



# SIMATIC S7-1500 Redundant Systems, S7-1500 R/H

Technical Details

# SIMATIC S7-1500 Redundant Systems

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# Motivation and Product Strategy

SIMATIC S7-1500 Redundant Systems

# SIMATIC S7-1500 Redundant Systems

## Motivation

### Preventing plant downtime

High availability during operation,  
Avoidance of loss of production



### Prevention of damages

Avoidance of unplanned production stops where the product to be processed would be permanently damaged



### Prevention of data losses

The data remain intact and long restart times after a failure are eliminated.

### Operation without persons locally

Maintenance trips can be better planned



**Redundant systems reduce costs**

# SIMATIC S7-1500 Redundant Systems

## Product Strategy SIMATIC S7-1500 R/H

### Based on Standard S7-1500 CPUs and PROFINET

- Basis Hardware Standard-CPU/Fail-safe CPUs
- Basis PROFINET as communication standard



### Transparent Programming

- Engineering Tool TIA Portal incl. all programming languages
  - Redundancy functions fully integrated in TIA Portal
  - No special Know-How for redundancy required
  - Simple scaling: Standard → S7-1500 R → S7-1500 H



### Extensive Scalability

- Scalability of switch-over time (S7-1500 R → S7-1500 H)
- Scalability of the Redundancy Architecture
- Scalability of the CPU Performance



### Step by Step Product Launch Strategy

- First release with basic redundancy functions
- Step by Step increasing of feature set in future versions



# | System Overview

SIMATIC S7-1500 Redundant Systems

# SIMATIC S7-1500 Redundant Systems

## System Overview

Consistent concept –  
**Identical** synchronization  
process

**Scaling** of the switching  
performance over the **available  
bandwidth** of the  
sync connection

CPU type

Synchronization

Hot-Standby

I/O systems

Type of connection

### Redundant – S7-1500 R



**CPU 1513R / CPU 1515R**

via **PROFINET Ring (MRP)**

**Yes, fail-over time ca. 300ms**

### High available – S7-1500 H



**CPU 1517H / CPU 1518HF**

via **Sync-Modules / FO**

**Yes, fail-over time ca. 50ms**

















ET 200SP and ET 200MP

Single connection (PN redundancy S2) and switched S1 <sup>1)</sup>

1) See slide [Switched S1 Device](#)




# SIMATIC S7-1500 Redundant Systems

## PLC Hardware

	CPU 1513R-1 PN 6ES7513-1RL00-0AB0	CPU 1515R-2 PN 6ES7515-2RM00-0AB0	CPU 1517H-3 PN 6ES7517-3HP00-0AB0	CPU 1518HF-4 PN 6ES7518-4JP00-0AB0
Program / Data memory	300 kB code 1,5 MB data	500 kB code 3 MB 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 
SIPLUS Type	-	6AG1515-2RM00-7AB0	6AG1517-3HP00-4AB0	-





Fail-safe

-  PROFINET IO Controller, Supports RT, MRP, Transport Protocol TCP/IP, Open User Communication
-  PROFINET Basic Services, Transport Protocol TCP/IP, Open User Communication
-  SPF Slot for H-Synchronization

# SIMATIC S7-1500 Redundant Systems

## Accessories for SIMATIC S7-1500 H

	For short distances up to 10m	For long distances Up to 10km	Each H-System needs
<b>Sync Module SFP</b> <small>SFP = Small Form-Factor Pluggable</small> 	6ES7960-1CB00-0AA5	6ES7960-1FB00-0AA5	4 pieces
	<b>Plastic Fiber Optic Cable</b>  Pre-fabricated: <ul style="list-style-type: none"> <li>• 6ES7 960-1BB00-5AA5 (1m)</li> <li>• 6ES7 960-1BC00-5AA5 (2m)</li> <li>• 6ES7 960-1CB00-5AA5 (10m)</li> </ul>	<b>Glass Fiber Optic Cable</b> <ul style="list-style-type: none"> <li>• Monomode fiber</li> <li>• LC/LC connector</li> <li>• Duplex crossed</li> <li>• 9/125µm</li> </ul>	2 pieces

Overview: Fiber Optic Cables at Siemens:

<https://mall.industry.siemens.com/mall/en/de/Catalog/Products/10000396?tree=CatalogTree>

# System Redundancy and Network Configuration

SIMATIC S7-1500 Redundant Systems

# PROFINET System Redundancy Concept

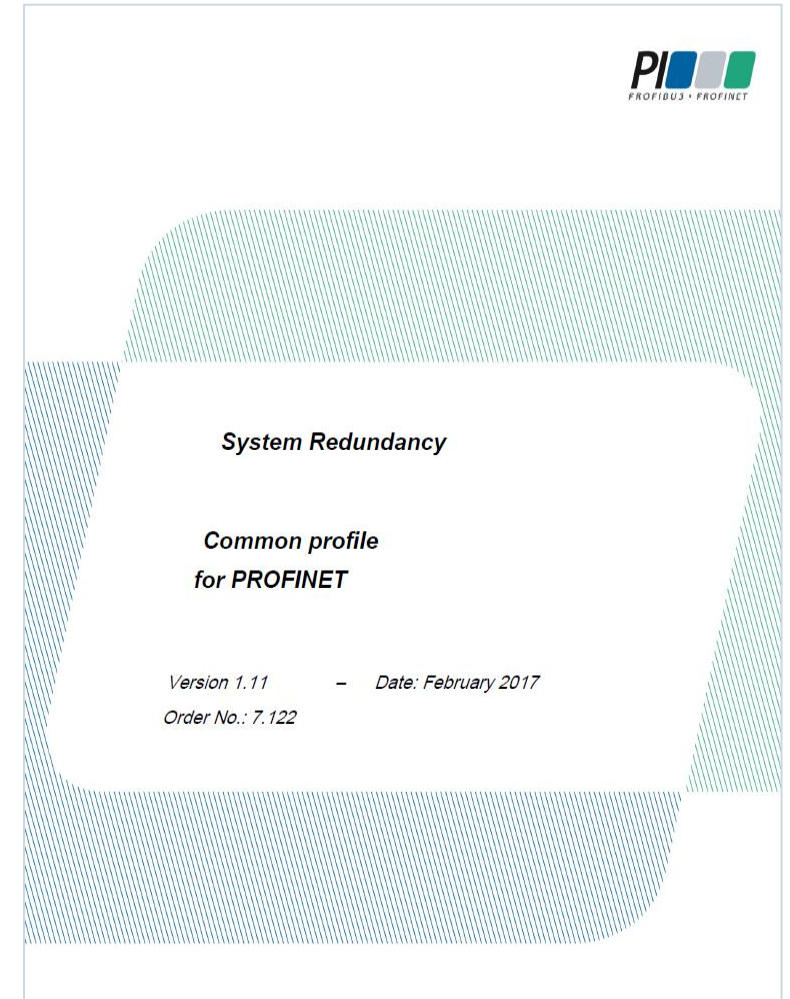
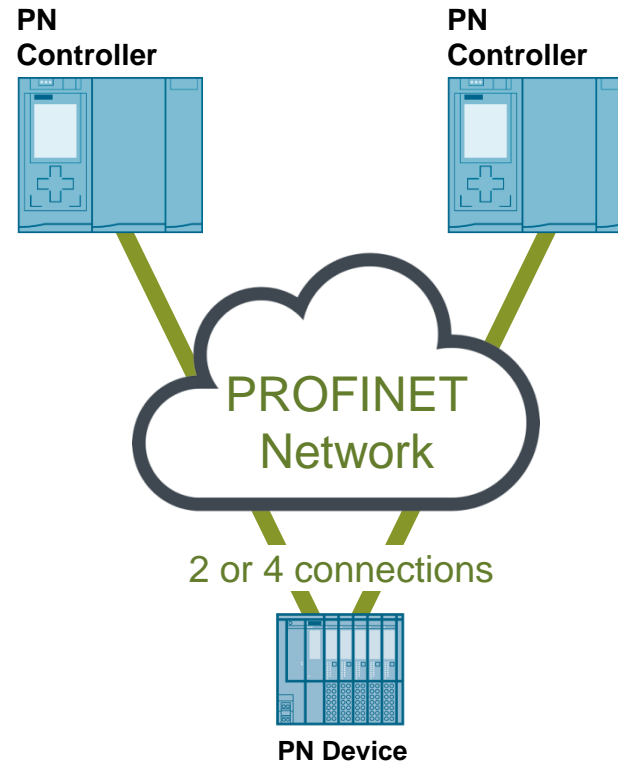
## PROFINET System Redundancy

A System with redundant PN controllers and single or redundant PN devices.

Three levels:

1. PN Controller
2. PROFINET Network
3. PN Device

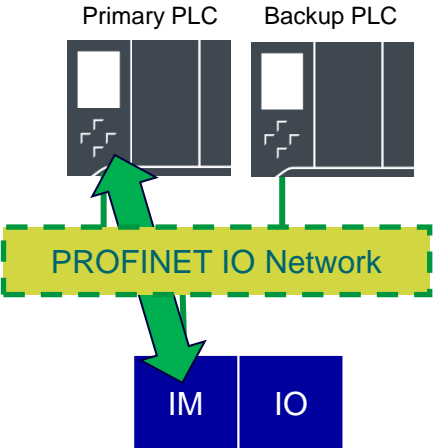
Redundancy at one level is independent of redundancy at each other level.



# PROFINET System Redundancy

## Redundancy Modes

### S1 Mode

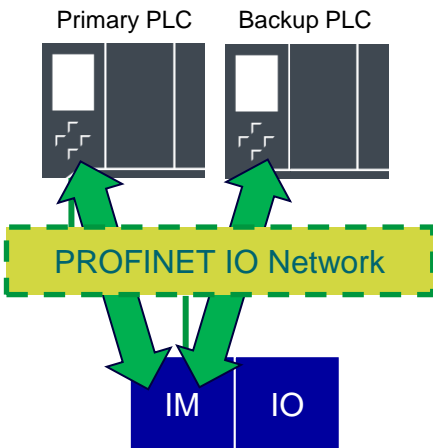


**S1 Device**

- S → Single interface
- 1 → one connection to one PLC

Standard PLC + R/H

### S2 Mode

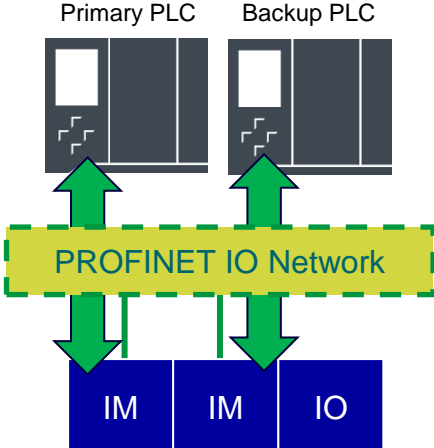


**S2 Device**

- S → Single interface
- 2 → can switch between two connections

For R/H PLC

### R1 Mode



**R1 Device**

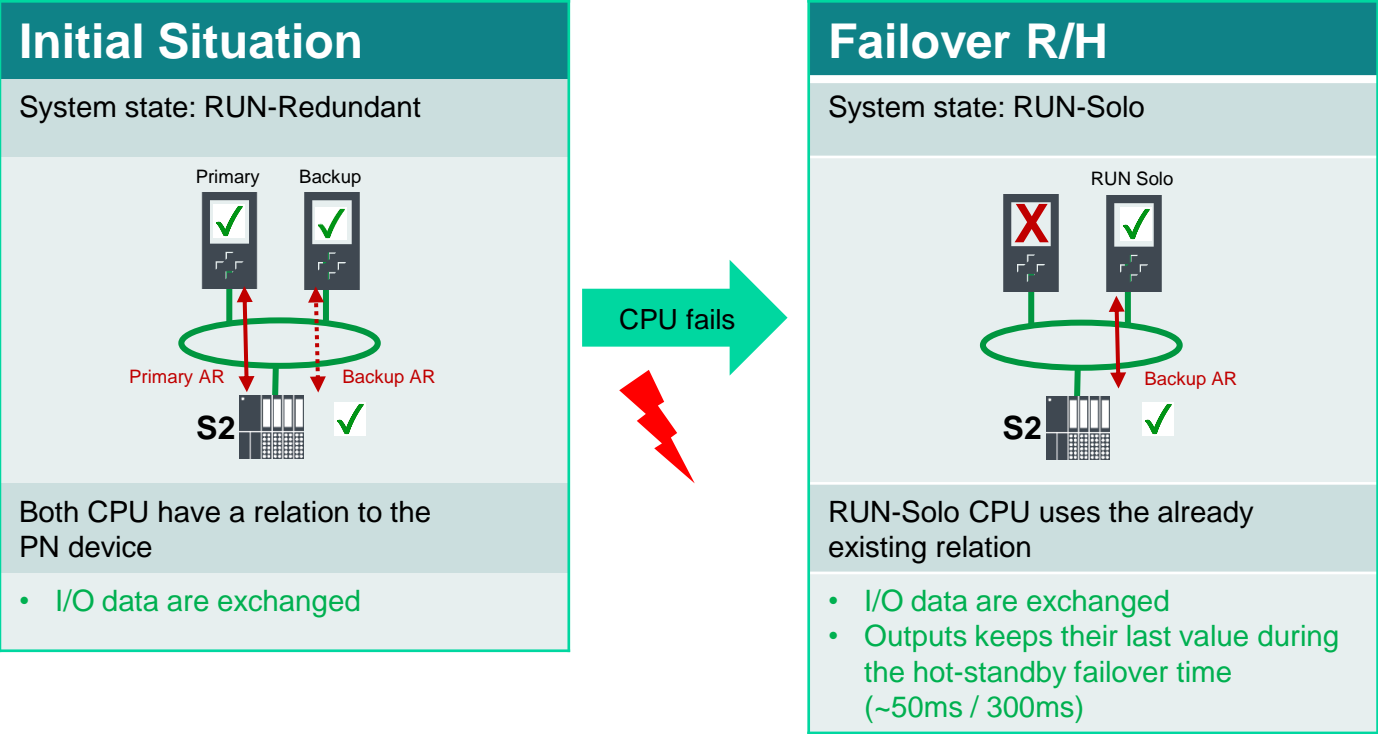
- R → Redundant interface
- 1 → each interface has one connection to one PLC

Future 1500 H release

Details about PN System Redundancy modes: See <https://support.industry.siemens.com/cs/ww/en/view/109756450>

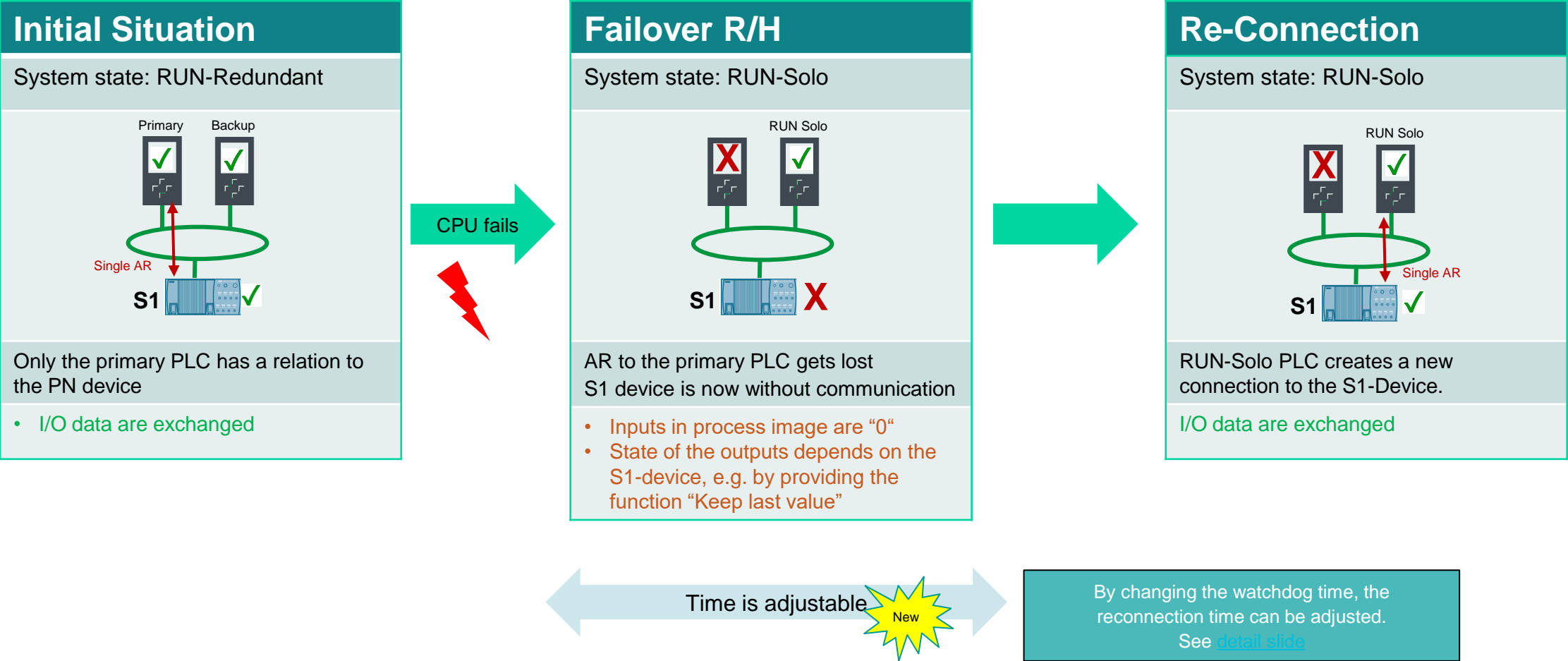
# PROFINET System Redundancy

## Behavior of PN Devices with System Redundancy S2



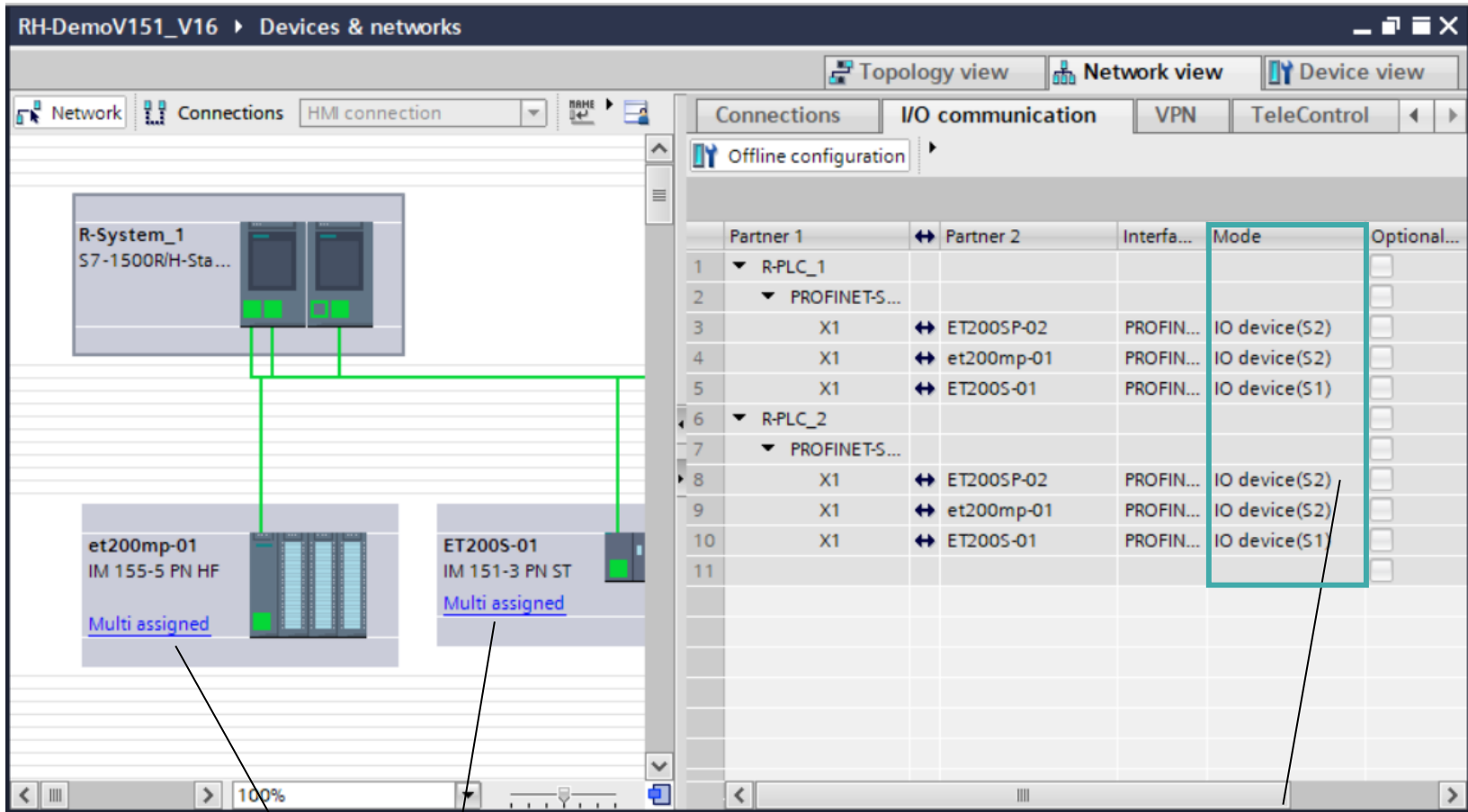
# PROFINET System Redundancy

## Behavior of PN Devices without System Redundancy (S1)



# PROFINET System Redundancy

## Visualization of redundancy modes in TIA Portal








In the network view S1 and S2 devices are marked as „Multi-assigned“

Differences are shown in the column „Mode“ of the I/O communication table. Here: ET 200MP is connected as S2 device

# PROFINET System Redundancy

## Siemens I/O Systems with PN S2 support

<b>ET 200SP</b> IM155-6 PN HF (FW>=4.2)		6ES7155-6AU01-0CN0 6ES7155-6AU30-0CN0
<b>ET 200MP</b> IM155-5 PN HF (FW>=4.2) Also available with active backplane		6ES7155-5AA00-0AC0 6ES7590-0BL00-0AA0 The active backplane bus allows to pull and plug modules during operation.
<b>ET 200eco PN M12-L</b> (FW >= 1.1)		6ES7 14*-6**00-0BB0
<b>PN/PN-Coupler</b>		6ES7158-3AD10-0XA0
<b>ET 200SP HA</b> IM155-6 PN HA (with Single IM)		6DL1155-6AU00-0PM0

