section 15.1. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.5.2 <vip> example in a farm module

The following example configures load balancing to port 80 and virtual IP address between nodes in an on-premises cluster. The virtual IP address is configured on all nodes.

```
<vip>
    <interface_list>
      <interface check="on" arpreroute="on" arpinterval="60" arpelapse="10">
        <virtual_interface type="vmac_directed">
          <virtual_addr addr="192.168.1.222" where="alias" check="on"/>
        </virtual_interface>
      </interface>
    </interface_list>
    <loadbalancing_list>
       <group name="FarmProto">
         <rule port="80" proto="tcp" filter="on_port"/>
       </group>
    </loadbalancing_list>
  </vip>
```

See also the full example in section 15.2. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.5.3 Alternative to <vip> for servers in different networks

The configuration of a virtual IP address with a <vip> section in `userconfig.xml` requires servers in the same IP network (network rerouting and load balancing made at level 2).

If servers are in different IP networks, the <vip> section cannot be configured. In this case, an alternative is to configure the virtual IP in a load balancer. The load balancer routes packets to the physical IP addresses of servers by testing an URL status named health check and managed by SafeKit.

So, SafeKit provides a health check for SafeKit modules. For this, configure the health check in the load balancer with:

- HTTP protocol
- port 9010, the SafeKit web service port
- URL `/var/modules/`*`AM`*`/ready.txt`, where *`AM`* is the module name

In a mirror module, the health check:

- returns OK, that means that the instance is healthy, when the module state is `PRIM(Ready)` or `ALONE(Ready)`
- returns NOT FOUND, that means that the instance is unhealthy, in all other states

In a farm module, the health check:

- returns OK, that means that the instance is healthy, when the farm module state is `UP (Ready)`
- returns NOT FOUND, that means that the instance is out of service, in all other states

Another alternative is that you implement a special DNS configuration and a DNS rerouting command inserted in the SafeKit restart scripts.

13.5.4 <vip> syntax

13.5.4.1 Virtual IP loadbalancing in farm architecture

```
<vip [tcpreset="off"|"on"]>
 <interface_list>
  <interface
    [check="off"|"on"]
    [arpreroute="off"|"on"]
    [arpinterval="60"]
    [arpelapse="1200"]
  >

   <virtual_interface
   [type=""vmac_directed"|"vmac_invisible"]
   [addr="xx:xx:xx:xx:xx"]
   >
     <virtual_addr
      addr="virtual_IP_name or virtual_IP_address"
      [where="alias"]
      [check="off"|"on"]
      [connections="off"|"on"]
     />
     …
   </virtual_interface>
  </interface>
 </interface_list>
 <loadbalancing_list>
   <group name="group_name"
     <cluster>
        <host name="node_name" power="value" />
        …
     </cluster>
     <rule
       [virtual_addr="*"|"virtual_IP_name"|"virtual_IP_address"]
       [port="*"|"value"]
        proto="udp"|"tcp"
        filter="on_addr"|"on_port"|"on_ipid"
     />
     …
   </group>
   …
```

```
 </loadbalancing_list>
</vip>
```

The <vip> tag and subtree **cannot** be changed with a dynamic configuration.

13.5.4.2 Virtual IP failover in mirror architecture

For on-premises SafeKit cluster:

```
<vip [tcpreset="off"|"on"]>
 <interface_list>
  <interface
    [check="off"|"on"]
    [arpreroute="off"|"on"]
    [arpinterval="60"]
    [arpelapse="1200"]
  >

   <real_interface>
    <virtual_addr
      addr="virtual_IP_name or virtual_IP_address"
      where="one_side_alias"
      [check="off"|"on"]
      [connections="off"|"on"]
    />
    …
   </real_interface>
  </interface>
  …
 </interface_list>
</vip>
```

13.5.5 <vip><interface_list>, <interface>, <virtual_interface>, <real_interface>, <virtual_addr> attributes

`<vip`	
`[tcpreset="off"|"on"]`	Before unconfiguring the virtual IP address, all connections with the virtual IP address as IP source are reset. The reset is disabled when set to `off`. Default value: `on`
`<interface_list>`	
`<interface`	Definition of an interface with virtual IP addresses. Define as many <interface> sections as there are network interfaces to configure.
`[check="off"|"on"]`	Set an interface checker on the interface to stop the service and put it in the WAIT state when the interface is down. The name of the interface checker is `intf.<network_IP_mask>` (`intf.192.168.0.0`).

	Default value: `on` For more information, see section 13.13.
`[arpreroute="off"|"on"]`	Automatically broadcast gratuitous ARP on virtual IP addresses defined in <real_interface> section. Default value: `off`.
`[arpinterval="60"]`	Time in seconds between two gratuitous ARP. Default value: `60` s
`[arpelapse="1200"]`	Time during which gratuitous ARP are sent. Default value: `1200` s
`[name="`*`interface name`*`"]`	**Linux only** You can specify the name of the network interface on which the virtual IP addresses will be set. Ex.: `name="bond0"` Default: no value, SafeKit detects the network interface with virtual IP addresses set on it.

13.5.5.1 <virtual_interface>, <virtual_addr> attributes in farm architecture

Use with farm modules for virtual IP load balancing :

`<virtual_interface`	Definition of virtual IP addresses configured on an Ethernet interface.
`type=` `"vmac_directed"|` `"vmac_invisible"`	• `type="vmac_directed"` Advertise the MAC address of one of the servers as the associated mac address, as with normal traffic. No promiscuous mode needed. For details, see section 13.5.7.3. • `type="vmac_invisible"` The virtual MAC address never visible in Ethernet headers to allow broadcasting of switch. Needs promiscuous mode. For details, see section 13.5.7.2. When running SafeKit into a virtual machine, you must turn on the promiscuous mode on the virtual network adapter. See SK-0099 for the procedure to follow for Hyper-V and VMware ESXi. Note: can be used for a mirror module with a need of transparent rerouting.

`[addr="xx:xx:xx:xx:xx"]`	Unicast virtual MAC address value. If not set, default is the concatenation of "5A:FE" (Safe) and the first configured virtual IP address in hexadecimal. Ignored in `vmac_directed` mode.
`<virtual_addr`	Definition of one Virtual IP address. Set as many `<virtual_addr>` sections as there are virtual IP addresses on the interface.
`addr="`*`virtual_IP_name`*`"`| `"`*`virtual_IP_address`*`"`	Name or address of the virtual IP (prefer an IP address to be independent from the name server). IPv4 or IPv6 address.
`where="alias"`	Configuration for farm module: the virtual IP address is defined on all servers as an alias IP address. Load balancing rules apply only for this type of virtual IP addresses. Note : when VMAC is used with a mirror module, set here `where="one_side_alias"`
`[check="off"`|`"on"]`	Defines an ip checker on the virtual IP address to stopstart the module when the virtual IP is deleted or in conflict. The name of the ip checker is `ip.<addr value>` (`ip.192.168.1.99`). Default value: `on` For more information, see section 13.14
`[connections="off"`|`"on"]`	Enables counting of the number of active connections on the virtual address. This count is stored in the resource named `connections.<virtual addr value>` (for example: `connections.192.168.1.99`) which is assigned every 10 seconds. This value is provided as a guideline only. Default value: `off`
`netmask="`*`defaultnetmask`*`"`	Linux and IPV4 only. By default, the netmask of the network interface on which the virtual IP address is set. Set the netmask if there are several netmasks on the interface.
`</virtual_interface>`	

13.5.5.2 <real_interface>, <virtual_addr> attributes in mirror architecture

Use with mirror modules for virtual IP failover:

<real_interface>	Definition of virtual IP addresses associated with the real MAC address of the interface.
<virtual_addr	Definition of one virtual IP address. Set as many virtual_addr sections as there are virtual IP addresses on the interface.
addr= "*virtual_IP_name*"| "*virtual_IP_address*"	Name or address of the virtual IP (prefer an IP address to be independent from the name server). IPv4 or IPv6 address.
where="one_side_alias"	The Virtual IP address will be aliased on the server on which the module becomes PRIM or ALONE.
[check="off"|"on"]	Defines an ip checker on the virtual IP address to stopstart the module when the virtual IP is deleted or in conflict. The name of the ip checker is ip.<addr value> (ip.192.168.1.99). Default value: on For more information, see section 13.14.
[connections="off"|"on"]	Enables counting of the number of active connections on the virtual address. This count is stored in the resource named connections.<virtual addr value> (for example: connections.192.168.1.99) which is assigned every 10 seconds. This value is provided as a guideline only. Default value: off
netmask="*defaultnetmask*"	Linux and IPV4 only. By default, the netmask of the network interface on which the virtual IP address is set. Set the netmask if there are several netmasks on the interface.
</real_interface>	

13.5.6 <loadbalancing_list>, <group>, <cluster>, <host> attributes

Use with farm module.

For many load-balancing examples, see section 15.2. It presents the configuration via the web console along with the corresponding userconfig.xml.

<loadbalancing_list>	

<table>
<tr><td><group</td><td>Definition of a load balancing group. Define as many sections as there are groups.

See multi group example in section 15.2.2.4.</td></tr>
<tr><td>name="*group_name*"</td><td>Name of the load balancing group.</td></tr>
<tr><td><cluster</td><td>Optional definition of the server set on which the load current group balancing will be applied. If no <cluster> section is defined, the rules apply to all servers of the farm.</td></tr>
<tr><td><host</td><td>Definition of one node in the cluster. Define as many hosts sections as there are nodes configured for the module.</td></tr>
<tr><td>name="*node_name*"</td><td>Define the name of the host. *node_name* must be the name of a node name set into the SafeKit cluster configuration (see section 12).</td></tr>
<tr><td>power="*value*"</td><td>Relative weight to apply to the current node in this load balancing group’s cluster. Can be equal to 0, which means no traffic will be dispatched to this node. See section 13.5.7.4 for more information.</td></tr>
<tr><td></cluster></td><td></td></tr>
<tr><td><rule</td><td>Definition of a load balancing rule for the group. Define as many sections as there are load balancing rules for this group.</td></tr>
<tr><td>[virtual_addr=
"*" |
"*virtual_IP_address*"|
"*virtual_IP_name*"]</td><td>Virtual IP name or address scope of the rule.

By default, all virtual IP addresses: *</td></tr>
<tr><td>[port="*"|"*value*"]</td><td>TCP or UDP port to which the load balancing rule applies.

By default, all ports: *</td></tr>
<tr><td>proto="udp" | "tcp" | "arp"</td><td>• proto="udp"
Load balancing rule applies to the UDP protocol.
• proto="tcp"
Load balancing rule applies to the TCP protocol.
• proto="arp"
Load balancing rule applies to the IP<->MAC resolution protocol (arp or neighbor discovery)</td></tr>
</table>

`filter="on_addr" | "on_port" | "on_ipid"`	• `filter="on_addr"` Load balancing criteria is the source IP address (client, far end of the connection) • `filter="on_port"` Load balancing criteria is the source port (client, far end of the connection). • `filter="on_ipid"` Load balancing is made on the client ip_id at input. Useful for UDP. No sense for TCP and for IPv6 addresses.

13.5.7 <vip> Load balancing description

13.5.7.1 <vip> prerequisites

See network prerequisites described in section 2.3.2.

13.5.7.2 What is the vmac_invisible type?

When `type="vmac_invisible"`, a virtual MAC address is mapped on the virtual IP address with a unicast MAC Ethernet address on several network nodes. When a network device tries to resolve the virtual IP address into its corresponding MAC address, the SafeKit servers respond with the virtual MAC address. However, SafeKit servers use its physical MAC address to communicate. To "see" the packets sent to the virtual MAC address the interface is set to promiscuous mode. So, the virtual MAC address is invisible to layer 2 network devices. Ethernet switches therefore forward virtual MAC address directed packets to all the ports in the same vlan as the source, reaching all the servers of the farm. A kernel module running on each farm server is responsible for filtering out the packets that should not be processed by a given farm node, according to the load balancing rules defined.

With the virtual MAC address technology, the failover time is null. There is no network rerouting after a failure: all network equipment keeps their mapping virtual IP address, virtual MAC address.

When running SafeKit into a virtual machine, you may have to turned on the promiscuous mode on the virtual network adapter. See SK-0099 for the procedure to follow for Hyper-V and VMware ESXi.

To test a virtual MAC address in your network, see section 4.3.7.

13.5.7.3 What is the vmac_directed type?

When `type="vmac_directed"`, there is in fact no virtual MAC address. Farm servers reply to virtual IP resolution requests with their own physical MAC address. A kernel module running on each farm server is responsible for filtering and dispatching the packets to their designated target farm node according to the load balancing rules defined. In `vmac_directed` mode there is a short failover time for clients that have resolved the virtual IP address as the MAC address of the failed server. This is comparable to what happens in “real interface” mode. Clients that have another farm server’s MAC address in their cache are not affected.

To help minimize failover time in ipv4, set the `arpreroute` attribute to "on" on the corresponding `<interface>` tag, and tune the `arpelapse` and `arpinterval` attributes to the desired values. Ipv6 does not need `arpreroute`, it has a built-in mechanism that takes care of the failover.

13.5.7.4 How does load balancing work?

On all the servers of the farm, the load balancing algorithm filters received packets according to the identity of the sender. The criteria to check is defined by configuration in `userconfig.xml`: client IP address, client port… (i.e.: level 3 load balancing), or requestor address (arp rules, i.e., level 2 load balancing). The criteria are hashed into a value representing the server on which the packet is to be accepted.

When a server fails, the membership protocol reconfigures the filters to re-balance the traffic of the failed server on the available servers.

Each server can have a power (=1, 2…) and then takes more or less traffic. The power is implemented by the number of bits set to 1 in the hash table (a bitmap of 256 bits).

A bitmap example is given in section 4.3.5.

13.6 File replication - <rfs>, <replicated>

For mirror modules only.

In Linux, you must set the same value for uid/gid on the two nodes for replicating file permissions. When replicating a filesystem mount point, you must apply a special procedure described in section 13.6.4.2.

In Windows, it is strongly recommended to enable the USN journal on the drive that contains the replicated directory as described in section 13.6.4.3.

If you install and run several application modules on the same server, the replicated directories must be different for each application module.

13.6.1 <rfs> example

- Example in Windows:

```
<rfs async="second">
        <replicated dir="c:\safedir" mode="read_only"/>
</rfs>
```

- Example in Linux:

```
<rfs async="second">
        <replicated dir="/safedir" mode="read_only"/>
</rfs>
```

See also a full example at section 15.1.

For the configuration of a dedicated replication network, refer to section 15.1.2.2. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.6.2 <rfs> syntax

```
<rfs
     [acl="on"|"off"]
     [async="second"|"none"]

     [iotimeout="nb seconds"]
     [roflags="0x10"|"0x10000"]
     [locktimeout="100"]
     [sendtimeout="30"]

     [nbrei="3"]
     [ruzone_blocksize="8388608"]
     [namespacepolicy="0"|"1"|"3"|"4"]
     [reitimeout="150"]
     [reicommit="0"]
     [reidetail="on"|"off"]
     [allocthreshold="0"]
     [nbremconn ="1"]

     [checktime="220000"]
     [checkintv="120"]
     [nfsbox_options="cross"|"nocross"]
     [scripts="off"]
     [reiallowedbw="20000"]
     [syncdelta="nb minutes"]
     [syncat="synchronization scheduling"]
>
  <replicated dir="absolute path of a directory"
  [mode="read_only"]
>
  <tocheck path="relative path of a file or subdir" />
  <notreplicated path="relative path of a file or subdir" />
  <notreplicated regexpath="regular expression on relative path of a file or
subdir" />
  …
 </replicated>
</rfs>
```

Only `async`, `nbrei`, `reitimeout` and `reidetail` attributes of `<rfs>` tag can be changed with a dynamic configuration. The `<flow>` tag, describing the replication flow, can also be changed dynamically.

13.6.3 <rfs>, <replicated> attributes

`<rfs`	
`[mountoversuffix="suffix"]`	**Linux only** During the module configuration, the replicated directory "`/a/dir`" is renamed "`/a/dir`*`suffix`*". The directory **/a/dir** is created and it is: • a mount point to `/a/dir`*`suffix`* when the module is started • a link to "`/a/dir`*`suffix`*" when the module is stopped By default, *suffix* value is "_For_SafeKit_Replication".

	If there is a hard failure, then the symbolic link will not be restored. In this case, you must restore the symbolic link manually. **Restriction** You cannot explicitly specify a root file system as a replicated directory (because of the directory rename that is not allowed across a file system). The work around is to manipulate the fstab file as described in a KB on https://support.evidian.com. When the module is started, NEVER ACCESS files in "`/a/dir`*`suffix`*", otherwise the modifications will not be replicated, and the system will become inconsistent. ALWAYS ACCESS replicated files through "`/a/dir`".
`[acl= "on" | "off"]`	Setting acl to `on` activate the replication of ACL on files and directories. Default value: `off` **Restriction for Windows** ACL replication will not work if the SYSTEM account does not have the "Full control" access right on all the replicated forest. File ACLs are replicated literally (as SID values), therefore ACL granted to locally defined users and groups will be meaningless on the remote system. File encryption and file compression attributes are not supported.
`[async= "second" | "none"]`	Setting async mode to `second` is a way to improve file replication performances: modification operations are cached on the secondary server and the acknowledgements are sent more quickly to the primary server. • `async="none"` It ensures more robustness: modification operations are put on disk of the secondary before sending acknowledgement to the primary. • `async="second"` In case of double failure at the same time of both `PRIM` and `SECOND` servers, if the `PRIM` server cannot restart, then the `SECOND` server does not have up-to-date data on its disk.

	There is data loss if the `SECOND` server is forced to start as primary with the prim command. Default value: `second` This attribute's value can be changed with a dynamic configuration.
`[packetsize]`	**Linux only** Maximum size in bytes for NFS replication packets. It must be lower than the maximum size allowed by the NFS server of both servers. When it is set into the configuration, it is used as mount options for rsize and wsize. By default, the size is the one of the NFS server.
`[reipacketsize="8388608"]`	Maximum size in bytes of reintegration packets. In Linux, this value must be less or equal to `packetsize`. Default value in Linux: value of `packetsize` if it is set into the configuration and is lower than `8388608`; else `8388608` Default value in Windows: `8388608` bytes
`[ruzone_blocksize="8388608"]`	Size of a zone for the modification bitmap of a file. It must be a multiple of `reipacketsize` attribute. Default value: value of `reipacketsize` if it is set into the configuration; else `8388608`
`[iotimeout]`	**Windows only** IO time out in seconds in the Windows file system filter. If an IO cannot be replicated and if the timeout expires in the filter, then the `PRIM` server becomes `ALONE`. If not set, the default value is dynamically calculated.
`[roflags="0x10"|"0x10000"]`	**Windows only** • `roflags="0x10"` To ensure the consistency of the data replicated on the 2 servers, the modification of the replicated directories/files must only take place on the `PRIM` server. If changes are made on the `SECOND` server, they are notified in the module log with the identification of the process responsible so that the administrator can correct this anomaly. • `roflags="0x10000"` With this flag, since SafeKit 7.4.0.31, the module is also be stopped on the `SECOND` server. Default value: `0x10`

`[locktimeout="100"]`	Timeout in seconds for replication requests. If a request cannot be served within this timeout, the `PRIM` server becomes `ALONE`. Default value: `100` seconds
`[sendtimeout="100"]`	Since SafeKit > 7.4.0.5 Timeout in seconds for sending TCP packets to the remote node. If a packet cannot be sent within this timeout, the `PRIM` server becomes `ALONE`. Increase this value in case of low networks. Default value: `30` seconds In SafeKit 7.4.0.5, the default value was 12O seconds.
`[nbrei="3"]`	Number of reintegration threads running in parallel for resynchronizing files. Default value: `3` This attribute's value can be changed with a dynamic configuration.
`[namespacepolicy="0"|"1"|"3"|"4"]`	• `namespacepolicy="0"` Deactivate the zone reintegration on Windows or Linux • `namespacepolicy="1"` In Windows, zone reintegration after reboot when the module has been properly stopped is not active • `namespacepolicy="3"` In Windows, it allows zone reintegration after reboot when possible. It activates the USN change journal on the volume containing the replicated directories (see `fsutil usn` command for creating USN change journal on a volume). Even with this configuration, full reintegration is used instead of zone reintegration when: o the USN change journal associated with the volume has been deleted/recreated for administration reasons o discontinuity in the USN journal is detected • `namespacepolicy="4"` When zone synchronization is not possible (on the first reintegration or when zones are not available), the files that need to be synchronized are fully copied. If this reintegration does not complete, the next one will copy again these files. To avoid this, set `namespacepolicy="4"`. This option also enables USN journal checking in Windows. Default value: `4` since SafeKit > 7.4.0.5 (not supported in previous releases)

`[reitimeout= "150"]`	Timeout in seconds for reintegration requests. The timeout can be increased to avoid reintegration failure on heavy load of the primary server. Default value: `150` seconds This attribute's value can be changed with a dynamic configuration.
`[reicommit="0"]`	**Linux only** Set `reicommit="nb blocks"` to commit every (nb blocks)* `reipacketsize` when reintegrating one file (in addition to the commit at the end of the copy). This can help to succeed reintegration of big files but slows down reintegration time. Default value: `0` that means no intermediate commit
`[reidetail= "on"|"off"]`	Detailed logging for reintegration. Default value: `off` This attribute's value can be changed with a dynamic configuration.
`[allocthreshold= "0"]`	**Windows only** Size in Gb to apply the allocation policy before reintegration. When `allocthreshold> 0`, enable fast allocation of disk space for files to be synchronized on the secondary node. This feature avoids a timeout when the primary writes at the end of the file, when the file is large (> 200 Gb) and not yet completely copied. Since SafeKit 7.4.0.64, the allocation policy has changed and is applied for: • Newly created files (files that did not exist on the secondary when the reintegration starts) • Files with size on the primary >= `allocthreshold (size in Go)` • Full synchronization on the first reintegration ; on start with full synchronization (`safekit second fullsync`) ; when synchronization by zones is disabled (`namespacepolicy="0"`) Default value: `0` (that disables the feature)
`[nbremconn="1"]`	Number of TCP connections between the primary and the secondary nodes. This value may be increased to improve the replication and synchronization throughput when the network has high latency (in cloud for instance). Default value: 1

[checktime= "220000"]	**Linux only** Timeout in milliseconds for the null request that checks the local replicated file system. Run the `safekit stopstart` command when the timeout is reached. Default value: `220 000` milliseconds
[checkintv= "120"]	**Linux only** Interval in seconds between two null requests. Default value: `120` seconds
nfsbox_options="cross"|"nocross"	**Windows only** It specifies the policy to apply when a reparse point of type `MOUNT_POINT` is present in the replicated directory tree. This policy applies to all replicated directories. `MOUNT_POINT` reparse points in NTFS can represent two types of objects: an NTFS mount point (for example the `D:\` directory) or an NTFS "directory junction" (a form of "symbolic link" to another part of the file system namespace). • `nfsbox_options="cross"` The `MOUNT_POINT` reparse point object itself is not replicated/reintegrated. It is evaluated, and the reintegration/replication process the target content as it would do for the content of a standard directory. This is useful for instance when a replicated directory is a mount point (e.g., replicating a "drive letter" root). This is the default configuration value. • `nfsbox_options="nocross"` The `MOUNT_POINT` reparse point object itself is replicated/reintegrated, but not evaluated. Reintegration does not descend into the target of the reparse point. This is useful for instance when a replicated directory tree contains NTFS "junctions" that point to another part of the replicated tree (e.g., when replicating a PostgreSQL database, as PostgreSQL is known to need such objects). Default value: `cross`
[scripts= "on" | "off"]	`scripts="on"` activates `_rfs_*` script callbacks used to implement specific data replication management Default value: `off`
[reiallowedbw="20000"]	When defined, this attribute specifies the maximum bandwidth that the reintegration phase may use (for instance 20000 KB/s), in kilo bytes per second (KB/s). Due to implementation trade-off, a +/-10% fluctuation of the effectively used bandwidth is to be expected.

	The replication bandwidth is not affected by this parameter. By default, the attribute is not defined, and the bandwidth used by the reintegration is not limited
[syncdelta="*nb minutes*"]	• syncdelta <=1 The attribute is ignored and the default failover and start policy is applied: only an up-to-date server can start as primary or run a failover. • syncdelta >1 It changes the default failover and start policy. The not up-to-date server can become primary but only if the elapsed time, in minutes, since the last synchronization is lower than the syncdelta value (see section 13.6.4.4). Default value: 0 minutes
[syncat="*synchronization scheduling*"]	Default: real-time replication and automatic synchronization (no scheduling) Use syncat for scheduling the synchronization of replicated directories on the secondary node (see section 13.6.4.10). The module must be started for enabling this feature. Once synchronized, the module blocks in the WAIT (NotReady) state until the next synchronization. The scheduling is based on native job scheduler: • On Unix, the job is defined in the safekit user's crontab • On Windows, the job is defined as a system task You must configure syncat with the syntax of the native job scheduler. For instance, for synchronizing daily, after midnight: • in Windows syncat="/SC DAILY /ST 00:01:00" • in Unix syncat="01 0 * * *" See crontab documentation in Unix and schtasks.exe documentation in Windows, for the full syntax of scheduled date and time. Since SafeKit configuration is just a front end to the job scheduler, when scheduling is not working, please check first for syntax errors.
[<flow name ="network"> [<server addr="IP_1" />	**Legacy** configuration preserved for backwards compatibility.

<server addr="IP_2" />] </flow>]	When this section is not defined, the replication flow uses the same network as the heartbeat with ident="flow" if there is one, if not it uses the first heartbeat (see section 13.3). If you define this section, be coherent with heartbeat ident="flow", if there is one, because default failover rules apply to this heartbeat. This <flow> tag subtree can be changed with a dynamic configuration for setting a new replication flow for instance. The name attribute of <flow> define the network used for replication flow. It must present in global cluster configuration (see section 12). The <server> tag is a legacy syntax used in previous SafeKit version (before 7.2). It's supported for compatibility reason but must not be used for new modules. In the same userconfig.xml, you must not use the syntax for SafeKit 7.1 and the one for SafeKit 7.2.
<replicated	Begin the definition of replicated directories. Set as many lines as there are replicated directories.
dir="*abs_path*"	Absolute path of a directory to replicate.
[mode= "read_only"]	Read-only access rights on the secondary machine for replicated directories to avoid corruption
<notreplicated path="*relative*" />	Relative path of a file or sub-directory in a replicated directory. The file (or sub-directory) is not replicated. Set as many lines as there are non-replicated files or sub-directories.
<notreplicated regexpath="*regular expression*" />	Regular expression on the name of entries under the replicated directory : • **Replicate all except** entries matching the regular expression. For example, to avoid replicating entries with the extension .tmp or .bak in the /safedir directory or its sub-directories: <replicated dir="/safedir"> <notreplicated regexpath=".*\.tmp$" /> <notreplicated regexpath=".*\.bak$" /> </replicated> Note that /safedir/conf/config.tmp.swap is replicated. • **Replicate only** those entries in the directory that match the regular expression after the **!** For example, to replicate only entries with the extension .mdf or .ldf in the /safedir directory or its sub-directories: <replicated dir="/safedir"> <notreplicated regexpath="!.*\.mdf$" />

	`<notreplicated regexpath="!.*\.ldf$" />` `</replicated>` Rename between not replicated and replicated files is not supported. The regex engine is POSIX Extended regex (see POSIX documentation): • in Windows, case insensitive mode • in Linux, case sensitive mode As regular expressions are defined inside the XML file `userconfig.xml`, special characters interpreted by XML like '`<`' or '`>`' cannot be used in regular expressions.
`<tocheck path="`*`relative`*`" />`	Relative path of a file or sub-directory in a replicated directory. Checks the presence of the file or sub-directory before starting the replication mechanism. Avoids errors such as starting replication on an empty file system. Set as many lines as there are files or sub-directories to check.

13.6.4 <rfs> description

13.6.4.1 <rfs> prerequisites

See file replication prerequisites described in section 2.2.4.

13.6.4.2 <rfs> Linux

On Linux, interception of data is based on a local NFS mount. And the replication flow between servers is based on NFS v3 / TCP protocol.

The NFS mount of replicated directories from remote Unix clients is not supported. The NFS mount of other directories can be made with standard commands.

Procedure for replicating a mount point

When replicating a mount point in Linux, the module configuration fails with the error:

```
Error: Device or resource busy
```

In the following, we take the example of PostgreSQL module that set as replicated directories `/var/lib/pgsql/var` and `/var/lib/pgsql/data`. The `userconfig.xml` of the module contains:

```
<rfs … >
  <replicated dir="/var/lib/pgsql/var" mode="read_only" />
  <replicated dir="/var/lib/pgsql/data" mode="read_only" />
</rfs>
```

These directories are mount points as shown by the result of the command `df -H`. It returns for instance:

```
/dev/mapper/vg01-lv_pgs_var … /var/lib/pgsql/var
/dev/mapper/vg02-lv_pgs_data … /var/lib/pgsql/data
```

You must apply the following procedure for configuring the module to replicate these directories.

