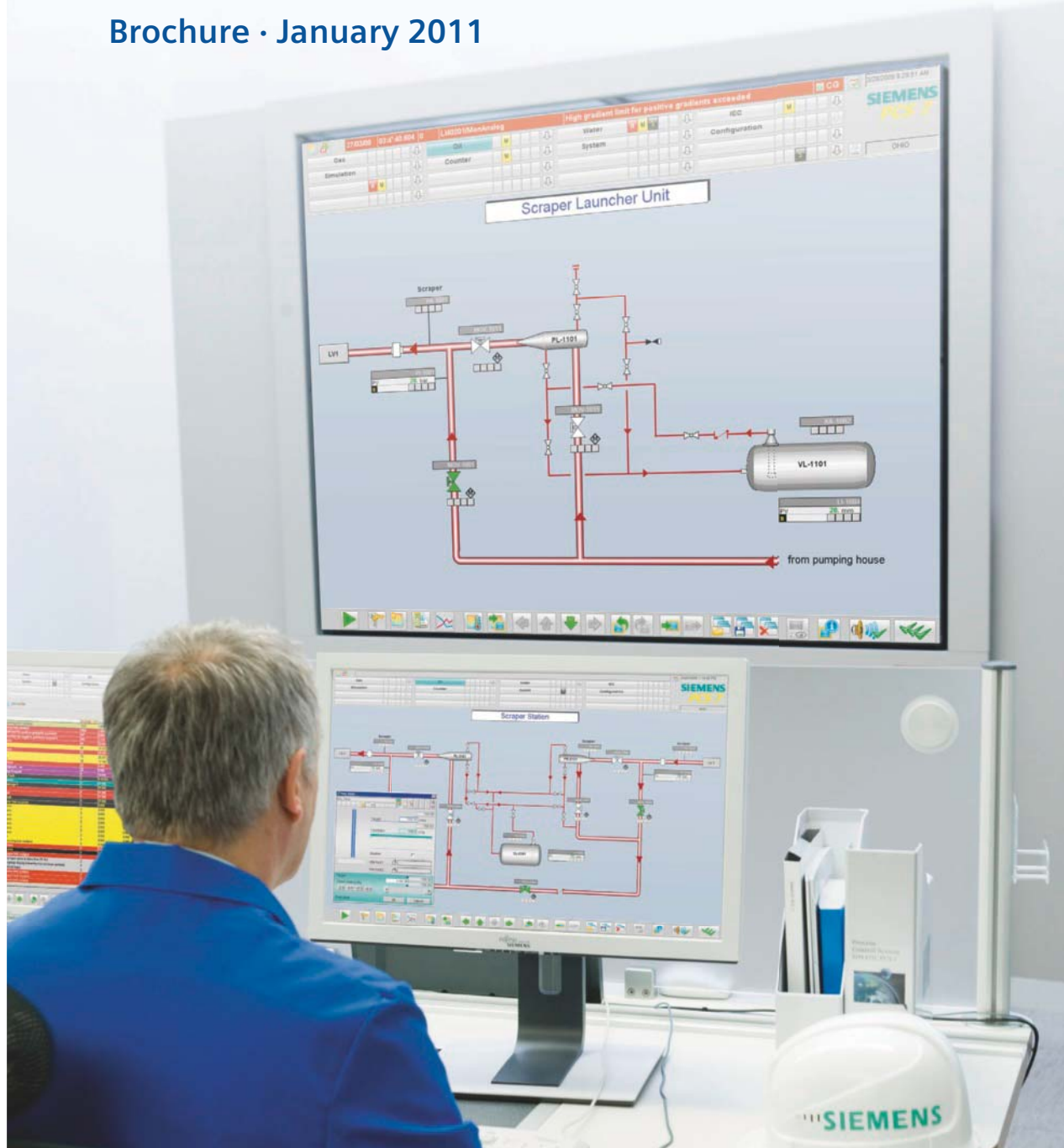# SIMATIC PCS 7 TeleControl

**Process control system with
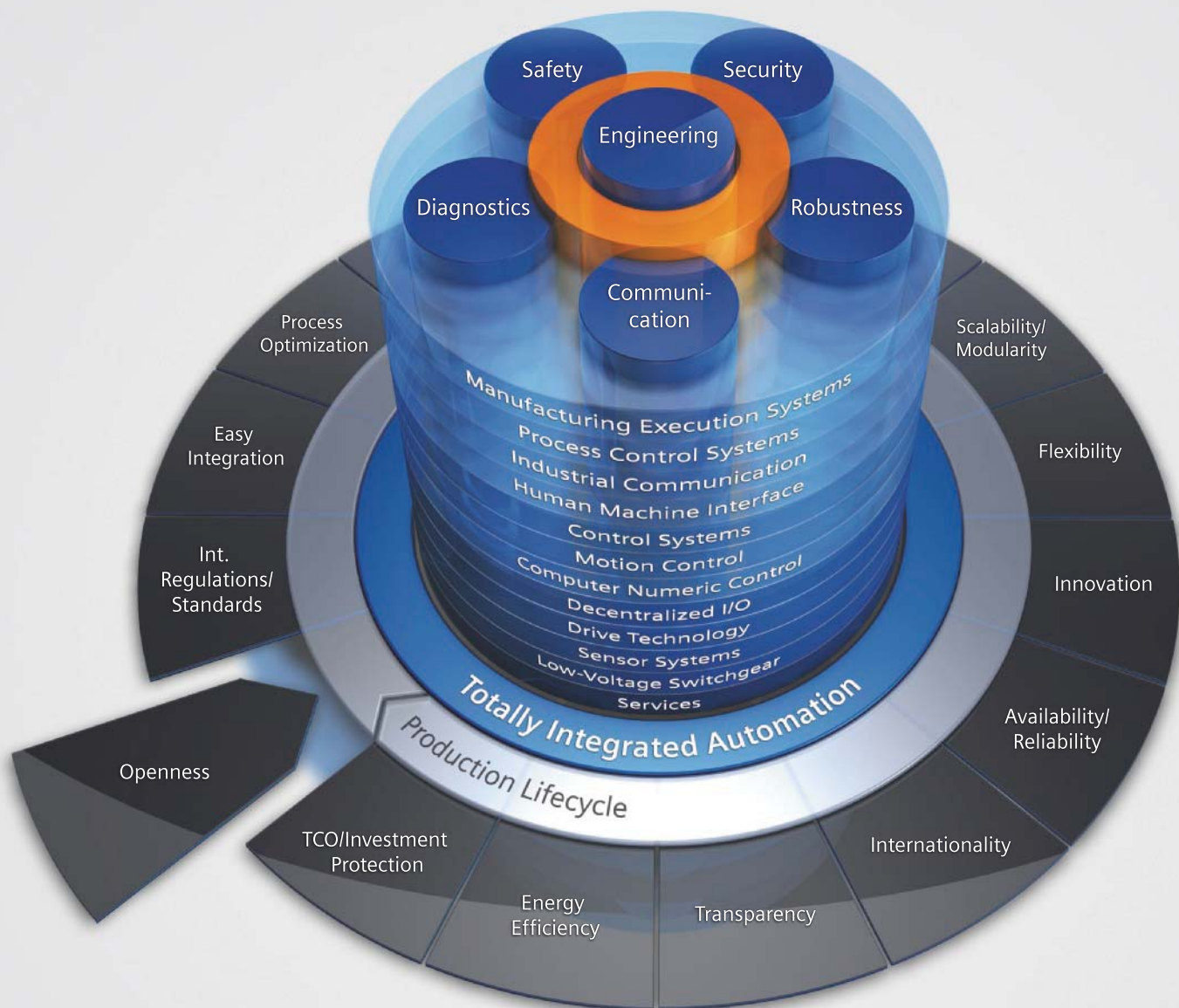integral telecontrol technology**

Brochure · January 2011

SIMATIC PCS 7

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With Totally Integrated Automation (TIA) from Siemens, a seamless offering of perfectly matched products, systems, and solutions for all hierarchy levels of industrial automation, you are optimally equipped for this purpose.

Contents

Integration of the telecontrol technology in TIA has made it possible to combine the automation of central plants and the monitoring of distributed units in a single process control system.

Homogenous operator control and monitoring using a common control station, uniform configuration with the same engineering system, and consistent utilization of hardware components from the TIA product portfolio result in significant savings with regard to investments, operation and servicing.

SIMATIC PCS 7 TeleControl

Process control system with integral telecontrol center

Automation of widely spread process plants

In a number of industries, especially the oil & gas, water & wastewater, power and transportation sectors, plants may sometimes be extremely widely spread. Individual distributed units may even be more than a thousand kilometers away from a central unit with a significantly higher degree of automation.

With a gas pipeline, for example, several slide valve and measuring stations are distributed between one of the compressor stations at the beginning of the pipeline and the relief station at the end.

A further example is the canal system of a widely branched wastewater network connected to a central sewage treatment plant via pumping stations and stormwater overflow tanks.

In both cases it is necessary to monitor regional units such as stormwater overflow tanks, pumping stations, slide valve stations or measuring stations from a far off control center, or to control them in the context of the complete plant.

Telecontrol systems with which automation functions can be executed from a remote control center over a telecommunication network (wide area network/WAN) are the ideal solution for such tasks.

The automation of a process plant, as described above, is distributed in conventional implementation concepts between heterogeneous system levels. Process control systems (PCS) are normally used for units with a higher degree of automation, e.g. the central sewage treatment plant. On the other hand, the local automation of small units with a low degree of automation (pumping stations, stormwater overflow tanks) is carried out using simple remote terminal units (RTUs) which communicate with their control center by means of a telecontrol link. To enable global monitoring, all systems of the automation project (PCS and RTU) are integrated in a host network control system.

However, it is far more effective if the telecontrol center for the RTUs is directly integrated into the process control system using SIMATIC PCS 7 TeleControl. In this case, the network control system as a superimposed integration level can be omitted. Uniform process control and totally integrated engineering for central and widely distributed units, together with simple and convenient data management, result in high efficiency with regard to operation and engineering. Low training and servicing costs are further positive aspects.
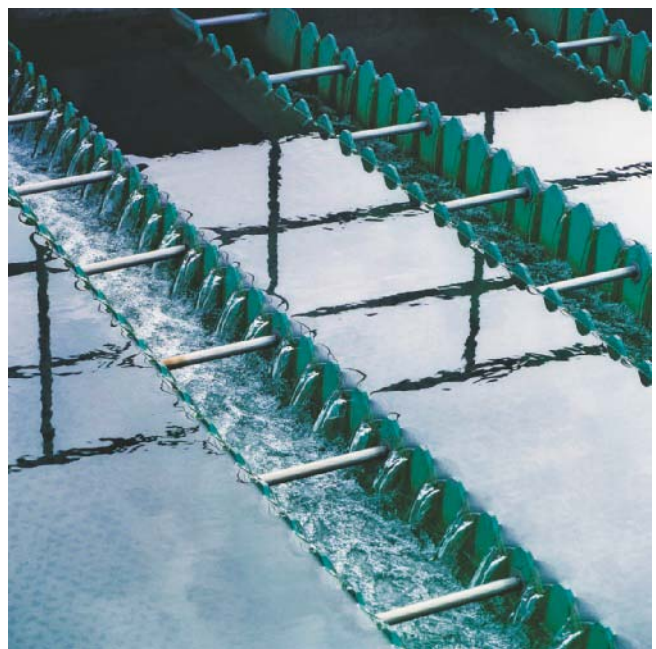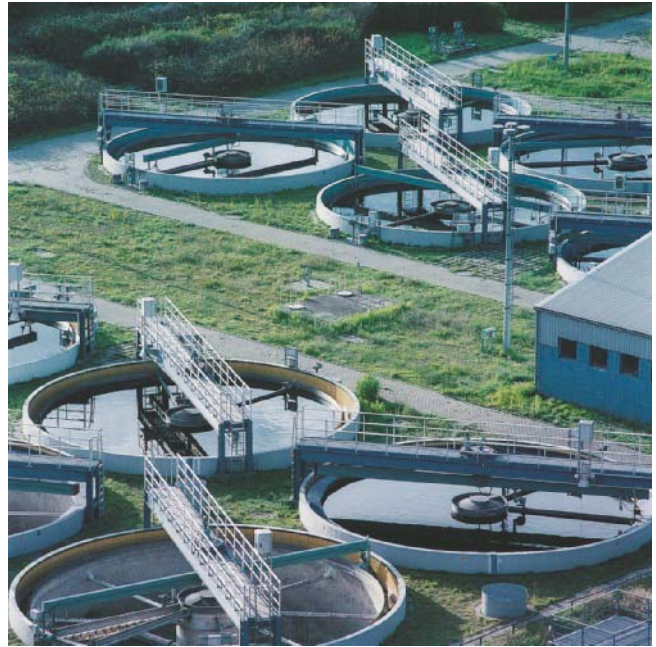
Typical application areas

Remote control and monitoring of distributed stations, as well as data recording and transmission, with the following focal points:

Oil and gas industries

- Compressor, pressure reduction, transfer, block valve, and metering stations in gas networks
- Pumping and block valve stations in oil pipelines
- Automation on the wellhead of gas and oil wells
- Stations for the injection of water or CO_2 in gas or oil fields

Water industry

- Well, pumping and valve stations in water supply networks and irrigation plants
- Stormwater overflow tanks and pumping equipment in wastewater networks
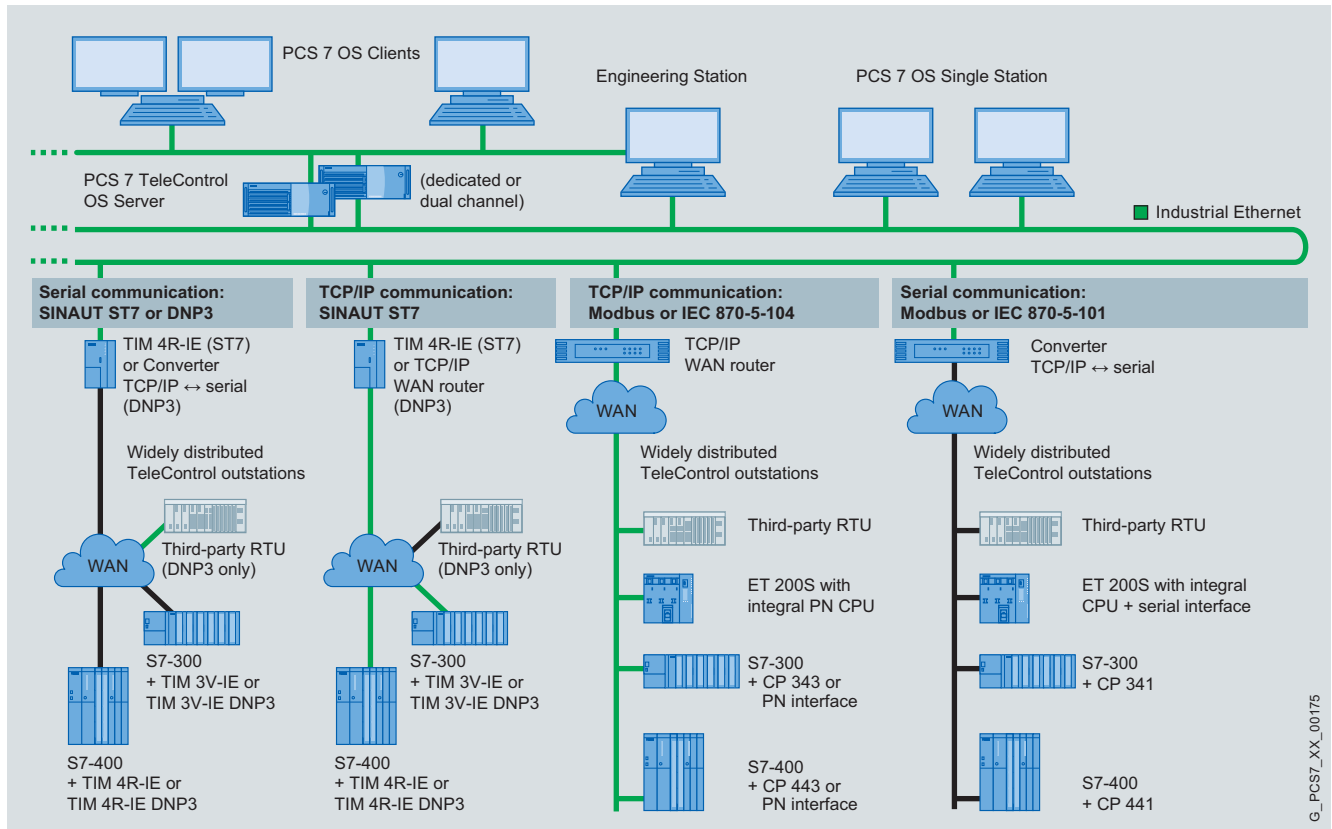- Storage units (elevated tanks)

