SIEMENS

SIPROTEC 5 Application Note

SIP5-APN-006:
Multiple communication options

Answers for infrastructure and cities.

SIPROTEC 5 - Application: SIP5-APN-006 Multiple communication options with SIPROTEC 5

Content

1 Using the flexible communication features of SIPROTEC 5 for communication redundancies

1.1 Summary

This application describes various communication examples using SIPROTEC 5. These applications are intended to familiarize readers with the multifaceted communication options, in particular with the multiple protocols and communication redundancies of the SIPROTEC 5 device series, and to provide suggestions that lead to solutions for their communication requirements.

1.2 Introduction

The SIPROTEC 5 modular concept ensures the consistency and integrity of all functionalities across the entire device series.

Powerful and flexible communication is the prerequisite for distributed and peripheral system landscapes. In SIPROTEC 5 this is a central element of the system architecture enabling a wide variety of communication requirements to be satisfied while providing utmost flexibility. Figure 1 shows a possible hardware configuration equipped with 4 communication modules. Figure 2 shows the CB202 expansion module with 3 slots for plug-in modules. Two of these slots can be used for communication applications.

Owing to the flexibility of hardware and software, SIPROTEC 5 features the following system properties:

- adaptation to the topology of the desired communication structure, such as: ring or star configurations

- scalable redundancy in hardware and software (protocols)

- multiple communication channels to various super ordinate systems

- pluggable communication modules that can be retrofitted

- the module hardware is independent of the communication protocol used

- 2 independent protocols on a serial communication module

- up to 8 interfaces are available

- data exchange via IEC 61850 for up to 6 clients using an Ethernet module or the integrated Ethernet interface

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Figure 1: SIPROTEC 5 device with 4 communication module

Figure 2: CB202: expansion modules with communication modules and analog input module

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1.3 Redundancy of communication technology

Regardless of the desired protocol, the communication technology used enables communication structures to be tailored to the requirements of users. They can basically be divided into Ethernet and serial communication topologies

1.3.1 Redundancy through Ethernet network topologies

Ethernet based substation-wide networks are increasingly being used in modern substation automation systems in practice. These networks transport both the communication services to the central substation computer controller and the signals between the devices of the bay level. Usually, a single Ethernet subsystem is set up for this purpose since the bandwidth of today's Ethernet networks is sufficient for the entire data traffic

The electrical and optical Ethernet modules of the SIPROTEC 5 devices support different network topologies. This applies independently of the selected protocol (IEC 61850 or DNP3 TCP).

If the module operates in dual homing redundancy (without activating the integrated switch), it can be connected to external switches either in simple or redundant configuration. Only one interface at the same time processes the protocol applications (e.g. IEC 61850) in this case. The second interface operates in standby mode (hot standby), and the connection to the switch is monitored. If the interface which processes the protocol traffic fails, the standby interface is activated within a few milliseconds and takes over (Figure 3).

When activating the integrated switch, SIPROTEC 5 devices can be integrated directly into the electrical or optical communication ring consisting of up to 40 devices (Figure 4). In this case, both interfaces of the module send and receive at the same time. Mixed configurations of SIPROTEC 5 and SIPROTEC 4 devices in the ring topology are possible with up to 30 devices. Ring redundancy based on RSTP ensures short switchover times if the communication is interrupted, allowing the protocol applications to continue operation virtually without interruption. This configuration is independent of the protocol application running on the Ethernet module and the external RSTP switches.
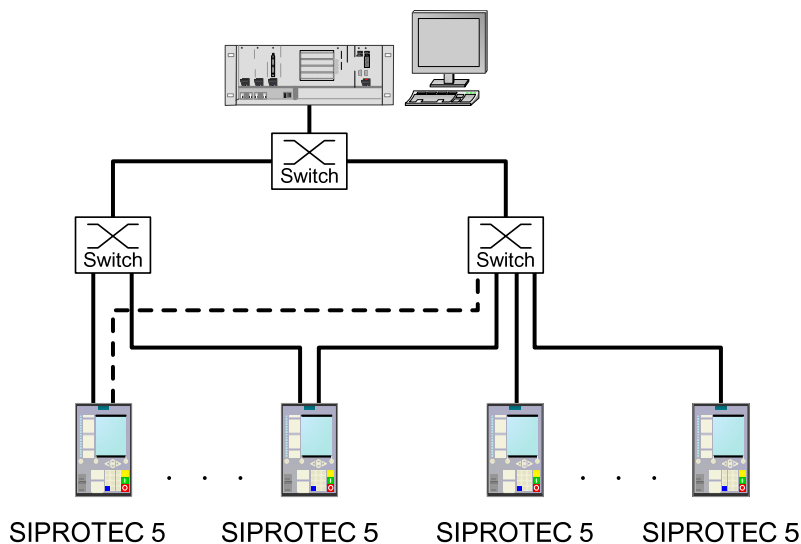