# PROFINET System Redundancy

## Siemens Drives / Switches with PN S2 support

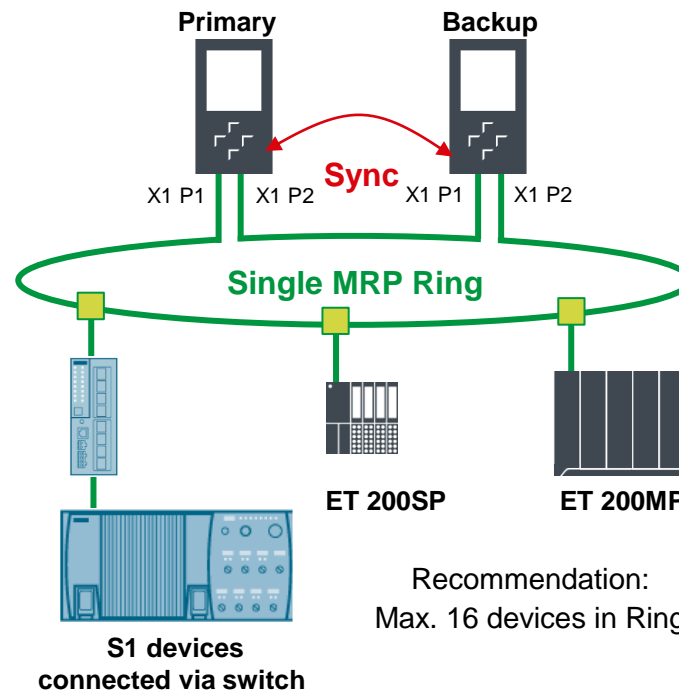
<b>SINAMICS S120</b> <b>CU310-2PN (FW &gt;=5.2)</b> (with gsdml)		6SL3040-1LA01-0AA0
<b>SINAMICS S120</b> <b>CU320-2PN (FW &gt;=5.2)</b> (with gsdml)		6SL3040-1MA01-0AA0
How to configure SINAMICS drives on an S7-1500R/H system? See application example: <a href="https://support.industry.siemens.com/cs/ww/en/view/109744811">https://support.industry.siemens.com/cs/ww/en/view/109744811</a>		
<b>SCALANCE XC-200 Series</b>		6GK5 2 . . - . . . 00 - 2 . C2
<b>SCALANCE XP-200 Series</b>		6GK5 2 . . - 0 . A00 - . . S6
<b>SCALANCE XF204-2BA</b>		6GK5 204-2AA00-2GF2

# Network Configuration with S7-1500 R/H Requirements

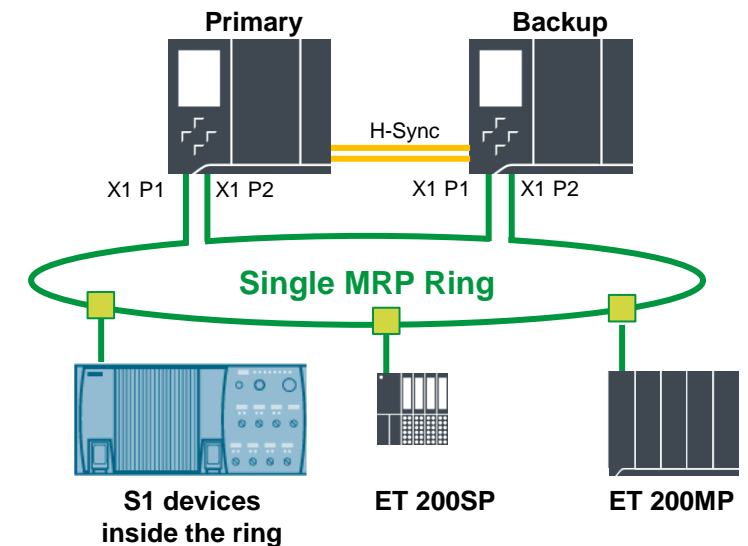
## Requirements for the PROFINET network configuration

- MRP Ring (default setting in the configuration)
- PN IO only at X1 interface
- PLC's need to be part of the ring
- S7-1500 R:
  - no devices in the connection between the two PLC's
  - S1 devices should be connected via a switch <sup>1)</sup>

## Redundant 1500 R



## High Available 1500 H



Recommendation:  
Max. 16 devices in Ring

1) Reason: S1 devices do not forward H-Sync telegrams during a reconfiguration of the MRP ring. This can lead to a high cycle time in case of a interrupt in the ring.  
See chapter „H-Sync Forwarding“ in the system manual of S7-1500R/H for more details

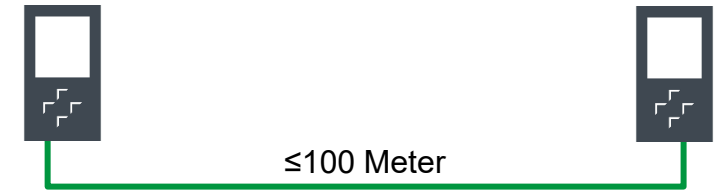
# Network Configuration with S7-1500 R

## Length of the synchronization connection



CPU 1513R  
CPU 1515R

Direct Link  
up to 100 m



Fiber optic link  
(media converter) up to 3 km



# Network Configuration with S7-1500 H

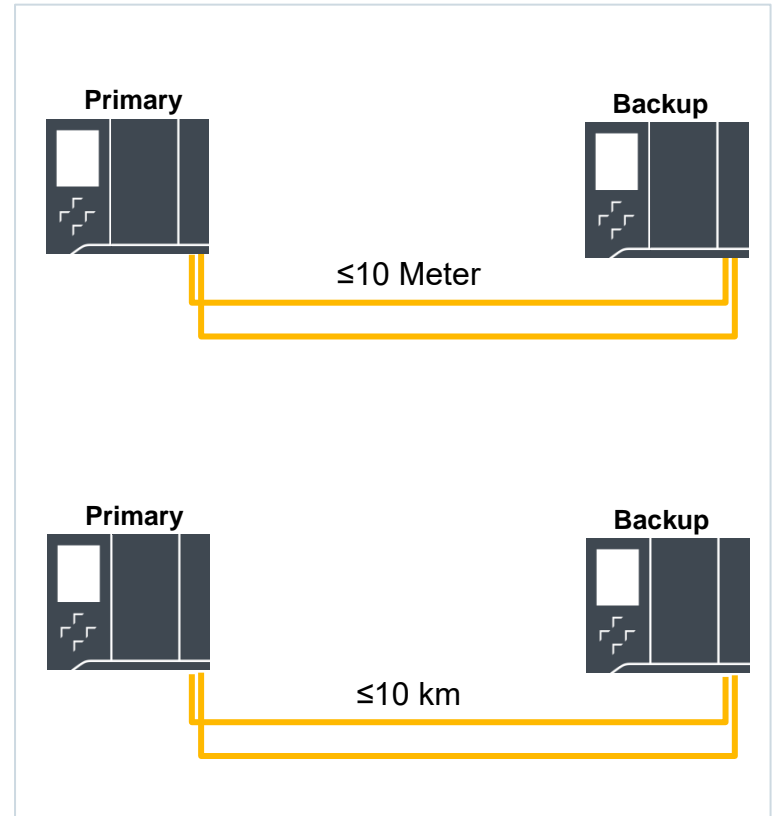
## Length of the synchronization connection



CPU 1517H  
CPU 1518HF

Short distance sync modules  
→ up to 10 Meter

Long distance sync modules  
→ up to 10 km

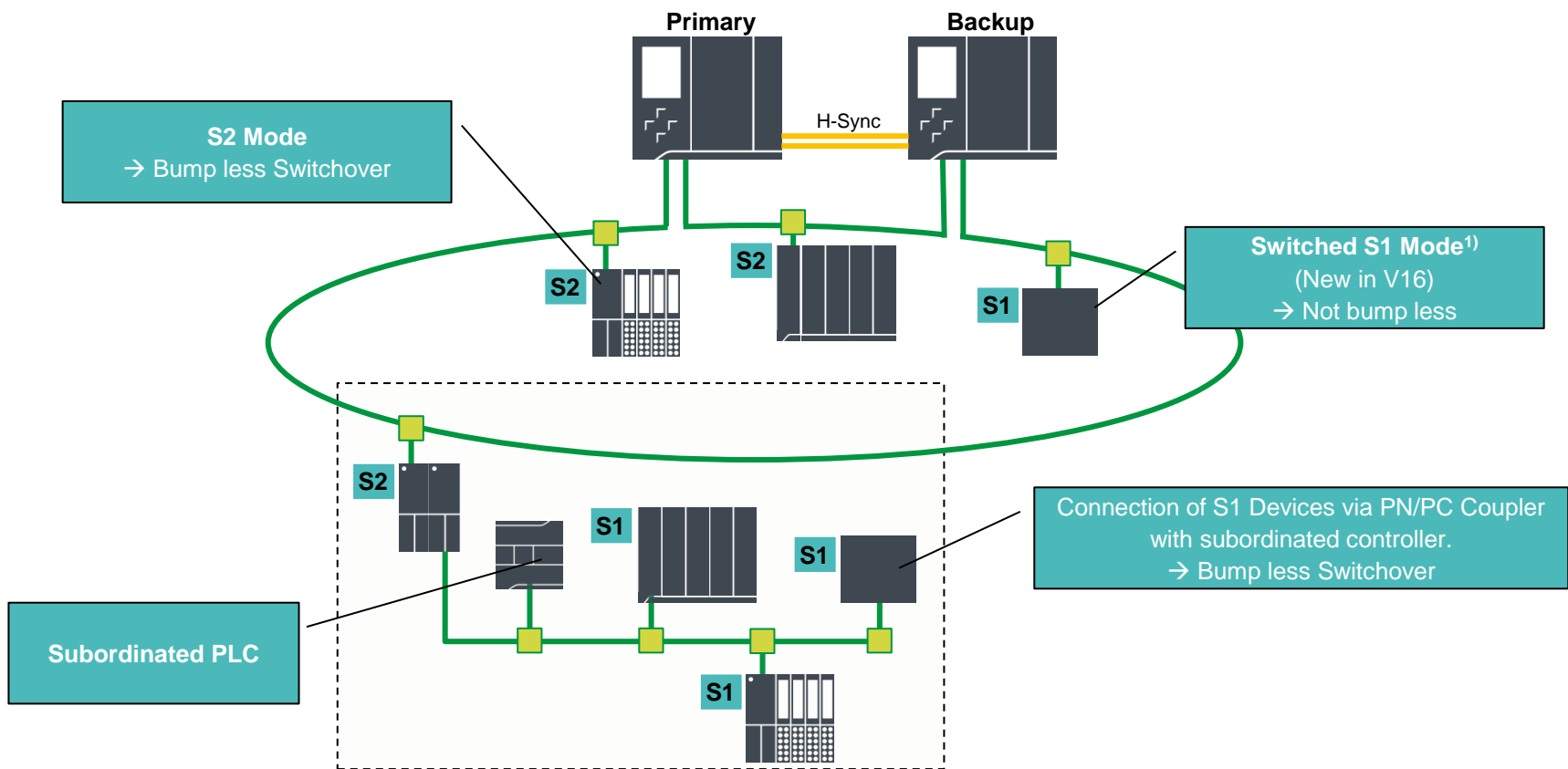


The sync cables are redundant.  
The loss of one fiber optic cable has no impact on the runtime behavior..

# Network Configuration with S7-1500 R/H

## Connection of PROFINET Devices

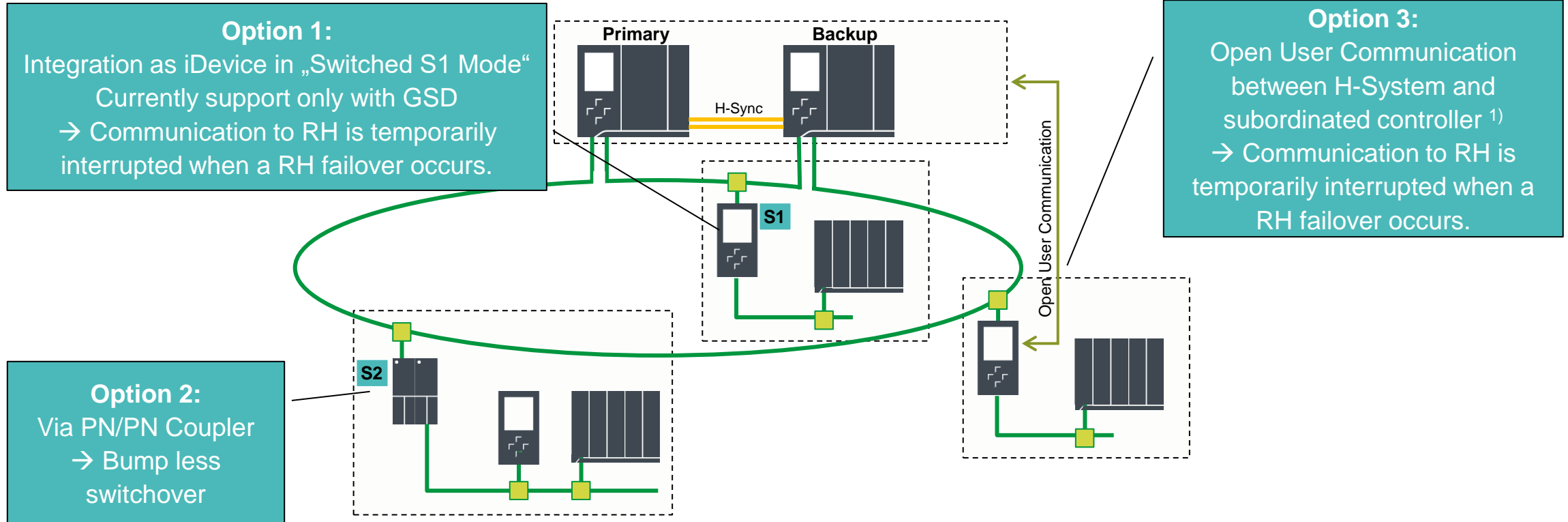
### S2 and S1 Devices can be connected



1) For S7-1500R, S1 devices should be connected via a switch to the MRP ring

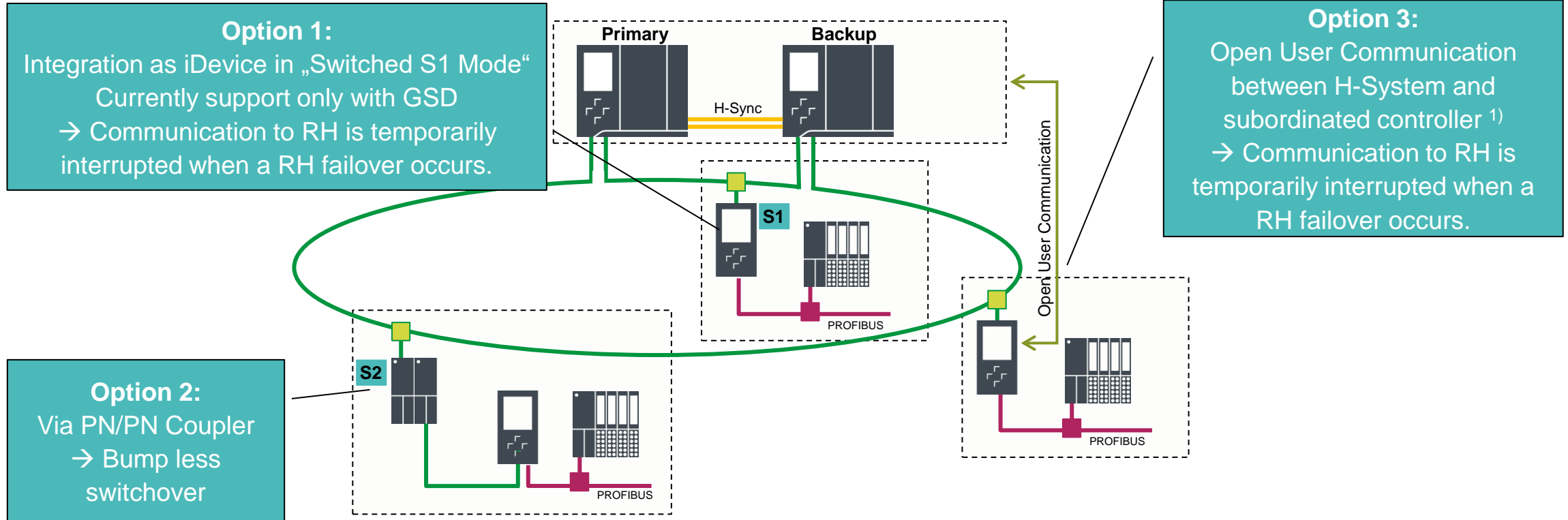
# Network Configuration with S7-1500 R/H

## Connection of Subordinated Controller



# Network Configuration with S7-1500 R/H

## Connection of PROFIBUS DP Slaves



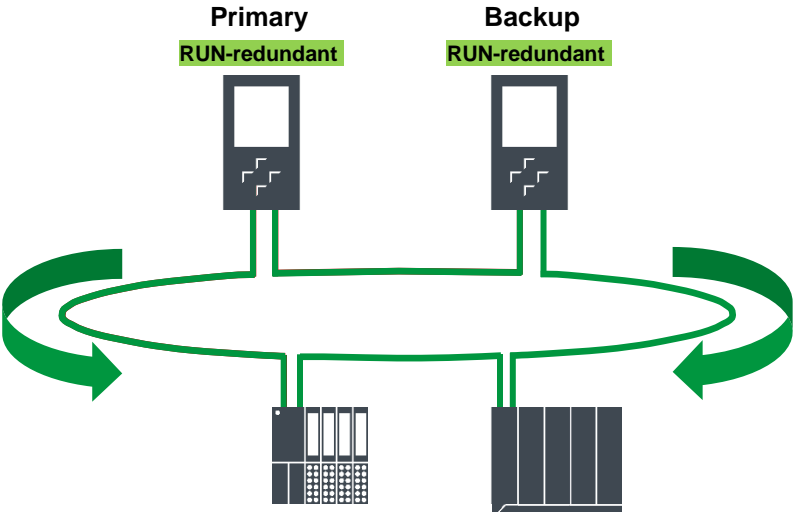
Please note: IE/PB Link and IE/PB LINK HA are currently not supported

# | Failure Scenarios

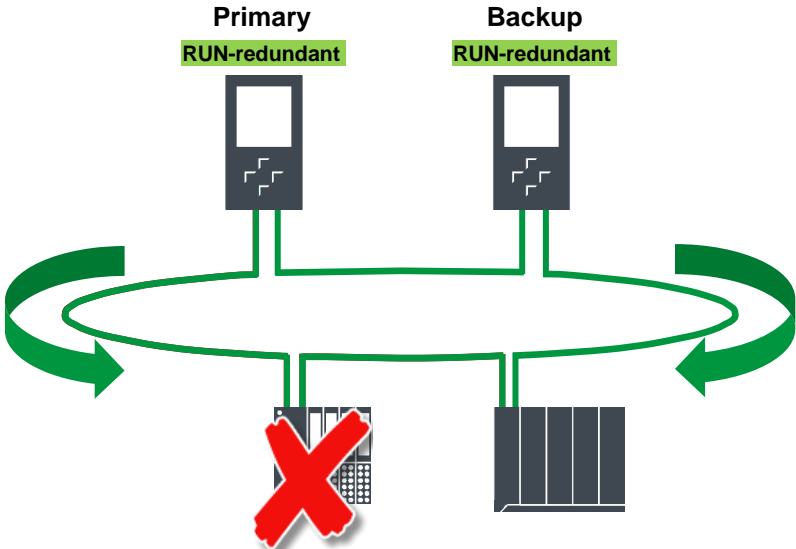
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# Failure scenarios for S7-1500 R/H

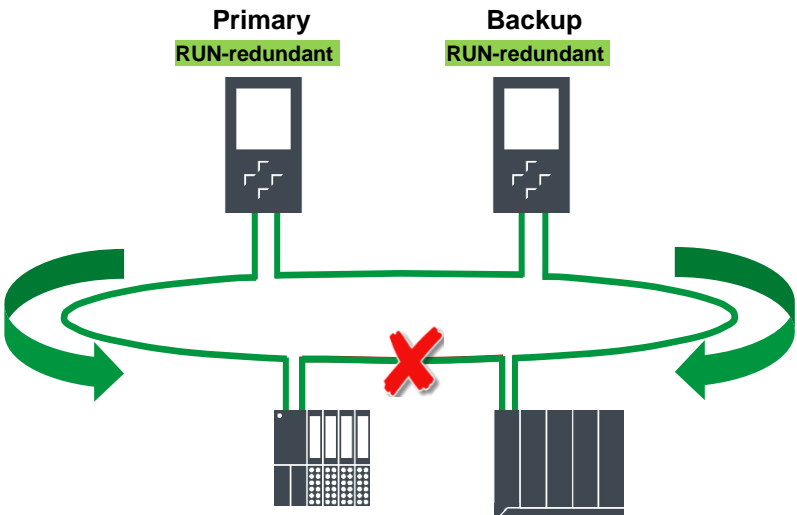
Primary or Backup CPU failure



Failure of an IO device in the PROFINET ring

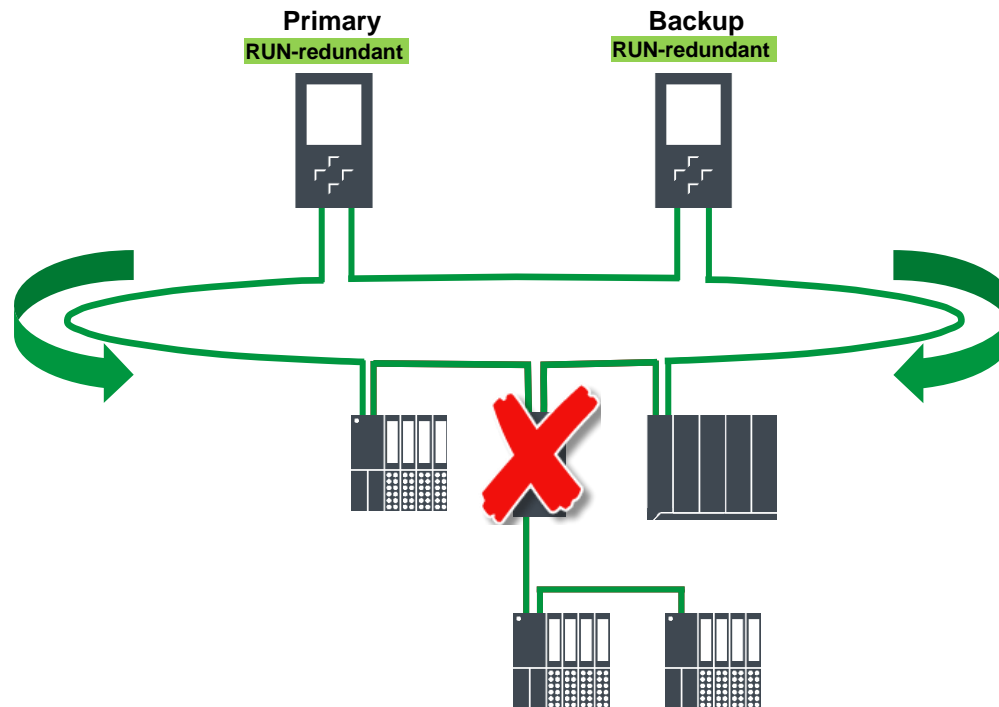


Failure of the PROFINET cable in the PROFINET ring



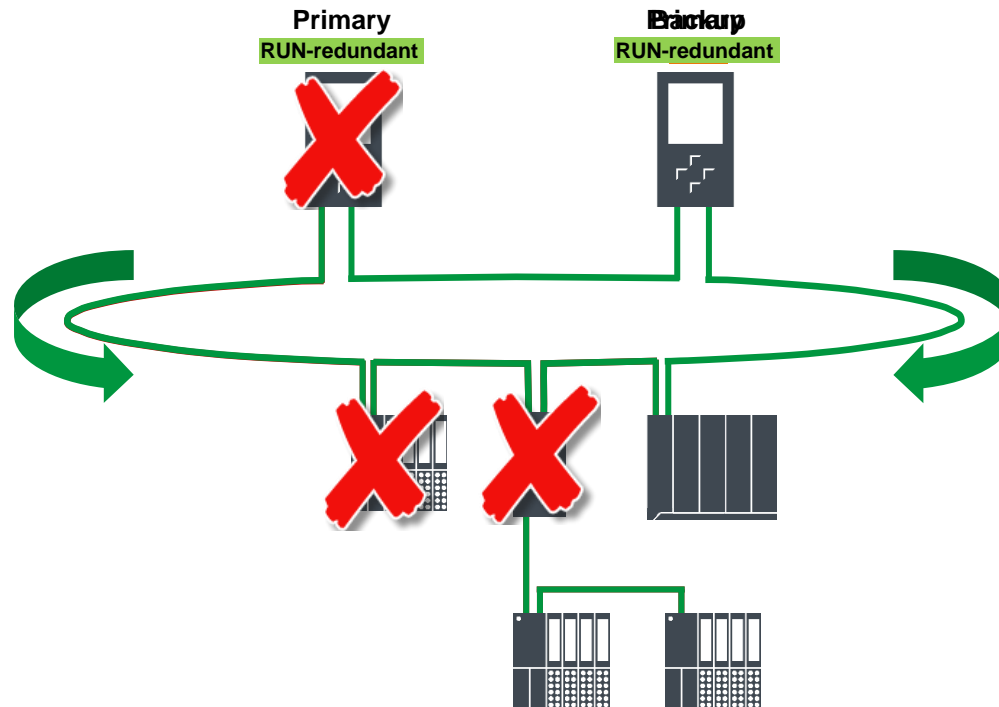
## Failure scenarios for S7-1500 R/H

Failure of a switch in the PROFINET ring  
(with line topology)



