Redundant Systems SIMATIC S7-1500 R/H

Technical details

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SIMATIC S7-1500 Redundant Systems
Further technical slide sets

This document is part of a three-part set of slides

This document

Part 1: Redundant Systems SIMATIC S7-1500 R/H

Part 2: PROFINET System Redundancy with S7-1500 R/H and ET 200

Part 3: Network configuration with S7-1500 R/H

Legend:

New with TIA Portal V18 / Firmware V3.0

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SIMATIC S7-1500 Redundant Systems
Content

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2. System Overview
3. Failure Scenarios
4. Communication via System IP addresses
5. Safety for Redundant Systems
6. Load Program / Project
7. Hardware extensions in Run with IO-Link
9. HMI Connection
10. Programming Recommendations
11. Specific Functions for R/H
12. Security for Redundant Controllers
13. What‘s new with Firmware V3.0
14. Add-Ons
15. Feature Comparison / Limitations
16. Ordering Information

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Motivation and product strategy

SIMATIC S7-1500 Redundant Systems

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SIMATIC S7-1500 Redundant Systems
Motivation

Avoiding plant downtimes
High availability during operation, avoidance of production downtimes

Prevention of data loss
The data is retained and long recovery times after a failure are eliminated.

Prevention of damage
Avoidance of unplanned production stops, where the product to be processed would be permanently damaged.

Operation without persons on site
Trips for maintenance are easier to plan

Save maintenance effort
Applicative solutions are usually complicated and difficult to maintain

Redundant Systems reduce costs

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SIMATIC S7-1500 Redundant Systems
Product Strategy SIMATIC S7-1500R/H

Based on standard S7-1500 CPUs and PROFINET

- The basis is hardware of the standard and Failsafe CPUs
- The basis is the PROFINET communication standard

Transparent programming (like standard)

- Standard engineering tools incl. all programming languages
  - Complete Integration in TIA Portal
  - No special redundancy know-how required
  - Easy scaling:
    Standard CPU → S7-1500 R → S7-1500 H
    Standard F-CPU → S7-1500HF

Scale extensively

- Scaling the switching time (S7-1500 R → S7-1500 H)
- Scaling the redundancy architecture
- Scaling performance from CPU 1513 to 1518

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System Overview

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SIMATIC S7-1500 Redundant Systems
System Overview

Consistent concept –
Identical
Synchronization process

	Redundant S7-1500R	High Available S7-1500H
		
CPU Type	**CPU 1513R / CPU 1515R**	**CPU 1517H / CPU 1518HF**
Synchronization	via **PROFINET Ring** (MRP)	via **Sync-Module / FO**
Hot-Standby	**Yes** fail-over time ca. 300 ms	**Yes** fail-over time ca. 50 ms
Max distance between CPUs	**100 m,** with media converters a few km	**40 km**
PROFINET System Redundancy	**S2 and S1 switched**	**R1, S2 and S1 switched**
Structure of the PROFINET network	**MRP Ring**	**Any**

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SIMATIC S7-1500 Redundant Systems
CPU Types

	CPU 1513R-1 PN 6ES7513-1RM03-0AB0 (New)	CPU 1515R-2 PN 6ES7515-2RN03-0AB0 (New)	CPU 1517H-3 PN 6ES7517-3HP00-0AB0	CPU 1518HF-4 PN 6ES7518-4JP00-0AB0
Program/ Memory	600 kB Code 2.5 MB of data	1 MB Code 4.5 MB of data	2 MB Code 8 MB data	9 MB Code 60 MB data
Interfaces	X1	X1 X2	X1 X2 X3 X4	X1 X2 X3 X4 X5
Firmware	From V3.0	From V3.0	From V2.6	From V2.8
SIPLUS variant	-	-	6AG1517-3HP00-4AB0	-

Fail-safe

- PROFINET IO Controller, Supports RT, MRP, TCP/IP, Open User Communication
- PROFINET Basic Services, TCP/IP, Open User Communication
- SFP module slot for H-synchronization

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SIMATIC S7-1500 Redundant Systems
Sync modules and sync lines

Sync Module
4 pieces per H-system

Sync Cable
2 pieces per H-system

Distance	Sync Module	Sync Cable	Fiber Type / Connector
Up to 10 m	6ES7960-1CB00-0AA5	Pre-fabricated: 6ES7 960-1BB00-5AA5 (1m) 6ES7 960-1BC00-5AA5 (2m) 6ES7 960-1CB00-5AA5 (10m)	Multimode / LC
From 2 m to 10 km	6ES7960-1FB00-0AA5	Single mode fiber 9/125 µm Specification OS1 or OS2	Single Mode/LC
From 8 km to 40 km	6ES7960-1FE00-0AA5	Single mode fiber 9/125 µm Specification OS2	Single Mode/LC

New

Overview of fiber optics at Siemens:
https://mall.industry.siemens.com/mall/en/en/Catalog/Products/10000396?tree=CatalogTree

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Failure Scenarios

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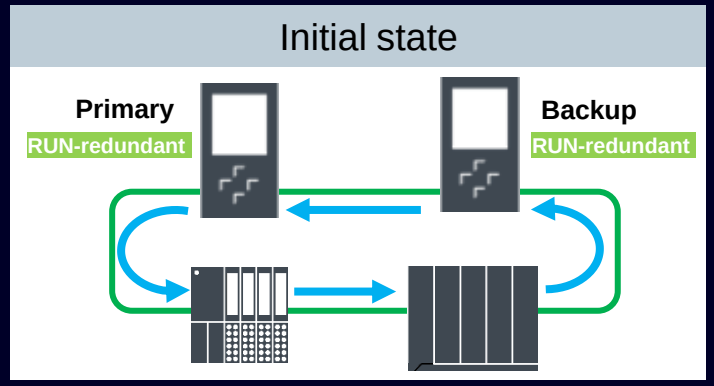
Failure scenarios for S7-1500 R/H
IO connection via Ring topology

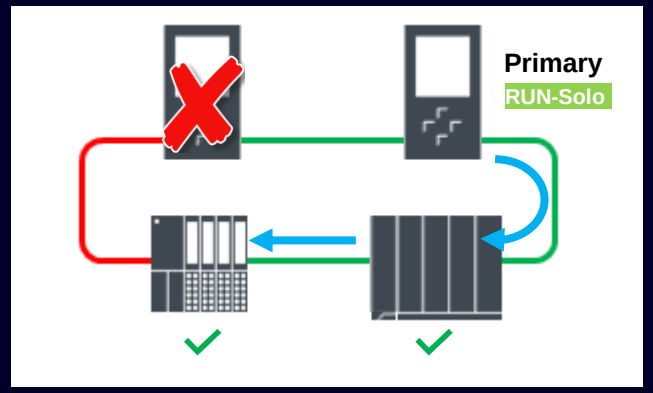
Initial state



I/O data

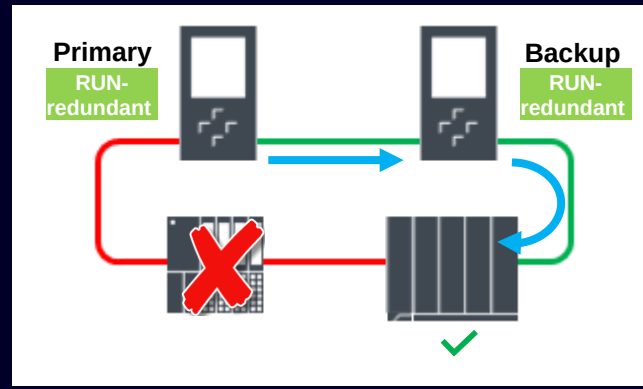
Primary CPU or backup CPU failure

IO communication is switched to the remaining CPU



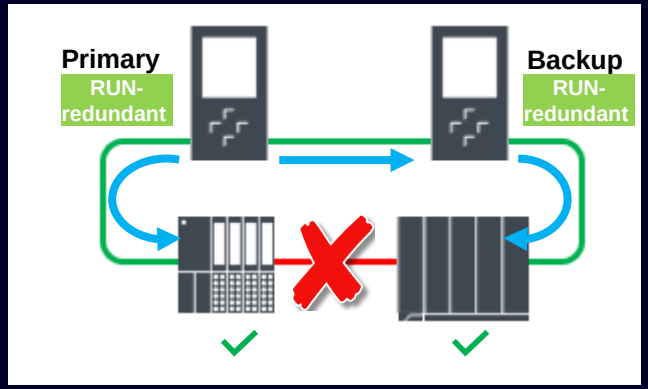
Failure of an IO device

IO communication takes place via MRP ring from Primary CPU to remaining IO-Devices



Failure of a PROFINET cable in the ring

IO communication continues via MRP Ring.



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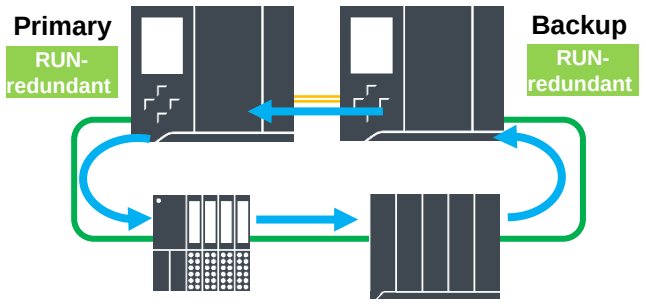
Failure scenarios for S7-1500 H (from firmware V3.0)
IO connection via Line topology

New

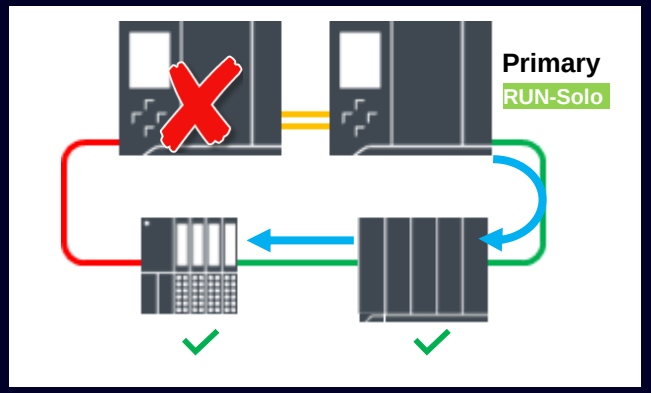
Initial state



I/O data

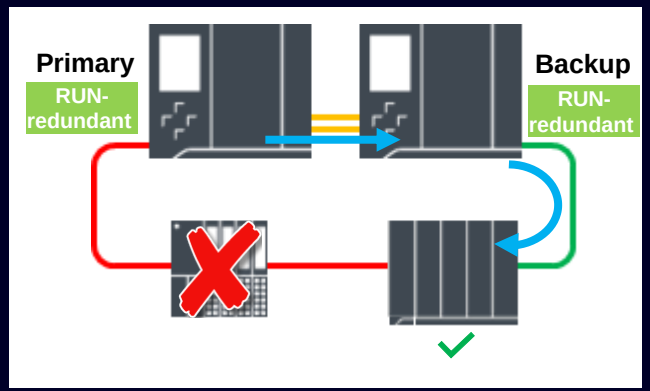
Primary CPU or backup CPU failure

IO communication is switched to the remaining CPU



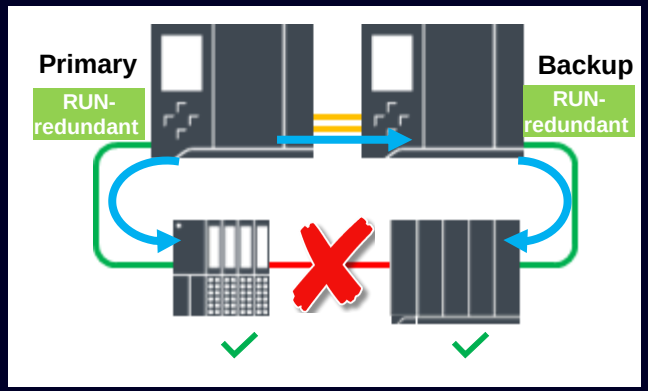
Failure of an IO device

IO communication takes place via Fiber H-Sync Connection from Primary CPU to remaining IO-Devices



Failure of a PROFINET line

IO communication takes place directly or via Fiber H-Sync Connection von Primary CPU



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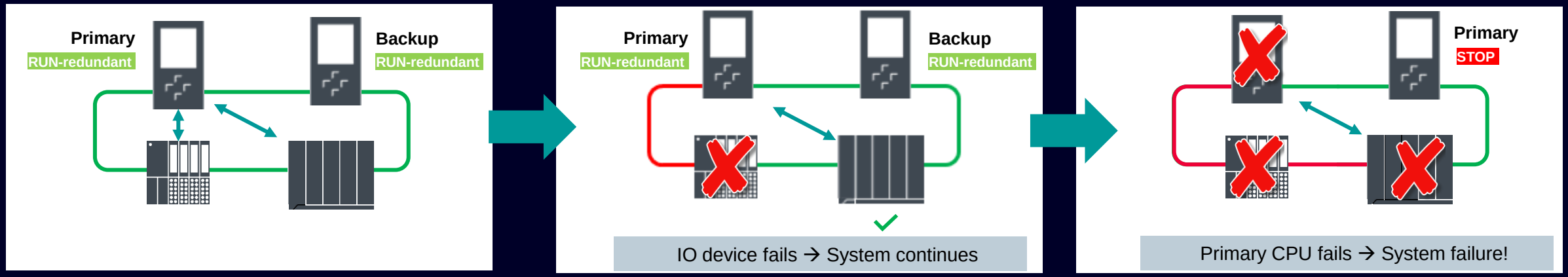
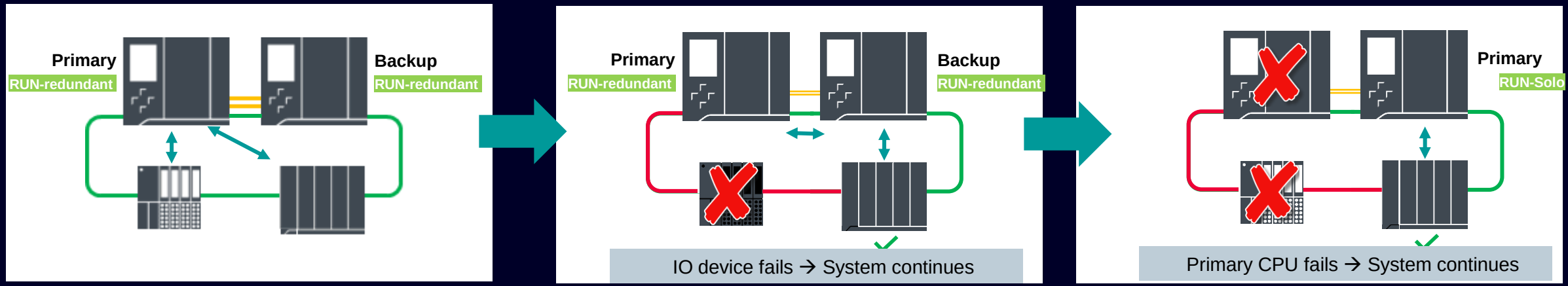
Failure scenarios for S7-1500 R/H

Double fault: Failure of an IO device AND der Primary-CPU

Behavior with S7-1500R



Behavior at S7-1500H



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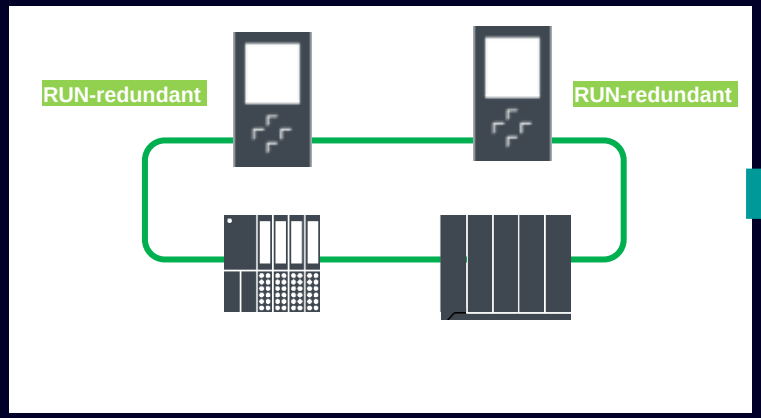
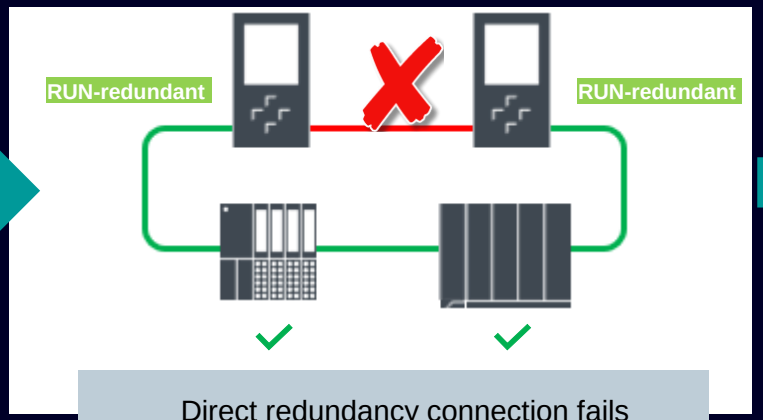
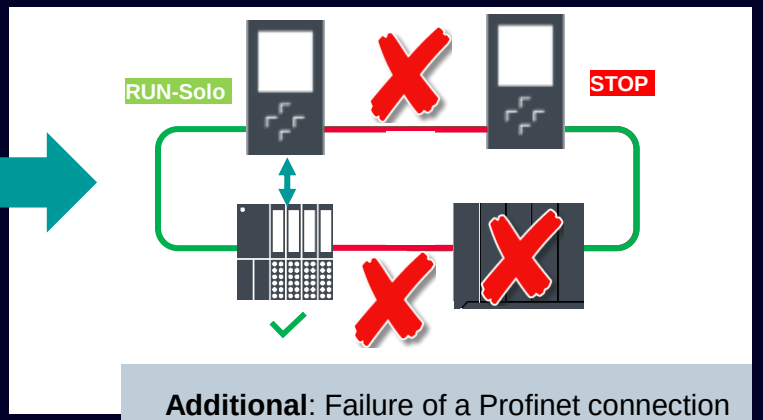
Failure scenarios for S7-1500 R
Failure of redundancy connections to CPU synchronization

Behavior with S7-1500R





Direct redundancy connection fails
→ System remains in RUN redundant



Additional: Failure of a Profinet connection in the ring

Case 1: Time interval between the two failures > 100ms
→ Run-solo operation with partial failure of IO devices

Case 2: Time interval between the two failures < 100ms
→ Both CPUs are in the primary role (undefined state)

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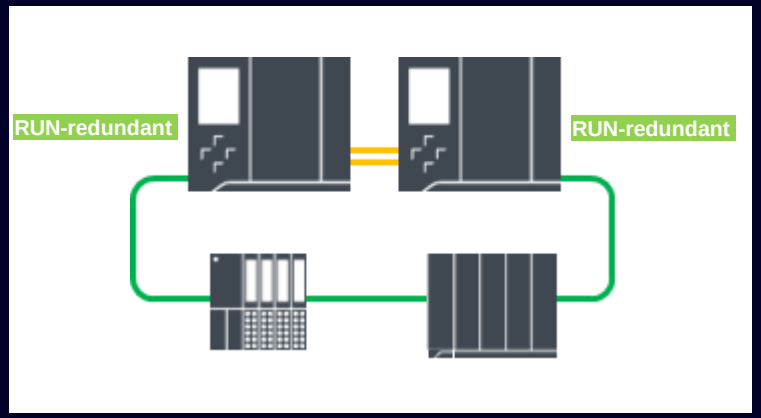
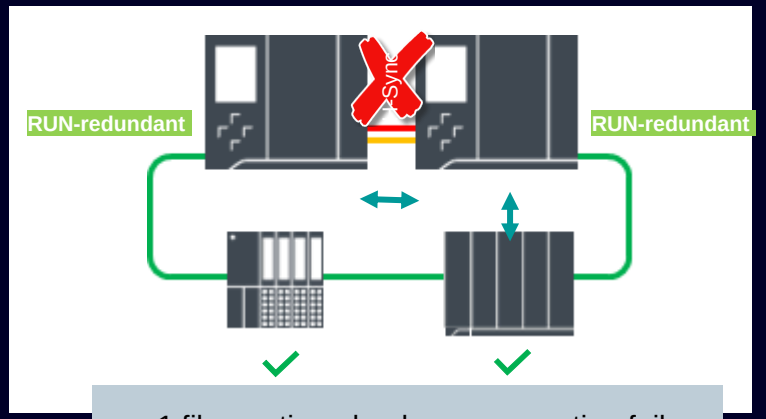
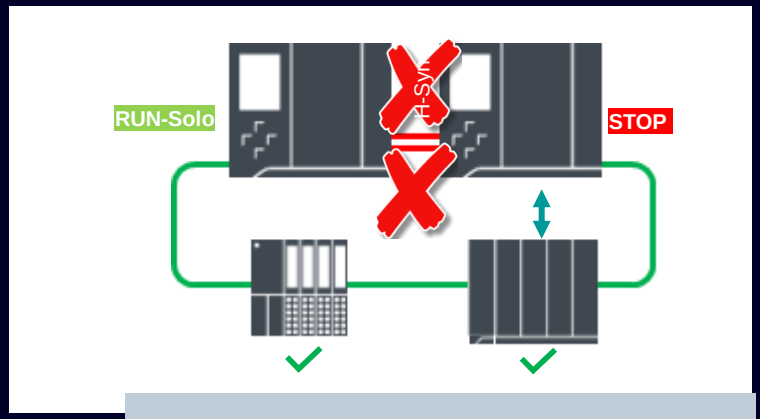
Failure scenarios for S7-1500 H
Failure of redundancy connections to CPU synchronization