Figure 3: Star configuration: Redundant or single connection to external switches
(Dual homing redundancy)

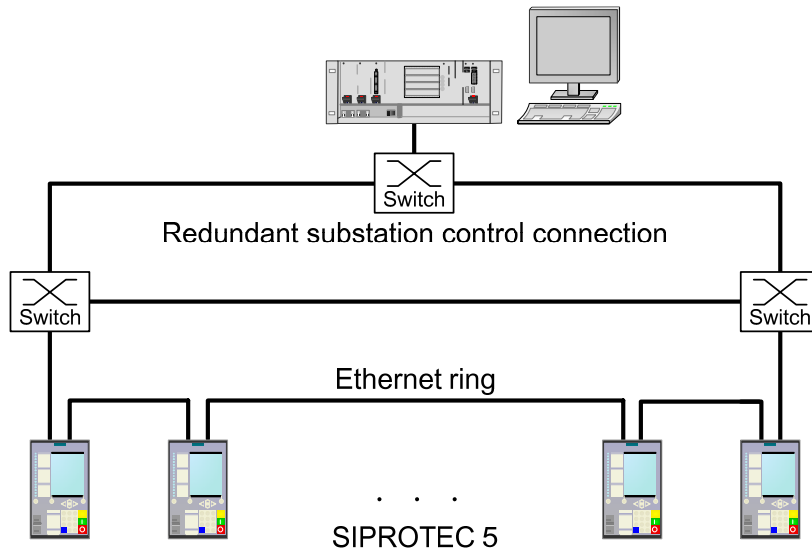# SIPROTEC 5 Application
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Figure 4: Ring configuration: Operation with integrated switch (RSTP)

By using multiple communication modules and protocols SIPROTEC 5 allows the set up of several subsystems and separation of different applications. For example, a dedicated bus for field signals (GOOSE) and a separated bus to the central substation automation system can be implemented. (See Figure 5)
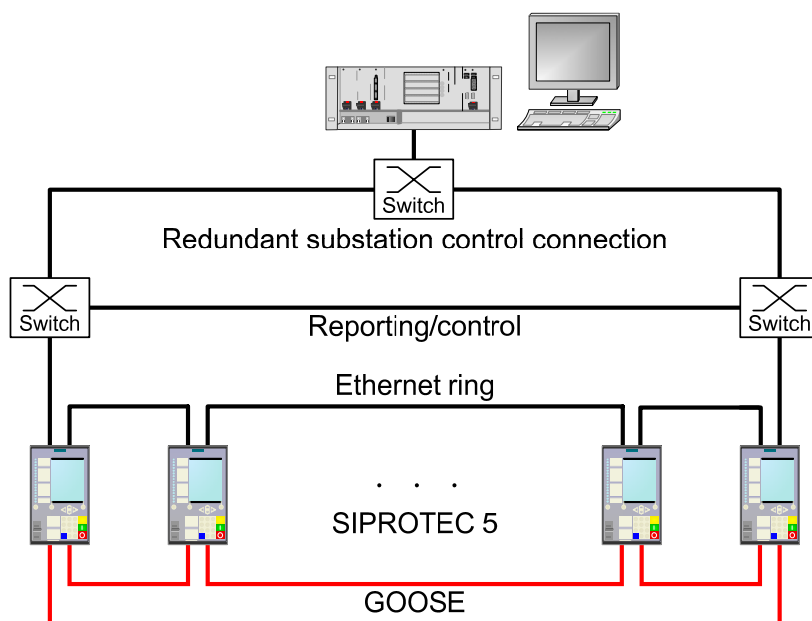