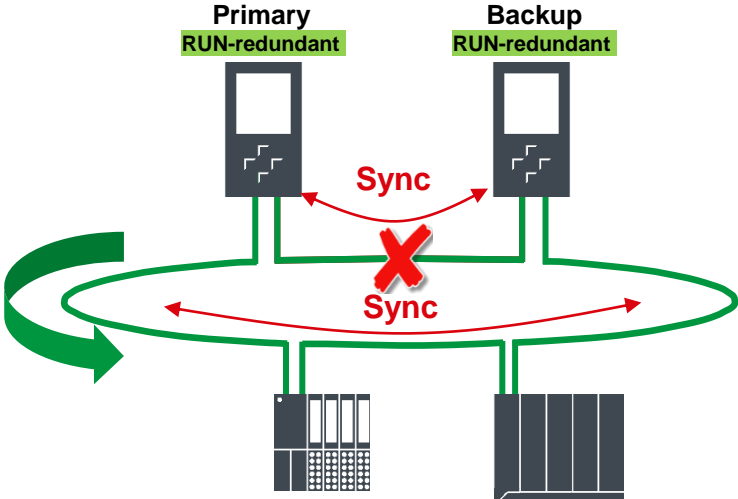
## Specific failure scenarios for S7-1500 R

Failure of an IO device in the PROFINET ring AND the Primary CPU

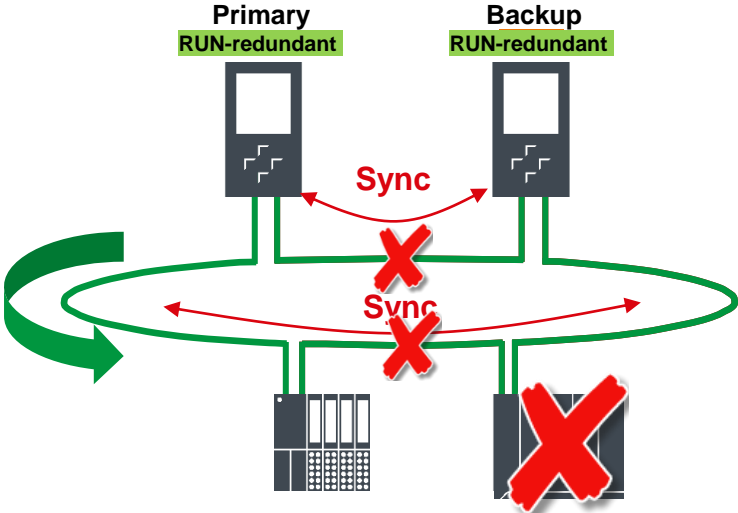


# Specific failure scenarios for S7-1500 R

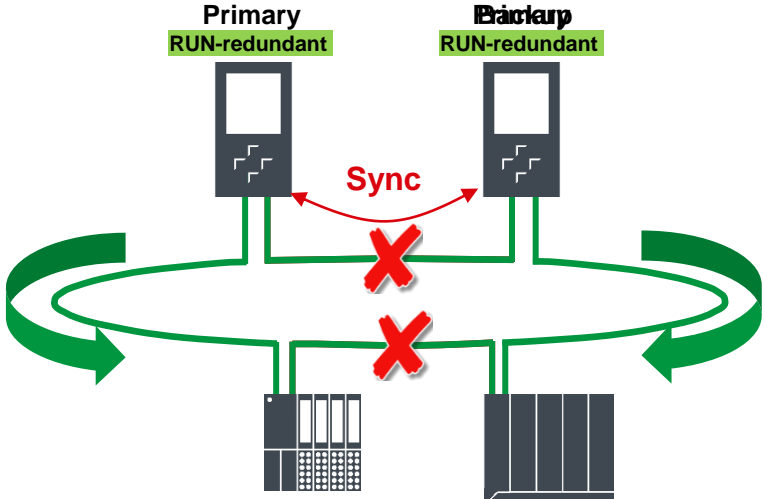
Failure of a direct redundancy connection



Failure of the two direct redundancy connections and PROFINET cable in the PROFINET ring



Time interval 2<sup>nd</sup> failure > 1500ms

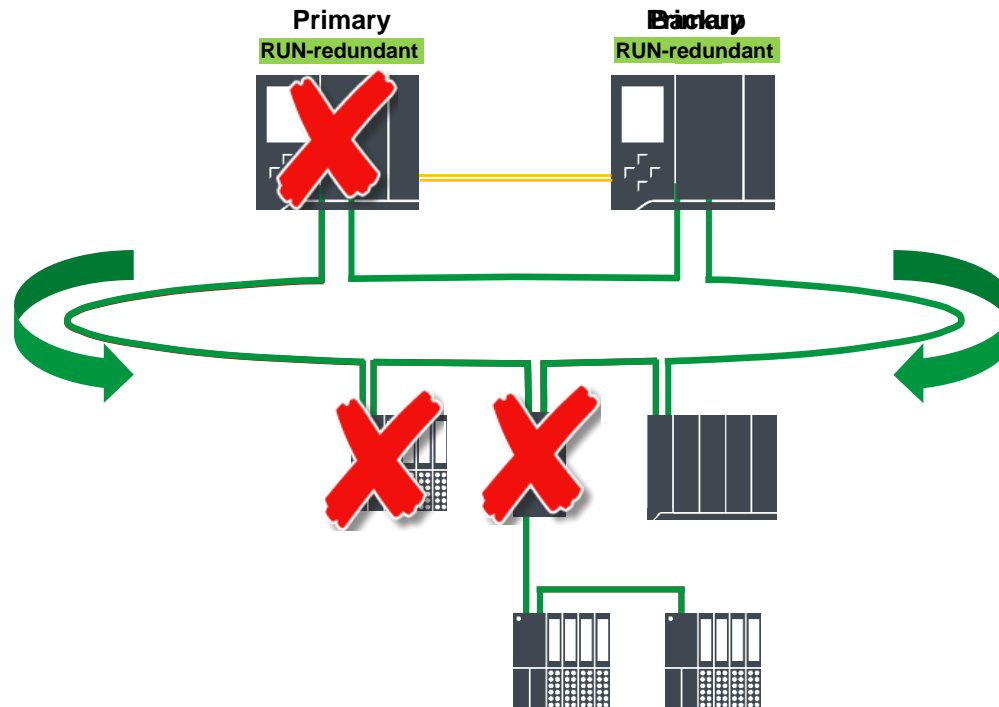


Time interval 2<sup>nd</sup> failure < 100ms

! Undefined Condition !

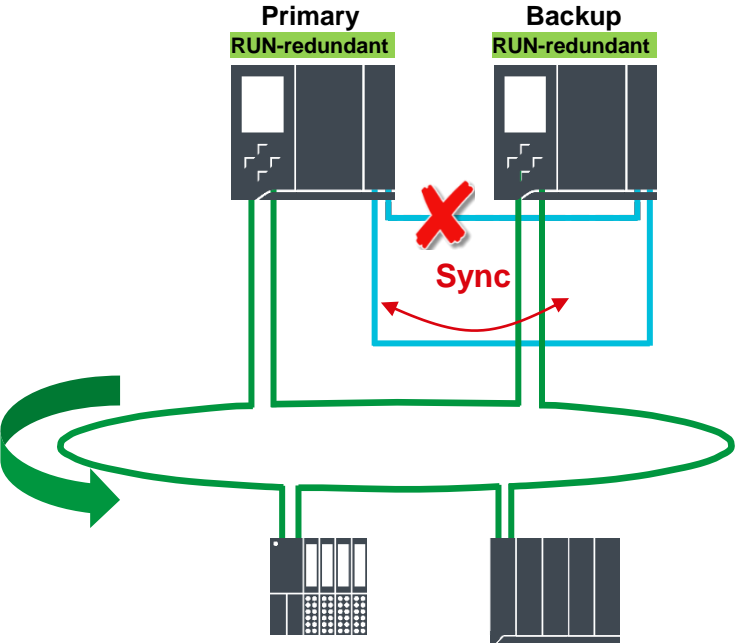
## Specific failure scenarios for S7-1500 H

Failure of an IO device in the PROFINET ring AND of the Primary CPU

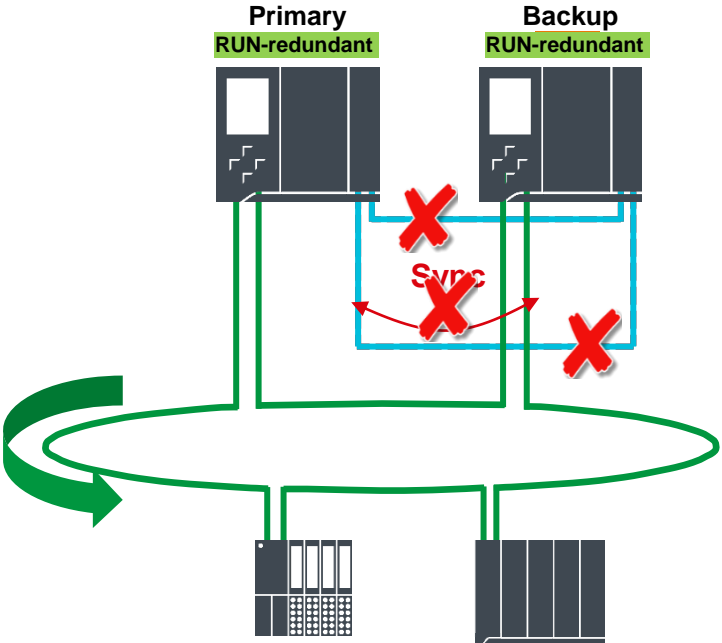


# Specific failure scenarios for S7-1500 H

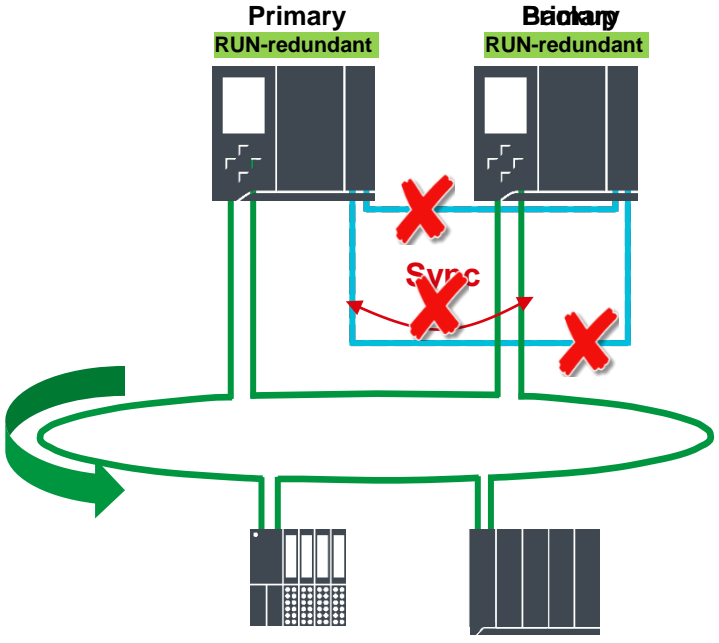
## Failure of a direct redundancy connection



## Failure of the two direct redundancy connections



Time interval 2<sup>nd</sup> failure > 55ms

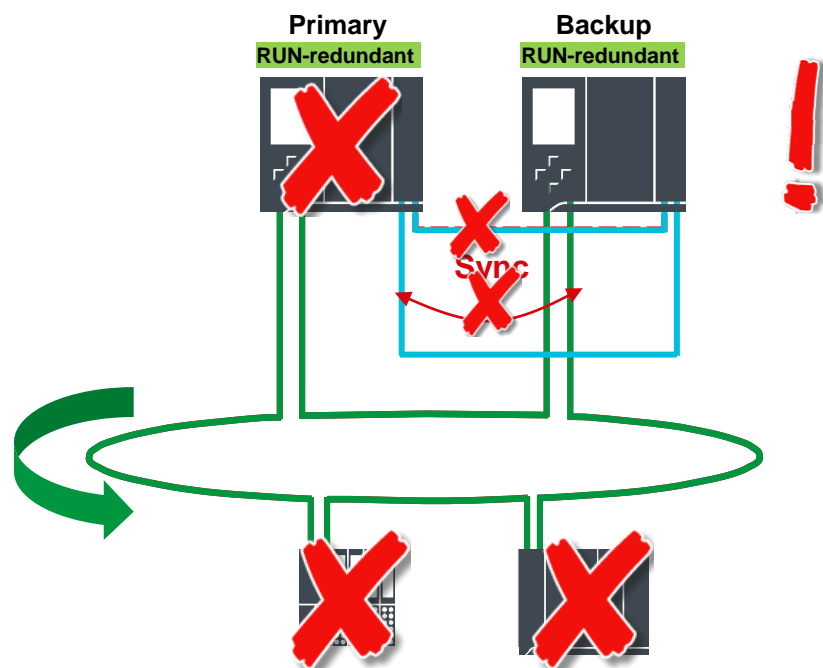


Time interval 2<sup>nd</sup> failure < 55ms

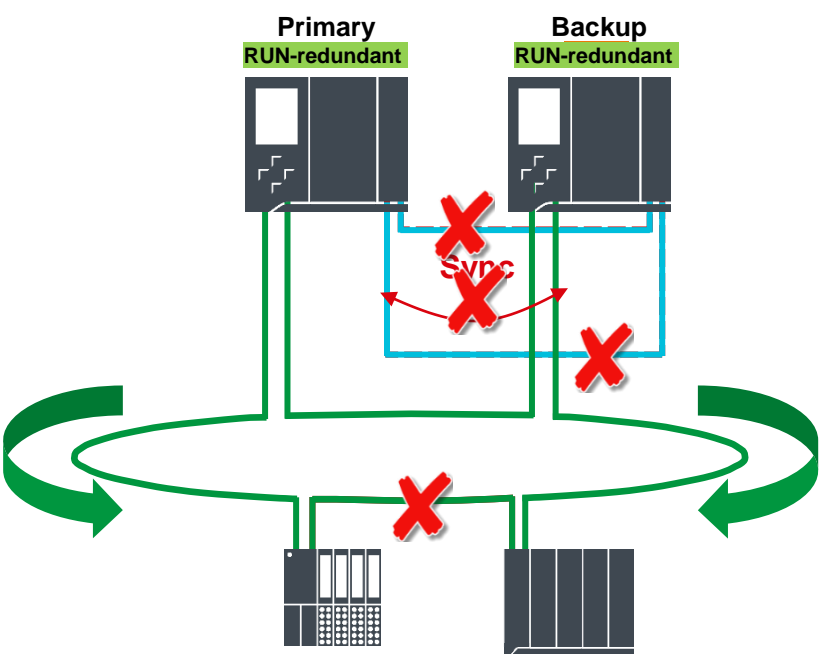
Undefined Condition

# Specific failure scenarios for S7-1500 H

Failure of the direct redundancy connection and of the Primary CPU



Failure of the two direct redundancy connections and PROFINET cable in the ring



Time interval 2<sup>nd</sup> failure > 55ms

# Communication via System-IP and Device-IP Addresses

SIMATIC S7-1500 Redundant Systems

# Communication via System-IP Addresses

## IP-Addresses for R/H System

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

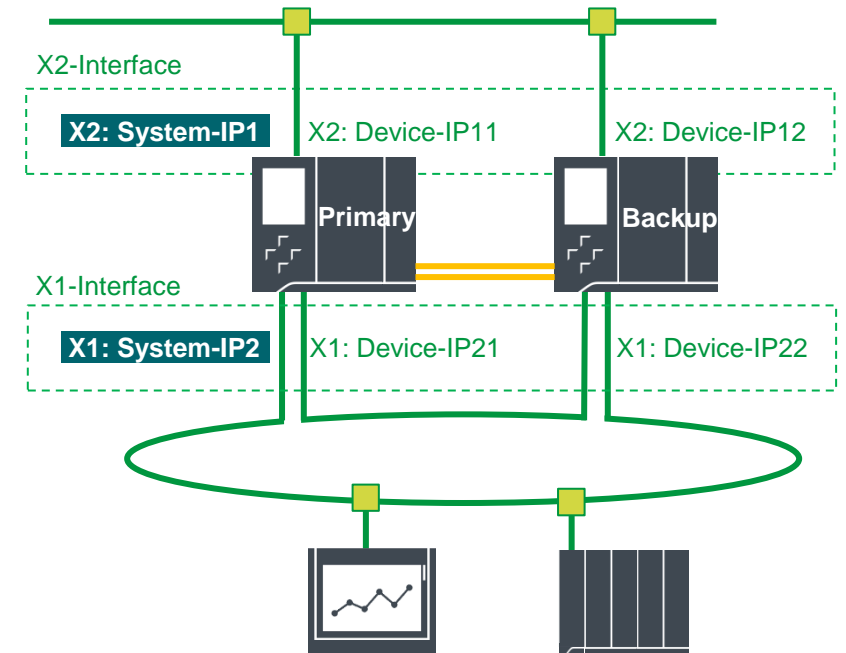
### System IP address for switched communication

☒ Enable the system IP address for switched communication

IP address: 192 . 168 . 0 . 3

Subnet mask: 255 . 255 . 255 . 0

Virtual MAC address: 00- 00- 5E- 00- 01- 1

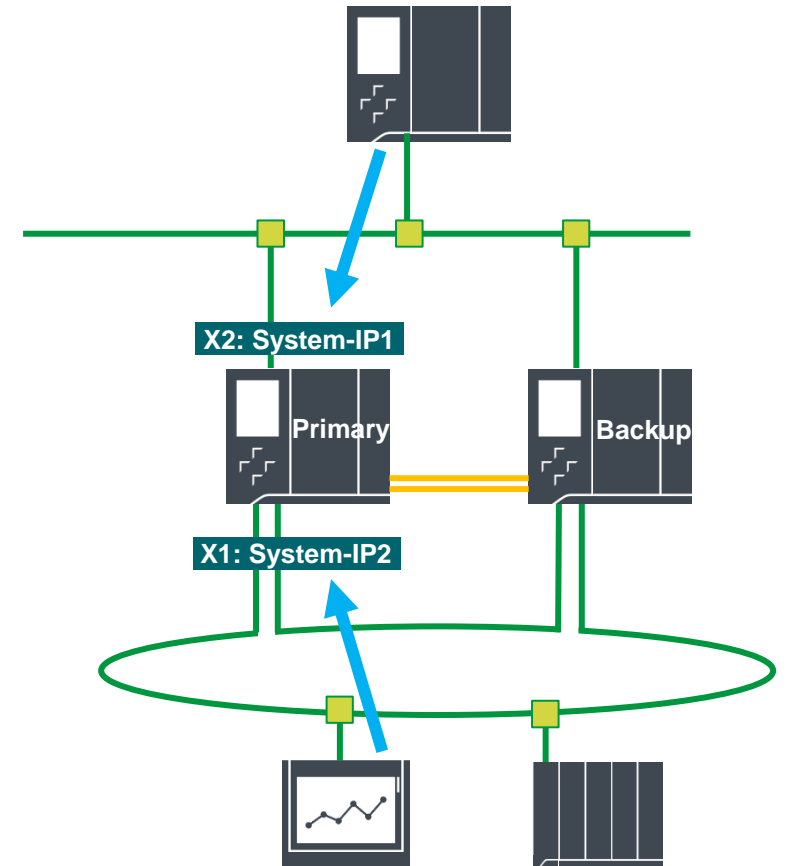


# Communication via System-IP Addresses

## Behavior

The System-IP Address is automatically assigned to the Primary CPU

For a communication partner (e.g. a standard PLC or HMI) the R/H system behaves like a “normal” (non redundant) communication partner.

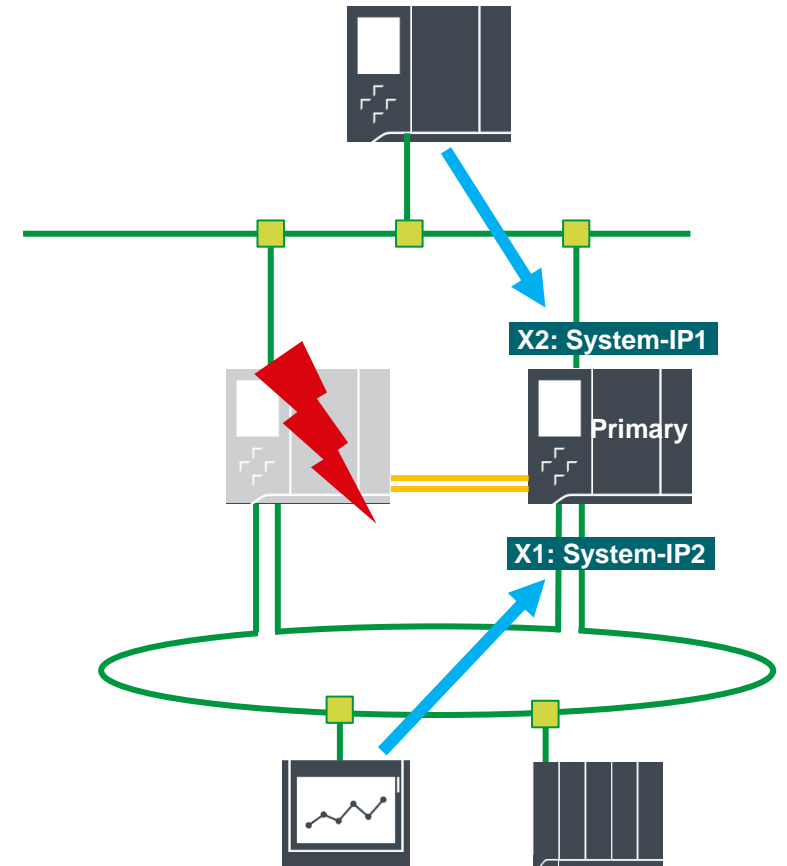


# Communication via System-IP Addresses

## Behavior at Primary-Backup Failover

When the Primary Controller fails, the System-IP addresses are automatically transferred to the Backup PLC.