Energy management, environmental protection, and transportation

- Equipment for power generation and distribution
- District heat supply
- Traffic control systems
- Tunnels
- Railway stations
- Lighthouses
- Environmental monitoring equipment
- Weather stations

SIMATIC PCS 7 TeleControl system architecture

System overview

SIMATIC PCS 7 TeleControl system architecture

Integration in process control

The telecontrol center for the outstations (RTU) is integrated into the process control of the SIMATIC PCS 7 process control system in the form of an operator station in single station or server design (also redundant as option). No additional automation system for conditioning telecontrol-specific data need be planned in the SIMATIC PCS 7 system. With large quantity frameworks, a PCS 7 TeleControl operator station (single station/server) is preferably responsible only for the telecontrol mode (dedicated). With small quantity frameworks, a server or a single station can also control SIMATIC PCS 7 automation systems (AS) in central plant areas in addition to the telecontrol systems (dual-channel mode).

The OS clients of the client/server multi-user system are able to display data from RTUs and SIMATIC PCS 7 AS - which they receive from a server with dual-channel functionality or from two separate servers - together in one process image. Display is primarily on faceplates for process objects such as motors, valves etc., but also by means of trend curves and messages.

Engineering

To enable engineering of the PCS 7 TeleControl operator station (single station/server), the functions of the engineering station of the SIMATIC PCS 7 process control system are expanded by DBA technology (Data Base Automation) and the SIMATIC PCS 7 TeleControl block library.

Communication with the outstations (remote terminal units)

For communication with the outstations, SIMATIC PCS 7 TeleControl uses the SINAUT ST7, DNP3 and Modbus protocols (both via serial and TCP/IP communication connections) as well as IEC 870-5-101 (serial) and IEC 870-5-104 (Ethernet TCP/IP).

The serial RTU link is possible at low cost via the following components which can be connected directly to the PCS 7 TeleControl OS (single station or server):

- **SINAUT TIM communication modules**
  (SINAUT ST7 telecontrol protocol)
- **TCP/IP converters – serial**
  (DNP3, Modbus, IEC 870-5-101 telecontrol protocols)
  Devices from MOXA or Lantronix can be used as serial TCP/IP converters.

By means of Ethernet TCP/IP, the RTUs can be connected directly or via TCP/IP WAN routers to the SIMATIC PCS 7 system bus (SINAUT ST7, DNP3, Modbus, IEC 870-5-104 telecontrol protocols). When using the SINAUT ST7 telecontrol protocol, the SINAUT TIM communication module can be used in addition to the TCP/IP WAN router or as an alternative.

Telecontrol communication over the wide area network is largely determined by the communication infrastructure which already exists. Various transmission media such as dedicated line, analog or digital telephone networks, wireless networks (GSM or private), DSL or GPRS can also be combined with each other.

Outstations (remote terminal units)

Since the requirements of the widely distributed units with regard to scope and performance of the automation functions are usually in the low to mid range, controllers with minimum dimensioning are normally used as RTUs.

SIMATIC PCS 7 TeleControl particularly supports the following types of RTU for distributed automation on site:

- **Controllers integrated in SIMATIC ET 200S**
  (Modbus, IEC 870-5-101/104 telecontrol protocols)
- **SIMATIC S7-300/S7-300F controllers**
  (SINAUT ST7, DNP3, Modbus, IEC 870-5-101/104 telecontrol protocols)
- **SIMATIC S7-400/S7-400F controllers**
  (SINAUT ST7, DNP3, Modbus, IEC 870-5-101/104 telecontrol protocols)
- **SIMATIC S7-400H/S7-400FH redundant controllers**
  (IEC 870-5-101/104 and DNP3 telecontrol protocols)

In addition to these, appropriate third-party RTUs can also be connected to the telecontrol center in SIMATIC PCS 7 by means of the DNP3, Modbus, IEC 870-5-101/104 telecontrol protocols.

SIMATIC PCS 7 TeleControl cannot only integrate newly configured RTUs into SIMATIC PCS 7, it can also migrate units which already exist outdoors by means of DNP3, IEC 870-5-101/104, Modbus or EDC drivers. The Data Base Automation (DBA) software substantially facilitates project-specific adaptation of the system and importing of existing configurations during migration. Extensions can be added during plant operation if necessary.

Spectrum of outstations and integration versions

| Telecontrol protocol	SINAUT ST 7		Modbus		DNP3		IEC 870-5-101	IEC 870-5-104
Type of communication	Serial	Ethernet TCP/IP	Serial	Ethernet TCP/IP	Serial	Ethernet TCP/IP	Serial	Ethernet TCP/IP
Interface on the PCS 7 TeleControl OS	TIM 4R-IE	TCP/IP WAN router or/and TIM 4R-IE	TCP/IP converter — serial	TCP/IP WAN router	TCP/IP converter — serial	TCP/IP WAN router	TCP/IP converter — serial	TCP/IP WAN router
RTU/interface — ET 200S with integral CPU (corresponds to S7-314)	–	–	IM 151-7 CPU or IM 151-8 PN/DP CPU as well as 1 SI module Modbus	IM 151-8 PN/DP CPU + S7-OpenModbus software / TCP PN-CPU	–	–	IM 151-7 CPU or IM 151-8 PN/DP CPU as well as 1 SI module + SIPLUS RIC library	IM 151-8 PN/DP CPU + SIPLUS RIC library
S7-300/S7-300F	TIM 3V-IE	TIM 3V-IE	CP 341	CP 343 + SW library	TIM 3V-IE DNP3	TIM 3V-IE DNP3	CP 341 + SIPLUS RIC library	CP 343 + IEC on S7 or integral PN interface + SIPLUS RIC library
S7-400/S7-400F	TIM 4R-IE	TIM 4R-IE	CP 441	CP 443 + SW library	TIM 4R-IE DNP3	TIM 4R-IE DNP3	CP 441 + SIPLUS RIC library	CP 443 + SIPLUS RIC library or integral PN interface + SIPLUS RIC library
S7-400H/S7-400FH	–	–	–	–	TIM 4R-IE DNP3	TIM 4R-IE DNP3	ET 200M + 2 x CP 341 + SIPLUS RIC library	CP 443 + SIPLUS RIC library
Third-party station	–	–	Depends on type of station		Depends on type of station		Depends on type of station	
Dialup lines	●	–	–	–	●	–	–	–
Dedicated line and radio networks	●	●	●	●	●	●	●	●
Master-slave	●	●	●	●	●	●	●	●
Peer-to-peer	●	●	–	–	–	–	●	●
Mesh networks	●	●	–	–	●	●	●	●
Time tagging in RTU	●	●	–	–	●	●	●	●
RTU time synchronization	●	●	–	–	●	●	●	●
Data buffering in RTU	●	●	–	–	●	●	● 1)	● 1)
Routing with SIMATIC PDM	●	●	–	–	–	–	–	●
International standard	–	–	● (many versions)	● (many versions)	●	●	●	●

1) Data buffering is limited to two SIMATIC S7 data blocks. Depending on the SIMATIC CPU, this corresponds to approx. 800 to 3 200 buffered frames.
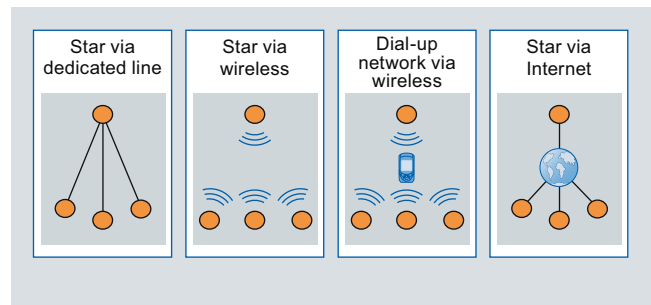
Topologies

Basic topologies

Differently structured telecontrol networks can be implemented in the wide area network (WAN) based on the following four basic topologies.

Point-to-point	Multi-point	Star	Ring
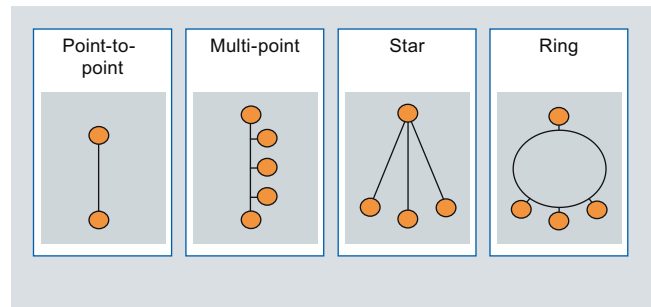
Media versions

Depending on the support provided by the selected telecontrol protocol, various transmission media are available for these basic topologies, e.g. dedicated line, private wireless networks, mobile radio networks, dial-up networks (wireless/landline), DSL over Internet.
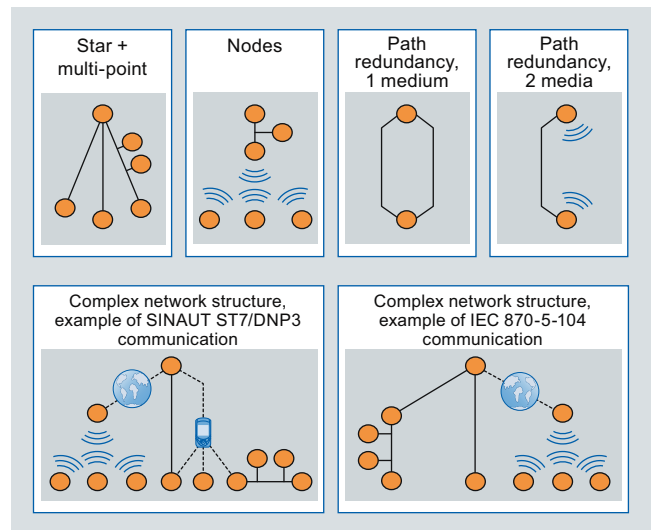
Some of these media versions are shown in the example of the star topology.

Star via dedicated line	Star via wireless	Dial-up network via wireless	Star via Internet

Combinations of basic topologies and media versions

Through a combination of several basic topologies of the same or different media versions, it is additionally possible to design more complex network topologies, even with redundant communication paths.

This allows adaptation to the respective local conditions and to the existing infrastructure.

Star + multi-point	Nodes	Path redundancy, 1 medium	Path redundancy, 2 media

Complex network structure, example of SINAUT ST7/DNP3 communication

Complex network structure, example of IEC 870-5-104 communication

SIMATIC PCS 7 TeleControl system components

PCS 7 TeleControl Operator System

Single-user and multi-user systems

Depending on the magnitude of the automation project and the required number of operator stations, the SIMATIC PCS 7 TeleControl Operator System can be configured either as a single-user system (PCS 7 TeleControl OS single station) or as a multi-user system with client/server architecture:

- Single-user system
  - Up to 5 000 process objects
  - Up to approx. 3 000 measuring points
  - Low number of operator stations

- Multi-user system (client/server)
  - Up to 8 500 process objects per OS server
  - Up to approx. 5 000 measuring points per OS server
 - Up to 32 operator stations (OS clients)

In a single-user system architecture, all operation and monitoring functions for a complete project (plant/unit) are concentrated in one station.

A multi-user system has up to 32 operator stations (OS clients) which are supplied with data from one or more servers (OS server or PCS 7 TeleControl OS server) via the terminal bus.

The multi-client architecture of the multi-user system allows an OS client to call data from various servers, e.g. from two separate servers for local units and for units connected by means of PCS 7 TeleControl.
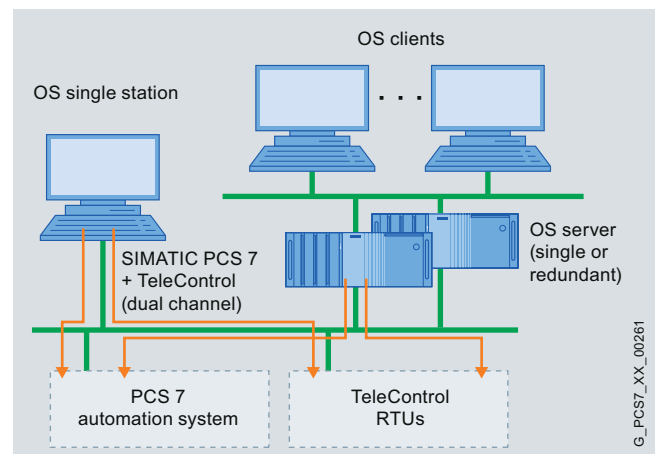
The PCS 7 TeleControl OS server of the multi-user system can also have a redundant design. All internally generated information (e.g. alarm states or results of calculations) is matched in the redundant pair of PCS 7 TeleControl OS servers.

