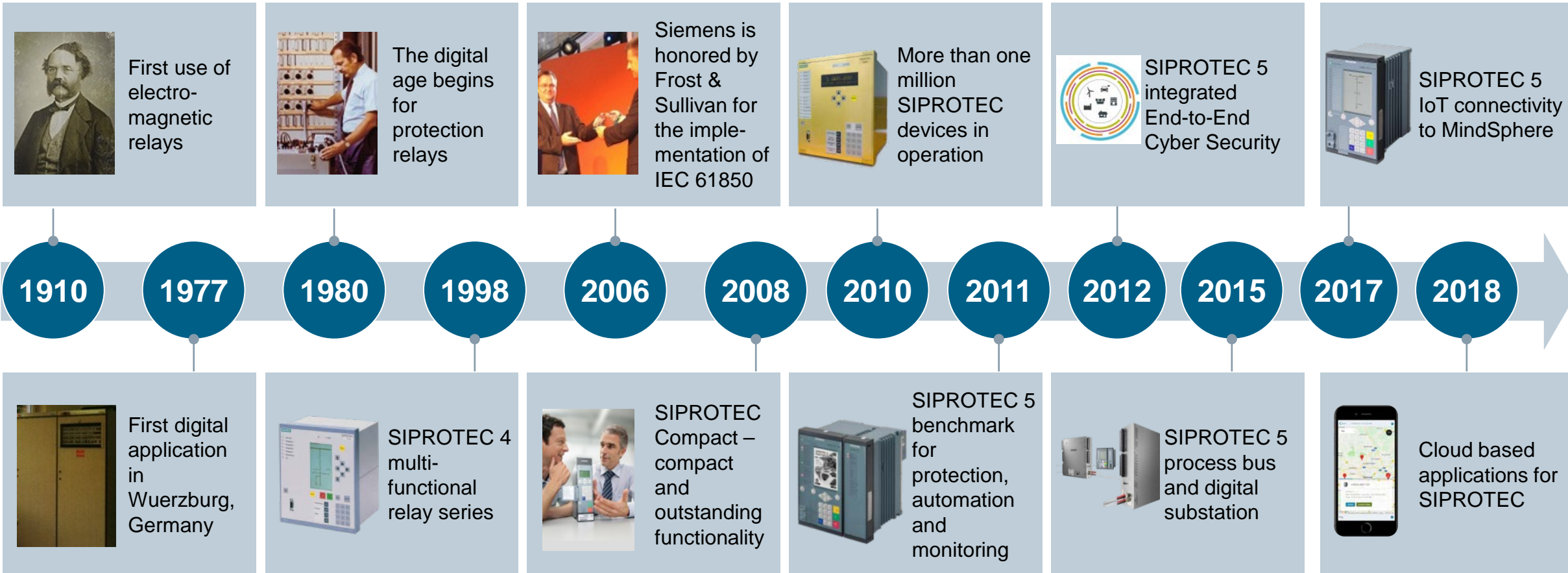# SIPROTEC 5 – V7.9 / V 8.0

Protection, Automation and Monitoring
of Digital Substations

Sasho Martinovski, Protection & Commissioning Engineer
September 12-13, 2019 | VAR Partner Day 2019 | Bled, Slovenia

SIEMENS
Ingenuity for life

siemens.at/var

SIPROTEC –
Synonym for the world's leading protection technology

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More than 1.6 Mill. devices installed therein >500,000 with IEC 61850

First use of electro-magnetic relays

The digital age begins for protection relays

Siemens is honored by Frost & Sullivan for the imple-mentation of IEC 61850

More than one million SIPROTEC devices in operation

SIPROTEC 5 integrated End-to-End Cyber Security

SIPROTEC 5 IoT connectivity to MindSphere

1910 | 1977 | 1980 | 1998 | 2006 | 2008 | 2010 | 2011 | 2012 | 2015 | 2017 | 2018

First digital application in Wuerzburg, Germany

SIPROTEC 4 multi-functional relay series

SIPROTEC Compact – compact and outstanding functionality

SIPROTEC 5 benchmark for protection, automation and monitoring

SIPROTEC 5 process bus and digital substation

Cloud based applications for SIPROTEC

Sasho Martinovski / Energy Automation Products

SIPROTEC 5 –
The benchmark for protection, automation and monitoring

SIPROTEC 5 –
A flexible generation of intelligent, digital field devices with a high degree of modularity

Individually configurable devices –
Save money over the entire life cycle

Trendsetting system architecture –
Flexibility and safety for all kind of grids

Multi-layered integrated safety mechanism –
Highest possible level of safety and availability

Consistent system and device engineering –
Efficient operating concepts, flexible engineering

Sasho Martinovski / Energy Automation Products

SIPROTEC 5 – Proven solutions for all applications

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7SJ8	Overcurrent and feeder protection
7SA8	Distance protection
7SD8	Line differential protection
7SL8	Combined line differential & distance protection
7UT8	Transformer differential protection
7VE8	Paralleling device
7SS85	Busbar protection
7SK8	Motor protection
7VK8	Breaker management
7UM85	Generator protection
6MD8	Bay controller
7KE85	Fault recorder
6MU85	Merging unit

Easy engineering and evaluation – DIGSI and SIGRA

Highlights V7.9 and V8.0

- ***SIPROTEC DigitalTwin***
- Compatibility of SIPROTEC 4 and SIPROTEC 5 for 87L and 21
- IEC 61850-9-2 Process bus for digital substations (Server/Client)
- SIPROTEC 6MU85 Merging Unit
- Time synchronization with IEEE 1588 for High Precision applications
- SIPROTEC 7SS85 distributed busbar protection based on process bus
- Point-on-wave switching
- Conformal coating of SIPROTEC 5 devices as standard
- Cyber Security
- ATEX certification for 7SK85 and 7UM85
- New overcurrent and feeder protection SIPROTEC 7SJ81
- Web Browser
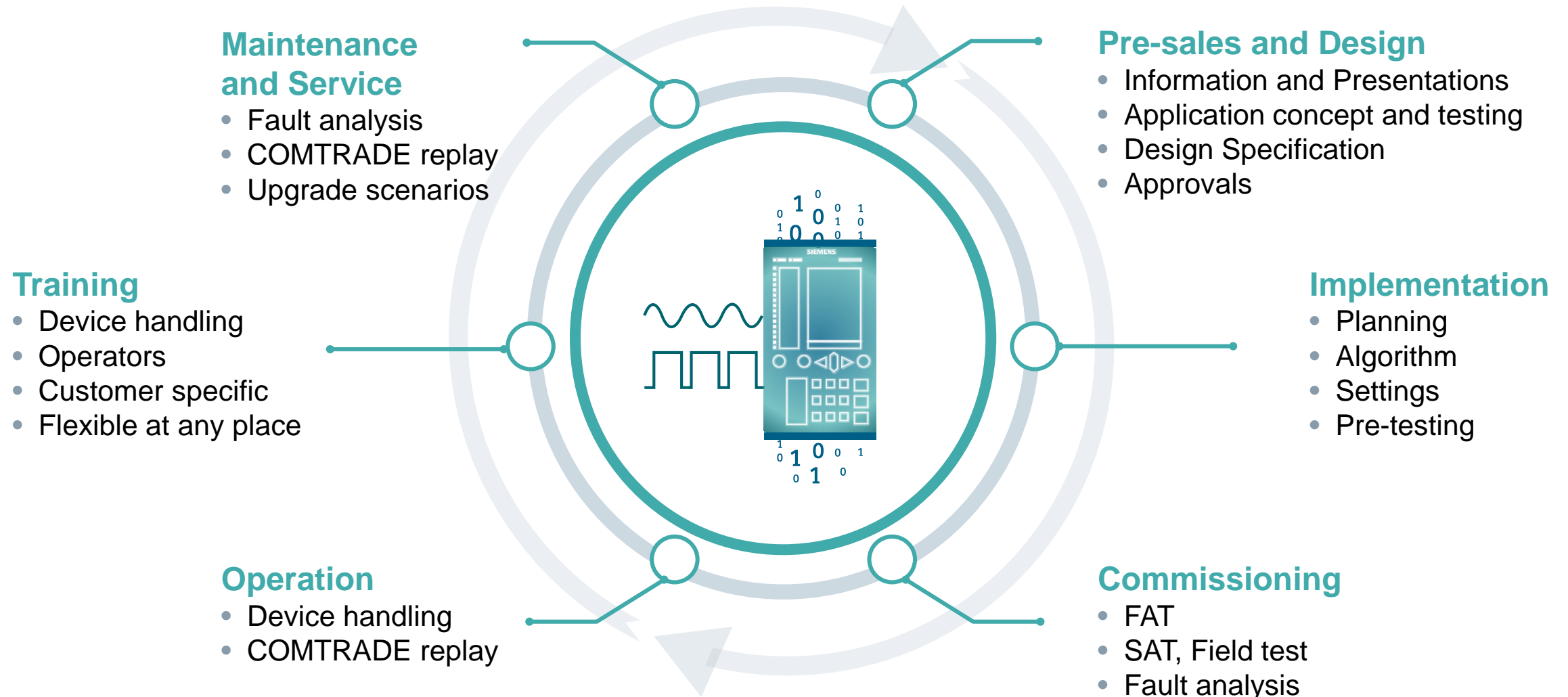- Further functions

SIPROTEC DigitalTwin

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Application Scenarios

Control Center

Integration in SICAM Systems

SIPROTEC DigitalTwin

Station Level

Firewall

SICAM PAS — Substation Automation

SICAM SCC — Human Machine Interface

SICAM PQS — Power Quality Analysis

DIGSI 5 Online Testing — DIGSI

Communication — Station bus

Field Level

Process Simulation
Device Testing
Device Training

GOOSE Testing

Remote Substation

Testing of protection interface

Process Level

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Saves time, increases quality throughout the entire lifecycle of your system

SIEMENS
Ingenuity for life

Maintenance and Service
- Fault analysis
- COMTRADE replay
- Upgrade scenarios

Pre-sales and Design
- Information and Presentations
- Application concept and testing
- Design Specification
- Approvals

Training
- Device handling
- Operators
- Customer specific
- Flexible at any place

Implementation
- Planning
- Algorithm
- Settings
- Pre-testing

Operation
- Device handling
- COMTRADE replay

Commissioning
- FAT
- SAT, Field test
- Fault analysis

Saves time, increases quality throughout the entire lifecycle of your system

SIEMENS
Ingenuity for life

Maintenance and Service
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Operation
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- COMTRADE replay

Commissioning
- FAT
- SAT, Field test
- Fault analysis

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Benefits –
The customer value proposition

SIEMENS
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Testing of the energy automation system within minutes, without hardware and without additional effort

- Simulation and validation of product properties
- Faster energization of new systems thanks to shorter project lifetimes
  - Increase engineering quality
  - Virtual testing before start of commissioning
  - Shortest commissioning times
- Reduced OPEX with shorter outages for higher availability thanks to better pre-testing
- Efficient, scalable trainings on the job
- Fast and realistic fault analysis by easily reproducing the behavior of products and systems

Time and Costs

Agility and Flexibility

Outage management

Training and maintenance

12-13 SEP 2019   Sasho Martinovski / Energy Automation Products

Access your SIPROTEC DigitalTwin in 5 Steps
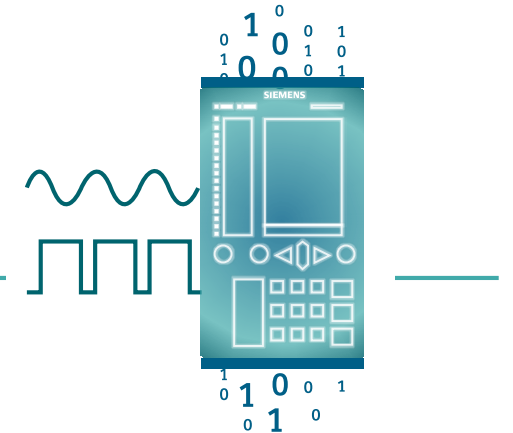
1