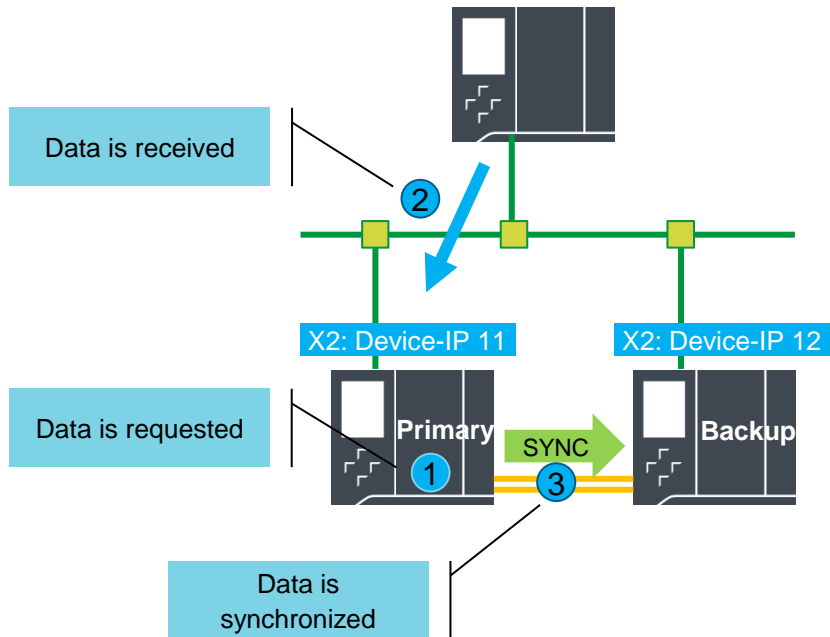
→ A Standard-Controller / HMI can continue the communication with the same IP Address.



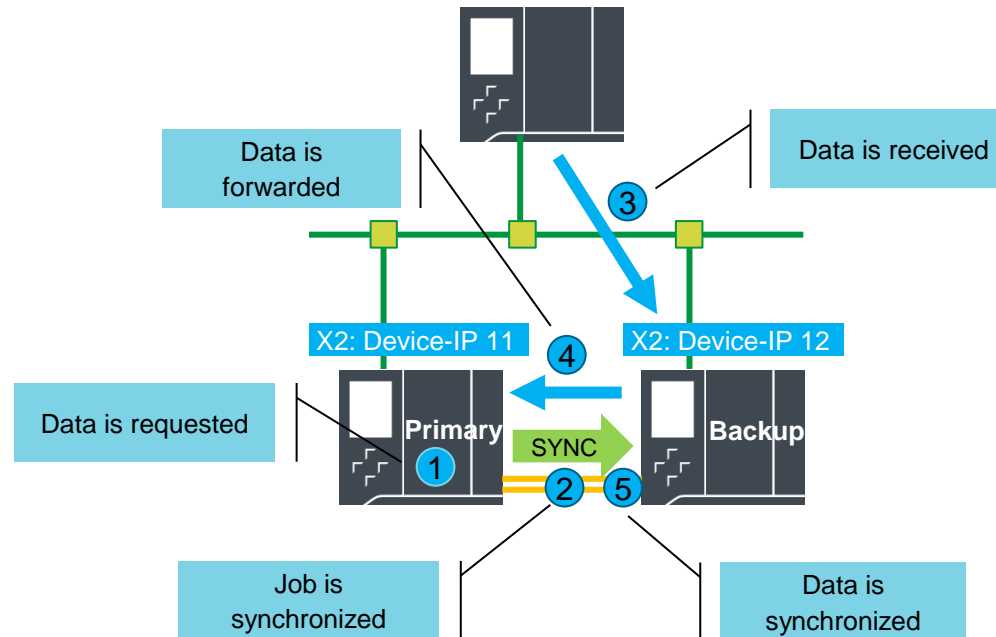
# Communication via Device-IP Addresses Behavior

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

Communication via the Primary PLC



Communication via the Backup PLC



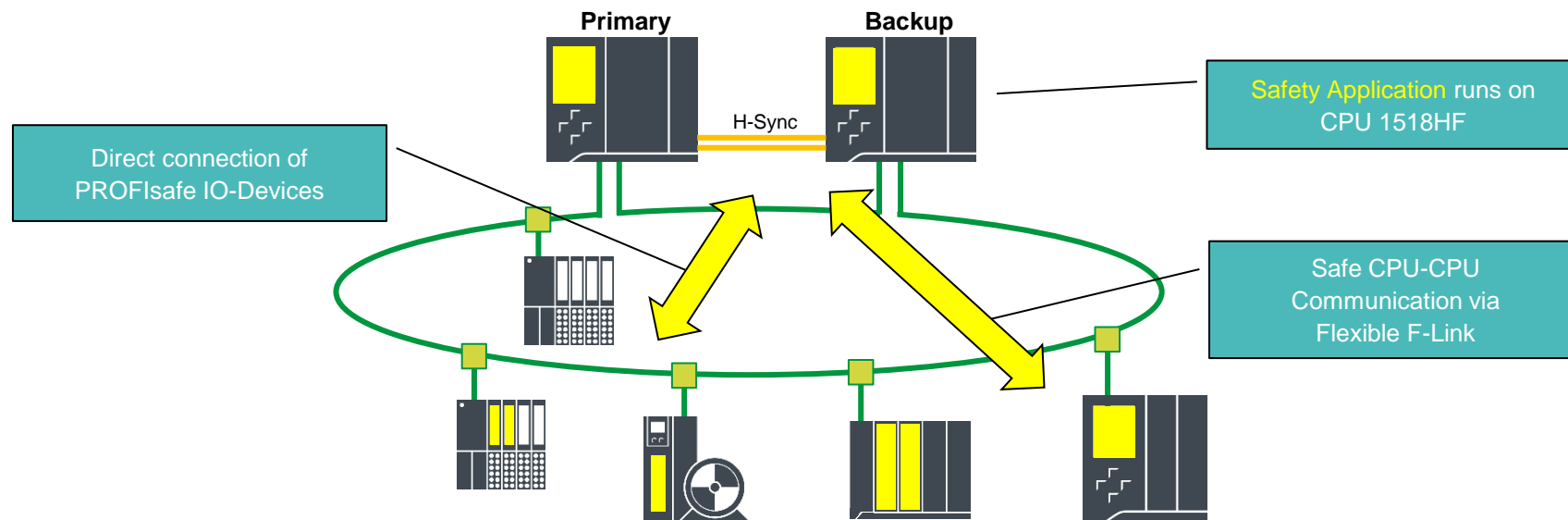
# Safety for Redundant Systems

SIMATIC S7-1500 Redundant Systems

# Network configuration with S7-1500 HF Safety Devices

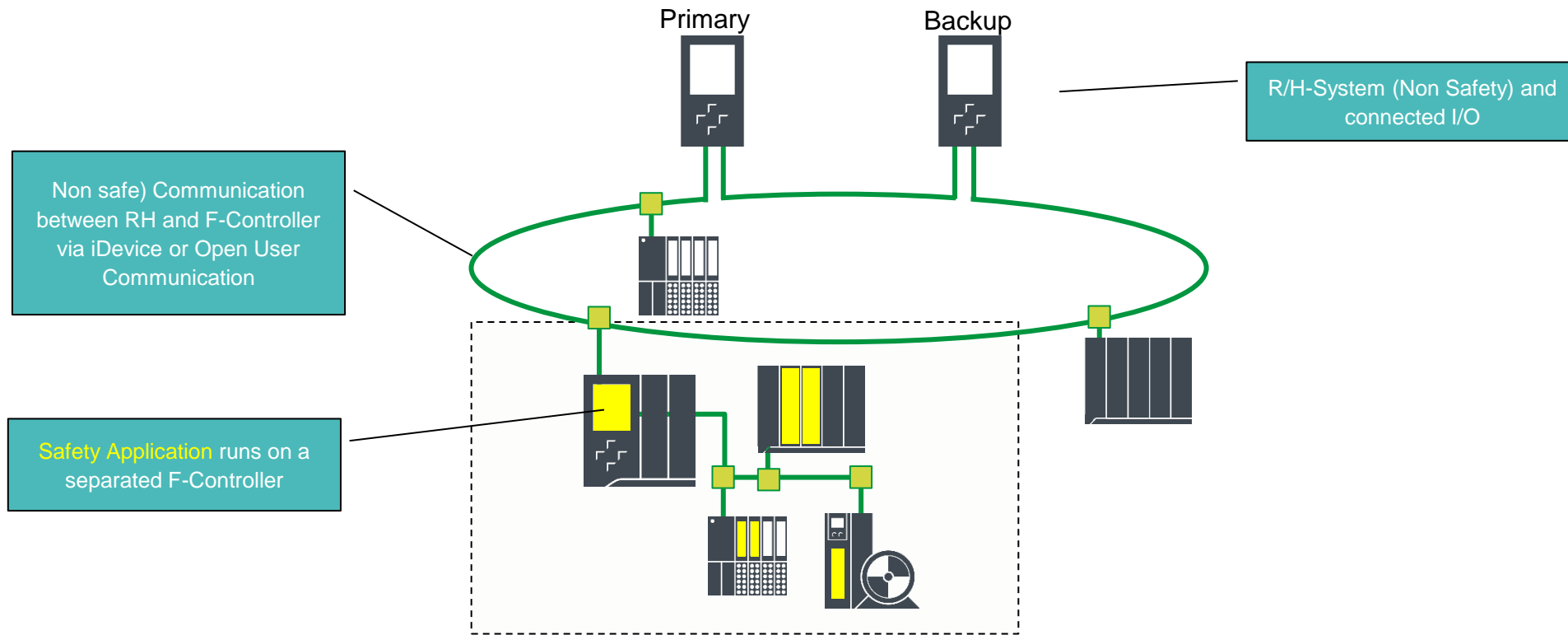
## Direct integration of safety devices with SIMATIC CPU 1518HF

New



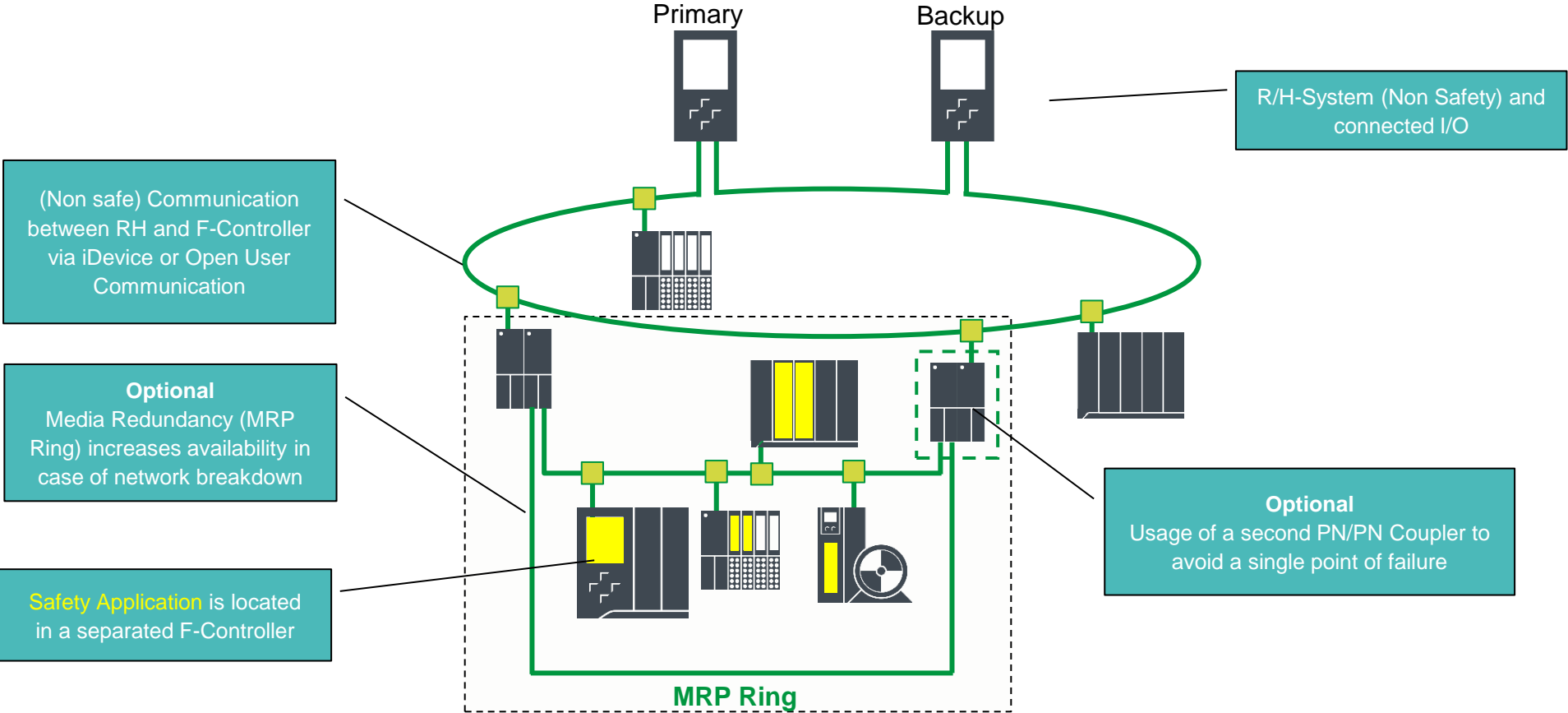
# Network configuration with S7-1500 R Safety Devices

Safety Devices can be integrated via subordinated F-Controller



# Network configuration with S7-1500 R Safety Devices

Safety Devices can be integrated via subordinated F-Controller, connected via PN/PN coupler



# Hardware Extensions in RUN with IO-Link

SIMATIC S7-1500 Redundant Systems

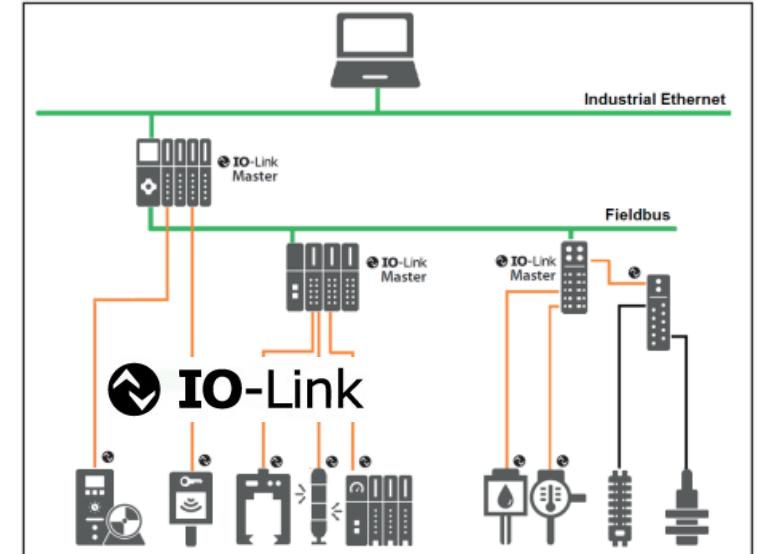
# Configuration in RUN (CiR) with IO-Link Overview

## What is IO-Link?

- IO-Link is a digital, point-to-point, industrial standard (IEC 61131-9) used for connecting digital sensors and actuators
- IO-Link devices are offered by most sensor manufacturers
- Siemens provides IO-Link Master modules for
  - ET 200SP
  - ET 200MP
  - ET 200eco PN
  - ET 200AL
  - ET 200pro

## These CiR use cases can already be solved today with IO-Link

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



## More information about IO-Link?

See <https://www.siemens.com/io-link>

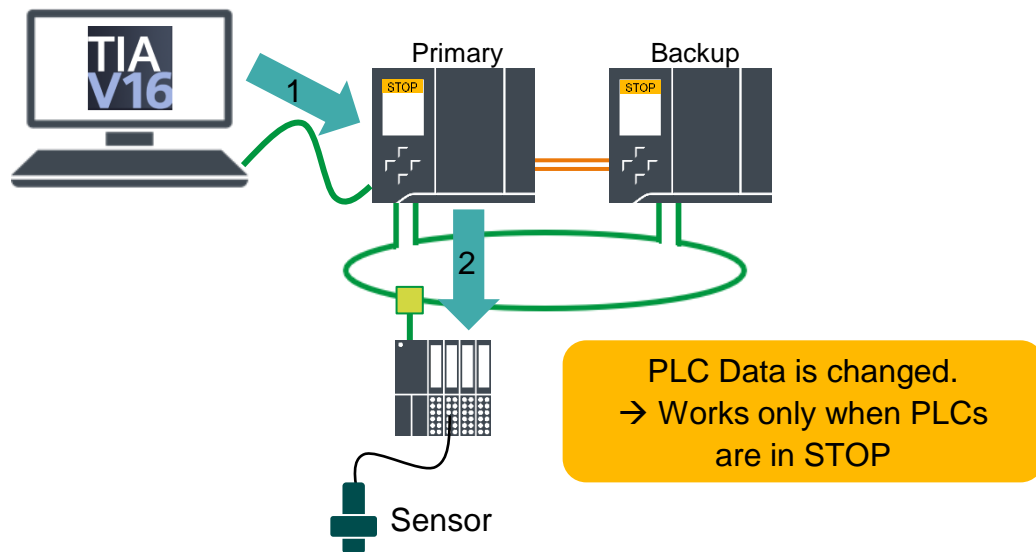
Or <https://www.io-link.com>

# Configuration in RUN (CiR) with IO-Link

## How does it work?

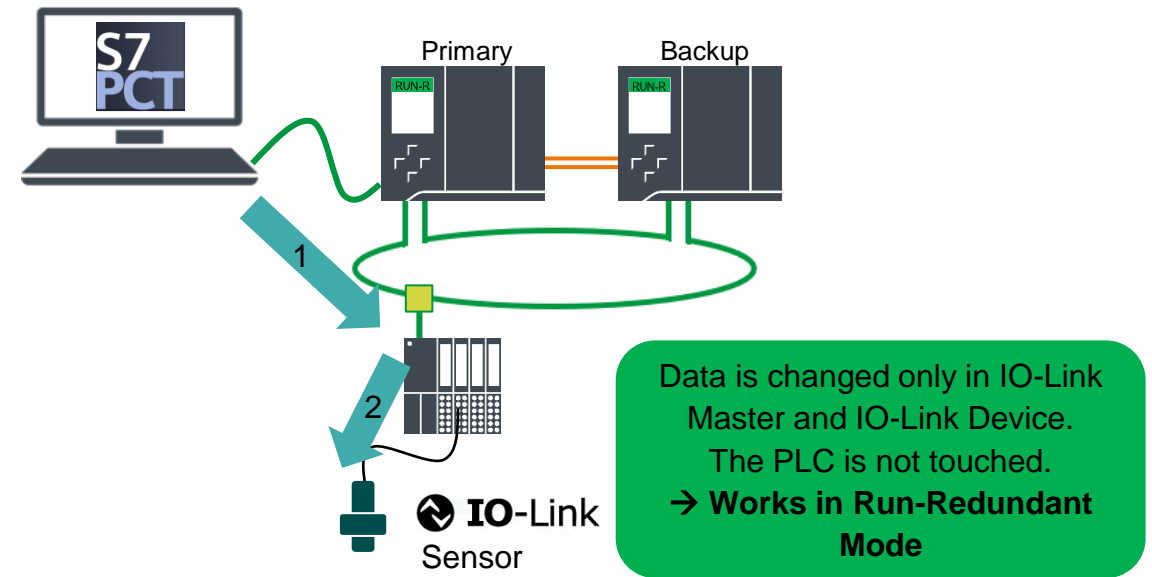
IO-Link devices (sensors or actuators) are configured via the IO-Link Master.  
The PLC or the H-System is not involved here.