The graduated scalability of the process objects of PCS 7 TeleControl OS single station and PCS 7 TeleControl OS server permits fine and flexible matching of the SIMATIC PCS 7 TeleControl Operator System to the size of the respective automation project.
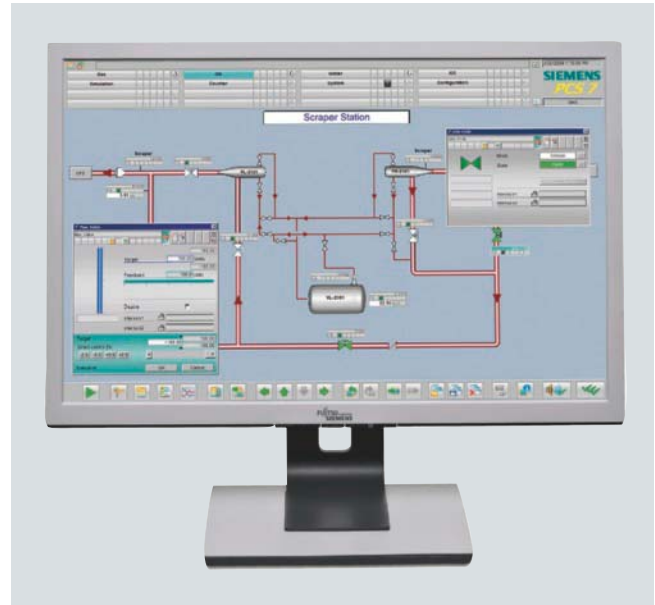
Uniform process control for central and remote units

Dual-channel operation

Dual-channel operation with single-user and multi-user systems

PCS 7 TeleControl OS single station and PCS 7 TeleControl OS server are preferably used just for telecontrol functions (dedicated), but can also access central SIMATIC PCS 7 plant areas via an additional second channel in the case of small quantity frameworks (double-channel operation). In this way, data from the RTUs of the telecontrol system can be displayed in one process image together with data from SIMATIC PCS 7 AS.

PCS 7 TeleControl blocks for system-conformant operator control and monitoring

The RTUs are integrated into the PCS 7 TeleControl Operator System by means of the PCS 7 TeleControl blocks such that there is no difference for the operator with regard to operating philosophy and alarm behavior for the central or remote automation functions.

The blocks required for data conditioning and display are saved in a library. These blocks support SIMATIC PCS 7 compliant operator control by means of symbols and faceplates, as well as the hierarchy of SIMATIC PCS 7 fault messages.

In addition to blocks for processing of process data, the library also contains blocks for diagnostics and for control of communication. If necessary, the supplied basic library can be extended by new script-based block types specific to the project by using the DBA Type Editor.

Long-term archiving and logging

The PCS 7 TeleControl Operator System includes a high-performance cyclic archive based on Microsoft SQL Server for time-limited saving of process values and messages/events. Data from this cyclic archive can be exported time-controlled or event-controlled to a long-term archive (StoragePlus/central archive server).
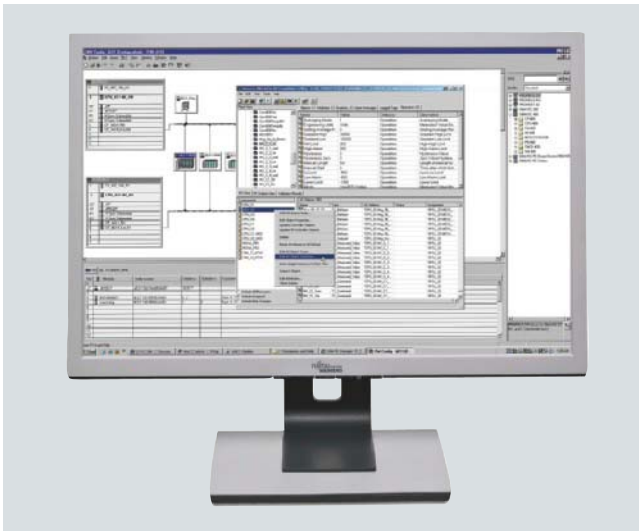
The logging system of the PCS 7 TeleControl Operator System supports the display and evaluation of data recorded during operation by means of various predefined types of protocol which can also be matched individually:

• Message sequence report
• Message and archive log
• Measured value log
• Operator input log
• System message log
• User log

The logs saved in EMF format can be previewed on the screen, and can be printed manually or time- or event-controlled.

In order to comply with statutory directives and standards it may be necessary to provide special proof, e.g. proof of conformity with the ATV M260 standard for sewage treatment plants. The SIMATIC PCS 7 add-on product ACRON equipped with additional functionalities for long-term archiving and logging provides excellent support for this purpose.

PCS 7 TeleControl engineering station

Engineering station of the SIMATIC PCS 7 process control system

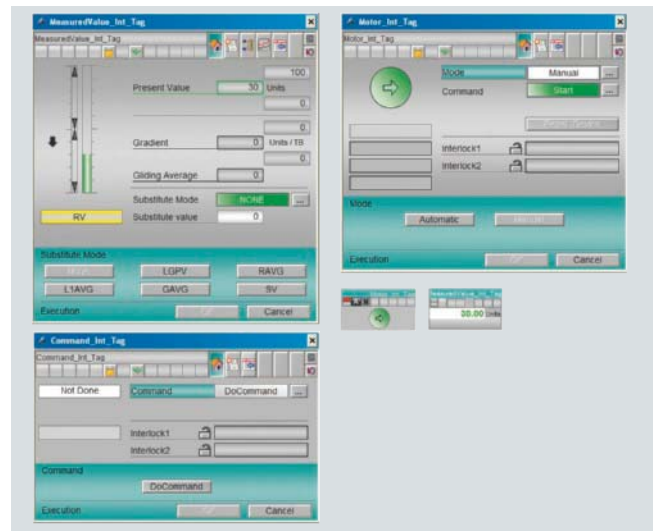SIMATIC PCS 7 TeleControl block library

To enable engineering of the PCS 7 TeleControl operator station (single station/server), the functions of the engineering station of the SIMATIC PCS 7 process control system are expanded by DBA technology (Data Base Automation) and the SIMATIC PCS 7 TeleControl block library.

Data Base Automation (DBA)

Engineering can be automated efficiently and in conformance with SIMATIC PCS 7 using the DBA technology. DBA supports plant expansion during ongoing operation, and facilitates project-specific adaptation of the system as well as importing of existing configurations in the course of migration.

The DBA executed in the engineering station automatically generates the OS runtime database with the display hierarchy, required variables, alarms, alarm messages and alarm priorities, as well as the specific faceplates and block symbols.

The display hierarchy is the basis for navigation between the process displays, for alarm management, and for implementation of safety measures. DBA positions the type-specific block symbols, e.g. measured value, counter value, motor or gate valve, in the process images. These symbols are linked to the corresponding function blocks and faceplates through the database. Manual configuration is mainly limited to the design and positioning of the static graphic elements, e.g. pipes or tanks.

In addition to the SIMATIC PCS 7 TeleControl basic library, new user blocks can also be defined using the DBA type editor. During database generation, the user blocks are treated like the blocks from the basic library.

Using the DBA type editor it is possible to assign the frequently unstructured variables of an RTU once to a block type and to display the variable structured on the operator station via the block's faceplate.

SIMATIC PCS 7 TeleControl blocks

The PCS 7 TeleControl OS symbols, faceplates and diagnostics displays created in conformance with SIMATIC PCS 7 take into account the specific features of telecontrol applications. This is demonstrated, for example, by the example of the counter block which offers versatile conditioning options for information on transported or processed quantities. At least one OS faceplate and one OS symbol are available for each type of block.

In addition to arrangement of information in a variable structure, the user blocks generated with the DBA type editor can also calculate derived values using Visual Basic scripts in the server. This results in numerous possibilities for extending the functionality and for adapting the system to individual customer requirements.

Type-specific OS faceplates and OS symbols for the user blocks can be created using the standard tools for SIMATIC PCS 7 OS engineering (Graphics Designer and Faceplate Designer).

Remote terminal units

Classification of the remote terminal units			
RTU	**Applications**	**Possible tele-control protocols**	**Information points/ buffer size**
RTU Small: controller integrated in SIMATIC ET 200S			
	RTU with up to approx. **30 I/Os** For small, cost-sensitive applications	• Modbus	No buffering
		• IEC 870-5-101 • IEC 870-5-104	Up to approx. 200 information points Buffer size: 800 information points
RTU Medium: SIMATIC S7-300/S7-300F controller			
	RTU with up to approx. **100 I/Os** For medium-sized applications; extremely flexible configuration S7-300F for safety-related applications	• SINAUT ST7 • DNP3	TIM buffering (up to 16 000 frames or up to 32 000 frames with TIM 3V-IE Advanced)
		• Modbus	No buffering
		• IEC 870-5-101 • IEC 870-5-104	Up to approx. 2 000 information points Buffer size: 800 to 3 200 information points
RTU Large: SIMATIC S7-400/S7-400F controller			
	RTU with up to approx. **500 I/Os** For larger applications requiring increased performance S7-400F for safety-related applications	• SINAUT ST7 • DNP3	TIM buffering (up to 56 000 frames)
		• Modbus	No buffering
		• IEC 870-5-101 • IEC 870-5-104	Up to approx. 5 000 information points Buffer size: 3 200 information points
RTU Large: SIMATIC S7-400H/S7-400FH controller			
	Like S7-400/S7-400F	• DNP3	TIM buffering (up to 56 000 frames)
		• IEC 870-5-101 • IEC 870-5-104	Up to approx. 5 000 information points Buffer size: 3 200 information points

The remote control units supported by SIMATIC PCS 7 TeleControl have a performance classified as Small, Medium or Large.

Controllers of SIPLUS extreme design are also available in all performance classes, and can be operated under extreme conditions, e.g. ambient temperatures from -25 °C to +70 °C, condensation or exposure to media.

In addition, the SIMATIC S7-300F and S7-400F controllers can be used to implement safety-related applications on site and automatically set the plant to a safe status in the event of a dangerous fault.

Telecontrol protocols

General/elementary telecontrol functions

Telecontrol systems use special protocols to implement data transmission between the control center and the outstations (RTUs) at the process level for the automation functions on site. These telecontrol protocols manage the secure and error-free data transmission over the WAN even with a low bandwidth and poor transmission quality.

In addition to short transmission times for the information, this task requires effective protection of the frames against:

- Undetected bit errors
- Undetected frame errors resulting from synchronization errors
- Undetected loss of information
- Frame falsification
- Segregation or fault in related information

This particularly applies to event-controlled frames over transmission channels with a limited bandwidth and uncertain noise response.

Since irregular bit sequences are compiled for data transmission, no limitation in codes must exist.

Time tagging

When linking RTUs by means of SINAUT ST7, DNP3, IEC 870-5-101 or IEC 870-5-104 telecontrol protocol, the raw data in the outstations is provided with a time tag and transmitted to the PCS 7 TeleControl OS (server/single station) acting as control center. Adaptation, further processing, and archiving are carried out here. This procedure is appropriate for the event-based principle of operation of the telecontrol protocol as well as the subsequent chronological processing of data previously buffered in the outstation.
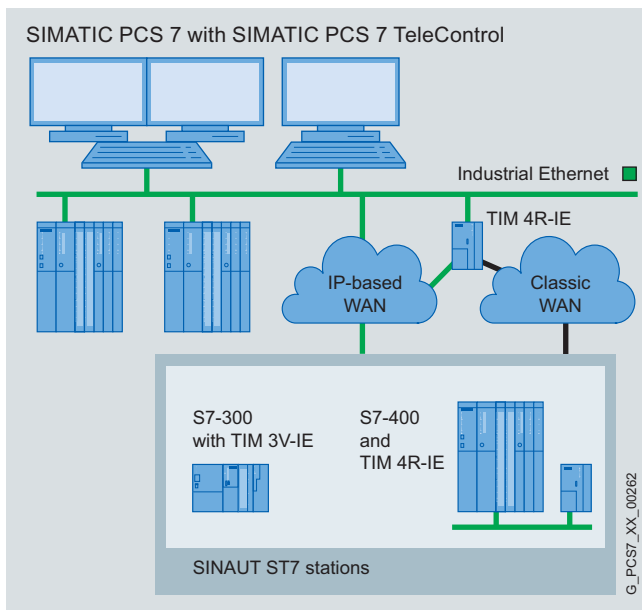
Clock synchronization

The PCS 7 TeleControl OS is the clock master for the RTUs connected by means of SINAUT ST7, DNP3, IEC 870-5-101 or IEC 870-5-104, and regularly synchronizes their date and time via the telecontrol connection. Switching over between summertime and wintertime is also considered during the synchronization.

Data buffering

The SINAUT ST7, DNP3, IEC 870-5-101 and IEC 870-5-104 telecontrol protocols support reliable on-site intermediate buffering of the data including time tag, e.g. if a communication path is faulty or a station has failed. In addition, intermediate buffering of data can also be an effective means for reducing connection costs in the dial-up network.

A data update for all participating communication partners is performed automatically following debugging or restarting of the failed station. Important events are not lost, and the integrity of the control center archive is assured.