Open DIGSI 5 project
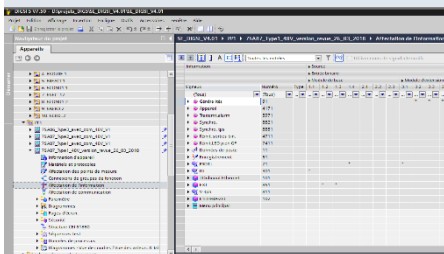
2

Export SIM file
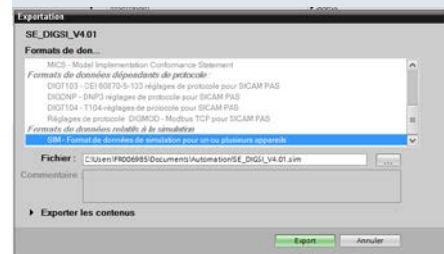
3

Connection to the Cloud

4

Import SIM

5

SIPROTEC DigitalTwin
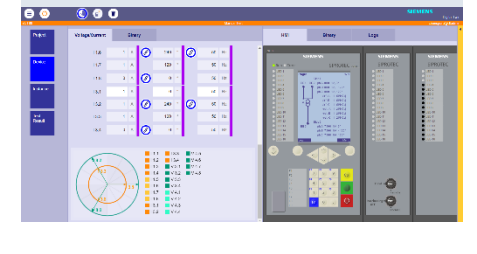
Sasho Martinovski / Energy Automation Products

Highlights V7.9 and V8.0

SIEMENS
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- SIPROTEC DigitalTwin

- ***Compatibility of SIPROTEC 4 and SIPROTEC 5 for 87L and 21***

- IEC 61850-9-2 Process bus for digital substations (Server/Client)

- SIPROTEC 6MU85 Merging Unit

- Time synchronization with IEEE 1588 for High Precision applications

- SIPROTEC 7SS85 distributed busbar protection based on process bus

- Point-on-wave switching

- Conformal coating of SIPROTEC 5 devices as standard

- Cyber Security

- ATEX certification for 7SK85 and 7UM85

- New overcurrent and feeder protection SIPROTEC 7SJ81

- Web Browser

- Further functions

Interoperability of SIPROTEC 4 and SIPROTEC 5
Line protection – Profile

Requirment
- Replacement of protection devices after end of live
- New devices to be added to the protection topology
- Stepwise replacement or retrofit of SIPROTEC 4 protection devices

Solution
- Direct interoperable connection of SIPROTEC 5 and SIPROTEC 4 protection interfaces
- 2 – 6 line end differential protection
- Distance protection: PUTT or POTT teleprotection
- Transformer within protection zone

PUTT: Permissive Underreaching Transfer Trip
POTT: Permissive Overreaching Transfer Trip

Function
- Modules changeable and upgradeable
- Range extension via additional repeater
- Monitoring of protection interface transfer quality
- Remote commands and signals via protection interface

Benefits
- Mixed operation SIPROTEC 4 and SIPROTEC 5
- Step-by-step replacement and expansion of individual substations
- Line differential protection of other systems remains in operation
- Short switch-off time during conversion
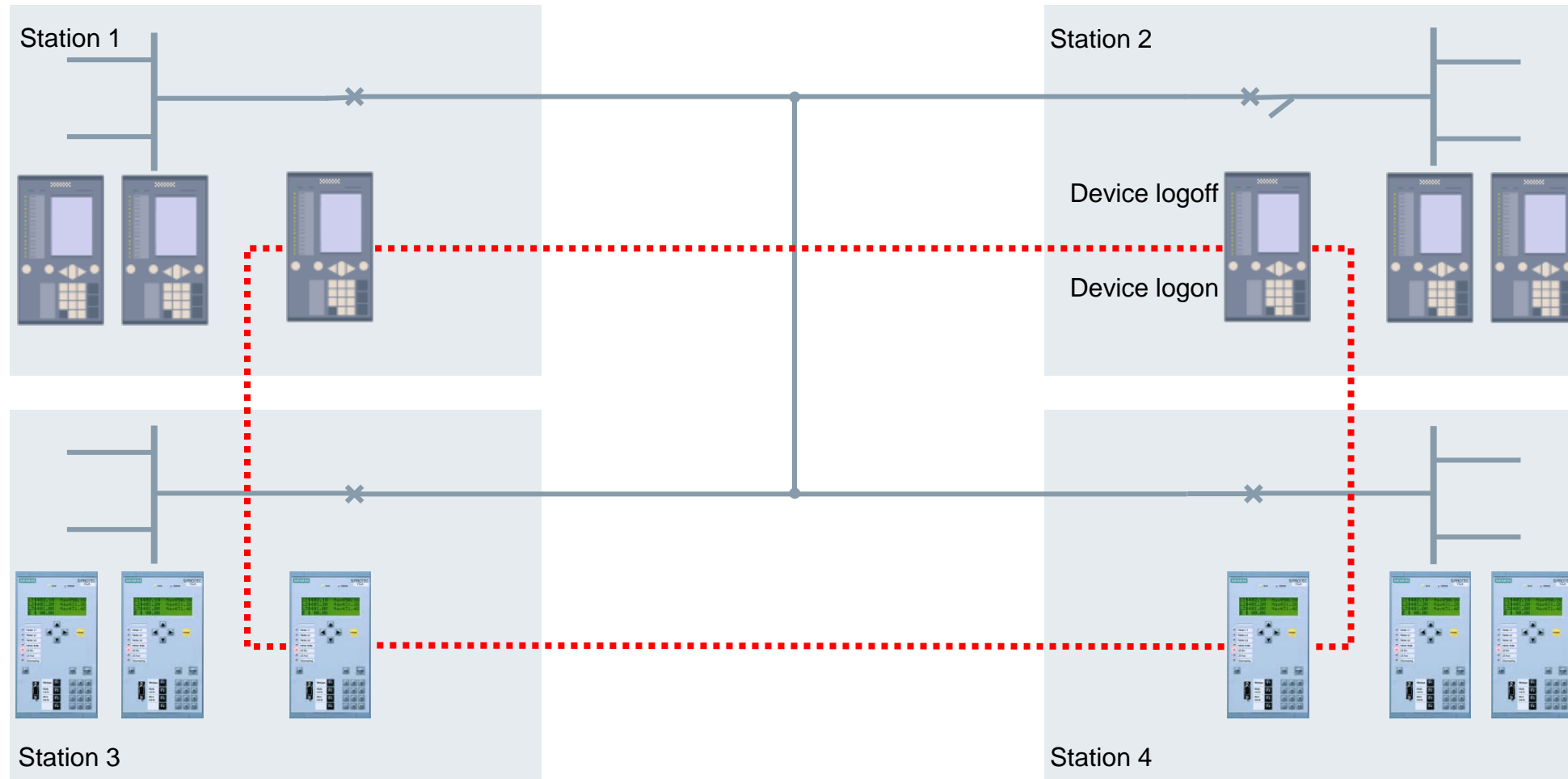- Use of existing communication links

USART-AE2FO
FO5

USART-AE2FO
FO5
7XV5662   7XV5662

USART-AE2FO
FO17
7XV5461-0BG00
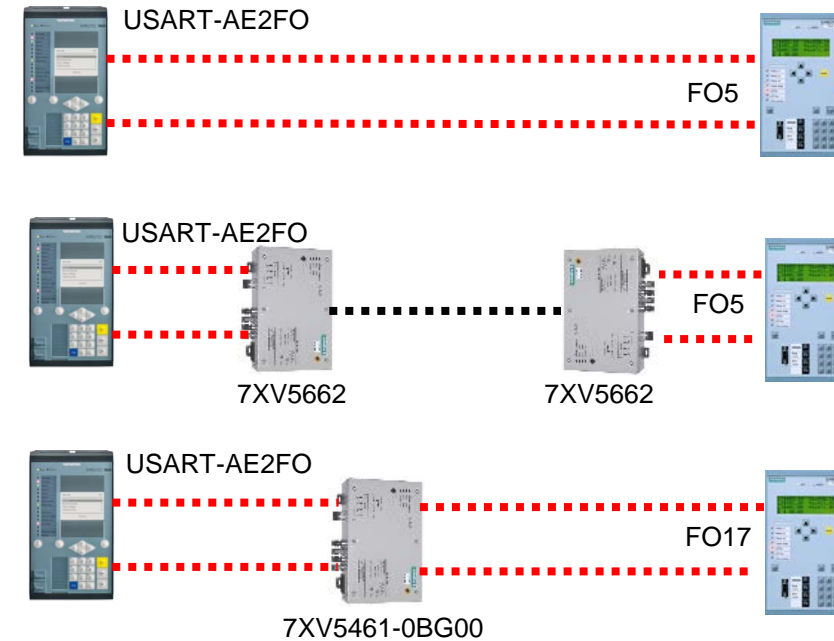
Interoperability of SIPROTEC 4 and SIPROTEC 5
Communication infrastructure
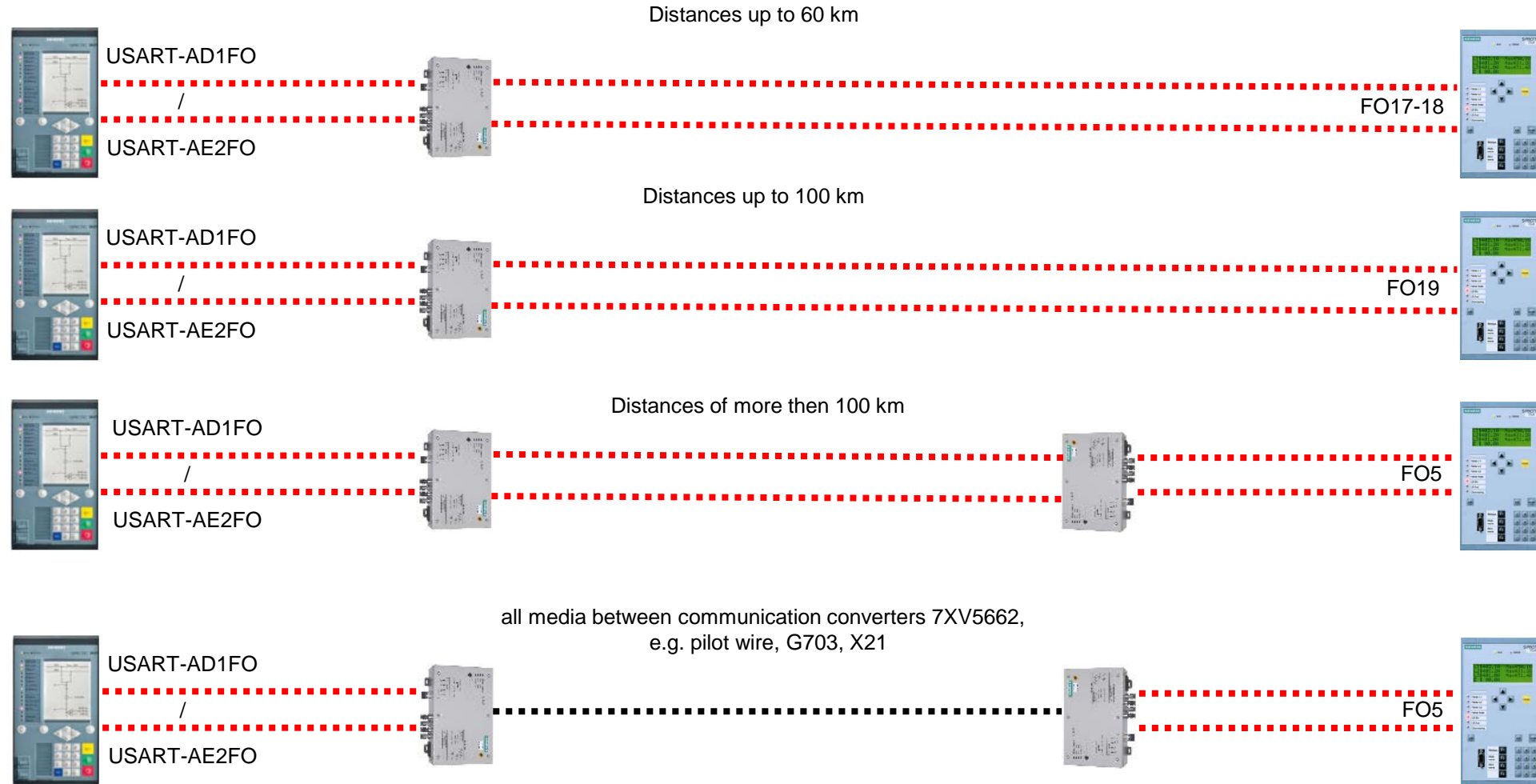
Distances up to 60 km