1. umount the file systems by running the commands:

   `umount /var/lib/pgsql/var`

   `umount /var/lib/pgsql/data`

2. configure the module by running the command:

   `/opt/safekit/safekit config -m postgresql`

   The configuration should succeed (no errors)

3. check the symbolic links created by running the command `ls -l /var/lib`. It returns:

```
lrwxrwxrwx 1 root var -> var_For_SafeKit_Replication
lrwxrwxrwx 1 root data -> data_For_SafeKit_Replication
```

4. edit `/etc/fstab` and change the two lines:

```
/dev/mapper/vg01-lv_pgs_var /var/lib/pgsql/var ext4…
/dev/mapper/vg02-lv_pgs_data /var/lib/pgsql/data ext4…
```

   With

```
/dev/mapper/vg01-lv_pgs_var /var/lib/pgsql/var_For_SafeKit_Replication ext4…
/dev/mapper/vg02-lv_pgs_data /var/lib/pgsql/data_For_SafeKit_Replication ext4..
```

5. mount the file systems by running the commands:

   `mount /var/lib/pgsql/var_For_SafeKit_Replication`

   `mount /var/lib/pgsql/data_For_SafeKit_Replication`

- Apply this procedure on both nodes if replicated directories are mount point on both nodes. Once applied, you can use the module as usual: i.e., safekit start stop etc …
- It is the same procedure for all mounts points that must be replicated

To protect the start of the module on a non-mounted and empty directory, you can insert in `userconfig.xml` the checking of a file inside the replicated directory. Example for `/var/lib/pgsql/var` (do the same for `/var/lib/pgsql/data` with a file inside this directory which is always present):

```
<replicated dir="/var/lib/pgsql/var" mode="read_only">
    <tocheck path="postgresql.conf" />
</replicated>.
```

If you want to unconfigure the module (or uninstall whole SafeKit package), you must reverse this procedure by:

1. umount the file systems with:

   `umount /var/lib/pgsql/var_For_SafeKit_Replication`

   `umount /var/lib/pgsql/data_For_SafeKit_Replication`

2. de-configure the module with

```
/opt/safekit/safekit deconfig -m postgresql
```

3. edit `/etc/fstab` to undo previous editing
4. mount the file systems with:

```
mount /var/lib/pgsql/var
mount /var/lib/pgsql/data
```

13.6.4.3 <rfs> Windows

On Windows, interception of data is based on a file system filter. And the replication flow between servers is based on NFS v3 / TCP protocol.

The `rfs` filter may not work correctly with some anti-viruses.

On Windows, you can mount remotely a replicated directory from a workstation. If you want to mount with the virtual name instead of the digital virtual IP address, you must set the two following registry keys on the server side:

```
[HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Lsa]
"DisableLoopbackCheck"=dword:00000001
[HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\lanmanserver\paramete
rs] "DisableStrictNameChecking"=dword:00000001
```

In Windows, to enable zone reintegration after server reboot, when the module has been successfully stopped, the <rfs> component uses the NTFS USN log to verify that the information recorded on the zones is still valid after the reboot. When the control succeeds, the zone reintegration can be applied to the file; otherwise, the file must be fully copied.

By default, only the system drive has a USN log active. If the replicated directories are located on a different drive than the system drive, you must create the log (with `fsutil usn command`).

See SK-0066 for an example.

13.6.4.4 <rfs> replication and failover

With its file-replication function, mirror architecture is particularly suitable for providing high availability for back-end applications with critical data to protect against failure. The reason is that the secondary server data is strongly synchronized with the primary server data. A synchronized server is considered as up-to-date and only an up-to-date server can start as primary or run a failover.

If the application availability is more critical than the application data, this default policy can be relaxed by allowing a server to become primary if the time elapsed since the last synchronization is below a configurable delay. This is configured by setting the `syncdelta` attribute of the <rfs> tag:

- `syncdelta` <= 1

  The attribute is ignored and the default failover and start policy is applied. The default value is 0.

- `syncdelta` > 1

When the last up-to-date server is not responding, the not up-to-date server can become primary but only if the elapsed time since the last synchronization is lower than the `syncdelta` value (in minutes).

This feature is implemented with:

- `rfs.synced` resource

  When `syncdelta` is > 1, the `rfs.synced` resource is managed. This resource is `UP` if the replicated data are consistent and if the elapsed time, in minute since the last synchronization is lower than the `syncdelta` value.

- `syncedcheck` checker

  When `syncdelta` is > 1, this checker is running. It sets the value for the `rfs.synced` resource.

- `rfs_forceuptodate` failover rule

  When `syncdelta` is > 1, the following failover rule is valid:

```
rfs_forceuptodate:          if (heartbeat.* == down && cluster() == down &&
rfs.synced == up && rfs.uptodate == down) then rfs.uptodate=up;
```

  This rule leads to the primary start of the server when the up-to-date server is not responding and if the server is isolated and can be considered as synchronized according to `syncdelta` value.

13.6.4.5 <rfs> replication verification

You can check for the module, named *AM*, that files are identical on the primary and the secondary, by running the following command on the `SECOND` server: `safekit rfsverify -m AM`. Run `safekit rfsverify -m AM > log` to redirect the command output into the file named `log`.

This output of the command is a log like that of the reintegration in which the files to be copied (therefore different) are indicated. When on the primary, there is activity on the replicated directories, an anomaly may be detected while there is no difference between the files in the following cases:

- on Windows because modifications are made on disk before being replicated
- with `async="second"` (default) because reads can bypass the asynchronous writes.

To check if there is really an inconsistency, you must re-run the command on the secondary server making sure that there is no more activity on the primary.

On Windows, some files are systematically seen as erroneous by the verifier while there is no difference. This occurs when files are modified with `SetvalidData`: files are extended without resetting the new extension and the reads return random data from the disk.

It is strongly recommended to run this command only when there are no accesses to the replicated directories on the primary.

13.6.4.6 <rfs> file changes since the last synchronization

Before starting a secondary server, it may be useful to evaluate the number of files and data that have been changed on the primary server since the secondary server has stopped. This feature is provided by running the following command on the `ALONE` server: `safekit rfsdiff -m AM`. Run `safekit rfsdiff -m AM > log` to redirect the command output into the file named `log`.

This command runs on-line checks of regular files content of the module *AM*. It scans the entire replicated tree and displays the number of files that have been modified as well as the size that need to be copied. It also displays estimation for the synchronization duration. This is only estimation since only regular files are scanned and some other modifications may occur until the synchronization is run by the secondary server.

This command must be used with caution on a production server since it leads to an overhead on the server (for reading trees and files with locking). On Windows, rename of files can fail during the evaluation.

It is strongly recommended to run this command only when there are no accesses to the replicated directories.

13.6.4.7 <rfs> replication and reintegration bandwidth

The replication component monitors, on the `PRIM` server, the bandwidth used by replication and reintegration write requests.

Two resources (`rfs.rep_bandwidth` and `rfs.rei_bandwidth`) reflect the average bandwidth used by replication and reintegration respectively during the last 3 seconds, expressed in kilo bytes per second (KB/s).

If the replication load is IO intensive, the reintegration phase may saturate the network link and significantly slow down the application. In such a case, the `<rfs> reiallowedbw` attribute may be used to limit the bandwidth taken by the reintegration phase (see section 13.6.3). Please note that limiting the reintegration bandwidth will make the reintegration phase longer.

There are also 2 resources that reflect the network bandwidth (in in Kbytes/sec) used between nfsbox processes, that run on each node to implement replication and reintegration:

- `rfs.netout_bandwidth` is the network output bandwidth
- `rfs.netin_bandwidth` is the network input bandwidth

You can observe the value of `rfs.netout_bandwidth` on the primary or `rfs.netin_bandwidth` on the secondary to know the modification rate at the time of observation (write, create, delete, …). The history of the resource values gives an overview of its evolution over time.

The value of the bandwidth depends on the application, system, and network activity. Its measurement is available for information purposes only.

13.6.4.8 <rfs> synchronization by date

SafeKit 7.2 offers a new command `safekit secondforce -d date -m AM` that forces the module *AM* to start as secondary after copying only files modified after the specified date.

This command must be used with cautions since the synchronization will not copy files modified before the specified date. It is the administrator's responsibility to ensure that these files are consistent and up-to-date.

The date is in the format of YYYY-MM-DD[Z] or "YYYY-MM-DD hh:mm:ss[Z]" or YYYY-MM-DDThh:mm:ss[Z], where:

- YYYY-MM-DD indicates the year, month, and day
- hh:mm:ss indicates the hours, minutes, and seconds
- Z indicates that the time is in UTC time zone; when not set the time is in local time zone
- For instance:
- `safekit secondforce -d 2016-03-01 -m` *AM* for copying only files modified after the 1st of March 2016
- `safekit secondforce -d "2016-03-01 12:00:00" -m` *AM* for copying only files modified after the 1st of March 2016 at 12h, local time zone
- `safekit secondforce -d 2016-03-01T12:00:00Z -m` *AM* for copying only files modified after the 1st of March 2016 at 12h, UTC time zone

This command may be useful in the following case:

- the module is stopped on the primary server and a backup of the replicated data is done (on a removable drive for instance)
- the module is stopped on the secondary server and the replicated data is restored from the backup. It may be the first start-up or the repair of the secondary server.
- the module is started on the primary server that becomes `ALONE`
- the module is started on the secondary with the command `safekit secondforce -d date -m` *AM* where the date is the backup date

In this case, only the files modified since the backup date will be copied (full copy), instead of the full copy of all files.

In Windows, the file modification date on the secondary server is changed when the file is copied by the synchronization process. Therefore, `safekit secondforce -d date -m` *AM*, where date is prior to the last reintegration on this server, has no interest.

13.6.4.9 <rfs> external synchronization

On the first synchronization, all replicated files are fully copied from the primary node to the secondary node. During the following synchronizations, necessary when the secondary node comes back, only zones modified, during the secondary downtime, of files that have been modified on the primary node during the secondary node downtime. When the replicated directories are voluminous, the first synchronization can take a lot of time especially if the network is slow. For this reason, since SafeKit> 7.3.0.11, SafeKit provides a new feature to synchronize a large amount of data that must be used in conjunction with a backup tool.

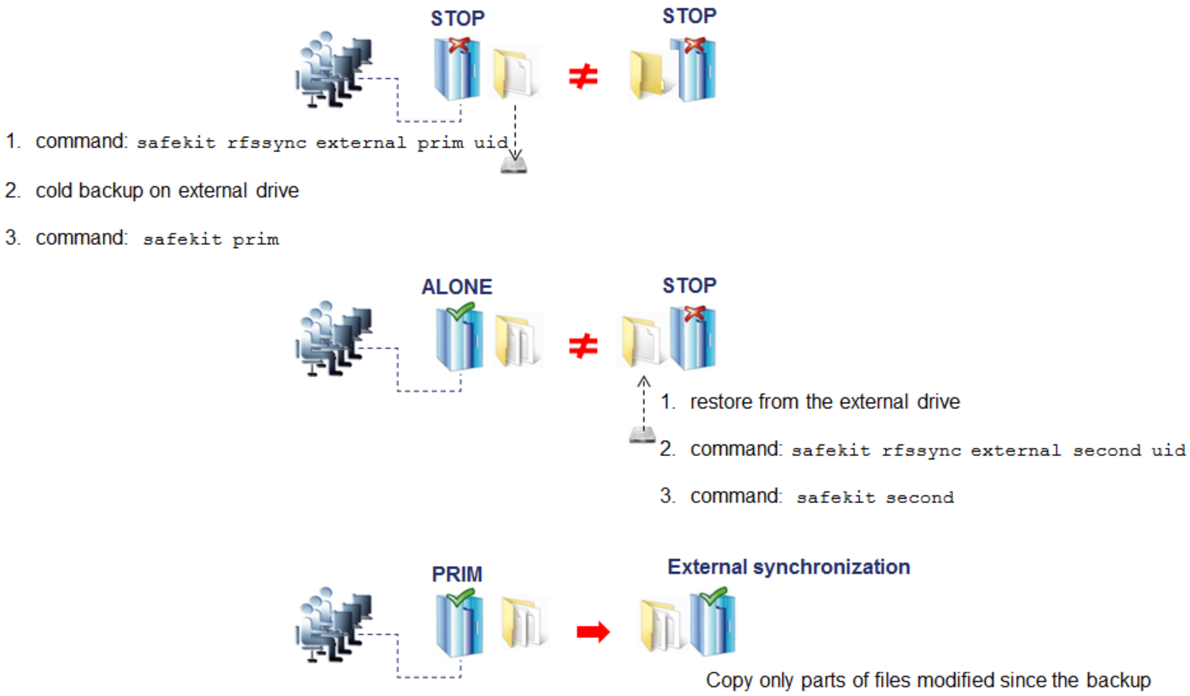
On the primary node, simply back up the replicated directories and pass the synchronization policy to the external mode. The backup is transported (using an external drive for instance) and restored to the secondary node, which is also configured to perform external synchronization. When the module is started on the secondary node, it copies only the file areas that were modified on the primary node since the backup

The external synchronization relies on a new SafeKit command `safekit rfssync` that must be applied on both nodes to set the synchronization policy to `external`. This command requires as arguments:

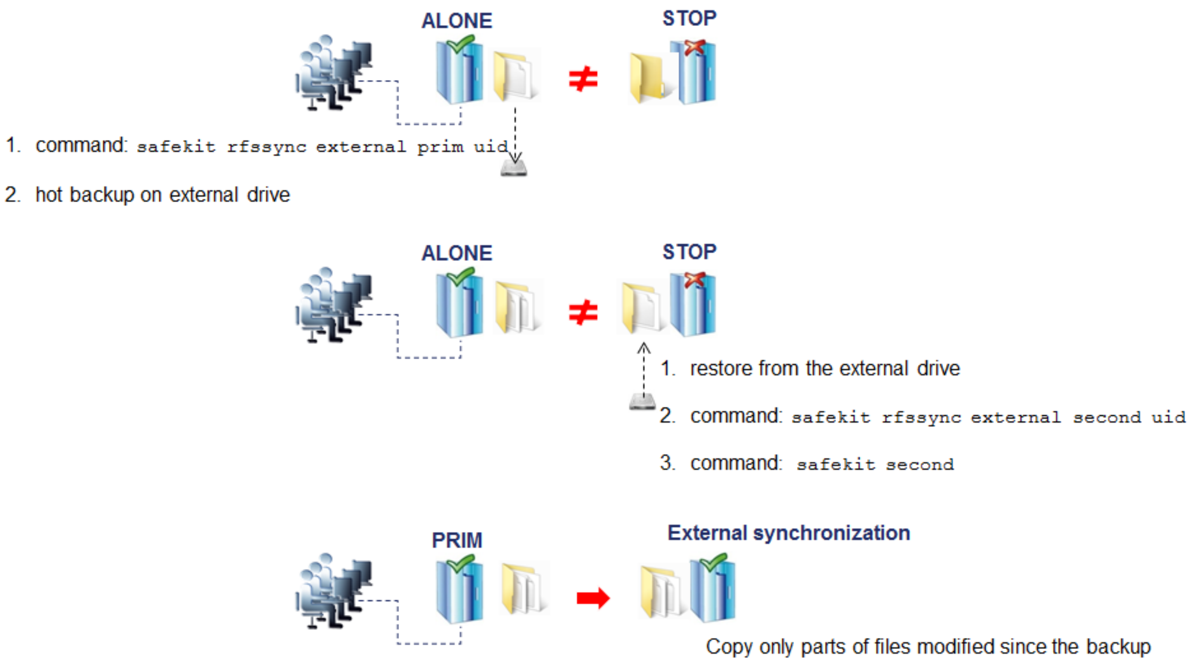
- the role of the node (`prim | second`)
- a unique identifier (`uid`)

External synchronization procedure

The external synchronization procedure, described below, is the procedure to be followed in the case of a cold backup of the replicated directories. In this case, the application must be stopped, and any modification of the replicated directories is prohibited until the module and the application are started, in ✓`ALONE (Ready)`. The order of operations must be strictly adhered to.



The external synchronization procedure, described below, is the procedure to be followed in the case of a hot backup of replicated directories. In this case, the module is ✓`ALONE (Ready)`; the application is started and changes to the contents of the replicated directories are allowed. The order of operations must be strictly adhered to.



`safekit rfssync` command

`safekit rfssync external prim` *`uid`* `[-m` *`AM`*`]`	Set the synchronization policy to `external`. It is identified by the value of *`uid`* (at max 24 char). The node is the primary one, the source for synchronizing data.
`safekit rfssync external second` *`uid`* `[-m` *`AM`*`]`	Set the synchronization policy to `external`. It is identified by the value of `uid` (at max 24 char). The node is the secondary one, the destination for synchronizing data
`safekit rfssync -d prim` *`uid`* `[-m` *`AM`*`]` `safekit rfssync -d second uid [-m` *`AM`*`]`	Disable the replicated directories change detection between the cold backup/restore and the start of the module. Use this option with caution since the external synchronization may not properly detect all changes to be copied.
`safekit rfssync full [-m` *`AM`*`]`	Set the synchronization policy to `full`. This will copy all files in their entirety on the next synchronization.
`safekit rfssync`	Display the current synchronization policy

Internals

The synchronization policy is represented by module's resources: `usersetting.rfssyncmode`, `usersetting.rfssyncrole`, `usersetting.rfssyncuid` and `rfs.rfssync`:

- `usersetting.rfssyncmode="default" (usersetting.rfssyncrole="default", usersetting.rfssyncuid="default")`

These values are associated with the standard synchronization policy, which is applied by default. It consists of copying only the modified areas of the files. When this policy cannot be applied, the modified files are copied in their entirety.

- `usersetting.rfssyncmode="full"` (`usersetting.rfssyncrole="default"`, `usersetting.rfssyncuid="default"`)

  These values are associated with the `full` synchronization policy. It is applied:

  - the first time the module is started after its first configuration
  - on `safekit` commands (`safekit second fullsync` ; `safekit rfssync full ; safekit primforce ; safekit config ; safekit deconfig`)
  - on change of pairing for the module

  The `full` synchronization policy will copy all files in their entirety on the next synchronization.

- `usersetting.rfssyncmode="external"`, `usersetting.rfssyncrole="prim | second"` and `usersetting.rfssyncuid="uid"`

  These values are associated with the `external` synchronization policy assigned with the commands `safekit rfssync external prim uid` and `safekit rfssync external second uid`. The next synchronization will apply the `external` synchronization policy.

- `rfs.rfssync="up | down"`

  This resource is only `up` when the synchronization policy, defined by the previous resources, can be applied.

When the synchronization policy is not the default policy, the synchronization policy automatically returns to the default mode after successful synchronization. To check the state of resources, see section 7.3.

In some cases, external synchronization cannot be applied, and the secondary node stops with an error specified in the module log. In this situation, you must either:

- complete the external synchronization procedure if this has not been done in its entirety on the 2 nodes
- fully reapply the external synchronization procedure on the 2 nodes
- revert to the `full` synchronization policy (`safekit rfssync full` command)
- apply the synchronization by date, using the date of the backup (see section 13.6.4.8). Unlike external synchronization, synchronization by date will copy the files, modified on the primary node, in their entirety (instead of just modified parts).

13.6.4.10 <rfs> scheduled synchronization

By default, SafeKit provides real-time file replication and automatic synchronization. On heavy loaded server or high latency network, you may want to let the secondary node weakly synchronized. For this, you can use the `syncat` attribute for scheduling replicated directories synchronization on the secondary node. The module must be started for enabling this feature. Once synchronized, the module blocks in the `WAIT (NotReady)` state until the next synchronization schedule. It is implemented with:

- the resource `rfs.syncat` that is set to `up` on the scheduled dates and set to `down` after the data synchronization

- the failover rule `rfs_syncat_wait` that blocks the module into the state `WAIT (NotReady)` until the `rfs.syncat` resource is `up`

If you want to manually force the synchronization, you can run the command: `safekit set -r rfs.syncat -v up -m AM` while the module is in the `WAIT (NotReady)` state.

With `syncat`, you just have to configure the scheduled time for the synchronization with the syntax of the native job scheduler: `crontab` in Linux and `schtasks.exe` in Windows (see section 13.6.3).

13.7 Enable module scripts - <user>, <var>

This section describes only the configuration options available for `<user>` tag. Refer to section 14 for a full description of module scripts.

When this tag is not set, the module scripts are not executed.

13.7.1 <user> example

```
<user logging="userlog" >
  <var name="name1" value="value1" />
</user>
```

For as example of `<var>` usage, refer to section 15.3. See also the full example of a mirror module at section 15.1 or a farm module at section 15.2. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.7.2 <user> syntax

```
<user
   [nicestoptimeout="300"]
   [forcestoptimeout="300"]
   [logging="userlog"|"none"]
   [userlogsize="2048"]
 >
   <var name="name1" value="value1" />
   …
</user>
```

The `<user>` tag and full subtree can be changed with a dynamic configuration.

13.7.3 <user>, <var> attributes

`<user`	
`[nicestoptimeout="300"]`	Timeout delay in seconds to execute the `stop_xx` script. Default value: `300` seconds
`[forcestoptimeout="300"]`	Timeout delay in seconds to execute the `stop_xx` -force script. Default value: `300` seconds

`[logging="userlog"|"none"]`	stdout and stderr messages of the application started in scripts. • `logging="userlog"` Messages are redirected into the log `SAFEVAR/modules/AM/userlog_<year>_<month>_<day>T<time>_<script name>.ulog` where *AM* is the module name (`SAFEVAR=C:\safekit\var` on Windows and `SAFEVAR=/var/safekit` on LINUX). • `logging="none"`, messages are not logged. Default value: `userlog`
`[userlogsize="2048"]`	Limit in KB of the size of the userlog On module start, the file is truncated to 0 if the size has reached this limit. Default value: `2048` KB
`[<var name="name1" value="value1"/>]`	Optional environment variable and its value are exported before the execution of module scripts. Define as many var sections as there are environment variables to export.

13.8 Virtual hostname - <vhost>, <virtualhostname>

13.8.1 <vhost> example

```
<vhost>
  <virtualhostname name="vhostname" envfile="vhostenv"/>
</vhost>
```

See also the example in section 15.12. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.8.2 <vhost> syntax

```
<vhost>
  <virtualhostname
     name="virtual_hostname"
     envfile="path_of_a_file"
    [when="prim"|"second"|"both"]
  />
</vhost>
```

The `<vhost>` tag and subtree cannot be changed with a dynamic configuration.

13.8.3 <vhost>, <virtualhostname> attributes

`<vhost>`	
`<virtualhostname`	

`name="virtual_hostname"`	Definition of the virtual hostname.
`envfile="path_of_envfile"`	Path of the environment file automatically generated by SafeKit during configuration command If the path of the file is relative, the file will be generated in the runtime environment of the application module i.e.: `SAFEUSERBIN` This generated environment file is used in module scripts to set the virtual hostname before starting and stopping the application. See the module template `vhost.safe` delivered with Linux and Windows package.
`[when="prim"|"second"|"both"]`	Define when the virtual hostname must be returned to the application instead of the physical one. Default value: `prim` means when the server is primary (`PRIM` or `ALONE`).
`/>`	
`</vhost>`	

13.8.4 <vhost> description

Some applications need to see the same hostname on all SafeKit servers (typically, because it is stored in a replicated file). With the virtual hostname, these applications see the virtual name whereas other applications see the physical name.

- On Linux

  Implementation is based on the LD_PRELOAD environment variable: `gethostname` and `uname` functions are overloaded.

- On Windows

  Implementation is based on the CLUSTER_NETWORK_NAME_ environment variable: the query API (GetComputerName, GetComputerNameEx, gethostname) functions take this variable into account. To use vhost for a service, use the command `vhostservice <service> [<file>]` before/after the service start/stop.

13.9 Process or service monitoring - <errd>, <proc>

`<errd>` section requires `<user/>` section.

13.9.1 <errd> example

See also a full example in section 15.4. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.9.1.1 Process monitoring

- Linux and Windows

  `myproc` is the command name of the process to monitor:

```
<errd>
  <proc name="myproc" atleast="1" action="restart" class="prim"/>
</errd>
```

- Linux only (since SafeKit > 7.2.0.29)

  `oracle_.*` is a regular expression on the command name of the process to monitor:

```
<errd>
  <proc name="oracle" nameregex="oracle_.*" atleast="1" action="restart"
class="prim"/>
</errd>
```

13.9.1.2 Service monitoring

`myservice` is the name of a service to monitor. In Windows, it is the name of a Windows service (since safekit > 7.3). In Linux, it is the name of a systemd service (since safekit > 7.4.0.19).

```
<errd>
<proc name="myservice" service="yes" atleast="1" action="restart" class="prim" />
</errd>
```

13.9.2 <errd> syntax

```
<errd
  [polltimer="10"]
>
  <proc name="command name and/or resource name for the monitored process (or
service in Windows)"
        [service="no|yes"]
        [nameregex=="regular expression on the command name"]
        [argregex="regular expression on process arguments, including command
name"]
        atleast="1"
        action="stopstart"|"restart"|"stop"|"executable_name"
        class="prim"|"both|"pre"|"second"|"sec"|"othername"]
        [start_after="nb polling cycles"]
        [atmax="-1"]
  />
  …
</errd>
```

The `<errd>` tag and full subtree can be changed with a dynamic configuration.

13.9.3 <errd>, <proc> attributes

`<errd`	
`polltimer="30"`	Time delay, in seconds, between two polls of the list of processes.

	Default value: `30` seconds
`<proc`	Definition of a process to monitor. Set as many proc sections as there are processes. A resource is associated with each <proc>, it is named `proc.<value of the attribute name>` (e. g `proc.process_name`). The resource is `up` when the monitoring condition is true; else `down` if false.
`name="`*`command_name`*`"`	*`command_name`* is the command name of the process to monitor. It is also the name of the resource associated with the monitored process. At max 15 characters in Linux (the command name can be truncated); 63 in Windows. For example: • `name="vi"` on Linux • `name="notepad.exe"` on Windows In Windows only, the name is automatically converted to lower case. See section 13.9.4 for help on retrieving the process command name.
Or `name="`*`service_name`*`"` `service="yes"`	*`service_name`* is the name of the service to monitor. It is also the name of the resource associated with the monitored service. At max 63 characters. For example: • `name="W32Time" service="yes"` for monitoring the Windows Time service • `name="ntpd" service="yes"` for monitoring the Linux Time service (systemd ntpd.service) The `service` attribute is optional. Default value: `no`
Or `name="`*`command_name`*`"` `nameregex="`*`regular expression on the command name`*`"`	**Linux only** `nameregex` is a regular expression applied on the command name for selecting the process to monitor. `name` is name of the resource associated with the monitored process. As regular expressions are defined inside the XML file `userconfig.xml`, special characters interpreted by XML like '<' or '>' cannot be used in regular expressions.

<table>
<tr>
<td></td>
<td>

For example:

- `nameregex="oracle _. *" name="oracle"`

  for monitoring oracle process that match the regular expression. The associated resource is `proc.oracle`

The `nameregex` attribute is optional.

</td>
</tr>
<tr>
<td>

`class=`

`"prim"|`

`"both"|`

`"pre"|`
`"second"|`

`"sec"|`

`"`*`othername`*`"`

</td>
<td>

The process belongs to a class.

The monitoring of a class is enabled/disabled with the command `safekit errd enable|disable "classname" -m` *AM*.

- `class="prim"|"both"|"pre"|"second"|"sec"`

  Activation/deactivation of these classes are automatically done in the `<user/>` component with `start_prim/stop_prim`, `start_both/stop_both`, `start_second/stop_second`, `start_sec/stop_sec`. For scripts details, see section 14.

- `class="`*`othername`*`"`

  For nonstandard classes, you must explicitly enable/disable process monitoring after/before the start/stop of the process.

</td>
</tr>
<tr>
<td>

`[argregex="`*`regular expression on process arguments`*`"]`

</td>
<td>

Regular expression matching the list of arguments of the process to monitor, including the executable name. Optional parameter.

The regex engine is POSIX Extended regex (see POSIX documentation):

- in Windows, case insensitive mode
- in Linux, case sensitive mode

As regular expressions are defined inside the XML file `userconfig.xml`, special characters interpreted by XML like '`<`' or '`>`' cannot be used in regular expressions.

See section 13.9.4 for help on retrieving the list of arguments of a process.