Behavior at S7-1500H





1 fiber optic redundancy connection fails
→ System remains in RUN redundant



Additional: Failure of the second fiber optic redundancy connection

Case 1: Time interval between the two failures > 55ms
→ Run-Solo operation

Case 2: Time interval between the two failures < 55ms
→ Both CPUs are in the primary role (undefined state)

Recommendation: Routing sync lines separately on the H-System

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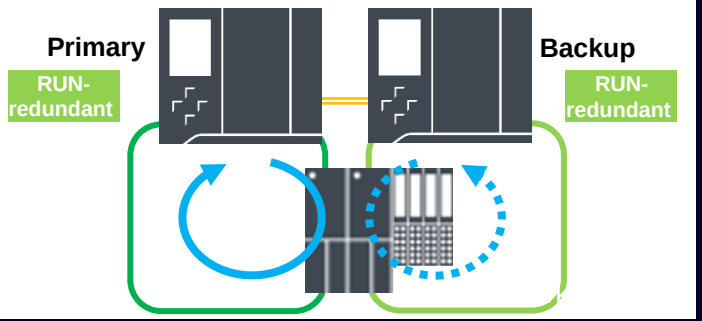
Failure scenarios for S7-1500 H (from firmware V3.0)
Design with system redundancy R1 and MRP rings

New

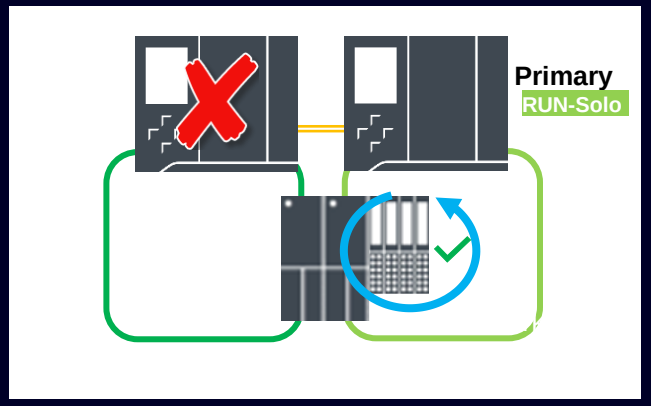
Initial state



I/O data

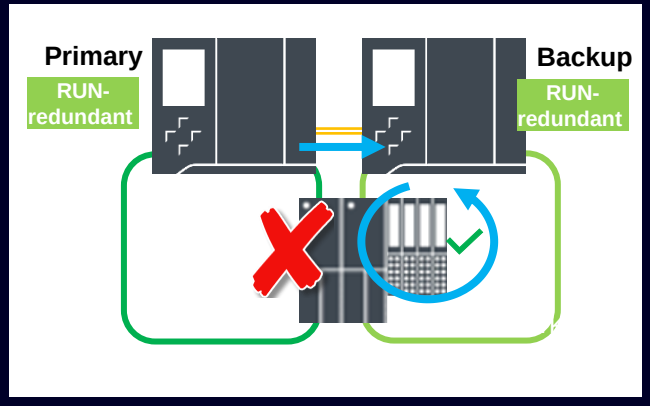
Primary CPU or backup CPU failure

IO communication is switched to the remaining CPU and the second interface module.



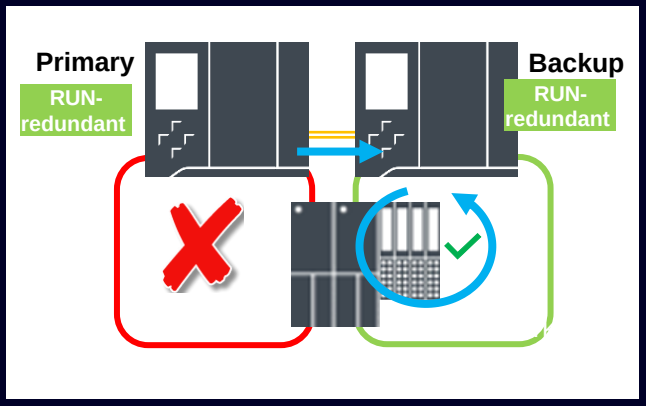
Failure of an interface module

IO communication takes place via Fiber H-Sync Connection from Primary CPU to remaining IO-Devices



Failure of a PROFINET network

IO communication takes place directly or via Fiber H-Sync Connection von Primary CPU



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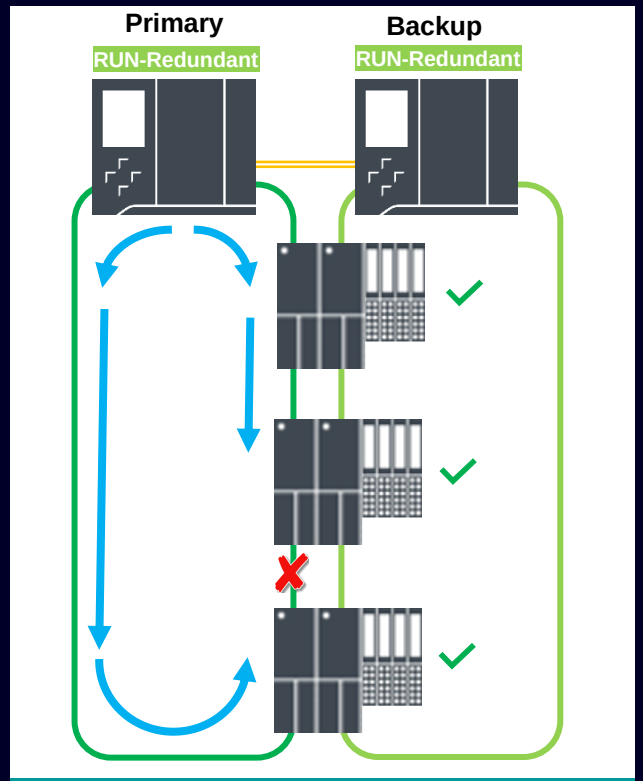
Specific failure scenarios for S7-1500 H

Setup with system redundancy R1 – failure of <u>one</u> Pilotages

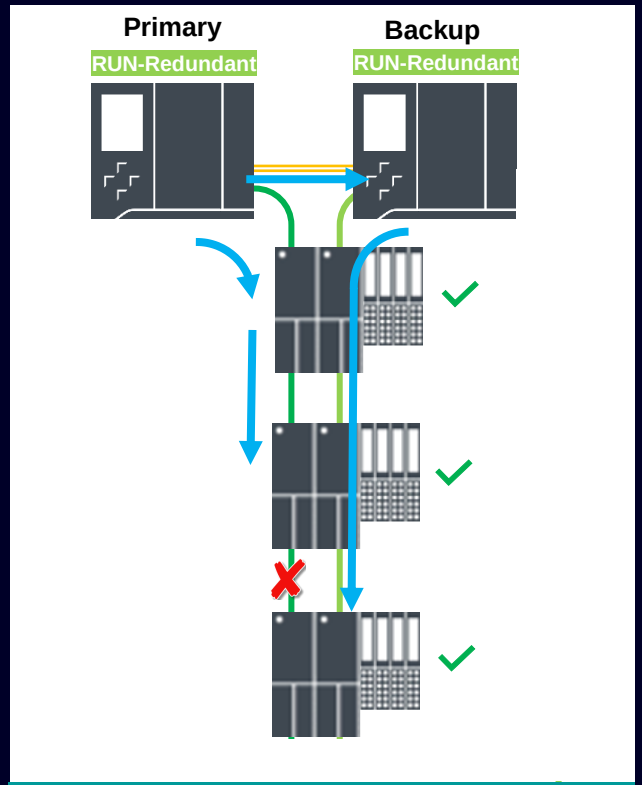
New

2 MRP Rings



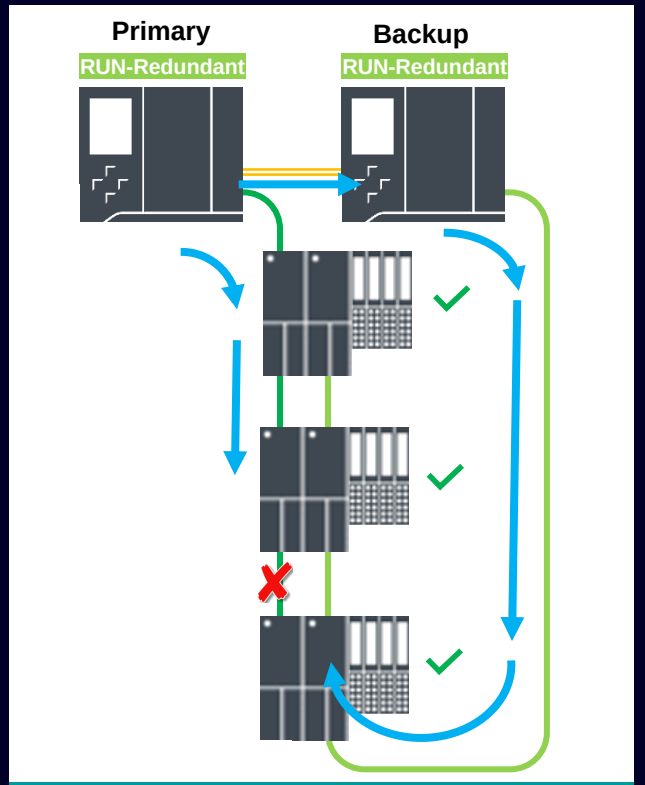
After MRP reconfiguration, all IO devices continue to work

Line topology - with feeding from the same direction



IO data is forwarded to the IO devices via the backup CPU

Line topology – with feeding from different directions



IO data is forwarded via the backup CPU.
All IO devices continue to work

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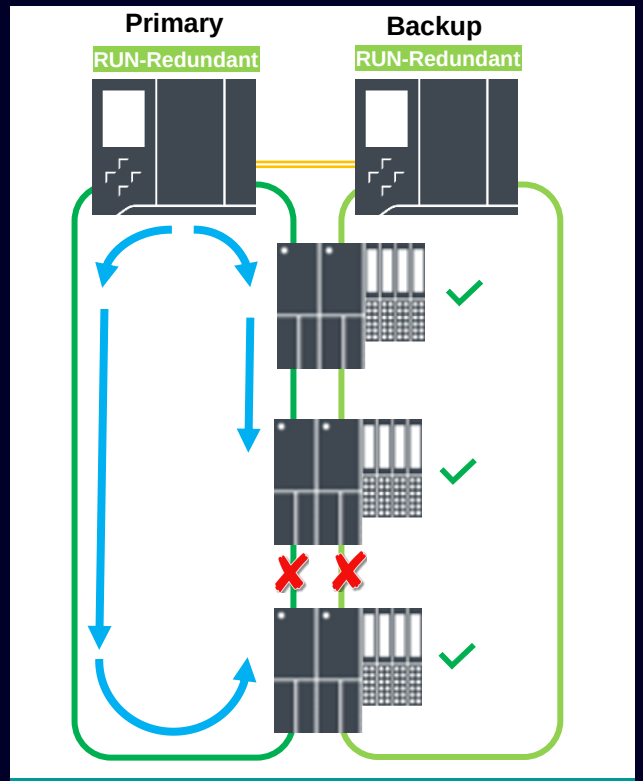
Specific failure scenarios for S7-1500 H

Setup with system redundancy R1 – failure of two Pilotages

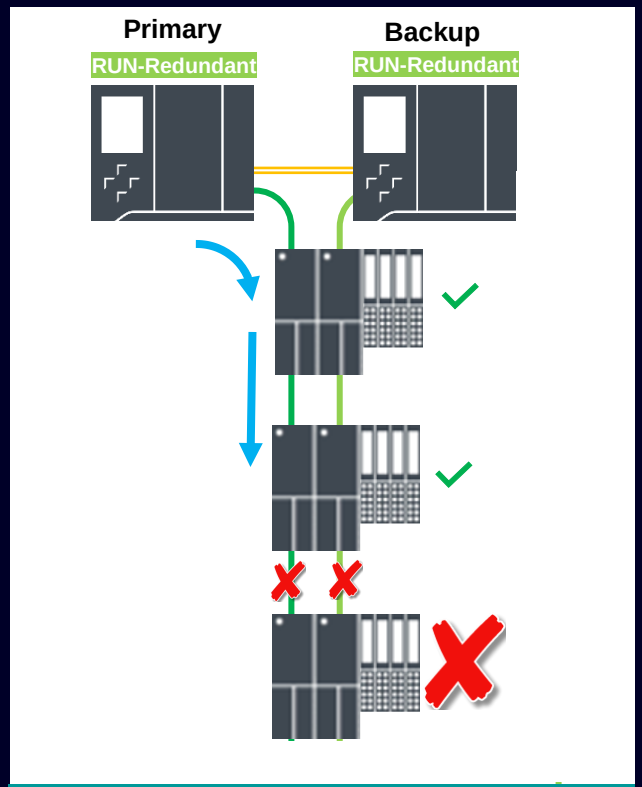
New

2 MRP Rings



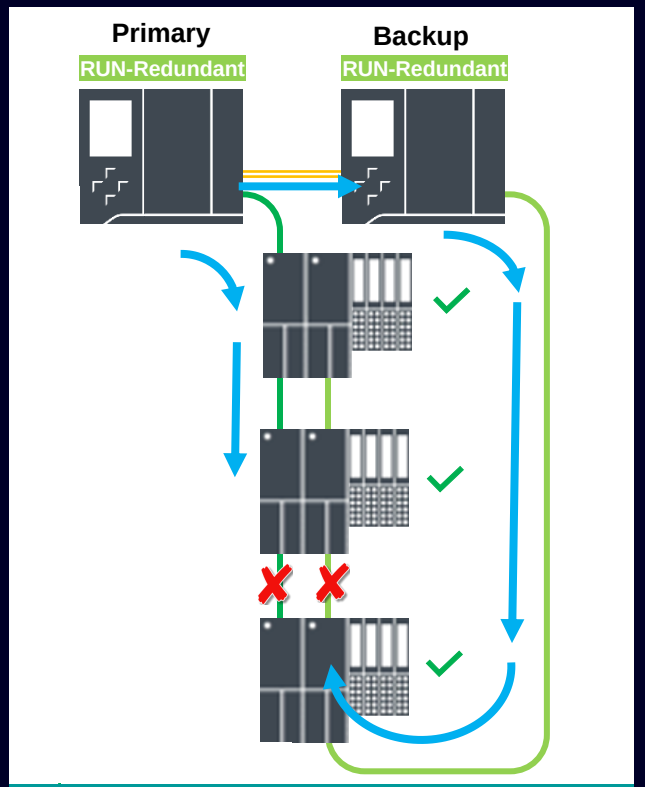
After MRP reconfiguration, all IO devices continue to work

Line topology - with feeding from the same direction



IO devices fail after interruption

Line topology – with feeding from different directions



IO data is forwarded via the backup CPU.
All IO devices continue to work

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Communication via System IP and Device IP addresses

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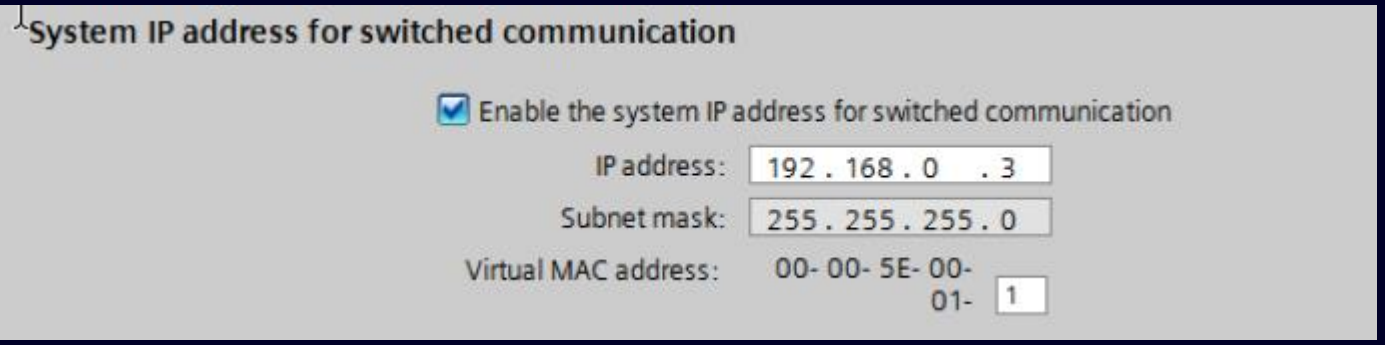
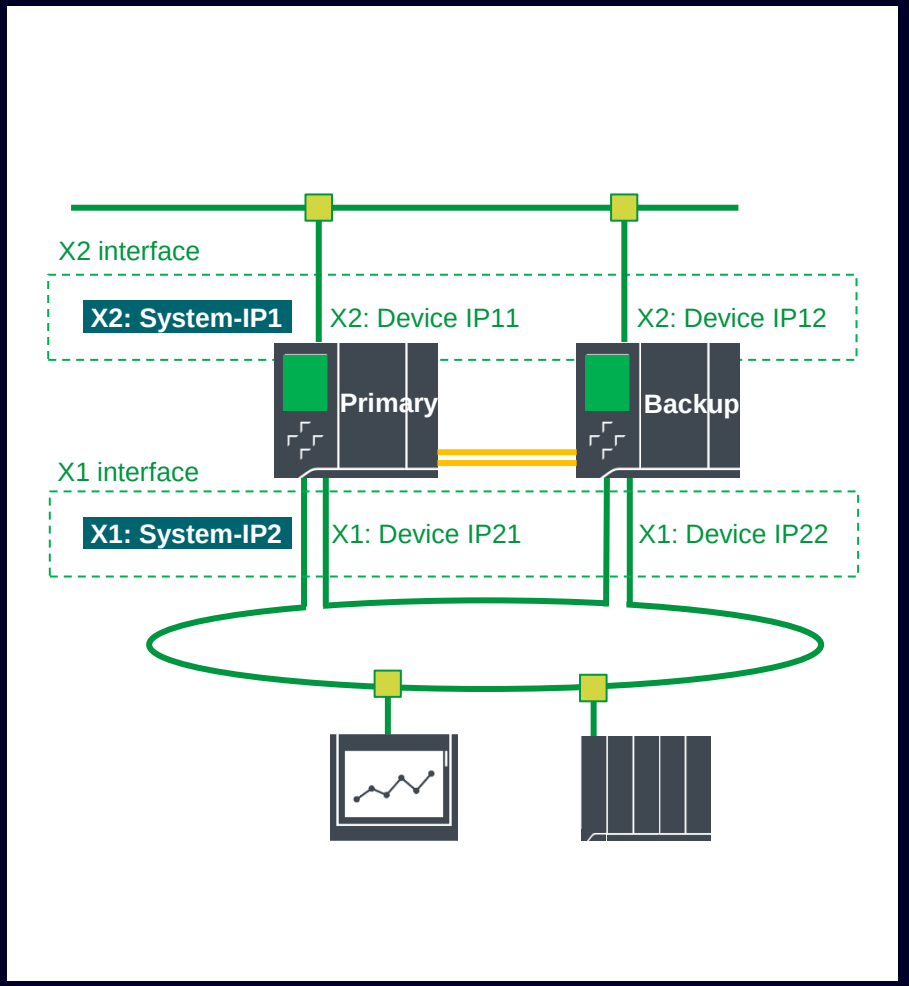
Communication via System IP
IP addresses for the R/H system

In addition to the Device IP addresses, for each interface pair of the R/H system, another
System IP address can be activated.