USART-AD1FO

/

USART-AE2FO

FO17-18

Distances up to 100 km

USART-AD1FO

/

USART-AE2FO

FO19

Distances of more then 100 km

USART-AD1FO

/

USART-AE2FO

FO5

all media between communication converters 7XV5662,
e.g. pilot wire, G703, X21

USART-AD1FO

/

USART-AE2FO

FO5

Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 1 – stepwise retrofit of protection relays

Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 1 – stepwise retrofit of protection relays

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Station 1

Station 2

Device logoff

Device logon

Station 3

Station 4

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Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 1 – stepwise retrofit of protection relays

Station 1

Station 2

Device logoff

Device logon

Station 3

Station 4

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Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 1 – stepwise retrofit of protection relays

SIEMENS
Ingenuity for life

Station 1

Station 2

Station 3

Station 4

Device logoff

Device logon

Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 2 – extension of tapped line

SIEMENS
Ingenuity for life

Station 1

Station 2

Device logoff

Device logoff

Interoperability of SIPROTEC 4 and SIPROTEC 5
Example 2 – extension of tapped line

Station 1

Station 2

Device logoff

Device logoff

Device logon

Device logon

Device logon

Station 3

Highlights V7.9 and V8.0

SIEMENS
Ingenuity for life

- SIPROTEC DigitalTwin
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- ***IEC 61850-9-2 Process bus for digital substations (Server/Client)***
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- Web Browser
- Further functions

Digital Substation 4.0

Benefits

- Flexible solutions for different level of digitalization
- Process bus closes the gap to a fully digitalized system
- Agile for future requirements
- Digitalization of all primary data close to the process
- Data for optimizing grid control and monitoring
- Remote engineering and testing

Digital Substation 4.0
Process Bus Overview

SIEMENS
Ingenuity for life
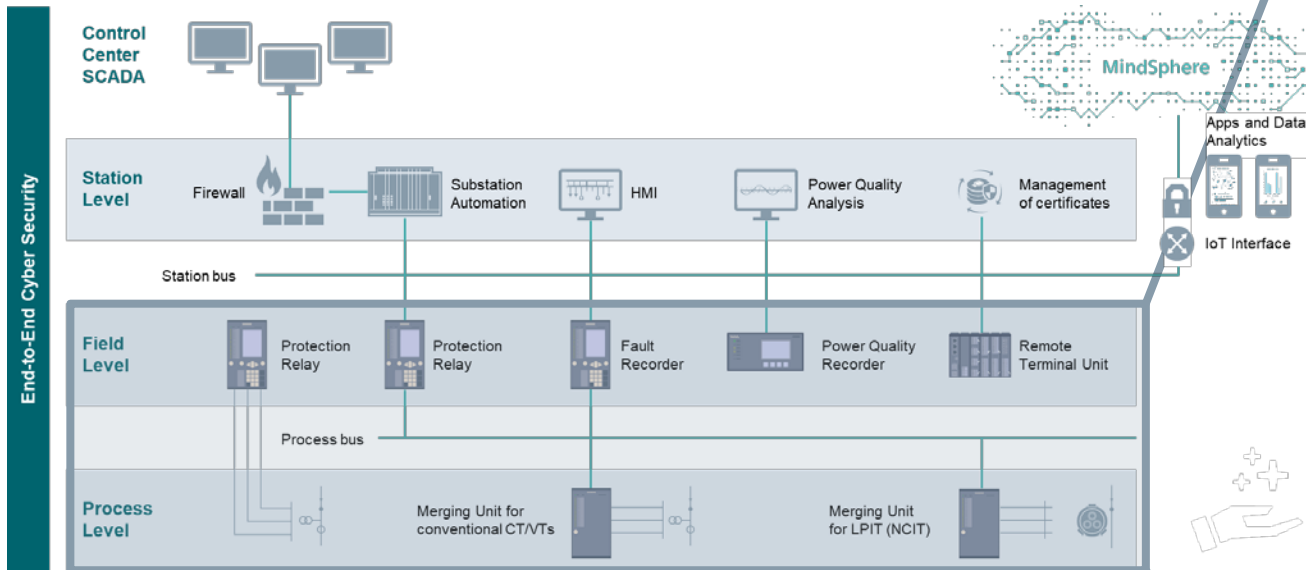
Protocol on ETH-BD-2FO	MU	PB Client	PTP (1 µs acc.)
7SA86, 7SA87	✓	✓	✓
7SD86, 7SD87	✓	✓	✓
7SL86, 7SL87	✓	✓	✓
7VK87	✓	✓	✓
7UT85, 7UT86, 7UT87	✓	✓	✓
7SK85	✓	✓	✓
7UM85	✓	✓	✓
7VE85	✓	✓	✓
7SS85	✓	✓	✓
7SJ85, 7SJ86	✓	✓	✓
6MD85, 6MD86	✓	✓	✓
6MU85	✓	✓	✓
7KE85	✗	✓	✓
7SJ81, 7Sx82 (non modular)	✗	✗	✗
7ST85, 6MD89	✗	✗	✗

MU: Merging Unit functionality – Sampled Measured Value server
PB Client: Process Bus Client – Sampled Measured Value client
PTP: Precision Time Protocol according to IEEE 1588v2/PTP with 1µs accuracy

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SIPROTEC Merging Unit
One base module adapts to all sensor types

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Principle of a Process Bus

- Stand-Alone merging unit
- Copper wires via short distances
- Digital interface for instrument transformers **IEC 61869-9**

- Merging unit as part of switchgear
- Low power stand alone current, voltage and combined sensors
- **IEC 61869-10 and 11**

Conventional

LPIT

Rogowski coil

LPIT

C divider
R divider*
RC divider*

LPIT

Optical
current sensor'

Process bus
FO Ethernet

HSR* or PRP Network

IEC 61869

IEC 61850-9-2
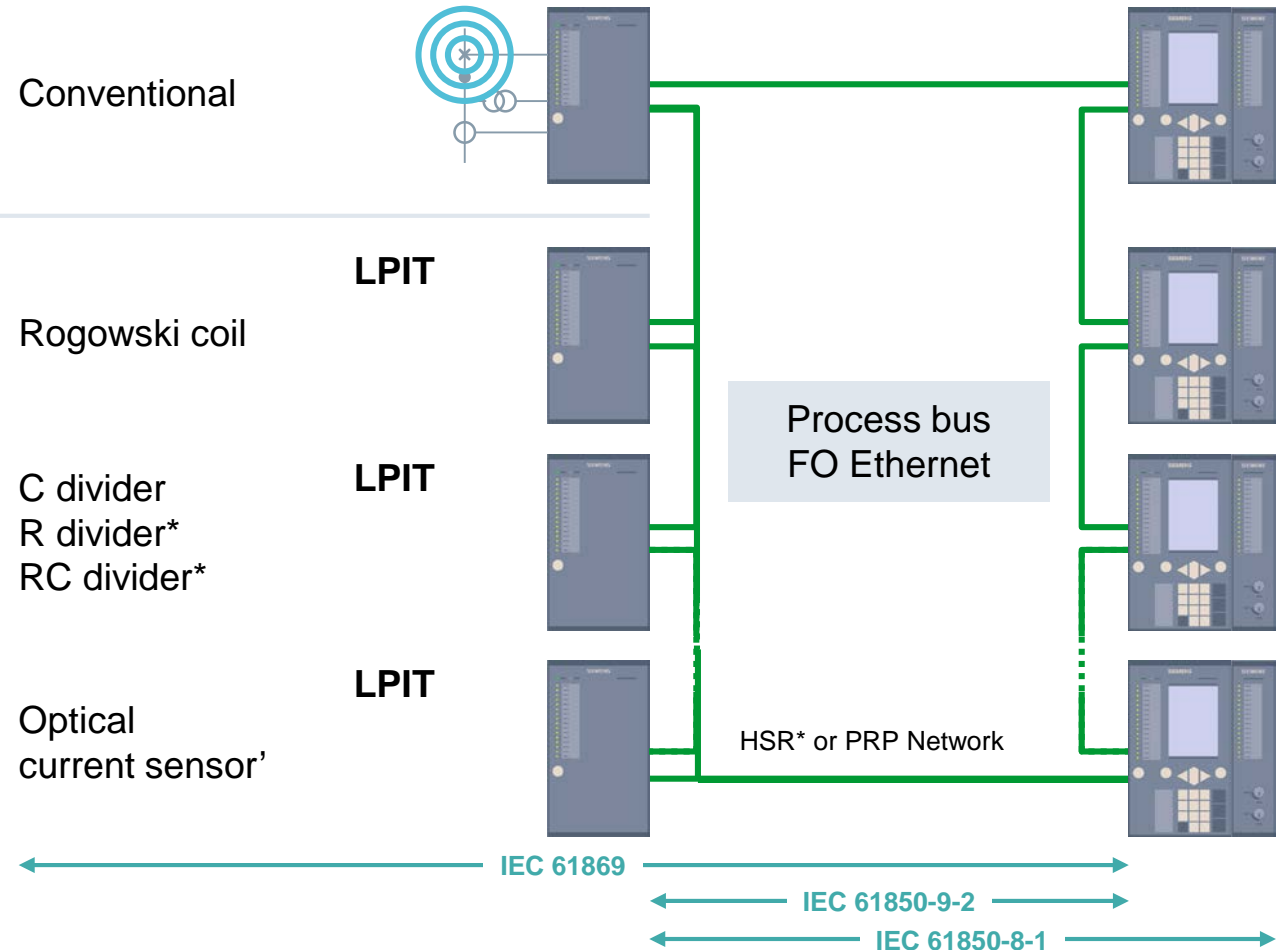
IEC 61850-8-1

* In preparation

Highlights V7.9 and V8.0

SIEMENS
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- Web Browser
- Further functions

SIPROTEC 5 Merging Unit –
Perfectly tailored fit to your requirements (examples shown)

Aux-PS	Single
CT	4 Rogowski*
VT	4 C divider
BI	19
BO-STD	9
BO-HS	4
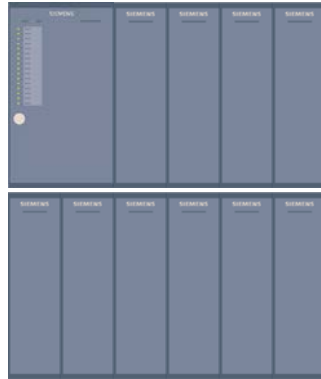
Aux-PS	Redundant*
CT	12 PCIT / 4 MCIT
VT	4 CIT
BI	111
BO-STD	91
BO-HS	8
4 … 20 mA	4

Aux-PS	Redundant*
CT	8 PCIT
VT	4 CIT
BI	35
BO-STD	15
BO-HS	8

TR 1200 IP

Aux-PS	Single
CT	8 optical*
VT	8 CIT
BI	11
BO-STD	7
4 … 20 mA	4
RTD	12

PCIT … Protection CIT, MCIT … Measurement CIT

* in preparation

Perfectly tailored fit

- Adaptable to multiple CT, VT, LPIT inputs
- Scalable BI and BO
- Direct "high speed" tripping of circuit breaker < 1 ms
- Collection of additional data (temperature, pressure, tap changer positions, …)
- Redundant power supply*
- Expandable by a 2nd row

SIPROTEC 5
Merging Unit functionality

SIEMENS
Ingenuity for life

- Ethernet communication module **ETH-BD-2FO** for process bus functionality required
- One Sampled Measured Value (SMV) stream per ETH-BD-2FO Ethernet module
  - up to 32 analog values in any combination of CT and VT
  - or 4x CT, 4x VT (IEC 61850-9-2LE)

- Up to 4 **ETH-BD-2FO** modules supported

- IEC 61869-9, IEC 61869-13 compliant
- IEC 61850-8-1 GOOSE, MMS and Merging Unit protocol on the same Ethernet module