- Linux examples with `vi` editor on `myfile`

```
<proc name="vi" argregex=".*myfile.*" …
<proc name="vi" argregex="/myrep/myfile.*" …
<proc name="vi" argregex="/myrep/myfile" …
```

- Windows examples with `notepad` editor on `myfile`

```
<proc name="notepad.exe" argregex=".*myfile.*" …
<proc name="notepad.exe"
argregex="c:\\myrep\\myfile.*" …
```

</td>
</tr>
</table>

	`<proc name="notepad.exe" argregex="c:\\myrep\\myfile" …`
`atleast="1"`	Minimum number of processes that must be running. If this minimum is not reached, then SafeKit triggers an action • `name="oracle" argregex=".*db1.*" atleast="1"` means that an action will be triggered if less than one `oracle` instance is running on `db1`. • `atleast="-1"` this criterion is meaningless Default value: `1`
`action= "restart"|"stopstart"|"stop"|"noaction"|"`*`executable_name`*`"`	Action (or handler) to execute on the module • `action="restart"` triggers a local `restart` • `action="stopstart"` triggers a `stopstart` and may lead to a failover • `action="stop"` triggers a `stop` and may lead to a failover To avoid a loop on reproducible fault, a `maxloop` counter is incremented at each `restart`/`stopstart` command. For the `maxloop` definition, see section 13.2. • `action="noaction"` means logging a message • `action="`*`executable_name`*`"` To define a special handler, either set an absolute path or a path relative to the "bin" directory of the module: `SAFE/modules/`*`AM`*`/bin/`. We recommend a relative path and a handler defined inside the module. When defining a special handler, a new class name must be associated with the monitored process. For a special handler on Linux, on success, end with `exit 0`. For a special handler on Windows, on success, end with `%SAFEBIN%\exitcode 0`. With a different value, SafeKit performs a `stopstart` command. When running special handlers, the `maxloop` counter is not incremented. To increment it, use: `safekit incloop -m `*`AM`*` -i <handler name>` This command increments the counter and returns 1 when the limit has been reached. Default value: `stopstart`
`[start_after="`*`nb polling cycles`*`"]`	Without the `start_after` attribute the monitoring of processes is immediately effective. Otherwise, it is delayed for `(n-1)*polltimer` (in seconds) where:

	• n is the value given in start_after parameter • polltimer is the value set on the errd flag (30 seconds by default) For example, if start_after="3", the server is delayed for 60 seconds ((3-1)*30). The start_after parameter is useful if the process takes a certain time to start. Default value: 0
Advanced parameters	
atmax="-1"	Maximum number of processes that can run. If this maximum is reached, then SafeKit triggers an action. • atmax="-1" means that this criterion is meaningless. • atmax="0", an action is triggered each time the process is started. Default value: -1 this criterion is meaningless
</errd>	

13.9.4 <errd> commands

If the command is used inside a module script, then the SAFEMODULE environment variable is set and the -m *AM* parameter is not necessary.

safekit -r errdpoll_running	This command prints into the file **SAFEVAR/errdpoll_reserrd** (SAFEVAR=/var/safekit on Linux and SAFEVAR=c:\safekit\var on Windows if c: is the installation drive), one line for each running process with following fields: <pid> <command name> <command full name and arguments list> (parent=<parent pid>) In Windows, the command name is displayed in lower case. Useful to find the process name and its arguments for an <errd> configuration
safekit errd disable "*classname*" -m *AM*	Suspends the monitoring of the processes included in the class classname (for the application module *AM*). Must be explicitly done in stop_... scripts before stopping the application, for processes in class different from prim, both, second, sec.
safekit errd enable "*classname*" -m *AM*	Resumes the monitoring of the processes defined with the class classname (for the application module *AM*).

<table>
<tr><td></td><td>Must be explicitly done in start_... scripts after starting the application, for processes in class different from <code>prim</code>, <code>both</code>, <code>second</code>, <code>sec</code>.</td></tr>
<tr><td><code>safekit errd off -m AM</code></td><td>Suspends the monitoring of all processes except SafeKit processes (for the application module <code>AM</code>).

Useful when stopping manually the application without triggering error detection.

With SafeKit < 8.2, use
<code>safekit errd suspend -m AM</code></td></tr>
<tr><td><code>safekit errd on -m AM</code></td><td>Resumes the monitoring of processes suspended with <code>safekit errd suspend</code> (for the application module <code>AM</code>).

With SafeKit < 8.2, use
<code>safekit errd resume -m AM</code></td></tr>
<tr><td><code>safekit errd list -m AM</code></td><td>Lists all processes monitored by SafeKit (including SafeKit processes) and defined in the application module <code>AM</code>.

The list displayed may be truncated due to internal limits. The full list can be found in the file <code>SAFEVAR/modules/AM/errdlist</code>.

<code>SAFEVAR=/var/safekit</code> on Linux and
<code>SAFEVAR=c:\safekit\var</code> on Windows if c: is the installation drive.</td></tr>
<tr><td><code>safekit kill -name="process_name" [-argregex="…"] -level="kill_level"</code></td><td><code><errd></code> component must run.
<code>level="test"</code>: only display the process list
<code>level="terminate"</code>: kill processes
<code>level="9"</code>: send SIGKILL signal to processes (Linux only)
<code>level="15"</code>: send SIGTERM signal to processes (Linux only)
Windows examples ("class CatlRegExp" for more information)
<pre>safekit kill -name="notepad.exe"
-argregex=".*myfile.*" -level="terminate"
safekit kill -name="notepad.exe"
-argregex="c:\\myrep\\myfile.*"
-level="terminate"</pre>
Linux examples ("man regex" for more information)
<pre>safekit kill -name="vi"
-argregex=".*myfile.*" -level="9"</pre></td></tr>
</table>

	`safekit kill -name="vi" -argregex="/myrep/myfile.*" -level="9"`

13.10 Checkers - <check>

SafeKit provides checkers that test a critical element and affect the state of a module resource based on the test result. Upon error detection by a checker, the failover machine performs an action on the module according to the failover rule associated with the checker. For a complete description, see section 13.10.3.

The checkers provided by SafeKit are:

- section 13.11 "TCP checker - <tcp>"
- section 13.12 "Ping checker - <ping>"
- section 13.13 "Interface checker - <intf>"
- section 13.14 "IP checker - <ip>"
- section 13.15 "Custom checker - <custom>"
- section 13.16 "Module checker - <module>"
- section 13.17 "Splitbrain checker - <splitbrain>"

13.10.1 <check> example

All built-in checkers are configured under a single `<check>` section:

```
<check>
  <!-- Insert below <tcp> <ping> <intf> <ip> <custom> <module> <splitbrain> tags
-->
</check>
```

13.10.2 <check> syntax

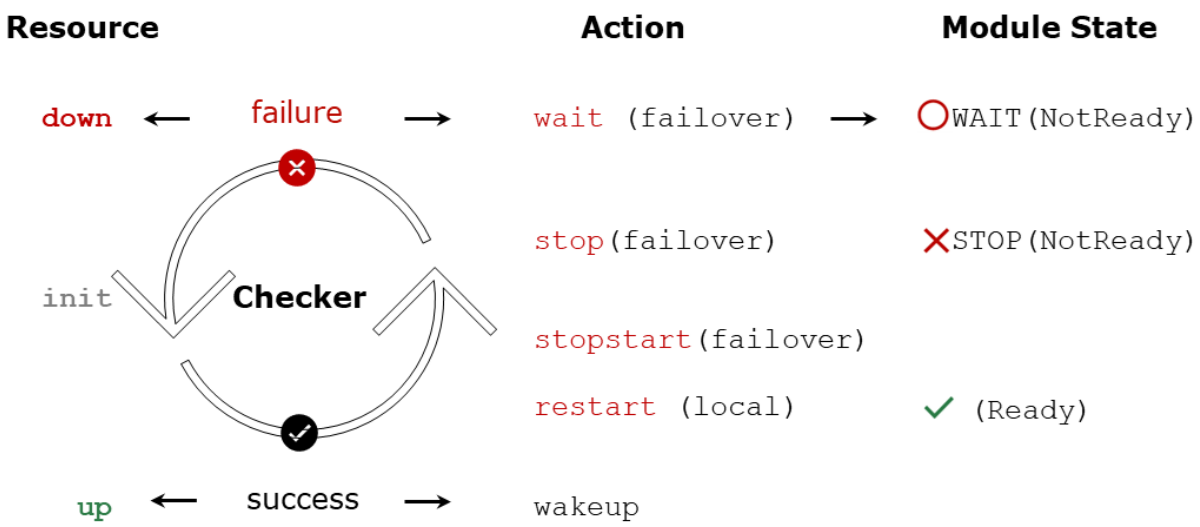
```
<check>
  <tcp …>
    <to …/>
  </tcp>
  …
  <ping …>
    <to …/>
  </ping>
  …
  <intf …>
    <to …/>
  </intf>
  …
  <ip …>
    <to …/>
  </ip>
  …
  <custom …/>
  …
  <module …>
    [<to …/>]
  </module>
```

```
…
  <splitbrain …/>
</check>
```

The <check> tag and full subtree can be changed with a dynamic configuration.

13.10.3 <checker> description

A checker tests a critical element (by default every 10 seconds) and affects the state of the associated resource, setting it to `up` or `down` based on the test result. The failover machine evaluates the failover rules and executes the action associated with the checker when the resource changes state.



- The initial state of the resource is `init`. The failover machine keeps the module in the `WAIT (Transient)` state as long as at least one resource used by a rule with a `wait` action is in the `init` state.
- If the test fails, the associated resource is set to `down`. The failover rule associated with the checker determines which action to take in this case. Possible actions on the module are `restart`, `stop`, `stopstart`, or `wait`.
  - The `restart` action triggers a local restart of the application without changing the module's state.
  - The actions `stop`, `stopstart`, and `wait` involve stopping the module, and consequently the application, followed by an automatic restart in the cases of `stopstart` and `wait`. Stopping the module may trigger a failover to the other node if it is `(Ready)`.
  - When the action is `wait`, the module remains stuck in the `WAIT (NotReady)` state as long as the resource is `down`.

  The actions `restart`, `stopstart`, and `wait` increment the error detection counter. When this counter exceeds the `maxloop` limit within the time interval `loop_interval` (by default, on the 4th error detection within 24 hours; see section 13.2.3), the module is stopped.

- If the test succeeds, the associated resource is set to `up`. This triggers the implicit `wakeup` action if the associated action is `wait`. The module exits the `WAIT (NotReady)` state and continues its normal startup process.

The configuration of the checker determines:

- The name of the associated resource
- Optionally, the name of the associated failover rule and the action

13.10.3.1 Module resource associated with a checker

- The initial state of the resource is `init`
- If the test fails, the associated resource is set to `down`
- If the test succeeds, the associated resource is set to `up`

For a description of the resources, see section 13.18.4.1.

The name of the resource associated with the checker is determined from its configuration:

- The resource class is the value of the XML tag of the checker: `tcp`, `ping`, `intf`, `ip`, `custom`, `module` or `splitbrain`
- The resource id is the value of the `ident` attribute.

For example, for the following configuration of a ping checker:

```
<check>
  <ping ident="testR2" action="wait">
    <to addr="R2"/>
  </ping>
</check>
```

The associated resource is named **`ping.testR2`**.

The current value of the resource is visible:

- via the web console as described in section 3.4.4.2
- with the command `safekit state -v -m AM` (where *AM* is the name of the module)

```
…
ping.testR2                    down          yyyy-mm-dd
```

State changes of the resource are visible in the module log:

- via the web console as described in section 3.4.4.1
- with the command `safekit logview -A -m AM` (where *AM* is the name of the module)

```
I | Resource ping.testR2 set to up by pingcheck
…
C | Resource ping.testR2 set to down by pingcheck
```

13.10.3.2 Failover rule associated with checker

The failover rule associated with the checker defines which action to take when its resource goes down. For a description of the failover rules, see section 13.18.4.2.

The possible actions for the module are `restart`, `stop`, `stopstart` or `wait`.

The failover rule associated with the checker is determined based on its configuration:

- The checkers `intf`, `ip`, `module`, and `splitbrain` have a predefined default rule that applies to all resources of that type:

```
/* rule for module checkers */
module_failure: if (module.? == down) then wait();

/* rule for interface checkers */
interface_failure: if (intf.? == down) then wait();

/* rule for ip checkers */
ip_failure: if (ip.? == down) then stopstart();

/* rules for splitbrain */
splitbrain_failure: if (splitbrain.uptodate == down) then wait();
```

- The checkers `tcp`, `ping`, and `custom` have a rule generated with the value of the action attribute if it is set to `stop`, `stopstart`, `restart` or `wait`.

  For example, for the following configuration of a ping checker:

```
<check>
  <ping ident="testR2" action="wait">
    <to addr="R2"/>
  </ping>
</check>
```

  The generated rule is named :

```
p_testR2 : if (ping.testR2 == down) then wait();
```

  The name of the rule has as a prefix the first letter of the checker name (`t`, `p` or `c`), followed by _, then the value of the attribute `ident`.

- The `tcp`, `ping`, and `custom` checkers do not have a failover rule if the value of the action attribute in their configuration is set to `noaction`. In this case, the user must explicitly add the associated failover rule in the module configuration. For example, for the following configuration of a custom checker, the failover rule is added explicitly :

```
<check>
  <custom ident="checkfile" exec="checker.ps1"
          arg="c:\safekit\checkfile" when="prim" action="noaction"/>
</check>

<failover>
  <![CDATA[
    checkfile_failure: if( custom.checkfile == down ) then restart();
  ]]>
</failover>
```

When the failover rule is activated, it is visible:

- Through the web console in the detailed status of the module described in section 3.4.2.2
- By a message in the module log like the following:

```
C | Action wait according to the failover rule p_testR2
```

  The module log can be viewed:

  - Through the web console as described in section 3.4.4.1
  - Using the command `safekit logview -A -m AM` (where *AM* is the name of the module)

13.11 TCP checker - <tcp>

By default, there is a `restart` action on the module when the `tcp` checker detects a connection failure to the TCP service.

Since SafeKit 8.2.3, the action can be configured using the `action` attribute of the `<tcp>` tag.

Insert the `<tcp>` tag into the `<check>` section if this one is already defined.

13.11.1 <tcp> example

```
<check>
  <tcp ident="R1test" when="prim" action="restart" >
    <to addr="R1" port="80"/>
  </tcp>
</check>
```

- The resource associated with the checker is named `tcp.R1test` (with the prefix `tcp.`)
- The generated failover rule, which performs a `restart` when the resource goes `down`, is named `t_R1test` (with the prefix `t_`) and is equivalent to:

```
t_R1test: if (tcp.R1test == down) then restart();
```

For a description of checkers, refer to section 13.10.3.

See also example in section 15.5. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.11.2 <tcp> syntax

```
  <tcp
    ident="tcp_checker_name"
    when="prim|second|both|pre"
    [action=" stop|stopstart|restart|wait|noaction"]
  >
    <to
     addr="IP address or name to check"
     port="TCP port to check"
     [interval="10"]
```

```
    [timeout="5"]
    />
</tcp>
```

Since SafeKit 8.2.3, use the `action` attribute to define the action to be taken when an error is detected by the tcp checker.

Before SafeKit 8.2.3, the action was static and defined by the default failover rule that applies to all `tcp` class resources:

```
tcp_failure: if (tcp.? == down) then restart();
```

13.11.3 <tcp> attributes

`<tcp`	Set as many `<tcp>` sections as there are TCP checkers.
`ident="`*`tcp_checker_name`*`"`	TCP checker name. It defines the resource associated with the checker: **`tcp`**`.`*`tcp_checker_name`* (with the prefix `tcp.`)
`when="prim|second|both"` `[action="stop|stopstart|restart|noaction"]`	Use this value to test an internal TCP service of the application once it has started: • `when="prim"` for a mirror module The checker is started after/stopped before the execution of the `start_prim/stop_prim` scripts. • `when="both"` for a farm module The checker is started after/stopped before the execution of the `start_both/stop_both` scripts. • `when="second"` for a mirror module The checker is started after/stopped before the execution of the `start_second/stop_second` scripts. Since SafeKit 8.2.3, you can configure the action to take when an error is detected with: • `action="stop|stopstart|restart"` `stop`, `stopstart` or `restart` the module. The name of the associated failover rule is **`t_`***`tcp_checker_name`* (with the prefix `t_`) • `action="noaction"` No action is generated automatically. The action must be explicitly written in the `<failover>` tag (see section 13.18). Default value: `action="restart"`

`when="pre"` `action="wait|noaction"`	Use this value to test an external TCP service before the application starts: • `when="pre"` The checker starts after/ends before the execution of the `prestart`/`poststop` scripts Since SafeKit 8.2.3, you can configure the action to be taken in case of error detection with: • `action="wait"` `wait` on the module. The name of the associated failover rule is **t_***tcp_checker_name* (with the prefix `t_`) • `action="noaction"` No failover rule generated. The action must be explicitly written in the `<failover>` tag (see section 13.18).
`<to`	
`addr="`*IP address or name*`"`	IP address or name to check (ex.: `127.0.0.1` for a local service). IPv4 or IPv6 address.
`port="`*value*`"`	TCP port to check.
`[interval="10"]`	Interval in seconds between two connections trials. Default value: `10` seconds
`[timeout="5"]`	Connection establishment timeout in seconds. Default value: `5` seconds
`</tcp>`	

13.12 Ping checker - <ping>

By default, there is a `wait` action on the module when the `ping` checker detects a ping failure on a device.

Since SafeKit 8.2.3, the action can be configured using the `action` attribute of the `<ping>` tag.

Insert the <ping> tag into the <check> section if this one is already defined.

13.12.1 <ping> example

```
<check>
  <ping ident="testR2" action="wait">
    <to addr="R2"/>
  </ping>
```

```
</check>
```

- The resource associated with the checker is named `ping.testR2` (with the prefix `ping.`)
- The generated failover rule, which performs a `wait` when the resource goes `down`, is named `p_testR2` (with the prefix `p_`) and is equivalent to:

```
p_testR2: if (ping.testR2== down) then wait();
```

For a description of checkers, refer to section 13.10.3.

See also the example in section 15.6. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.12.2 <ping> syntax

```
 <ping
   ident="ping_checker_name"
   [when="pre|prim|second|both"]
   [action="wait|stop|stopstart|restart|noaction"]
 >
   <to
    addr="IP address or name to check"
    [interval="10"]
    [timeout="5"]
    />
 </ping>
```

13.12.3 <ping> attributes

`<ping`	Set as many ping sections as there are ping checkers.
`ident="`*`ping_checker_name`*`"`	Ping checker name. It defines the resource associated with the checker: **`ping`**`.`*`ping_checker_name`* (with the prefix `ping.`)
`when="pre"` `action="wait|noaction"`	Use this value to test an external device before the application starts. • `when="pre"` The checker starts after/ends before the execution of the `prestart`/`poststop` scripts Since SafeKit 8.2.3, you can configure the action to be taken in case of error detection with: • `action="wait"` `wait` on the module. The name of the associated failover rule is **`t_`***`tcp_checker_name`* (with the prefix `t_`) • `action="noaction"` No failover rule generated. The action must be

	explicitly written in the `<failover>` tag (see section 13.18). Default value : `when="pre" action="wait"`
`when="prim|second|both"` `action="stop|stopstart|restart|noaction"`	Use this value to test a device after the application has started: • `when="prim"` for a mirror module The checker is started after/stopped before the execution of the `start_prim/stop_prim` scripts. • `when="both"` for a farm module The checker is started after/stopped before the execution of the `start_both/stop_both` scripts. • `when="second"` for a mirror module The checker is started after/stopped before the execution of the `start_second/stop_second` scripts. Since SafeKit 8.2.3, you can configure the action to take when an error is detected with: • `action="stop|stopstart|restart"` `stop`, `stopstart` or `restart` the module. The name of the associated failover rule is **p_***ping_checker_name* (with the prefix `p_`) • `action="noaction"` No action is generated automatically. The action must be explicitly written in the `<failover>` tag (see section 13.18).
`<to`	
`addr="`*IP address or name*`"`	External IP address or name to check. IPv4 or IPv6 address.
`[interval="10"]`	Interval in seconds between two ping requests. Default value: `10` seconds
`[timeout="5"]`	Reply timeout in seconds to the ping. Default value: `5` seconds
`</ping>`	

13.13 Interface checker - <intf>

By default, there is a `wait` action on the module when the `intf` checker detects a failure on the interface.

Insert the <intf> tag into the <check> section if this one is already defined.

13.13.1 <intf> example

```
<check>
  <intf  ident="test_eth0">
    <to  local_addr="192.168.1.10"/>
  </intf>
</check>
```

- The resource associated with the checker is named `intf.test_eth0` (with the prefix `intf.`)
- The failover rule, which performs a `wait` when an `intf` class resource goes `down`, is static and defined by the default failover rule:

```
interface_failure: if (intf.? == down) then wait();
```

For a description of checkers, refer to section 13.10.3.

See also the example in section 15.10. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.13.2 <intf> syntax

```
  <intf
    ident="intf_checker_name"
    [when="pre"]
       >
    <to
     local_addr="interface_physical_IP_address"/>
  </intf>
```

13.13.3 <intf> attributes

`<intf`	`<intf>` sections are automatically generated on network interface when `<interface check="on">` is set (see the virtual IP definition in section 13.5).
`ident="`*`intf_checker_name`*`"`	Interface checker name. It defines the resource associated with the checker: **`intf`**`.`*`intf_checker_name`* (with the prefix `intf.`)
`[when="pre"]`	Fixed value.

	• `when="pre"` The checker starts after/ends before the execution of the `prestart`/`poststop` scripts In case of error detection, the action is `wait`. The name of the failover rule, **`interface_failure`**, is static and predefined.
`<to local_addr="IP address" />`	Physical IP address configured on the network interface to check. IPv4 or IPv6 address.
`</intf>`	

13.14 IP checker - <ip>

By default, there is a `stopstart` of the module when the IP checker detects that the IP address is not configured locally. On Windows, it also detects conflicts with that address.

Insert the `<ip>` tag into the `<check>` section if this one is already defined.

13.14.1 <ip> example

```
<check>
  <ip  ident="ip_check" >
    <to  addr="192.168.1.10" />
  </ip>
</check>
```

- The resource associated with the checker is named `ip.ip_check` (with the prefix `ip.`)
- The failover rule, which performs a `stopstart` when an `ip` class resource goes `down`, is static and defined by the default failover rule:

```
ip_failure: if (ip.? == down) then stopstart();
```

For a description of checkers, refer to section 13.10.3.

See also the example in section 15.11. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.14.2 <ip> syntax

```
  <ip
    ident="ip_checker_name"
    [when="prim"|"both"]
  >
    <to
     addr="IP address or name to check"
     [interval="10"]
     />
  </ip>
```

13.14.3 <ip> attributes

`<ip`	`<ip>` sections are automatically generated on the virtual IPs when `<virtual_addr check="on">` is set (see the virtual IP definition in section 13.5).
`ident="`*`ip_checker_name`*`"`	Interface checker name. It defines the resource associated with the checker: **`ip.`***`ip_checker_name`* (with the prefix `ip.`)
`[when="prim"|"both"]`	Default if not set. • `when="prim"` for a mirror module The checker is started after/ended before the execution of the `start_prim/stop_prim` scripts. • `when="both"` for a farm module The checker is started after/ended before the execution of the `start_both/stop_both` scripts. In case of error detection, the action is `stopstart`. The name of the failover rule, **`ip_failure`**, is static and predefined.
`<to`	
`addr="`*`IP address or name`*`"`	Local IP address or name to check. IPv4 or IPv6 address.
`[interval="10"]`	Interval in seconds between two checks. Default value: `10` seconds
`</ip>`	

13.15 Custom checker - <custom>

A custom checker is an executable (script or binary) that you develop to test a resource or application. It consists of a loop that performs a test at appropriate intervals. Its role is to set the associated resource's status to `up` or `down`. Then, a failover rule decides the action to be taken on the module when the resource is down.

Since SafeKit 8, the action can be configured using the `action` attribute of the `<custom>` tag.

Insert the `<custom>` tag into the `<check>` section if this one is already defined.

13.15.1 <custom> example

- Example with `action!="noaction"`

```
<check>
```

```
  <custom ident="AppChecker" when="prim" exec="mychecker" action="stopstart"/>
</check>
```

- The resource associated with the checker is named `custom.AppChecker` (with the prefix `custom.`)
- The generated failover rule, which performs a `stopstart` when the resource goes `down`, is named `c_AppChecker` (with the prefix `c_`) and is equivalent to:

```
c_AppChecker: if (custom.AppChecker == down) then stopstart();
```

- Example with `action="noaction"`

```
<check>
  <custom ident="AppChecker" when="prim" exec="mychecker" action="noaction"/>
</check>
```

No failover rule is generated. The user has the option to define one explicitly in the `<failover>` tag. For example:

```
…
<failover>
  <![CDATA[
    custom_failure: if (custom.AppChecker == down) then stopstart();
  ]]>
</failover>
```

In SafeKit < 8, the `action` attribute did not exist, and the action was configured by defining a failover rule in the `<failover>` tag, as shown in the example above. Therefore, the default value of the action attribute is equivalent to `noaction` to maintain backward compatibility with older configurations.

See also the example in section 15.7. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.15.2 <custom> syntax

```
<custom
   ident="custom_checker_name"
   when="pre|prim|second|both"
   exec="executable_path"
   arg="executable_arguments"
   action="wait|stop|stopstart|restart|noaction"
/>
```

13.15.3 <custom> attributes

`<custom`	Set as many custom sections as there are custom checkers.
`ident="`*`custom_checker_name`*`"`	Custom checker name. It defines the resource associated with the checker:

	custom.*custom_checker_name* (with the prefix custom.) A custom checker must set its associated resource state itself, using the command `safekit set -r custom.custom_checker_name -v up|down` Note that SafeKit automatically initializes the state of the resource to `init`, and the failover machine stays in the `WAIT` state if its value is not set.
`when="pre"` `action="wait"|"noaction"`	Use this value to test an external component before the application starts: • `when="pre"` The checker starts after/ends before the execution of the `prestart`/`poststop` scripts Since SafeKit 8, you can configure the action to be taken in case of error detection with: • `action="wait"` `wait` on the module. The name of the associated failover rule is **c_***custom_checker_name* (with the prefix `c_`) • `action="noaction"` No failover rule generated. The action must be explicitly written in the `<failover>` tag (see section 13.18).
`when="prim"|"second"|"both"` `action="stop"|"stopstart"|"restart"|"noaction"`	Use this value to test a component after the application starts: • `when="prim"` for a mirror module The checker is started after/stopped before the execution of the `start_prim/stop_prim` scripts. • `when="both"` for a farm module The checker is started after/stopped before the execution of the `start_both/stop_both` scripts. • `when="second"` for a mirror module The checker is started after/stopped before the execution of the `start_second/stop_second` scripts. Since SafeKit 8, you can configure the action to take when an error is detected with: • `action="stop|stopstart|restart"` `stop`, `stopstart` or `restart` the module. The name of the associated failover rule is **c_***custom_checker_name* (with the prefix `c_`)

	• action="noaction" No failover rule generated. The action must be explicitly written in the <failover> tag (see section 13.18).
exec="*executable_path*"	Defines the executable path of the custom checker. Can be a binary executable or a script file. When the path of *executable_path* is relative, it is relative to SAFEUSERBIN. In this case, put your executable file in SAFE/modules/*AM*/bin/ of your application module and use a relative path. See section 10.1 for more information on path values. We recommend a relative path and an executable inside the module. • In Windows, the executable can be a binary or a ps1, vbs or cmd script • In Linux, the executable can be a binary or a shell script
arg="*executable_arguments*"	Defines the executable arguments when the custom checker is started.

13.16 Module checker - <module>

By default, there is a wait of the module when the module checker detects the unavailability of another SafeKit module. The module checker also performs a stopstart action when it detects that the external module has been restarted (whether by a restart, a stopstart, or because of a failover). The module checker retrieves the status of the module by connecting to the SafeKit web service running on the server where the module is activated (see section 10.8 for details on the web service).

Insert the <module> tag into the <check> section if this one is already defined.

13.16.1 <module> example

- Example using the default configuration of the SafeKit web service (protocol : HTTP, port : 9010) :

```
<check>
  <module name="mysql">
    <to addr="172.24.190.21" port="9010"/>
  </module>
</check>
```

mysql is the name of the external module and 172.24.190.21 is its virtual IP address.

  - The resource associated with the checker is named module.mysql_172.24.190.21 (with the prefix module.)

- The failover rule, which performs a wait when a module class resource goes down, is static and defined by the default failover rule:

```
module_failure: if (module.? == down) then wait();
```

- The same example using the secured configuration of the SafeKit web service (protocol : HTTPS, port : 9453) :

```
<check>
  <module name="mysql">
    <to  addr="172.24.190.21" port="9453" secure="on"/>
  </module>
</check>
```

For a description of checkers, refer to section 13.10.3.

See also examples in section 15.9. It presents the configuration via the web console along with the corresponding userconfig.xml.

13.16.2 <module> syntax

```
 <module
    [ident="module_checker_name"]
    name="external_module_name">
    [<to
     addr="IP addres or name the Safekit server running the external module"
     port="port of the SafeKit web server"
     [interval="10"]
     [timeout="5"]
     [secure="on"|"off"]
     />]
</module>
```

13.16.3 <module> attributes

<module	Set as many <module> sections as there are module checkers.
name="*external_module_name*"]	Name of the module checker.
[ident="*module_checker_name*"]	Name of the external SafeKit module to check. It defines the resource associated with the checker: **module**.*module_checker_name* (with the prefix module.) If this attribute is not provided, the resource name is constructed from the name and addr attributes : **module**.*external_module_name_address_or_name*
[<to	Definition of the server(s) running the external module to check.