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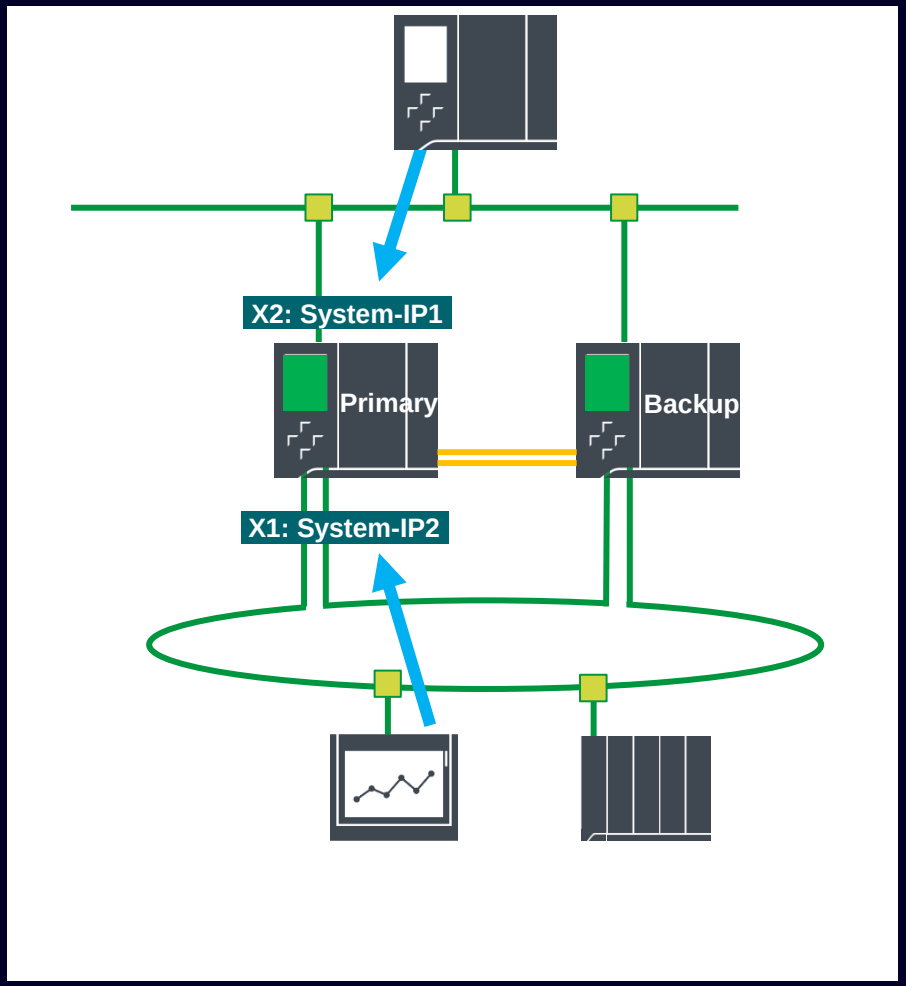
Communication via System IP
Behavior assigned to the primary CPU.

The System IP address is automatically assigned to the primary CPU.

For a communication partner (e.g. standard PLC or HMI), the R/H system behaves like a "normal" (non-redundant) connection partner.



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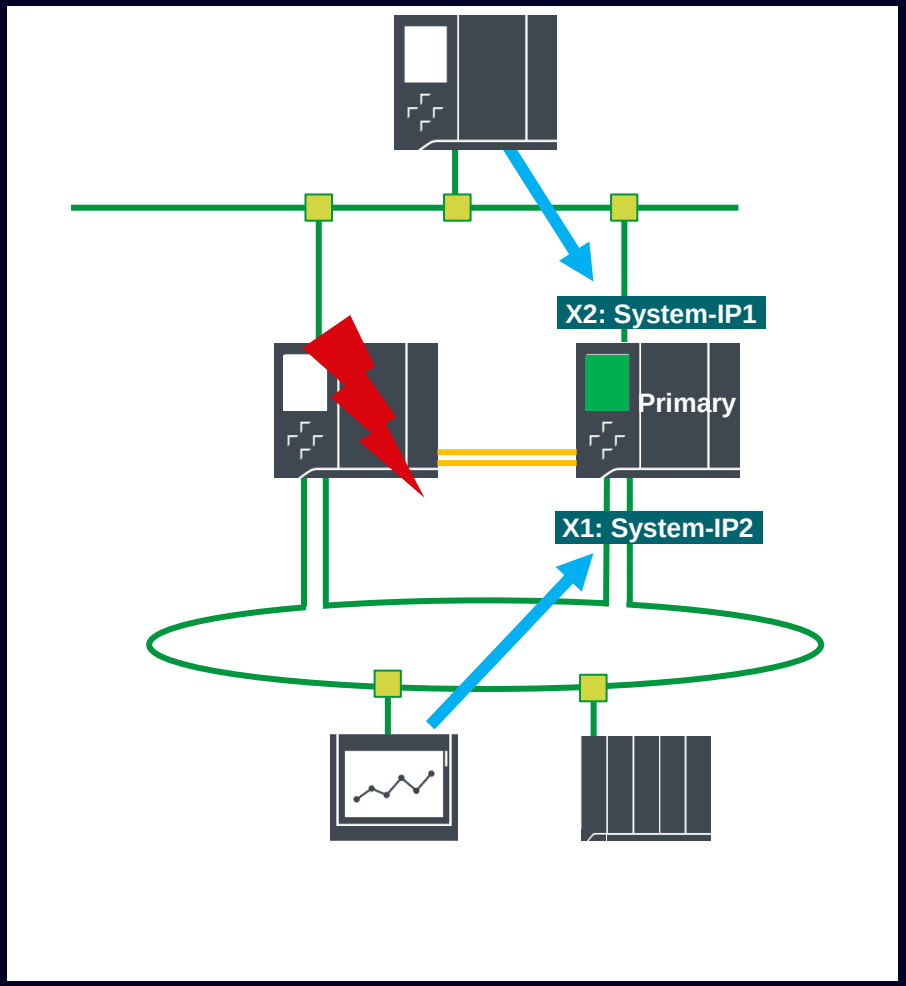
Communication via System IP
Behavior with Primary Backup Failover

If the primary controller fails, the System IP addresses are automatically moved to the backup PLC

→ A standard controller / HMI can continue to communicate via the same IP address



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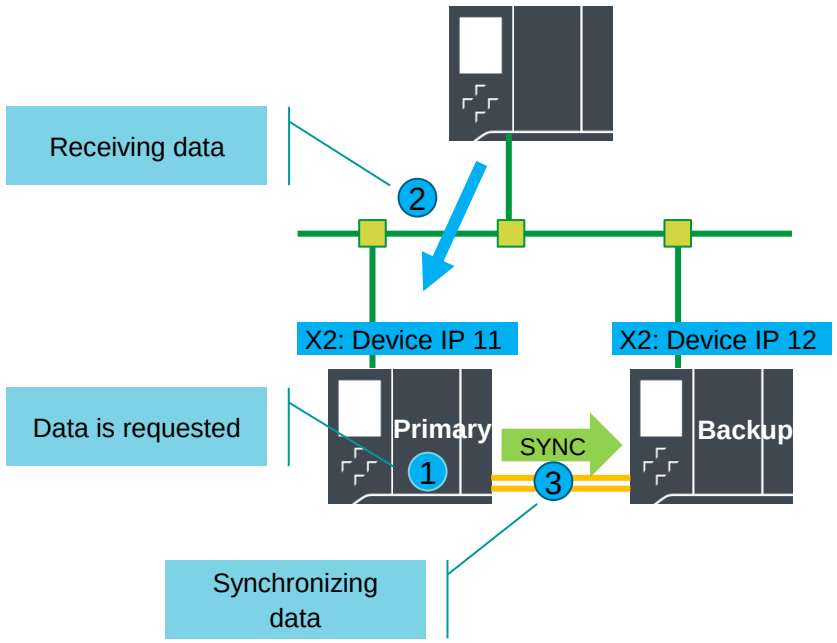
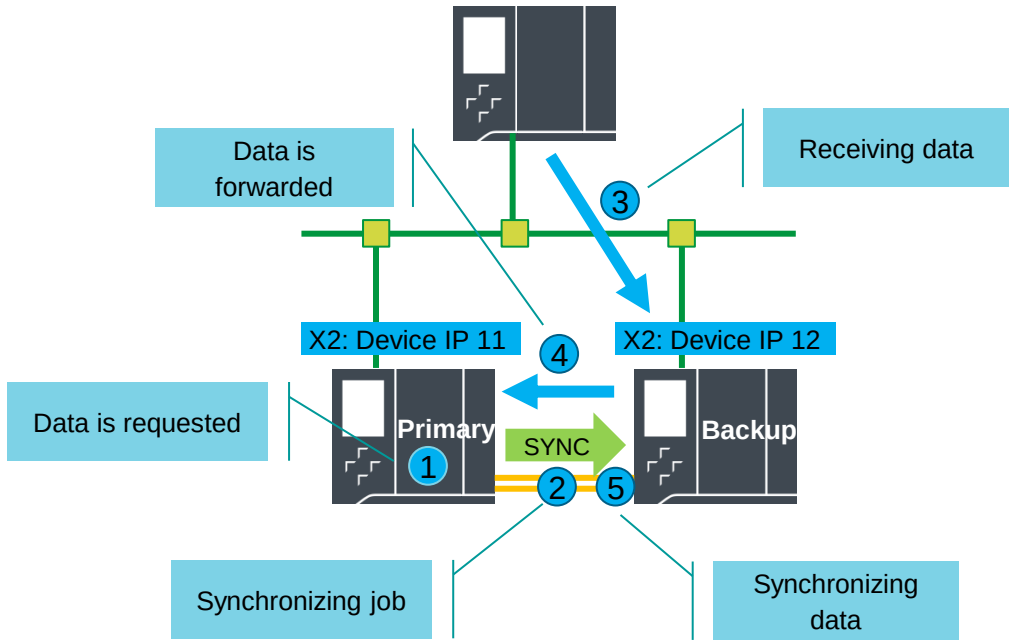
Communication via Device IP addresses
Behavior automatically assigned to the primary CPU.

Communication via Device IP addresses works both via the Primary as well as via the backup CPU.
Please note: Using the connection via the Backup-PLC leads to higher sync load in the system.

Communication via Primary PLC



Communication via the Backup PLC



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Safety for Redundant Systems

SIMATIC S7-1500 Redundant Systems

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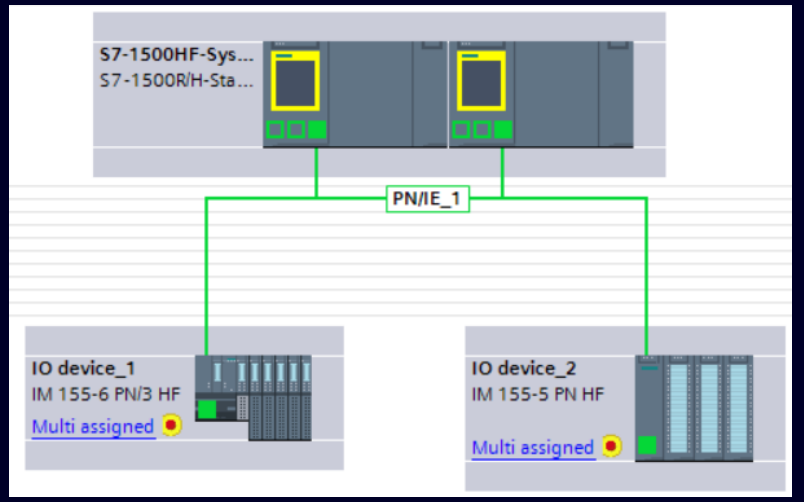
Safety for Redundant Systems
Realize Safety Applications with redundant Controller

High Availability + Failsafe = CPU 1518HF

- Engineering ab STEP 7 Professional V17 und STEP 7 Safety
- Safety programming as with non-redundant fail-safe PLC
- Supported PROFIsafe Communication
- Supports flexible F-Link (safe controller/controller communication)
- Fail-over scenario without stop the safety program

Almost Commissioning Mode

- The Fast Commissioning Mode in deactiviated safety mode allows short turnaround times:
  - Faster compile time of the F program
  - In this mode, the F program can also be loaded in the System State RUN
  - To change back to the safety mode, a STOP-RUN transition is required



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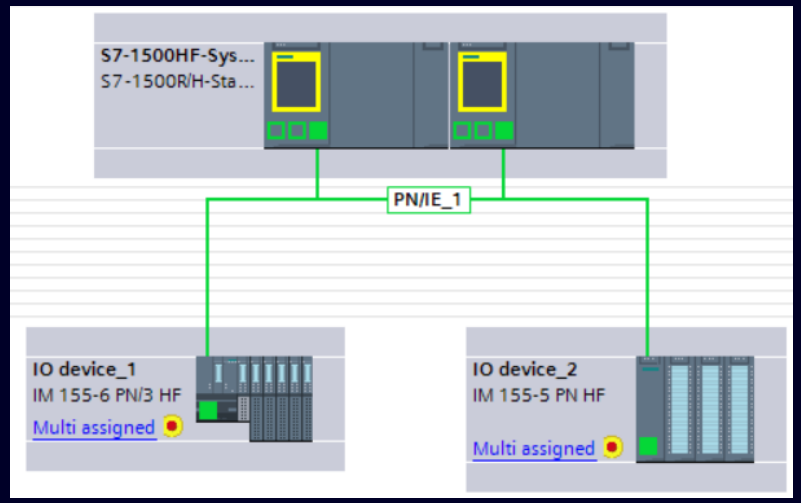
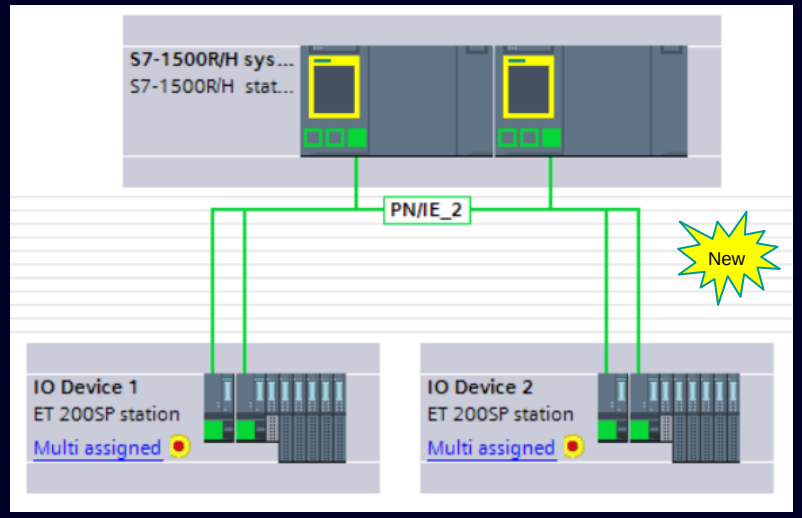
Safety for Redundant Systems
Realize Safety Applications with redundant Controller

High availability + Fail-safe = CPU 1518HF
Both S2 and R1 configurations are supported





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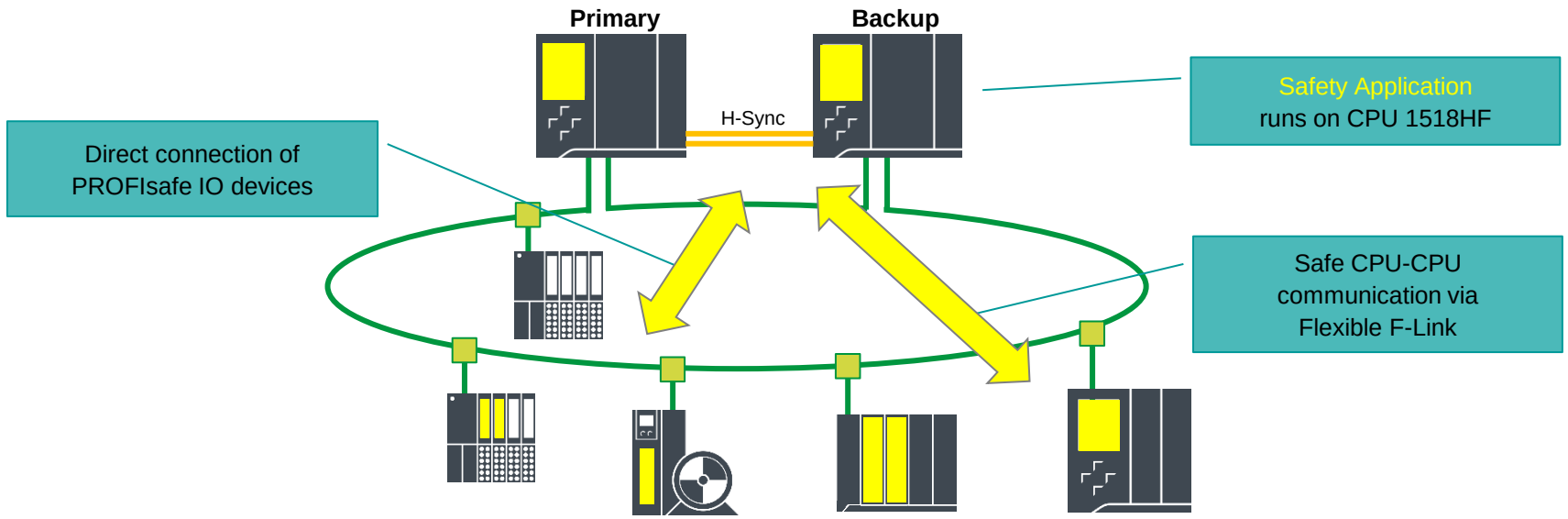
Network configuration with S7-1500 HF
Safety Devices

Direct integration of fail-safe devices with SIMATIC CPU 1518HF



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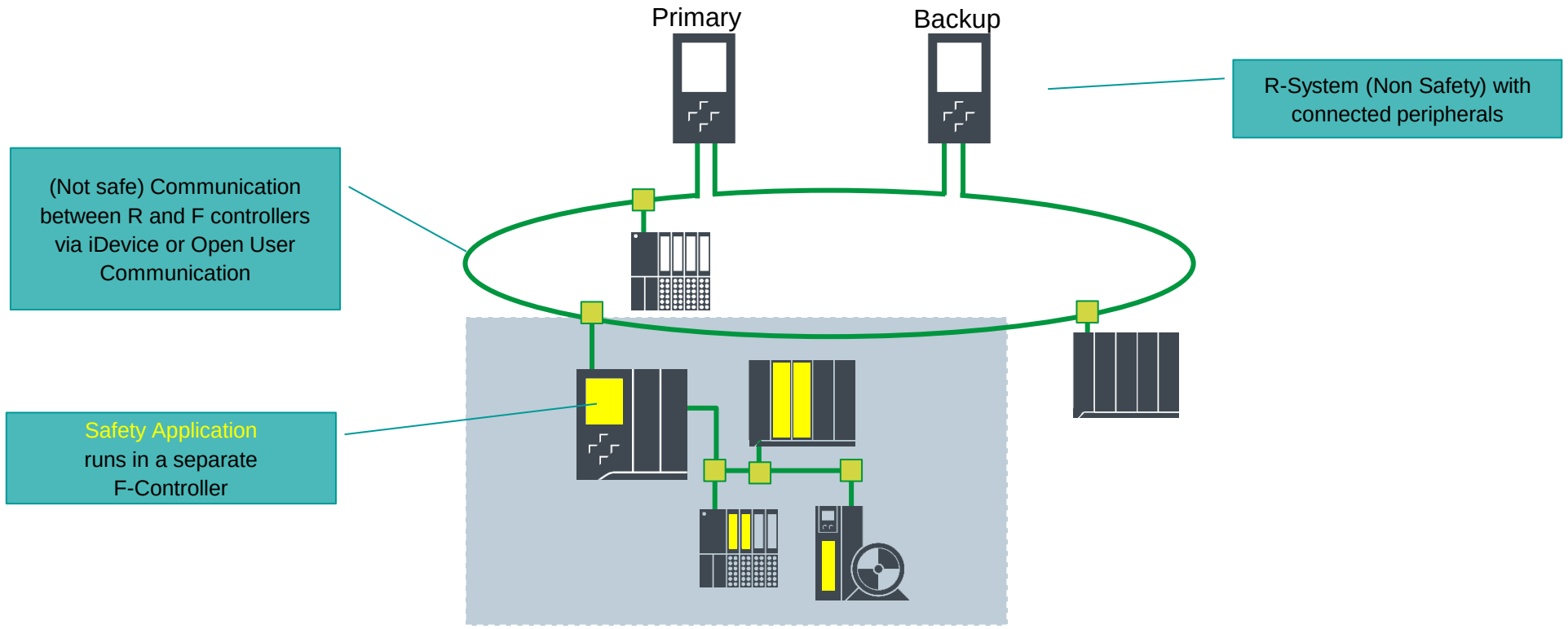
Network configuration with S7-1500 R
Safety Devices

