

Modernization as a key to lower production costs

How to integrate a modernized automation system into an existing infrastructure

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A typical plant consists of multiple machines, which in a modern environment exchange data with each other. This is called horizontal integration. These machines are also a part of a bigger assembly and therefore exchange data with upper level monitoring and planning systems (MES/ERP systems). This is called vertical integration. For a seamless work- and materialflow, both horizontal and vertical integration needs to be achieved. The necessary data exchange is typically realized using networks. Different systems hereby support different sets of protocols, similar to humans speaking different languages. The main challenge is the diversity of systems used.

In order to optimally utilize the machines in a plant or factory, it became more and more a standard to use above mentioned planning systems. In plants or factories running for years now a modernization enables the use of such systems. This in turn can help lower production cost through better utilization of the machinery. As an end user one can lower production cost and increase productivity through this measure.

During a modernization the OEM or end user may want to provision for such higher level planning systems. This requires that networks are being modernized as well. Legacy automation systems may not fully support modern

networks or protocols on such networks.

A modernization for a whole plant or factory leads also to intermediate situations, where a mixture of modern and legacy systems exist. The end customer still wants to be able to keep production up and running while participating in the improved productivity planning software would allow for.

Contents

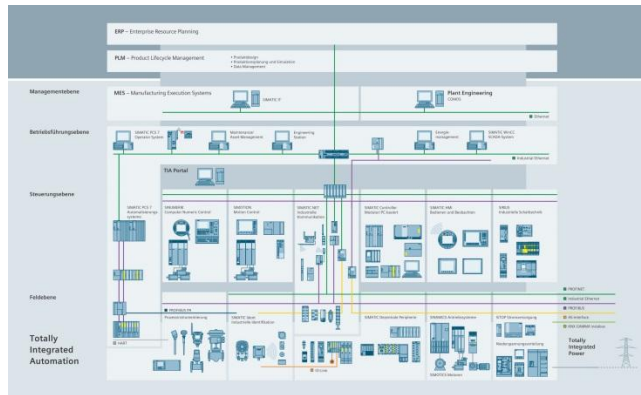
In this document options and concepts will be introduced allowing the operation of a diverse set of automation systems. It will list today's possibilities to exchange data between modern automation systems, such as the SIMATIC S7-1500 and a legacy process automation controller.

1–70	Existing infrastructures
1–30	Heterogenous automation networks
31–54	Homogenizing heterogenous networks
55–70	Gateways
71–21	Existing protocols
71–85	Homgenizing protocols
86–95	Protocol drivers
96–120	Integrating a SIMATIC S7
121–152	Integration possibilities
153–160	Conclusions
161–168	Abbreviations

Integration into existing infrastructure

Heterogenous automation networks

Such networks not only consist of a single type of network, they rather employ specialized networking technologies for different tasks in a plant or factory.



There are different types of tasks to perform in a networked plant or factory requiring different properties of a network.

In the cell or machine level networking typically requires fast and deterministic response behavior with a limited amount of data.

The plant wide networking system on the other hand requires more data to be transferred at once but allow for non-deterministic behavior.

With today's technology deterministic behavior and large data amounts are no longer mutual exclusive. This allows a unification of the used network media to a single network media, reducing installation and maintenance cost.

In an effort to modernize a plant there will be intermediate situations, where modern network technology and legacy networks need to be operated side-by-side. This requires concepts to solve the challenge of the data transfer between the networks. In order to solve this, basically two questions need to be answered.

- How to connect the physical media to each other?
- How to transfer the user data from one network to another?

Not only specialized networks create above mentioned challenges, but also different protocols on the same network media. This is typically caused by the mix of automation systems of different vendors or different generations of the same vendor.

Homogenizing heterogenous networks

One answer to above mentioned questions is the homogenization of the network. This requires a network able to handle both larger data amounts in a deterministic manner. Ethernet with it's easy to install network cables allows for all kinds of network topologies. Such topologies include:

- Line topology – often used in the machine level networking with deterministic response behavior and small data amounts.
- Star topology – often seen in the plant wide networks with larg data amounts and non-deterministic behavior

Both topologies can be realized with either small port count switches, for line topologies, or high port count switches for star topologies.

PROFINET, with its low protocol overhead and simple communication structures allow cooperation of standard TCP/IP services for non-deterministic behavior but large data amounts side-by-side with highspeed, highly deterministic I/O data exchange with limited data amounts as found on the machine level.