	Default is the local server.
addr="*address_or_name*"	IP address or name of the external module. IPv4 or IPv6 address.
port="*port of the SafeKit web service*"	Port of the SafeKit web service. 9010 for HTTP ; 9453 for HTTPS
[interval="10"]	Interval in seconds between two checks. Default value: 10 seconds.
[timeout="5"]	Check reply timeout in seconds. Default value: 5 seconds
[secure="on"|"off"]	Use HTTP protocol (secure="off") or HTTPS (secure="on") Default value: off
/>]	
</module>	

13.17 Splitbrain checker - <splitbrain>

SafeKit provides a split-brain checker that is suits mirror architectures. Split-brain is a situation where, due to temporary failure of all network links between SafeKit nodes, and possibly due to software or human error, both nodes switched to the primary role while isolated. This is a potentially harmful state, as it implies that the application is running on both nodes. Moreover, when file replication is enabled, modifications to the data are made on the two nodes.

The split-brain checker detects the loss of all connectivity between nodes and selects only one node to become the primary. The other node is not up-to-date anymore and goes into the WAIT state until:

- the heartbeat becomes available again

or

- the administrator runs safekit commands to force the start as primary (safekit stop then safekit prim).

The primary node election is based on the ping of an IP address, called the **witness**. The network topology must be designed so that only one node can ping the witness in case of split-brain. If this is not the case, both nodes will go primary.

- Ping between nodes and witness must be enabled
- Since SafeKit 8.2.1, multiple witnesses can be defined. This makes it possible to tolerate the failure of one witness, at least one of which must be accessible.

Insert the <splitbrain> tag into the <check> section if this one is already defined.

13.17.1 <splitbrain> example

```
<check>
  <splitbrain ident="witness" exec="ping" arg="192.168.1.100 192.168.2.120"/>
</check>
```

- The resource associated with the checker is named `splitbrain.witness` (with the prefix `splitbrain.`)
- In case of network isolation between nodes, the split-brain checker assigns the `splitbrain.uptodate` resource as `up` or `down` according to access to the witness.
- The failover rule, which performs a `wait` when the `splitbrain.uptodate` resource goes `down`, is static and defined by the default failover rule:

```
splitbrain_failure: if (splitbrain.uptodate == down) then wait();
```

For a description of checkers, refer to section 13.10.3.

See also example in section 15.8. It presents the configuration via the web console along with the corresponding `userconfig.xml`.

13.17.2 <splitbrain> syntax

```
  <splitbrain
     ident="witness"
     exec="ping"
     arg="witness1_IP_name  witness2_IP_name"
  />
```

13.17.3 <splitbrain> attributes

`<splitbrain`	Set only one split-brain checker.
`ident="`*`witness_name`*`"`	Custom checker name. It defines the resource associated with the checker: **`splitbrain`**`.`*`witness_name`* (with the prefix `custom.`) The resource is assigned to : • `up`, if at least one witness responds • `down`, if not all witnesses respond
`[when="pre"]`	Fixed value. • `when="pre"` The checker starts after/ends before the execution of the `prestart`/`poststop` scripts On split-brain detection:

	• The node that has access to the witness (splitbrain.witness_name="up") sets the resource splitbrain.uptodate to up and becomes primary • The other server that does not have access to the witness (splitbrain.witness_name="down") sets the resource splitbrain.uptodate to down. This triggers the wait action of the static and predefined failover rule, named **splitbrain_failure**.
exec="ping"	Fixed value. Use a pinger to ping the witness and set splitbrain.witness_name state.
arg=" *witness1_IP_name* *witness2_IP_name*"	List of IP addresses or witness names to ping. IPv4 or IPv6 address. Multiple witness definition supported since SafeKit 8.2.1.
</splitbrain>	

13.18 Failover machine - <failover>

SafeKit provides checkers that test a critical element and affect the state of the associated resource based on the test result. Upon error detection by a checker, the failover machine executes an action on the module according to the failover rule associated with the checker. For a complete description, see section 13.10.

Some SafeKit components (<heart>, <rfs>, <vipd>, <errd>) manage their own resources and provide their own failover rules. These rules should not be modified or deleted, as doing so may lead to abnormal behavior of SafeKit.

The failover machine regularly evaluates (by default, every 5 seconds) the overall state of all resources and applies an action based on the true failover rules.

In farm architecture, the failover machine can work only on the states of local resources whereas in mirror architecture, the failover machine can work on the states of local and remote resources.

As the states of resources are exchanged on heartbeat channels, it is better to have several heartbeat channels (see section 13.3 for heartbeats definition).

Failover rules can be written in a simple language specific to SafeKit or in Lua using SafeKit function calls

13.18.1 <failover> example

The examples of rules written in this section are added to the default rules or those generated based on the configuration of the checkers.

- Example of adding a rule written in the failover machine language

```
<failover>
   <![CDATA[
     custom_failure: if (custom.AppChecker == down) then stopstart();
```

```
   ]]>
</failover>
```

- Example of adding a rule using the Lua language and the `if_then` function call

  The prefix "`--Lua Rules`" indicates that the following section should be interpreted using the Lua interpreter.

```
<failover>
   <![CDATA[
     --Lua Rules
     Rules = Rules +
     {
custom_failure=if_then("custom.AppChecker","down",Action.stopstart),_group="check
er"}
   ]]>
</failover>
```

- Example of a rule to disable the default rule named `ip_failure` and add the rule `allip_failure`

```
<failover>
<![CDATA[
  --Lua Rules
  Rules.disable("ip_failure")
  -- Add here any Lua rules intended to replace the mentioned rules, or write the
legacy rules in another CDATA section
]]>
<![CDATA[
   allip_failure: if (ip.* == down) then stopstart();
]]>
</failover>
```

Use a separate `<![CDATA[ … ]]>` section for each language.

13.18.2 <failover> syntax

```
<failover [extends="yes"] [period="5000"] [handle_time="15000"]>
<![CDATA[
  label: if (expression) then action;
  …
]]>
</failover>
```

The `<failover>` tag and subtree cannot be changed with a dynamic configuration.

13.18.3 <failover> attributes

`<failover`	
`[extends="yes"|"no"]`	• `extends="yes"` The new failover rules extend the default failover rules (see section 13.18.4 for its definition).

	• `extends="no"` The new failover rules overwrite the default one (avoid this configuration). Default value: `yes`.
`[period="5000"]`	Period in milliseconds between two evaluations of failover rules. Default value: `5000` milliseconds (5 seconds)
`[handle_time="15000"]`	A failover action must be stable (the same) at least during the time `handle_time` (in milliseconds) before being applied by the failover machine. Default value: `15000` milliseconds (15 seconds). `handle_time` must be a multiple of the `period` value.

13.18.4 <failover> description

13.18.4.1 Module resources

The syntax to design the resources is as follows:

```
resource ::= [local. | remote.] 0/1resource_class.resource_id   (default: local)
resource_class ::= ping | intf | tcp | custom | module | heartbeat | rfs
resource_id ::= * | ? | name
resource_state ::= init | down | up | unknown
```

`init`	Special initialization state of a resource when the checker is not started. If a resource in the `init` state is used in a failover rule, SafeKit does evaluate the rule.
`up`	Resource OK
`down`	Resource KO
`unknown`	Special state of a remote resource; the remote state is unknown at the test time (ex.: when the remote module is stopped).

13.18.4.2 Failover rules

SafeKit provides default failover rules and generated failover rules from the module checkers' configuration. Users can also write their own failover rules.

Default failover rules

The default failover rules for the checkers (`module`, `intf`, `ip`, `splitbrain`) are:

```
<failover>
<![CDATA[
  /* rule for module checkers */
  module_failure: if (module.? == down) then wait();
```

```
  /* rule for interface checkers */
  interface_failure: if (intf.? == down) then wait();

  /* rule for ip checkers */
  ip_failure: if (ip.? == down) then stopstart();

  /* rules for splitbrain */
  splitbrain_failure: if (splitbrain.uptodate == down) then wait();
]]>
</failover>
```

There are also:

- failover rules dedicated to file replication management, heartbeats…
- the `Implicit_wakeup` rule that is applied when no `wait` rule applies. It runs the `wakeup` action.

Since SafeKit 7.5, default failover rules are using a new syntax based on the Lua language.

Generated failover rules

The checkers `tcp`, `ping`, and `custom` have a rule generated when the value of the action attribute if it is set to `stop`, `stopstart`, `restart` or `wait`.

The name of the rule has as a prefix the first letter of the checker's name (`t`, `p` or `c`), followed by _, then the value of the attribute `ident` (e.g. `p_router, t_service`, `c_app`).

Configured failover rules

The user can also define his own rules into the section `<failover><![CDATA[ … ]]></failover>`. By default, these are added to the default and generated rules.

See examples in section 13.18.1.

Failover rules can be written using one of the following syntaxes:

- Failover machine language

```
label: if ( expression ) then action;
```

```
label ::= string

action ::= stop() | stopstart() | wait() | restart() | swap()

expression ::= ( expression )
| ! expression
| expression && expression
| expression || expression
| expression == expression
| expression != expression
| resource ::= [local. | remote.] 0/1resource_class.resource_id
| resource_state
```

- Lua language
  - o `if_then` function call to define a rule

```
--Lua Rules
Rules = Rules +
{ label=if_then("resource","resource_state",action),_group="checker" }
```

```
label ::= string

action ::= Action.stop | Action.stopstart | Action.wait |
Action.restart | Action.swap

| resource ::= resource_class.resource_id
| resource_state
```

- `Rules.disable` function call to disable a rule based on its label

```
--Lua Rules
Rules.disable("failover_rule_label")
```

Use a separate `<![CDATA[ … ]]>` section for each language.

13.18.4.3 Actions

The actions (`restart(), stopstart(), stop(), swap()`) of the failover machine are equivalent to control commands (with the `-i identity` parameter) described in section 9.3.

`maxloop / loop_interval / automatic_reboot` are applied if `-i identity` is passed to commands. This is the case when called from the failover machine or checkers.

14. Scripts for a module configuration

➩ Section 14.1 “List of scripts”

➩ Section 14.2 “Variables and arguments passed to scripts”

➩ Section 14.3 “Scripts output”

➩ Section 14.4 “Scripts execution automaton”

➩ Section 14.5 “SafeKit special commands for scripts”

Examples of scripts are given in section 15.

To enable scripts call, `<user>` tag must be defined in `userconfig.xml` as described in section 13.7.

Scripts must executables:

- in Windows, an executable with the extension and type: `.cmd`, `.vbs`, `.ps1`, `.bat` or `.exe`
- in Linux, any type of executable

Each time you update scripts, you must apply the module configuration onto the servers (with the SafeKit console or command).

During the configuration phase, scripts are copied from `SAFE/modules/AM/bin` in the execution environment directory `SAFE/private/modules/AM/bin` (=`SAFEUSERBIN`, do not touch scripts at this place) where *AM* is the module name.

14.1 List of scripts

Below the list of scripts that can be defined by the user. The essential scripts start/stop are those that start and stop the application within the module.

14.1.1 Start/stop scripts

`start_prim` `stop_prim`	**Scripts for a mirror module.** To start & stop application on the `ALONE` or `PRIM` server
`start_both` `stop_both`	**Scripts for a farm module.** To start & stop application on all `UP` servers in a farm cluster In the special case they are defined in a mirror module, they are also executed on both servers (`PRIM`, `SECOND` or `ALONE`)
`start_second` `stop_second`	**Special scripts for a mirror module** To start & stop application on the "`SECOND`" server When the secondary server becomes the primary one, `stop_second` followed by `start_prim` is executed

start_sec stop_sec	**Special scripts for a mirror module**
stop_[both, prim, second, sec] force	**Scripts for all modules** The stop scripts are called twice: once for a graceful shutdown of the application (without force as first argument), a second time with a force parameter for a rapid shutdown (with `force` as first argument).
prestart poststop	**Scripts for all modules** Executed at the very beginning of the module start and at its end. By default, `prestart` contains `stop_sec`, `stop_second`, `stop_prim`, `stop_both` to stop application before starting the module under the control of SafeKit.
transition	**Script for all modules** This script is executed on state transitions described in section 14.4

14.1.2 Other scripts

config	`config` is called when executing the `safekit config -m` *AM* command on the application module. You can make a special application configuration in this script.
deconfig	`deconfig` is called when executing the `safekit deconfig -m` *AM* command, which is itself called at the application module uninstallation. You can remove a special application configuration made previously in the `config` script.
confcheck	`confcheck` is called when executing the `safekit confcheck -m` *AM* command on the application module. You can add in this script some tests for checking changes on the application configuration files.
state	`state` is called when executing the `safekit state -v -m` *AM* command on the application module. You can display a special state of the application.
level	`level` is called when executing the `safekit level -m` *AM* command on the application module. You can display the application version.

14.2 Variables and arguments passed to scripts

All scripts are called with 3 parameters:

- the current state (`STOP,WAIT,ALONE,PRIM,SECOND,UP`),
- the next state (`STOP,WAIT,ALONE,PRIM,SECOND,UP`)
- the action (`start`, `stop`, `stopstart` or `stopwait`).

The `stopwait` argument is passed during the execution of the `wait` action triggered by a checker.

The stop scripts are called twice:

- a first time for a graceful shutdown of the application
- a second time with a `force` parameter for a forced shutdown (with `force` as first argument)

The environment variables that can be used inside scripts are:

- `SAFE`, `SAFEMODULE`, `SAFEBIN`, `SAFEUSERBIN`, `SAFEVAR`, `SAFEUSERVAR` (for details, see section 10.1)

The definition of `SAFEMODULE`, which contains the name of the module, allows omitting the `-m AM` option with the safekit command if it is to apply to the `SAFEMODULE`.

- all variables defined in `<user>` tag of `userconfig.xml` (see section 13.7).

For an example with environment variables, refer to section 15.3.

14.3 Scripts output

14.3.1 Output into script log

By default (`logging="userlog"` in `<user>` tag of `userconfig.xml`), the stdout and stderr of the script are redirected into the file `SAFEVAR/modules/AM/userlog_<year>_<month>_<day>T<time>_<script name>.ulog` where:

- `SAFEVAR=C:\safekit\var` in Windows and `/var/safekit` in Linux
- *AM* is the module name
- `<year>_<month>_<day>T<time>` are date and time of execution of the script
- `<script name>` is the script name

To insert a `message` into the script log, add the following command into the script:

```
echo "message"
```

or in PowerShell:

```
Write-Host "message"
```

14.3.2 Output into module log

To insert messages with level E or I into the *AM* module log, add the following command into the script:

- in Windows

```
"%SAFE%/safekit" printe "message"
"%SAFE%/safekit" printi "message"
```

- in Linux

```
"$SAFE/safekit" printe "message"
"$SAFE/safekit" printi "message"
```

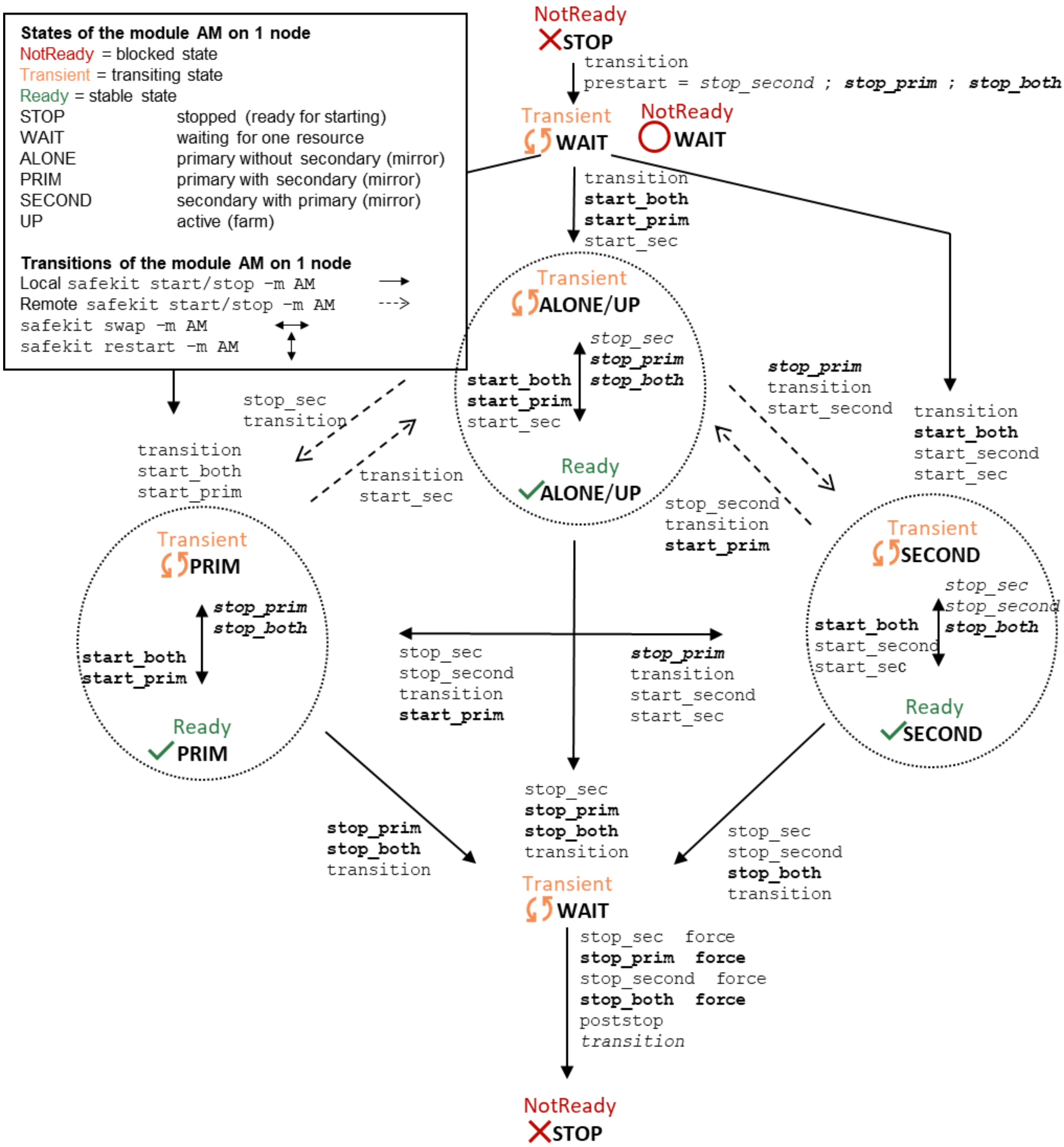
Level E messages are visible in the non-verbose log; level I messages are found in the verbose log

In the execution environment of the *AM* script, the `-m` *AM* option is unnecessary for the `safekit` command.

14.4 Scripts execution automaton

Most of the time, stop scripts are called twice (without the `force` parameter and then with the `force` parameter). In that case the script name is written in italic.

For instance, first transition from `STOP` to `WAIT` calls the script `transition STOP WAIT start` is called.



Since SafeKit 8.2.4, when stopping the module, the `stop_xxx` scripts with the `force` argument can be executed a second time before the `poststop` call.

14.5 SafeKit special commands for scripts

Special commands are installed under `SAFE/private/bin`. Special commands can be called directly in module scripts with `%SAFEBIN%\specialcommand` or `$SAFEBIN/specialcommand`. Outside module scripts, use `safekit -r` command.

`safekit -r <special command> [<args>]`	*<special command> <args>* executed within the SafeKit environment. When the command name is not an absolute path, the command is searched in `SAFEBIN=SAFE/private/bin` directory.

14.5.1 Commands for Windows

14.5.1.1 sleep, exitcode, sync commands

On Windows, you can use the following basic commands:

- `%SAFEBIN%\sleep.exe <timeout value in seconds>`

  To be used inside stop scripts because net stop service is not synchronous
- `%SAFEBIN%\exitcode.exe <exit value>`

  To return an error value when the script exits
- `%SAFEBIN%\sync.exe \\.\<drive letter:>`

  To sync file system cache of a disk

14.5.1.2 namealias command

`%SAFEBIN%/namealias [-n | -s ] <alias name>`

`-n` to add a new NetBIOS name (se

t into `start_prim`) or `-s` to suppress the NetBIOS name (set into `stop_prim`)

You can also use the SafeKit command `netnames` (or the windows command `nbtstat`) to list NetBIOS information.

14.5.2 Commands for Linux

14.5.2.1 Managing the crontab

`$SAFEBIN/gencron` `[del | add]` *`<user name>`* `[all |<command name>]` `-c "<comment>"`	• `del` to disable the entries in `stop_prim` (by inserting comments) • `add` to enable the entries in `start_prim` (by removing comments) • *`<user name>`* user name in the crontab • `all` to apply on all entries • *`<command name>`* to apply on the name of the command • *`<comment>`* header of the comment that will be inserted

The following example applies to the crontab entry:

```
5 0 * * * $HOME/bin/daily.job >> $HOME/tmp/out 2>&1
```

For a mirror module, to manage this entry on the primary, insert :

- Its activation into `start_prim`

```
$SAFEBIN/gencron add admin daily.job -c "SafeKit configuration for
$SAFEMODULE"
```

- Its deactivation into `stop_prim`

```
$SAFEBIN/gencron del admin daily.job -c "SafeKit configuration for
$SAFEMODULE"
```

14.5.2.2 Bounding command

$SAFEBIN/boundcmd *<timeout value>* *<command path>* [*<args>*]	• *<timeout value>* maximum time allocated to execute the command • *<command path>* path to the command to execute • *<args>* optional arguments to the command

`boundcmd` returns the exit code of the command when the command terminates before the timeout; otherwise, it exits with the value 2.

For example, to flush data on disk with a timeout of 30 seconds, run:

```
$SAFEBIN/boundcmd 30 /bin/sync 1>/dev/null 2>&1
```

14.5.3 Commands for Windows and Linux

safekit -r processtree list | kill …	List running processes as a tree (except for `all`) and optional kill • `safekit -r processtree list all` List all running processes. • safekit -r processtree list *<process command name>* List all running processes with the specified command name. • safekit -r processtree kill <process command name> List and kill all running processes with the specified command name. • safekit -r processtree list | kill *<process command name>*| all *<regular expression on the full command - path and arguments>* List (and kill) all running process with the specified command name and arguments. For regular expression syntax: • in Windows, see class CatlRegExp • In Linux, see man regex • Windows examples `safekit -r processtree kill notepad.exe ".*myfile.*"` `safekit -r processtree list all "mirror"` • Linux examples `safekit -r processtree kill vi ".*myfile.*"`

	safekit -r processtree list all "mirror"
safekit incloop -m *AM* -i <*handler name*>	The module has a maxloop counter, the number of restart, stopstart and wait of the module on error detection. The module is stopped when this counter reaches the maxloop value over the loop_interval period. When running special handlers, the maxloop counter is not incremented. To increment it, use the command: safekit incloop -m *AM* -i <handler name> It increments the maxloop counter for the module *AM* and returns 1 when the limit has been reached. For an example, refer to section 15.4.2.
safekit resetloop -m *AM* [-i <*handler name*>]	Reset the maxloop counter to the value 0
safekit checkloop -m *AM*	For checking the maxloop counter for the module *AM*, use the command: safekit checkloop -m *AM* • It returns 0 when the maxloop counter is not reached or the last increment occurred outside loop_interval • It returns 1 when the maxloop counter is reached and the last increment occurred during loop_interval

15. Examples of module configurations

- Section 15.1 “Mirror module example with `mirror.safe`”
- Section 15.2 “Farm module example with `farm.safe`”
- Section 15.3 “Macro and script variables example with `hyperv.safe`”
- Section 15.4 “Process monitoring example with `softerrd.safe`”
- Section 15.5 “TCP checker example”
- Section 15.6 “Ping checker example”
- Section 15.7 “Custom checker example with `customchecker.safe`”
- Section 15.8 “Split-brain checker example”
- Section 15.9 “Module checker example”
- Section 15.10 “Interface checker example”
- Section 15.11 “IP checker example”
- Section 15.12 “Virtual hostname example with `vhost.safe`”

Some examples are taken from the modules delivered with the SafeKit package, under `SAFE/Application_Modules`. Many real integration examples are also described in SafeKit Quick Installation Guides.

> ! The .safe are platform dependent and therefore different in Windows and Linux, mainly for module scripts.

The module configuration can be modified in two ways:

- either through the module configuration wizard in the SafeKit web console (see section 3.3)
- or by directly editing the files `SAFE/module/AM/conf/userconfig.xml` or the scripts under `SAFE/module/`*`AM`*`/bin` (where *AM* is the name of the installed module)

To take effect, at the next module startup, the new configuration must be applied:

- either at the last step of the module configuration wizard
- or with the command `safekit config -H "node1,node2" -E AM` executed on the node where the files have been modified

> ! Before applying the configuration, close all editors, file explorers, shells, or command prompts that may access a file under `SAFE/modules/`*`AM`* on the nodes.

15.1 Mirror module example with `mirror.safe`

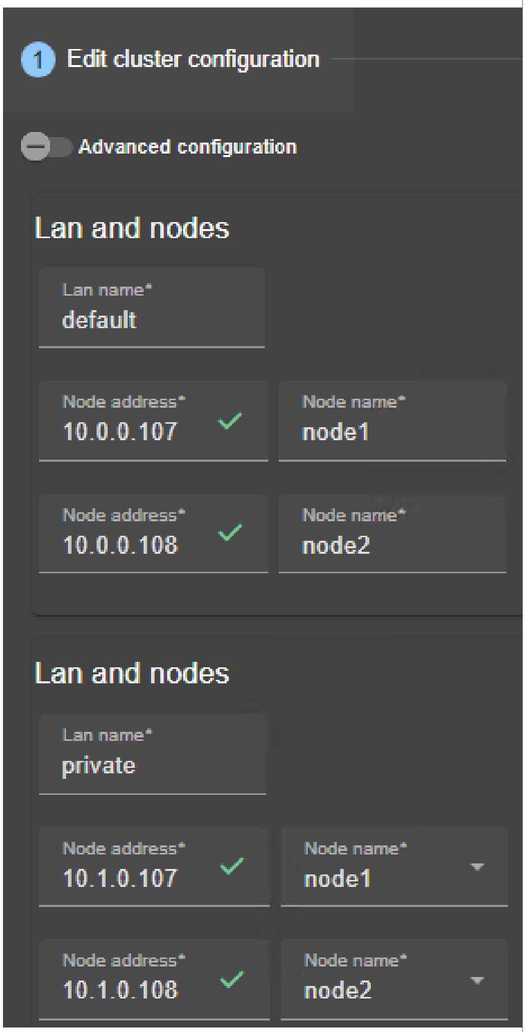
Below is the configuration of the mirror module, `mirror.safe`.

To test a mirror module, refer to section 4.2.

The following description is for Windows. For Linux, please refer to `mirror.safe` delivered with the Linux package that includes Linux configuration and scripts.

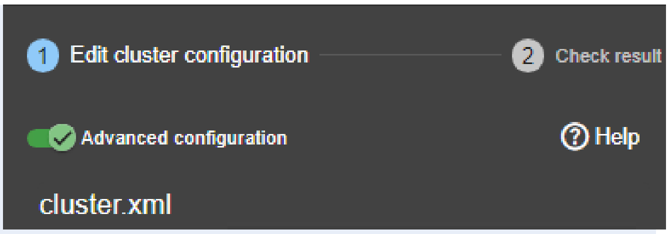
15.1.1 Cluster configuration with two networks

The cluster configuration includes two networks, such as `default` and `private`. The second network is designed to illustrate the configuration of a dedicated network for replication traffic within the module configuration. Most configurations typically include only one network.



To start the cluster configuration wizard, refer to section 3.2.

Switch to "Advanced configuration" to edit the XML if needed.




```
<cluster>
   <lans>
      <lan name="default">
         <node name="node1"
addr="10.0.0.107"/>
         <node name="node2"
addr="10.0.0.108"/>
      </lan>
      <lan name="private">
         <node name="node1"
addr="10.1.0.107"/>
         <node name="node2"
addr="10.1.0.108"/>
      </lan>
   </lans>
</cluster>
```

For detail on XML configuration refer to section 12.1.