Connection of fail-safe devices via a subordinate F-controller



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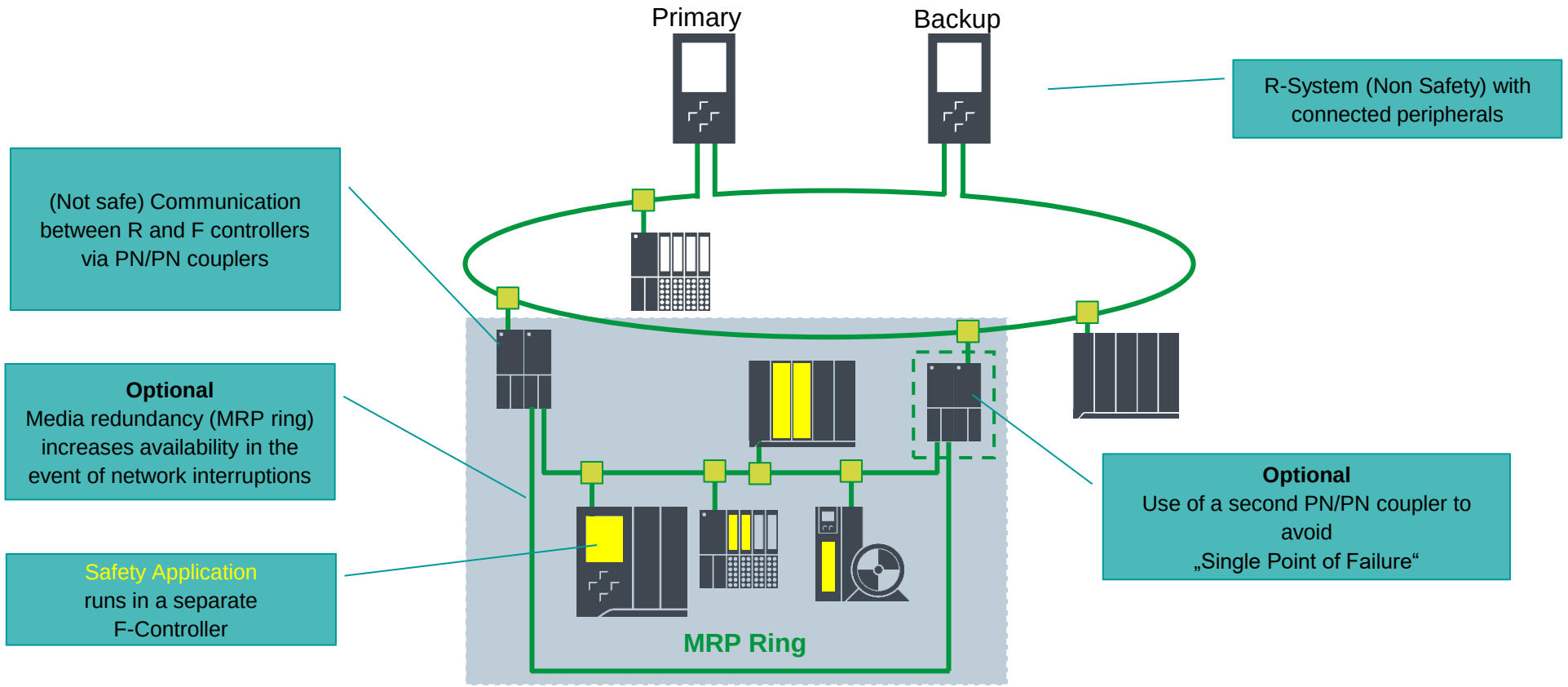
Network configuration with S7-1500 R
Safety Devices

Connection of fail-safe devices by a subordinate F-controller with PN/PN coupler



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Load project
Load program

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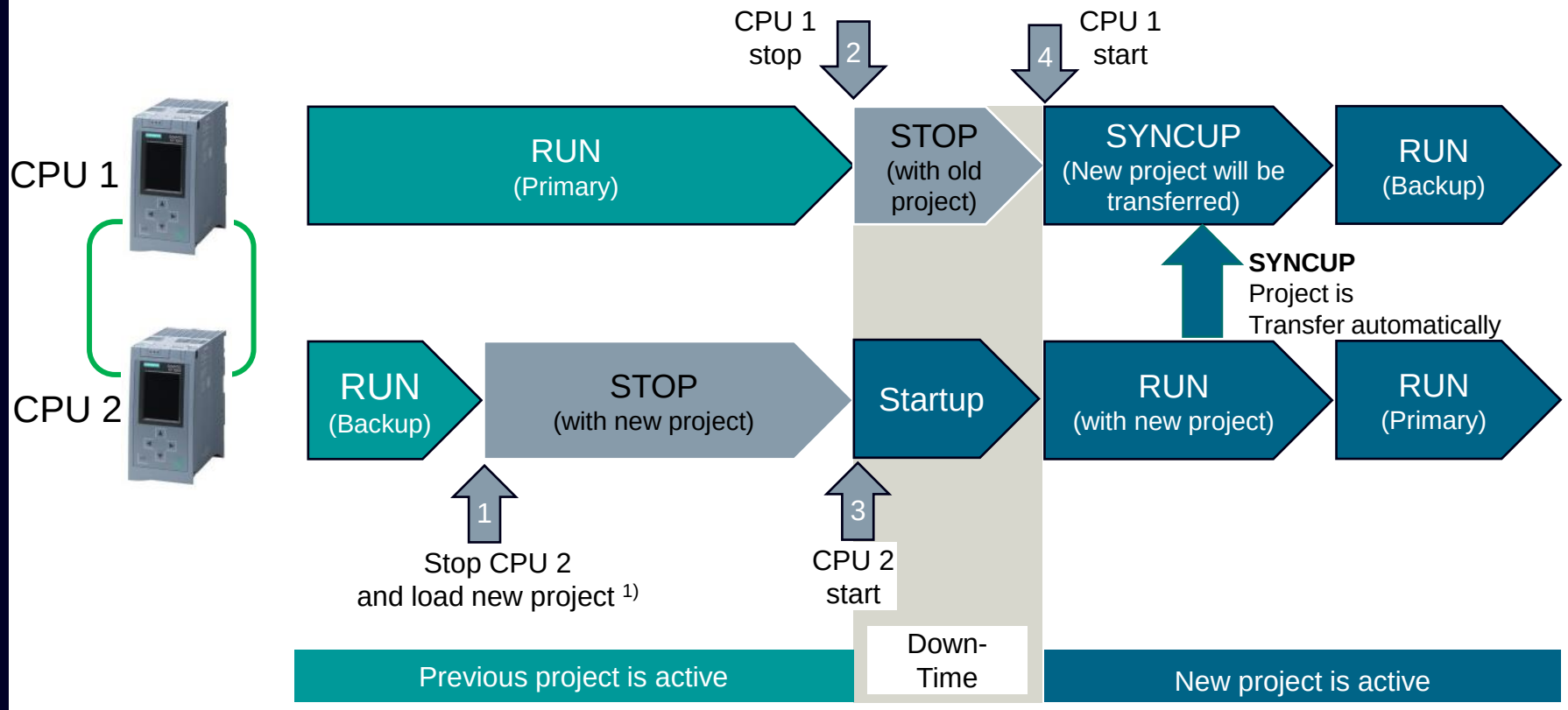
Load project in S7-1500R/H
Procedure with changes to the hardware configuration

Changes to the hardware configuration can only be loaded in the STOP state of a CPU.
To minimize downtime, the following procedure is recommended:



1) Using the "Load into Backup CPU" function from the project tree of the TIA Portal

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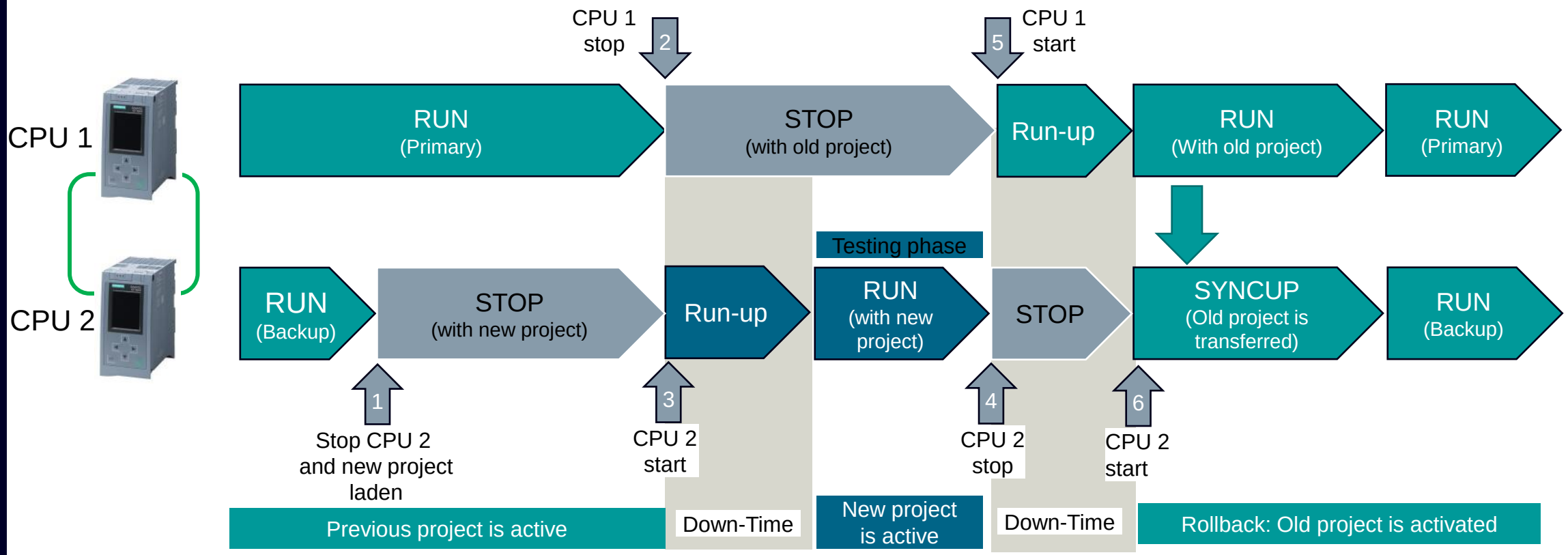
Load project in S7-1500R/H
Rollback to previous project status

With a similar approach, a quick "rollback" to the original status of a project planning can also be realized. This can be useful if a program change is not successful.



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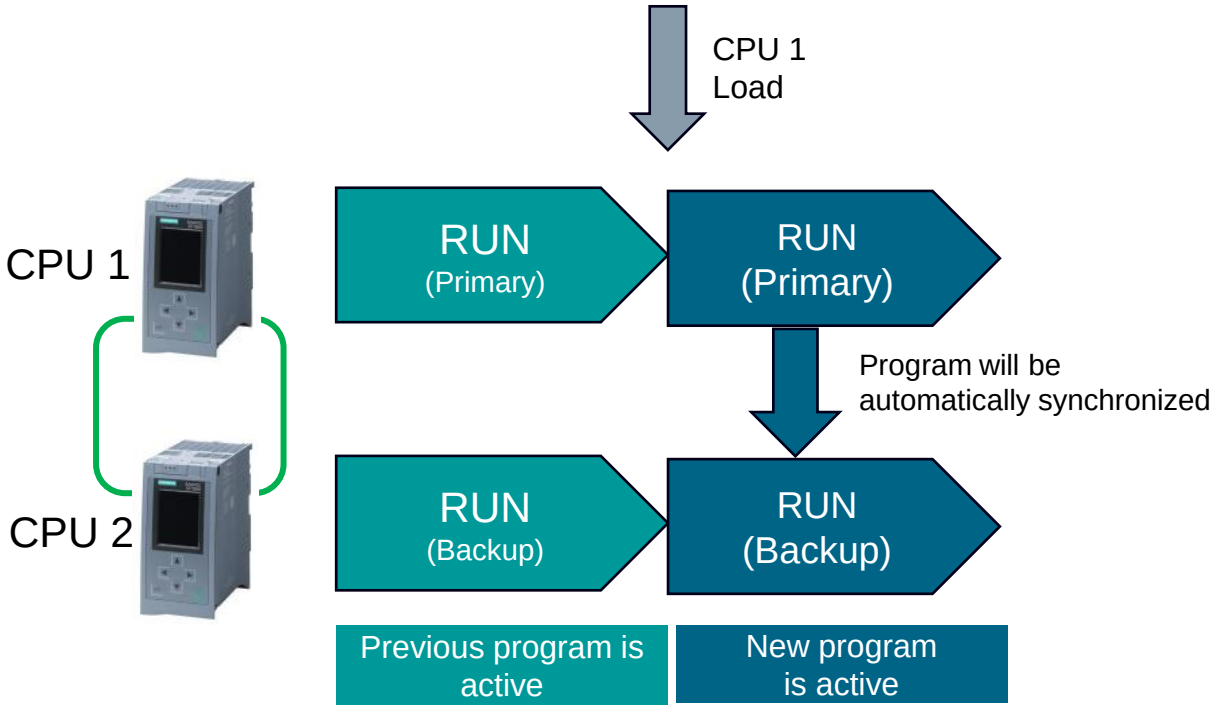
Load program in S7-1500R/H
Procedure without changes to the hardware configuration

If only the program of the CPU has been changed, this can be loaded in the RUN-Redundant state



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Hardware extensions in RUN with IO-Link

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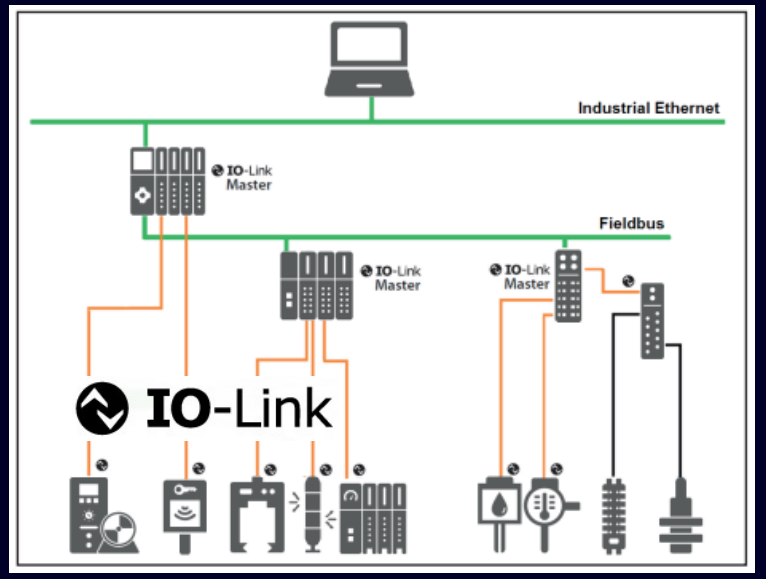
Hardware extensions in RUN with IO-Link
Applications

IO-Link for the extension of the hardware of a plant in the RUN

By using IO-Link, it is possible to carry out plant expansions without interrupting operation.

What is IO-Link?

- IO-Link is a standardized point-to-point IO technology (IEC 61131-9) to communicate digitally with sensors and actuators.
- IO-Link devices are offered by most sensor manufacturers
- Siemens has IO-Link masters for the complete ET 200 family in its portfolio
  - AND 200SP
  - AND 200MP
  - AND 200eco PN
  - AND 200AL
  - AND 200pro



The following use cases can be solved with IO-Link

1. Add new sensors or actuators
2. Change the type of a sensor / actuator
3. Configure measuring point (e.g. adjust measuring range)

More information about IO-Link?

See https://www.siemens.com/io-link
or https://io-link.com/

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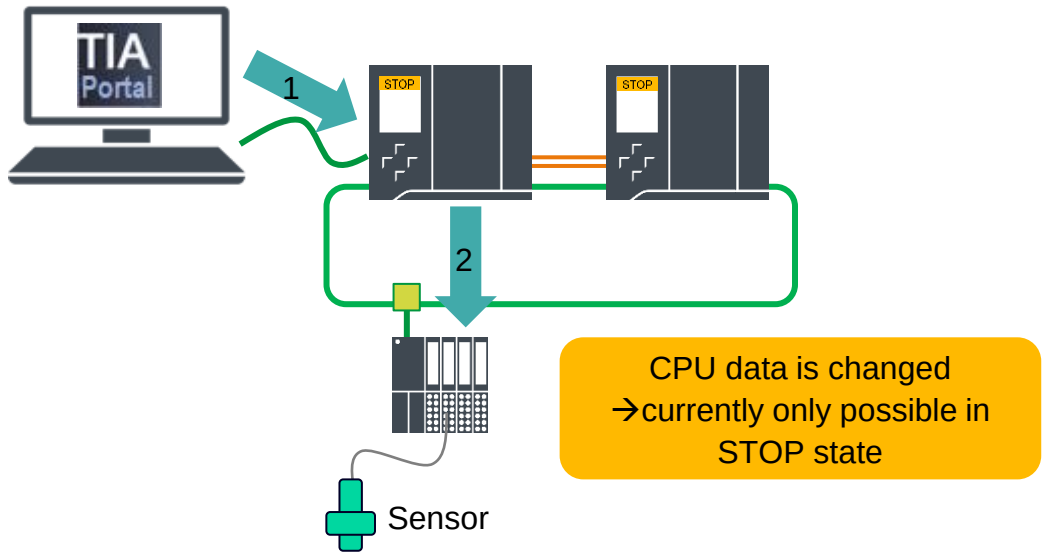
Hardware extensions in RUN with IO-Link
Functionality

With IO-Link, the actuators/sensors are configured directly via the IO-Link master.
The CPU or the RH system is not involved.

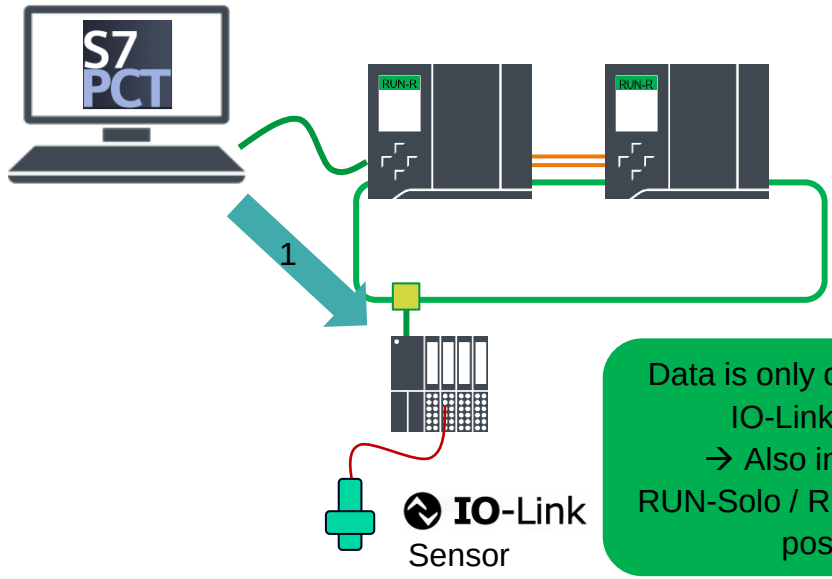
Sequence of HW configuration with conventional actuators/sensors



CPU data is changed
→currently only possible in STOP state

1. TIA Portal project is loaded into the PLC
2. PLC sends the data to the ET 200

Procedure of the hardware configuration with IO-Link



Data is only changed in the IO-Link devices
→ Also in condition RUN-Solo / RUN-Redundant possible

1. S7-PCT Tool loads the data into the IO-Link master
2. The IO-Link master configures the IO-Link devices

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Hardware enhancements in RUN (CiR) with IO-Link
Procedure – Add new measuring point

Construction
Commissioning phase
System im STOP

1. Reserve IO-Link master modules into a Install ET 200 station
2. Perform TIA HW configuration
3. Load TIA Portal Project

Advantage:
An IO-Link port can universal for all channel types will use:
- Digital input
- Digital output
- IO-Link (Analog Values)

→ Only one assembly type for all applications
- ET 200SP: CM 4xIO-Link, 6ES7137-6BD00-0BA0
- ET 200MP: CM 8xIO-Link, 6ES7547-1JF00-0AB0

Hardware Extension
Production phase
System in RUN-Redundant

1. Connecting the sensor to the IO-Link master
2. Starting the IO-Link configuration tool "S7-PCT" from the TIA Portal
3. Inserting and parameterizing IO-Link sensor/actuator in PCT
4. IO-Link Master laden

→ **Process values of the IO-Link device are exchanged**

Program Extension
Production phase
System in RUN-Redundant

1. Use a corresponding PLC tag (symbol) in the TIA Portal and in the PLC program
2. Load the supplemented PLC program into the R/H system

→ **The program evaluates the data of the new measuring point**

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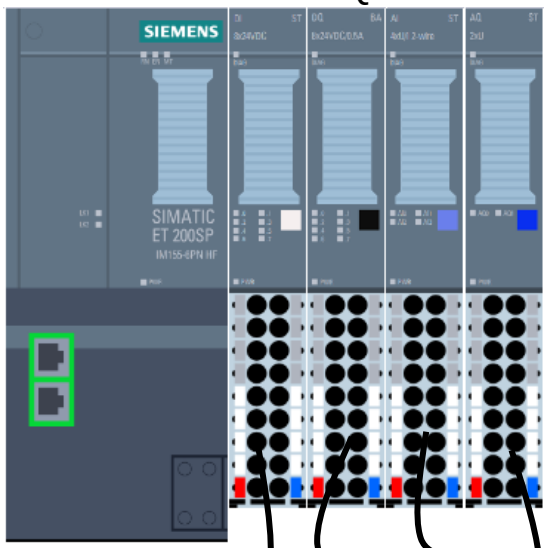
Connection of a sensor / actuator
Example: ET 200SP