Under some circumstances homogenizing the network can only be the longterm goal or is the result of the modernization. In between different solutions must be found.

Gateways

With being able to adopt the physical properties of one network to another network, gateways typically offer the adaptation to different network protocols as well. Gateways typically have therefore at least two network ports allowing the participation in two otherwise different networks.

Gateways exist with different combinations of networks and network protocols. Therefore they offer the most flexibility to interconnect networks of different generations and with different specialization.

Disadvantage of gatways is the fact that they need a configuration, which is typically not part of an engineering tool for an automation system. Gateways add tpxically latencies to the transfer of the data as well; however this may only negatively affect highly deterministic systems.

Industrial Communication with Totally Integrated Automation makes production processes



more efficient



more flexible



more reliable

“How to integrate a modernized automation system into an existing infrastructure”

Existing protocols

Homogenizing protocols

Another approach to easily transfer data between different networks is the application of a uniform protocol, such as the S7 protocol implemented in modern SIMATIC S7 controllers. With a uniform protocol the gateways between different networks degrade to physical converters matching the physical properties of the networks. These devices are called bridges.

In a modernization scenario the use of a uniform protocol can be the final goal as it is to use only a single network media type.

Still an end user or the OEM faces the situation that a modern system needs to be integrated into an existing network.

Protocol drivers

With otherwise identical networks protocol adaptations can be realized by different means. Gateways have been mentioned already and yet there is still another option.

This option requires at least two things to be fulfilled.

- A common layer of communication, such as TCP or UDP and ...
- ... a granted user access to such layer.

In this scenario the user may be able to implement a protocol driver himself or apply one already available.

Integrating a SIMATIC S7

For example an end user or OEM wants to integrate a modern Siemens SIMATIC S7 controller into an existing legacy Rockwell installation. The legacy Rockwell installation may contain one or more networks out the below listed ones.

- Universal Remote I/O is a RS 485 physics based serial network running at baudrates up to 230kBit/s. The protocol is proprietary to Rockwell. There are some gateway manufacturer available allowing an adaptation to other networks.
- DeviceNet is a network typically used in small data mount applications for simple sensors and actuators
- ControlNet can be found on the field level networking field devices or other controllers on a horizontal level.

Suited for deterministic behavior but limited data amount

- EtherNet/IP is one of the more modern networks utilizing current IEEE 802.3 standardized ethernet physics.

Since a SIMATIC S7 controller is not able to access physical-ly any of these networks, except EtherNet/IP networks,, some of the above mentioned networks can only be accessed using a gateway to any of the remaining networks. In an effort of modernization an ethernet based network would be the first choice.

Integration possibilities

As all modern SIMATIC S7 controllers have an integrated Ethernet interface with a granted user access to layer 4 and above of the 7 layer ISO-OSI communication model, the integration of an EtherNet/IP driver is in general possible. As of today the following protocol or service drivers exist:

- a gateway to Universal Remote I/O
- a gateway to Automax drive systems
- a driver for a robot controller

Besides that the SIMATIC S7 can act as an EtherNet/IP adapter or scanner for a limited number of adapters. As supported by the legacy Rockwell system the use of native TCP or UDP communications is also an option.

Sometimes the OEM or end- customer may find himself in a situation, where a modification of the original code of the legacy systems is not desirable. In this case the data exchange can only be realized using available services in these legacy systems

Within the SIMATIC system such services are based on the S7 protocol suite. Legacy systems of other vendors may offer similar services.

Once these services become available on a SIMATIC supported physical layer, a driver implementation can achieve the desired solution as well. Data access without code modification in the legacy system is currently available for EtherNet/IP based CIP services

- ReadDataTable/ WriteDataTable
- PLC-5 typed Read/ PLC-5 typed Write

With these services data inside the legacy system can be accessed without any changes on the program inside the legacy system.

Conclusions

The integration of a modern SIMATIC controller in a legacy installation is not as difficult as it seems at first glance. There are many options available allowing the end user or OEM to get to a unified network infrastructure. He doesn't have to fear to loss of production during the modernization, since gateways can be used as an interim solution.

Abbreviations

OEM	Original Equipment Manufacturer
ISO	International Standardization Organization
OSI	Open Systems Interconnection
TCP	Transport Control Protocol
UDP	User Datagram Protocol
IEEE	Institute of Electrical and Electronics Engineers

Siemens AG
Gleiwitzer Strasse 555
90475 Nuremberg
Germany

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