SINAUT ST7 telecontrol protocol

SIMATIC PCS 7 with SIMATIC PCS 7 TeleControl

Industrial Ethernet

TIM 4R-IE

IP-based WAN

Classic WAN

S7-300 with TIM 3V-IE

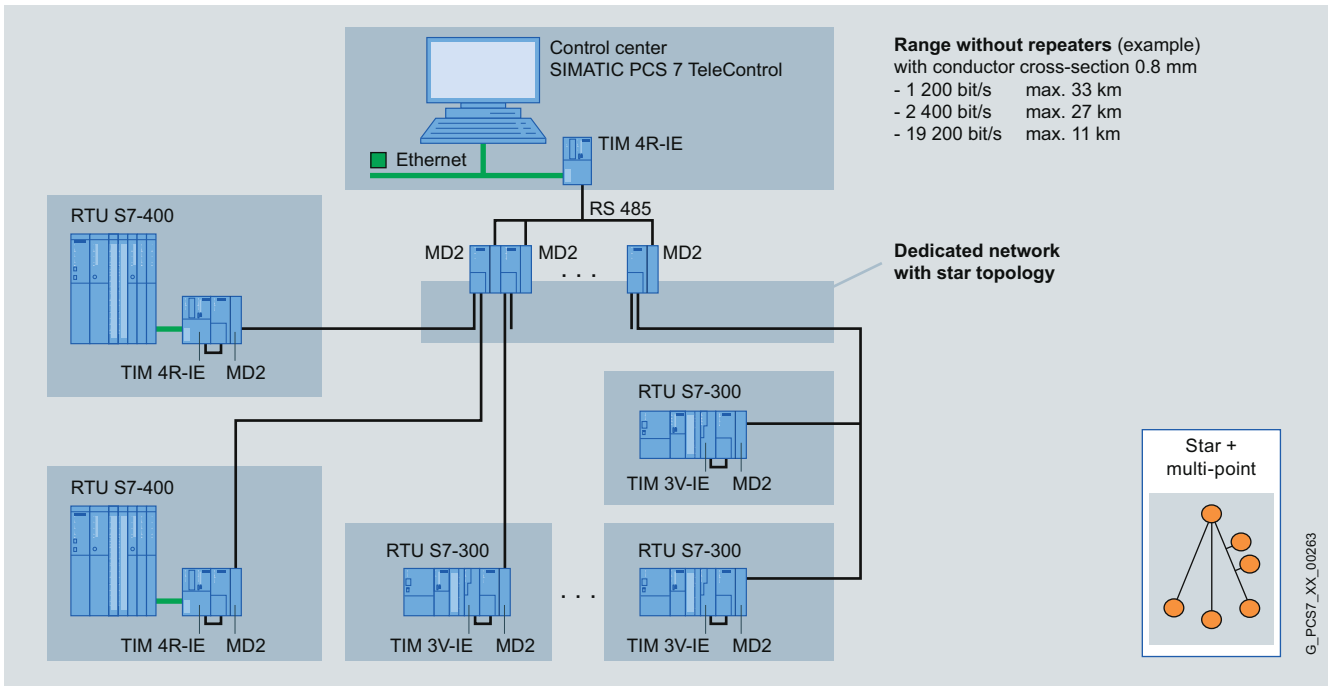S7-400 and TIM 4R-IE

SINAUT ST7 stations

G_PCS7_XX_00262

Overview of SIMATIC PCS 7 TeleControl with SINAUT ST 7 telecontrol protocol

The telecontrol system based on the SINAUT ST7 telecontrol protocol is used for fully-automatic monitoring and control of widely distributed outstations (RTUs) which exchange data with each other and with one or more control centers over a wide variety of WAN (Wide Area Network) media.
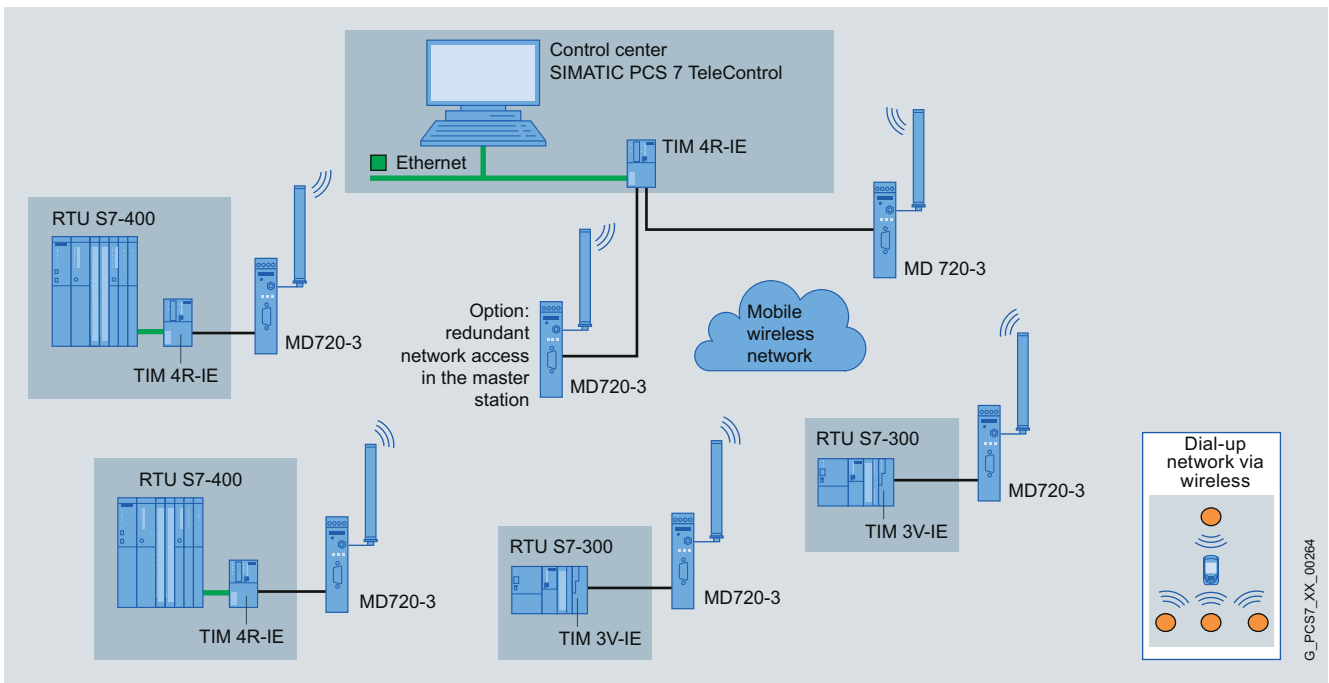
SIMATIC S7-300/S7-300F and SIMATIC S7-400/S7-400F controllers are used for the outstations and node stations, and SIMATIC PCS 7 with SIMATIC PCS 7 TeleControl for the control center. Further hardware and software components round off the range of products:

• TIM communication modules
• MD modem modules
• GSM/GPRS components
• TCP/IP routers and switches
• SCALANCE S612 and S613 security modules
• Dedicated-line accessories
• Cables
• SINAUT ST7 engineering software, comprising:
  - SINAUT TD7 library with blocks for the data point objects of the SIMATIC S7 CPU or the TIM module
  - SINAUT ST7 engineering package for configuration of stations, networks and connections as well as for diagnostics

In order to implement complete hierarchical telecontrol networks, the basic topologies of point-to-point, multi-point, star and ring can be configured using classic or also TCP/IP-based media, and combined flexibly independent of the infrastructural conditions. SINAUT ST7 is thus distinguished by a wide range of possible selections and combinations.

Range without repeaters (example)
with conductor cross-section 0.8 mm
- 1 200 bit/s   max. 33 km
- 2 400 bit/s   max. 27 km
- 19 200 bit/s   max. 11 km

SINAUT ST7 - example of classic dedicated network (star + multi-point topologies)

SINAUT ST7 - example of classic mobile radio network (GSM) with CSD data service (star topology)

Classic WAN media

- Dedicated copper line, private or rented
- Private radio network (optionally with time slot procedure)
- Analog telephone network
- Digital ISDN network
- Mobile radio network GSM
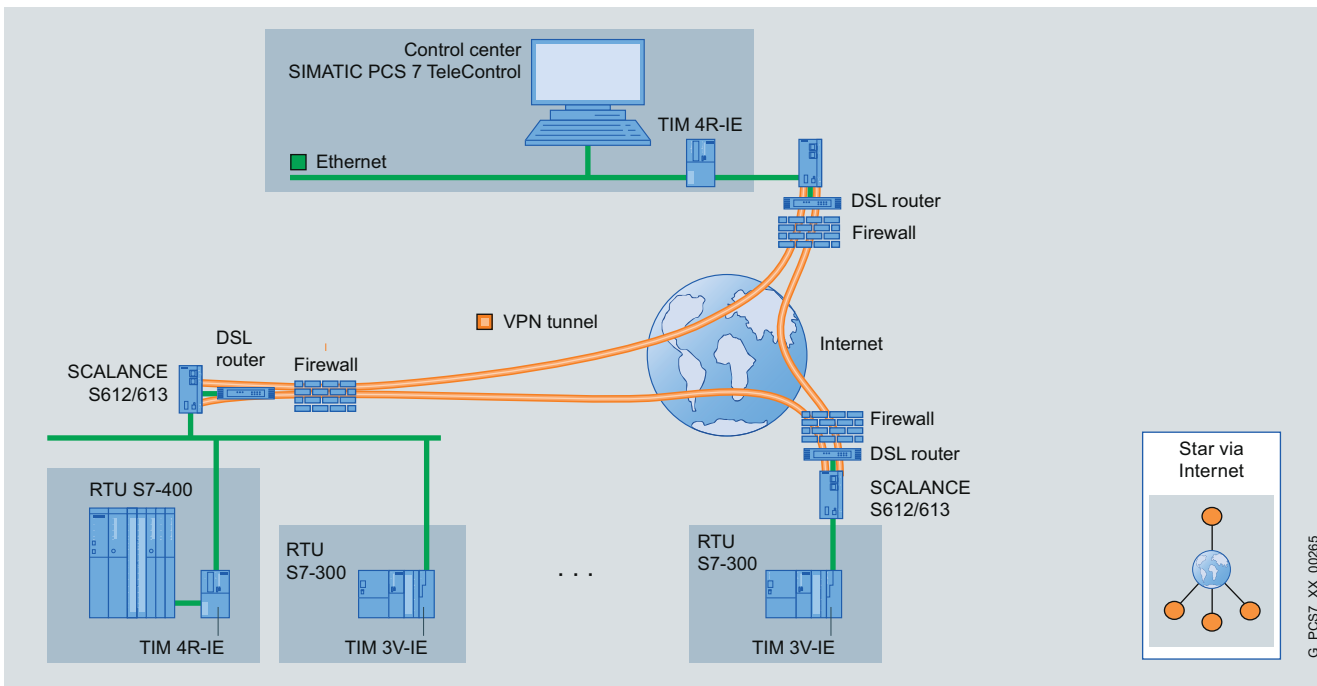
SINAUT ST7 - example of secure TCP/IP-based connection over Internet via DSL (star topology)
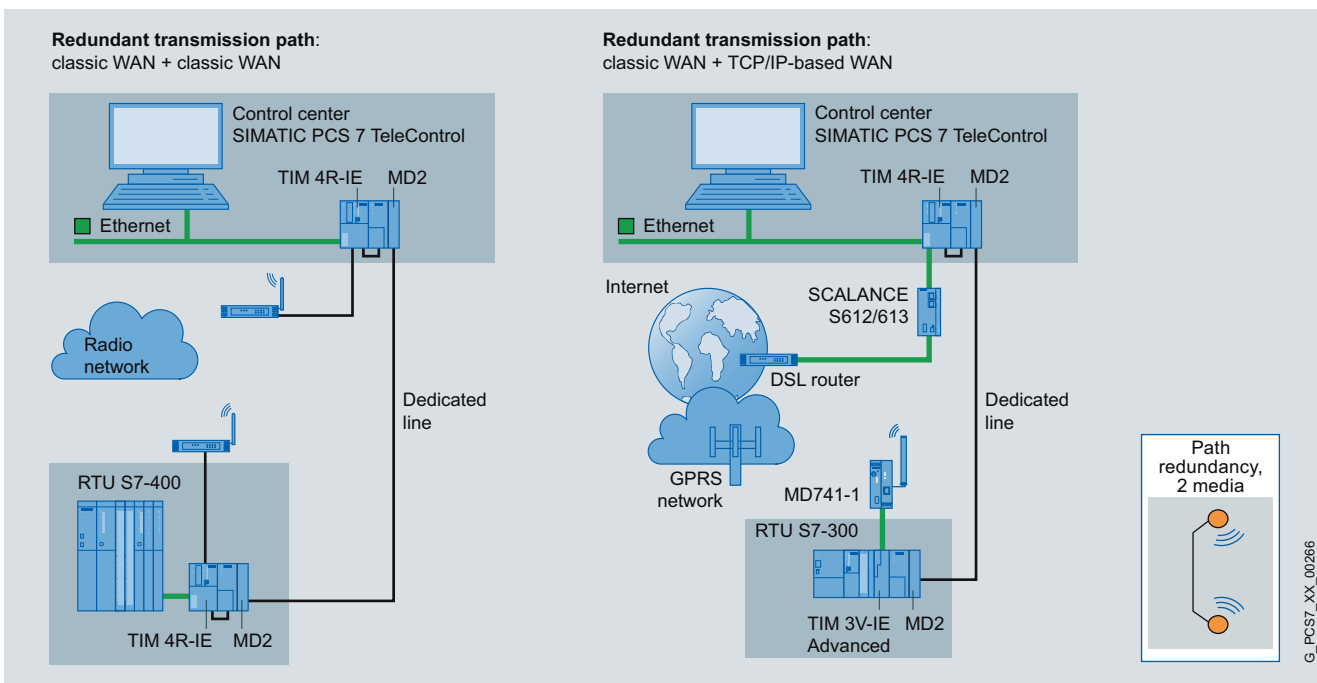
SINAUT ST7 - example of redundant telecontrol connections (point-to-point topology)

TCP/IP-based WAN media

- Special radio network optimized for Ethernet, e.g. with SCALANCE W industrial wireless LAN components
- SCALANCE X switches with optical ports and fiber-optic cables for distances up to 120 km
- Public network and Internet via DSL or GPRS
- Broadband system such as OTN, PCM30, etc.

To achieve redundant data transmission, it is also possible to connect an outstation via two transmission paths to the control center in the SIMATIC PCS7 process control system or to a node station. It is irrelevant whether the two paths are of the same type or different, e.g. dedicated line with telephone network/ISDN and GPRS.

**Special characteristics
of SINAUT ST7 communication**

Up to 10 000 stations can be addressed with SINAUT ST7. Information on the source and target addresses is included in the message frames. The functionality of SINAUT ST7 communication is particularly characterized by the following features:

Change-driven data transmission
- Change-driven transmission of process data between RTUs as well as between an RTU and the control center
- Signaling of failures in connections, RTUs or the control center
- Automatic data updating for all communication partners involved following troubleshooting and following the startup of an RTU or control center

Chronological processing of process data
- Time tagging of all data frames at the place of origin allows process data to be archived by the process control system in the correct chronological order
- The time of the SINAUT ST7 stations in the WAN can be synchronized via SIMATIC PCS 7 (including summertime/wintertime switchover)

Local data storage
- Depending on the version, the TIM communication module can temporarily store (for several hours or even days) up to 56 000 message frames should the connection or the communication partner fail
- Intermediate storage of message frames of lower priority in the case of priority-controlled data transmission (with dial-up networks or quantity-dependent data transmission costs)

Remote programming and remote diagnostics
- Remote diagnostics and remote programming over the WAN using the "PG routing" function
- PG routing shares the available bandwidth with the process data transmission, but has a higher priority
- Uploads, downloads, remote diagnostics, firmware upgrades or changes in automation functions on the stations can be carried out online from the control center in SIMATIC PCS 7

Alarm output per text message
- The RTUs can send text messages depending on events in order to alarm personnel on call
- Receipt of messages can be acknowledged from a mobile phone
- Depending on the services offered by the mobile radio provider, the text message can also be output as an e-mail, fax or voice mail
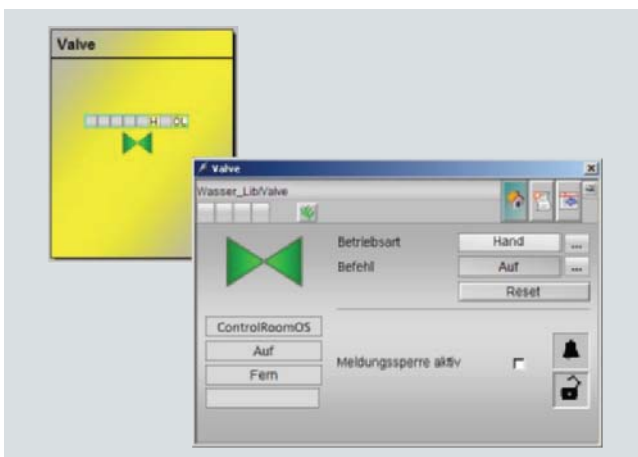
SIMATIC water library: block symbol and faceplate for a valve

**Technological configuration with the
SIMATIC water library**

The SIMATIC water library from Siemens supports effective configuration of the SIMATIC PCS 7 process control system with technological function blocks for implementing applications for water supply and disposal.