Conventional

Four different module types are required

DI DQ RTD AI



Proximity switch
24 VDC

Contactor
24 VDC

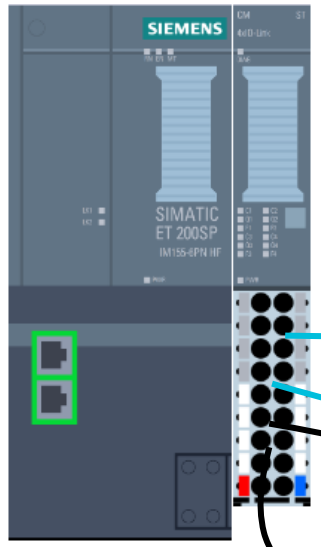
Temp-Sensor
PT 100

Flow
4..20mA

With IO-Link

Only 1 module type is required

CM IOL



The connection is selected via S7-PCT

Port	Betriebsmodus
1	DI
2	DO
3	IO-Link
4	IO-Link

→ In RUN-redundant state of the R/H system possible

Proximity switch
24 VDC

Contactor
24 VDC

Temp-Sensor
IO-Link

Flow
IO-Link

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HMI Connection

SIMATIC S7-1500 Redundant Systems

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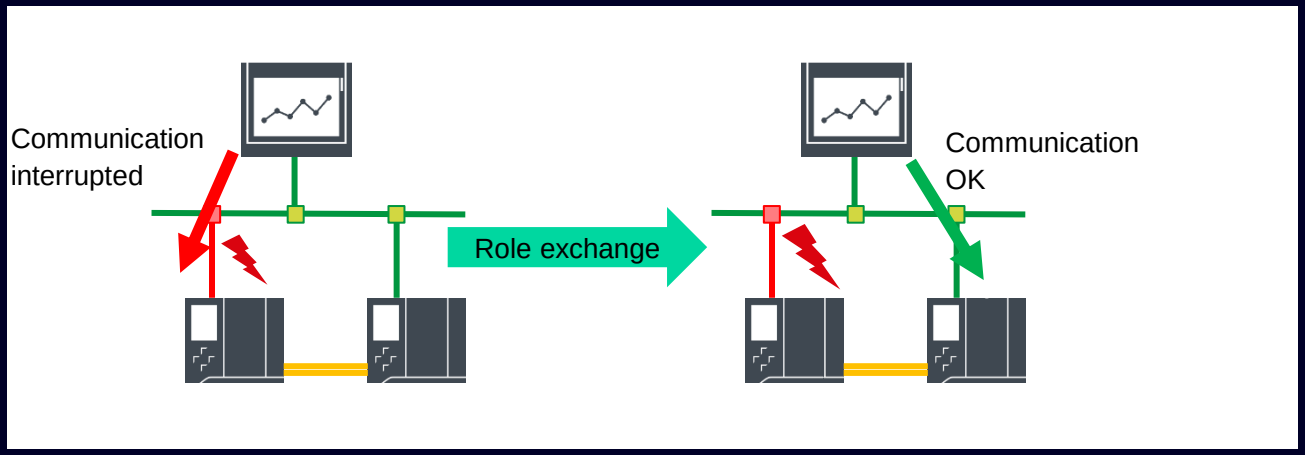
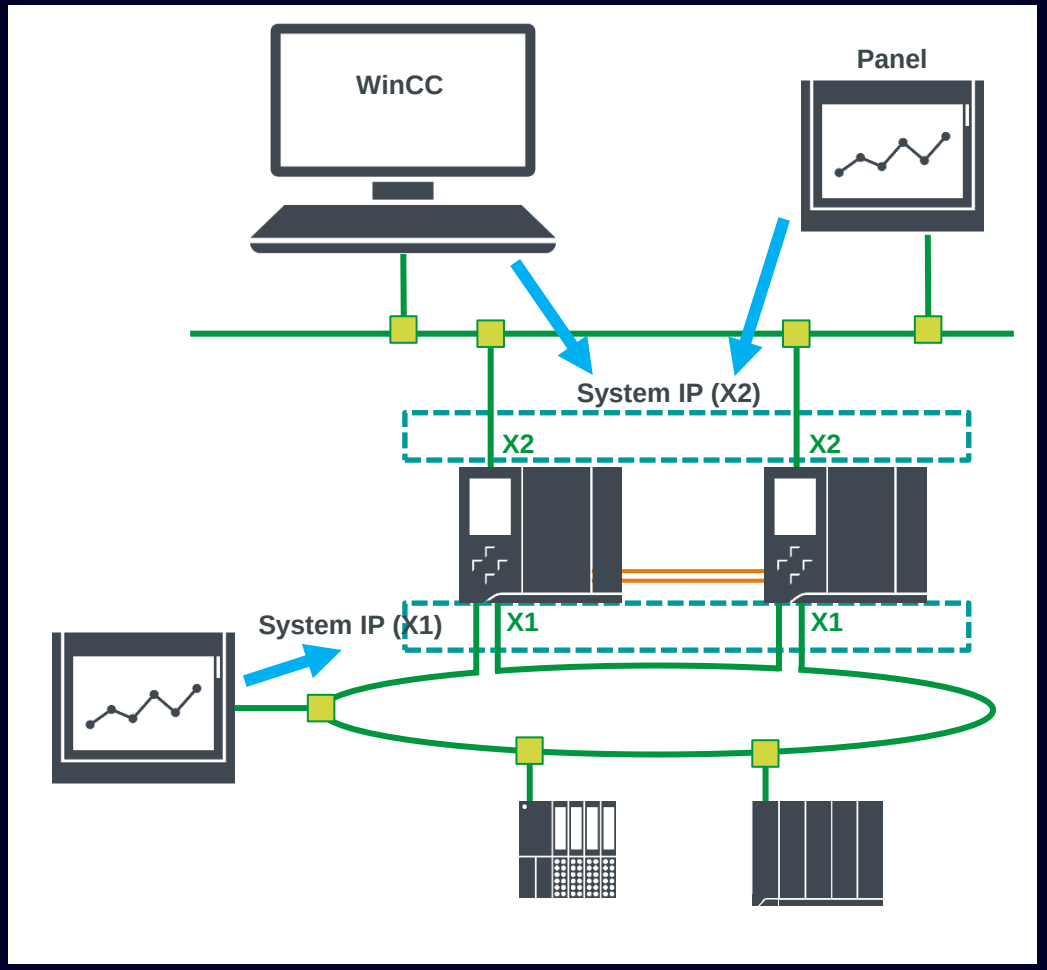
HMI Connection
via a non-redundant network using System IP address

An HMI connection via the System IP addresses for a non-redundant network is possible in all cases.

Note when connected via X2:
If the connection to the Primary PLC is interrupted, communication with the R/H system is no longer possible because the System IP address remains with the Primary PLC. In this case, the role of the PLCs can be changed programmatically to remedy the situation. See slide RH_CTRL Instruction





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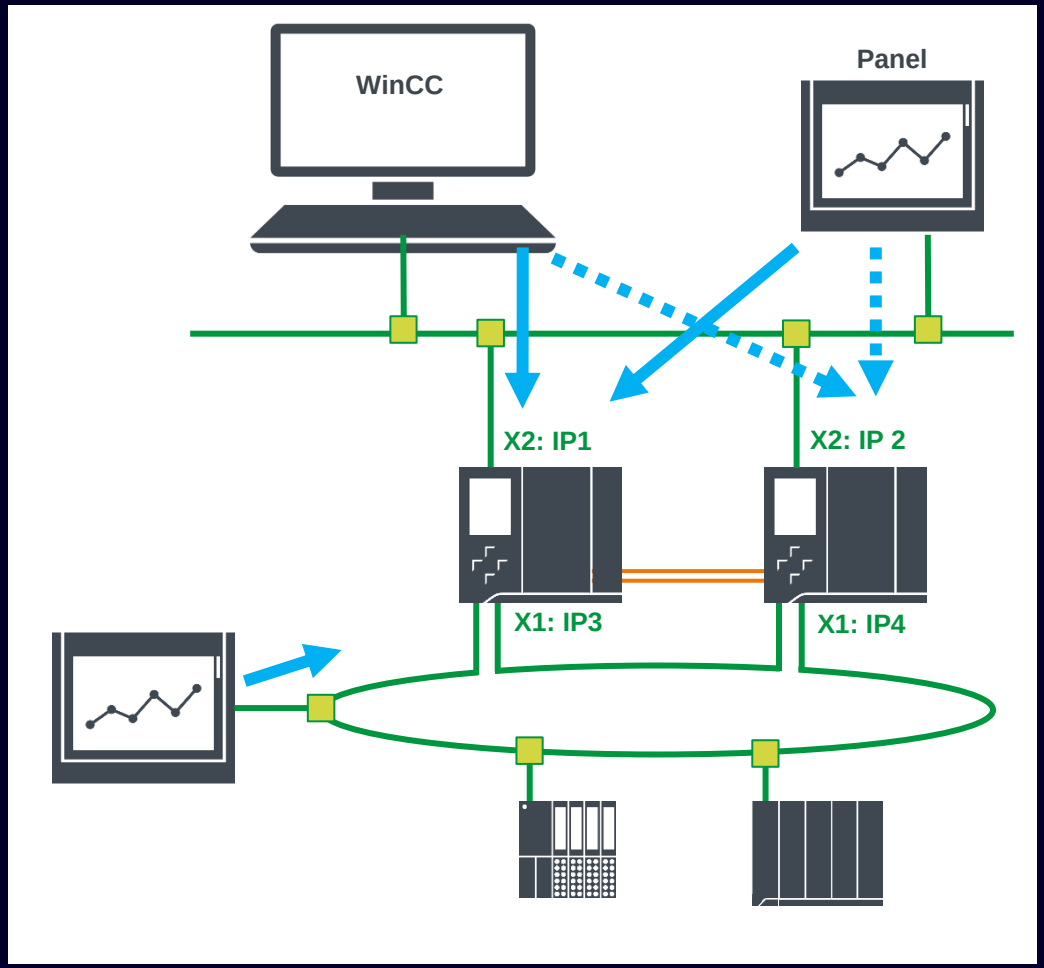
HMI Connection
via a non-redundant network using Device IP addresses

An HMI connection via the Device IP addresses requires a switching option on the HMI side. This is possible with

- WinCC OA ab V3.18
- WinCC V7.5 SP1 via Scripting
- SIMATIC Panels via Scripting

The following application example is available for connecting SIMATIC panels to an R/H system:
https://support.industry.siemens.com/cs/ww/de/view/109781687



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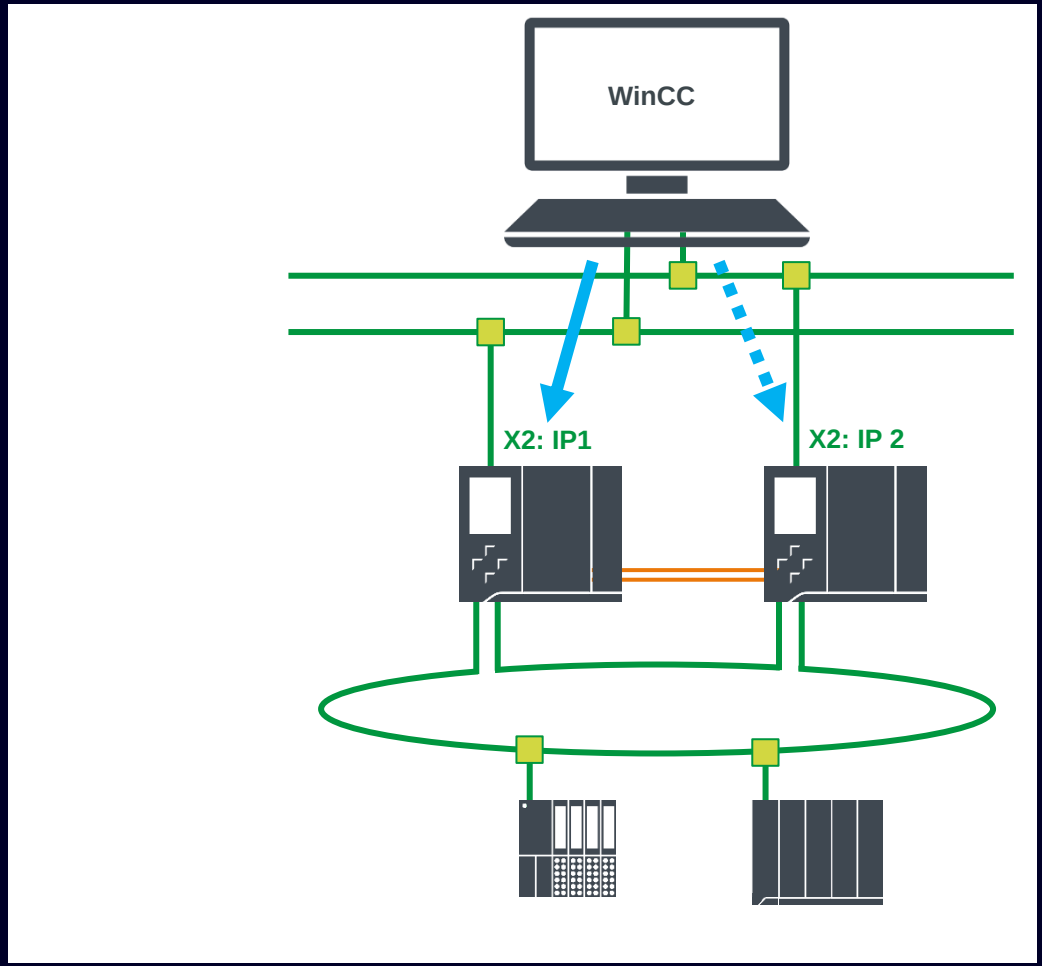
HMI Connection
via redundant network using Device IP addresses

The HMI connection via a redundant network using Device IP addresses is possible with

- WinCC OA ab V3.18
- WinCC V7.5 SP1 via Scripting

The communication connection is switched by WinCC in the event of a fault. See
https://support.industry.siemens.com/cs/ww/de/view/109773067



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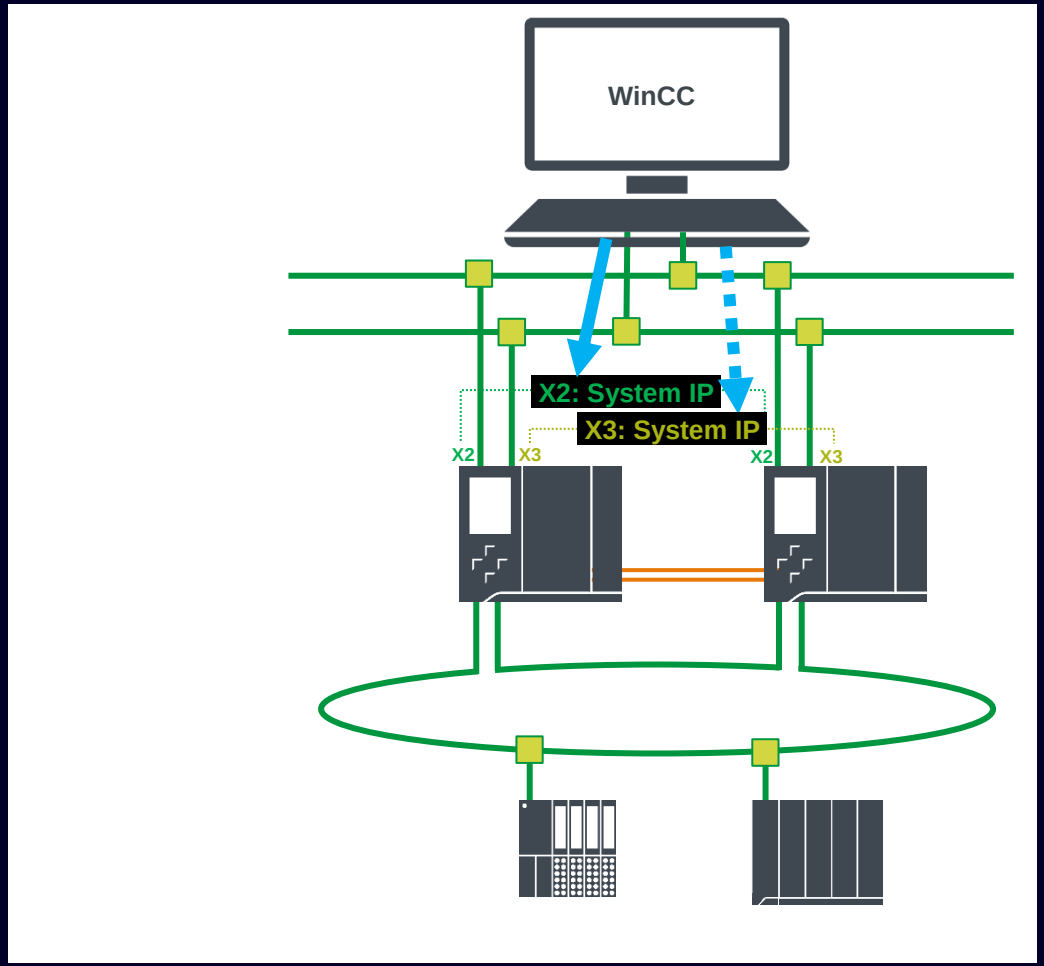
HMI Connection
via redundant network using System IP addresses

The HMI connection via a redundant network using System IP addresses is possible with

- WinCC OA ab V3.18
- WinCC V7.5 SP1 via Scripting

Use of R/H interfaces:
System IP of X1 and X2 for CPU 1515R-2 PN and CPU 1517H-3 PN
System IP of X2 and X3 with CPU 1518HF-4 PN

Behavior in case of error:
- If the primary CPU fails, the RH system switches over by moving the System IP addresses
- If a network fails, WinCC switches over



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Programming Recommendations

SIMATIC S7-1500 Redundant Systems

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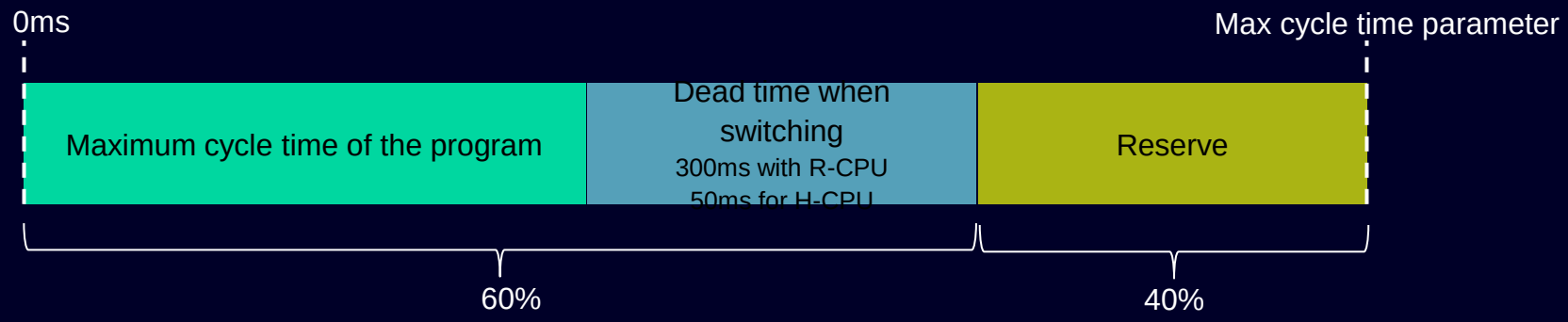
Programming recommendations SIMATIC S7-1500 R/H (I)

1) Set maximum cycle time

The maximum cycle time should be set as large as the process allows.
This can shorten the time for the SYNCUP, as the transition to RUN-redundant only takes place when the actual cycle time is <80% of the set maximum cycle time.
Recommendation**:**



2) Set minimum cycle time as high as possible

By increasing the minimum cycle time to the minimum value required for the process, the system load due to synchronization is reduced.
This also shortens the SYNCUP phase and leads to higher performance in communication.

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Programming recommendations SIMATIC S7-1500 R/H (II)

3) Avoid direct peripheral access

Each direct peripheral access is synchronized in the system state RUN-Redundant and leads to a higher cycle time.
Recommendation: In the RH system, the inputs and outputs of the IO devices should only be accessed via the process image or the subprocess images.

4) Reduce communication during the SYNCUP phase

If possible, the communication load should be kept low during a SYNCUP phase. This will speed up the SYNCUP process. This can be done programmatically via the SFC "GET_DIAG".

```
#RetVal := GET_DIAG(MODE := 1, LADDR := "Local1~RHSystem", CNT_DIAG => #CNT_DIAG_temp, DIAG := #DIS);
IF #DIS.OperatingState <> 38 (* 38 = "SYNCUP system state" *)  THEN
  // not in syncup
  "Load"();
END_IF;
```

5) Reduce cyclic interrupts during the SYNCUP phase

If cyclic interrupts are used intensively in the program and it is tolerable to reduce the call frequency during the SYNCUP phase, then the sync load can be reduced by calling the system function "SFC SET_CINT". This measure also helps to shorten the SYNCUP time. In normal state (RUN-Solo or RUN-Redundant) the alarm times can then be changed back to the original state.