- Sample synchronization via IEEE 1588v2/PTP

- Engineering with DIGSI 5 and IEC 61850 System Configurator
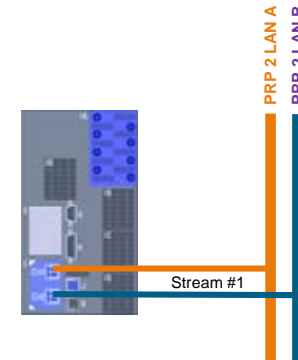
Example:
Minimum configuration of SMV streams
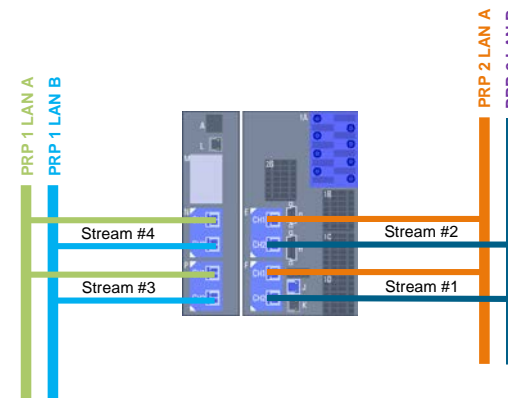
Example:
Maximum configuration of four SMV streams, publishing to two physically separated networks (four networks possible)

	MU
7SA86, 7SA87	✓
7SD86, 7SD87	✓
7SL86, 7SL87	✓
7VK87	✓
7UT85, 7UT86, 7UT87	✓
7SK85	✓
7UM85	✓
7VE85	✓
7SS85	✓
7SJ85, 7SJ86	✓
6MD85, 6MD86	✓
6MU85	✓
7KE85	✗
7SJ81, 7Sx82 (non modular)	✗
7ST85, 6MD89	✗

Availability of Merging Unit functionality (server)

SIPROTEC 5
Process Bus Client

- Ethernet communication module **ETH-BD-2FO** necessary
- Up to 32 analog values per ETH-BD-2FO (up to 80[1] using 3x ETH-BD-2FO)

- Support of IEC 61850-9-2LE streams
- Support of IEC 61869 flexible streams
- IEC 61850-8-1 GOOSE, MMS and Process Bus Client protocol on the same module

- Supported protection functions 87B, 87L, 87T, 21,
- 67/67N, 50/50N, 51/51N, … [2]
- Test- and Simulation Bit support
- Sample synchronization for mixed configurations of direct connected instrument transformers and sampled measured values via IEEE 1588v2/PTP
- Interoperability with multivendor merging units [3]

- Engineering with DIGSI 5 and IEC 61850 system configurator

ETH-**BD**-2FO

	PB Client
7SA86, 7SA87	✓
7SD86, 7SD87	✓
7SL86, 7SL87	✓
7VK87	✓
7UT85, 7UT86, 7UT87	✓
7SK85	✓
7UM85	✓
7VE85	✓
7SS85	✓
7SJ85, 7SJ86	✓
6MD85, 6MD86	✓
6MU85	✓
7KE85	✓
7SJ81, 7Sx82 (non modular)	✗
7ST85, 6MD89	✗

Availability of Process Bus Client functionality
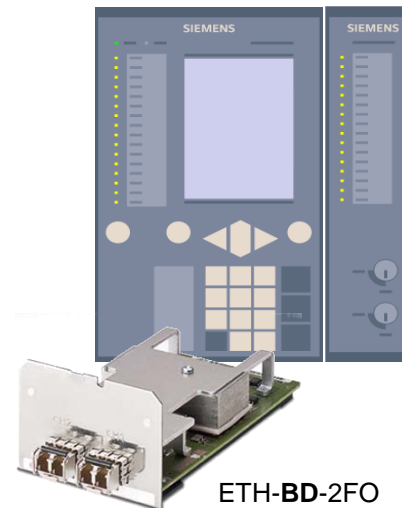
1) Limitations: network bandwidth of 100Mbit/s, limitation of 40 analog values per SIPROTEC 5 device (except 7SS85 limit of 80 values)
2) 87L supports two terminals
3) Interoperability is regulated in IEC 61850-9-2 Edition 2.1 (not published at this time), use of 3rd party MU must be coordinated with DG SA&P headquarter

SIPROTEC 5 Process bus example
Physically network segregation example

Feeder 1	Feeder 2	Feeder 3	Feeder x	Bus VT's
6MU85	6MU85	6MU85	6MU85	6MU85

Feeder CT values

PRP process bus networks

CT, VT values per feeder

Bus VT values

7UT86	7SD86	7SA86	7SJ85	7SS85	7KE85
Transformer Differential Protection	Line Differential Protection	Distance Protection	Overcurrent Protection	Busbar Differential Protection	Fault Recorder
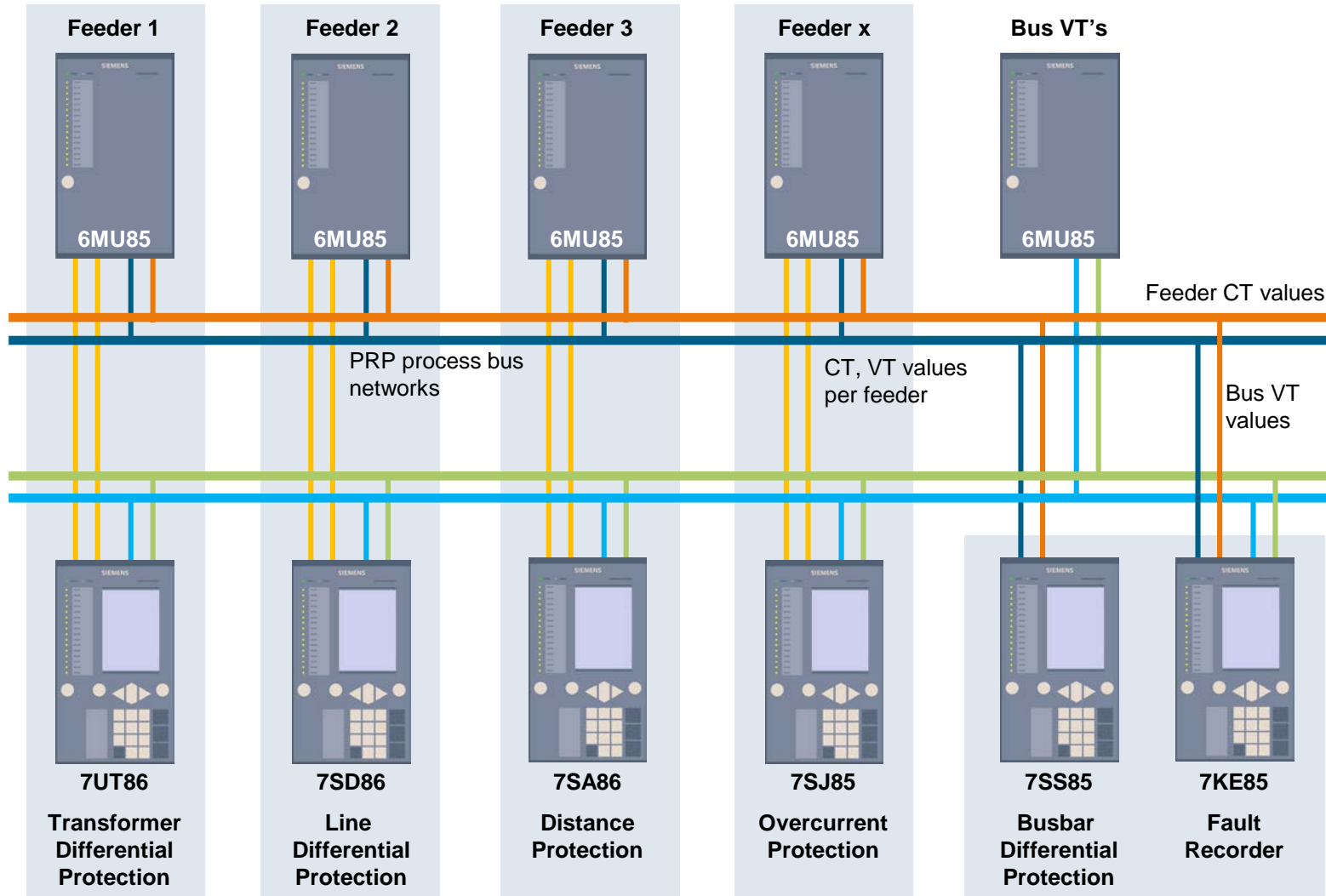
Simplify complexity

Use of more than one redundant process bus network reduces the network engineering

Increase the bandwidth with additional Ethernet interfaces

Efficient use of network bandwidth with customization of the analog values per SMV streams (not only IEC 61850-9-2LE data set)

Central Protection for small substations

Process Bus (PRP)