These technological function blocks can now also be used on the basis of the SINAUT ST7 telecontrol protocol. The telecontrol functions are integrated using additive blocks in the CFC, i.e. without modifying the existing technological function blocks or the associated block symbols and faceplates. The philosophy of SIMATIC PCS 7 TeleControl with regard to uniform process control of central and remote units using an operator system is thus extended in the direction of uniform engineering. Standardization and reuse of the ready-made functions significantly reduces the requirements for engineering, testing and training, as well as maintenance and updating.

Operating modes

The communication mode between the control center and outstation (RTU) depends on the support provided by the telecontrol protocol, the configuration of the telecontrol communication, and the type of WAN.

The SINAUT ST 7 telecontrol protocol supports the following operating modes:

- Polling
  - Control of data exchange by the TIM module of the control center
  - The TIM of the control center calls the outstations and node stations one after the other
  - Stations with modified data (since the last transmission) send this when called
  - Stations without modified data only acknowledge the call
  - Transmission of control center data for the stations in between the calls
  - Data exchange using internode communication between the stations is possible via the polling TIM of the control center

- Polling with time slot procedure
  - Operating mode for a radio network with division of the radio frequency between several providers
  - Typically 6 s/min (time slot) for each provider for data exchange
  - Data exchange during the time slot is carried out as described under "Polling"
  - Following the data exchange, the frequency swaps to the next provider
  - Data exchange using internode communication between the stations is possible via the polling TIM of the control center
  - Control of the polling TIM by DCF77 or GPS radio-controlled clock for exact observation of the time slot

- Multi-master polling with time slot procedure
  - Operating mode for communication between outstations and more than one control center via dedicated line or radio network
  - Each control center is assigned one or more time slots per minute for polling
  - Separate data buffer for each control center in the stations (including node stations)
  - Data exchange using internode communication between the stations is possible via the polling TIM of the active control center
  - Redundant internode communication is possible; upon failure of the preferred control center, internode communication is carried out via the TIM of the alternative control center
  - Each TIM of the control centers involved must be controlled by means of a DCF77 or GPS radio-controlled clock for exact observation of the time slot

- Spontaneous mode in dial-up networks
  - Data from outstations and node stations can be assigned priorities for transmission in the dial-up network: normal, high, alarm
  - Immediate establishment of a dial-up connection for data with alarm priority or high priority; priority transmission of alarm frames
  - Intermediate storage of data with normal priority; transmission during the next dial-up connection with the partner in the original chronological order (FIFO principle)
  - Transmitted data from the control center always has high priority
  - Data exchange possible between the stations with direct internode communication

- Spontaneous mode in the TCP/IP-based WAN
  - Establishment of a permanent S7 connection between two TIMs or between TIM and control center
  - Exchange of SINAUT ST7-specific data packets via this S7 connection using S7 communication functions with application of the TCP/IP transport protocol
  - If the data transmission costs are related to the data quantity, processing is carried out with priority as with spontaneous mode for dial-up networks: immediate transmission of data with high priority and alarm priority (latter with priority); collection of data with normal priority and transmission in larger blocks
  - If the data quantity is not cost-relevant, all data is transmitted immediately to the respective partner, i.e. without intermediate storage. Message frames with alarm priority then have priority.

DNP3 telecontrol protocol

Widely distributed outstations (RTUs) can be controlled and monitored with the DNP3 telecontrol protocol via serial or Ethernet TCP/IP communication links by means of the tele-control center in SIMATIC PCS 7. The control center integrated with SIMATIC PCS 7 TeleControl into the operator system of the process control system is the master during telecontrol communication.

The slaves are represented by the outstations. SIMATIC S7-300/S7-300F and S7-400/S7-400F/S7-400H/S7-400FH controllers as well as third-party RTUs can be used as out-stations.

Further hardware and software components round off the range of products:

- TIM communication modules
- TCP/IP converters – serial and MD modem modules
- GSM/GPRS components
- TCP/IP routers and switches
- SCALANCE S612 and S613 security modules
- Dedicated-line accessories
- Cables
- Engineering package for configuration of DNP3 data objects, stations, networks and connections as well as for diagnostics

In order to implement the telecontrol networks, the basic topologies of point-to-point, multi-point, star and ring can be configured using classic or also TCP/IP-based media, and com-bined flexibly independent of the infrastructural conditions.
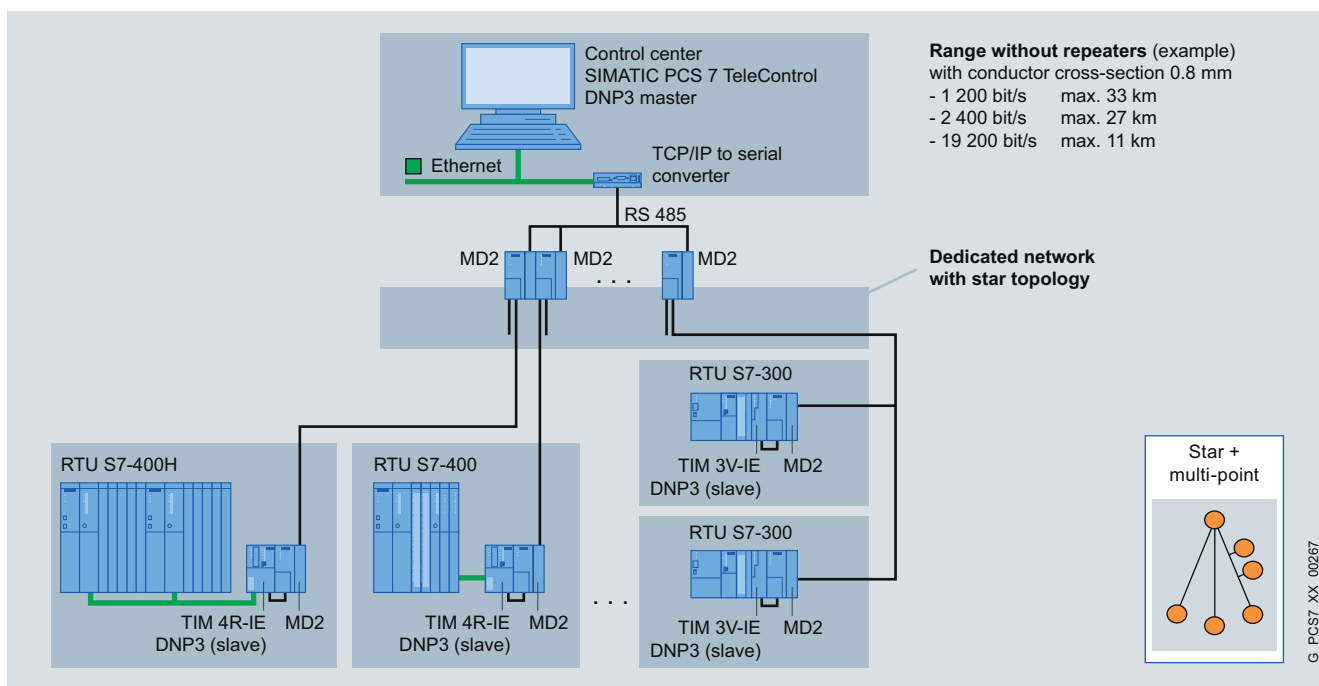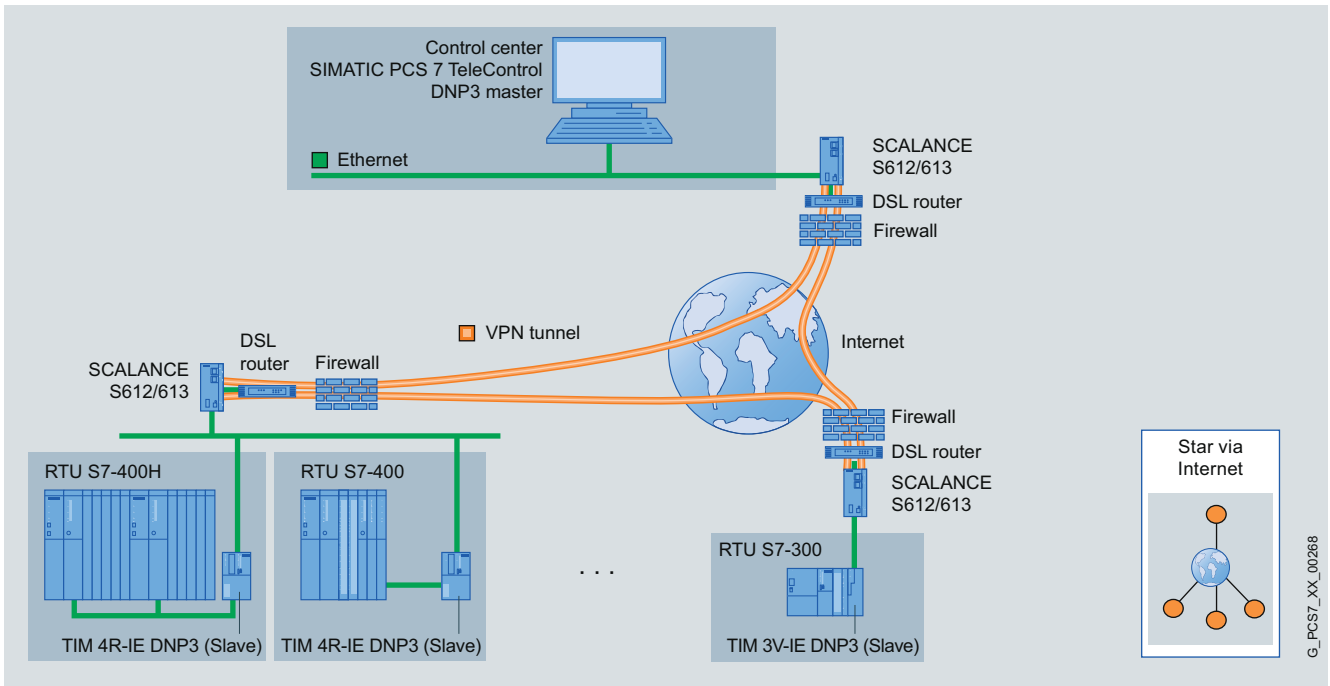

DNP3 - example of classic dedicated network (star + multi-point topologies)
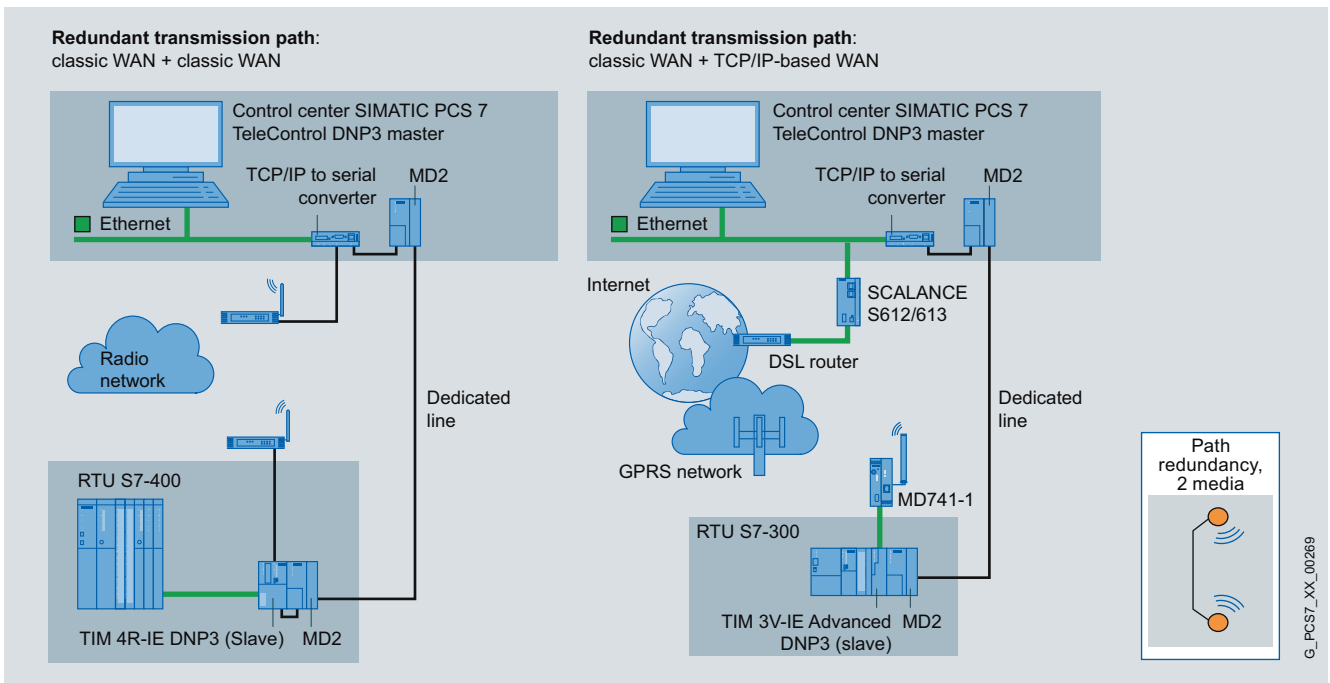
Classic WAN media

- Dedicated line via modem, e.g. SINAUT MD2
- Private wireless networks
- Analog telephone network
- Digital ISDN network
- Mobile radio network GSM

DNP3 - example of secure TCP/IP-based connection over Internet via DSL (star topology)

DNP3 - example of redundant telecontrol connections (point-to-point topology)

TCP/IP-based WAN media

- Ethernet networks, e.g. SCALANCE X with fiber-optic cables
- Industrial Wireless LAN with SCALANCE W
- Public networks and the Internet using DSL and/or GPRS

To permit redundant data transmission, outstations can be connected to the SIMATIC PCS 7 TeleControl center over two paths.