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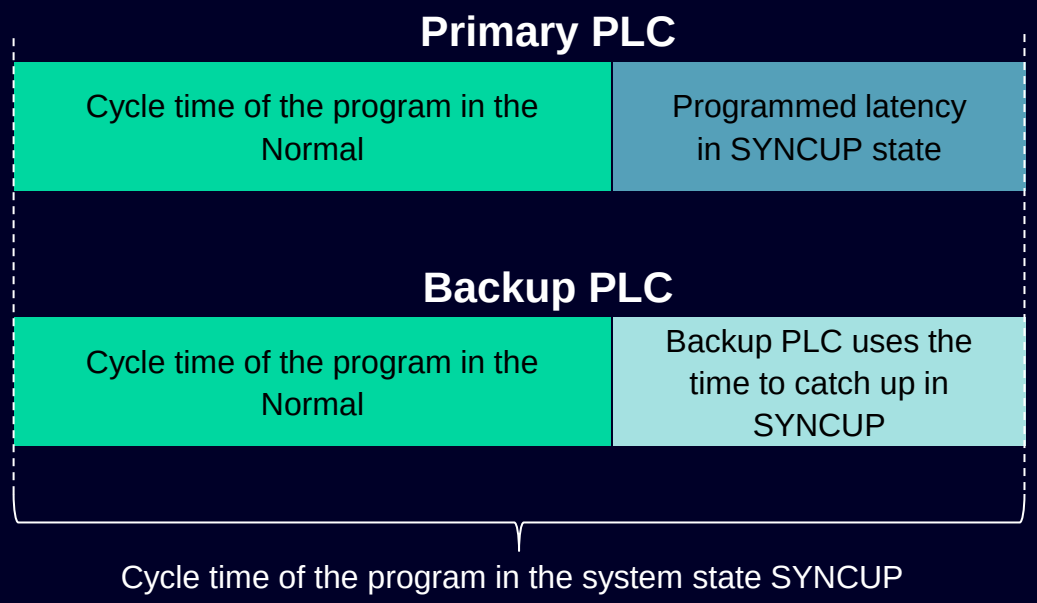
Programming recommendations SIMATIC S7-1500 R/H (III)

6) Use of the WAIT function in the system state SYNCUP

If a longer cycle time is tolerable in the SYNCUP system state, the SYNCUP process can be accelerated by calling the system function "WAIT" at the end of OB1. This is possible because the WAIT function on the backup PLC is used to catch up.




```
IF #DIS.OperatingState = 38 THEN
   // if in syncup
   WAIT(30000);
END_IF;
```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Specific functions for R/H controllers

SIMATIC S7-1500 Redundant Systems

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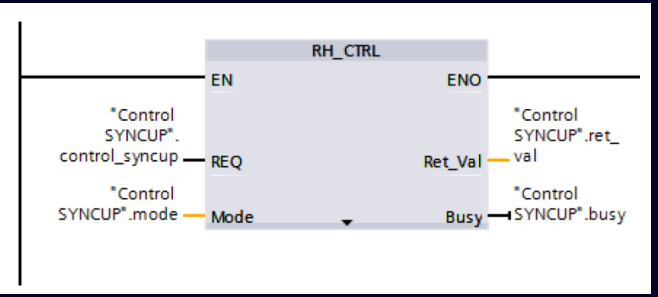
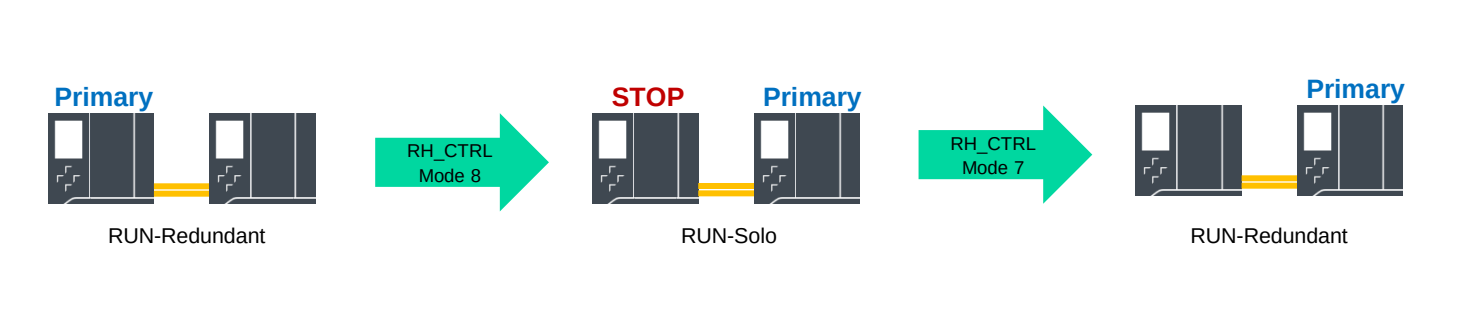
RH_CTRL Instruction
Switch CPU programmatically

Extensions of the RH_CTRL instruction

- **Request SYNCUP**: If the system is in the RUN-Solo state, the SYNCUP can be restarted by calling this function to bring the system back into the redundant state.
- **Stop Primary-PLC:** When running redundantly, the primary PLC is stopped and the backup PLC runs in RUN solo mode.
  If the SYNCUP is then requested again (mode 7), the system works with **swapped roles (primary/backup)** redundant.
- **Stop backup PLC:** When running redundantly, the backup PLC is stopped and the primary PLC continues to run in RUN solo mode.





Mode	Function
3	Lock SYNCUP
4	Share SYNCUP
7	Request SYNCUP
8	Stop Primary-PLC
9	Stop Backup PLC
10	Check if SYNCUP is locked

New

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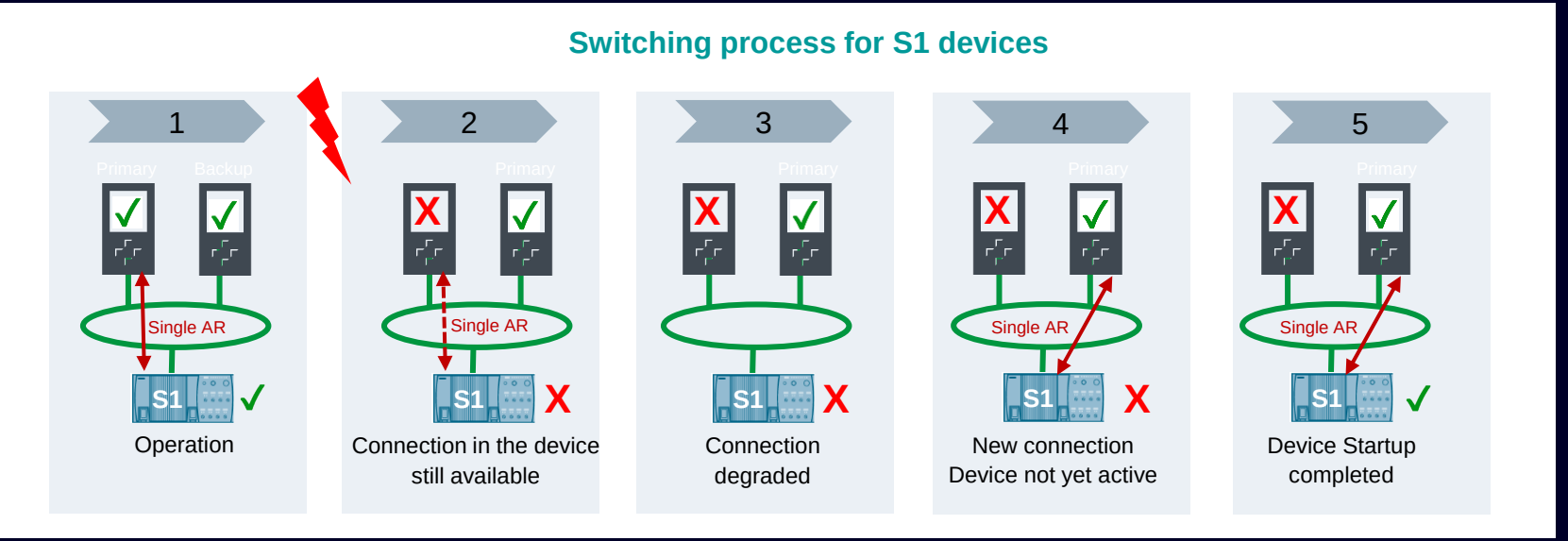
Switched S1
Adjustable switching time for the "Switched S1" function



1) System in redundant operation, IO data is exchanged
2) After fail-over: IO Device holds the existing connection until the expiration of the Watchdog-Time. As long as no further connection is possible.
3) IO device is ready for a new connection to the controller
4) The new connection is established, the IO device start-up begins
5) IO data is exchanged again

AR = Application Relation (connection between controller and device)

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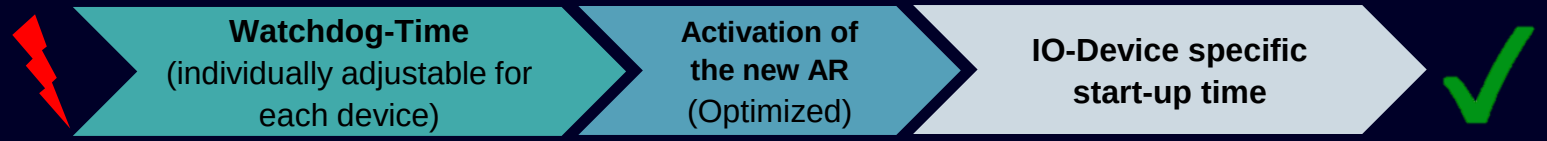
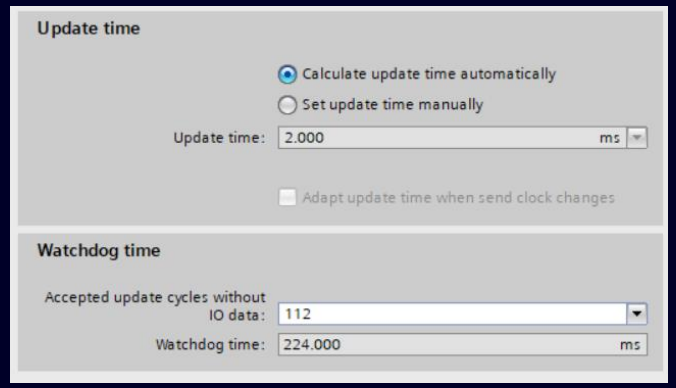
Switched S1
Adjustable switching time for the "Switched S1" function

Previous time behavior (with FW version 2.8)

New time behavior (with FW version 2.9)





Example measurement with CPU 1517H and iDevice (short device start-

	FW V2.8	FW V2.9
IO data active again after	3 seconds	0.6 seconds

AR = Application Relation (connection between controller and device)

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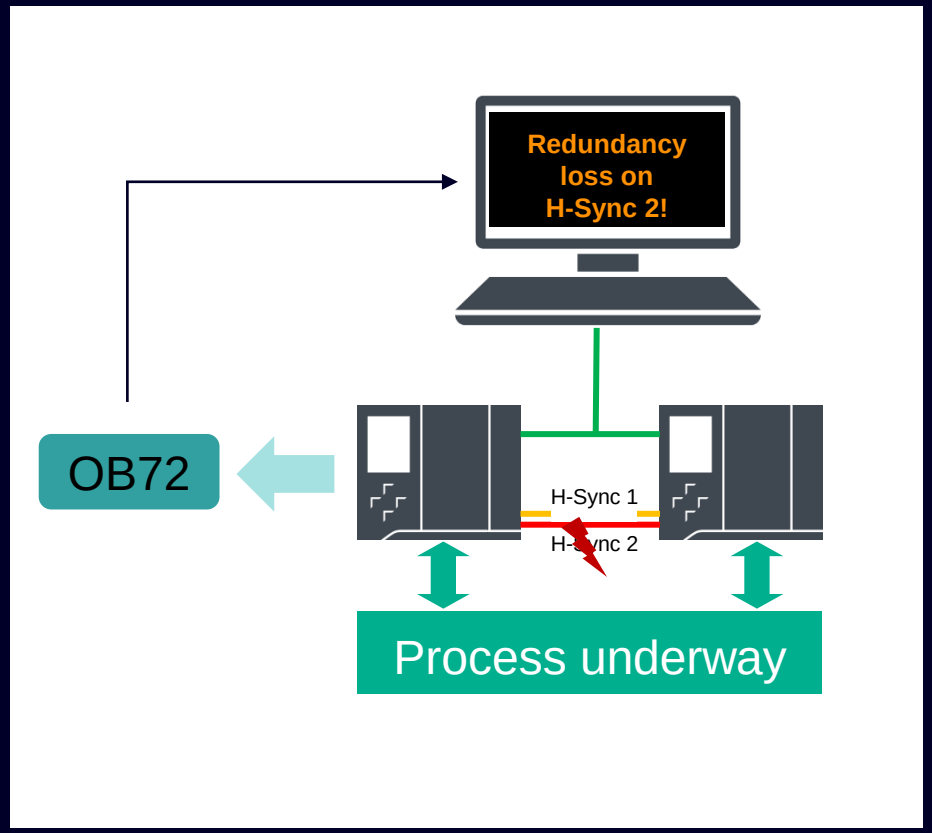
Reporting loss of redundancy
OB72 reports loss of redundancy during synchronization

- If a sync line fails, the maintenance LED on the controller lights up and the H-System continues to work in redundant mode.
- The failure of a sync line is reported from firmware V2.9 by calling the OB72 (redundancy loss).
- This can be used to report a request to restore the sync line.



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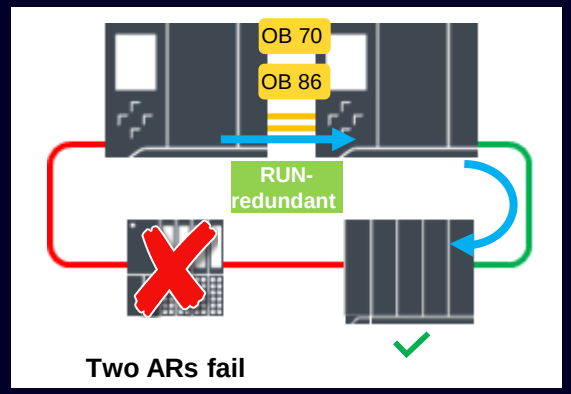
Reporting of peripheral redundancy errors
OB70 reports loss of peripheral redundancy

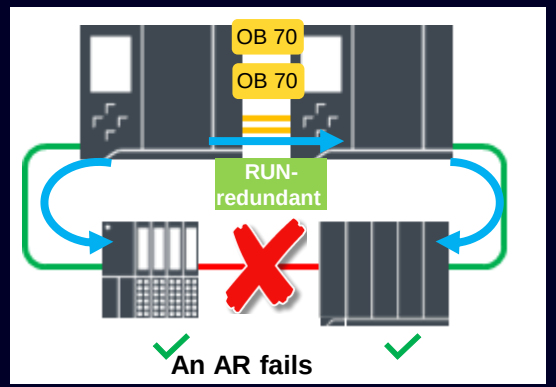
New

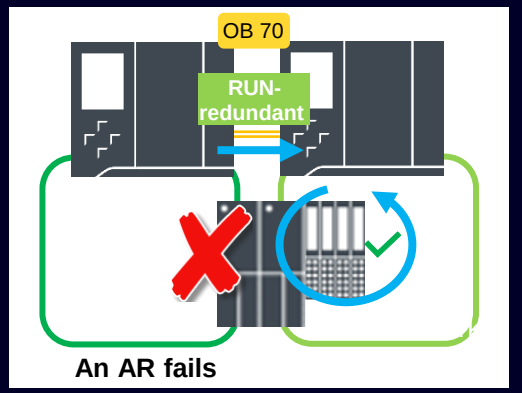
In the H system [1)], the OB 70 is called if in the system state **RUN-Redundant** on a R1/S2 device **redundancy loss** or a **redundancy return** event.

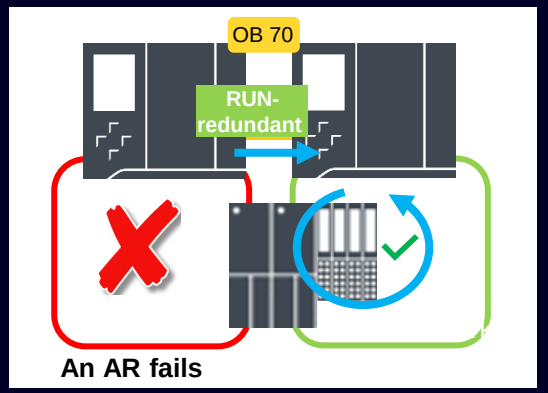
- **Redundancy Loss**: An AR of two ARs of an R1/S2 device fails
- **Redundancy Return:** The second AR of an R1/S2 device is rebuilt

Example scenarios for the OB 70 call:









1) (CPU 1517H / CPU 1518HF with firmware V3.0)

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Security at R/H

SIMATIC S7-1500 Redundant Systems

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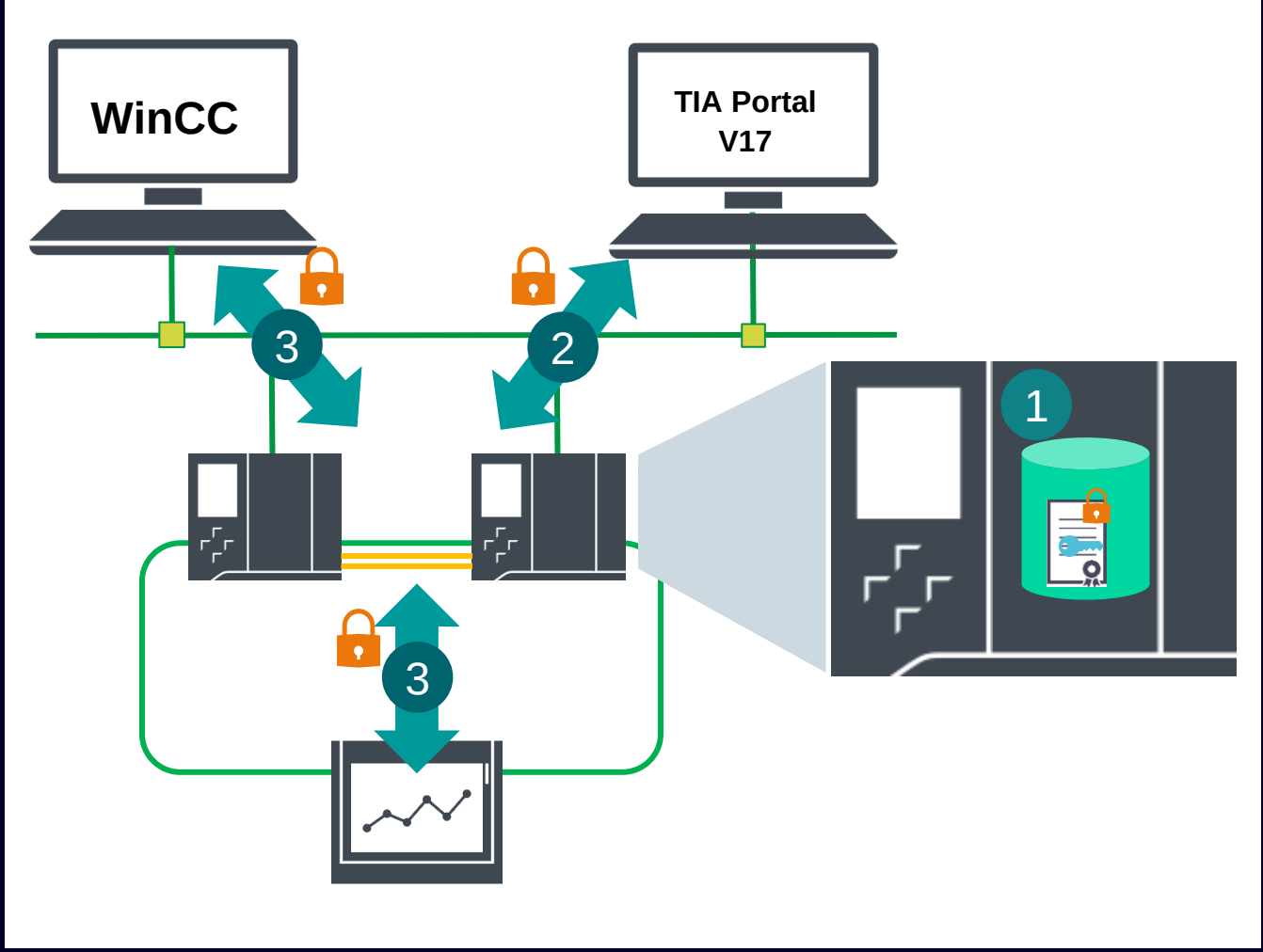
Security Enhancements
Protection of configuration data / Secure communication to HMI and TIA Portal



Extensions from firmware V2.9 and ab TIA Portal V17

1. Protection of configuration data
2. Secure communication between controllers and TIA Portal V17
3. Secure communication between controllers and HMI

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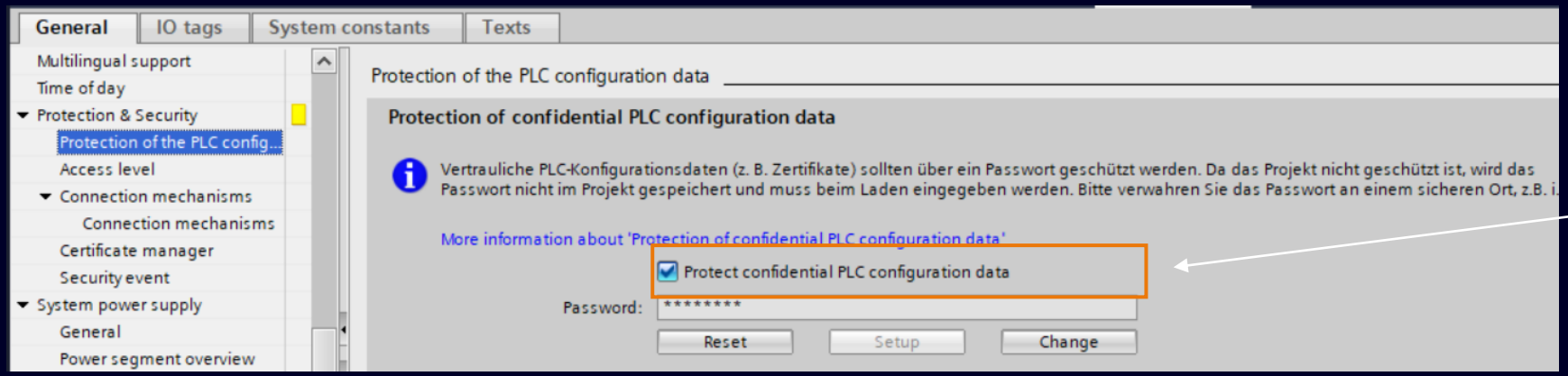
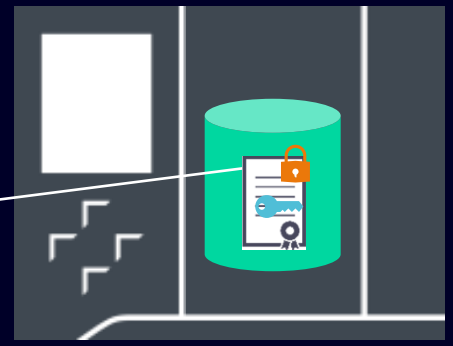
Protection of configuration data
Properties

Configuration data protection can be activated/deactivated via the TIA Portal.