Figure 5: Multiple substation buses for Reporting and GOOSE communication

1.3.2 Redundancy through serial communication structures

The redundant connection to substation controllers, e.g. SICAM PAS, is possible via 2 independent, serial plug-in modules or via a serial double module. In addition to the redundant connection, it is also possible to implement serial connection to redundant or different substation automation systems with the same or with different protocols.
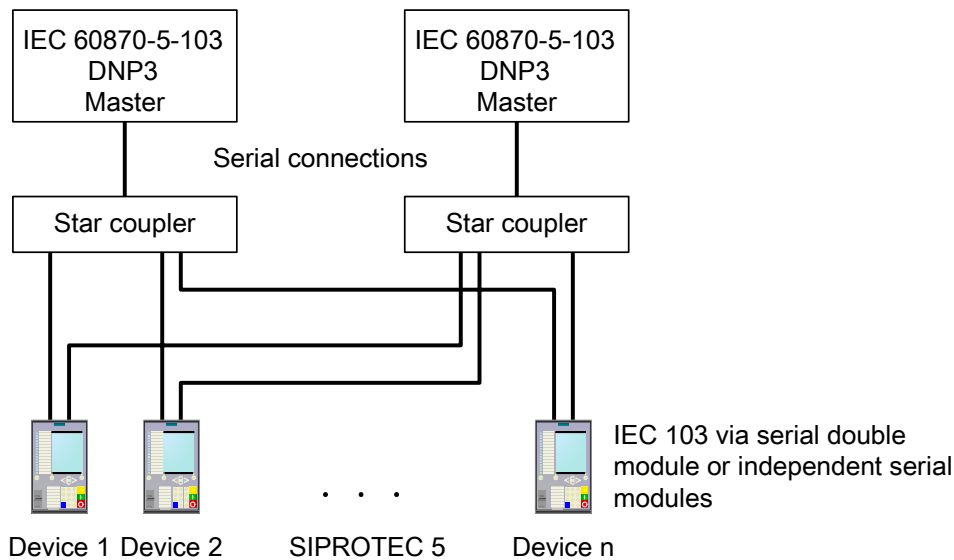
Figure 6: Redundant optical connection of devices to IEC 60870-5-103 or DNP 3 master (e.g. SICAM PAS)

1.4 Redundancy of protocols

Also protocol redundancies are possible. Thus different degrees of protocol redundancies can be implemented. 4 plug-in module slots can be equipped with communication modules and protocol applications. These modules and protocols operate in parallel.

1.4.1 Serial protocols:

Redundant or different serial protocols are capable of running simultaneously in the device, e.g. DNP 3 and IEC 60870-5-103. Communication is effected to one or more masters.

Two serial protocols can run on a double module (Figure 4). It is not relevant in this context whether these are two protocols of the same type or two different protocols.
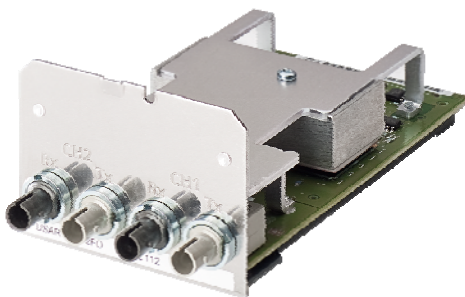