**Special characteristics
of DNP3 communication**

Change-driven data transmission
- Change-driven transmission of process data between RTU and control center
- Signaling of RTU, control center or connection failure
- Automatic data updating for all communication partners involved following troubleshooting and following the startup of the RTU or control center

Chronological processing of process data
- Time tagging of all data frames at the place of origin allows process data to be archived by the process control system in the correct chronological order
- The time of the DNP3 stations in the WAN can be synchronized via SIMATIC PCS 7 (including summertime/wintertime switchover)

Local data storage
- The TIM communication module can temporarily store (for several hours or even days) message frames should the connection or the communication partner fail
- Intermediate storage of message frames of lower priority in the case of priority-controlled data transmission (with dial-up networks or quantity-dependent data transmission costs)

Operating modes

The DNP3 telecontrol protocol supports the following operating modes (functional principle similar to that described in the section for the SINAUT ST7 telecontrol protocol):

- Polling
- Polling with time slot procedure
- Multi-master polling with time slot procedure
- Spontaneous mode in dial-up networks
- Spontaneous mode in the TCP/IP-based WAN

# IEC 870-5-101/IEC 870-5-104 telecontrol protocol
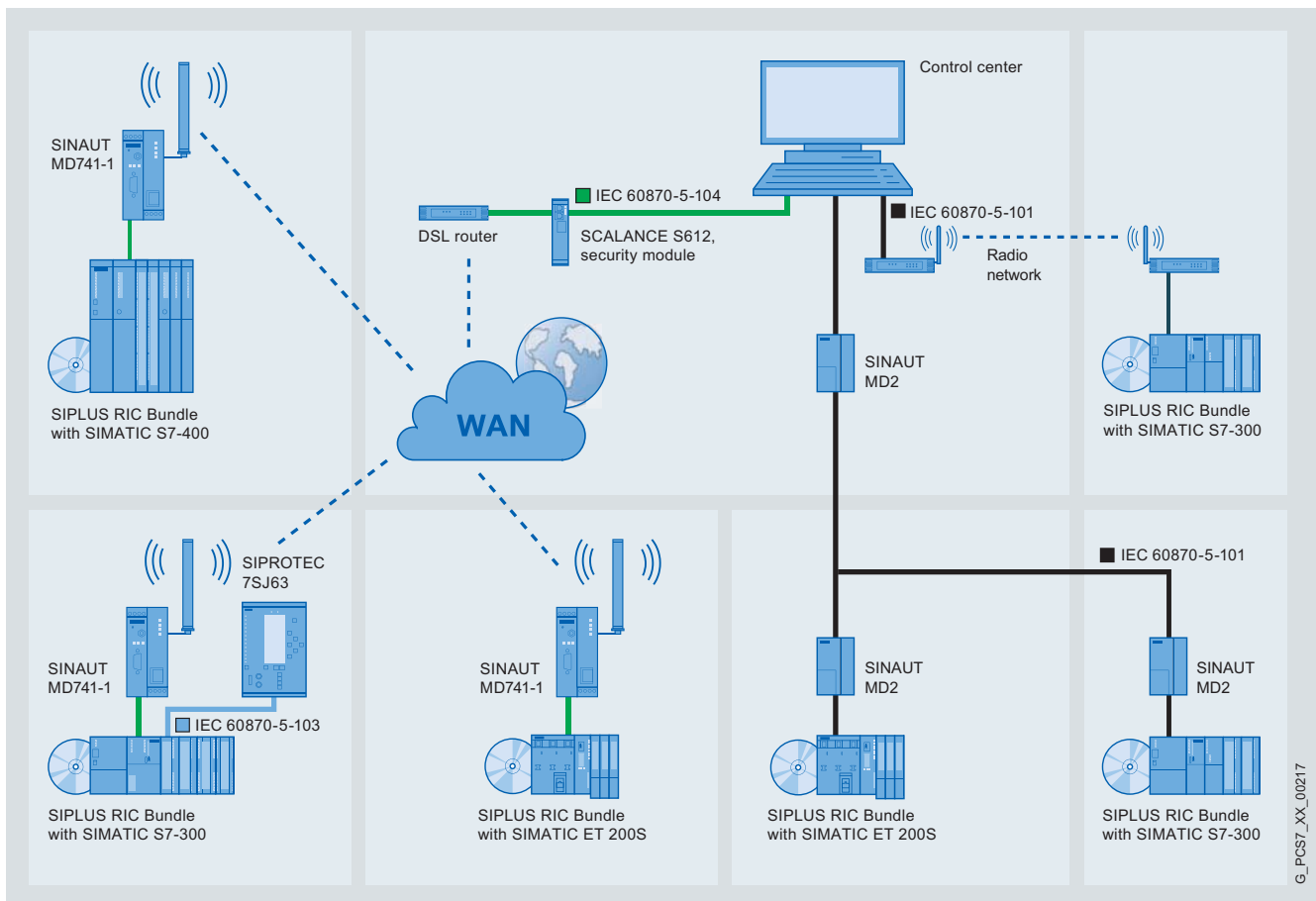
Flexible communication options in the WAN with IEC 870-5-101/IEC 870-5-104 telecommunication protocols

A telecontrol center which is seamlessly integrated into the SIMATIC PCS 7 process control system by means of SIMATIC PCS 7 TeleControl can control and monitor geographically dispersed outstations via serial (IEC 870-5-101 telecontrol protocol) or Ethernet TCP/IP (IEC 870-5-104 telecontrol protocol) communication links.

SIMATIC S7 controllers (SIMATIC ET 200S with integral CPU, SIMATIC S7-300/S7-300F, and SIMATIC S7-400/S7-400F/ S7-400H/S7-400FH) as well as third-party RTUs can be used as outstations in this context. The control center is the master during communication with the outstations.

The IEC 870-5-101 and IEC 870-5-104 telecontrol protocols are anchored in the telecommunication product range SIPLUS RIC. Based on specific libraries for telecontrol protocols, SIPLUS RIC comprises low-cost bundles for outstations which are based on SIMATIC ET 200S with integral CPU, SIMATIC S7-300 or SIMATIC S7-400.

The performance of the telecontrol stations can be scaled with SIPLUS RIC bundles configured as slaves for the telecontrol link as shown below:
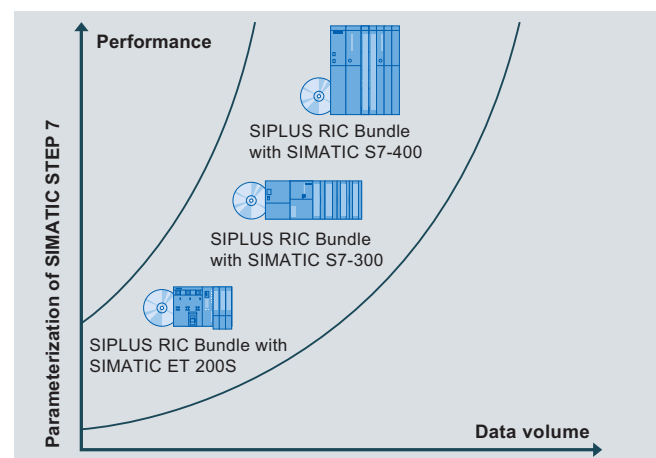
Scalable performance of SIPLUS RIC bundles

The SIPLUS RIC bundles usually comprise:

*   CPU
*   Interface/communication module (if necessary)
*   Memory card
*   CD with library and registration code.

SIPLUS RIC products require additional material to establish telecommunication links, e.g. TCP/IP converters – serial, dedicated line modems, media converters, TCP/IP routers, SCALANCE S612 and S613 security modules, switches, cables etc.

In order to implement telecontrol networks, basic topologies including point-to-point, multi-point, star and ring can be configured using classic or TCP/IP-based media. These can be combined flexibly independent from existing infrastructure.

**Classic WAN media
(IEC 870-5-101 telecontrol protocol)**

*   Dedicated line via modem, e.g. SINAUT MD2
*   Dedicated line over fiber-optic cables
*   Private wireless networks

**TCP/IP-based WAN media
(IEC 870-5-104 telecontrol protocol)**

*   Ethernet networks, e.g. SCALANCE X with fiber-optic cables
*   Industrial Wireless LAN with SCALANCE W
*   Public networks and the Internet using DSL and/or GPRS
*   Satellite communication, e.g. with Inmarsat
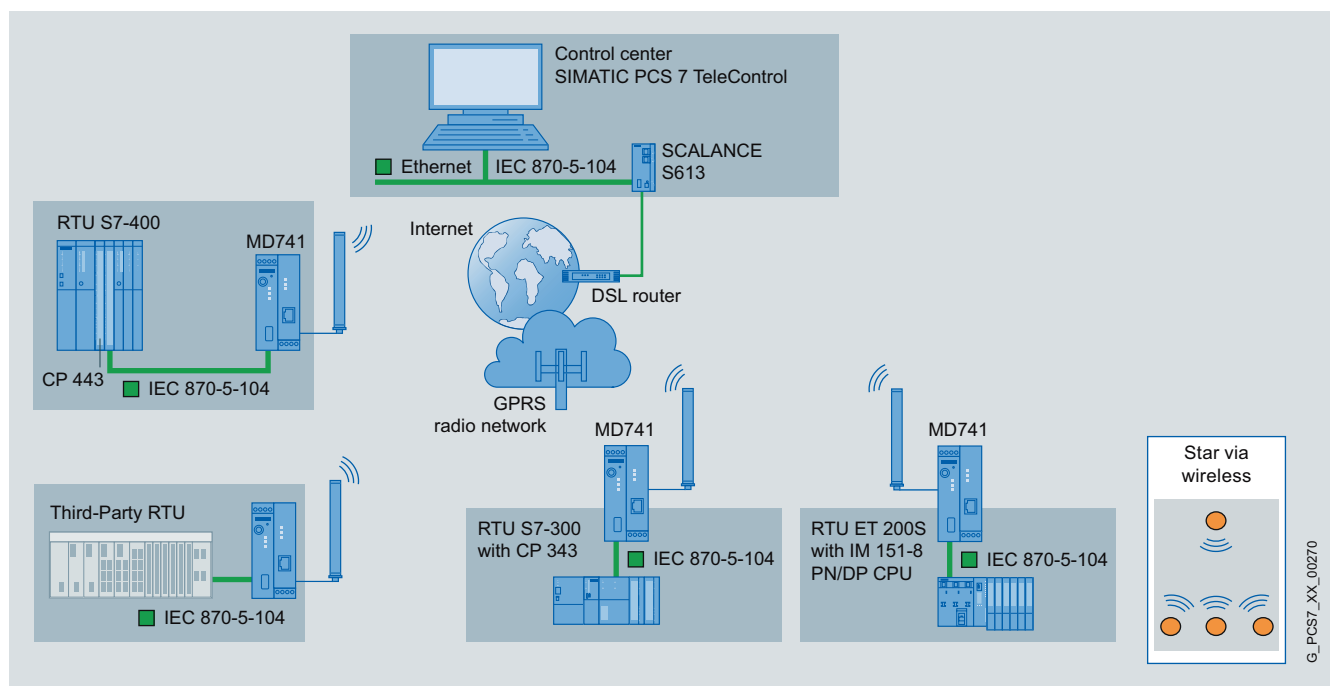
IEC 870-5-104 - example of TCP/IP-based WAN with GPRS radio network (star topology)
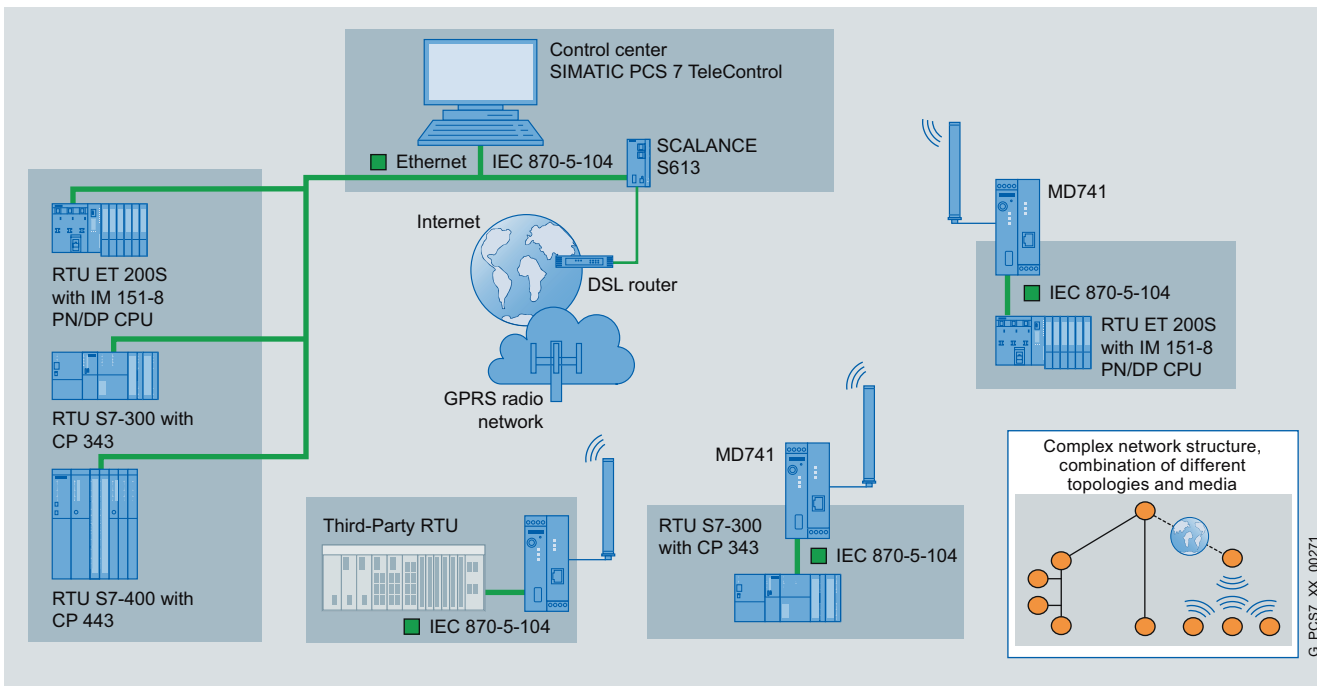
IEC 870-5-104 - example of complex TCP/IP-based WAN with cable and GPRS networks

It is also possible to connect an outstation via two transmission paths to the control center in the SIMATIC PCS7 process control system to achieve redundant data transmission. Redundant transmission paths can be based on the same or different communication protocols.
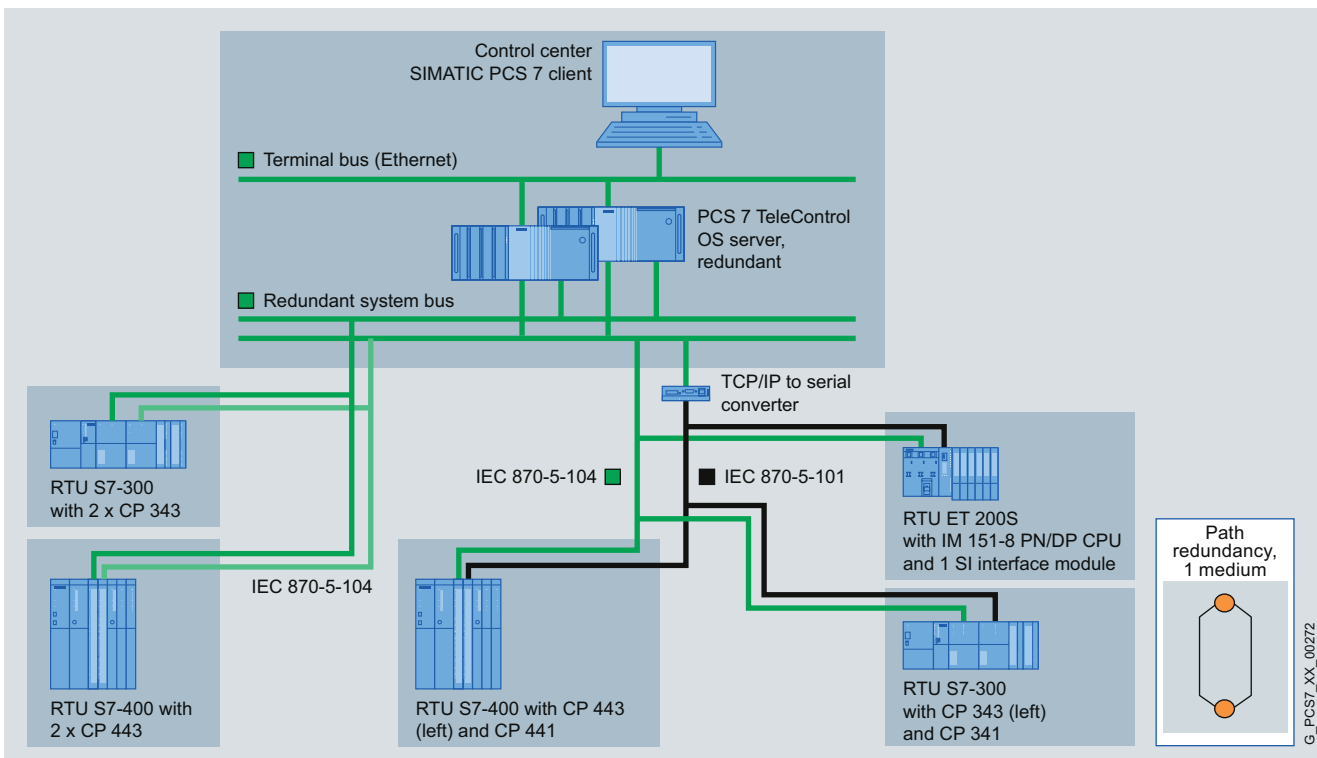
IEC 870-5-101/104 - example of redundant telecommunication links (IEC 870-5-101 representation without modems)

Modbus telecontrol protocol

The Modbus telecommunication protocol is suitable for the integration of existing units with a Modbus infrastructure into the SIMATIC PCS 7 process control system.