IEEE 1588v2 / PTP GMC

Sample synchronisation

6MU85　6MU85　6MU85

Central Protection with 7SS85

| FG VI 01 3ph 1 | 50 | 67 |
| | 51 | 21 |

| FG VI 02 3ph 1 | 50 | 67 |
| | 51 | 21 |

| FG VI 10 3ph 1 | 50 | 67 |
| | 51 | 21 |

FG Bus　87SS

| FG Circuit Breaker 1 | 50BF |
| | CTRL |

| FG Circuit Breaker 2 | 50BF |
| | CTRL |

| FG Circuit Breaker 10 | 50BF |
| | CTRL |

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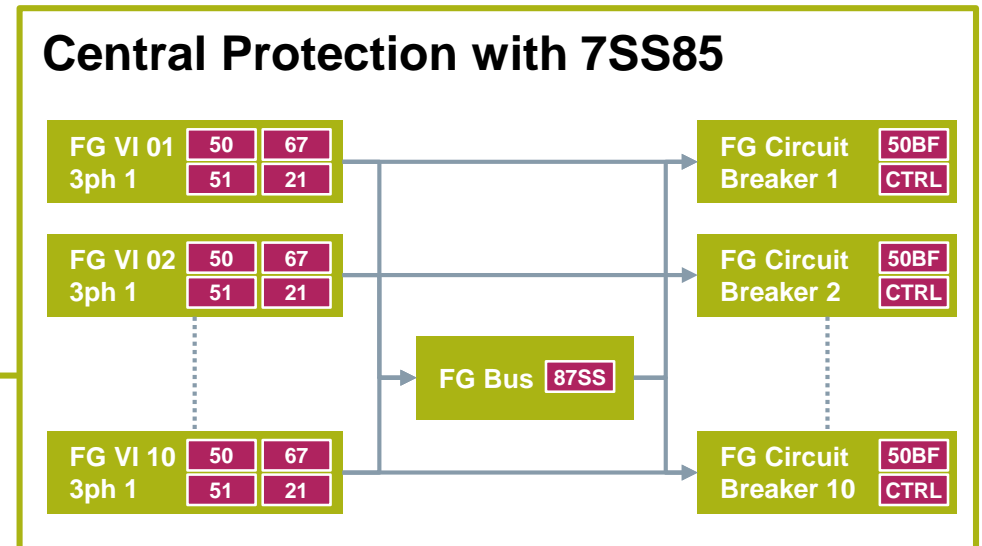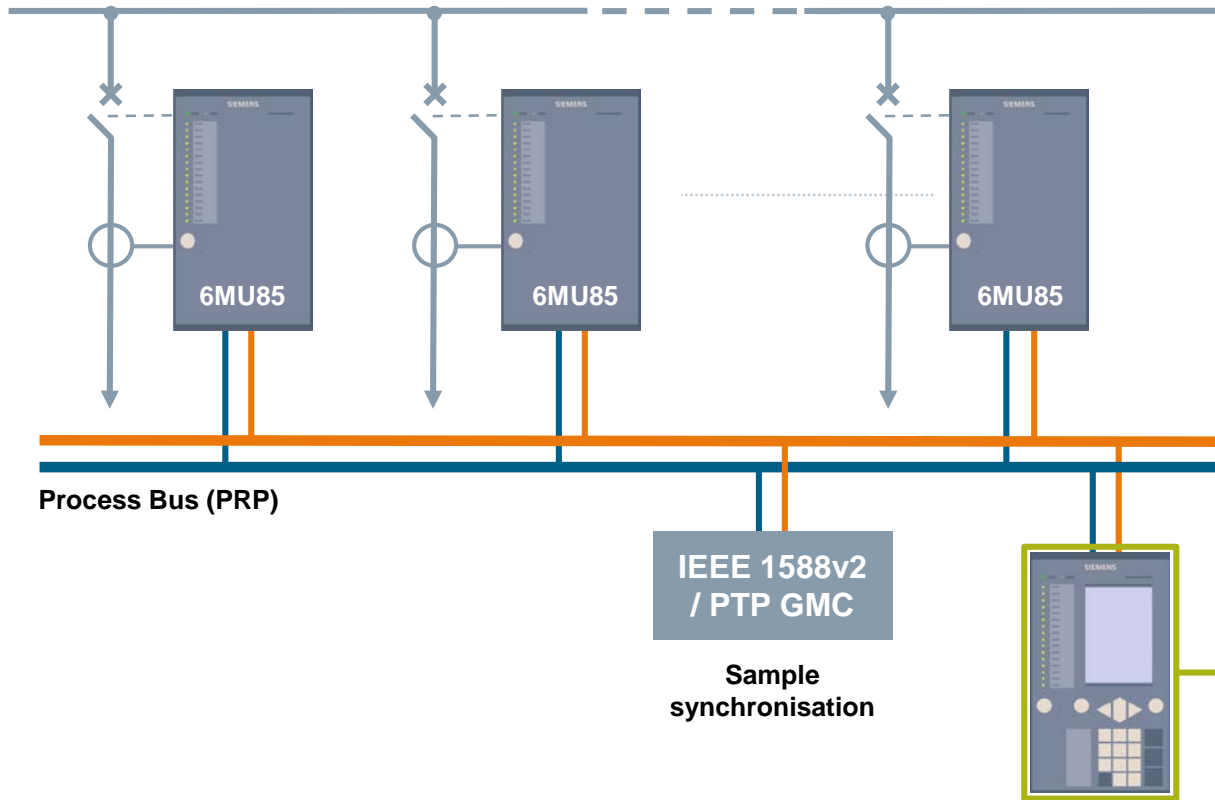
Central Protection for small substations and Line Protection
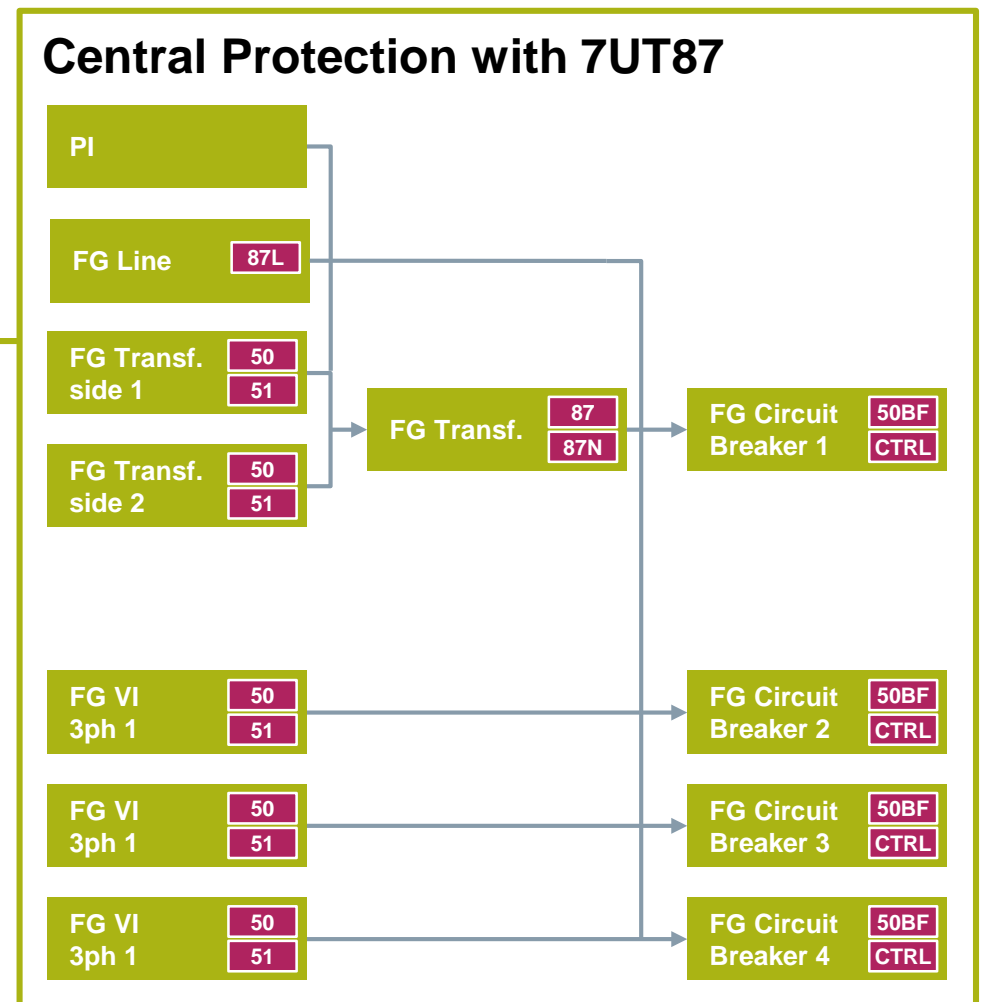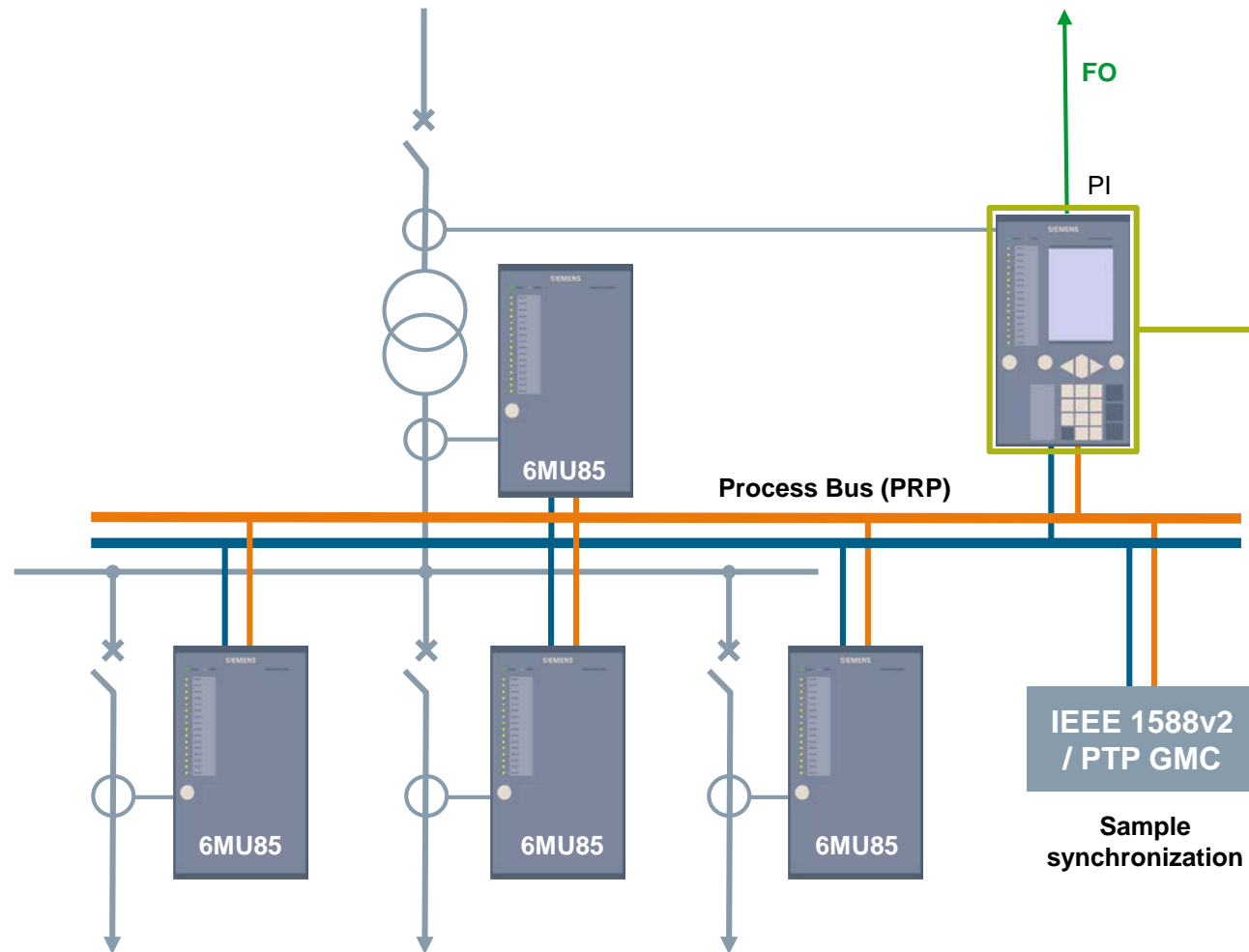
Central Protection with 7UT87

PI
FG Line — 87L
FG Transf. side 1 — 50 / 51
FG Transf. side 2 — 50 / 51
FG Transf. — 87 / 87N
FG Circuit Breaker 1 — 50BF / CTRL
FG VI 3ph 1 — 50 / 51
FG Circuit Breaker 2 — 50BF / CTRL
FG VI 3ph 1 — 50 / 51
FG Circuit Breaker 3 — 50BF / CTRL
FG VI 3ph 1 — 50 / 51
FG Circuit Breaker 4 — 50BF / CTRL

FO
PI

6MU85
6MU85
6MU85
6MU85

Process Bus (PRP)

IEEE 1588v2 / PTP GMC

Sample synchronization

Sasho Martinovski / Energy Automation Products

Highlights V7.9 and V8.0

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- ***Time synchronization with IEEE 1588 for High Precision applications***

- SIPROTEC 7SS85 distributed busbar protection based on process bus

- Point-on-wave switching

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- Cyber Security

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SIPROTEC 5
New Ethernet module – ETH-BD-2FO

SIEMENS
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Communication module for the transmission of Ethernet protocols via 2 optical interfaces

Supports modular SIPROTEC 5 devices 7xx85/86/87*

Available protocols (DIGSI 5 V7.90)
- PRP
- Line Mode
- IEC 61850-8-1 GOOSE, MMS
- COMFEDE support via MMS file transfer
- IEEE 1588v2/PTP (1µs accuracy) ordinary slave clock for radial networks (PRP and Line Mode)
- DIGSI 5 protocol
- DCP, DHCP
- Homepage
- WebUI
- SysLog
- RADIUS

Additional protocols (DIGSI 5 V8.00)
- Process Bus Client
- Merging Unit

ETH-**BD**-2FO
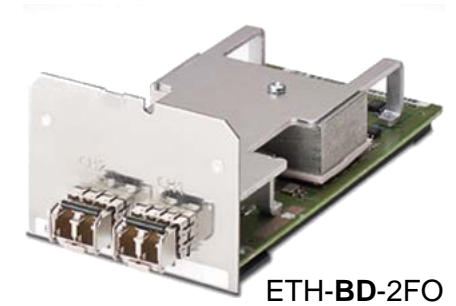
Connector type	2 x duplex LC
Wavelength	λ = 1300 nm
Baud rate	100 Mbit/s
Max. line length	2 km for 62.5 µm/125 µm optical fibers

Transmit Power	Minimum	Typical	Maximum
50 µm/125 µm, NA1 = 0.2	-24.0 dBm	-21.0 dBm	-17.0 dBm
62.5 µm/125 µm, NA1 = 0.275	-20.0 dBm	-17.0 dBm	-14.0 dBm

Receiver sensitivity	Maximum -12.0 dBm Minimum -31.0 dBm
Optical budget	Minimum 7.0 dB for 50 µm/125 µm, NA1 = 0.2 Minimum 11.0 dB for 62.5 µm/125 µm, NA1 = 0. 275
Interface design	Corresponds to IEEE 802.3, 100Base-FX
Laser class 1 as per EN 60825-1/-2	With the use of 62.5 µm/125 µm and 50 µm/125 µm optical fibers

Comment: 1 numerical aperture (NA = sin θ (launch angle))