### Hardware configuration with conventional sensors



1. TIA Portal Project is loaded to PLC
2. PLC sends data to ET 200

### Hardware configuration with IO-Link



1. S7-PCT Tool loads into IO-Link Master
2. IO-Link Master configures IO-Link Devices

# Configuration in RUN (CiR) with IO-Link

Example: Procedure to add a new sensor

## Installation

Commissioning Phase  
System in STOP

1. Insert reserve ET 200 IO-Link Master
2. Configure ET 200 in TIA Portal
3. Load TIA Portal project

### Benefit of IO-Link compared with conventional IO-Modules:

An IO-Link port can be used to connect to different channel types:

- Digital Input
- Digital Output
- IO-Link (analog values)

→ Only one module type for all sensor types

- 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. Connect Sensor with IO-Link Master
2. Start PCT Tool from TIA Portal
3. Select IO-Link Sensor in PCT
4. Configure IO-Link Sensor in PCT
5. Load IO-Link Master

→ **Result: Process values are transferred from Sensor to PLC**

## Program Extension

Production Phase  
System in RUN-Redundant

1. Add program tag (symbol) in TIA Portal
2. Use tag in PLC program
3. Load PLC program to R/H PLC

→ **Result: Program reacts on input from new sensor**

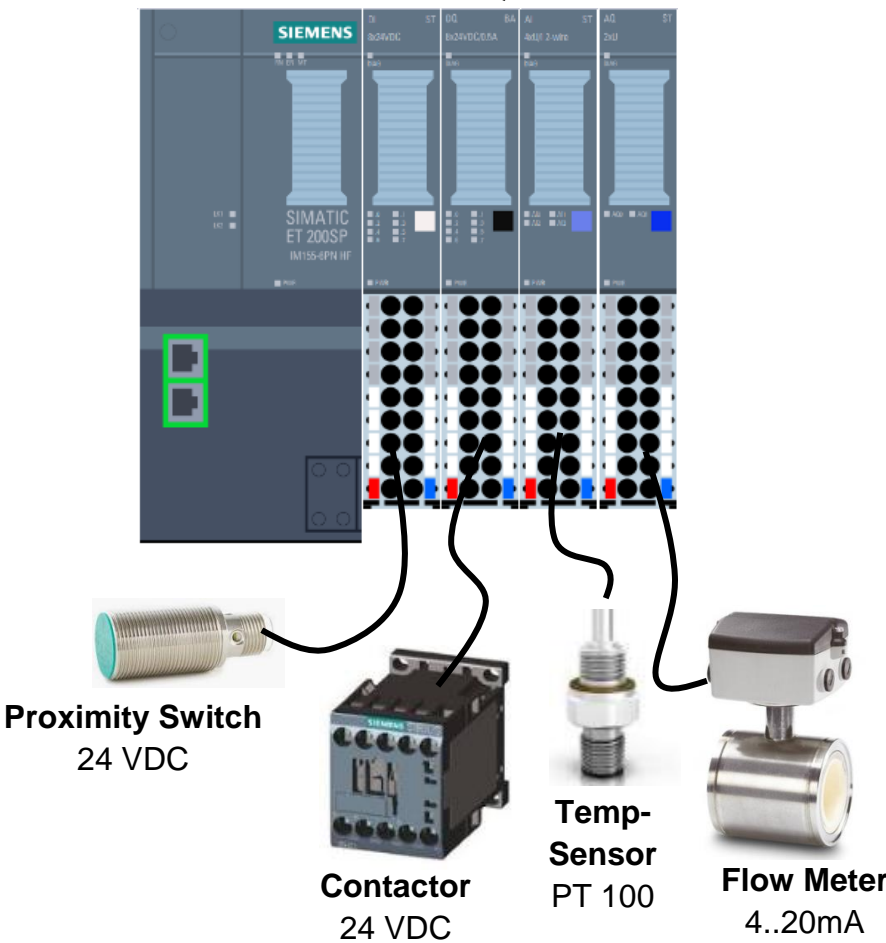
# Sensor / Actuator Connection

## Example for ET 200SP

### Conventional

Four different module types are required

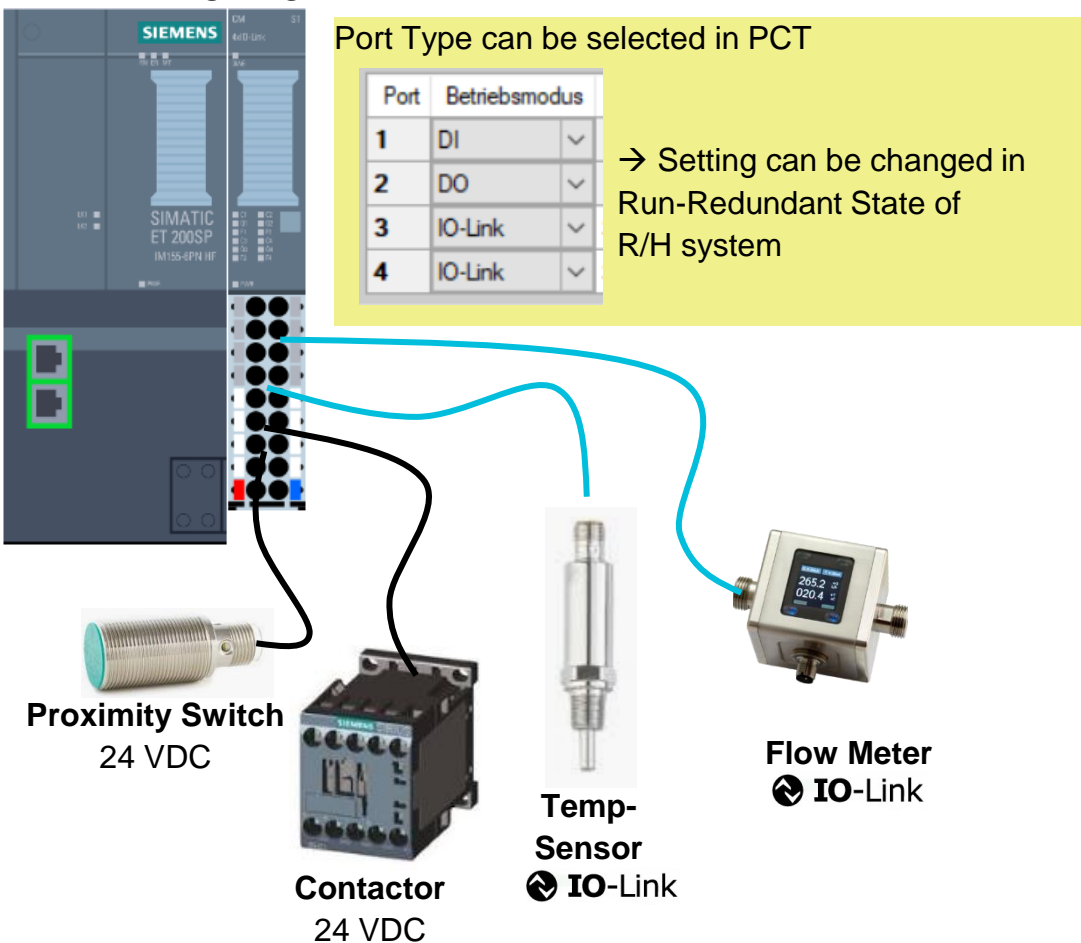
DI DQ RTD AI



### With IO-Link

Only one module type required

CM IOL



# | HMI Connection

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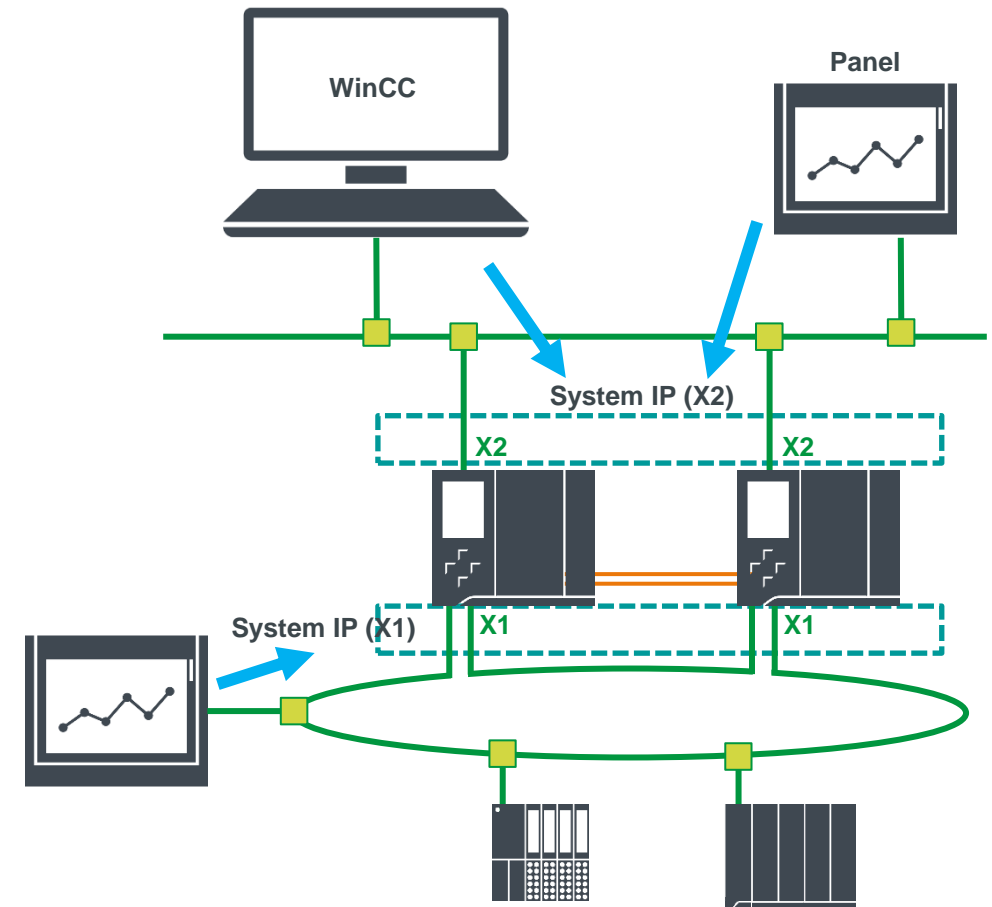
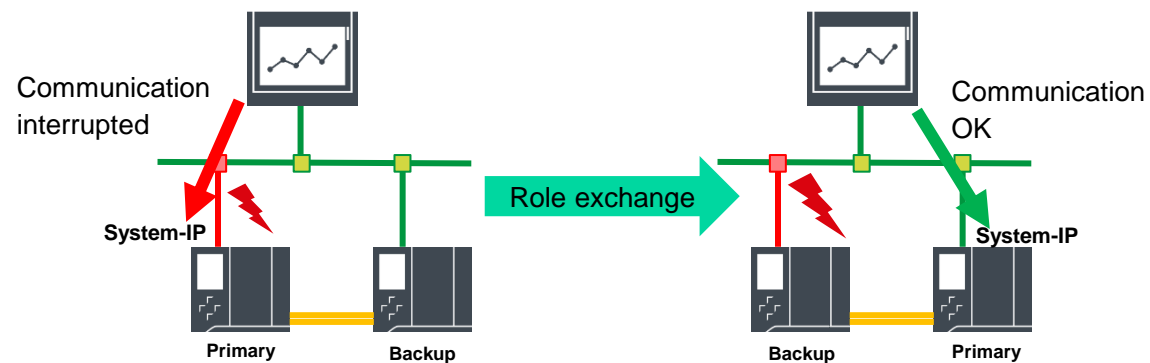
# HMI Connection for R/H Systems via a non-redundant network with system IP address

A HMI connection via the system IP addresses with a non-redundant network is possible in all cases.

Note for connection via X2:

If the connection to the Primary-PLC is interrupted, communication with the system is no longer possible because the system IP address remains with the Primary-PLC. To remedy this, the role of the PLCs can be exchanged program-controlled in this case. See slide

[Extension RH\\_CTRL](#)



# HMI Connection for R/H Systems

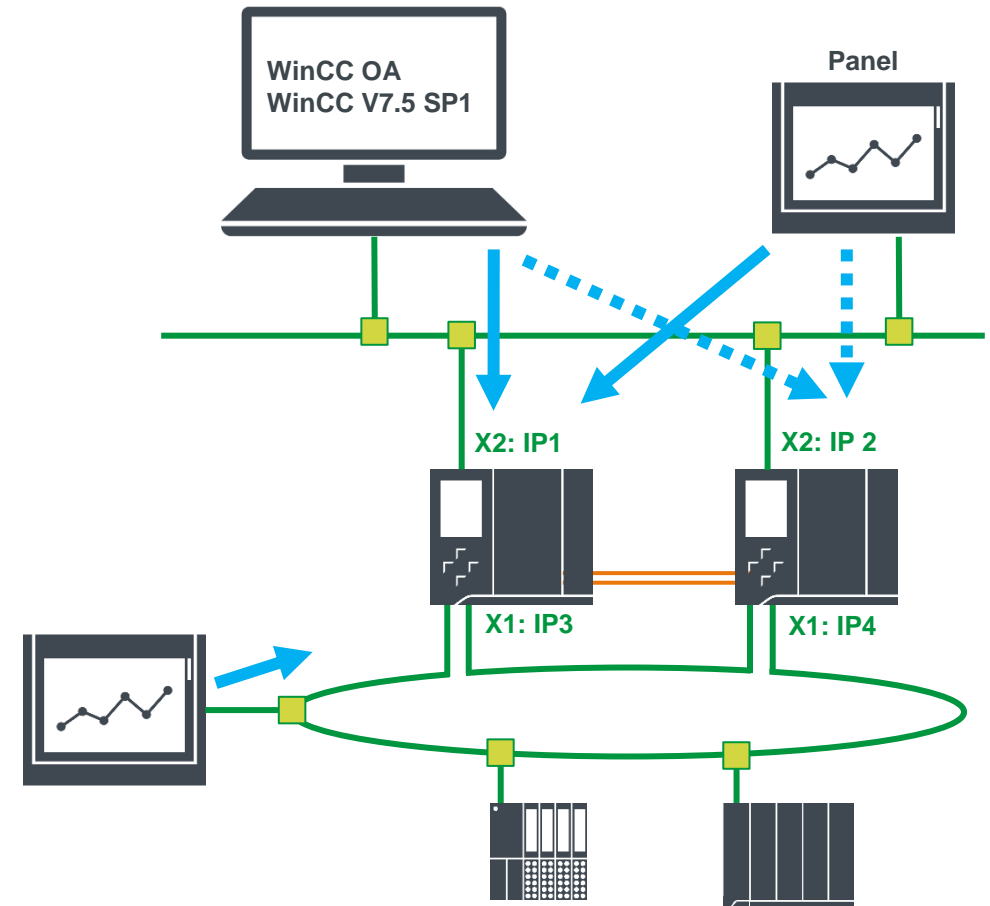
via a non-redundant network with device IP addresses

A HMI connection via the device IP addresses requires a switching option on HMI side. This is supported by

- WinCC OA from V3.17
- 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/en/view/109781687>



# HMI Connection for R/H Systems

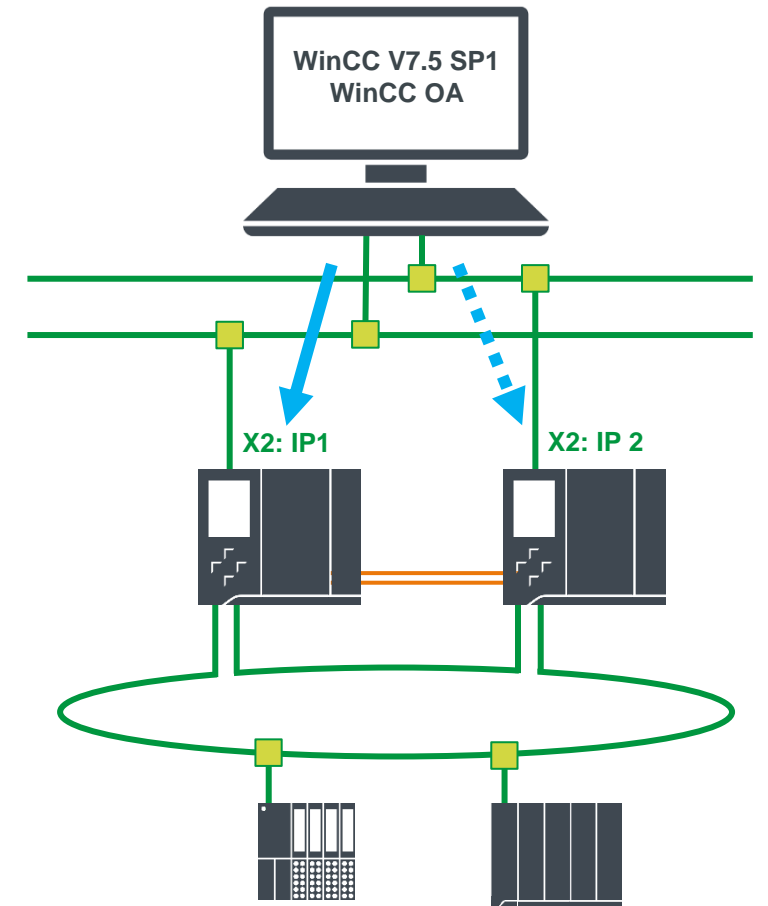
via a redundant network with device IP addresses

A HMI connection via a redundant network using device IP addresses is possible with

- WinCC OA from V3.17
- WinCC V7.5 SP1 via scripting

The switching of the communication connection in case of an error is done by WinCC. See

<https://support.industry.siemens.com/cs/ww/en/view/109773067>



# HMI Connection for R/H Systems

## via a redundant network with system IP addresses

A HMI connection via a redundant network using system IP addresses is possible with

- WinCC OA from V3.17
- WinCC V7.5 SP1 via scripting

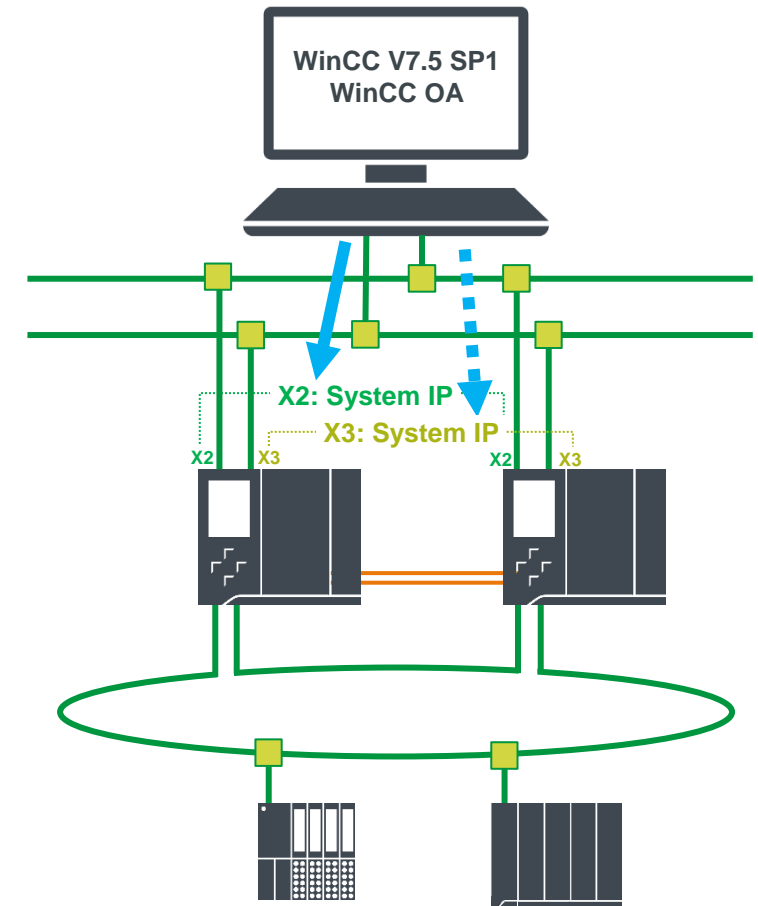
Use of the CPU interfaces:

System-IP of X1 and X2 with 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

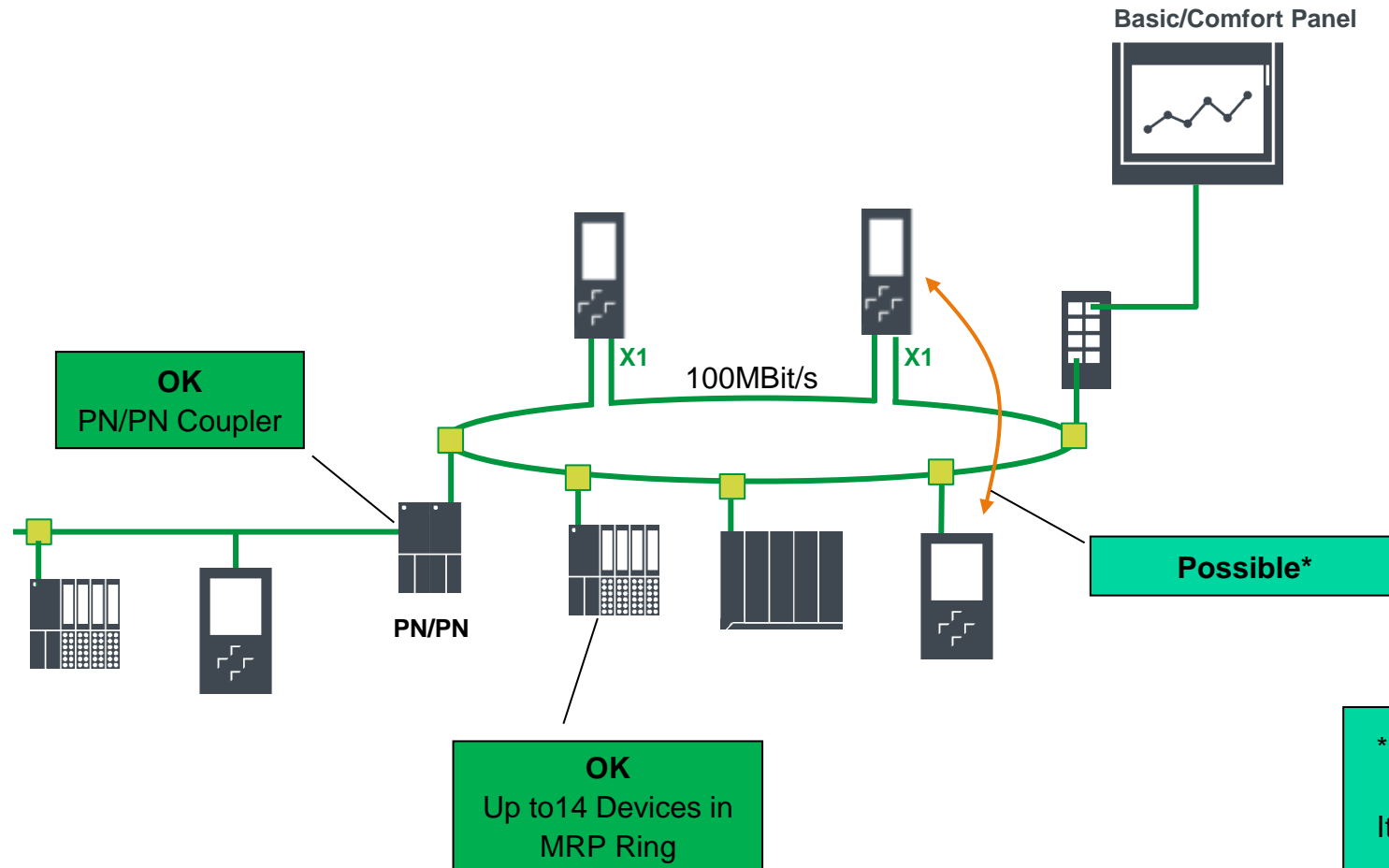
- If the Primary PLC fails, the system switches over by moving the system IP addresses.
- If one network fails, switch over is done by WinCC