Figure 7: Serial optical double module

The communication hardware is independent of the required protocol. This protocol is specified during parameterization with DIGSI 5. Figure 8shows the routing of the two ports of a serial double module.
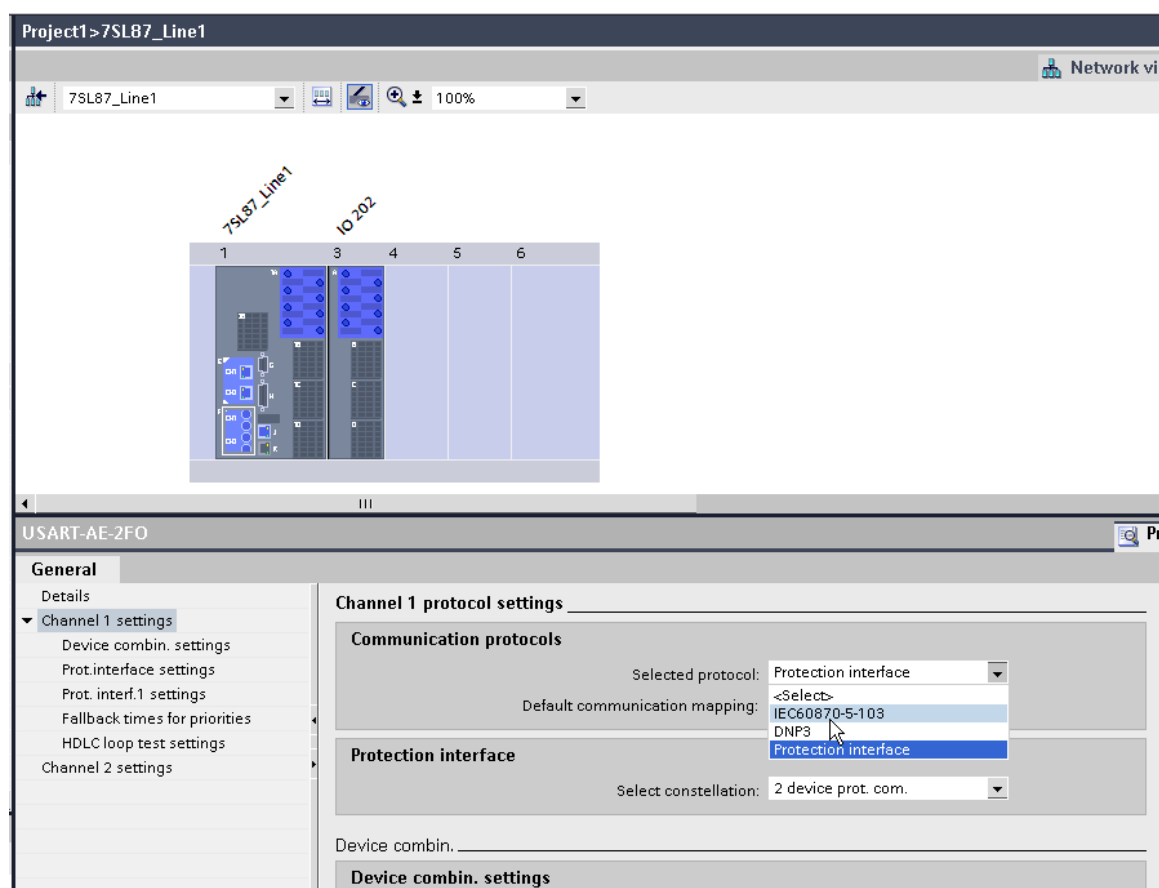
Figure 8: Routing of protocols in DIGSI 5

1.4.2 Ethernet protocols:

The Ethernet module can be plugged in once or multiple times in the device. This enables running identical or different protocol applications in multiple instances. Multiple networks are possible for IEC 61850 or DNP3 TCP. But they can also be operated in a common Ethernet network. A module implements the IEC 61850 protocol application, e.g. the data exchange between devices using GOOSE messages. The other module is responsible for the client-server communication over the DNP TCP protocol. The client-server architecture of IEC 61850 enables one server (device) to send reports to up to 6 clients simultaneously. In this case, only one network is used.
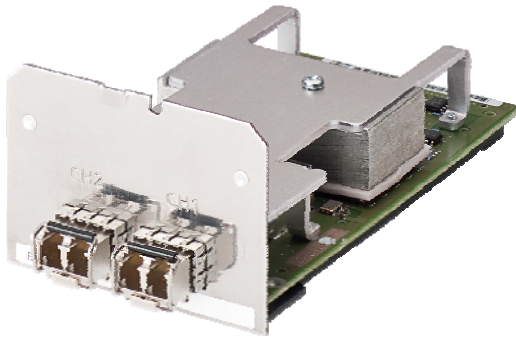
Figure 9: Optical Ethernet module