15.1.2 Mirror module configurations

The `mirror.safe` delivered since SafeKit 8.2.4, has been enhanced to allow the definition of the services list using a macro called `SERVICES` into the module configuration. The module scripts utilize this value to:

- check that the listed services exist on the server and disable their automatic startup at boot during module configuration
- automatically start and stop the listed services when necessary, during the module runtime

Therefore, integrating a new application using `mirror.safe` is limited to:

- getting the names of the relevant services

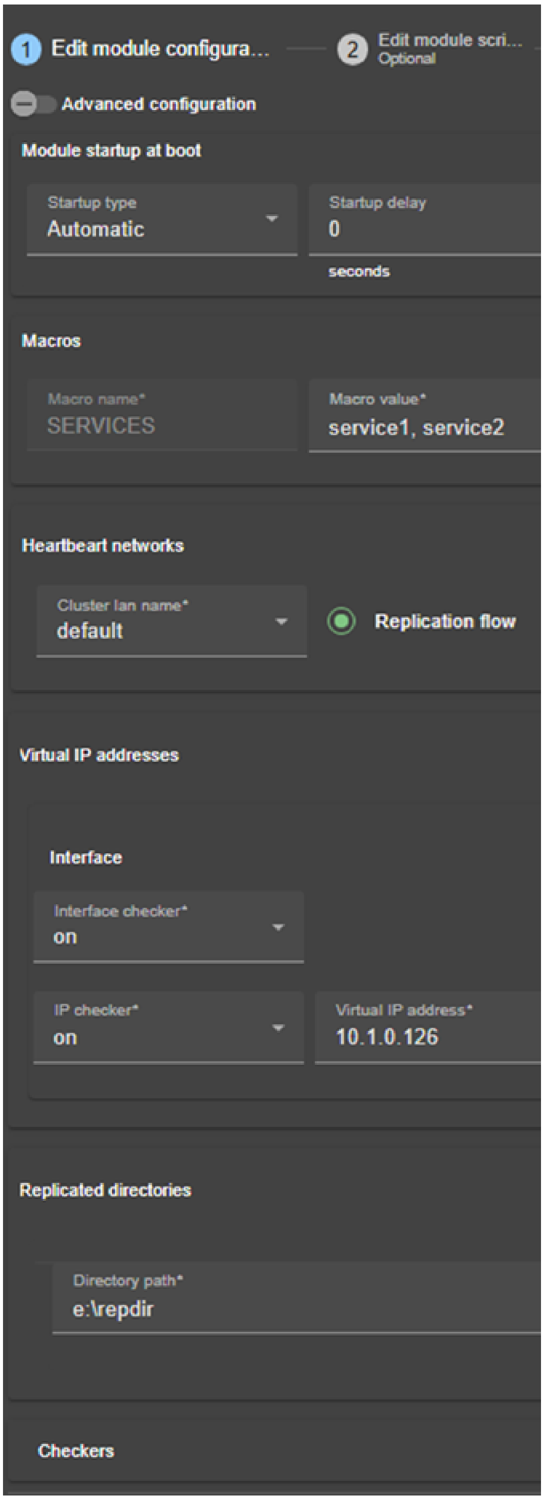
  To list all installed services on a server, use:

  - the PowerShell cmdlet `Get-Service` in Windows
  - the command `systemctl list-unit-files --type=service` in Linux
- determining the paths of the directories to replicate
- obtaining an unused IP address as the virtual IP

Below are examples of mirror module configurations, featuring a virtual IP address, real-time replication, and failover.

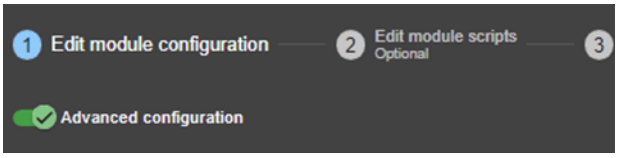
15.1.2.1 Configuration with a virtual IP address, real-time replication, and failover

The following configuration use only one network for the heartbeats and replication flow.



To start the module configuration wizard, refer to section 3.3.

Switch to "Advanced configuration" to edit the XML if needed.




```
<!DOCTYPE safe>
<safe>

<macro name="SERVICES" value="service1,
service2"/>

<service mode="mirror" boot="on">

 <heart>
  <heartbeat name="default">
  </heartbeat>
 </heart>

 <vip>
  <interface_list>
    <interface check="on">
     <real_interface>
      <virtual_addr addr="10.1.0.126"
where="one_side_alias" check="on"/>
     </real_interface>
    </interface>
  </interface_list>
 </vip>

 <rfs>
   <replicated dir="e:\repdir"/>
 </rfs>

 <user>
   <var name="SERVICES"
value="%SERVICES%"/>
 </user>

</service>
</safe>
```

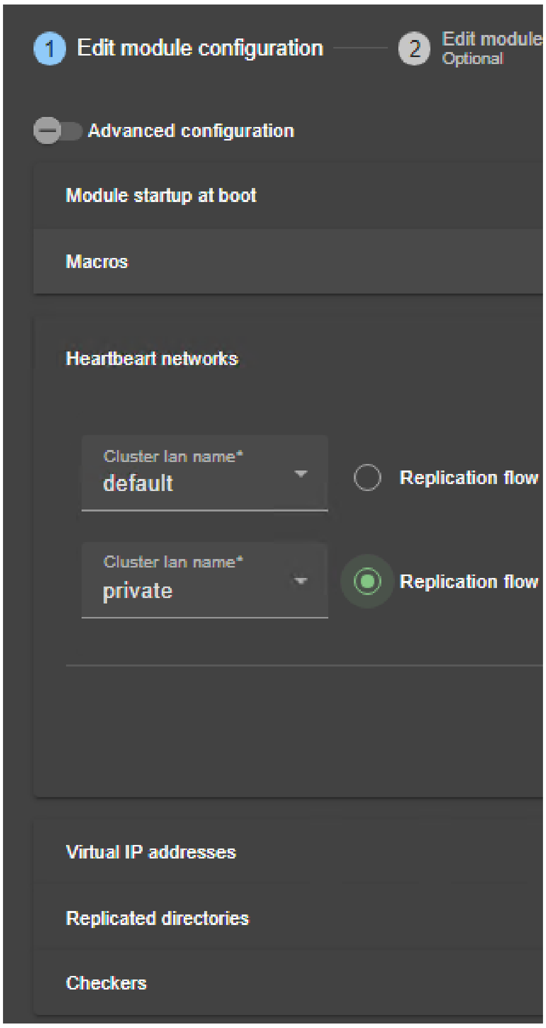
For detail on XML configuration of:

- <macro> refer to section 13.1
- <service> refer to section 13.2
- <heart> refer to section 13.3
- <vip> refer to section 13.5
- <rfs> refer to section 13.6
- <user>, <var> refer to section 13.7

Define the names of the services in the `SERVICES` macro. These services will be automatically started and stopped by the module's scripts of SafeKit 8.2.4's mirror.safe.

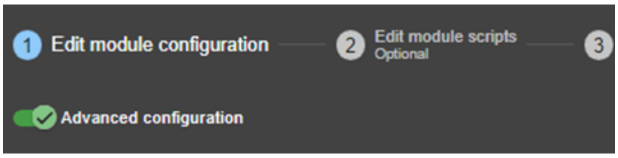
15.1.2.2 Configuration of a dedicated replication network

The module is configured to use both cluster networks as defined in section 15.1.1. The one named `private` is selected as the "Replication flow" for replication traffic.



To start the module configuration wizard, refer to section 3.3.

Switch to "Advanced configuration" to edit the XML if needed.




```
<!DOCTYPE safe>
<safe>
<macro name="SERVICES" value="service1,
service2"/>
<service mode="mirror" boot="on">

 <heart>
  <heartbeat name="default"/>
  <heartbeat name="private"
ident="flow"/>
 </heart>

 <vip>
  <interface_list>
   <interface check="on">
    <real_interface>
     <virtual_addr addr="10.1.0.126"
where="one_side_alias" check="on"/>
    </real_interface>
   </interface>
  </interface_list>
 </vip>

 <rfs>
  <replicated dir="e:\repdir"/>
 </rfs>

 <user>
   <var name="SERVICES"
value="%SERVICES%"/>
 </user>

</service>
</safe>
```

For detail on XML configuration see section 13.

15.1.3 Mirror Module scripts

Below are Windows scripts of the mirror module to start/stop services on the primary node. For Linux, please refer to the `mirror.safe` delivered with the Linux package that includes Linux scripts.

For detail on module scripts, refer to section 14.

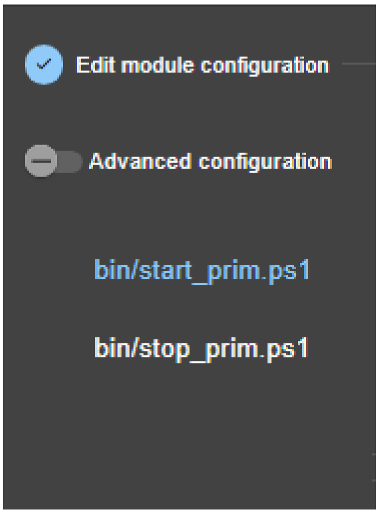
For details on script logging (with `echo`, `Write-Host` and `safekit printe` commands), refer to section 14.3.

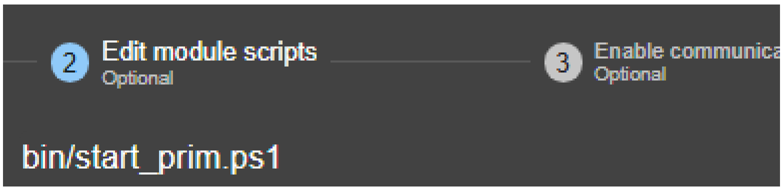
With the `mirror.safe` module delivered since SafeKit 8.2.4, the user no longer needs to modify the scripts to insert the start and stop commands for each service. Indeed, the new module scripts use the value of `SERVICES` to retrieve the names of the services to be started or stopped.

Below, we still show how to edit the scripts in case you need to adapt them for specific needs. For example, `milestone.safe` requires starting App pools after the IIS service has been started. It does not present any difficulty to adapt the generic script to insert this operation.

15.1.3.1 start_prim script

`start_prim` script is called when the mirror module is starting as primary (manual or automatic start after `stopstart` or `wait`) or restarting on a primary node (`restart`). It must contain the start of the services integrated into the module. The services run on only on the primary node.



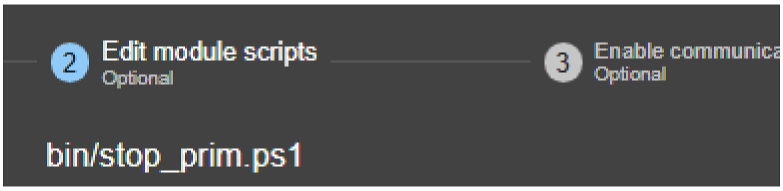



```
…

# Start and check of services defined in SERVICES
Write-Host "--- Start and check of SERVICES
$($servicesArray -join ', ')"
foreach ($serviceName in $servicesArray) {
    # Start the service
    …
    # Check the service status
}
```

With the `mirror.safe` module delivered since SafeKit 8.2.4, the script stops the module if a service start fails or does not reach a started status. This behavior can be changed by commenting out the call to the function `Stop_Module_And_Exit`.

15.1.3.2 stop_prim script

`stop_prim` script is called when the module is stopping (`stop`, `stopstart` or `wait`) or restarting on a primary node (`restart`). It must contain the stop of the services integrated into the module.




```
…

$gracefulStop = ($args[0] -ne "force")

…
# Stop and check of services
if ($gracefulStop) {
 Write-Host "--- Stop and check of SERVICES
$($servicesArray -join ', ')"
 foreach ($serviceName in $servicesArray) {
  # Graceful stop
  # Stop the service
    …
 }
}
…
```

15.2 Farm module example with `farm.safe`

Below is the configuration of the farm module, `farm.safe`.

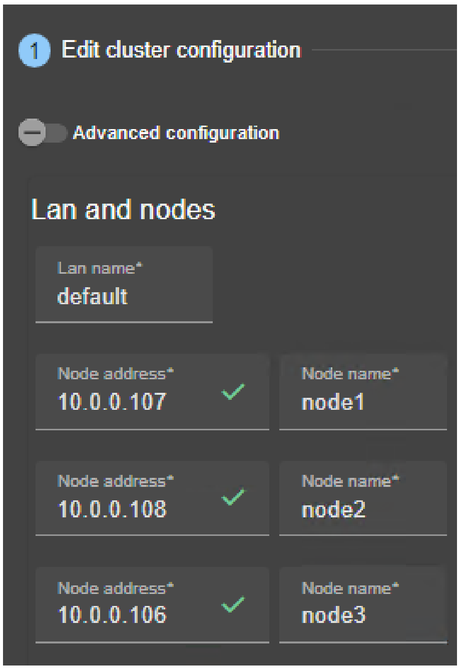
To test a mirror module, refer to section 4.3.

The following description is for Windows. For Linux, please refer to `farm.safe` delivered with the Linux package that includes Linux configuration and scripts.

15.2.1 Cluster configuration with three nodes

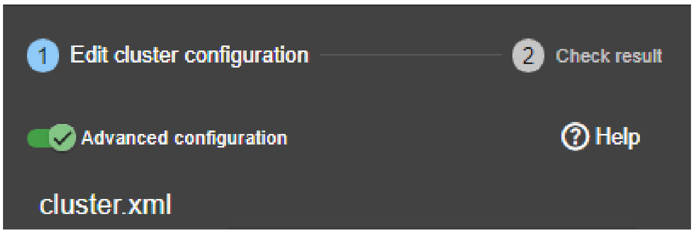
The cluster configuration includes a single network, named `default`, and three nodes to demonstrate advanced load balancing configuration. Most cluster configurations typically include only two nodes.

Only a farm module with load balancing and no replication can be configured on more than 2 nodes. A mirror module with replication can be configured only on two nodes.



To start the cluster configuration wizard, refer to section 3.2.

Switch to "Advanced configuration" to edit the XML if needed.




```
<cluster>
   <lans>
      <lan name="default">
         <node name="node1" addr="10.0.0.107"/>
         <node name="node2" addr="10.0.0.108"/>
         <node name="node3" addr="10.0.0.106"/>
      </lan>

   </lans>
</cluster>
```

For detail on XML configuration refer to section 12.1.

15.2.2 Farm module configurations

The `farm.safe` delivered since SafeKit 8.2.4, has been enhanced to allow the definition of the services list using a macro called `SERVICES` into the module configuration. The module scripts utilize this value to:

- check that the listed services exist on the server and disable their automatic startup at boot during module configuration
- automatically start and stop the listed services when necessary, during the module runtime

Therefore, integrating a new application using `farm.safe` is limited to:

- getting the names of the relevant services

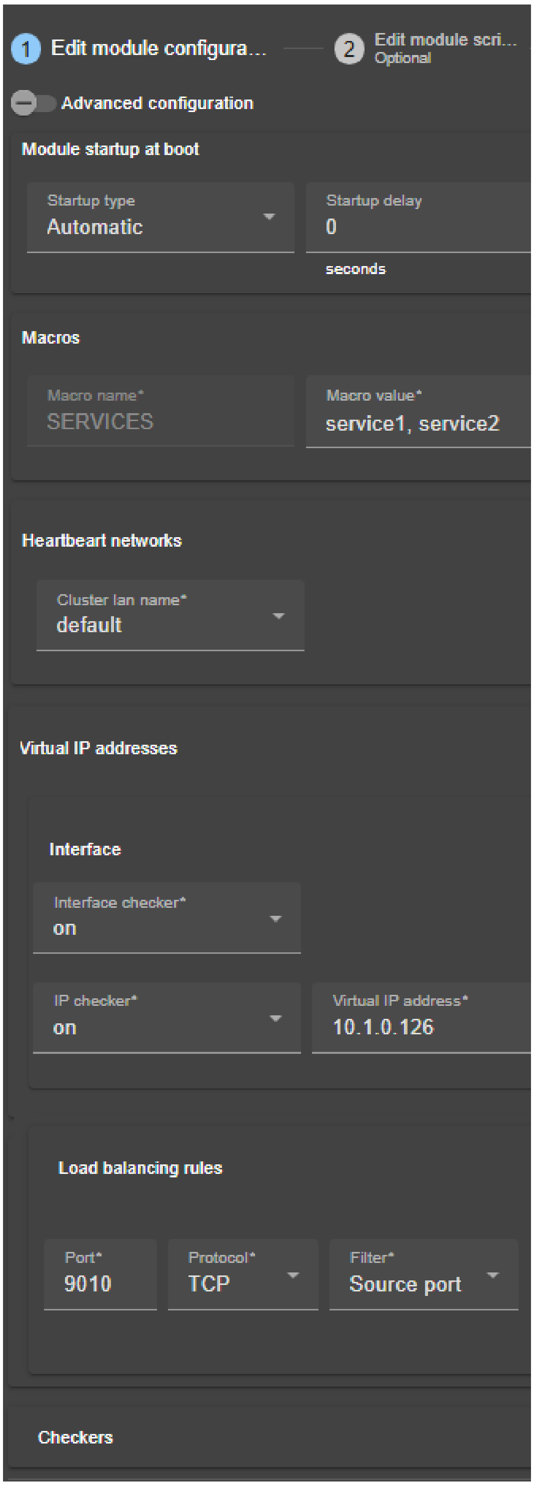
  To list all installed services on a server, use:

  - the PowerShell cmdlet `Get-Service` in Windows
  - the command `systemctl list-unit-files --type=service` in Linux
- obtaining an unused IP address as the virtual IP
- determining the load-balancing rules

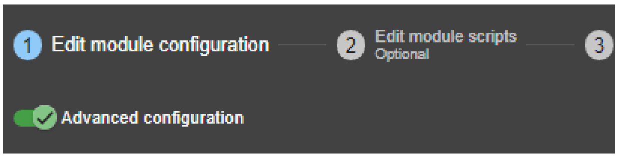
Below are examples of the farm module configurations, featuring a virtual IP address, load-balancing rules, and failover.

15.2.2.1 Configuration with a virtual IP address, load-balancing rule, and failover

The defined load-balancing rule allows you to view the load distribution among the nodes by accessing the SafeKit web page http://host:9010/safekit/mosaic.html.



To start the module configuration wizard, refer to section 3.3.




```
<!DOCTYPE safe>
<macro name="SERVICES" value="service1,
service2"/>
<safe>
 <service mode="farm" boot="on">

  <farm>
   <lan name="default"></lan>
  </farm>

  <vip>
   <interface_list>
    <interface check="on">
     <virtual_interface
type="vmac_directed">
      <virtual_addr addr="10.1.0.126"
where="alias" check="on"/>
     </virtual_interface>
    </interface>
   </interface_list>

   <loadbalancing_list>
    <group name="FarmProto">
     <rule port="9010" proto="tcp"
filter="on_port"/>
    </group>
   </loadbalancing_list>
  </vip>

  <user>
   <var name="SERVICES"
value="%SERVICES%"/>
 </user>

 </service>
</safe>
```

For detail on XML configuration of:

- <macro> refer to section 13.1
- <service> refer to section 13.2
- <farm> refer to section 13.4
- <vip> refer to section 13.5
- <user>, <var> refer to section 13.7

Switch to "Advanced configuration" to edit the XML if needed.	

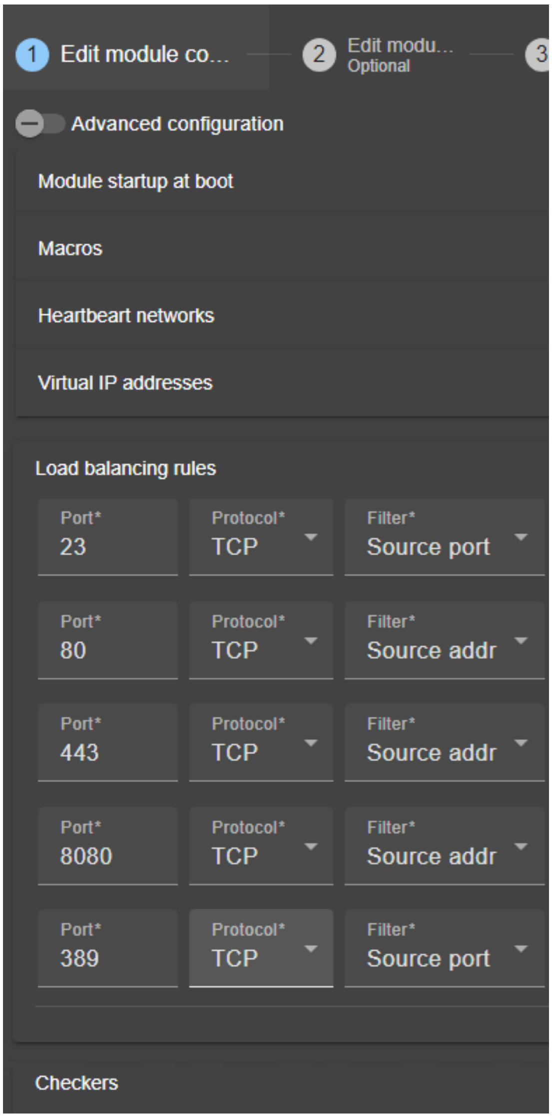
Other examples of load balancing rules configuration are described in the following.

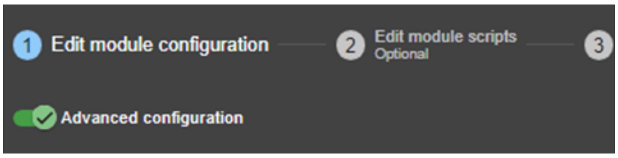
15.2.2.2 Configuration of TCP load-balancing rules

Below is the load balancing configuration for accessing the virtual IP using the TCP protocol on the specified ports:

- 80 (HTTP), 443 (HTTPS), 8080 (HTTP proxy)

  With HTTP and HTTPS, network load balancing is set on the client IP source address and not on the client TCP source port, to ensure that the same client is always connected to the same web server over several TCP connections (stateful versus stateless servers: see section 1.3.3).
- 389 (LDAP) et 23 (Telnet)






```
<!DOCTYPE safe>
<safe>
 <macro name="SERVICES" value="service1,
service2"/>
 <service mode="farm" boot="on">
  <farm>
    <lan name="default"></lan>
  </farm>
  <vip>
   <interface_list>
    <interface check="on">
     <virtual_interface
type="vmac_directed">
      <virtual_addr addr="10.1.0.127"
where="alias" check="on"/>
     </virtual_interface>
    </interface>
   </interface_list>
   <loadbalancing_list>
    <group name="FarmProto">
     <rule port="23" proto="tcp"
filter="on_port"/>
     <rule port="80" proto="tcp"
filter="on_addr"/>
     <rule port="443" proto="tcp"
filter="on_addr"/>
     <rule port="8080" proto="tcp"
filter="on_addr"/>
     <rule port="389" proto="tcp"
filter="on_port"/>
    </group>
   </loadbalancing_list>
  </vip>
```

To start the module configuration wizard, refer to section 3.3.

Switch to "Advanced configuration" to edit the XML if needed.

```
  <user>
   <var name="SERVICES"
value="%SERVICES%"/>
  </user>
 </service>
</safe>
```

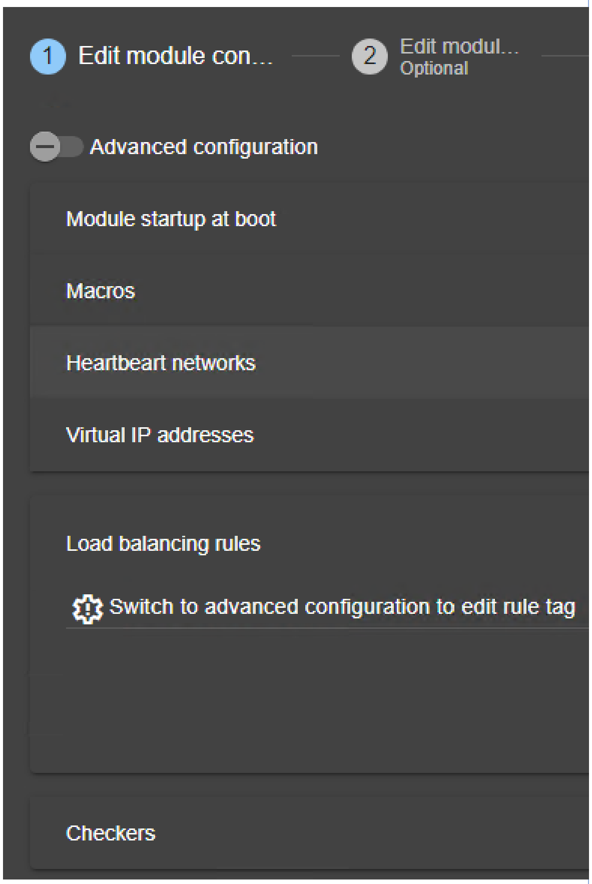
For details on `<loadbalancing_list>` configuration, refer to section 13.5.6.

15.2.2.3 Configuration of UDP load-balancing rules

Below is the load balancing configuration for accessing the virtual IP using the UDP protocol on the specified ports:

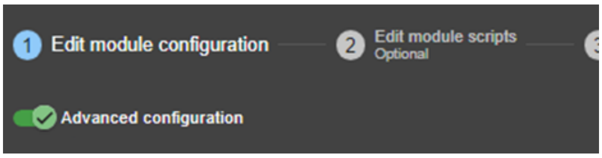
- 53 (DNS)
- 1645 (RADIUS)

With "`on_ipid`", the load balancing is made on the IP identifier field in the packet IP header. The load balancing works even if the client always presents the same client IP address and client port at input.



To start the module configuration wizard, refer to section 3.3.

The wizard do not present `on_ipid` filter. Switch to "Advanced configuration" to edit it.



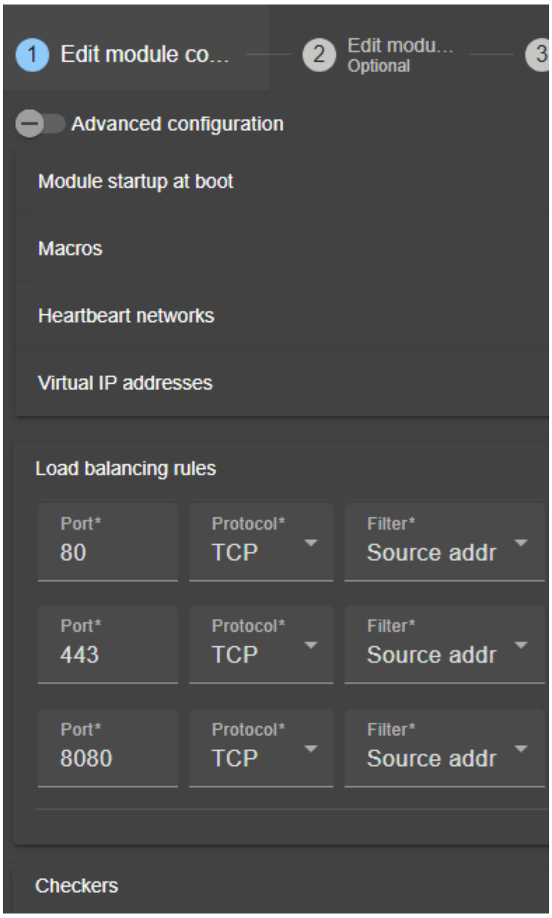

```
<!DOCTYPE safe>
<safe>
 <macro name="SERVICES"
value="service1, service2"/>
 <service mode="farm" boot="on">
  <farm>
   <lan name="default"></lan>
  </farm>
  <vip>
   <interface_list>
    <interface check="on">
     <virtual_interface
type="vmac_directed">
      <virtual_addr addr="10.1.0.127"
where="alias" check="on"/>
     </virtual_interface>
    </interface>
   </interface_list>
   <loadbalancing_list>
    <group name="FarmProto">
     <rule port="53" proto="udp"
filter="on_ipid" />
     <rule port="1645"  proto="udp"
filter="on_ipid" />
    </group>
   </loadbalancing_list>
  </vip>

  <user>
```

```
   <var name="SERVICES"
value="%SERVICES%"/>
  </user>
 </service>
</safe>
```

For details on <loadbalancing_list> configuration, refer to section 13.5.6.

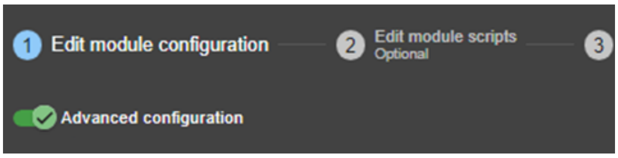
15.2.2.4 Configuration of advanced load-balancing rules

With the following configuration example, you are defining a farm of 3 nodes with a priority for HTTP traffic on the 1st node, HTTPS on the 2nd node and proxy HTTP on the 3rd node.



To start the module configuration wizard, refer to section 3.3.

The wizard do not present details on the load-balancing groups. Switch to "Advanced configuration" to edit them.




```
<!DOCTYPE safe>
<safe>
 <macro name="SERVICES" value="service1,
service2"/>
 <service mode="farm" boot="on">
  <farm>
    <lan name="default"></lan>
  </farm>
  <vip>
   <interface_list>
    <interface check="on">
     <virtual_interface
type="vmac_directed">
      <virtual_addr addr="10.1.0.127"
where="alias" check="on"/>
     </virtual_interface>
    </interface>
   </interface_list>
   <loadbalancing_list>
     <group name="http_service">
      <cluster>
        <host name="node1" power="3"/>
        <host name="node2" power="1"/>
        <host name="node3" power="1"/>
      </cluster>
      <rule port="80" proto="tcp"
filter="on_addr"/>
      </group>
      <group name="https_service">
       <cluster>
        <host name="node1" power="1"/>
        <host name="node2" power="3"/>
        <host name="node3" power="1"/>
       </cluster>
       <rule port="443" proto="tcp"
filter="on_addr"/>
      </group>
```

```
      <group name="httpproxy_service">
       <cluster>
        <host name="node1" power="1"/>
        <host name="node2" power="1"/>
        <host name="node3" power="3"/>
       </cluster>
       <rule port="8080" proto="tcp"
filter="on_addr"/>
      </group>
   </loadbalancing_list>
  </vip>

  <user>
   <var name="SERVICES"
value="%SERVICES%"/>
  </user>
 </service>
</safe>
```

For details on `<loadbalancing_list>` configuration, refer to section 13.5.6.