Telecontrol communication for control and monitoring of widely distributed outstations (RTUs) from a control center in SIMATIC PCS 7 is possible with this protocol via both serial and TCP/IP communication links.

The control center, represented by the SIMATIC PCS 7 Operator System with SIMATIC PCS 7 TeleControl, is the Modbus master. SIMATIC S7 controllers (SIMATIC ET 200S with integral CPU, SIMATIC S7-300/S7-300F, and SIMATIC S7-400/S7-400F) as well as third-party RTUs with a suitable Modbus interface can be used as outstations (Modbus slaves).

The SIPLUS RIC range includes low-cost bundles for outstations with Modbus telecontrol protocol (serial or TCP/IP), based on SIMATIC ET 200S with integral CPU and SIMATIC S7-300. These usually comprise:

*   CPU
*   Interface/communication module (if necessary)
*   Memory card
*   CD with library and registration code.

In addition, further material is required to establish the telecommunication links, e.g. TCP/IP converters – serial, dedicated line modems, media converters, TCP/IP routers, switches, cables etc.

The Modbus telecontrol protocol can be used to implement telecontrol networks based on point-to-point and multi-point topologies, both serial and TCP/IP. The following media can be used for this:

Classic WAN media

*   Dedicated line via modem, e.g. SINAUT MD2
*   Dedicated line over fiber-optic cables
*   Private wireless networks

TCP/IP-based WAN media

*   Ethernet networks, e.g. SCALANCE X with fiber-optic cables
*   Industrial Wireless LAN with SCALANCE W
*   Public networks and the Internet using DSL and/or GPRS

To permit redundant data transmission, outstations can be connected to the control center in the SIMATIC PCS 7 process control system over two paths. Two operating modes are available:

*   Load sharing: parallel utilization of both paths
*   Master/standby: only one path is active, the other is passive
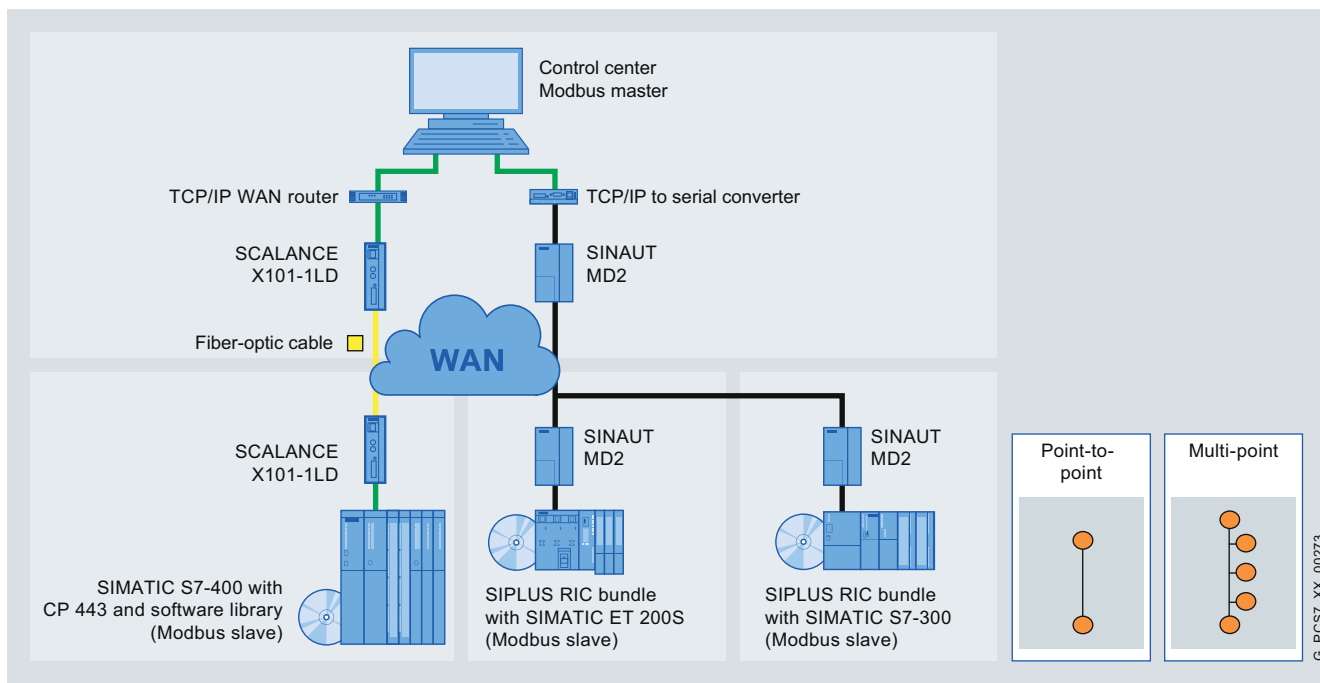
Modbus - example of serial and TCP/IP telecontrol connections (multi-point/point-to-point topologies)
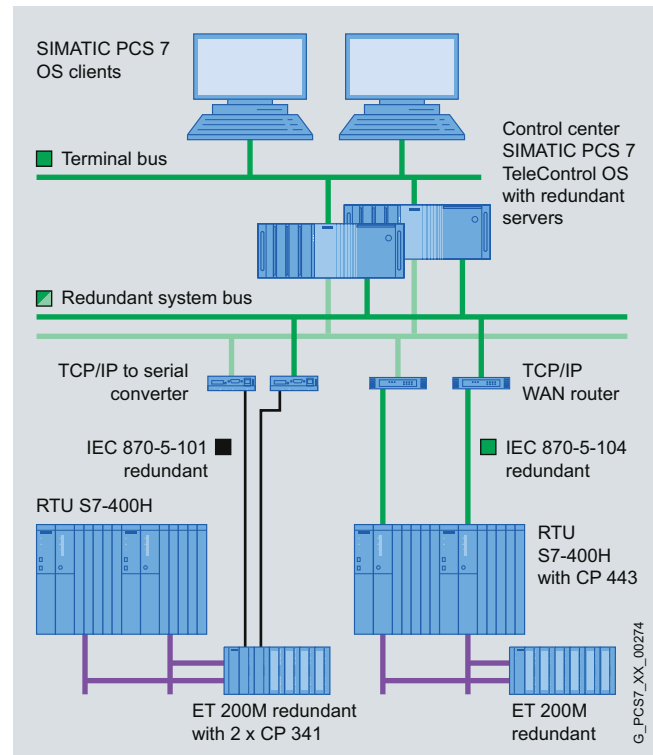
Redundancy

Increasing the plant availability

For the individual telecontrol protocols, reference was already made as to how the availability of telecontrol communication can be increased using redundant transmission paths. However, as a result of seamless integration of the telecontrol technology into the SIMATIC PCS 7 process control system, the redundant design of the telecontrol communication is embedded in the redundancy concept of the complete system and must therefore be considered globally.

The example of a SIMATIC PCS 7 process control system with integral telecontrol linking of RTUs on the basis of the IEC 870-5-101/IEC 870-5-104 protocols demonstrates the various possibilities for increasing plant availability:

- Redundant SIMATIC PCS 7 TeleControl OS servers for process control of central and widely distributed units and for archiving
- Redundant system bus for system communication
- Redundant telecontrol communication between control center and RTUs over two separate transmission paths
- Redundant RTUs on the basis of S7-400H/ S7-400FH controllers for local automation of remote units
- Redundant PROFIBUS for communication between controller and process I/O (I/O modules, process instruments and devices in the field)
- Redundant process I/O

It is also possible to implement safety-related functions in the RTU (up to SIL 3) based on the S7-400FH controller and F modules in the ET 200M remote I/O station.

Redundant telecontrol configuration based on the IEC 870-5-101/IEC 870-5-104 protocols

Migration

Migration of existing telecontrol systems

Units with Modbus communication

The Modbus is widely used in automation plants due to its straightforwardness and openness. The Modbus telecontrol protocol can be used to implement both serial and TCP/IP communication links between a control center in SIMATIC PCS 7 and RTUs with a corresponding Modbus interface.

In this manner, existing units with a Modbus infrastructure can be integrated at low cost into the SIMATIC PCS 7 process control system. The RTUs of these units can be SIMATIC S7 controllers (SIMATIC ET 200S with integral CPU, SIMATIC S7-300/S7-300F and SIMATIC S7-400/S7-400F) as well as third-party RTUs. Whereas RTUs with Modbus TCP/IP interface can be integrated directly, serial third-party RTUs require specific interface converters for telecontrol communication.
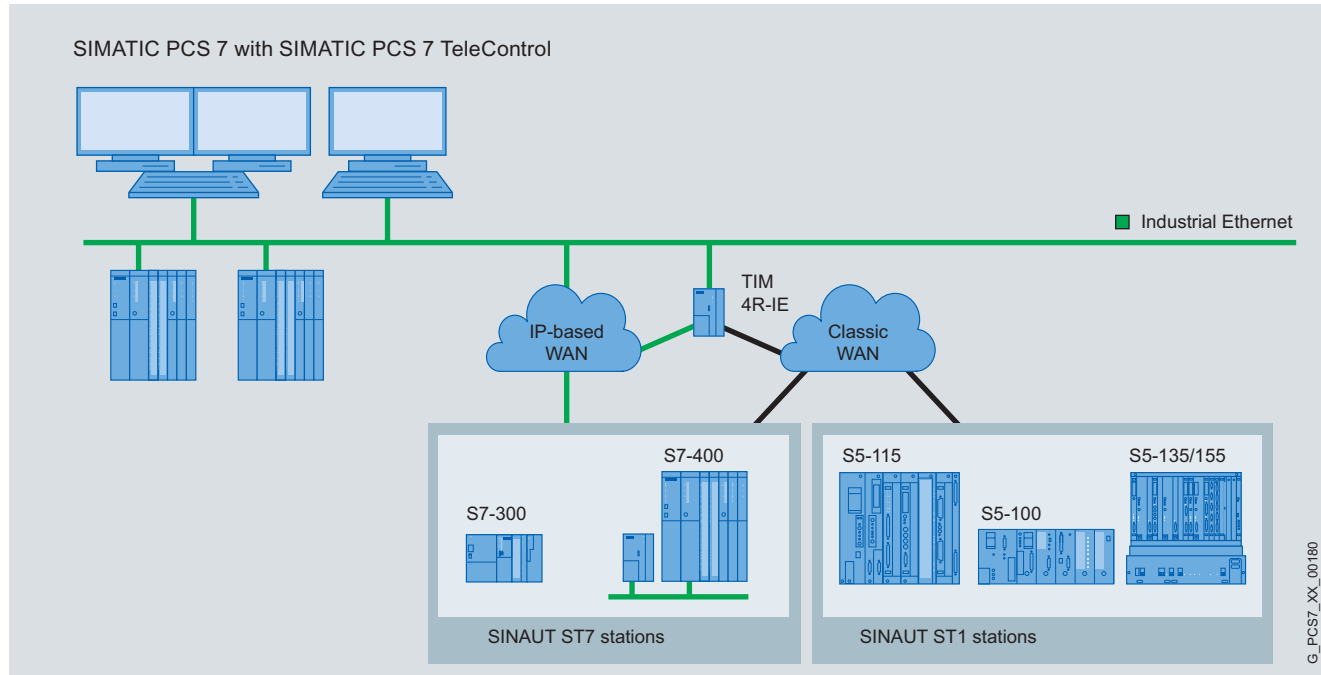
Engineering data of third-party RTUs can be imported in CSV format into the PCS 7 TeleControl engineering (DBA). The status of the RTUs and the transmission paths is evaluated by the "Diagnostics Modbus RTU" block and displayed in the control center.
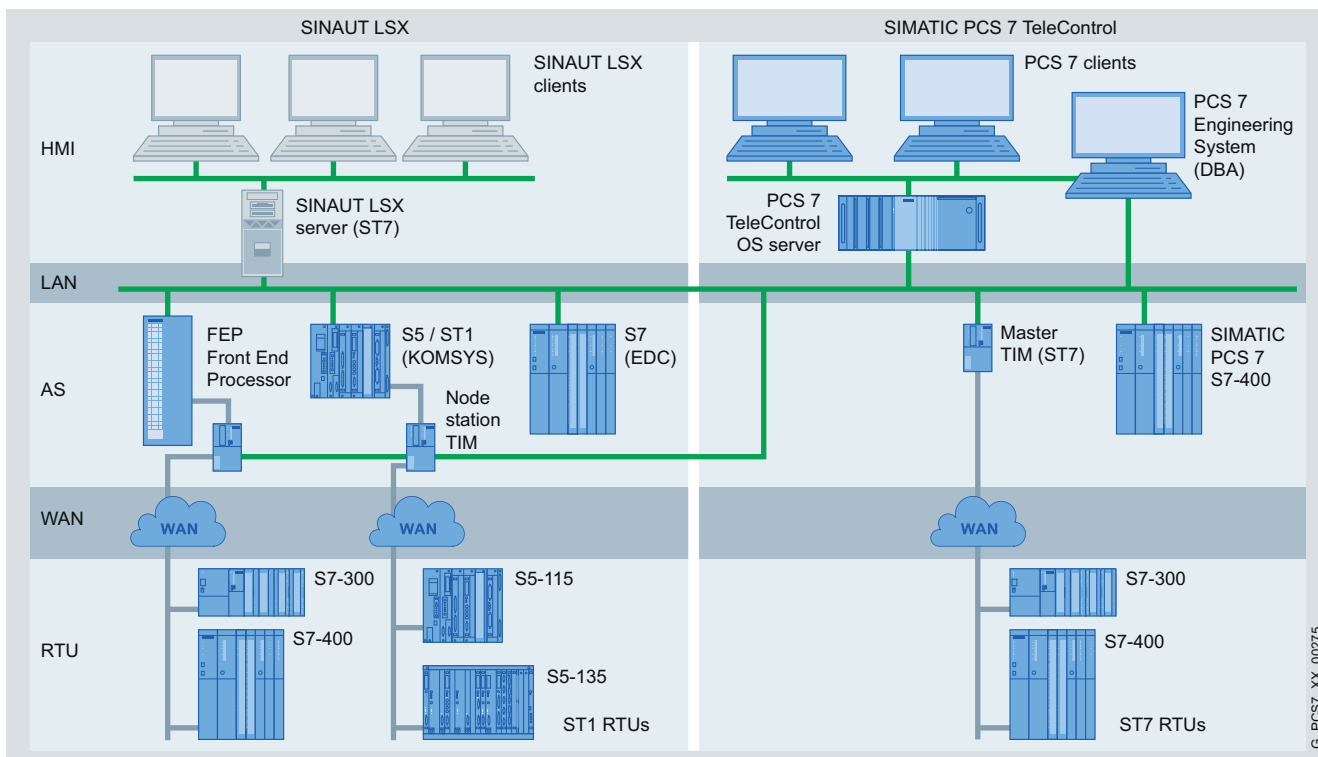
SINAUT ST1 stations based on SIMATIC S5

During the migration of existing systems, it is possible to integrate outstations based on SIMATIC S5 into the SIMATIC PCS 7 process control system using SIMATIC PCS 7 TeleControl. In the process, the ST1 telecontrol protocol is converted into the ST7 protocol in the central TIM communication module.