# Installation Recommendations

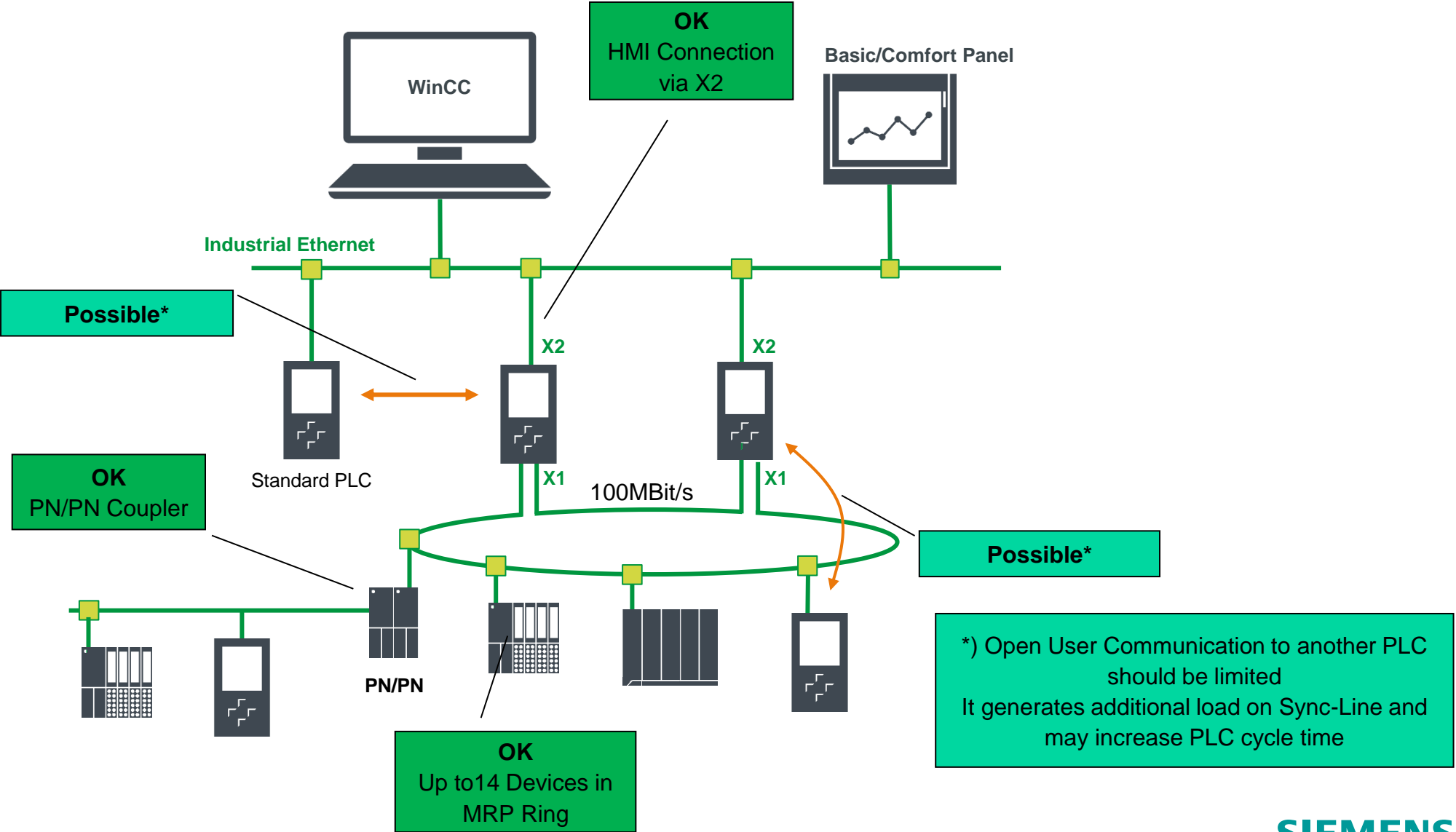
SIMATIC S7-1500 Redundant Systems

# Installation Recommendations for CPU 1513R-1 PN

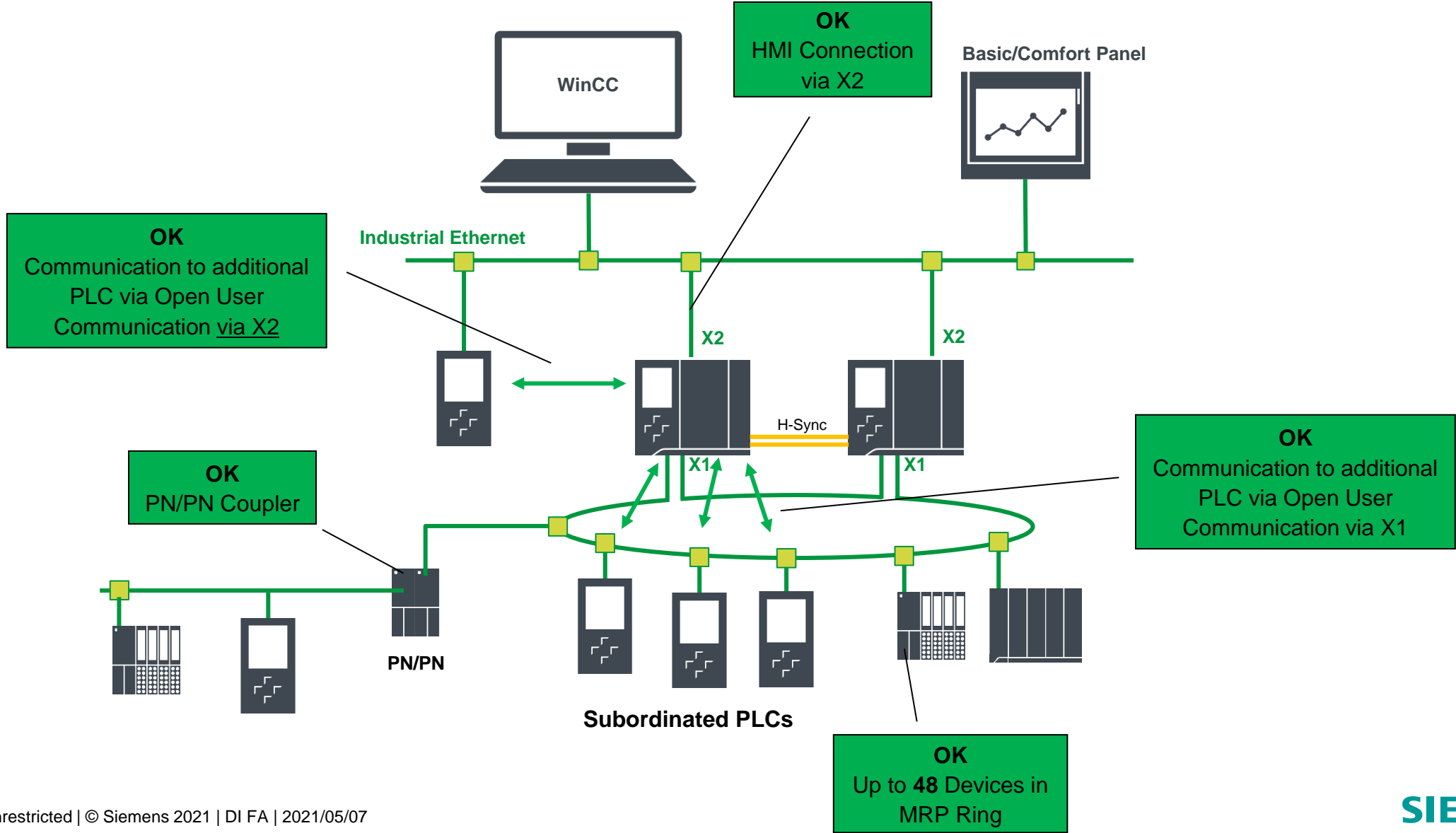


\*) Open User Communication to another PLC should be limited  
It generates additional load on Sync-Line and may increase PLC cycle time

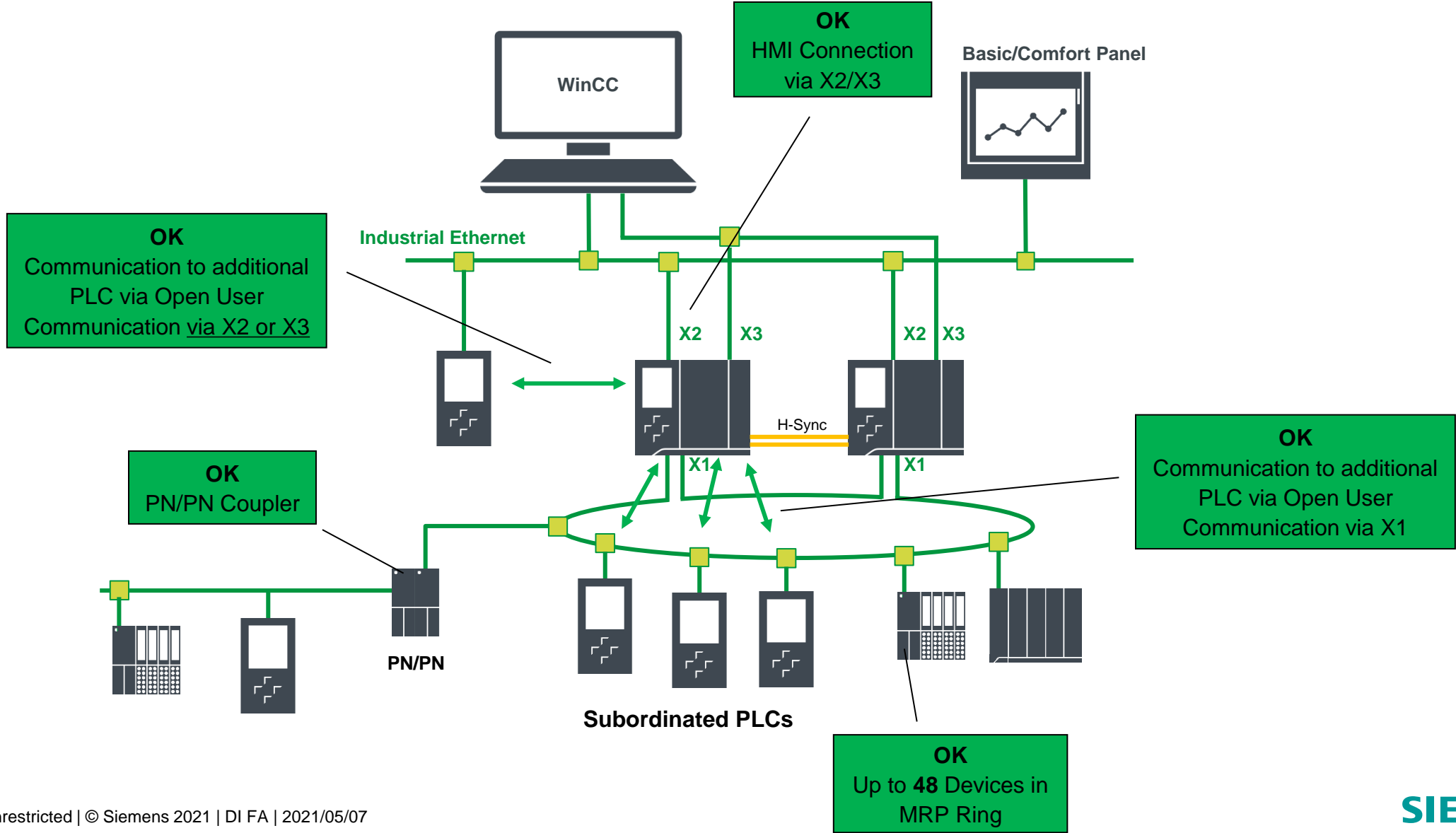
# Installation Recommendations for CPU 1515R-2 PN



# Installation Recommendations for CPU 1517H-3 PN



# Installation Recommendations for CPU 1518HF-4 PN



# Programming Recommendations

SIMATIC S7-1500 Redundant Systems

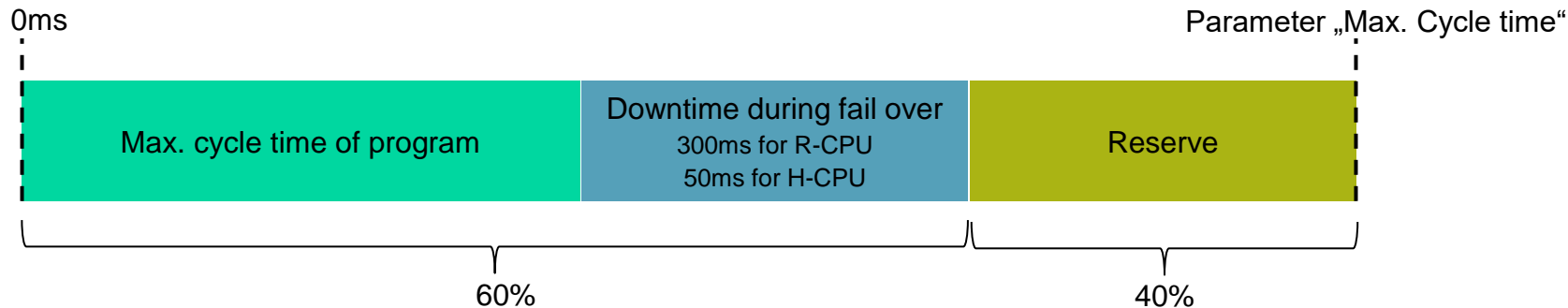
# Programming recommendations for SIMATIC S7-1500R/H (I)

## 1) Adjust maximum cycle time

The maximum cycle time should be set as large as the process allows.

This can shorten the duration for the SYNCUP phase, since the transition to RUN-Redundant state only takes place when the actual cycle time is <80% of the maximum cycle time.

Recommendation:



## 2) Set minimum cycle time as high as possible

Increasing the minimum cycle time to the minimum value required for the process reduces the system load due to synchronization.

This also shortens the SYNCUP phase and leads to higher performance during communication.

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

## 3) Avoid direct I/O access

Each instance of direct I/O access is synchronized in the RUN-Redundant system state and results in a higher cycle time. Recommendation: Access the inputs and outputs of the IO devices over the process image or process image partitions.

## 4) Reduce communication load during SYNCUP

If possible, the communication load should be kept low during a SYNCUP phase. This accelerates the SYNCUP process. This can be program controlled by the SFC "GET\_DIAG".

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

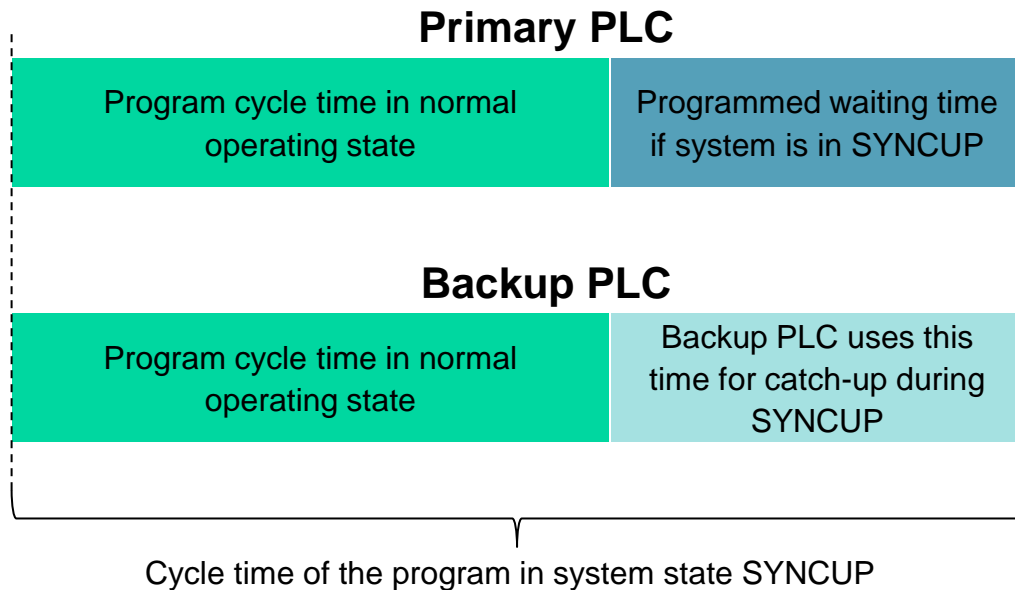
## 5) Reduce load of cyclic OBs during SYNCUP

If the program has considerable load in cyclic OBs, it can be temporarily reduce by calling the SFC SET\_CINT for those OBs. In SYNCUP state, set the cycle time for the OB to a longer time, and restore it to its original time in all other states (solo and redundant)

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

## 6) Use the WAIT function when system is in state SYNCUP

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



```
IF #DIS.OperatingState = 38 THEN
  // if in syncup
  WAIT(30000);
END_IF;
```

# New Features with Firmware V2.9 (TIA Portal V17)

SIMATIC S7-1500 Redundant Systems

# SIMATIC S7-1500 Redundant Systems

## New Features in with Firmware Version 2.9

### New features

New CPU 1518HF-4 PN <sup>1)</sup>

Safety for redundant Systems with CPU 1518HF-4 PN <sup>1)</sup>

MRP-Interconnect

Simulation of S7-1500R/H in PLCSIM Advanced <sup>2)</sup>

Extension of the RH\_CTRL Instruction

Improved performance for “Switched S1” feature

OB72 call in case of redundancy loss of a sync line

Enhanced Security Features <sup>1)</sup>

### New support of S7-1500 standard features

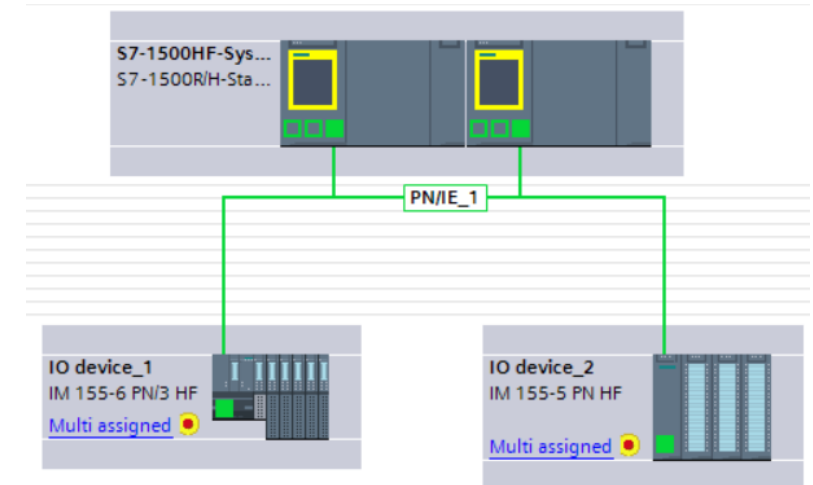
Recipe Function (Instruction RecipeExport" and "RecipeImport, ....) <sup>1)</sup>

# New in TIA Portal V17: Safety for redundant Systems

## Realize Safety Applications with redundant Controller

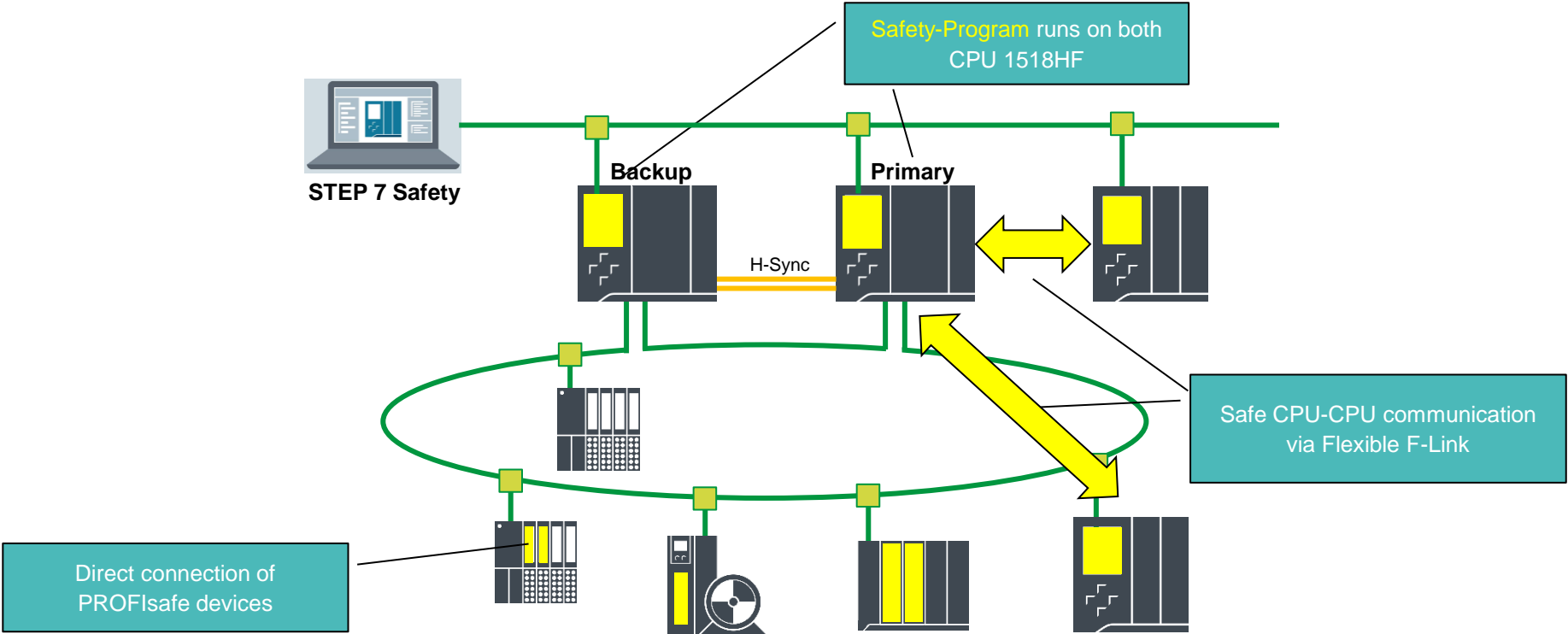
### High Availability + Failsafe = CPU HF

- Engineering in STEP 7 Professional (TIA Portal) V17 and STEP 7 Safety
- Safety programming like non-redundant Fail-safe PLC
- Support of PROFI-safe communication
- Support of Flexible F-Link (safe controller/controller communication)
- Fail-Over scenario without stop of the safety program
- Fast commissioning mode reduces turnaround time
  - Fast compile of F-programs in deactivated safety mode



# New in TIA Portal V17: Safety for redundant Systems

## Configuration Example

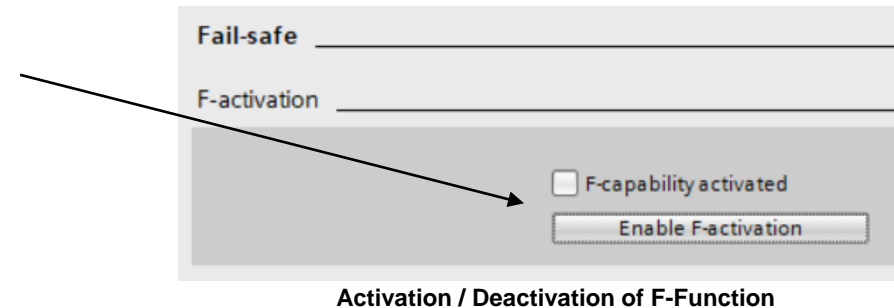


# New in TIA Portal V17: CPU 1518HF-4 PN

## Safety, More Memory, 3<sup>rd</sup> PN Interface

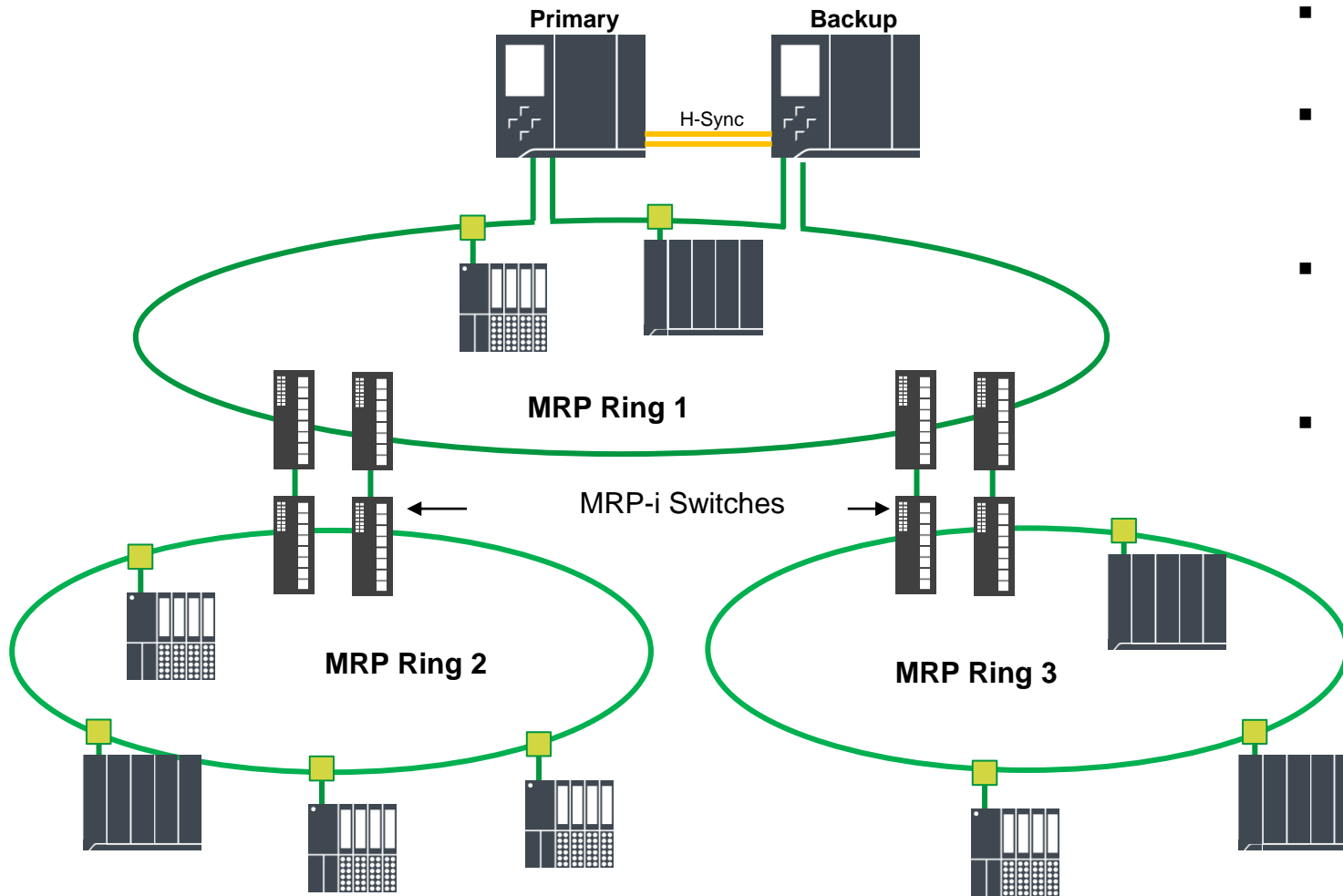
### CPU 1518HF-4 PN

- For Safety- and Standard Applications
- Three Ethernet-Interfaces for Communication
  - X1 (2 Ports): PROFINET RT
  - X2 (1 Port): PROFINET Basic services, 100MBit/s
  - X3 (1 Port): PROFINET Basic services, 1 Gbit/s
- 9 MB Memory for Program
- 60 MB Memory for Data
- Can also be used as Non-Safety H-Controller
- Same size as CPU 1517H
- Same accessories as for CPU 1517H