1.5 Examples

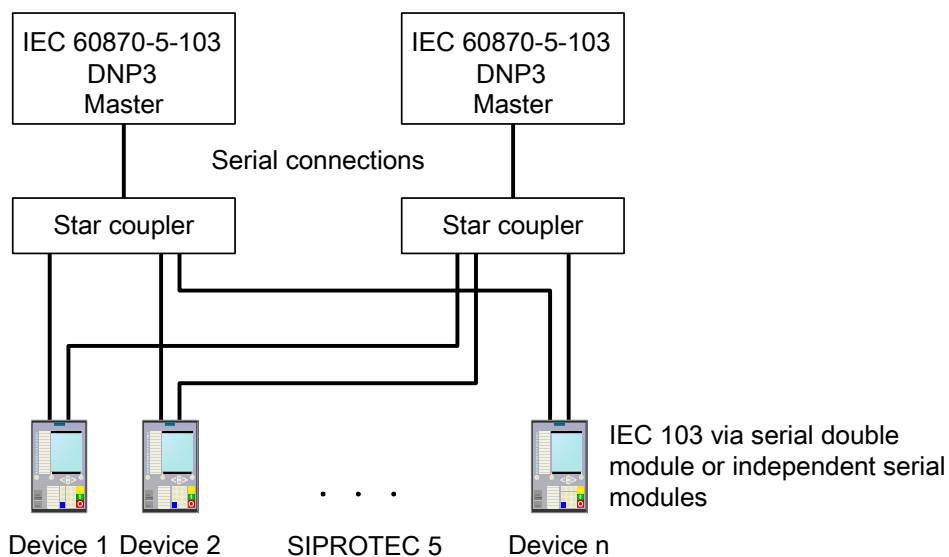### 1.5.1 Example 1: Two redundant substation automation systems

Figure 10: Redundant IEC 60870-5-103 or DNP 3 communication

Figure 10 shows a serial optical network which connects the serial protocol interfaces of the device to one mater, respectively. Transmission is accomplished in multipoint-star configuration and with interference-free isolation via optical fiber.

For the IEC 60870-5-103 protocol, the device supports special redundancy procedures. For instance, a primary master can be configured that is preferred to the second master in control direction. The current process image is transmitted to both masters.
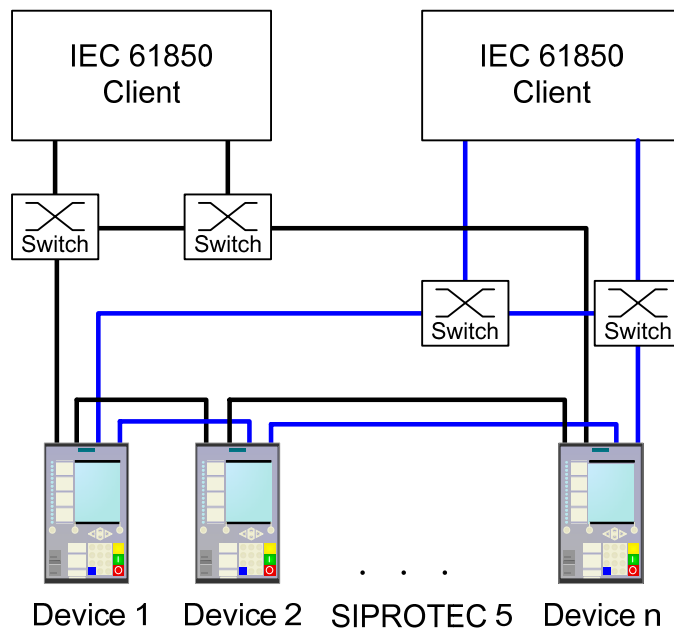
Figure 11:Redundant communication to two IEC 61850 clients

The Figure 11 describes a fully redundant solution based on IEC 61850. 2 Ethernet communication modules are plugged into each SIPROTEC 5 device. 2 redundant optical fiber rings are set up by means of the switches integrated in the module and connected to the redundant clients (substation automation systems). Alternatively, the redundant IEC 61850 communication could also be accomplished via a common optical ring.

1.5.2 Example 2: Two substation automation systems with different protocols

Since both the serial protocols and the Ethernet-based protocols are only specified during parameterization, the configuration described previously can also be implemented using mixed protocols. This can be a particularly interesting application case if different control centers are connected via different protocols. This could be, for example, the control center of the transmission system and the control center of the distribution system.