- The protection password is <u>not</u> stored in the project but stored independently of the project data in the CPU. It is not readable and must therefore be stored in a safe place.
- If protection of the configuration data is activated, special features must therefore be taken into account during the initial commissioning and replacement of a controller. → see next slides

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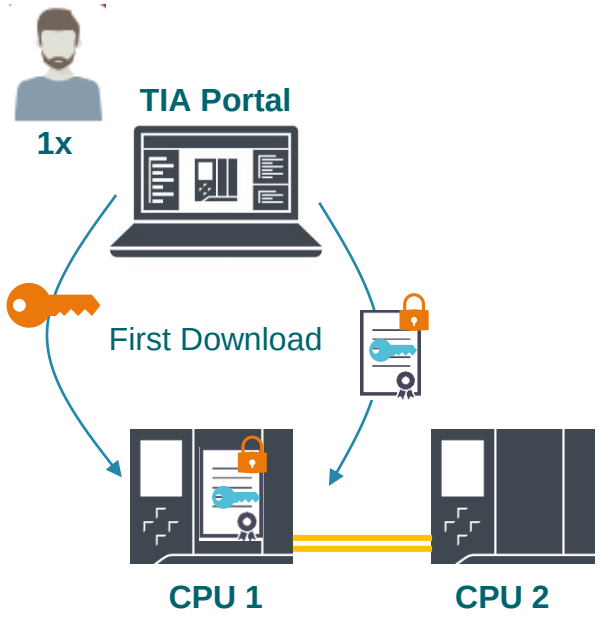
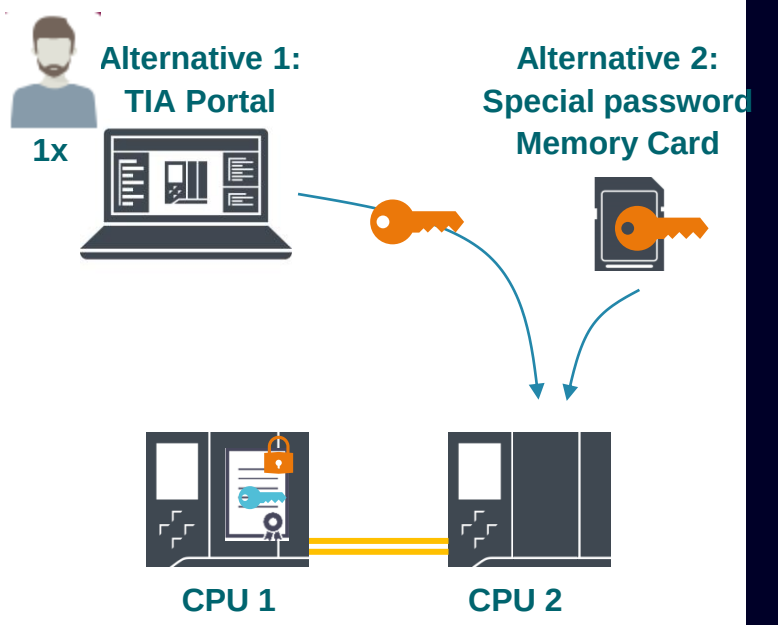
Special features when activating password protection of the configuration data
Initial commissioning of an RH system

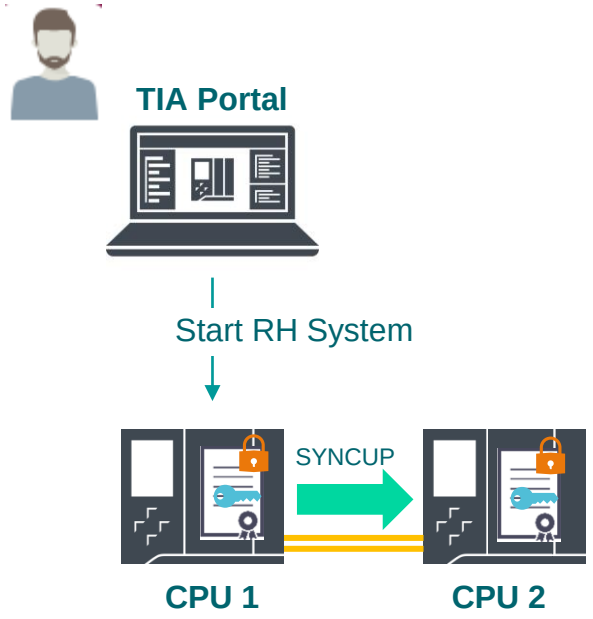
Step 1) Load the configuration and set the password



Step 2) Set password in CPU 2



Step 3) Start RH System → Synchronizing data



Without this step, the SYNCUP process will fail!


Certificate with private key for PG/HMI communication


Password to protect configuration data

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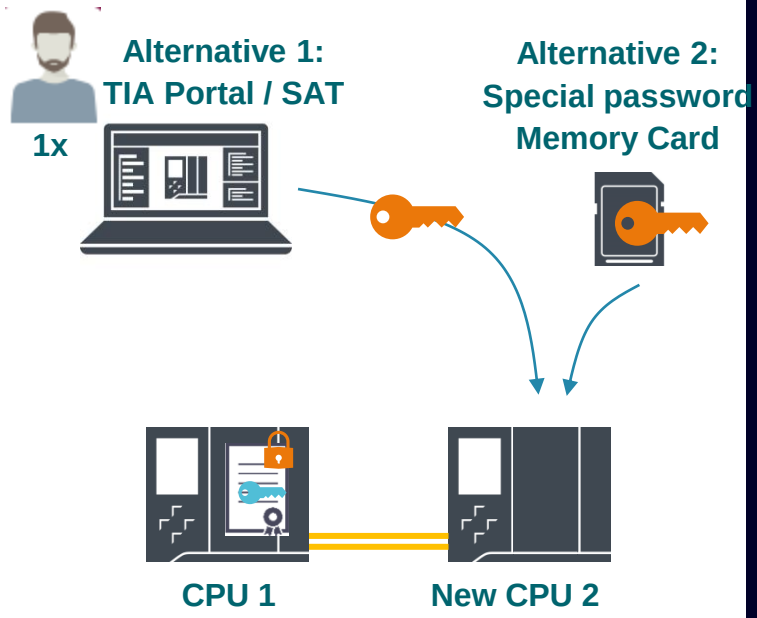
Special features when activating password protection of the configuration data
Replacing an R/H CPU

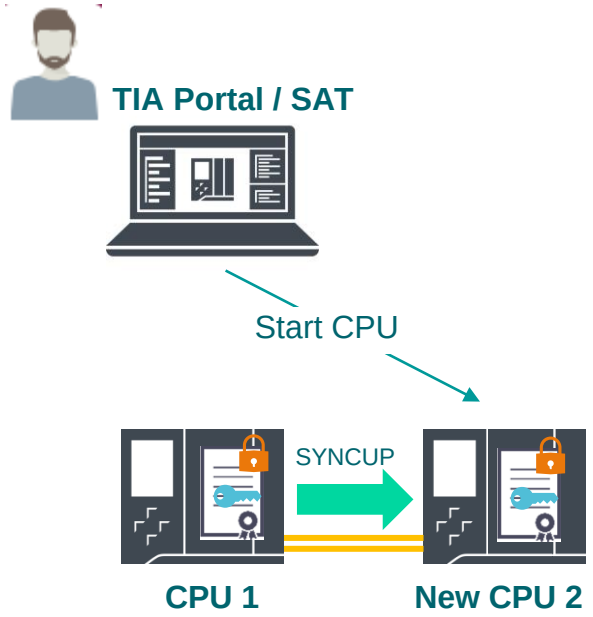
Event: A CPU fails and needs to be replaced

Step 1) Change CPU and reset password



Without this step, the SYNCUP process will fail!

3) Start the new CPU → Synchronizing data



Certificate with private key for PG/HMI communication

Password to protect configuration data

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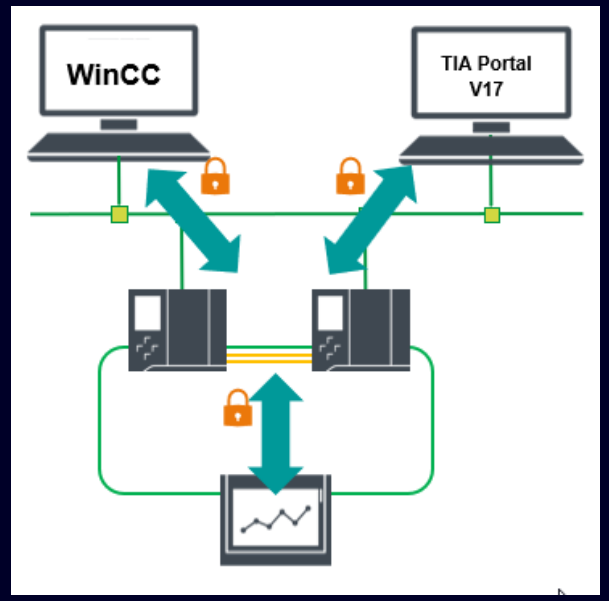
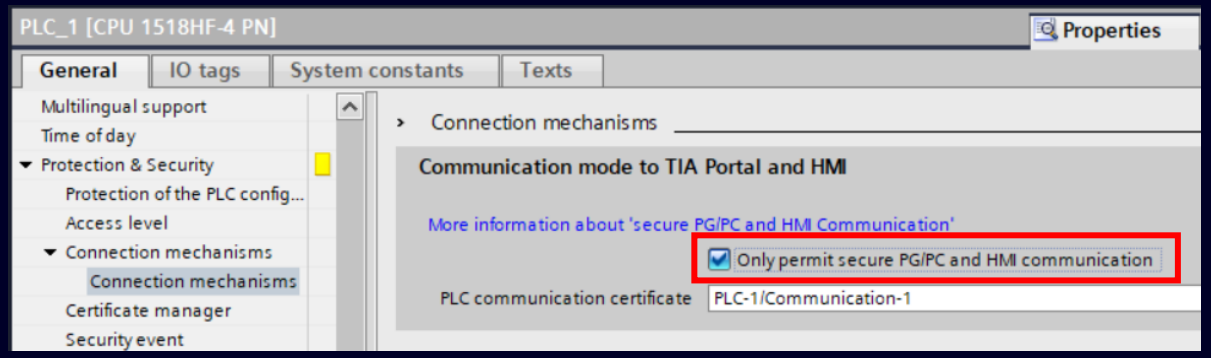
Secure communication with HMI and TIA Portal

For controllers with firmware V2.9 or higher, secure communication used with

- TIA Portal from V17
- WinCC Runtime from V17
- Basic Panels 2nd Generation, Comfort Panel 1st Generation, Mobile Panels
- WinCC Unified ab V17, Unified Comfort Panels
- WinCC OA ab V3.18 Patch 4
- WinCC ab V7.5 SP2 Update 4

- In order to be able to communicate with other HMI devices, deselect the option shown below.





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What's New with Firmware V3.0 (TIA Portal V18)

SIMATIC S7-1500 Redundant Systems

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SIMATIC S7-1500 Redundant Systems
What's New with Firmware Version 3.0

New Features / Improvements
System redundancy R1 for S7-1500H and ET 200SP
Flexible network topologies with S7-1500H
Maximum distance between H-CPUs now possible up to 40 km
Support in STEP 7 CFC (TIA Portal V18)
New OB 70 "Peripheral Redundancy Error"
Extensions RH_CTRL SYNCUP Status

New support for SIMATIC S7-1500 standard functions
CREATE_DB, DELETE_CB,
READ_DBL and WRIT_DBL
ReadFromArrayDBL and WriteToArrayDBL

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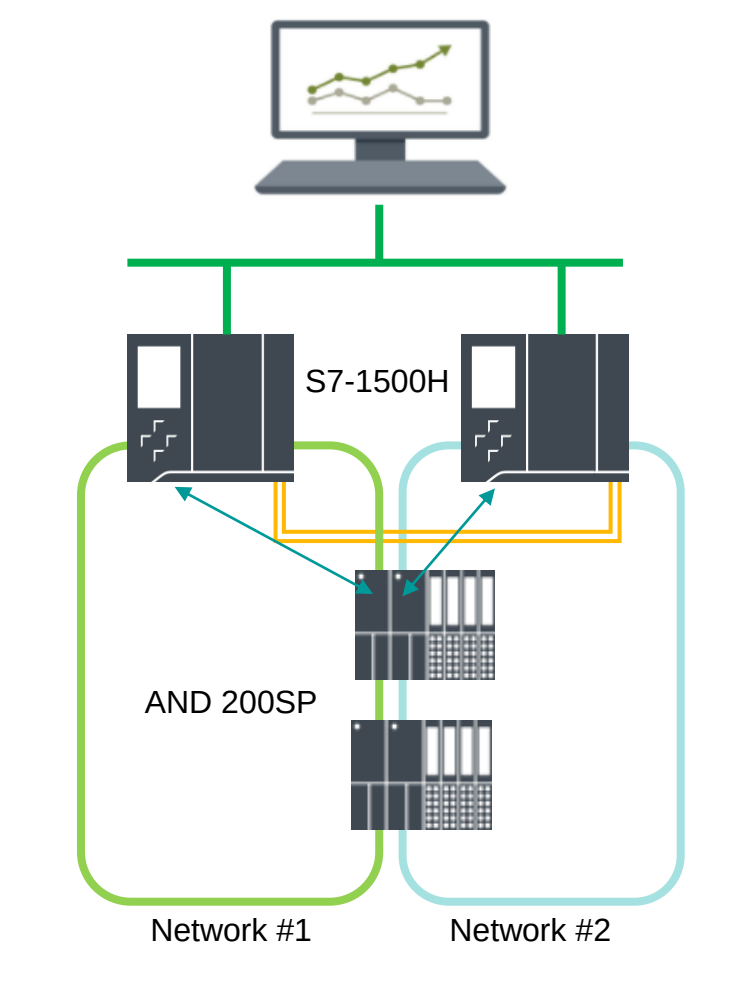
SIMATIC S7-1500H
System redundancy R1 for S7-1500H and ET 200SP



System Redundancy R1

- Increased availability
- Seamless switching in the event of an ET 200 SP interface module failure **(as well as ET200 SP HA or ET 200 iSP)**
- High robustness due to two networks **(ring or line)**
- **Fault tolerance: CPU, PROFINET Interruption, Interface-Module and Subnet**

For details on system redundancy R1, see Slide Set – Part 2
„PROFINET System Redundancy with S7-1500R/H and ET 200"

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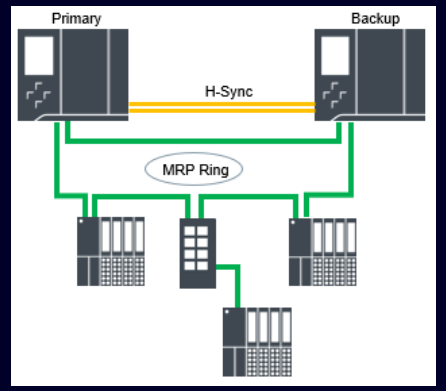
SIMATIC S7-1500H
More flexibility in network structures

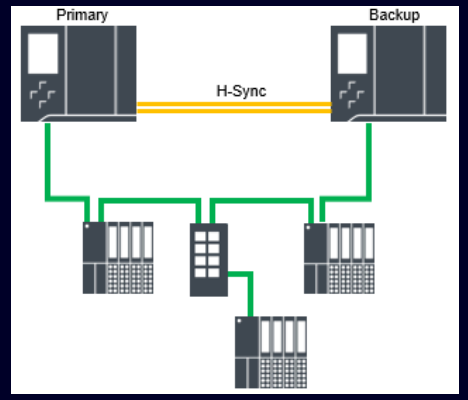
In addition to the construction of an MRP ring, any other structures are possible. For example

- Line Topology
- Separated Ring
- Hybrid Topology

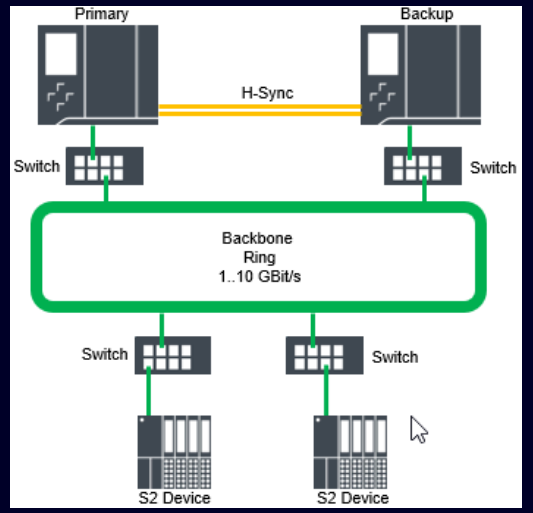
Simple MRP ring (since V15.1)



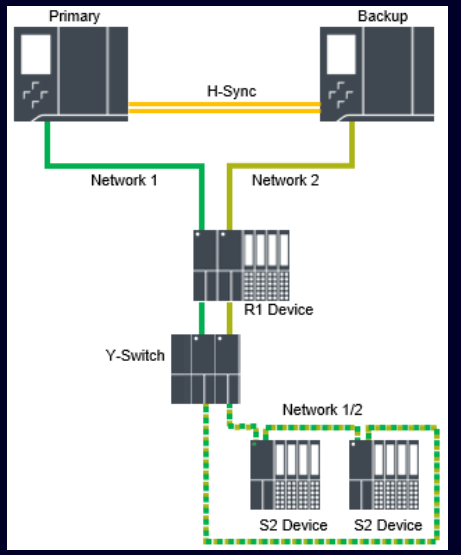
Line Topology



Separated Ring



R1 Line + Y-Switch



- Easier to integrate into existing network structures
- High flexibility in assembly

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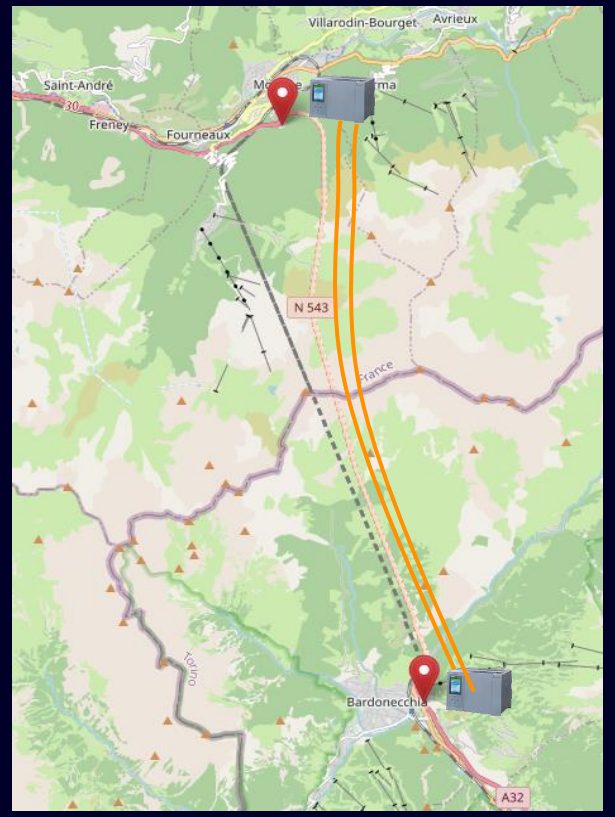
SIMATIC S7-1500H
Wide range fiber optic modules up to 40km

- New sync modules for CPU 1517H and CPU 1518HF
- Distance between H-CPUs: Minimum 8 km – Maximum 40 km
- Application for large-scale structures (tunnel systems)
- Requires TIA Portal V18 and CPU firmware V3.0

	Article	Fiber Optic Type	Length of fiber optic cable
	6ES7960-1CB00-0AA5	Multimode	10m
	6ES7960-1FB00-0AA5	Single Mode	2 meters to 10km
New 	6ES7960-1FE00-0AA5	Single Mode	8 km to 40km

Attention: When using the 40km sync module
6ES7960-1FE00-0AA5 a maximum ambient temperature of 55°C applies



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Innovated Hardware for R CPUs
Technical comparison