## New with FW-Version V2.9: MRP Interconnect

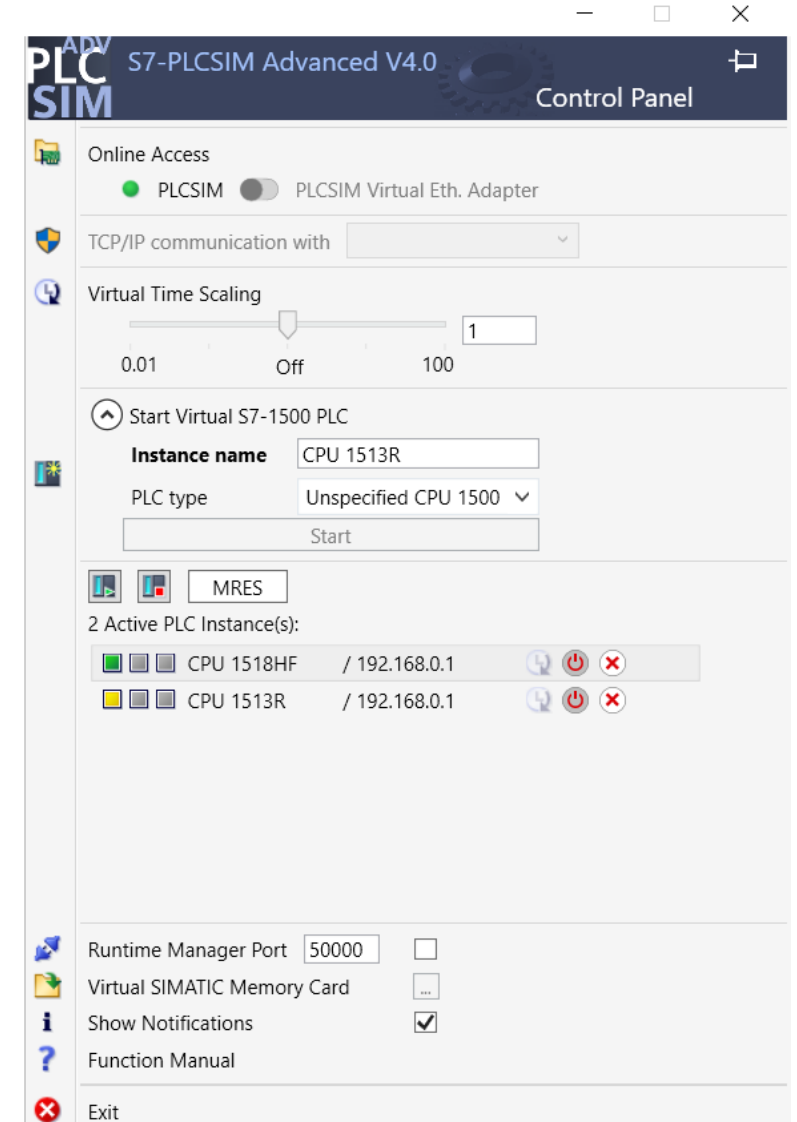
### Coupling of multiple MRP rings



- MRP-Interconnect Switches allow to couple multiple MRP-Rings.
- Because redundant switches can be used, a coupled ring keeps on working even if one switch fails.
- In each ring, up to 50 devices can be used → No more need to use stitches when more than 50 devices are needed. → Increased availability.
- Can be used with the following SCALANCE Switches: XR500, XM400, XC200, XF204-2BA, XP200

## New: Support of S7-1500 R/H in PLCSIM Advanced Simulation of a R/H-Program in Solo-Mode

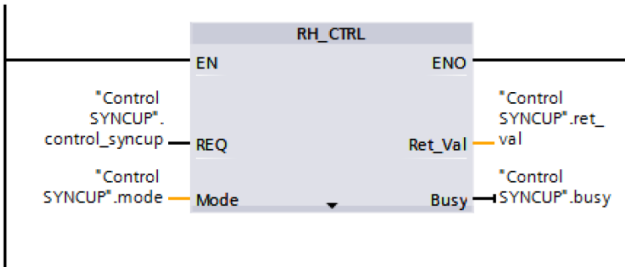
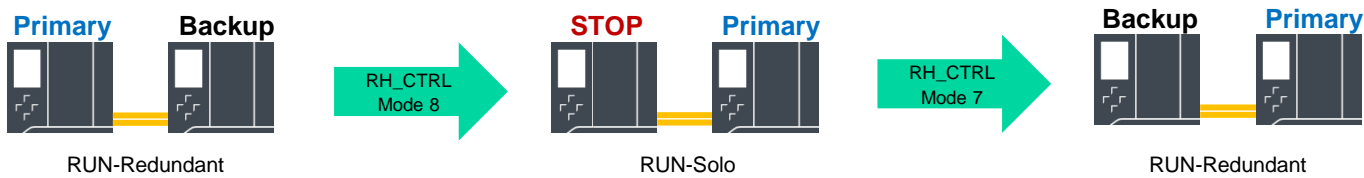
- With PLCSIM Advanced V4.0 it is now possible to test the PLC program also for R/H/HF controller without installed hardware.
- The simulation runs only in RUN-Solo Modus of the system.
- Instructions which changes the behavior of the redundancy system (like disable SyncUp) can be used, but they do not have an effect.



# New in TIA Portal V17: Extension of RH\_CTRL

## Switch PLC roles in user program

- Firmware V2.9 now supports three new modes of the RH\_CTRL instruction:
- **Request SYNCUP:** If the system is in RUN-Solo mode, this mode restarts the SYNCUP procedure so that it changes to RUN-redundant.
  - **Stop Primary-PLC:** In RUN-Redundant mode, the primary PLC is stopped and the backup PLC takes over the process. If then the Syncup-Request function is called, the system continues with **exchanged roles (Primary/Backup)** in redundant mode.
  - **Stop Backup-PLC:** In RUN-Redundant mode, the backup PLC is stopped and the primary PLC continues in RUN-Solo mode.
  - These functions can also be used with older TIA Portal versions! The only precondition is firmware version V2.9.



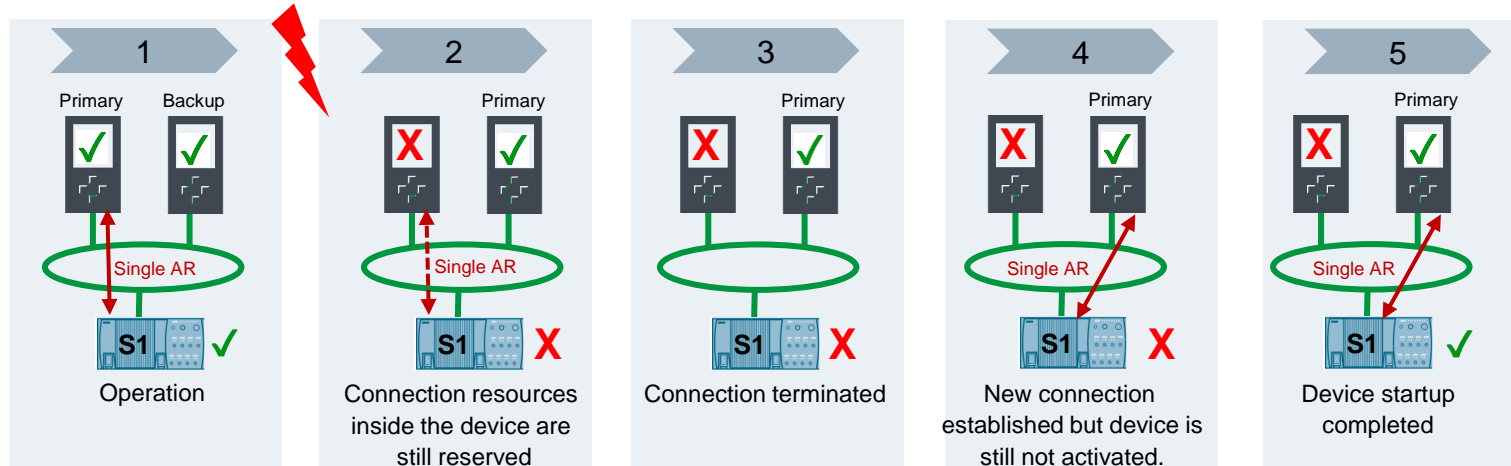
Mode	Function
3	Disable SYNCUP
4	Enable SYNCUP
7	Request SYNCUP
8	Stop Primary-PLC
9	Stop Backup-PLC



# New with Firmware V2.9: Faster S1 fail-over time

## Adjustable fail-over with „Switched S1“ function

Fail over procedure with S1 Devices



- 1) System in state „RUN-Redundant“ IO-data are exchanged
- 2) After fail-over: IO device still holds the connection until configured watchdog time is over.  
During this time, no additional connection is possible
- 3) IO-Device is now ready for a new connection to the IO-Controller
- 4) A new connection is established; the IO-Device now begins startup
- 5) IO-Data are exchanged

AR = Application Relation (Connection between Controller and Device)

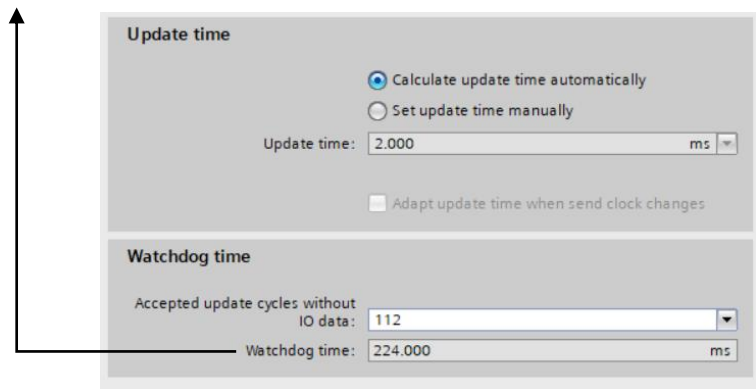
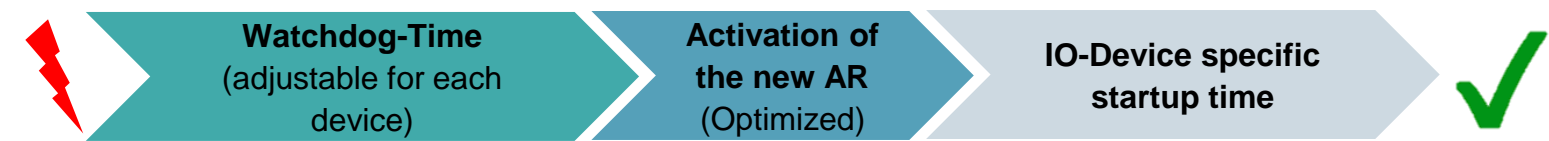
# New with Firmware V2.9: Faster S1 fail-over time

Adjustable fail-over with „Switched S1“ function

## Timing with FW-Version 2.8



## New timing with FW-Version 2.8



Measures example values with CPU 1517H and iDevice  
(short startup time inside the iDevice)

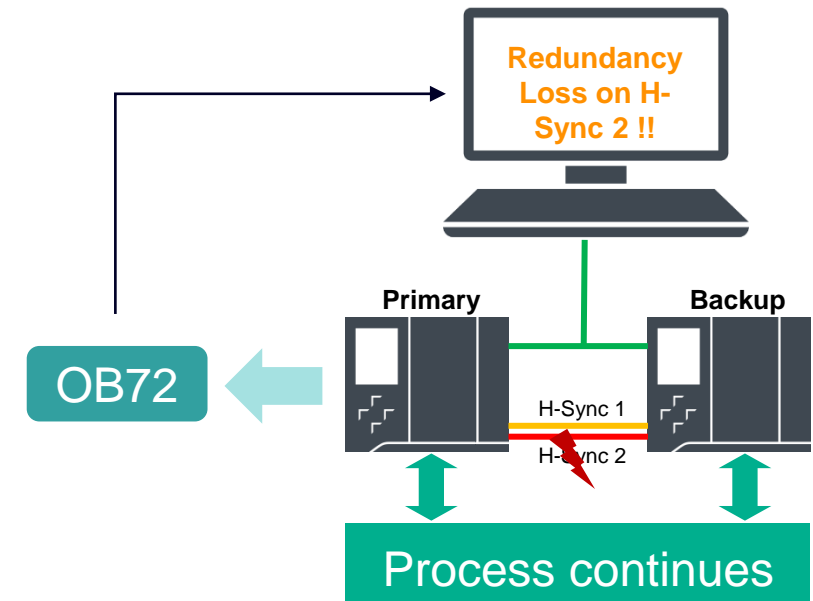
	FW V2.8	FW V2.9
IO data transfer interrupted for..	3 Seconds	0,6 Seconds

AR = Application Relation (Connection between Controller and Device)

## New in TIA Portal V17: Event on redundancy loss

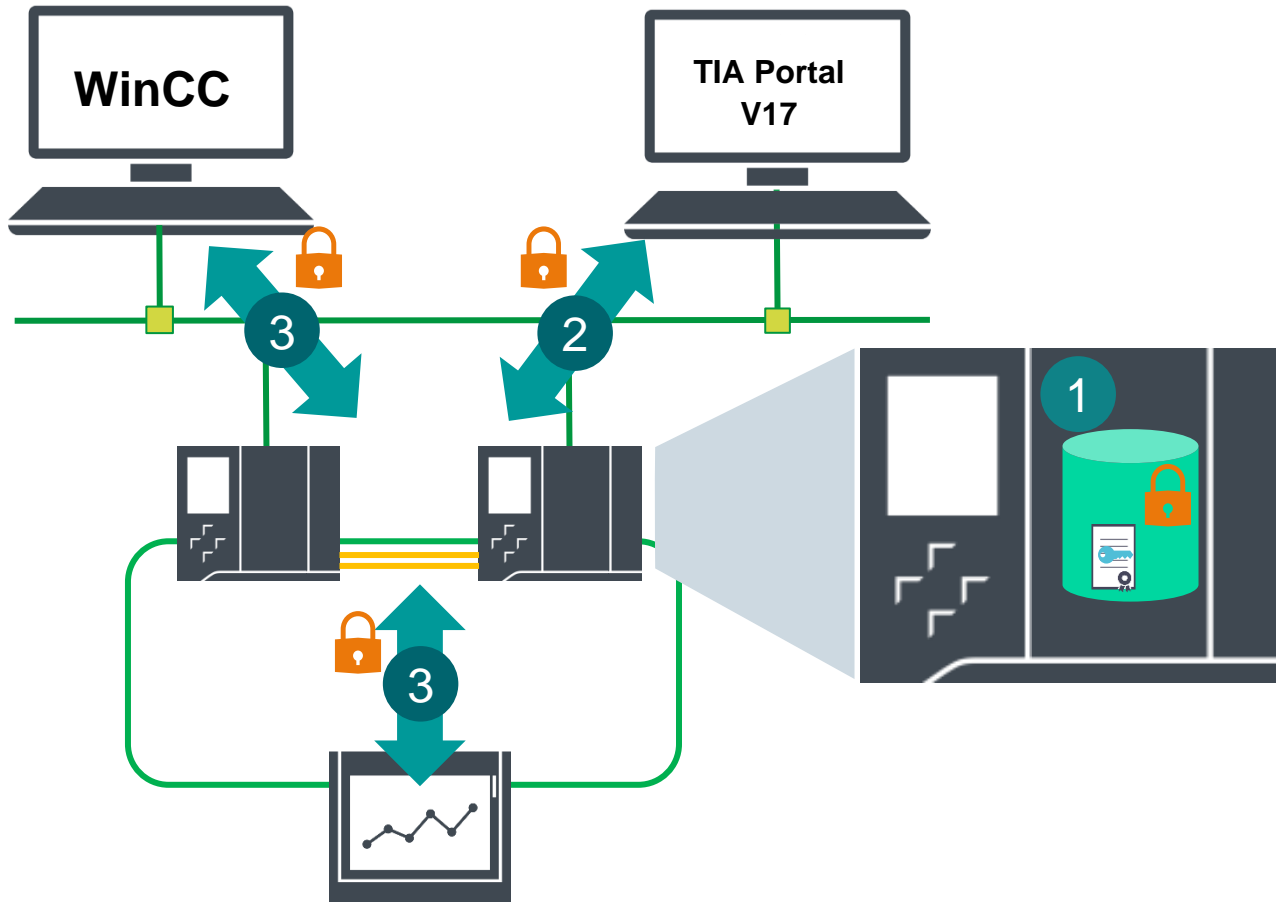
### OB72 is called in case of H-Sync redundancy loss

- If one of both Sync-Lines fails, the H-System continues the operation in redundant mode but the maintenance LED is on.
- With firmware version V2.9 in this case also the OB72 (loss of redundancy) is called.
- So a maintenance request to repair the defect sync line can be generated.



# New in TIA Portal V17: Security Enhancements

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



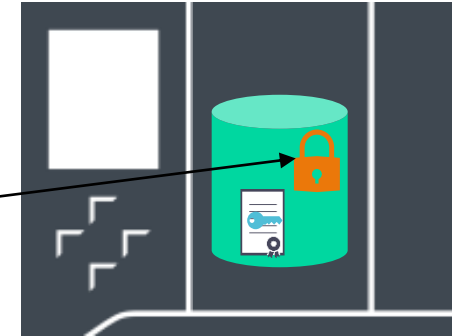
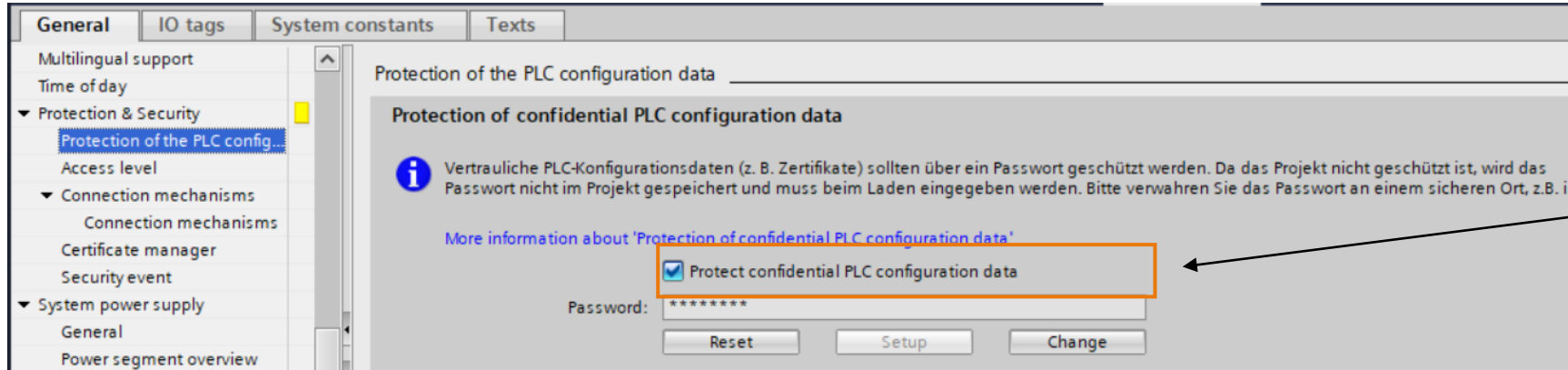
## Enhancements with Firmware V2.9 und TIA Portal V17

- 1 Protection of configuration data
- 2 Secure communication between controller and TIA Portal V17
- 3 Secure communication between controller and HMI

# Password protection of confidential configuration data

## General concept

Protection of configuration data can be activated/deactivated in TIA Portal.