15.2.3 Farm module scripts

Below are Windows scripts for a farm module to start/stop services on all nodes. For Linux, please refer to the `farm.safe` delivered with the Linux package that includes Linux scripts.

For detail on module scripts, refer to section 14.

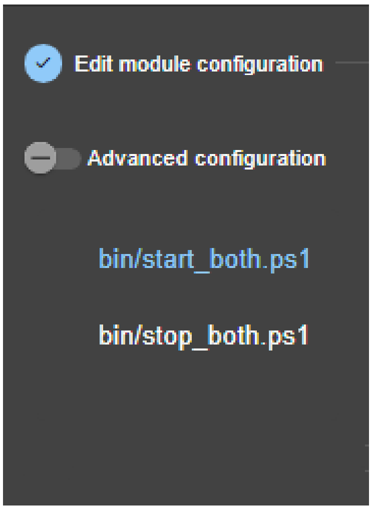
For details on script logging (with `echo`, `Write-Host` and `safekit printe` commands), refer to section 14.3.

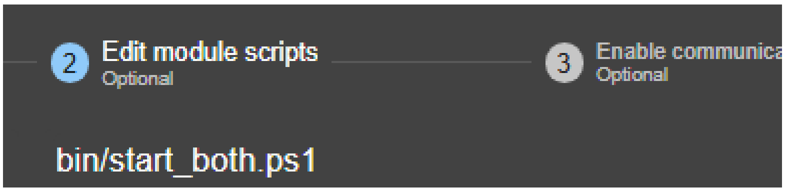
With the `farm.safe` module delivered since SafeKit 8.2.4, the user no longer needs to modify the scripts to insert the start and stop commands for each service. Indeed, the new module scripts use the value of `SERVICES` to retrieve the names of the services to be started or stopped.

Below, we still show how to edit the scripts in case you need to adapt them for specific needs. For example, `milestone.safe` requires starting App pools after the IIS service has been started. It does not present any difficulty to adapt the generic script to insert this operation.

15.2.3.1 start_both script

`start_both` script is called when the farm module is starting (manual or automatic `start` after `stopstart` or `wait`) and restarting (`restart`). It must contain the start of the application integrated into the module. The application runs on all nodes.



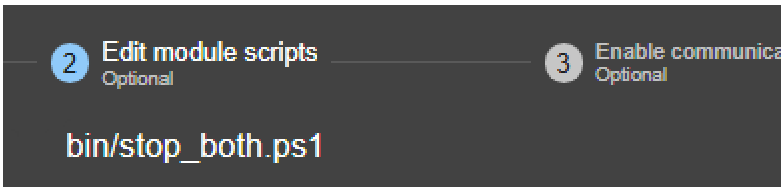



```
…

# Start and check of services defined in SERVICES
Write-Host "--- Start and check of SERVICES
$($servicesArray -join ', ')"
foreach ($serviceName in $servicesArray) {
    # Start the service
    …
    # Check the service status
}
```

With the `farm.safe` module delivered since SafeKit 8.2.4, the script stops the module if a service start fails or does not reach a started status. This behavior can be changed by commenting out the call to the function `Stop_Module_And_Exit`.

15.2.3.2 stop_both script

`stop_both` script is called when the farm module is stopping (`stop`, `stopstart` or `wait` exit) or restarting (`restart`). It must contain the stop of the application integrated into the module.



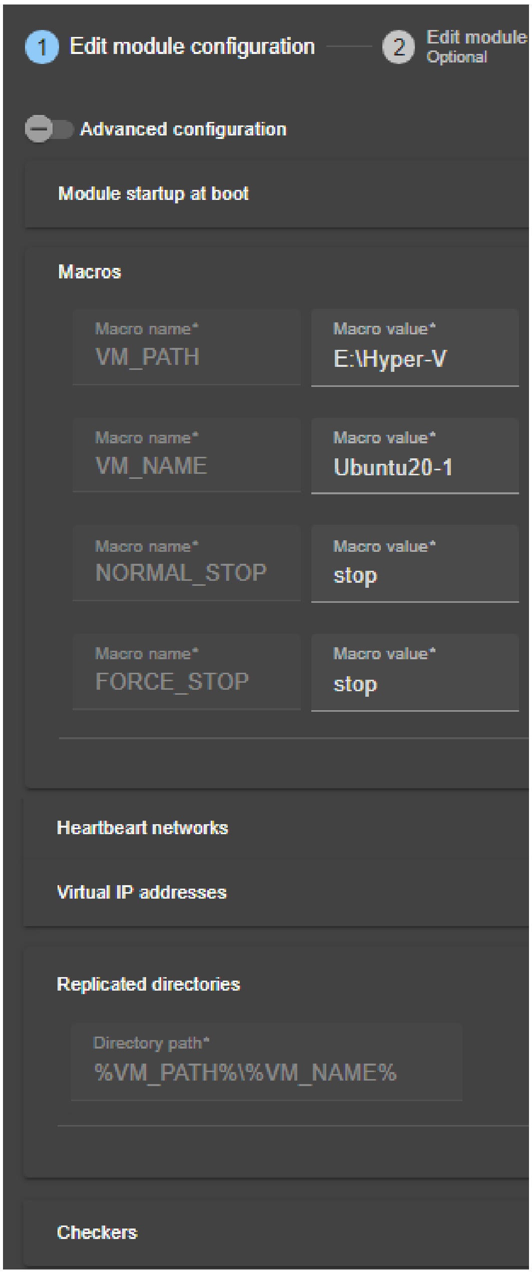

```
…

$gracefulStop = ($args[0] -ne "force")

…
# Stop and check of services
if ($gracefulStop) {
 Write-Host "--- Stop and check of SERVICES
$($servicesArray -join ', ')"
 foreach ($serviceName in $servicesArray) {
  # Graceful stop
  # Stop the service
    …
 }
}
…
```

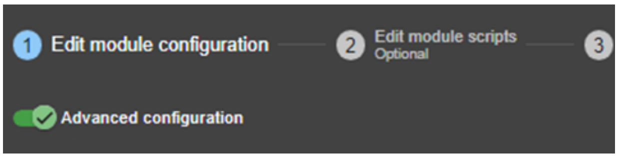
15.3 Macro and script variables example with `hyperv.safe`

The module `hyperv.safe` brings high availability to Hyper-V between two Windows servers. It is a mirror module configuration, with a virtual IP address, real-time replication, and failover. It is presented to demonstrate the use of macros and module script environment variables.

15.3.1 Module configuration with macros and var

In the following example, four `<macro>` are configured and their values are used to define the replicated directory path `<dir>` (i.e. `E:\Hyper-V\Ubuntu20-1`) and the environment variables `<var>` for module scripts. Note that in the example, the names of the macros and the variables are identical, which is not a requirement.






```
<!DOCTYPE safe>
<safe>
 <macro name="VM_PATH"
        value="E:\Hyper-V"/>
 <macro name="VM_NAME"
        value="Ubuntu20-1"/>
 <macro name="NORMAL_STOP"
        value="stop"/>
 <macro name="FORCE_STOP"
        value="stop"/>
 <service mode="mirror">
  <heart>
    <heartbeat name="default" />
  </heart>
  <rfs scripts="on" acl="on"
namespacepolicy="0" allocthreshold="10">
    <replicated
dir="%VM_PATH%\%VM_NAME%">
    </replicated>
  </rfs>
  <user>
    <var name="VM_PATH"
         value="%VM_PATH%\%VM_NAME%"/>
    <var name="VM_NAME"
         value="%VM_NAME%"/>
    <var name="NORMAL_STOP"
         value="%NORMAL_STOP%"/>
    <var name="FORCE_STOP"
         value="%FORCE_STOP%"/>
   </user>
 </service>
</safe>
```

For detail on XML configuration of:

- `<macro>` refer to section 13.1.
- `<user>`, `<var>` refer to section 13.7.

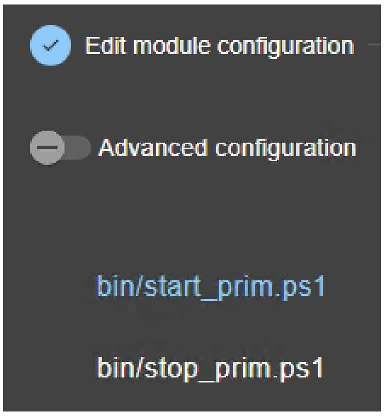
To start the module configuration wizard, refer to section 3.3. The wizard do not present the `user` configuration. Switch to "Advanced configuration" to edit it.	

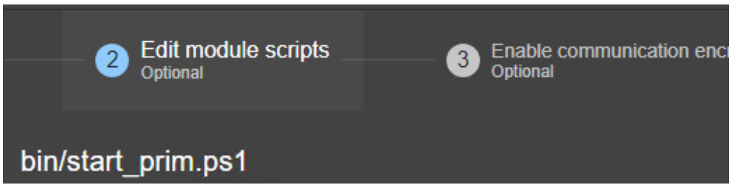
15.3.2 Module scripts with var

Below, the `start_prim.ps1` accesses the environment variables defined at the time the script is executed:

- the SafeKit environment variables `SAFE` and `SAFEUSERVAR`
- the module environment variables `VM_PATH`, `VM_NAME`… defined in the `<var>` sections of `<user>`

For details, refer to section 14.2.






```
$safe = (Get-Item env:SAFE).Value
$suv = (Get-Item env:SAFEUSERVAR).Value
$vmname = (Get-Item env:VM_NAME).Value
$vmpath = (Get-Item env:VM_PATH).Value

…
```

15.4 Process monitoring example with `softerrd.safe`

The module `softerrd.safe` is a demonstration mirror module for process monitoring. This feature is also available in a farm module.

The tests consist of terminating the monitored processes (i.e., `mybin`, `myotherbin`, or `myappli`) using the `safekit kill` command.

To test the process/service monitoring, refer to section 4.4.1.

The following description is for Windows. For Linux, please refer to `softerrd.safe` delivered with the Linux package that includes Linux configuration and scripts.

15.4.1 Module configuration with process monitoring

Detecting the shutdown of:

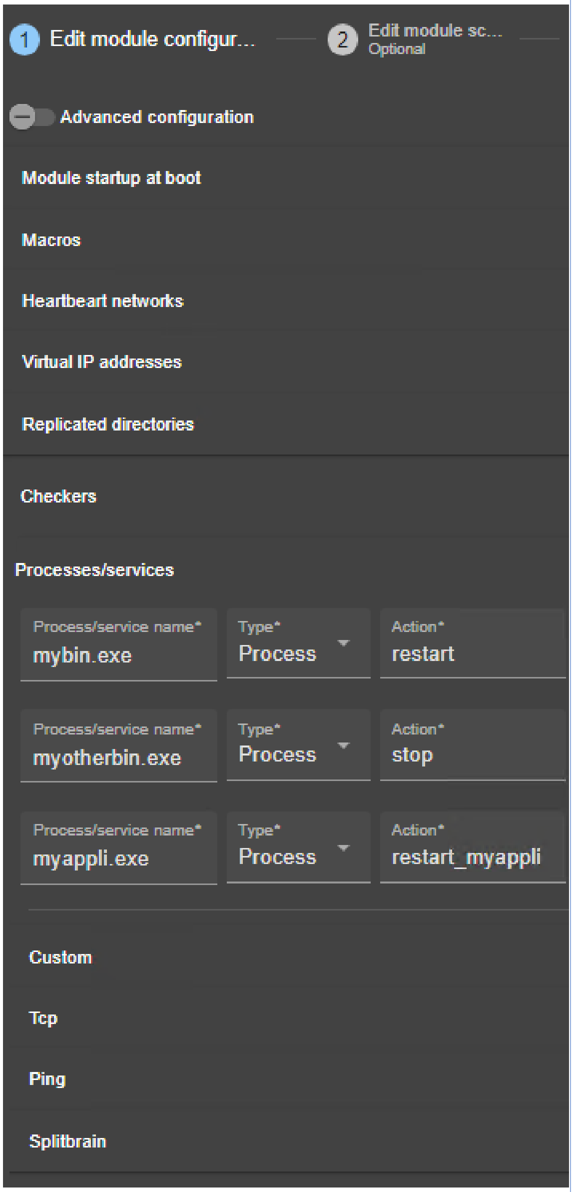
- `mybin.exe` causes the module to restart (`action="restart"`). Its monitoring enabled/disabled after/before the execution of `start_prim`/`stop_prim` (`class="prim"`).

- `myotherbin.exe` causes a stop of the module (`action="stop"`). Its monitoring enabled/disabled after/before the execution of `start_second`/`stop_second` (`class="second"`).
- `myappli.exe` causes the execution of a special handler `restart_myappli.cmd` (`action="restart_myappli"`) located into the `bin` directory of the module. The monitoring of `myappli` is manually enabled/disabled in the module scripts after/before its launch/stop (e.g. `class="myappli"`). Refer to scripts detailed in section 15.4.2.

  This configuration allows for the individual restart of the `myappli` process without having to completely restart the application integrated in `start_prim`/`stop_prim`.

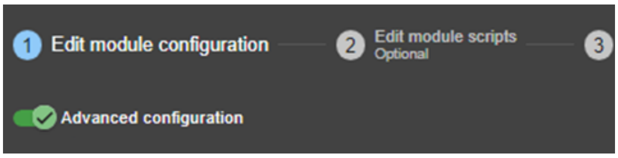
The actions `restart` and `stopstart` automatically increment the `maxloop` counter to limit the number of automatic actions in the event of persistent errors. By default, the module is stopped on the 4th error detection within 24 hours (see `maxloop` and `loop_interval` in section 13.2.3).

If the action involves executing a special script, this script must manually manage the `maxloop` counter (i.e., `restart_myappli.cmd`).



To start the module configuration wizard, refer to section 3.3.

The wizard do not present details on `class` associated to process. Switch to "Advanced configuration" to edit them.



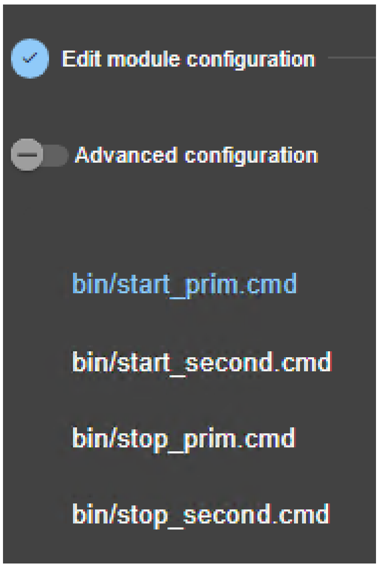

```
<!DOCTYPE safe>
<safe>
 <service mode="mirror">
   <heart>
     <heartbeat name="default">
     </heartbeat>
   </heart>

   <errd>
    <proc name="mybin.exe"
          action="restart"
          class="prim"/>
    <proc name="myotherbin.exe"
          action="stop"
          class="second"/>
    <proc name="myappli.exe"
          action="restart_myappli"
          class="myappli"/>
   </errd>

   <user>
   </user>

 </service>
</safe>
```

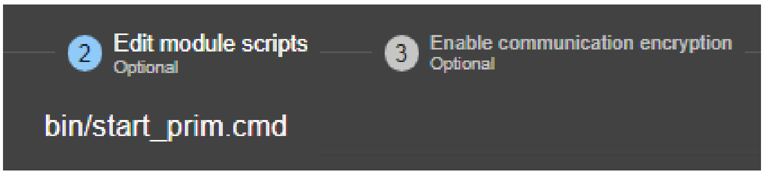
For details on XML configuration of `<errd>`, see section 13.9.

15.4.2 Advanced configuration of module scripts

The module monitors the presence of the following processes:

- `mybin` and `myappli` started/stopped on the primary node with `start_prim`/`stop_prim`
- `myotherbin` started/stopped on the secondary node with `start_second`/`stop_second`

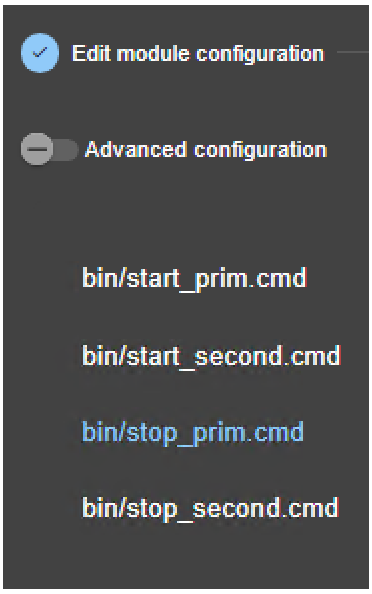


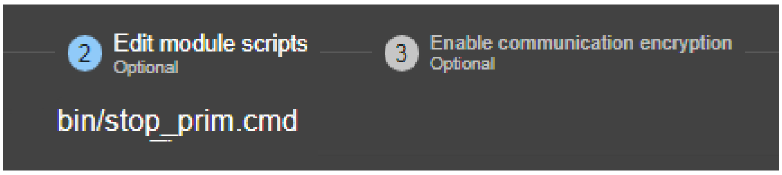



```
@echo off
echo "Running start_prim %*"

%SAFE%\safekit printi "start mybin"
start %SAFEUSERBIN%\mybin.exe 10000000

%SAFE%\safekit printi "start myappli"
start %SAFEUSERBIN%\myappli.exe 10000000
%SAFE%\safekit errd enable myappli
```

Note the call to `safekit errd enable myappli` to start monitoring the process with `class="myappli"` once this process is launched.

Refer to section 13.9.4 for the description of this command.

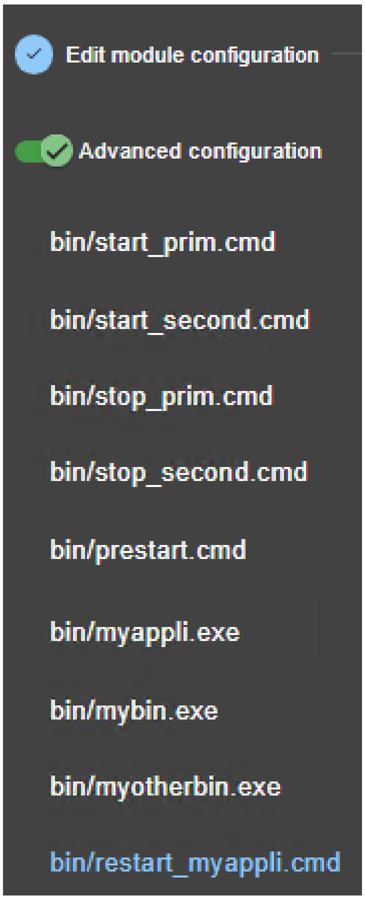




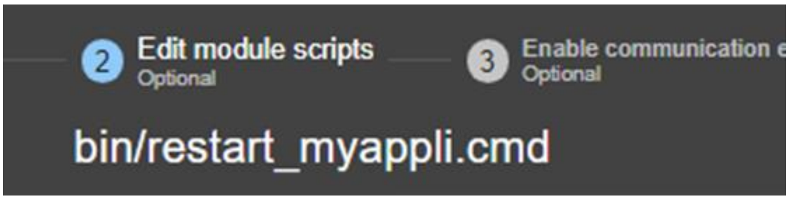

```
@echo off
echo "Running stop_prim %*"
%SAFE%\safekit printi "stop mybin"
%SAFE%\safekit kill -level="terminate" -
name="mybin.exe"

%SAFE%\safekit printi "stop myappli"
%SAFE%\safekit errd disable myappli
%SAFE%\safekit kill -level="terminate" -
name="restart_myappli.cmd"
%SAFE%\safekit kill -level="terminate" -
name="myappli.exe"
:end
```

Note the call to `safekit errd disable myappli` to stop monitoring the process with `class="myappli"`, before terminating this process.

The specific handler `restart_myappli.cmd` is editable in "Advanced Configuration". This script increments the `maxloop` counter and restarts the `myappli` process.



Switch to "Advanced configuration" to list and edit all scripts.




```
@echo off

%SAFE%\safekit printi "restart_myappli"

rem first disable monitoring of the application
%SAFE%\safekit errd disable myappli

rem increment loop counter
%SAFE%\safekit incloop -i "restart_myappli"
if  %errorlevel% == 0 goto next
rem max loop reached
%SAFE%\safekit stop -i "restart_myappli"
%SAFEBIN%\exitcode 0

:next
rem max loop not reached : go on restarting the
application
%SAFE%\safekit printi "Restart myappli"
%SAFE%\safekit kill -level="terminate" -
name="myappli.exe"
start %SAFEUSERBIN%\myappli.exe 10000000

rem finally, enable monitoring of the application
%SAFE%\safekit errd enable myappli
%SAFEBIN%\exitcode 0
```

Note the increment of the loop counter with `safekit incloop -i "restart_myappli"` and the stopping of the module when `maxloop` is reached.

Refer to section 14.5.3 for the description of this command.

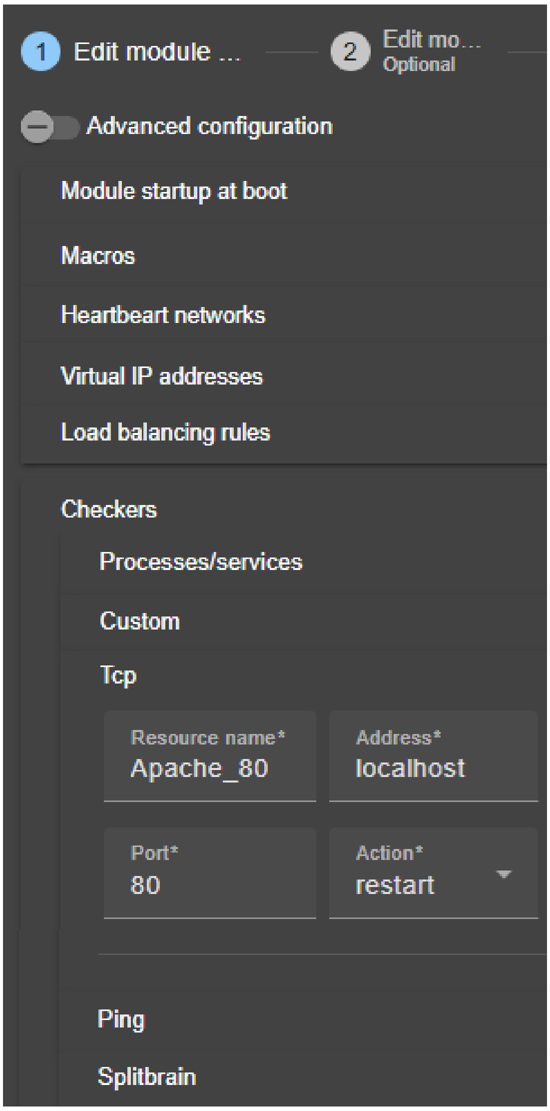
15.5 TCP checker example

Below is an example of the configuration of a TCP checker in a farm module. This checker tests the connection to the local web service on port 80. If the connection fails, the checker sets the resource **`tcp`**`.Apache_80` to `down`. The associated failover rule, named **`t_`**`Apache_80`, executes a `restart` of the module when the resource goes `down`.

- The resource name prefix is **`tcp`**.
- The failover rule name prefix is **`t_`**
- The suffix is the value of the attribute `ident`

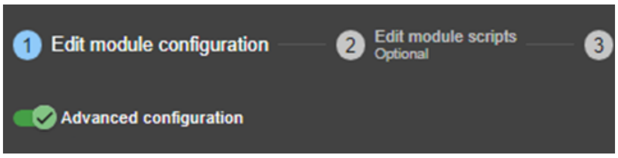
For a description of checkers, refer to section 13.10.3.

To test the TCP checker, refer to section 4.4.2 and section 4.4.3.



To start the module configuration wizard, refer to section 3.3.

Switch to “Advanced configuration” to edit the XML if needed.




```
<!DOCTYPE safe>
<safe>
 <service mode="farm" boot="on">
  <farm>
   <lan name="default"></lan>
  </farm>
  <vip>
   <interface_list>
    <interface check="on">
     <virtual_interface
type="vmac_directed">
      <virtual_addr addr="10.1.0.127"
where="alias" check="on"/>
     </virtual_interface>
    </interface>
   </interface_list>

   <loadbalancing_list>
    <group name="FarmProto">
     <rule port="80" proto="tcp"
filter="on_addr"/>
    </group>
   </loadbalancing_list>
  </vip>

  <user></user>

  <check>
   <tcp ident="Apache_80" when="both"
action="restart">
    <to addr="localhost" port="80"/>
   </tcp>
  </check>
 </service>
</safe>
```

For details on XML configuration of `<tcp>`, see section 13.11.

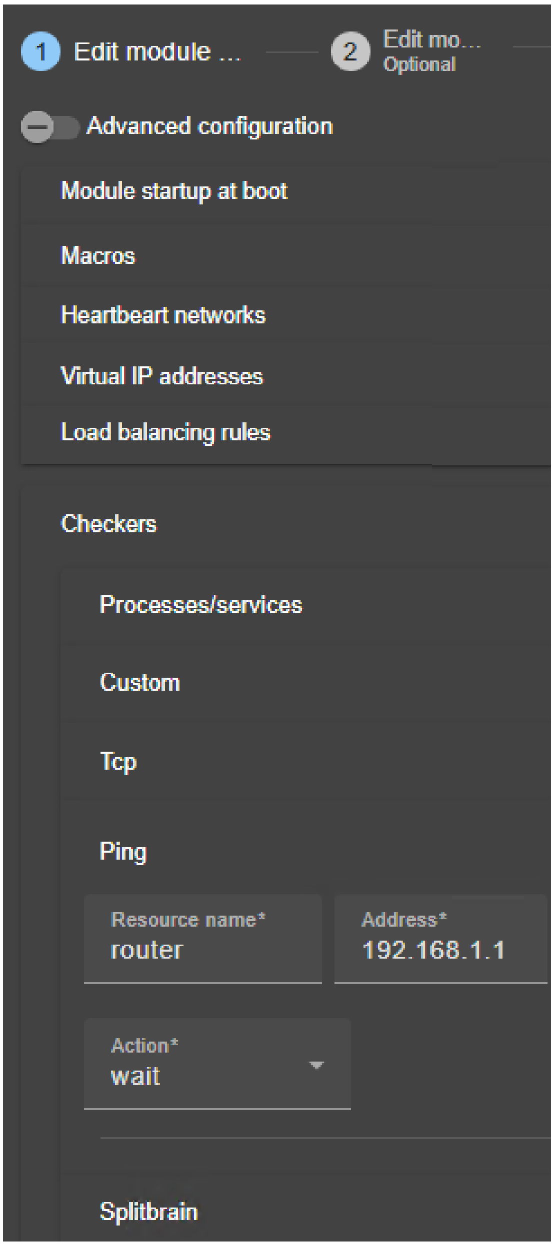
15.6 Ping checker example

Below is an example of the configuration of a ping checker in a mirror module. This checker tests that `192.168.1.1` responds to the ping. If the ping fails, the checker sets the resource **`ping`**`.router` to `down`. The associated failover rule, named **`p_`**`router`, executes a `wait` on the module when the resource goes `down`.

- The resource name prefix is **`ping`**.
- The failover rule name prefix is **`p_`**
- The suffix is the value of the attribute `ident`

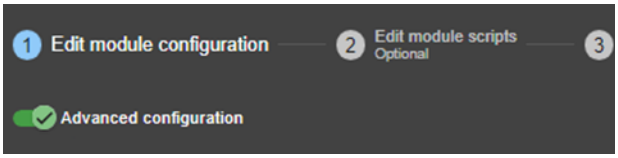
For a description of checkers, refer to section 13.10.3.

To test the ping checker, refer to section 4.4.5.



To start the module configuration wizard, refer to section 3.3.

Switch to "Advanced configuration" to edit the XML if needed.




```
<!DOCTYPE safe>
<safe>
<service mode="mirror" boot="on">

 <heart>
  <heartbeat name="default">
  </heartbeat>
 </heart>

 <vip>
  <interface_list>
   <interface check="on">
    <real_interface>
     <virtual_addr addr="10.1.0.126"
where="one_side_alias" check="on"/>
    </real_interface>
   </interface>
  </interface_list>
 </vip>

 <rfs>
  <replicated dir="e:\repdir"/>
 </rfs>

 <user></user>

 <check>
  <ping ident="router" when="pre"
action="wait">
    <to addr="192.168.1.1"/>
  </ping>
 </check>
</service>
</safe>
```

For details on XML configuration of `<ping>`, see section 13.12.

15.7 Custom checker example with `customchecker.safe`

The `customchecker.safe` module is a demonstration mirror module including a custom checker that tests the presence of a file on the primary server. This feature is also available in a farm module.