	CPU 1513R-1 PN	New	CPU 1515R-2 PN	New
Article	6ES7 513-1RL00-0AB0	**6ES7 513-1RM03-0AB0**	6ES7 515-2RM00-0AB0	**6ES7 515-2RN03-0AB0**
Installable firmware	Up to V2.9	**From V3.0**	Up to V2.9	**From V3.0**
Firmware compatible with	V2.6, V2.8, V2.9	**V2.6, V2.8, V2.9, V3.0**	V2.6, V2.8, V2.9	**V2.6, V2.8, V2.9, V3.0**
Display	Part of the front flap	**Part of the CPU**	Part of the front flap	**Part of the CPU**
Program memory	300 kByte	**600 kByte**	500 kByte	**1 Mbyte**
Memory	1.5 Mbyte	**2.5 Mbyte**	3 Mbyte	**4.5 Mbyte**
Processing time for bit operations	80 ns	**50 ns**	60 ns	**20 ns**
Operating temperature range	0°C... 60°C	**-30°C... 60°C**	0°C... 60°C	**-30°C... 60°C**

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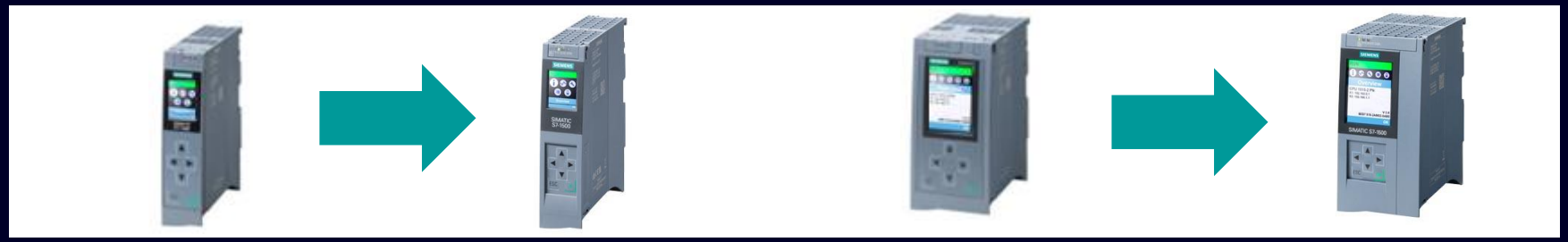
Innovated Hardware for R CPUs
Compatibility



The new R-CPUs are spare parts compatible with the existing R-CPUs

- Memory cards from existing CPUs can continue to be used 1:1 in the new CPUs
- New R CPUs can also be loaded with older TIA Portal versions. Configure the latest FW version there

Attention:

- In an R/H system, both CPUs must have the same article number and firmware version
  → If an R CPU fails, the same type must be replaced

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Supplements

SIMATIC S7-1500 Redundant Systems

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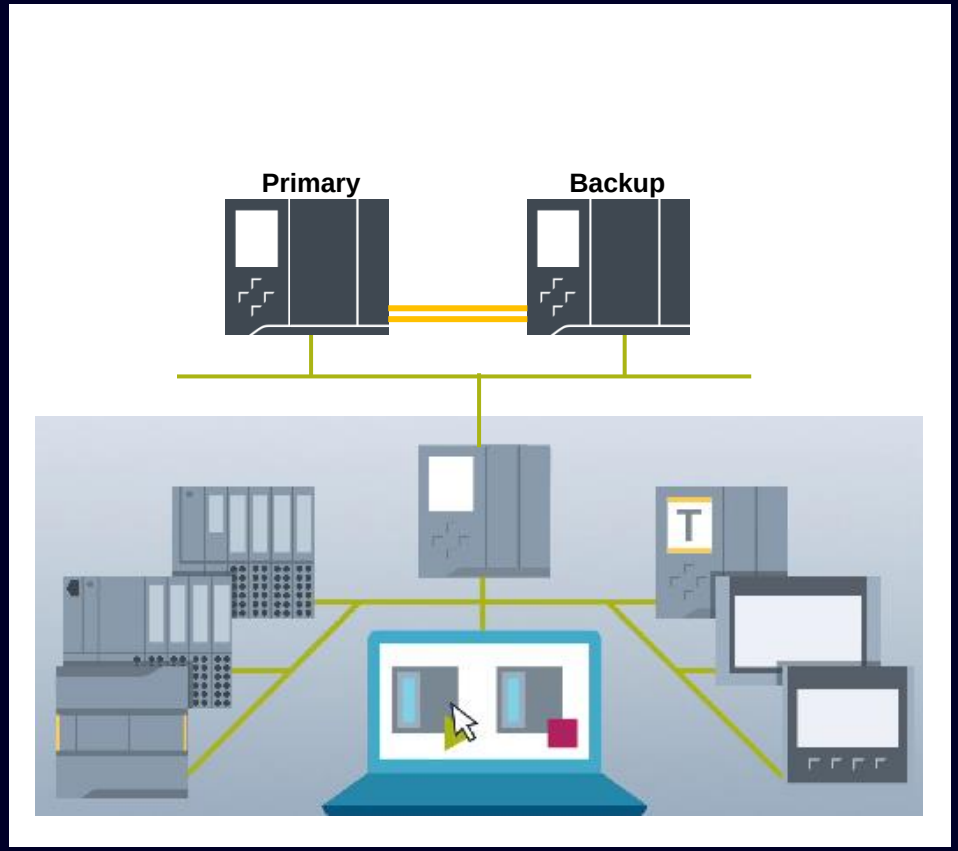
Support of S7-1500 R/H in the SIMATIC Automation Tool (SAT)

- As of version 4.0 SP3 of the SIMATIC Automation Tool, redundant controllers (S7-1500 R and S7-1500 H) are also supported.
- This can be used, for example, firmware updates or Program updates can be carried out easily.
- Information and download under the following link:

https://support.industry.siemens.com/cs/ww/en/view/98161300



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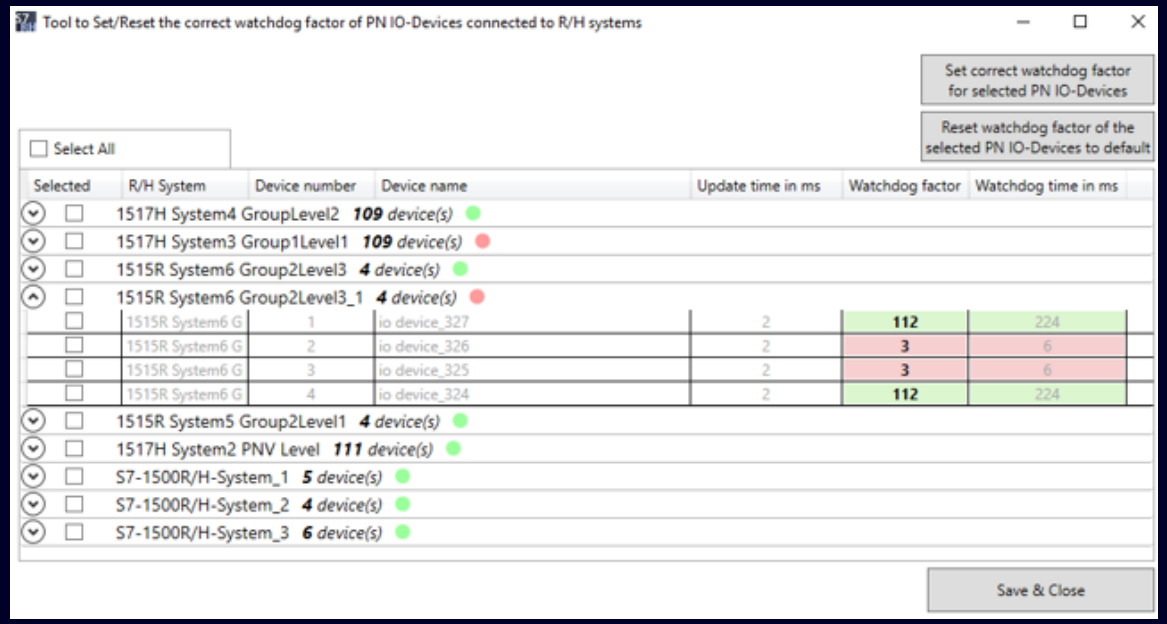
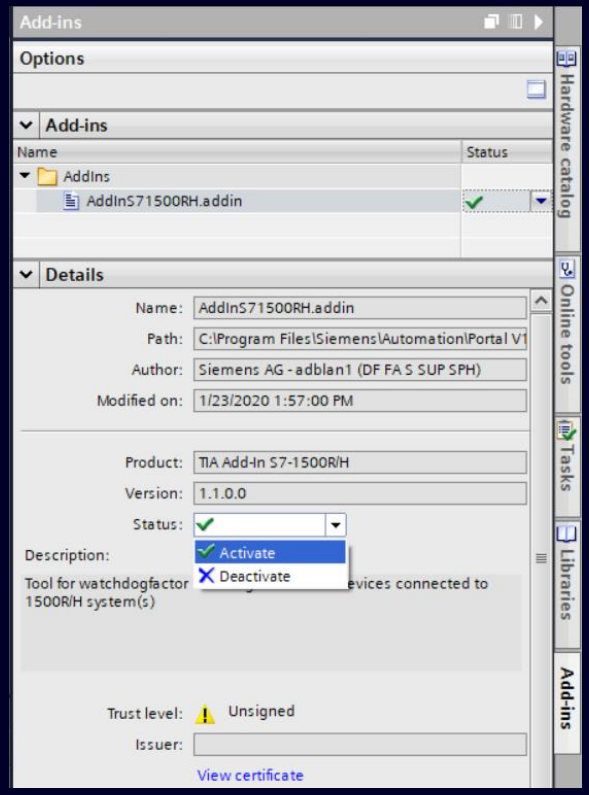
TIA Portal Add-In
Calculation of the watchdog time over a AddIn

To connect a PROFINET device to a redundant S7-1500 R/H system, it is necessary to set the correct watchdog time for each device. The SIMATIC S7-1500 R/H AddIn determines the correct factor and updates it in the settings
Available at https://support.industry.siemens.com/cs/ww/en/view/109769093





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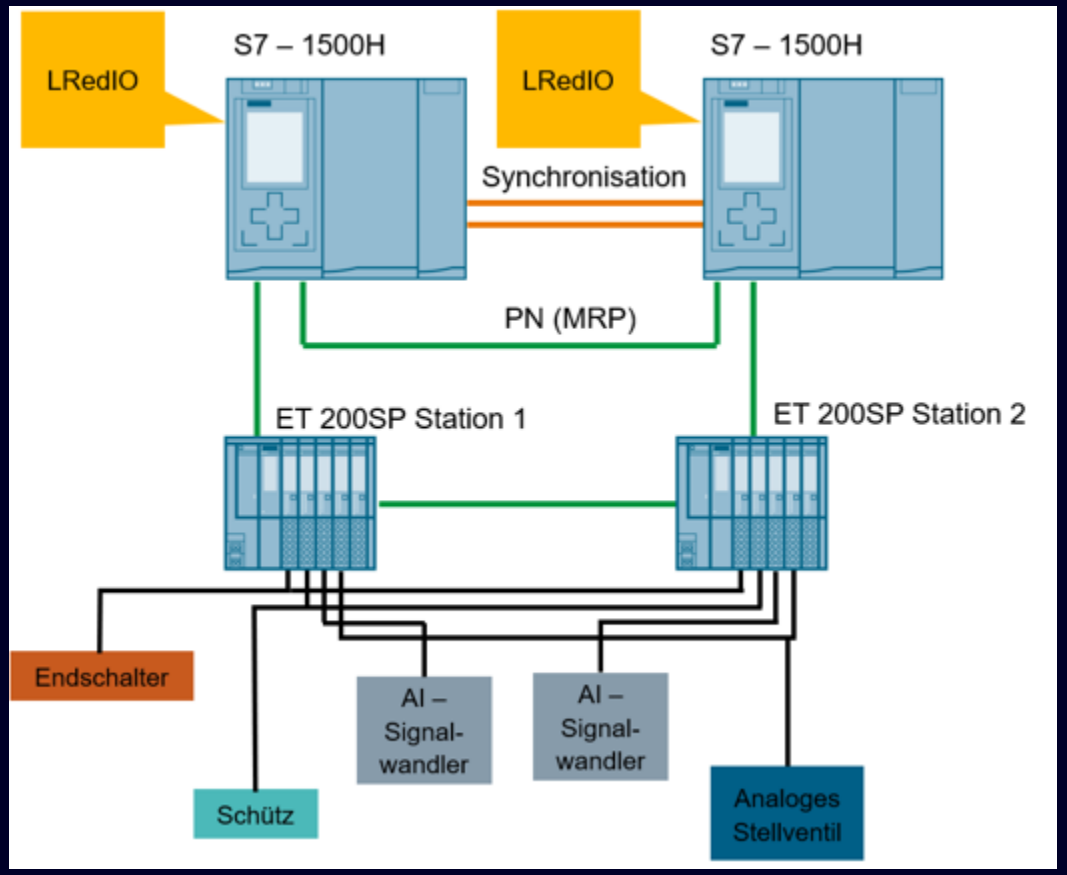
Application Example
Connection of redundant I/O in the user program



In this application example, a possibility is shown how I/O can be redundantly connected to a SIMATIC S7-1500 controller with blocks of the TIA Portal.

Funktionsbaustein	Funktion
LRedIO_RedDI	Redundanzfunktion für zwei Digitaleingänge
LRedIO_RedDQ	Redundanzfunktion für zwei Digitalausgänge
LRedIO_RedAI	Redundanzfunktion für zwei Analogeingänge
LRedIO_RedAQ	Redundanzfunktion für zwei Analogausgänge

Download: https://support.industry.siemens.com/cs/ww/en/view/109767576

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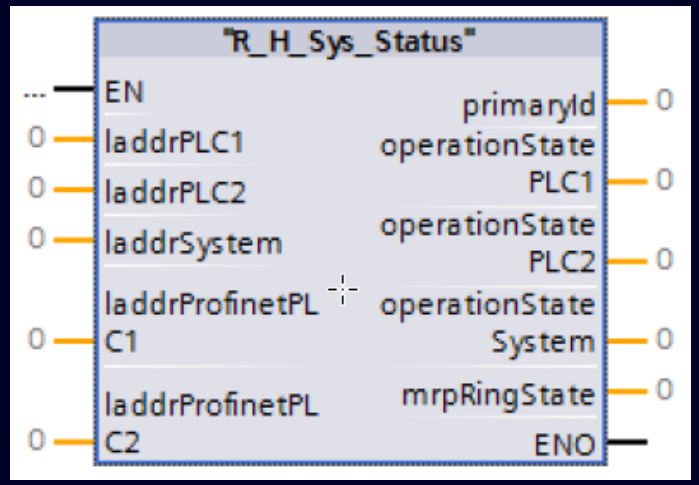
Application Example
Diagnosis of the operating status of a SIMATIC S7-1500 R/H system using FB

A function block is available for download for extended diagnostics of the SIMATIC S7-1500 R/H system.

Advantages

- Prefabricated diagnostic block for SIMATIC S7-1500 R/H systems
- Simple connection of different hardware addresses for extensive diagnostics
- Integrated self-diagnosis function (in addition to the standard diagnostic functions) of the SIMATIC S7-1500 R/H system for early detection and reporting of faults before they affect the process

Download: https://support.industry.siemens.com/cs/ww/en/view/109763768



Parameter	Data type	Note
primaryID	INT	Returns the redundancy ID of the primary PLC
operationStatePLC1	UINT	Operating state of the first PLC of the S7-1500R/H system
operationStatePLC2	UINT	Operating state of the second PLC of the S7-1500R/H system
operationState-System	UINT	Operating state of the R/H system
mrpRingState	UINT	State of the MRP ring: Open: 0 Closed: 1 State undefined: 2

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Communication Functions
Telecontrol and substation control technology with SIMATIC S7-1500R/H

Component	Version	Protocols	SIOS
TIM 1531 IRC 	From V2.1	• SINAUT ST7 • DNP3 • IEC 60870-5 101, 104	https://support.industry.siemens.com/cs/ww/en/view/109774204
SIPLUS RIC Library for SIMATIC S7-1500	From V1.7	• IEC 60870-5 101,102,103, 104	https://support.industry.siemens.com/cs/ww/en/view/109422039
IEC 61850 MMS Client AS LIBRARY		• IEC 61850 MMS	https://support.industry.siemens.com/cs/ww/en/pv/9LA1110-6PC10-2BC8/pi?dl=en

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Communication Functions
Redundant communication

Component	Version	Protocols	SIOS	Hint
SIMATIC Modbus/TCP Red S7-1200/S7-1500		Modbus/TCP	https://support.industry.siemens.com/cs/bd/en/ps/6AV6676-6MB40-0AX0	
Redundante Open User Communication		Various	https://support.industry.siemens.com/cs/ww/en/view/109763719	

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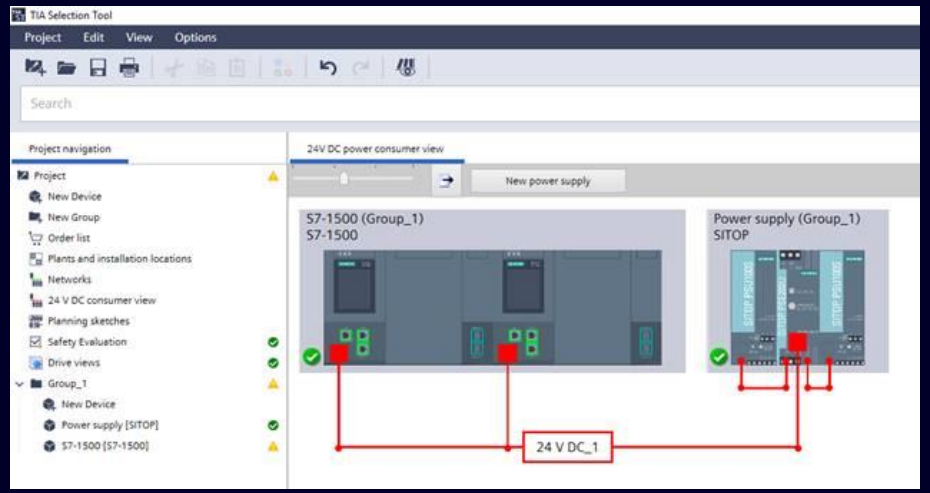
Redundant power supply
SITOP Redundancy Module RED1200

- Redundant design in the event of power failure
  - Stable DC voltage due to redundant switching of two same power supplies
- Redundant design in the event of a power failure
  - Feeding of power supplies from different supplies
- Flexible use
  - Redundant power supply setup for DC voltages from 12 to 48 V

Details

Manual



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Feature Comparison / Limitations

SIMATIC S7-1500 Redundant Systems

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Functional comparison with S7-1500 and S7-400H

	S7-1500 R/H	S7-1500	S7-400H
Communications	Open User Communication; S7 communication as server	(Secure) Open User Communication; S7 communication; Configured connections	Open device communication; S7 communication; Configured connections
OPC UA / Webserver	No	Yes	No
Redundant communication	Via LComRed Library	No	Yes
System-IP address	Yes	Not required	No
Redundant I/Os	Via LRedIO Library	Via LRedIO Library	Yes
Technology Objects	Counting, measuring, PID, BasicPos	Yes	No
IRT, Isochrone Mode, MRPD	No	Yes	No
Hardware enhancements in RUN	With IO-Link See slide section	With IO-Link	With switching (H-CiR)
Firmware Update in RUN	No	No	Yes
DHCP with DNS	No	Yes	No

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Configuration Restrictions for S7-1500R/H

	S7-1500 R/H	S7-1500	S7-400H
Central connection of Modules IO, CM/CP, System Power Supply	No	Yes	Yes
PROFINET network structure	S7-1500H: any S7-1500R: MRP Ring New	any	any
Operation of the RH system as Shared Device or iDevice	No	Yes	No
Operation of PROFIBUS devices	Via Coupling-PLC	Yes	Yes

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Ordering Information

SIMATIC S7-1500 Redundant Systems

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Ordering Information

SIMATIC CPU S7-1500 R

- CPU 1513R-1 PN
  - 6ES7 513-1RL00-0AB0
  - New 6ES7 513-1RM03-0AB0 (V3.0)
- CPU 1515R-2 PN
  - 6ES7 515-2RM00-0AB0
  - New 6ES7 513-1RM03-0AB0 (V3.0)

SIMATIC CPU S7-1500 H

- CPU 1517H-3 PN — 6ES7 517-3HP00-0AB0
- CPU 1518HF-4 PN — 6ES7 518-4JP00-0AB0

At distances of up to 10m between SIMATIC S7-1500 H controllers: Use of synchronization modules for fiber optic cables up to 10 m

- MLFB Module: 6ES7 960-1CB00-0AA5
- MLFB Fiber Optic Cable 1m: 6ES7 960-1BB00-5AA5
- MLFB fiber optic cable 2m: 6ES7 960-1BC00-5AA5
- MLFB Fiber Optic Cable 10m: 6ES7 960-1CB00-5AA5

At distances of up to 10 / 40 km between SIMATIC S7-1500 H controllers:

- MLFB Module: 6ES7 960-1FB00-0AA5 (10km)
  - New 6ES7 960-1FE00-0AA5 (40km)
- Single mode Fiber optic cable LC/LC duplex crossed 9/125µ

SIMATIC S7-1500 H Bundle

(2 SIMATIC CPU 1517-3 PN, 4 sync modules up to 10m and 2 sync cables 1m)

- 6ES7500-0HP00-0AB0

SIMATIC S7-1500 HF Bundle

(2 SIMATIC CPU 1518-4 PN, 4 sync modules up to 10m and 2 sync cables 1m)

- 6ES7 500-0JP00-0AB0

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Disclaimer

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

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