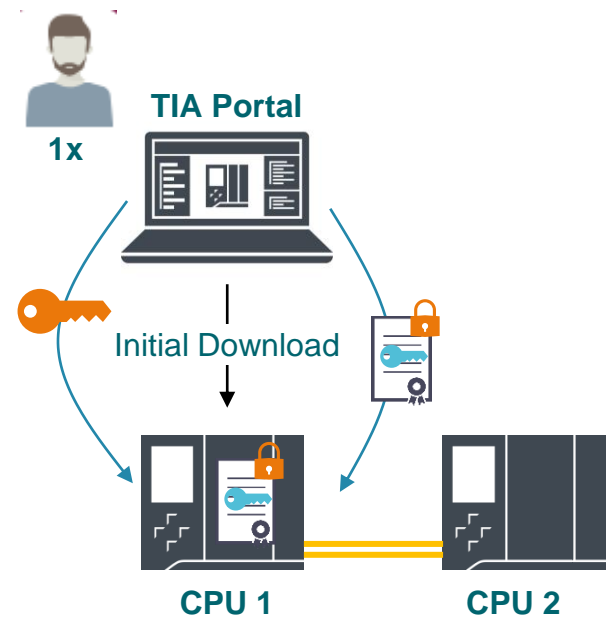


- The password for this protection is **not** stored in the TIA Portal project! It is only located inside the PLC but cannot be retrieved again. → Please save this password on a safe place (e.g. password manager)
- If the protection is activated, some things must be considered during initial commissioning and replacement of a controller → see next slides

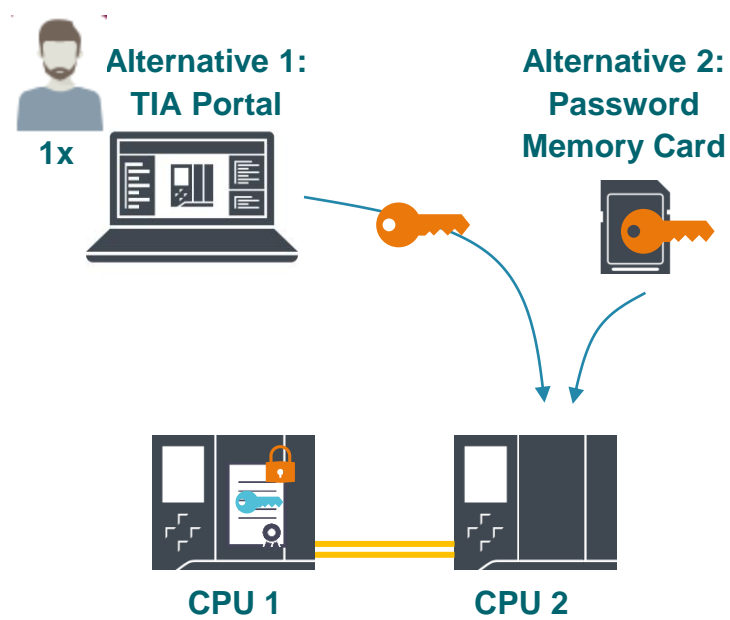
# Password protection of confidential configuration data

## Initial setup of a RH System

### 1) Download and set password in CPU 1

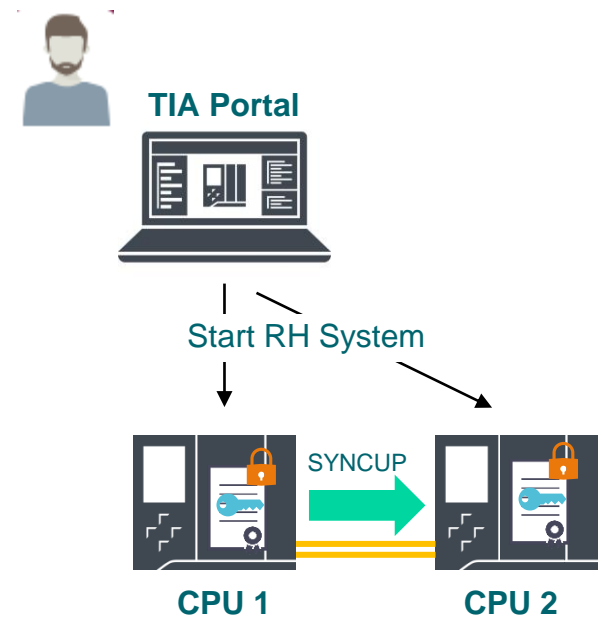


### 2) Set password in CPU 2



Without this step, SYNCUP will fail!

### 3) Start RH System – Program and Configuration are synchronized



Certificate with private key for PG/HMI communication



Password to protect confidential PLC configuration

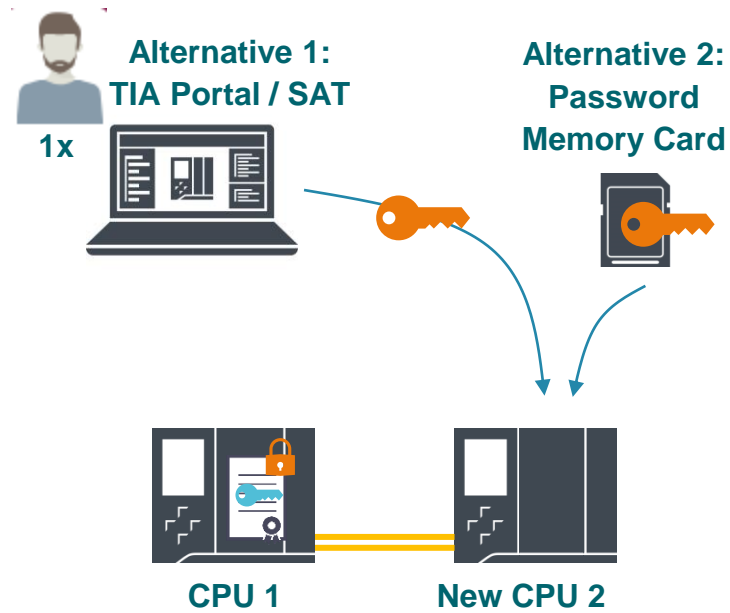
# Password protection of confidential configuration data

## Exchange of a defective RH CPU

### 1) One CPU fails and gets defective

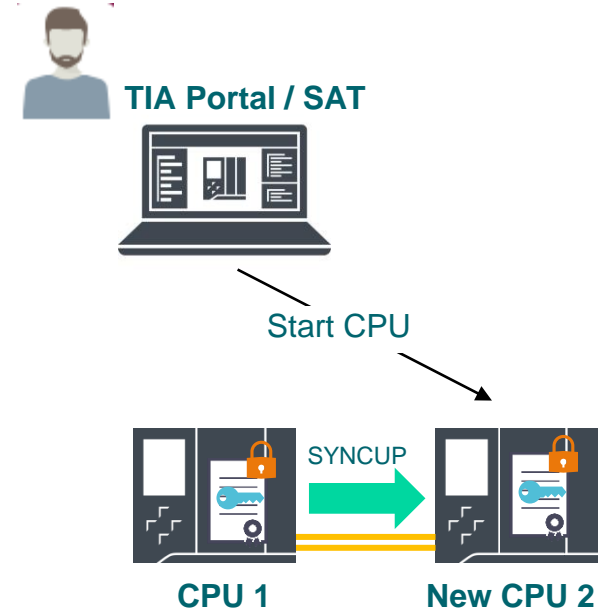


### 2) Exchange CPU and set password again



Without this step, SYNCUP will fail!

### 3) Start New CPU – Program and Configuration are synchronized



Certificate with private key for PG/HMI communication

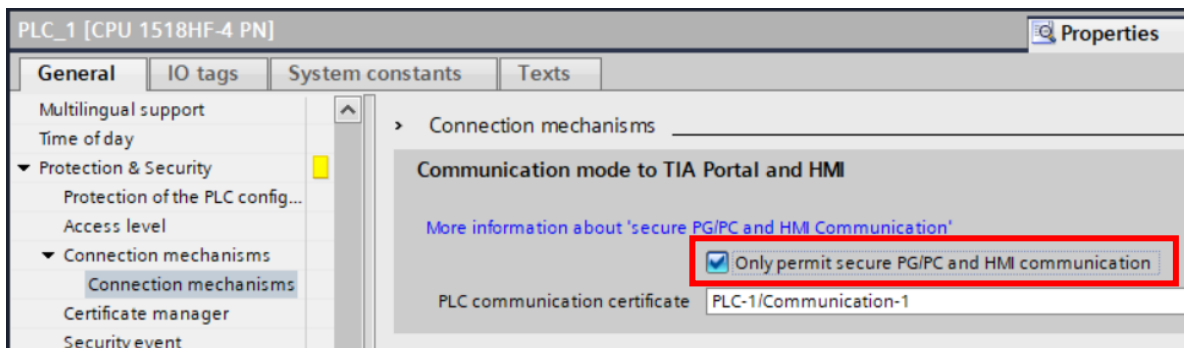
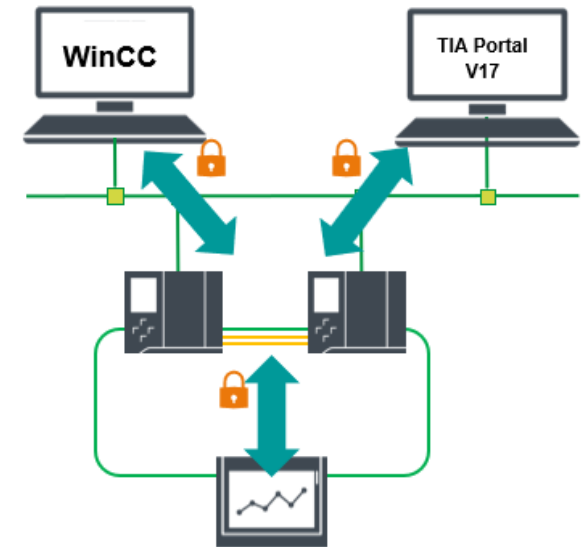


Password to protect confidential PLC configuration

# Secure Communication to HMI and TIA Portal

PLCs with firmware version  $\geq V2.9$  uses a secure communication to the following communication partners:

- TIA Portal V17
  - WinCC Runtime V17
  - Basic Panels 2<sup>nd</sup> Generation, Comfort Panel 1<sup>st</sup> Generation, Mobile Panels
  - WinCC Unified V17, Unified Comfort Panels
  - WinCC OA V3.18 + SP
  - WinCC V7.5 SP2 Update 1
- 
- In order to communicate with other HMI devices, the option shown below must be deactivated.



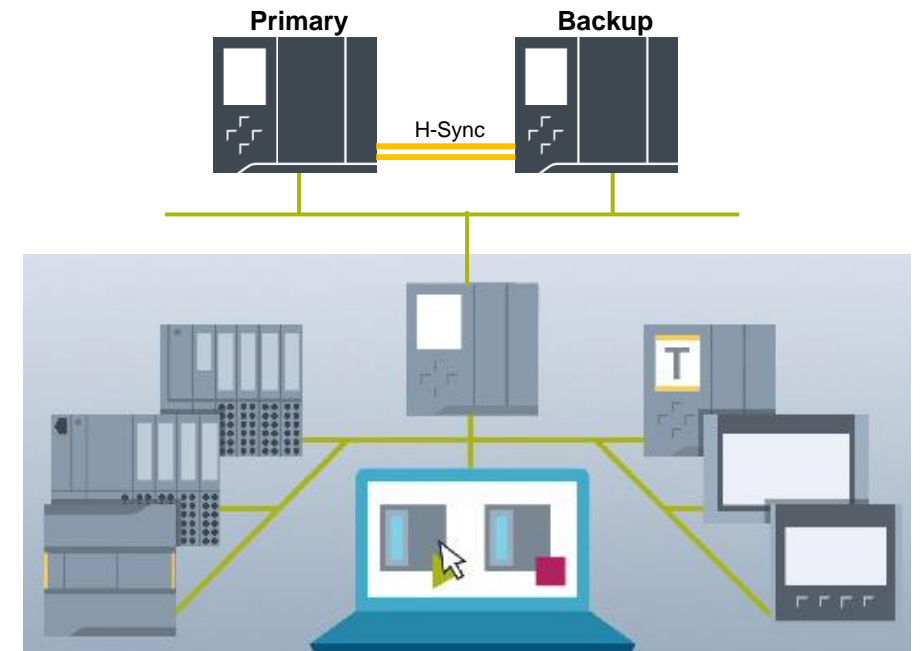
# | Add-Ons

SIMATIC S7-1500 Redundant Systems

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

- From version 4.0 SP3 of the SIMATIC Automation Tool, redundant controllers (S7-1500R und S7-1500H) are also supported.
- This allows e.g. an easy update of firmware or user program
- Information and download: See link below:

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



**SIMATIC Automation Tool**

# TIA Portal Add-In

## Calculation of the watchdog time

For the connection of a PROFINET device to a redundant system S7-1500R/H it is necessary to set the correct watchdog time for each device. The provided TIA Portal Add-In determines the correct factor and updates it in the settings

Available via <https://support.industry.siemens.com/cs/ww/en/view/109769093>

Tool to Set/Reset the correct watchdog factor of PN IO-Devices connected to R/H systems

Select All

Selected	R/H System	Device number	Device name	Update time in ms	Watchdog factor	Watchdog time in ms
<input checked="" type="checkbox"/>	1517H System4 GroupLevel2	109 device(s)				
<input checked="" type="checkbox"/>	1517H System3 Group1Level1	109 device(s)				
<input checked="" type="checkbox"/>	1515R System6 Group2Level3	4 device(s)				
<input checked="" type="checkbox"/>	1515R System6 Group2Level3_1	4 device(s)				
<input type="checkbox"/>	1515R System6 G	1	io device_327	2	112	224
<input type="checkbox"/>	1515R System6 G	2	io device_326	2	3	6
<input type="checkbox"/>	1515R System6 G	3	io device_325	2	3	6
<input type="checkbox"/>	1515R System6 G	4	io device_324	2	112	224
<input checked="" type="checkbox"/>	1515R System5 Group2Level1	4 device(s)				
<input checked="" type="checkbox"/>	1517H System2 PNV Level	111 device(s)				
<input checked="" type="checkbox"/>	S7-1500R/H-System_1	5 device(s)				
<input checked="" type="checkbox"/>	S7-1500R/H-System_2	4 device(s)				
<input checked="" type="checkbox"/>	S7-1500R/H-System_3	6 device(s)				

Set correct watchdog factor for selected PN IO-Devices

Reset watchdog factor of the selected PN IO-Devices to default

Save & Close

Add-ins

Options

Add-ins

Name	Status
Addins	
AddinS71500RH.addin	✓

Details

Name: AddinS71500RH.addin

Path: C:\Program Files\Siemens\Automation\Portal V1

Author: Siemens AG - adblan1 (DF FA S SUP SPH)

Modified on: 1/23/2020 1:57:00 PM

Product: TIA Add-In S7-1500R/H

Version: 1.1.0.0

Status: 

✓ Activate

✗ Deactivate

Description: Tool for watchdogfactor devices connected to 1500R/H system(s)

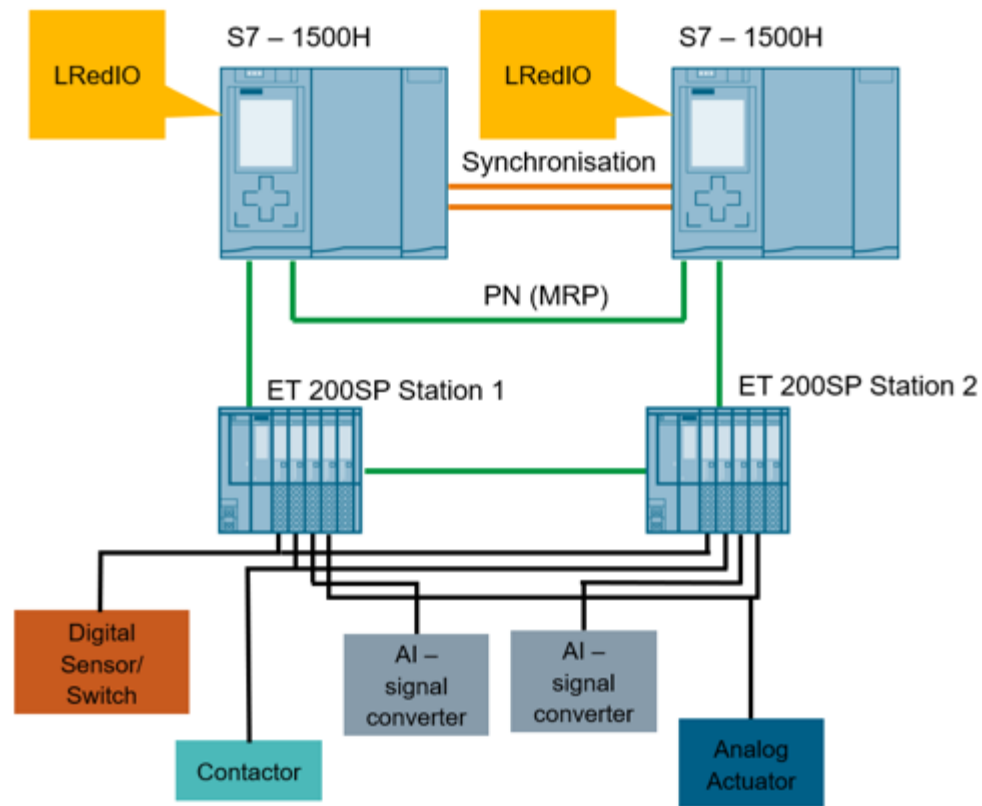
Trust level: ⚠ Unsigned

Issuer: 

View certificate

# Application Example

## Connection of redundant IOs



This application example shows how to connect redundant I/O signals to a S7-1500 controller. It works with the S7-1500R/H system but also can be used with non-redundant controllers

Function block	Function
LRedIO_RedDI	Redundancy function for two digital inputs
LRedIO_RedDQ	Redundancy function for two digital outputs
LRedIO_RedAI	Redundancy function for two analog inputs
LRedIO_RedAQ	Redundancy function for two analog outputs

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

# Application Example

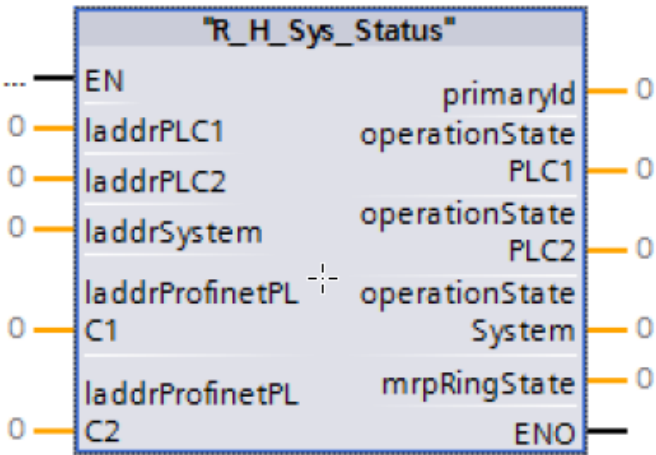
## Diagnostics of the operating state of an S7-1500 R/H system using a function block

Various operating states of an S7-1500R/H system can be read out in the user program by a diagnostics block

Benefits

- Ready-made diagnostics block for S7-1500R/H systems
- Easy interconnection of various hardware addresses for extensive diagnostics
- Integrated self-diagnostics function (in addition to the standard diagnostics functions) of the S7-1500R/H system for early detection and signaling of errors 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

# Communication Libraries

## Telecontrol with SIMATIC S7-1500 R/H

Product	Version	Supported Protocols	SIOS
<b>TIM 1531 IRC</b> 	From V2.1	<ul style="list-style-type: none"><li>• SINAUT ST7</li><li>• DNP3</li><li>• IEC 60870-5 101, 104</li></ul>	<a href="https://support.industry.siemens.com/cs/ww/en/view/109774204">https://support.industry.siemens.com/cs/ww/en/view/109774204</a>
<b>SIPLUS RIC Library</b> for SIMATIC S7-1500	From V1.7	<ul style="list-style-type: none"><li>• IEC 60870-5 101,102,103, 104</li></ul>	<a href="https://support.industry.siemens.com/cs/ww/en/view/109422039">https://support.industry.siemens.com/cs/ww/en/view/109422039</a>
<b>IEC 61850 Client Library</b>	V16	<ul style="list-style-type: none"><li>• IEC 61850 MMS</li></ul>	<a href="https://support.industry.siemens.com/cs/ww/en/view/109480624/">https://support.industry.siemens.com/cs/ww/en/view/109480624/</a>

# Communication Libraries

## Redundant Communication

Product	Supported Protocols	SIOS
<b>SIMATIC Modbus/TCP Red S7-1200/S7-1500</b>	Modbus/TCP	<a href="https://support.industry.siemens.com/cs/bd/en/ps/6AV6676-6MB40-0AX0">https://support.industry.siemens.com/cs/bd/en/ps/6AV6676-6MB40-0AX0</a>
<b>Redundant Open User Communication</b>	Multiple	<a href="https://support.industry.siemens.com/cs/ww/en/view/109763719">https://support.industry.siemens.com/cs/ww/en/view/109763719</a>

# Redundant Power Supply

## SITOP Redundancy Modules RED1200

EN

- Redundant design in the event of power failure
  - Stable DC voltage thanks to redundant switching of two identical power supplies
- Redundant design in the event of power failure
  - Power feed from different power supplies
- Decoupling diode when more than two power supplies are connected
- Protective diode for series connection of two power supplies for voltage increase
- Solution for different power ranges
  - SITOP RED1200 2 x 10 A: Operation with 2 x PSU 10 A
  - SITOP RED1200 2 x 20 A: Operation with 2 x PSU 20 A or 1 x PSU 40 A
- Fully integrated in TIA Selection Tool



[Details](#)  
[Manual](#)



# | Restrictions

SIMATIC S7-1500 Redundant Systems

# Restrictions for S7-1500 R/H

Restrictions of the configuration	S7-1500R/H	S7-1500	S7-400H
Central use of modules IO, CM/CP, System-Powersupply	no	yes	yes
PROFINET-Network structure	MRP Ring	any	any
Use of RH-Systems as shared device oder iDevice	no	yes	no
Use of PROFIBUS devices	Via Coupling PLC	yes	yes

# Restrictions for S7-1500 R/H

## Functional restrictions

	S7-1500R/H	S7-1500	S7-400H
S7-Communication (Client)	no <sup>1)</sup>	yes	yes
OPC UA / Webserver	no	yes	no
System-supported H-communication	no <sup>2)</sup>	no	yes
System-supported redundant I/Os	no <sup>3)</sup>	no	yes
Technology Objects	some <sup>4)</sup>	yes	no
Support for MRPD, clock synchrony and IRT	no	yes	no
Hardware extensions in RUN	With IO-Link <a href="#">See Slides</a>	With IO-Link	With switch over (H-CiR)
Firmware Update im RUN	no	no	yes
DHCP	no	yes	no

1) S7-Communication as Server is supported, Replacement: Open User Communication

2) Alternative: System IP-Address

3) Can be realized on application level, see [109767576](#)

4) TO Count, Measurement, PID, BasicPos are supported

# | Ordering Information

SIMATIC S7-1500 Redundant Systems

# Ordering Information

## SIMATIC CPU S7-1500 R

- CPU 1513R-1 PN                    6ES7 513-1RL00-0AB0
  - CPU 1515R-2 PN                    6ES7 515-2RM00-0AB0
- 

## SIMATIC CPU S7-1500 H

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

## Distance up to 10m between SIMATIC S7-1500 H controllers: Use of synchronisation modules for FO cables up to 10 m

- FO Module:                            6ES7 960-1CB00-0AA5
- FO cable 1m:                        6ES7 960-1BB00-5AA5
- FO cable 2m:                        6ES7 960-1BC00-5AA5
- FO cable 10m:                      6ES7 960-1CB00-5AA5

## Distance up to 10 km between SIMATIC S7-1500 H controllers

- FO Module:                            6ES7 960-1FB00-0AA5
  - Monomode FO cable LC/LC Duplex crossed 9/125µ
- 

## SIMATIC S7-1500 H Bundle

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

- 6ES7500-0HP00-0AB0

## SIMATIC S7-1500 HF Bundle

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

- 6ES7 500-0JP00-0AB0

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Publisher: Siemens 2021