If the file is not present, the checker sets the resource **`custom`**`.checkfile` to `down`. The associated failover rule, named **`c_`**`checkfile`, executes a `restart` of the module when the resource goes `down`.

- The resource name prefix is **`custom`**.
- The failover rule name prefix is **`c_`**
- The suffix is the value of the attribute `ident`

The `customchecker.safe` is delivered with the SafeKit package and can be used as a basis for writing your own checker.

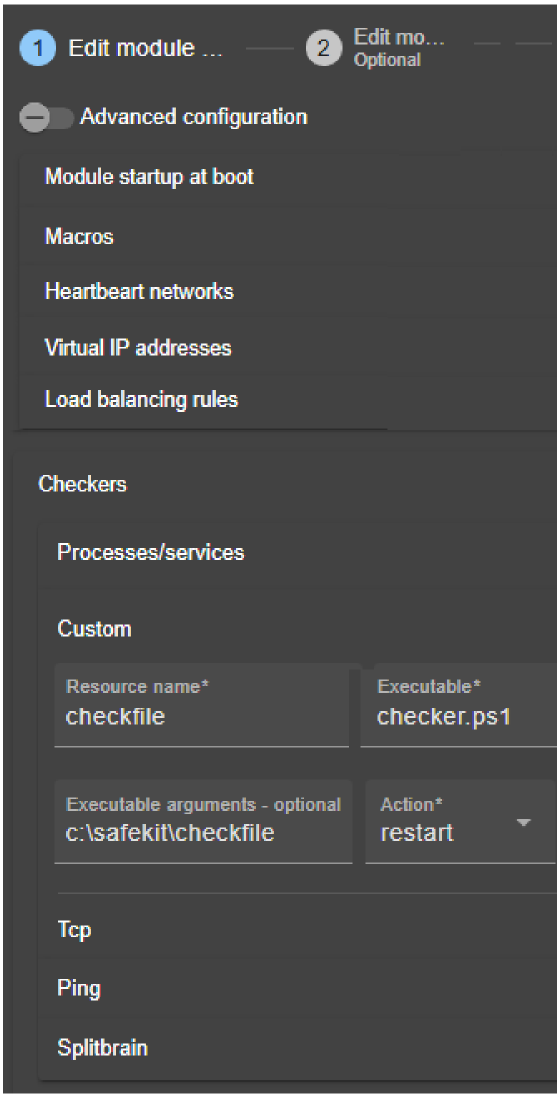
For a description of checkers, refer to section 13.10.3.

To test the custom checker, refer to section 4.4.7 and section 4.4.8.

The following description is for Windows. For Linux, please refer to `customchecker.safe` delivered with the Linux package that includes Linux configuration and scripts.

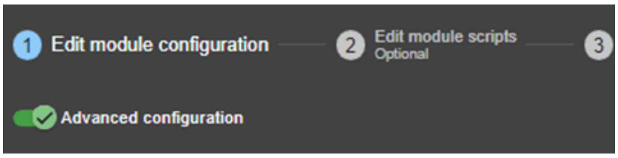
15.7.1 Module configuration with custom checker

The following example is the custom checker configuration supported since SafeKit 8 with the attribute `action`.



To start the module configuration wizard, refer to section 3.3.

Switch to "Advanced configuration" to edit the XML if needed.




```
<!DOCTYPE safe>
<safe>
<service mode="mirror" boot="on">

 <heart>
  <heartbeat name="default">
  </heartbeat>
 </heart>

 <vip>
  <interface_list>
   <interface check="on">
    <real_interface>
     <virtual_addr addr="10.1.0.126"
where="one_side_alias" check="on"/>
    </real_interface>
   </interface>
  </interface_list>
 </vip>

 <rfs>
  <replicated dir="e:\repdir"/>
 </rfs>

 <user></user>
 <check>
   <custom ident="checkfile"
exec="checker.ps1"
arg="c:\safekit\checkfile" when="prim"
action="restart"/>
 </check>
</service>
</safe>
```

For details on XML configuration of `<custom>`, see section 13.15.

The custom checker configuration for SafeKit < 8 is still supported. In previous releases, the custom checker configuration required to define an explicit failover rule in `userconfig.xml` as follow:

```
…
<check>
 <custom ident="checkfile" exec="checker.ps1" arg="c:\safekit\checkfile"
when="prim"/>
</check>
<failover>
 <![CDATA[
   c_checkfile: if( custom.checkfile == down ) then restart();
 ]]>
</failover>
```

```
…
```

Attribute action is not defined and its value, by default, is `noaction`.

The module configuration wizard do not present the `failover` section. You must switch to "Advanced configuration" to edit it.

15.7.2 Advanced configuration of module checker script

The custom checker is an infinite loop that performs a test and assigns the associated resource as `up` or `down` based on the test result.

The checker is called with at least 2 arguments:

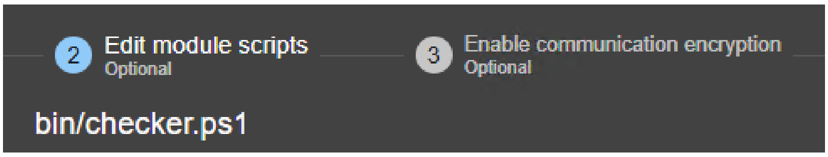
- The 1st argument is the module name
- The 2nd is the name of the resource to be assigned

If the `<custom>` configuration contains the `arg` attribute, its value is passed as the next arguments.

In the following example, the checker is written with the following precautions:

- The resource is only assigned if its value has changed
- When the resource is `down`, the checker consolidates this state (`grace` times) before assigning it. This can help to avoid false error detections.

Switch to "Advanced configuration" to list and edit all scripts.




```
# Custom checker template that tests if a file exists

param([Parameter(Mandatory = $true, ValueFromPipeLine =
$true, position=1)][String]$ModName,
      [Parameter(Mandatory = $true, ValueFromPipeLine =
$true, position=2)][String]$RName,
      [Parameter(Mandatory = $true, ValueFromPipeLine =
$true, position=3)][String]$Arg1Value,
      [Parameter(Mandatory = $false, ValueFromPipeLine
= $false, position=4)][String]$Grace="2",
      [Parameter(Mandatory = $false, ValueFromPipeLine
= $false, position=5)][String] $Period="5"
      )
# return up on success | down on failure
Function test([String]$Arg1Value)
{
  $res="down"
  if (Test-Path "$Arg1Value"){
    $res="up"
  }
  return $res
}

$customchecker=$MyInvocation.MyCommand.Name
$safekit="$env:SAFE/safekit.exe"
$gracecount=0
$prevrstate="unknown"
# wait a little
Start-Sleep $Period
```

```
while ($true){
  Start-Sleep $Period
  $rstate = test($Arg1Value)
  if($rstate -eq "down"){
    $gracecount+=1
  }else{
    $gracecount = 0
    if($prevrstate -ne $rstate){
      & $safekit set -r "$RName" -v $rstate -i
$customchecker -m $ModName
      $prevrstate = $rstate
    }
   }
   if($gracecount -ge $Grace){
     if($prevrstate -ne $rstate){
       & $safekit set -r "$RName" -v $rstate -i
$customchecker -m $ModName
       $prevrstate = $rstate
      }
      $gracecount = 0
   }
}
```

Note the call to `safekit set -r custom.checkfile -v up` (or `down`) to assign the resource value.

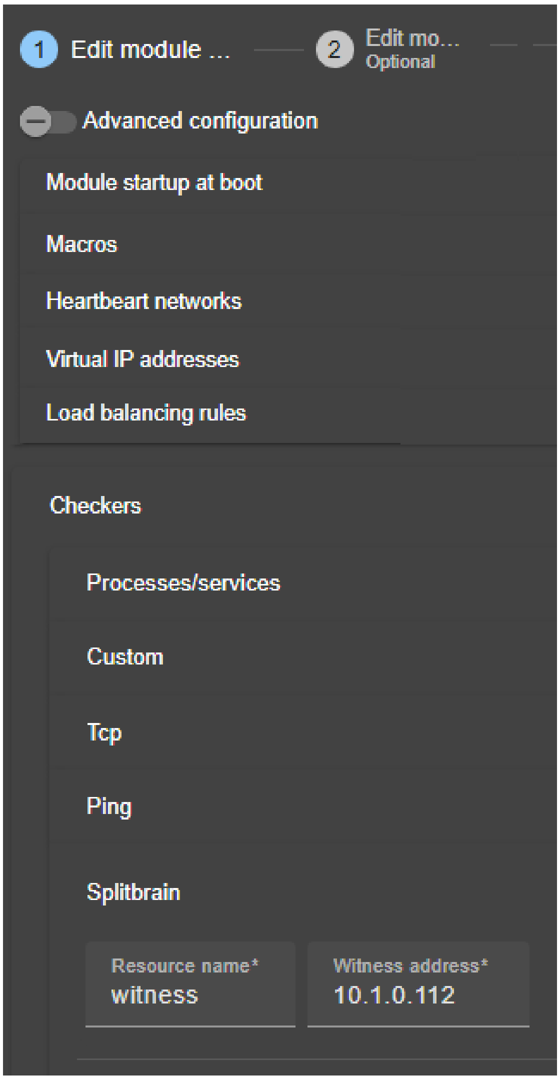
Refer to section 9.3 for the description of this command.

15.8 Split-brain checker example

Below is an example of the split-brain checker configuration in a mirror module. This feature is not also available in a farm module

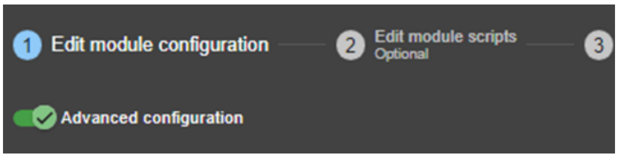
This checker tests if the address `192.168.1.1` responds to the ping. If the ping fails, the checker sets the **splitbrain**`.witness` resource to `down`.
In case of network isolation between nodes, the split-brain checker assigns the **splitbrain**`.uptodate` resource as `up` or `down` according to access to the witness. The static and predefined failover rule, named `splitbrain_failure`, executes a `wait` on the module when this resource goes `down`. This ensures that only the node with access to the witness becomes `ALONE`, while the other is stuck in the `WAIT` state.

- The resource name prefix is **splitbrain**.
- The suffix is the value of the attribute `ident`
- The failover rule is static and predefined, and tests the other resource managed by the split-brain checker, `splitbrain.uptodate`. Its name is `splitbrain_failure`.



To start the module configuration wizard, refer to section 3.3.

Switch to "Advanced configuration" to edit the XML if needed.




```
<!DOCTYPE safe>
<safe>
<service mode="mirror" boot="on">

 <heart>
  <heartbeat name="default">
  </heartbeat>
 </heart>

 <vip>
  <interface_list>
   <interface check="on">
    <real_interface>
     <virtual_addr addr="10.1.0.126"
where="one_side_alias" check="on"/>
    </real_interface>
   </interface>
  </interface_list>
 </vip>

 <rfs>
  <replicated dir="e:\repdir"/>
 </rfs>

 <user></user>

 <check>
  <check>
    <splitbrain ident="witness"
exec="ping" arg="10.1.0.112"/>
  </check>
 </check>
</service>
</safe>
```

For details on XML configuration of <splitbrain>, see section 13.17.

15.9 Module checker examples

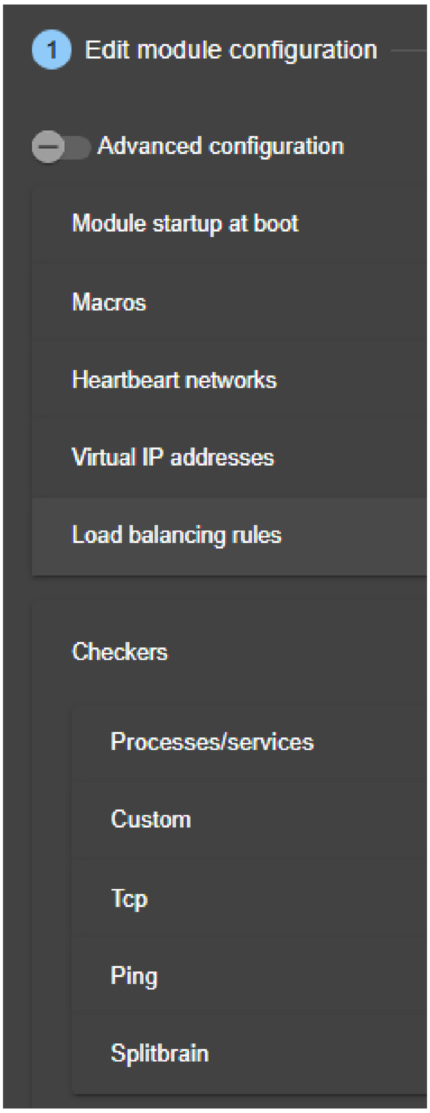
15.9.1 Example of a farm module depending on a mirror module

Below is an example of the configuration of a module checker in a farm module. This checker tests that the module name `mirror` with virtual IP address `10.0.0.129` is ready (`ALONE` or `PRIM`). If it is not ready, the checker sets the resource **module**`.mirror_10.0.0.129` to `down`. The static and predefined failover rule, named `module_failure`, executes a `wait` on the farm module when this resource goes `down`.

- The resource name prefix is **`module`**.
- The suffix is the value of the attribute `name` and `addr`
- The failover rule is static and predefined, and is named `module_failure`

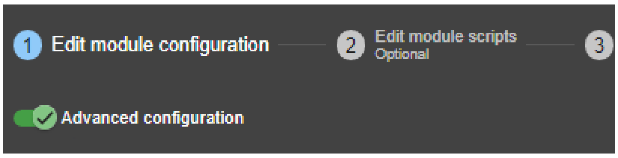
For a description of checkers, refer to section 13.10.3.

To test the module checker, refer to section 4.4.6.



To start the module configuration wizard, refer to section 3.3.

The wizard do not present the module checker. Switch to "Advanced configuration" to configure it.




```
<!DOCTYPE safe>
<safe>
 <service mode="farm" boot="on">

  <farm>
   <lan name="default"></lan>
  </farm>

  <vip>
   <interface_list>
    <interface check="on">
     <virtual_interface
type="vmac_directed">
      <virtual_addr addr="10.1.0.127"
where="alias" check="on"/>
     </virtual_interface>
    </interface>
   </interface_list>

   <loadbalancing_list>
    <group name="FarmProto">
     <rule port="9010" proto="tcp"
filter="on_port"/>
    </group>
   </loadbalancing_list>
  </vip>

  <user></user>

  <check>
   <module name="mirror">
     <to addr="10.0.0.129" port="9010"/>
   </module>
  </check>

 </service>
</safe>
```

For details on XML configuration of `<module>`, see section 13.16.

Note that the module dependency can be used when you deploy farm and mirror modules on the same SafeKit cluster or when you deploy farm and mirror modules on two different clusters. In this case, the password set to initialize the web service must be identical on both SafeKit clusters.

15.9.2 Example with leader.safe and follower.safe

The two demonstration modules `leader.safe` and `follower.safe` delivered with SafeKit allow you to configure one or more follower modules whose startup depends on the startup of the main mirror module, named leader.

For example, the main services of an application with replicated directories can be configured in the leader module, and some ancillary services of this application can be started in a follower module if you consider that its failure should only trigger its own restart; The other follower modules and the leader module are not impacted, which ensures service continuity for these modules.

The leader module is configured for a mirror architecture and includes the start and stop of the follower modules.

Each follower module is configured for a light architecture with module scripts and error detectors. The follower modules depend on the leader failover with the following module checker.

`follower/conf/userconfig.xml` - see section 13

```
<check>
  <module name="leader"/>
</check>
```

This is a shortcut for:

```
<module name="leader">
 <to addr="127.0.0.1" port="9010"/>
</module>
```

For details on XML configuration of `<module>`, see section 13.16.

If you change the listening port for the SafeKit web service (as described in section 10.8), replace the short configuration with the full one and change the port value.

15.10 Interface checker example

Below is the example of an interface checker configuration automatically generated when `<interface check="on">` is set. For details, refer to section 13.5.

In the `userconfig.xml` of the mirror module for instance, the virtual IP address is defined as follows:

```
<vip>
  <interface_list>
     <interface check="on">
         <real_interface>
           <virtual_addr addr="10.0.0.129" where="one_side_alias" check="on"/>
         </real_interface>
     </interface>
  </interface_list>
</vip>
```

When configuring the module, SafeKit generates the corresponding configuration for the interface checker. For the example, the automatically generated configuration is:

```
<check>
  <intf when="pre" ident="10.0.0.0">
    <to local_addr="10.0.0.107"/>
  </intf>
</check>
```

Where the value of ident is the network corresponding to the virtual IP address; the value of local_addr is the first IP address of the network corresponding to the virtual address.

The checker checks that the Ethernet cable is connected on this interface. If the cable is disconnected, the checker set the associated resource intf.10.0.0.0 to down. The static and predefined failover rule, named interface_failure, executes a wait on the module when this resource goes down.

- The resource name prefix is **intf**.
- The suffix is the value of the attribute ident
- The failover rule is static and predefined, and is named interface_failure

For configuration details of interface checker, see section 13.13.

For a description of checkers, refer to section 13.10.3.

To test the interface checker, refer to section 4.4.4.

15.11 IP checker example

Below is the example of an IP checker configuration automatically generated when <virtual_addr … check="on"> is set. For details, refer to section 13.5.

In the userconfig.xml of the mirror module for instance, the virtual IP address is defined as follows:

```
<vip>
  <interface_list>
     <interface check="on">
         <real_interface>
           <virtual_addr addr="10.0.0.129" where="one_side_alias" check="on"/>
         </real_interface>
     </interface>
  </interface_list>
</vip>
```

When configuring the module, SafeKit generates the corresponding configuration for the IP checker. For the example, the automatically generated configuration is:

```
<check>
  <ip ident="10.0.0.129" when="prim">
   <to addr="10.0.0.129"/>
  </ip>
</check>
```

Where the value of ident and addr are the the virtual IP address ; the value of when is prim for a mirror module, and both for a farm module.

The IP checker checks that the IP address is configured locally. If the IP address is not configured, the checker set the associated resource `ip.10.0.0.129` to `down`. The static and predefined failover rule, named `ip_failure`, executes a `stopstart` on the module when this resource goes `down`.

- The resource name prefix is **`ip`**.
- The suffix is the value of the attribute `ident`
- The failover rule is static and predefined, and is named `ip_failure`

For configuration details of IP checker, see section 13.14.

For a description of checkers, refer to section 13.10.3.

15.12 Virtual hostname example with `vhost.safe`

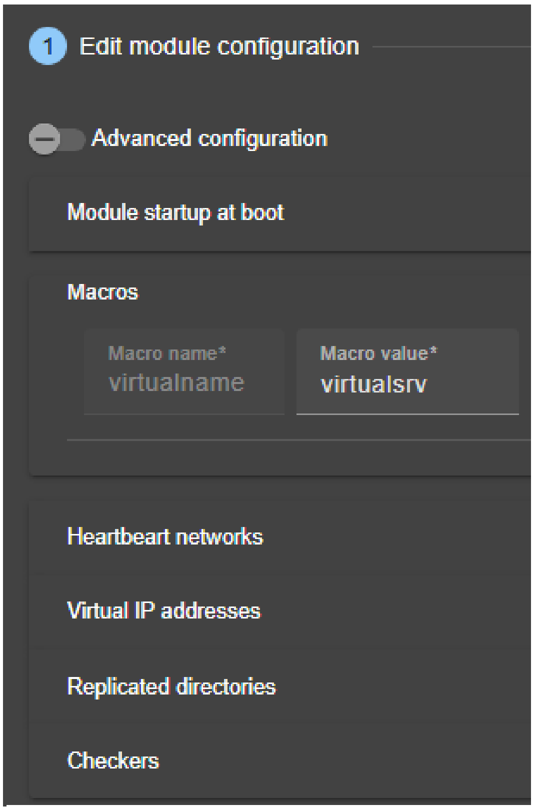
The demonstration module `vhost.safe` shows how to set a virtual hostname in a mirror module. This feature is also available in a farm module.

The following description is for Windows. For Linux, please refer to `vhost.safe` delivered with the Linux package that includes Linux configuration and scripts.

In Windows, the `vhost.safe` delivered since SafeKit 8.2.4 has been enhanced to allow testing the setup of the virtual hostname for a service. It relies on an HTTP service called `testhostname` that is created/deleted during the module configuration/deconfiguration. This service is started/stopped by the module scripts and listens on port 9999. The http://localhost:9999/hostname endpoint returns the value of the hostname as seen by the `testhostname` service, which is the virtual hostname when the module is primary.

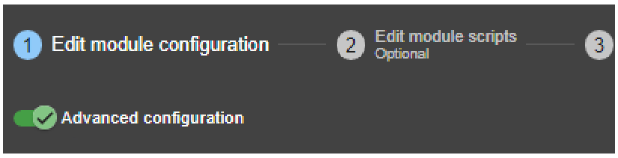
15.12.1 Module configuration with a virtual hostname

In the following example, one `<macro>` is configured and its value is used to define the virtual hostname.



To start the module configuration wizard, refer to section 3.3.

The wizard do not present the vhost. Switch to "Advanced configuration" to edit it.




```
<!DOCTYPE safe>
<safe>
<macro name="virtualname"
value="virtualsrv"/>

<service mode="mirror" boot="on">

 <heart>
  <heartbeat name="default">
  </heartbeat>
 </heart>

 <vip>
  <interface_list>
   <interface check="on">
    <real_interface>
     <virtual_addr addr="10.1.0.126"
where="one_side_alias" check="on"/>
    </real_interface>
   </interface>
  </interface_list>
 </vip>

 <rfs>
  <replicated dir="e:\repdir"/>
 </rfs>

 <user></user>

  <vhost>
   <virtualhostname name="%virtualname%"
envfile="vhostenv.cmd"/>
  </vhost>
</service>
</safe>
```

For details on XML configuration of <vhost>, see section 13.8.

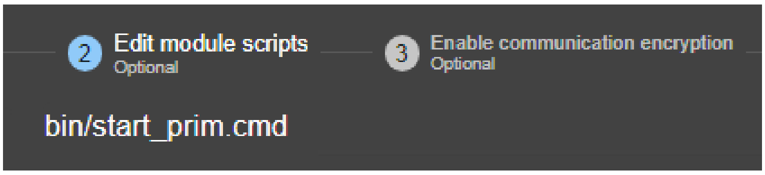
15.12.2 Module scripts with a virtual hostname

In addition to the module configuration, special commands must be executed in the module scripts.

For details on script logging (with `echo` and `safekit printe` commands), refer to section 14.3.

15.12.2.1 start_prim script

The script runs commands to set the virtual hostname in the script environment, as well as in the Windows service environment.

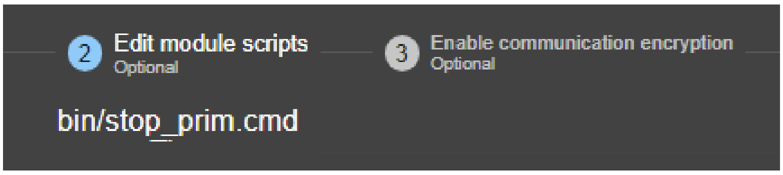



```
@echo off
echo "Running start_prim %*"

rem Set virtual hostname
CALL "%SAFEUSERBIN%\vhostenv.cmd"

rem Next commands use the virtual hostname
FOR /F %%x IN ('hostname') DO SET servername=%%x
echo "hostname is "%servername%

"%SAFE%\private\bin\vhostservice" testhostname

set res=0

net start testhostname

set res=%errorlevel%
if %res% == 0 goto end

:stop
"%SAFE%\safekit" printe "start_prim failed"

rem uncomment to stop the module when critical
rem "%SAFE%\safekit" stop -i "start_prim"

:end
```

For `safekit` command description, refer to section 9.

15.12.2.2 stop_prim script

The script runs commands to reset the virtual hostname in the script environment, as well as in the Windows service environment.




```
@echo off
echo "Running stop_prim %*"

rem Reset virtual hostname
CALL "%SAFEUSERBIN%\vhostenv.cmd"

rem Next commands use the real hostname
FOR /F %%x IN ('hostname') DO SET servername=%%x
echo "hostname is "%servername%

set res=0

rem default: no action on forcestop
if "%1" == "force" goto end

net stop testhostname
set res=%errorlevel%

rem If necessary, wait for the stop of the services
rem "%SAFEBIN%\sleep" 10

if %res% == 0 goto end

"%SAFE%\safekit" printe "stop_prim failed"

:end

"%SAFE%\private\bin\vhostservice" testhostname
```

For `safekit` command description, refer to section 9.

16. SafeKit cluster in the cloud

⇨ Section 16.1 "SafeKit cluster in Amazon AWS"

⇨ Section 16.2 "SafeKit cluster in Microsoft Azure"

⇨ Section 16.3 "SafeKit cluster in Google GCP"

You can install, configure, and administer SafeKit modules that run on virtual servers in the cloud instead of on-premises physical servers. This requires a minimum of cloud and/or server settings, especially to implement the virtual IP address.

16.1 SafeKit cluster in Amazon AWS

In the following, we suppose that you are familiar with:

- Amazon Elastic Compute Cloud (Amazon EC2) that offers computing capacity in the Amazon Web Services (AWS) cloud. For more information about the features of Amazon EC2, see the Amazon EC2 product page.
- AWS CloudFormation that helps deploying instances and applications on Amazon EC2. It permits to save a lot of time and effort so that you can spend less time managing EC2 resources and more time focusing on your applications that run in AWS.

Before implementing a SafeKit module, the administrator must :

1. Create instances (2 for a mirror module)
2. Make settings for AWS, instances, and SafeKit.
3. Then, apply specific settings for implementing your SafeKit module.

AWS settings

You must set AWS to:

- associate public addresses to each instance if you want to administer them with the SafeKit web console from the internet
- configure the security groups associated with network(s) to enable the communications of the SafeKit framework and the SafeKit web console. The ports to open are described in section 10.3.3.2
- use a high-bandwidth, low-latency network if real-time replication is used in a mirror module

Virtual machine settings

In each instance, you must also:

- install the SafeKit package
- apply the HTTPS configuration to secure the SafeKit web console (described in section 11)

SafeKit settings

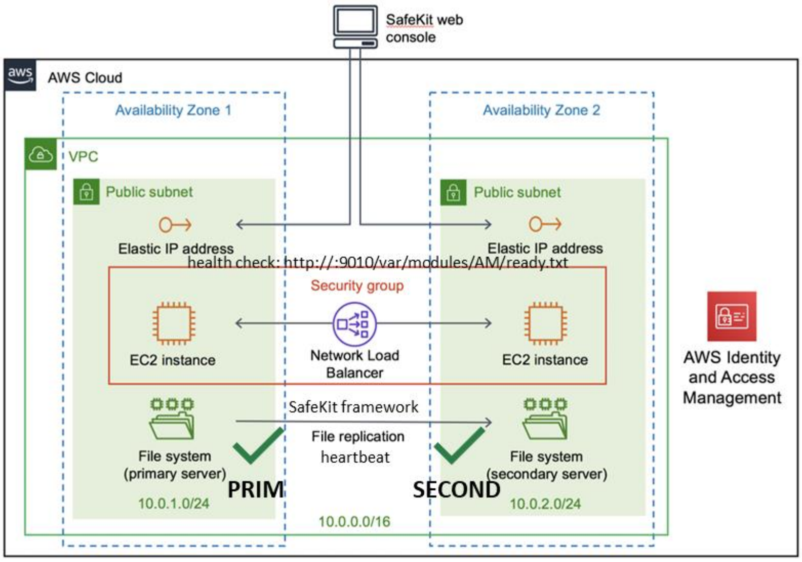
Finally, you must enter the SafeKit cluster configuration and apply it to all nodes (for details on cluster configuration, see section 12). For example, the SafeKit cluster configuration file would be:

```
<cluster>
<lans>
 <lan name="default">
  <node name="Server1" addr="10.0.11.10"/>
  <node name="Server2" addr="10.0.12.10"/>
 </lan>
</lans>
</cluster>
```

The `default` lan is used for SafeKit framework communications between cluster nodes.

16.1.1 Mirror cluster in AWS

Mirror module features are operational in the AWS cloud (real-time file replication, failover, process death detection, checkers, …), except the virtual IP address failover. Anyway, you can set up a SafeKit mirror module on the cluster and use the Elastic load balancing provided by AWS (see Elastic load balancing products in AWS) in such way that all the traffic is routed only to the primary node. An IP address and/or DNS name is associated with the load balancer that plays the role of the virtual IP.



You must configure yourself the AWS load balancer and the security group.

For the load balancer, you must:

- specify the rules for your application
- set the SafeKit cluster nodes in the target group
- configure the `health check`. It tests whether the instance is in a healthy state or an unhealthy state.

The load-balancer routes the traffic only to healthy instances. It resumes routing requests to the instance when this one has been restored to a healthy state.