Time and Sample synchronization
Precision Time Protocol – IEEE 1588v2/PTP

SIEMENS
Ingenuity for life

Communication Plug-In Module	NEW ETH-BD-2FO	ETH-BA-2EL ETH-BB-2FO
Protocol	IEEE 1588v2-2008	IEEE 1588v2-2008
Type of implementation	**Hardware / FPGA**	Software
Accuracy	1 **µ**s	1 ms
Supported devices	**modular** SIPROTEC 5 devices 7xx85/86/87 (except 7ST85, 6MD89)	All SIPROTEC 5 devices
Supported Redundancy	PRP Line Mode	PRP (symmetrical) Line Mode
Supported Profiles	**IEC 61850-9-3**	
Clock Type	Ordinary Slave Clock (OSC)	Ordinary Slave Clock (OSC)
Applications	• Date and Time synchronization • **Sample Synchronization for Process Bus** • **PMU data synchronization** • **87L stabilization for asymmetrical PI networks**	• Date and Time synchronization
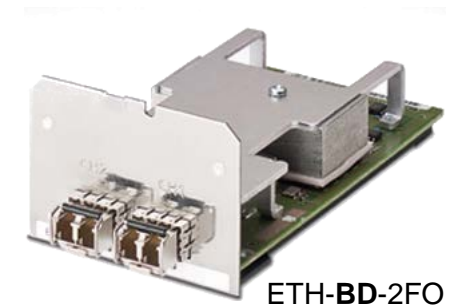
ETH-**BD**-2FO

Sasho Martinovski / Energy Automation Products

Highlights V7.9 and V8.0

SIEMENS
Ingenuity for life

- SIPROTEC DigitalTwin

- Compatibility of SIPROTEC 4 and SIPROTEC 5 for 87L and 21

- IEC 61850-9-2 Process bus for digital substations (Server/Client)

- SIPROTEC 6MU85 Merging Unit

- Time synchronization with IEEE 1588 for High Precision applications

- ***SIPROTEC 7SS85 distributed busbar protection based on process bus***

- Point-on-wave switching

- Conformal coating of SIPROTEC 5 devices as standard

- Cyber Security

- ATEX certification for 7SK85 and 7UM85

- New overcurrent and feeder protection SIPROTEC 7SJ81

- Web Browser

- Further functions

Busbar Protection SIPROTEC 7SS85

Universal protection device for both centralized and distributed busbar protection solutions

Fully-compatible, IEC 61850 distributed busbar protection

Sasho Martinovski / Energy Automation Products

Universal protection device for centralized and distributed busbar protection solutions

SIEMENS
Ingenuity for life

- Optional connection of the process data directly to the central unit or in the field to the merging unit

  - Acquisition of measured values in the field at the merging unit and transmission compliant to IEC 61850-9-2 and/or via central IO module in SIPROTEC 7SS85

  - Acquisition of binary input signals (e.g. isolator and circuit breaker positions, LS failure protection messages) in the field at the merging unit and transmission compliant with IEC 61850 GOOSE and/or via central IO module in the SIPROTEC 7SS85

  - Output of binary signals (e.g. protection trips, transfer trip, bay out of service) in the field via the merging unit compliant with IEC 61850 GOOSE and/or via central IO module in the SIPROTEC 7SS85

- New hardware standard variant V4 (1/3 housing, 19 BI, 11 BA, 0 CT, 0 VT) as preferred version for distributed busbar protection solutions

Hardware Variant	Binary Inputs	Binary Outputs	CTs	ETH-BD-2FO Module	Remarks
V1	15	13 (2S, 10F, 1 Life)	12	0	Standard variant for significant feature 9 (centralized)
V2	11	11 (2S, 8F, 1 Life)	16	0	Standard variant for significant feature B (centralized)
V3	15	15 (2S, 12F, 1 Life)	24	0	Standard variant for significant feature C, D, E (centralized)
V4	**19**	**11 (10S, 0F, 1 Life)**	**0**	**1**	**Standard variant for all significant features (distributed)**

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Fully compatible IEC 61850 distributed busbar protection

SIPROTEC 7SS85 as a process bus client

Merging Unit (Process bus Server) can be:

- SIPROTEC 6MU85
- Any modular SIPROTEC 5 device with a process bus communication module ETH-BD-2FO
- IEC 61850 compatible third-party Merging Unit

Analog and binary process information

- Acquisition of measured values in the field at the merging unit and transmission compliant with IEC 61850-9-2
- Acquisition of binary input signals (e.g. isolator and circuit breaker positions, LS failure protection messages) in the field at the merging unit and transmission compliant with IEC 61850 GOOSE
- Output of binary signals (e.g. protection trips, transfer trip, bay out of service) in the field via the merging unit compliant with IEC 61850 GOOSE

Engineering

- Standard IEC 61850 Configuration Tools (e.g. IEC 61850 System Configurator)
- DIGSI 5

Distributed busbar protection
SIPROTEC 7SS85

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SIPROTEC 7SS85 busbar protecion
(maximum 20 bays)

Time synchronization

IEEE 1588v2 /
PTP GMC

PRP LAN A

PRP LAN B

6MU85 6MU85 7SJ85 7SA86 7UT85
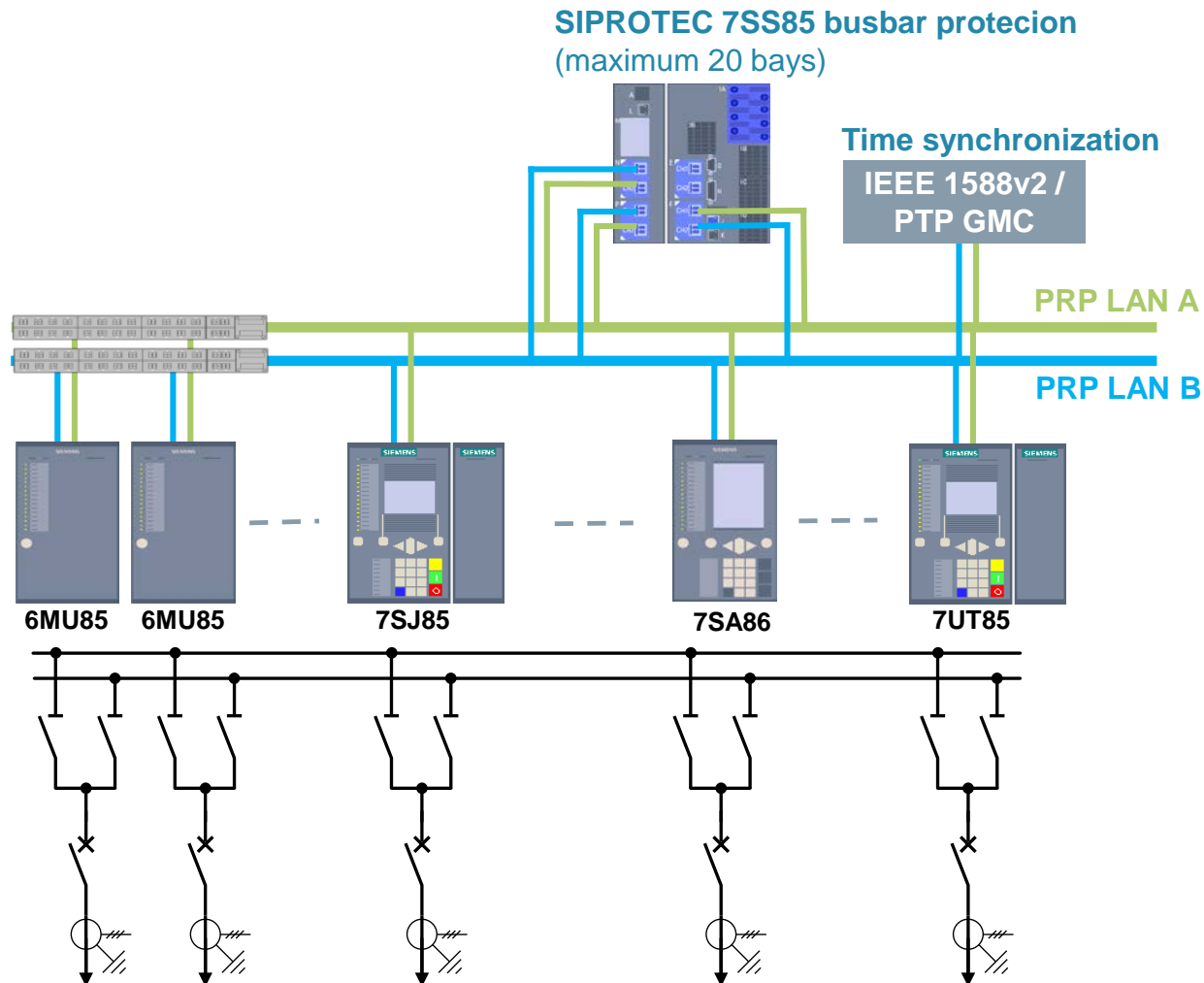
Smart transition of energy systems

- Inter-operable IEC 61850 busbar protection solution

- Distributed process data acquisition:
  - Merging Unit SIPROTEC
  - Every modular SIPROTEC 5 device
  - Third party merging unit

- Simple expansion of existing SIPROTEC 5 systems with distributed busbar protection

- Open engineering through standard IEC 61850 configuration tools and DIGSI 5

Busbar protection SIPROTEC 7SS85 as centralized protection

- Busbar protection (87B) for up to 20 bays

New
- Impedance protection (21T) for up to 10 bays

New
- Directional time-overcurrent protection phase/ground (67 /67N) for up to 10 bays

- Non-directional time-overcurrent protection phase/ground (50/51N) for up to 20 bays

- Circuit-breaker failure protection (50BF) for up to 20 bays

- End fault protection (50EF) for up to 20 bays

- Voltage protection for up to 4 voltage measurements

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Point-on-Wave Switching with SIPROTEC 5 (V7.90)

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Requirement

- Minimization of electro-dynamic and dielectric stress on equipment as a result of switching operations
- Longer service life of equipment and reduced aging
- Increased system reliability (via reduced voltage fluctuations and lower harmonic stress)

Solution

- 6MD86 as „stand alone" PoW device
- 6MD86 as Bay Controller + PoW functionality
- **Protection device (7UT8, 7SJ85, LineProt 7xx87) + BCU + PoW functionality**

Necessary Hardware:
- 2x IO209 with high-speed outputs for controlled single-phase CB opening
- 1x IO212 with 8x fast transducer inputs
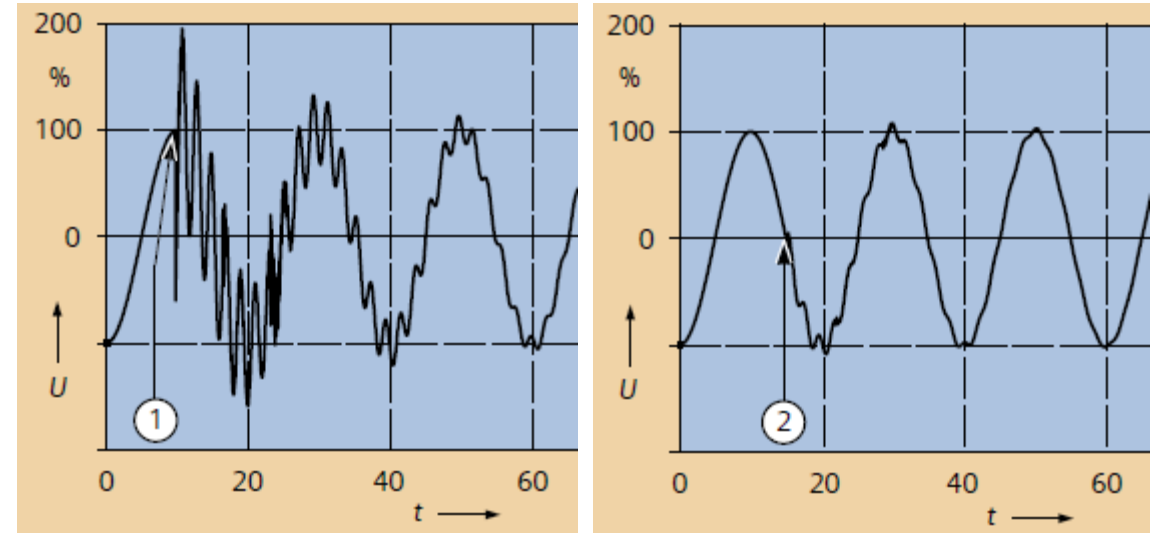
Benefits

- Reduced aging and increase system reliabilty
- Low invest: One device for control, protection and PoW function
- **One** device for all type of loads
- Integration into substation automation system with standard protocols like IEC 61850
- Easy engineering

Point-on-Wave Switching with SIPROTEC 5

SIEMENS
Ingenuity for life

Why „Point-on-Wave" Switching ?