Third-party stations

In addition to the Modbus telecontrol protocol, the DNP3 (serial and TCP/IP), IEC 870-5-101 (serial) and IEC 870-5-104 (TCP/IP) telecontrol protocols basically also support the control center linking of third-party RTUs when migrating existing systems. The implementation depends on whether the third-party RTU masters the corresponding protocol and whether the interface converters are available if necessary.

Integration of SINAUT ST1 stations into telecontrol communication

SINAUT LSX

SINAUT LSX clients

HMI

SINAUT LSX server (ST7)

LAN

FEP Front End Processor

AS

S5 / ST1 (KOMSYS)

Node station TIM

S7 (EDC)

WAN

WAN   WAN

RTU

S7-300

S7-400

S5-115

S5-135

ST1 RTUs

SIMATIC PCS 7 TeleControl

PCS 7 clients

PCS 7 Engineering System (DBA)

PCS 7 TeleControl OS server

Master TIM (ST7)

SIMATIC PCS 7 S7-400

WAN

S7-300

S7-400

ST7 RTUs

G_PCS7_XX_00275

Integration of existing SINAUT LSX systems per PCS 7 TeleControl S7 EDC driver

Integration of third-party stations with OPC

Along with additive engineering performance on the basis of DBA technology, SIMATIC PCS 7 TeleControl also allows integration of third-party RTUs for which an OPC server exists into the process control with the SIMATIC PCS 7 Operator System. SIMATIC PCS 7 TeleControl then supports data exchange between the operator system (OPC client) and the RTU (OPC server) per OPC DA.

SINAUT LSX systems

Existing SINAUT LSX systems can also be migrated with SIMATIC PCS 7 TeleControl. The SIMATIC S7 controllers with EDC communication protocol (Event Driven Communication) installed in the SINAUT LSX systems are then integrated into SIMATIC PCS 7 TeleControl per PCS 7 TeleControl S7 EDC driver. Because the SINAUT LSX system can coexist at all levels next to the new system architecture as long as necessary, modernization is possible step-by-step and without short-lived intermediate solutions.

Linking of SIPROTEC or third-party protection equipment

The protocol expansion IEC 870-5-103 Master for SIPLUS RIC bundles also allows interfacing of SIPROTEC or third-party protective equipment via SIMATIC PCS 7 TeleControl. The RTU (ET 200S with CPU, S7-300 or S7-400 controller) then serves as a converter between the IEC 870-5-103 protection data protocol and the IEC 870-5-101 or IEC 870-5-104 protocol.

Control center

SCALANCE S612

DSL router

IEC 60870-5-104

WAN

SINAUT MD741-1

SIPROTEC 7SJ63

IEC 60870-5-103

SIPLUS RIC bundle with SIMATIC S7-300

G_PCS7_XX_00276
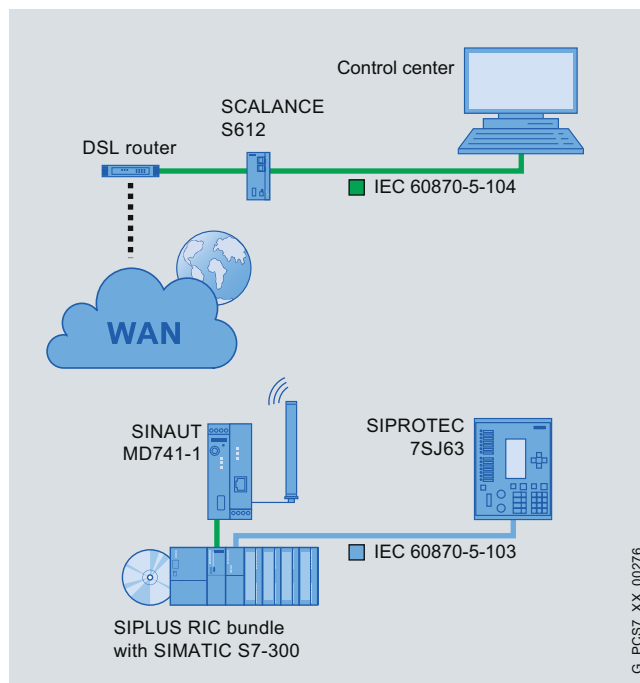
Example of interfacing of SIPROTEC protective equipment

Compared to PROFIBUS DP interfacing of the protective equipment, this configuration provides the following advantages:

• Greater distances are possible.
• The highly exact time stamps are transferred from the protective equipment to the control system.

Application examples

Automation of a gas pipeline with block valve and metering stations

Uniform automation of all stations in the gas network

- SIMATIC PCS 7 process control system for compressor and pressure reducing stations
- SIMATIC PCS 7 TeleControl with SINAUT telecontrol technology on the basis of S7-300/S7-400 controllers for block valve and metering stations
- Combination of process control at one operator station (SIMATIC PCS 7 OS client)
- Compliant process control with uniform faceplates, alarms, trends etc.

High system availability resulting from redundancy

- Redundant pair of SIMATIC PCS 7 OS servers
- Redundant pair of SIMATIC PCS 7 TeleControl OS servers
- Ring topology with redundant media

Integral safety technology for emergency shutdown (ESD)

ESD is integrated homogenously into the automation plant (compressor and relief stations):

- Redundant safety-related controllers
- Redundant PROFIBUS with PROFIsafe
- ET 200M with F modules
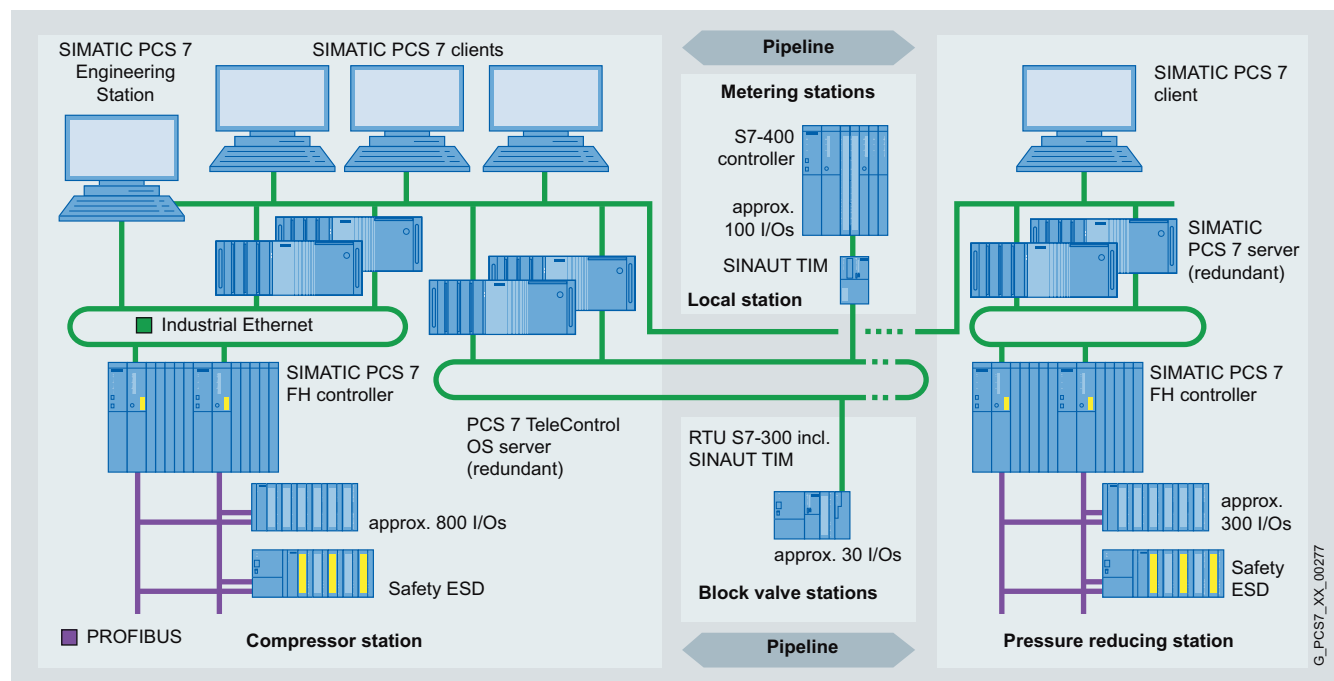
System architecture of gas pipeline automation with SIMATIC PCS 7 TeleControl

Automation of a sewage treatment plant
with pumping station and stormwater overflow tank
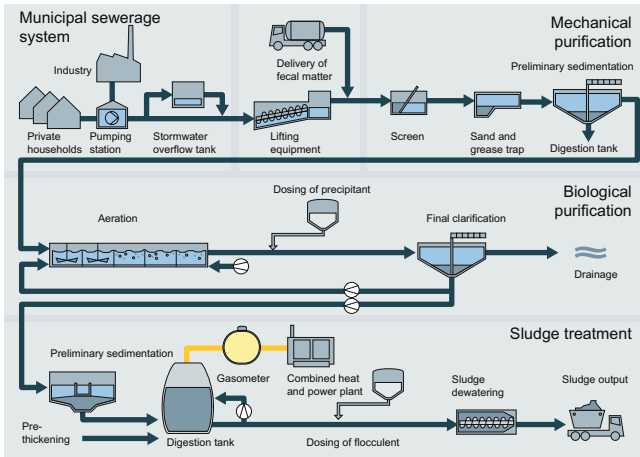
Symbolic technical representation of a sewage treatment plant

Uniform control of the complete wastewater network

- SIMATIC PCS 7 process control system in the sewage treatment plant
- SIMATIC PCS 7 TeleControl with SIPLUS RIC telecontrol technology on the basis of the IEC 870-5-104 protocol
- Combination of process control at one operator station (PCS 7 OS client)
- Compliant process control with uniform faceplates, alarms, trends etc.

Cost-effective RTUs exactly matched to the respective unit

- S7-300 controller for pumping station
- ET 200S with integral CPU for stormwater overflow tank

Secure communications

- Protection of telecontrol network by SCALANCE S613 industrial security module
- Application of GPRS technology

Reporting and archiving in compliance with ATV-DVWK M 260

With application of the SIMATIC PCS 7 add-on product ACRON
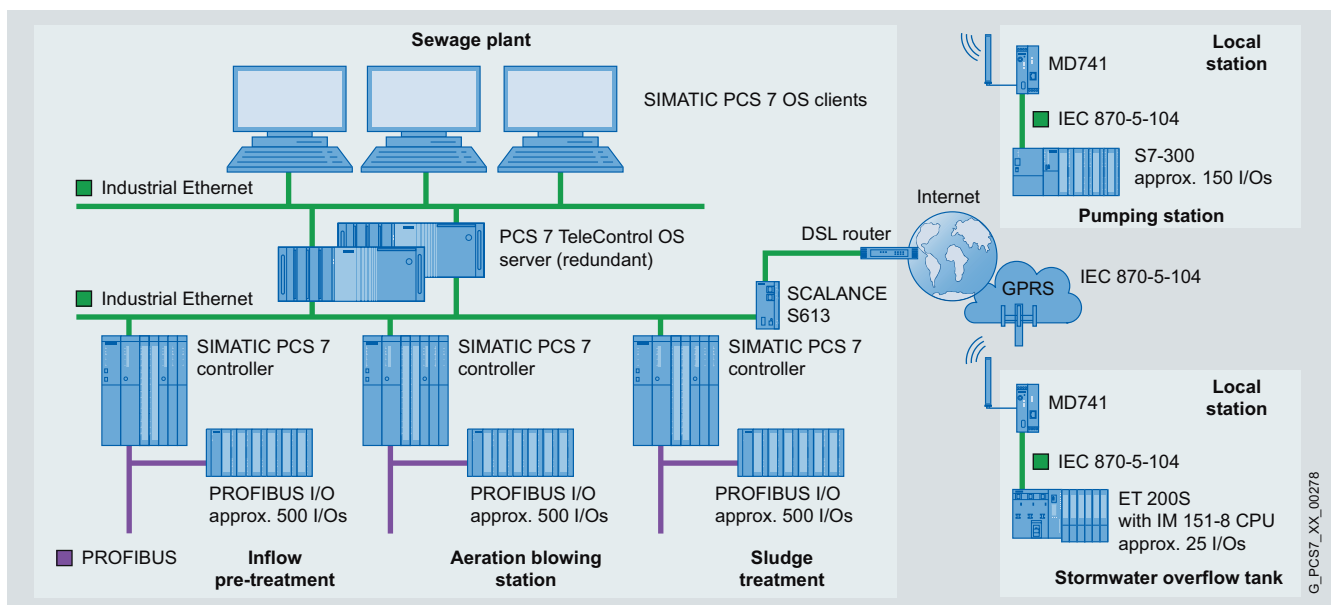
System architecture of sewage treatment plant automation with SIMATIC PCS 7 TeleControl

Additional information

SIMATIC controllers:
www.siemens.com/simatic-controller

SIMATIC automation systems:
www.siemens.com/simatic

Totally Integrated Automation:
www.siemens.com/totally-integrated-automation

SIPLUS extreme – ruggedness and refinement:
www.siemens.com/siplus-extreme

Service and Support:
www.siemens.com/automation/service&support

SIMATIC contacts:
www.siemens.com/automation/partner

Information material to download:
www.siemens.com/simatic/printmaterial

SIMATIC Guide Manuals:
www.siemens.com/simatic-docu

Ordering on the Internet with the Industry Mall:
www.siemens.com/industrymall