SafeKit provides a health checker for SafeKit modules. For this, configure it in the load balancer with:

- HTTP protocol
- port 9010, the SafeKit web service port
- URL `/var/modules/AM/ready.txt`, where *AM* is the module name

In a mirror module, the health checker:

- returns `OK`, that means that the instance is healthy, when the module state is ✓`PRIM (Ready)` or ✓`ALONE (Ready)`
- returns `NOT FOUND`, that means that the instance is out of service, in all other states

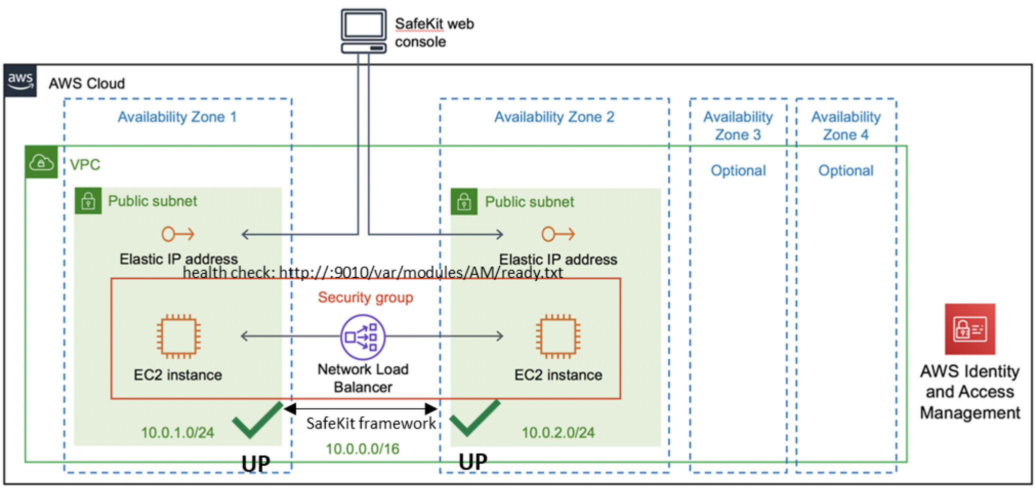
The AWS network security group must be at least configured to enable communications for the following protocols and ports:

- UDP - 4800 for the `safeadmin` service (between SafeKit cluster nodes)
- UDP - 8888 for the module heartbeat (between SafeKit cluster nodes)
- TCP - 5600 for the module real time file replication (between SafeKit nodes)
- TCP - 9010 for the load-balancer health check and the SafeKit web console in HTTP
- TCP - 9453 for the SafeKit web console in HTTPS
- TCP - 9001 for configuring the SafeKit web console for HTTPS

The module's port value depends on the module id (for details, see section 10.3.3.2).The previous values are the one for the first module installed on the node.

16.1.2 Farm cluster in AWS

Most farm module features are operational in the AWS cloud (process death detection, checkers), except the virtual IP address with load balancing . Anyway, you can set up a SafeKit farm module on the cluster and use the Elastic load balancing provided by AWS (see Elastic load balancing products in AWS). An IP address and/or DNS name is associated with the load balancer that plays the role of the virtual IP.



You must configure yourself the AWS load balancer and the security group.

For the load balancer, you must:

- specify the rules for your application
- set the SafeKit cluster nodes in the target group
- configure the `health check`. These tests whether the instance is in a healthy state or an unhealthy state.

The load-balancer routes the traffic only to healthy instances. It resumes routing requests to the instance when this one has been restored to a healthy state.

SafeKit provides a health check for SafeKit modules. For this, configure it in the load balancer with:

- HTTP protocol
- port 9010, the SafeKit web service port
- URL `/var/modules/`*`AM`*`/ready.txt`, where *AM* is the module name

In a farm module, the health check:

- returns `OK`, that means that the instance is healthy, when the module state ✓`UP (Ready)`
- returns `NOT FOUND`, that means that the instance is out of service, in all other states

The AWS network security group must be at least configured to enable communications for the following protocols and ports:

- UDP - 4800 for the `safeadmin` service (between SafeKit cluster nodes)
- TCP - 9010 for the load-balancer health check and the SafeKit web console in HTTP
- TCP - 9453 for the SafeKit web console in HTTPS
- TCP - 9001 for configuring the SafeKit web console for HTTPS

16.2 SafeKit cluster in Microsoft Azure

In the following, we suppose that you are familiar with Microsoft Azure that is a cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services through a global network of Microsoft-managed data centers. For more information about the features and use of Azure, see the Microsoft Azure portal.

Before implementing a SafeKit module, the administrator must :

1. Create virtual machines (2 for a mirror module)
2. Make settings for Azure, virtual machines, and SafeKit.
3. Then, apply specific settings for implementing your SafeKit module.

Azure settings

You must set Azure to:

- associate public IP addresses and DNS name to virtual machines if you want to administer them with the SafeKit web console from the internet
- configure the network security group to enable the communications of the SafeKit framework and the SafeKit web console. The ports to open are described in section 10.3.3.2
- use a high-bandwidth, low-latency network if real-time replication is used in a mirror module

Virtual machine settings

On each virtual machine, you must also:

- install the SafeKit package
- apply the HTTPS configuration to secure the SafeKit web console (described in section 11)

SafeKit settings

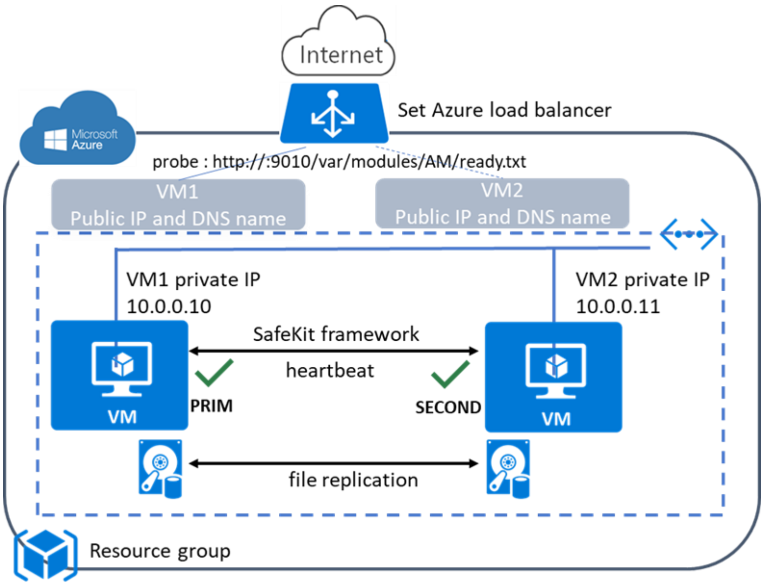
Finally, you must enter the SafeKit cluster configuration and apply it to all nodes (for details on cluster configuration, see section 12). For example, the SafeKit cluster configuration file would be:

```
<cluster>
<lans>
 <lan name="default">
  <node name="Server1" addr="10.0.0.10"/>
  <node name="Server2" addr="10.0.0.11"/>
 </lan>
</lans>
</cluster>
```

The `default` lan is used for SafeKit framework communications between cluster nodes.

16.2.1 Mirror cluster in Azure

Mirror module features are operational in the Azure cloud (real-time file replication, failover, process death detection, checkers, …) except the virtual IP address failover. Anyway, you can set up a SafeKit mirror module on the cluster and use the load balancing provided by Azure (see Load Balancer in Azure) and route request only to the primary node. An IP is associated with the load balancer that plays the role of the virtual IP.



You must configure yourself the Azure load balancer and the network security group.

For the load balancer, you must:

- specify the rules for your application
- set the SafeKit cluster nodes into the backend pool
- configure the `probe`. It tests whether the instance is in a healthy state or an unhealthy state.

The load balancer routes traffic only to healthy instances. It resumes routing requests to the instance when the instance has been restored to a healthy state.

SafeKit provides a probe for SafeKit modules. For this, configure the probe in the load balancer with:

- HTTP protocol
- port 9010, the SafeKit web service port
- URL `/var/modules/`*`AM`*`/ready.txt`, where *`AM`* is the module name

In a mirror module, the probe:

- returns `OK`, that means that the instance is healthy, when the module state is ✓`PRIM (Ready)` or ✓`ALONE (Ready)`
- returns `NOT FOUND`, that means that the instance is out of service, in all other states

The Azure network security group must be at least configured to enable communications for the following protocols and ports:

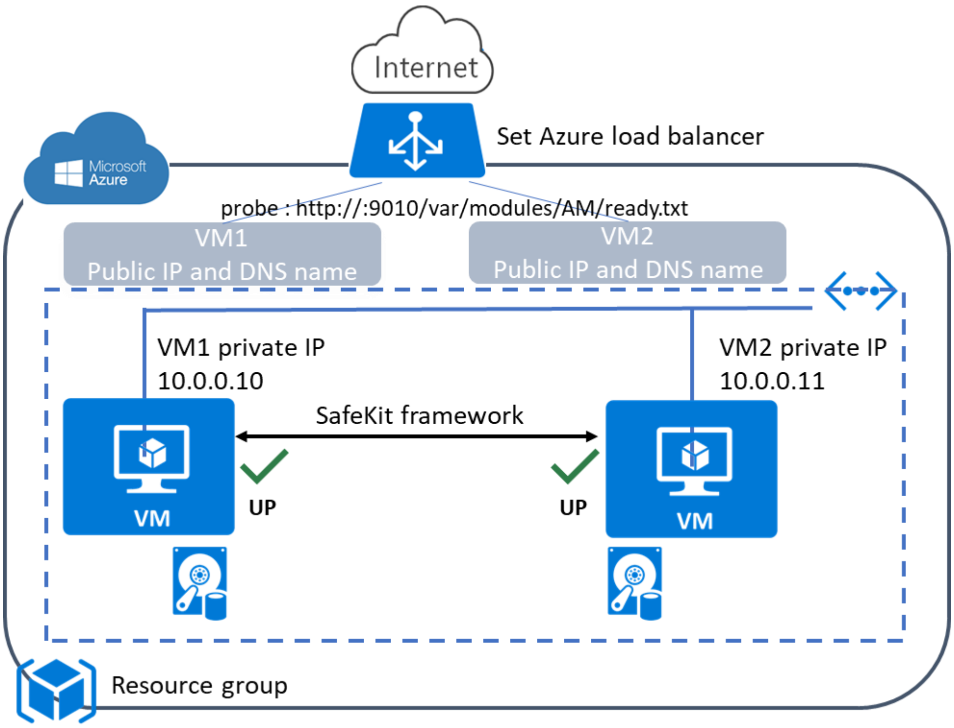
- UDP - 4800 for the `safeadmin` service (between SafeKit cluster nodes)
- UDP - 8888 for the module heartbeat (between SafeKit cluster nodes)
- TCP - 5600 for the module real time file replication (between SafeKit nodes)
- TCP - 9010 for the load-balancer health check and the SafeKit web console in HTTP

- TCP - 9453 for the SafeKit web console in HTTPS
- TCP - 9001 for configuring the SafeKit web console for HTTPS

The module's port value depends on the module id (for details, see section 10.3.3.2).The previous values are the one for the first module installed on the node.

16.2.2 Farm cluster in Azure

Most farm module features are operational in the Azure cloud (process death detection, checkers), except the virtual IP address with load balancing . Anyway, you can set up a SafeKit farm module on the cluster and use the load balancing provided by Azure (see Load Balancer in Azure). An IP is associated with the load balancer that plays the role of the virtual IP.



You must configure yourself the Azure load balancer and the network security group.

For the load balancer, you must:

- specify the rules for your application
- set the SafeKit cluster nodes as backend
- configure the `probe`. It tests whether the instance is in a healthy state or an unhealthy state.

The load balancer routes traffic only to healthy instances. It resumes routing requests to the instance when the instance has been restored to a healthy state.

SafeKit provides a probe for SafeKit modules. For this, configure the probe in the load balancer with:

- HTTP protocol
- port 9010, the SafeKit web service port
- URL `/var/modules/AM/ready.txt`, where *AM* is the module name

In a farm module, the probe:

- returns `OK`, that means that the instance is healthy, when the farm module state is ✓ `UP (Ready)`
- returns `NOT FOUND`, that means that the instance is out of service, in all other states

The Azure network security group must be at least configured to enable communications for the following protocols and ports:

- UDP - 4800 for the `safeadmin` service (between SafeKit cluster nodes)
- TCP - 9010 for the load-balancer health check and the SafeKit web console in HTTP
- TCP - 9453 for the SafeKit web console in HTTPS
- TCP - 9001 for configuring the SafeKit web console for HTTPS

16.3 SafeKit cluster in Google GCP

In the following, we suppose that you are familiar with Google Cloud Platform (GCP) that delivers virtual machines running in Google's innovative data centers and worldwide fiber network. For more information about the features and use of Google Cloud Platform, see the Google Cloud Computing documentation.

Before implementing a SafeKit module, the administrator must :

1. Create virtual machines (2 for a mirror module)
2. Make settings for Google Compute Engine (GCP), virtual machines, and SafeKit.
3. Then, apply specific settings for implementing your SafeKit module.

GCP settings

You must set GCP to:

- associate an external IP address (and optionally DNS name) to each virtual machine instance if you want to administer them with the SafeKit web console from the internet
- configure the firewall rules for the Virtual Private Cloud (VPC) network to enable the communications of the SafeKit framework and the SafeKit web console. The ports to open are described in section 10.3.3.2
- use a high-bandwidth, low-latency network if real-time replication is used in a mirror module

Virtual machine settings

On each virtual machine, you must also:

- install the SafeKit package
- apply the HTTPS configuration to secure the SafeKit web console (described in section 11)

SafeKit settings

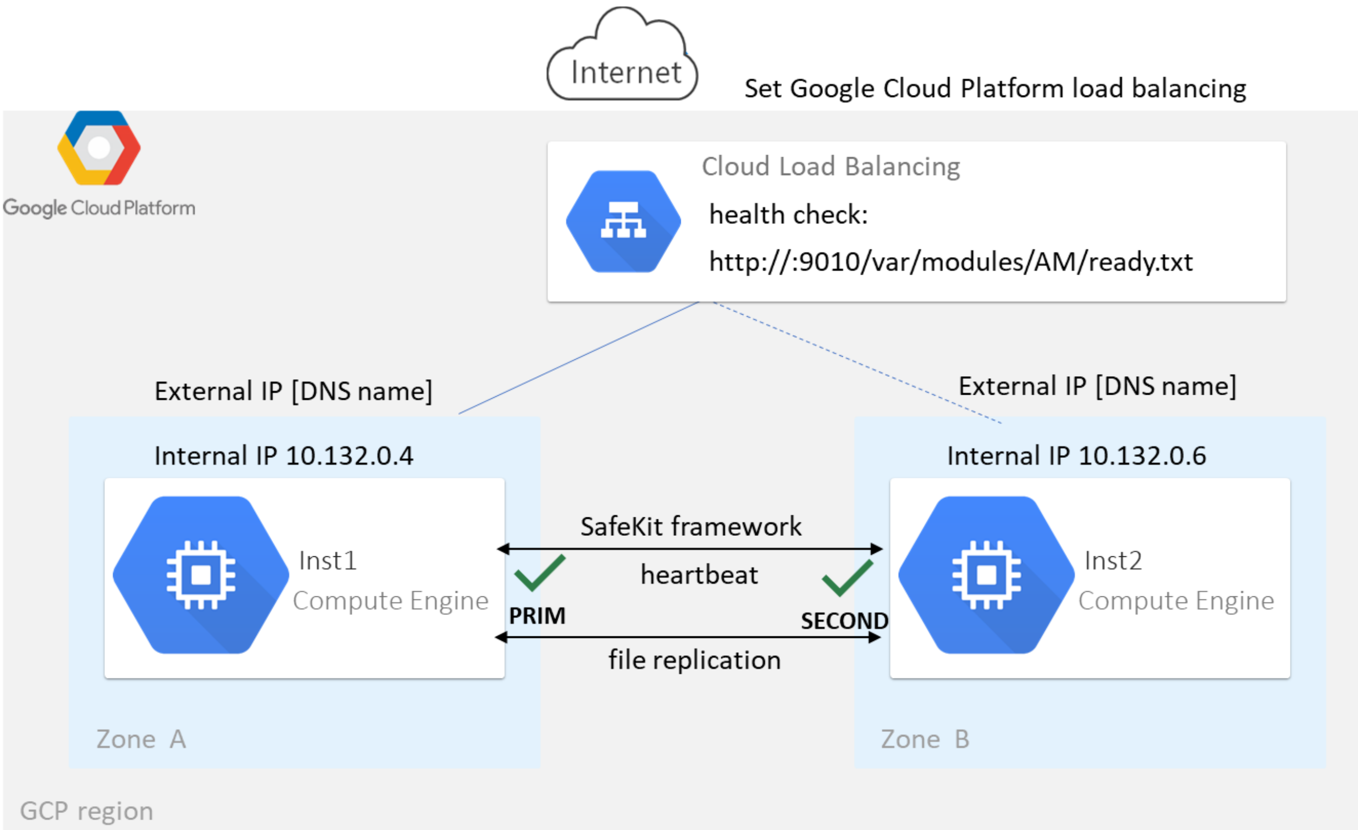
Finally, you must enter the SafeKit cluster configuration and apply it to all nodes (for details on cluster configuration, see section 12. For example, the SafeKit cluster configuration file would be:

```
<cluster>
<lans>
 <lan name="default">
  <node name=" Inst1" addr="10.132.0.4"/>
  <node name=" Inst2" addr="10.32.0.6"/>
 </lan>
</lans>
</cluster>
```

The `default` lan is used for SafeKit framework communications between cluster nodes.

16.3.1 Mirror cluster in GCP

Mirror module features are operational in the Google Cloud Platform (real-time file replication, failover, process death detection, checkers, …) except the virtual IP address failover. Anyway, you can set up a SafeKit mirror module on the cluster and use the load balancing provided by GCP (see Load Balancer in GCP) and route request only to the primary node. An IP is associated with the load balancer that plays the role of the virtual IP.



You must configure yourself the Google load balancer and the network firewall.

For the load balancer, you must:

- specify the rules for your application
- set the SafeKit cluster nodes as backend
- configure the `health check`. It tests whether the instance is in a healthy state or an unhealthy state.

The load balancer routes traffic only to healthy instances. It resumes routing requests to the instance when the instance has been restored to a healthy state.

SafeKit provides a health check for SafeKit modules. For this, configure the health check in the load balancer with:

- HTTP protocol
- port 9010, the SafeKit web service port
- URL `/var/modules/AM/ready.txt`, where *AM* is the module name

In a mirror module, the health check:

- returns `OK`, that means that the instance is healthy, when the module state ✓`PRIM (Ready)` or ✓`ALONE (Ready)`
- returns `NOT FOUND`, that means that the instance is unhealthy, in all other states

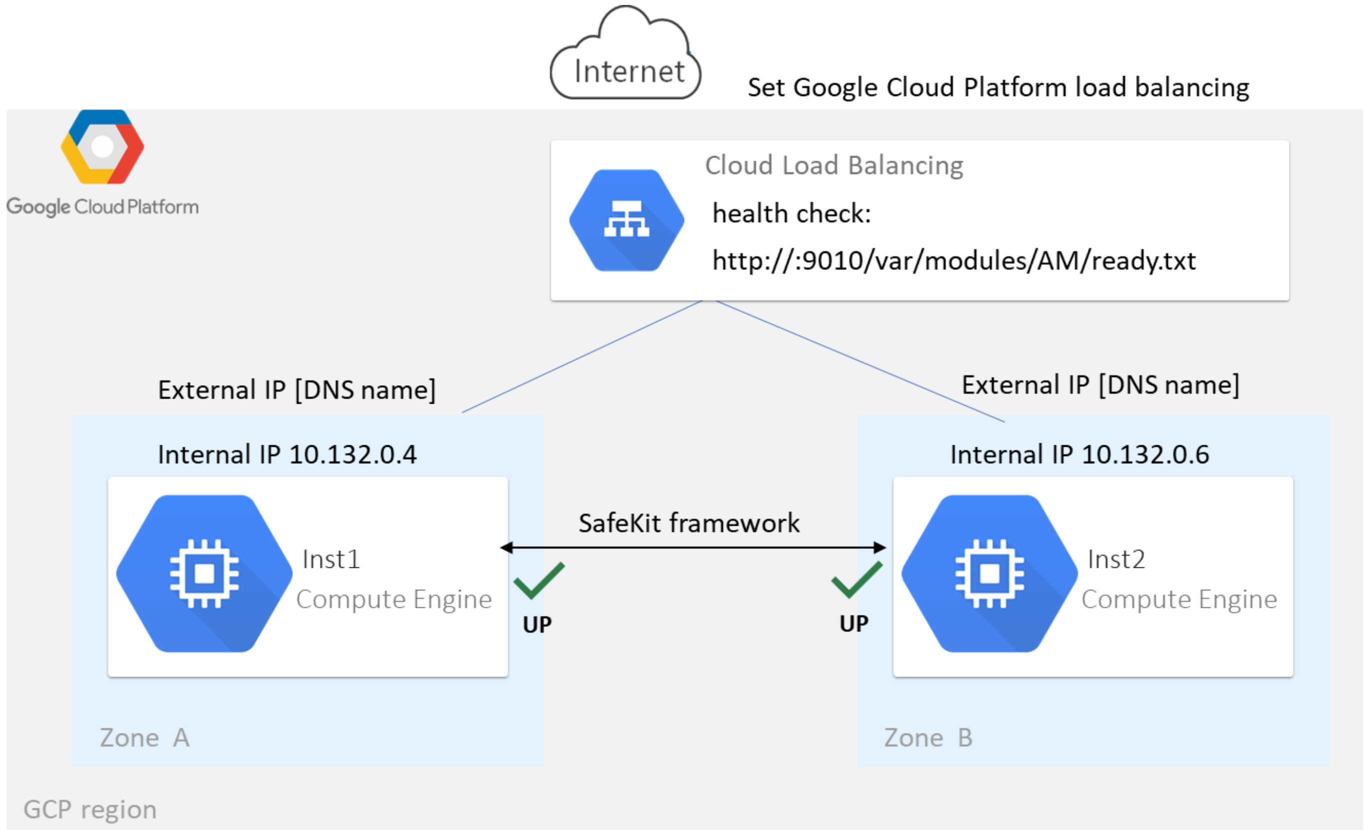
The network firewall must be at least configured to enable communications for the following protocols and ports:

- UDP - 4800 for the `safeadmin` service (between SafeKit cluster nodes)
- UDP - 8888 for the module heartbeat (between SafeKit cluster nodes)
- TCP - 5600 for the module real time file replication (between SafeKit nodes)
- TCP - 9010 for the load-balancer health check and the SafeKit web console in HTTP
- TCP - 9453 for the SafeKit web console in HTTPS
- TCP - 9001 for configuring the SafeKit web console for HTTPS

The module's port value depends on the module id (for details, see section 10.3.3.2).The previous values are the one for the first module installed on the node.

16.3.2 Farm cluster in GCP

Most farm module features are operational in the Google Cloud Platform (process death detection, checkers), except the virtual IP address with load balancing . Anyway, you can set up a SafeKit farm module on the cluster and use the load balancing provided by GCP (see Load Balancer in GCP). An IP is associated with the load balancer that plays the role of the virtual IP.



You must configure yourself the Google load balancer and the network firewall.

For the load balancer, you must:

- specify the rules for your application
- set the SafeKit cluster nodes as backend
- configure the `health check`. It tests whether the instance is in a healthy state or an unhealthy state.

The load balancer routes traffic only to healthy instances. It resumes routing requests to the instance when the instance has been restored to a healthy state.

SafeKit provides a health check for SafeKit modules. For this, configure the health check in the load balancer with:

- HTTP protocol
- port 9010, the SafeKit web service port
- URL `/var/modules/`*`AM`*`/ready.txt`, where *AM* is the module name

In a farm module, the health check:

- returns `OK`, that means that the instance is healthy, when the farm module state is ✓ `UP (Ready)`
- returns `NOT FOUND`, that means that the instance is out of service, in all other states

The network firewall must be at least configured to enable communications for the following protocols and ports:

- UDP - 4800 for the `safeadmin` service (between SafeKit cluster nodes)
- TCP - 9010 for the load-balancer health check and the SafeKit web console in HTTP
- TCP - 9453 for the SafeKit web console in HTTPS
- TCP - 9001 for configuring the SafeKit web console for HTTPS

17. Third-Party Software

SafeKit comes with the third-party software listed below.

For licenses details, refer to the links or the license files into the `SAFE/licenses` directory (`SAFE=/opt/safekit` in Linux and `SAFE=C:\safekit` in Windows if `%SYSTEMDRIVE%`=C:).

libnet	Packet Construction and Injection Libnet license - license Used for arpreroute and ping
swagger-ui	https://github.com/swagger-api/swagger-ui Apache2 License - https://github.com/swagger-api/swagger-ui/blob/master/LICENSE Swagger UI is a collection of HTML, JavaScript, and CSS assets that dynamically generate beautiful documentation from a Swagger-compliant API Used for to visualize the SafeKit API
Sqlite3	https://www.sqlite.org/about.html Public Domain License - https://www.sqlite.org/copyright.html SQLite is an in-process library that implements a self-contained, serverless, zero-configuration, transactional SQL database engine Used by SafeKit framework
Info-ZIP	http://info-zip.org BSD like license - http://infozip.sourceforge.net/license.html Used to pack/unpack a .safe module

And on Windows OS only :

libxml	http://xmlsoft.org MIT license - http://www.xmlsoft.org/FAQ.html#License Used by the SafeKit framework
libxslt	http://xmlsoft.org/XSLT/ MIT license - https://gitlab.gnome.org/GNOME/libxslt/blob/master/Copyright Used by the SafeKit framework
Net-SNMP	http://net-snmp.sourceforge.net BSD like and BSD license - http://www.net-snmp.org/about/license.html Used by SafeKit SNMP agent in Windows
HTTP server	https://httpd.apache.org/ Apache license - https://www.apache.org/licenses/LICENSE-2.0

	Used by the SafeKit web service for the web console, the distributed commands, and the module checker
APR	https://apr.apache.org/ Apache license - https://www.apache.org/licenses/LICENSE-2.0 Used by the Apache HTTP server
PCRE	http://www.pcre.org/ BSD license - https://www.pcre.org/licence.txt Used by the Apache HTTP server
libexpat	https://github.com/libexpat/libexpat BSD license - https://github.com/libexpat/libexpat/blob/master/expat/COPYING Used by the Apache HTTP server
mod_auth_openidc	https://github.com/OpenIDC/mod_auth_openidc Apache2 License - https://github.com/OpenIDC/mod_auth_openidc/blob/master/LICENSE.txt mod_auth_openidc is an OpenID Certified™ authentication and authorization module for the Apache 2.x HTTP server that implements the OpenID Connect Relying Party Used by the Apache HTTP server
cURL	http://curl.haxx.se Curl license - https://github.com/curl/curl/blob/master/docs/LICENSE-MIXING.md Used by the distributed commands and the module checker
OpenSSL	http://www.openssl.org dual OpenSSL and SSLeay license - https://www.openssl.org/source/license.html Used when securing the web console, the distributed commands, and the module checker
Lua	http://www.lua.org MIT license - https://www.lua.org/license.html Used by SafeKit framework and the web service
getopt.c	BSD License. Used to parse command arguments
oncw32	SUN RPC License. Used to transport NFS rpc

SafeKit uses the following third-party packages for the SafeKit web console:

Angular	https://angular.io MIT License - https://github.com/angular/angular-cli/blob/main/LICENSE

	Angular is an application-design framework and development platform for creating efficient and sophisticated single-section apps. @angular/animations, @angular/cdk, @angular/common, @angular/core, @angular/forms, @angular/material, @angular/material-moment-adapter, @angular/platform-browser, @angular/router, @angular/service-worker @babel/runtime
jszip	https://stuk.github.io/jszip/ MIT OR GPL-3.0-or-later license - https://github.com/Stuk/jszip/blob/main/LICENSE.markdown A library for creating, reading, and editing .zip files with JavaScript, with a lovely and simple API.
material-icons	https://github.com/marella/material-icons Apache-2.0 license - https://github.com/marella/material-icons/blob/main/LICENSE
moment	https://github.com/urish/angular-moment#readme MIT license - https://github.com/urish/angular-moment?tab=MIT-1-ov-file
ngx-logger	https://github.com/dbfannin/ngx-logger#readme MIT license - https://github.com/dbfannin/ngx-logger?tab=MIT-1-ov-file NGX Logger is a simple logging module for angular
rxjs	https://github.com/ReactiveX/rxjs Apache2 License - https://github.com/ReactiveX/rxjs/blob/master/LICENSE.txt Reactive Extensions For JavaScript
tslib	https://www.typescriptlang.org/ 0BSD Copyright (c) Microsoft Corporation Runtime library for typescript
vlq	https://github.com/Rich-Harris/vlq/blob/master/README.md MIT license - https://github.com/Rich-Harris/vlq/blob/master/LICENSE Convert integers to a Base64-encoded VLQ string, and vice versa
zone.js	https://github.com/angular/zone.js MIT license - https://angular.io/license Implements Zones for JavaScript

This list is available in file : safekit/web/htdcos/console/en/3rdpartylicenses.txt .

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