- "Point-on-Wave" Switching minimizes electro-dynamic and dielectric stress for operational equipment as a consequence of switching (control) operations

- Therefore, aging of operational equipment can be reduced and life time extended
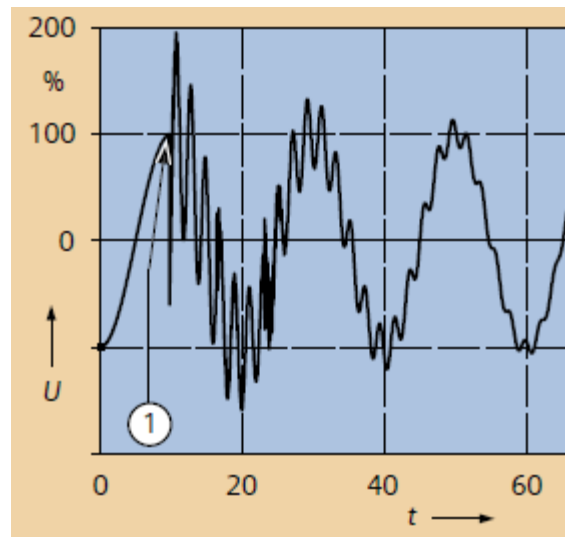
Switching a capacitive load
1) Closing time **not** optimized
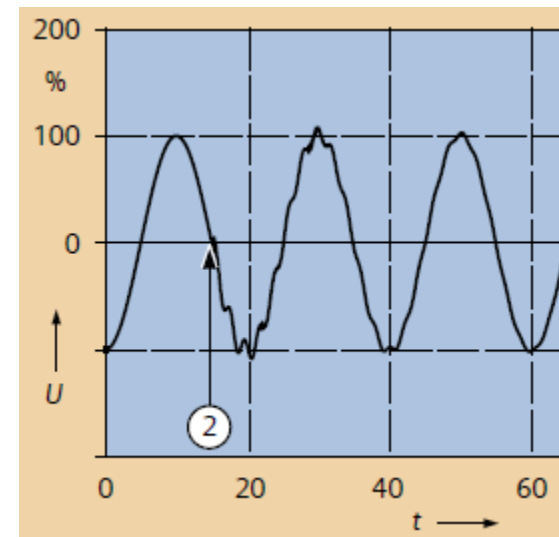
2) Closing time optimized

Point-on-Wave Switching with SIPROTEC 5 Applications

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Ingenuity for life

Type of load / operational equip.	Operation	Avoided stress / Reduction of
Inductive: • Transformer • Shunt reactor (coil)	Opening	Re-striking, overvoltage
	Closing	In-rush current
Capacitive: • Capacitor bank • Filter bank • Transmission line • Cable	Opening	Re-striking, overvoltage
	Closing	Overvoltage, In-rush current

Reduction of In-rush currents:

► minimizes electro-dynamical and dielectric stress → Longer service life

Minimization of overvoltage:

► minimizes dielectric stress → Increased system reliability

Point-on-Wave Switching Function with SIPROTEC 5

How does Point-on-Wave Switching work ? (simplified)

- PoW function operates the CB pole-selectively and determines the optimal switching instance for each phase / pole individually, with an IED accuracy of ~ 50µs

→ PoW switching can only be applied on circuit breakers that support phase-selective switching

- Example: Switching a "shunt reactor"
- Switching shall take place in the voltage maximum to avoid inrush currents

Switching sequence: C → B → A
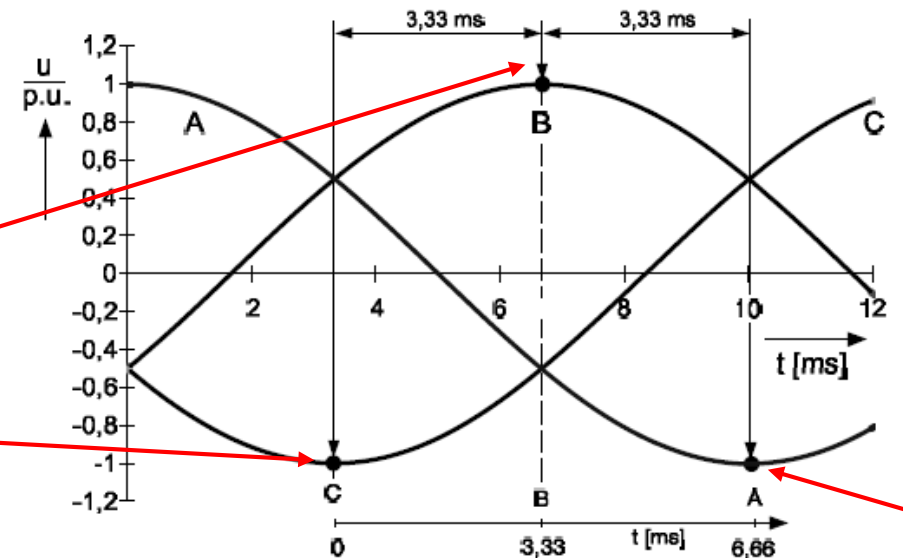
Point on Wave Switching SIPROTEC 5
Device configuration
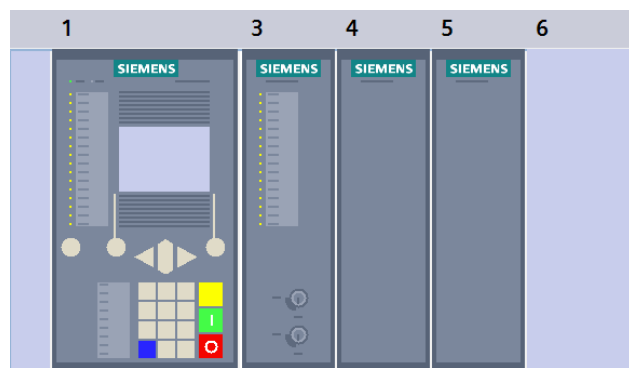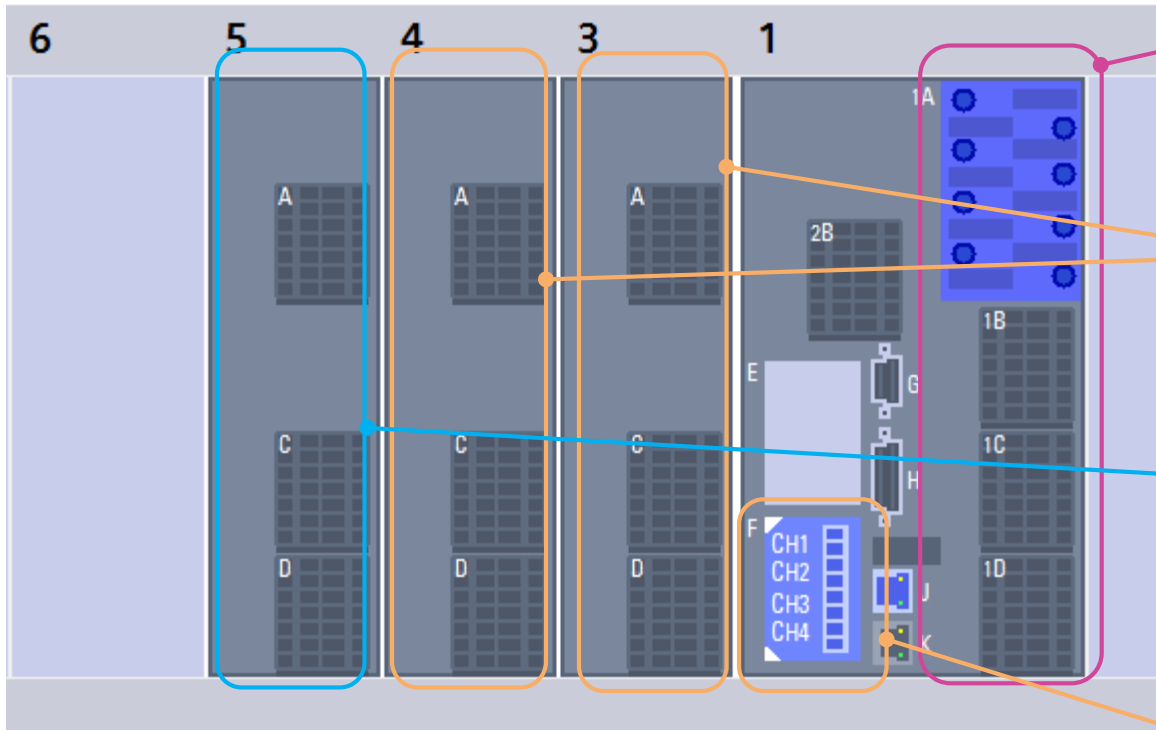
- IO202: 4xI, 4xV: & voltage measurement:
  - ▸ for reference voltage
  - ▸ for switching monitoring / recording

- 2x IO209: overall 8 x high-speed outputs (< 50µs switching accuracy)
  - ▸ for controlled CB-opening and CB-closing

- 1x IO212: 8 x fast transducer inputs (0..20 mA)
  - ▸ 3 inputs for Siemens-CB reference contacts
  - ▸ 2 inputs for CB-open / close control voltage
  - ▸ 1 input for temperature

- Optional: one plug-in module with 4 additional normal-speed transducer inputs:
  - ▸ 3 inputs for hydraulic CB pressure

Remarks:
- All transducer inputs are passive and require external 24 VDC supply
- CB control voltage must be externally transduced into 4..20 mA

Point-on-Wave switching device with SIPROTEC 5
Possible Device Types

PoW switching will be a platform functionality. This allows this functionality to be applied in different device application options:

1. Stand alone PoW-switching device: 6MD86

2. Bay Control and PoW-switching in one physical device: 6MD86

3. Protection, Bay Controller and PoW-switching in one physical device:
   e.g. 7SJ85
   (7SJ85 = Capacitor bank protection functionality)

The "PoW" function is available for configuration
as a new function in the DIGSI device-function library:
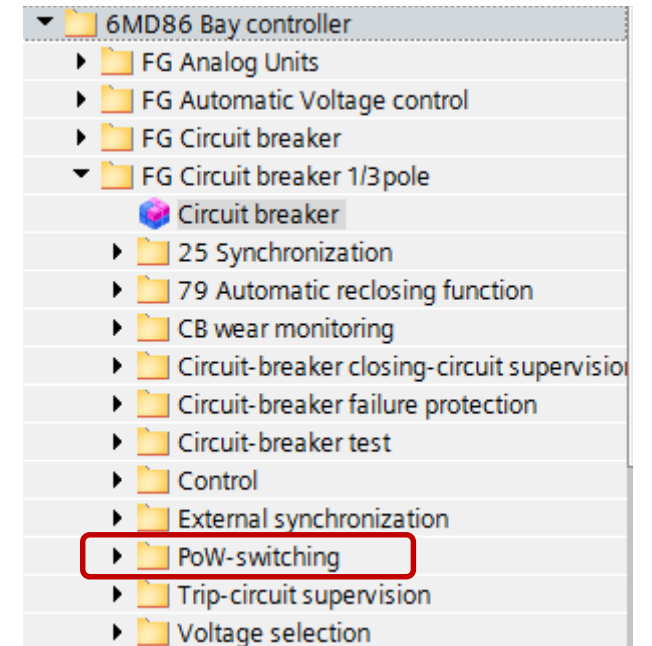
Sasho Martinovski / Energy Automation Products

Highlights V7.9 and V8.0

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Ingenuity for life

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- Point-on-wave switching
- ***Conformal coating of SIPROTEC 5 devices as standard***
- Cyber Security
- ATEX certification for 7SK85 and 7UM85
- New overcurrent and feeder protection SIPROTEC 7SJ81
- Web Browser
- Further functions