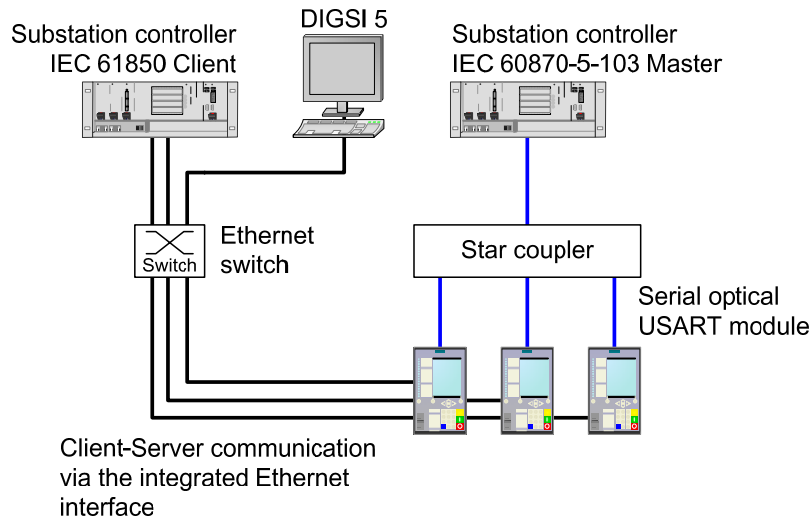The following figures show possible combinations:

Figure 12: Communication to IEC 61850 client and serial connection to an IEC 61870-5-103 master
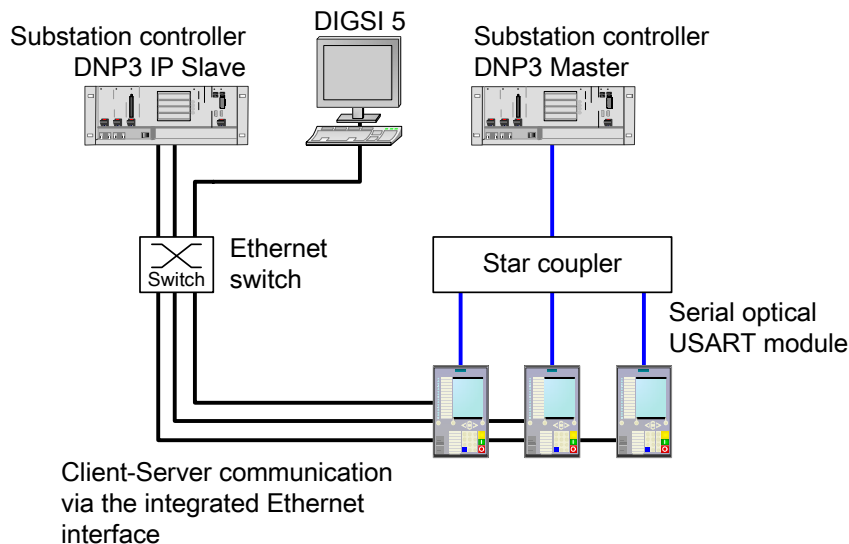

Figure 13: Communication to DNP3 TCP slave and serial connection to an DNP3 master

1.5.3 Example 3: Migration concepts

When converting existing systems, it is often impossible to exchange the bay units and the substation automation system at the same time. In this case, SIPROTEC 5 enables a stepwise conversion. In the first step, the bay level is replaced and the cross-bay wiring, e.g. interlocking, is ported to a station bus/process bus. The existing control system and with it the protocol are kept. For this purpose, an additional interface module is plugged in at the SIPROTEC 5 for this communication. In a subsequent step, the substation control system can be replaced independently of this, and the already existing station bus/process bus can be used.

Figure 14: and Figure 15 show the conversion of existing IEC 60870-5-103 and DNP 3 substation automation systems to Ethernet based solutions.

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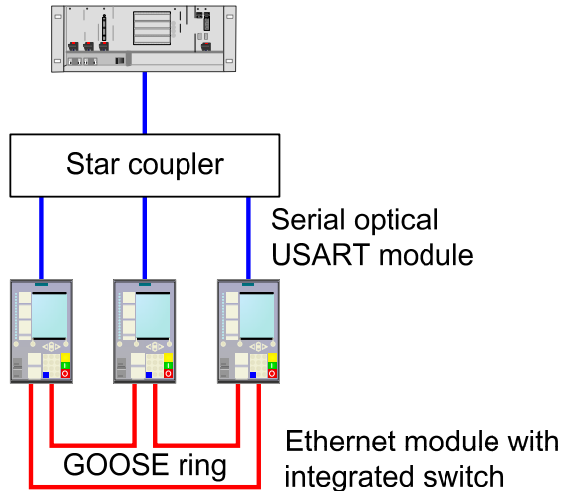Existing substation controller
IEC 60870-5-103 Master