Conformal Coating as standard SIPROTEC 5 devices
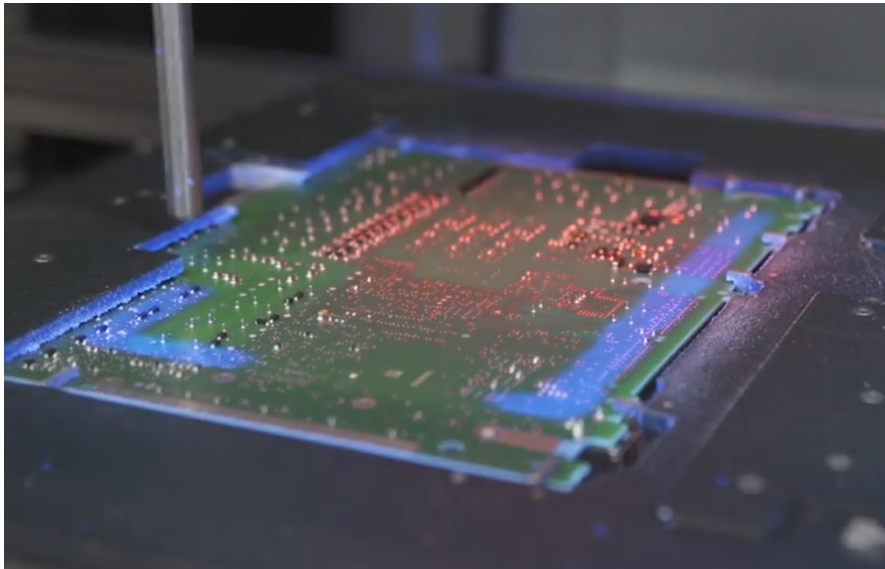
Conformal Coating:

- Double-sided coating of electronic modules, as standard
- As standard, at no additional charge, for all new orders of SIPROTEC 5 and SIPROTEC Compact devices

Customer Benefit:

- Highest lifetime and availability of SIPROTEC devices even under extreme environmental conditions:
- Increased protection against harmful environmental influences such as corrosive gases, salts, and moisture
- Additional mechanical protection against dust and abrasion
- Highest coating quality due to qualified production process

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Security News in SIPROTEC 5

Cyber Security

Customer-authorized DIGSI 5 Instances (V7.90)
- Use customer-issued client certificates in DIGSI 5 instances so that only these instances (and not any standard DIGSI 5 installation) can communicate with the customer's SIPROTEC 5 IEDs

Role-based Views In DIGSI 5 (V7.90)
- Users can only view or operate those functionalities in DIGSI 5 that are permitted for their assigned roles

Authenticated network access for COM-Modules (V8.00)
- COM-modules authenticate themselves using IEEE 802.1X und customer certificates against the switch in order to gain network access

…and other improvements in RBAC, security logging and HTTPS functionalities

Customer-authorized DIGSI 5 Instances (V7.90)

3. Mutually-authenticated und encrypted communication
between DIGSI 5 and the SIPROTEC 5 device
NEW: Only DIGSI 5 installations that connect using certificates signed by customer's CA are permitted

Device-side support for role-based access control including central user management and emergency access

Recording of security-relevant events and alarms over Syslog and in non-volatile security log in device

Confirmation codes for safety-critical operations

- AS BEFORE -

SIPROTEC 5

Bay level

1. Install customer-issued client certificate in the Windows User account (Client authorization)

SICAM GridPass
Certificate Manager

Customer CA and Certificates can be issued using SICAM GridPass

Other Windows users with DIGSI 5 without customer-issued certificates

2. Install in the device the customer CA that is used to sign the DIGSI 5 client certificates

Role-based Views In DIGSI 5 (V7.90)

SIEMENS
Ingenuity for life
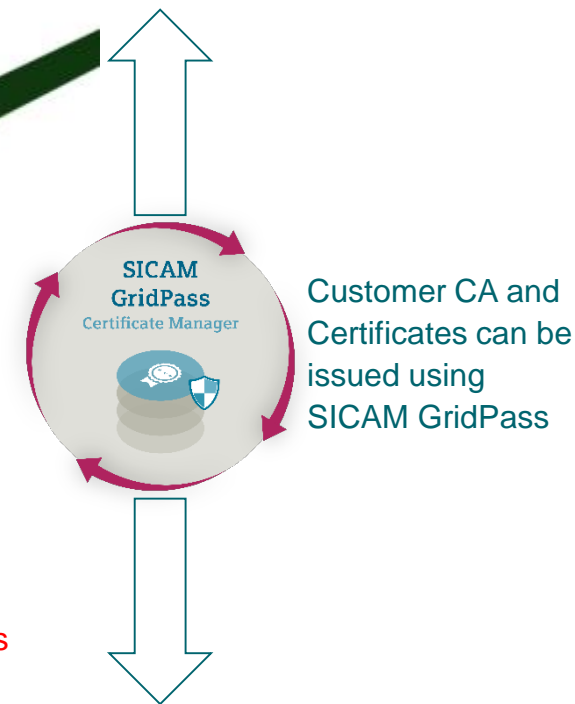
Role-based Views with central user management in DIGSI 5 – also when not connected to the device

NEW in V7.90: DIGSI 5 automatically determines the user's roles from his Windows session


Roles ←→ Users	Role
User 1	Engineer
User 2	Admin
…	

1 User requests access to IED with username and password

2 Authentication request with username, password via RADIUS

3 Authentication & Authorization (Role) response from RADIUS

4 Success/Fail Response from device to user

5 Role-based user session initiated/denied

All user logon attempts are logged as security events inside the device and via the Syslog protocol

Access Control Roles Mapping	Operation A	Operation B	Operation C	Operation …
Role 1	x	x		
Role 2		x	x	
…				

- Users can only view or operate those functionalities in DIGSI 5, that are permitted for their assigned roles

- Usage of (existing) central user administration for role-based DIGSI 5 experience

- Works with existing Microsoft Active Directory (AD) installations

- Roles and rights correspond to standards and guidelines e.g. IEC 62351, IEEE 1686, BDEW Whitepaper

- Works hand-in-hand with the RBAC feature in SIPROTEC 5 devices

- The role-based views are also available for Windows user accounts that are not centrally managed in AD

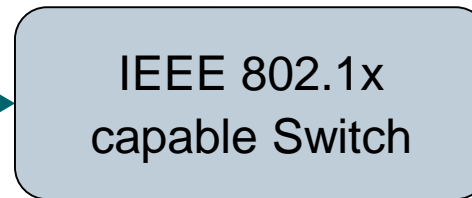# Authenticated Network Access for COM-Modules using IEEE 802.1X (V8.0)

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Ingenuity for life

1. **Install customer-issued IEEE 802.1X Client certificates for COM modules (for network client authentication)**

1. **Install customer-issued IEEE 802.1X CA certificate in RADIUS Server**

Customer CA und certificates can be created and managed with SICAM GridPass

SICAM GridPass Certificate Manager
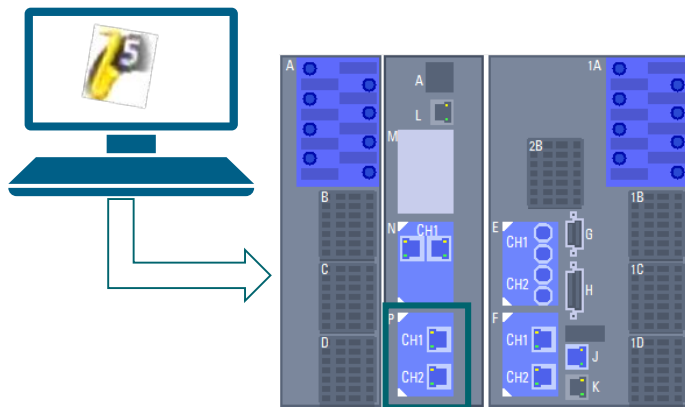
RADIUS Server

Line mode, not in Ring mode

IEEE 802.1x capable Switch

2. **During bootup, the device's COM module presents client certificate for authentication to the switch using IEEE 802.1X**

3. **RADIUS Server authenticates the device using its certificate and the switch grants or denies network access to the COM module**

Other products without customer-issued IEEE 802.1x client certificates

Highlights V7.9 and V8.0

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ATEX-Certification
for SIPROTEC 7SK85 and 7UM85

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Ingenuity for life

Application

- Use of Motor Protection and Machine Protection in potentially explosive atmospheres (e.g. Chemical-Industry)

Solution

- Certification of Hardware and Firmware by an independent and accredited institution: PTB = Physikalisch-Technische Bundesanstalt

PTB Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

Ex

(1) **EU-TYPE EXAMINATION CERTIFICATE**
(Translation)

(2) Equipment or Protective Systems Intended for Use in Potentially Explosive Atmospheres - Directive 2014/34/EU

Advantage

- SIPROTEC protection devices are applicable directly and without customer approvals in potentially explosive atmospheres

Highlights V7.9 and V8.0

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Overcurrent protection SIPROTEC 5 7SJ81
Profile

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- Your start with SIPROTEC 5 – device family
- Good price value
- Optimized functionality for feeder protection
- based on the successful SIPROTEC 7SJ82, with limited functionality

Overcurrent protection SIPROTEC 5 7SJ81 Profile

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Application

- Feeder protection
- All network types, medium voltage level

- 4 CT,   with 11 BI, 9 BO or 18 BI, 14 BO
- 4 CT, 4 VT   with 11 BI, 9 BO or 16 BI, 11 BO
- Up to **1** plug-in module
- 12 programmable LEDs
- Non-expandable via 1/6 modules
- Standard and large graphical display

non-expandable

Suitable device 7SJ81

Device functions

- Dir. & Non-Dir. OC protection with basic functionality
- Ground fault protection for comp./isolated networks
- V, f, P/Q protection functions
- AR, Sync function

- IEC 61850 (Edition 1 and 2)
- Cyber security
- Redundant communication
- SIPROTEC 5 standard functions for control and monitoring

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SIPROTEC 5
Web Browser - Extensions

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Simple, fast and secure access to device data

Recording:

- Download, Delete and Trigger of Fault Records

Parameterization:

- Change of settings within an active setting-group

Display all signal state:

- Indication of all information
- Centralized view on warnings, alarms and inactive functions

Highlights V7.9 and V8.0

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Fault Locator Plus
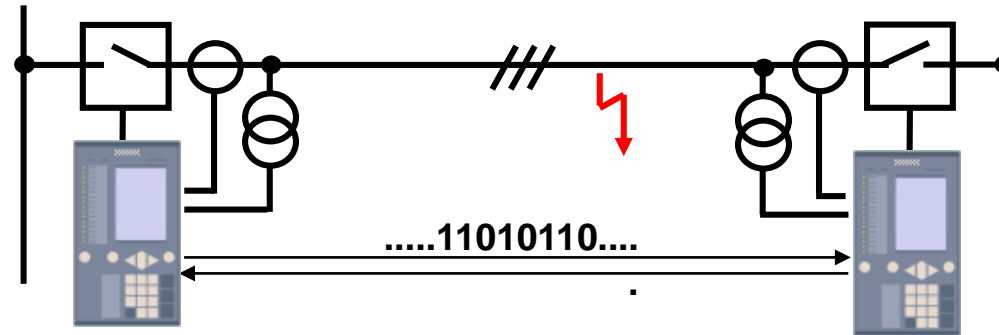
- Accurate fault location by measuring at both ends of a 2-ended line with communication link via protection interface (Accuracy of 99%)
- Separate line sections with individual line data for non-homogeneous lines, e.g. for overhead line/cable sections
- Section specific auto-reclosure (AR) on overhead line sections

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Phasor Measurement Unit (PMU) – Improvement

- Up to 40 channels supported (20 channels in V7.8)
- Applications with pure CT connections possible
- Additional information in configuration frame 3 (according to IEEE C37.118) available, e.g. GPS-Data, Global PMU ID, Configuration Change counter
- Longer names possible in Config Frame 3 for phasor names and channel names as well as for PMU-station name

SIPROTEC 5
Further functions

Positive-sequence overcurrent protection function (ANSI 50/51) – New function

Positive-sequence overcurrent protection function detects short circuits in electric equipment and is applied when the zero-sequence current or negative-sequence current should not influence the tripping, for example, on the tertiary delta winding of an auto transformer.

Frequency protection in function group Voltage/current 1-phase – New application

Over-frequency protection (ANSI 81O) and underfrequency protection (ANSI 81U) functions are now available in the 1-phase voltage/current function group.

Contact information

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Published by Siemens

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