Star coupler

Serial optical
USART module

Ethernet module with
integrated switch

GOOSE ring

Figure 14: Migration of an existing IEC 60870-5-103 substation to GOOSE communication

Existing substation controller
DNP3 Master

Star coupler

Serial optical
USART module

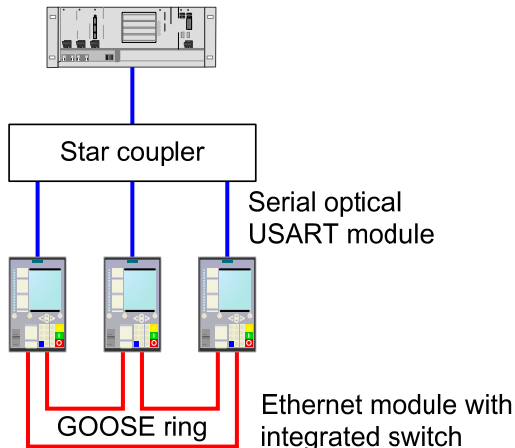Ethernet module with
integrated switch

GOOSE ring

Figure 15: Migration of an existing DNP 3 substation to GOOSE communication

1.5.4 Example 4: Dedicates buses for specific tasks applied for breaker-and-a-half application

The separation of substation communication and process bus can also be helpful for special applications. For instance, a kind of distributed device network can be implemented in this way. The devices of this network communicate via a dedicated communication network and exchange their signals independently of the general station bus. Compared to wired device networks this solution benefits from reduced wiring effort while additionally monitoring the signals. Figure 16 shows a possible solution for protection and control of beaker-and-a-half applications. The complex wiring between the devices is replaced by a dedicated Ethernet network based on IEC 61850 GOOSE. Via GOOSE messages information are exchanged between the devices. Thanks to the option of multiple communication modules, additional communication links for e.g. IEC 61850-5-103 or DNP 3 can be established

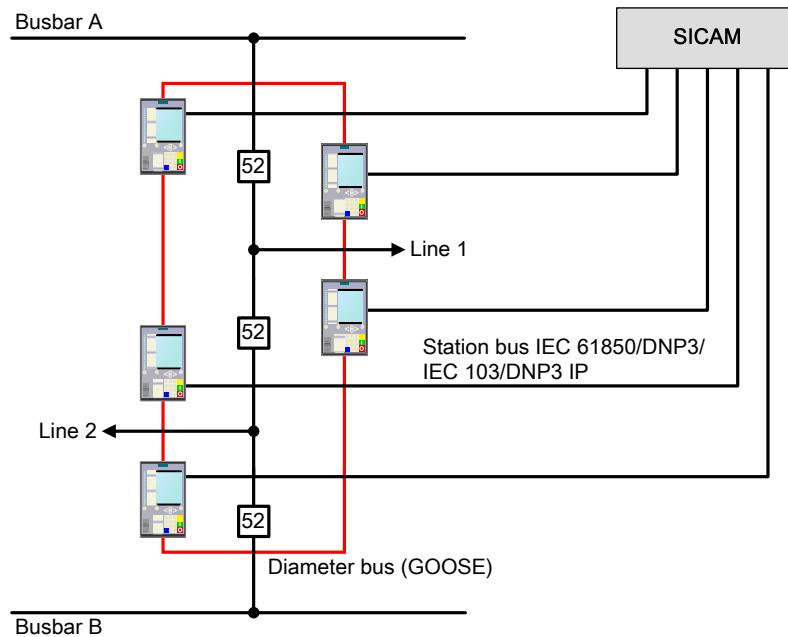IEC 60870-5-103 and IEC 61850 GOOSE

Busbar A

SICAM

52

Line 1

52

Station bus IEC 61850/DNP3/
IEC 103/DNP3 IP

Line 2

52

Diameter bus (GOOSE)

Busbar B

Figure 16: Communication architecture for one diameter

1.6 Summary

The flexibility and modularity of SIPROTEC 5 allows a wide variety of communication solutions to be implemented. These can be adjusted optimally to the operational requirements of different facilities and customers. This flexibility provides the basis for effective and optimized operating solutions, today and in the future.

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