Communication Structures for Industry 4.0
Industry 4.0 projects are implemented in many companies today. In this context, data communication gains importance as part of the digital production. In many cases, projects such as big data analytics, preventive maintenance, and remote maintenance by specialists are targeted as the first step in the process. As a second step, the main objective is to achieve the integration of business processes through cloud technologies, which help implement synergy across the company. The coordination of supply chains is a good example.

Reliable, stable, safe, and powerful communication infrastructure is an important requirement to achieve this objective. This requirement, in turn, necessitates the development of concepts that cover the aspects of maintenance, administration capability, fault-free operation, and data security for planning and integration of these architectures. Also underestimated today is the growth in the context of a scalable operation. The fourth industrial revolution of digitalization of production is different from the previous ones (steam engine, assembly line, robots) in that there is added value that is created outside the limits of the production cell or machine. Value is achieved by exchanging data using an IT infrastructure. Remote experts are one example by providing access to systems, regardless of their location, so experts can resolve issues quickly and competently. In a best-case scenario, experts can also access data sent continuously from machines or comparable systems to a central history server. Deriving patterns in errors quickly becomes possible through the immediate access to machine data. The added value of accessible machine data increases as the number of systems that you can analyze also increases, and thus more efforts are being made to use machine data for analysis. Specifically, machine builder can use the collected data and experiences for extended service to customers.

The availability of communication infrastructure has special importance now in the production process because each connection contributes significantly to improving the cost. To stay with our example, a remote expert can help across various sites, which in turn increases availability. Specialization among employees is required for maintenance because each specialized topic is very important and it is not possible to maintain specialist knowledge 24 hours a day due to cost. Communication infrastructure is now gaining significance with regard to production and has a direct influence on the efficiency of production.

In this example, IP communication infrastructure is required for various departments of a company. The production cell, factory, enterprise, and data center networks are commonly under different areas of responsibility. Compartmentalization can be useful, but is commonly subject to various other conditions. For this reason, it is necessary to develop a holistic concept that facilitates the operation, expansion, and troubleshooting of communication infrastructure beyond departmental boundaries and thus helps production.

The core competency of individual departments is the basis for the meaningful division of work. The following representation (see figure 2) is an example of the structure implemented to facilitate a joint project between production and IT departments.

The interaction between different departments also has technical aspects. For end-to-end troubleshooting, it is necessary to have trained professionals in the communication chain of the respective components. Cisco offers worldwide IT and operations training and certification solutions with certified system specialists available globally. Such specialists are in a position to guarantee common network, data, and security management practices that meet audit criteria.
Cisco is the market leader in communication infrastructure in cloud, data center, enterprise, and multimedia networks. In many cases, today’s production communications networks are connected to Cisco enterprise infrastructures. In previous years, Cisco developed industry-compliant communication components, which help integrate known IT mechanisms with automation technology. These systems are based on Cisco IOS® Software, which has been at the heart of Cisco products for more than 32 years, including Cisco switches, routers, and firewalls. Support for industry protocols began with the Ethernet/IP standard. Cisco now extends Industrial switching functionality to support PROFINET capabilities.

Cisco took the next step in industrial digitization with the introduction of edge computing, called IOx. IOx technology allows Java or Python-based container applications to run on routers and switches. Combinations of IOx in the industrial space creates flexibility to develop consistent concepts that cover the aforementioned properties, such as reliability, stability, security, and performance.

Communication Network Production Cell (A)

In Figure 3, the production cell is based on the PROFINET standard, using the Media Redundancy Protocol (MRP) as the ring convergence protocol. Configuration of the network elements is also made using automation software based on the General Station Description (GSD) standard. The network meets the requirements of PROFINET Real Time Transfer (PN-RT), which is a class B definition. Cisco Industrial Ethernet 2000 Series and Industrial Ethernet 4000 Series switches can be used and offer many other features, some of which are listed by example:

- Port security: allows specific MAC addresses per port and control multicast and broadcast storms
- Authorized user rights: limit specific commands to the switch based on user or department
- Separation of VLANs: Ethernet separation of services (for example, surveillance cameras for quality assurance)
- IP routing: integrates IP connections with line rate in the system
- Security rules: defines access lists for Ethernet or IP connectivity
- Quality of service (QoS): can customize QoS information to company-specific architectures
Such functions are commonly recognized as enterprise network best practices. Alignment of the concepts between departments leads to a higher level of stability in operations and accelerated troubleshooting.

Figure 3. Relevant Components in Various Sectors of Communications Network

Connecting to Production and IT Networks (B)

The interfacing of the production cell to a production network has four focus areas that can be defined. The Cisco Industrial Router (IR) 809 is used by example. This industrial router is suitable for a DIN-Rail and is commonly integrated in the switching cabinet. The system offers a wide spectrum of functions that are also used in enterprise networks such as end-to-end monitoring through IP-SLA functions or central configuration management. The synergy between the departments in design and operation can be emphasized here:

- Data security between the production Cell and production network IR 809 is based on Cisco IOS Software and offers access lists as well as stateful firewall functions, allowing for complex rules that meet security requirements
- Integrating the systems in network infrastructure of the production network: The integration into the overall concept requires VLAN information in many cases or support of IP-routing protocols to guarantee overall availability using different network domains
- Termination of VPN tunnels or IP sessions – A termination of VPN/IP tunnels is often required to provide access to the machines for external experts. Tunnels are commonly used under normal conditions in combination with an identity server function. Cisco Identity Services Engine (ISE) plays a central role, which can be deployed across the entire company (for example, WLAN guest access or port security based on 802.1X). Another important aspect is that a central security instance enables scaling at larger scale while maintaining data security rules at the same level. The Cisco IR 809 and 829 also have free contact, which in combination with a key-lock allows access to the system only if the operator acknowledges it. This combination is required to make sure that the machine user is aware that even the security system of the machine can be affected through remote monitoring
Edge computing for machine data normalization - IOx is an open development platform based on the Cisco Industrial Router 809, 819, and 829, allowing applications on these devices. This capability is used to collect machine data and sensor data in a decentralized manner and provide the data to various systems relevant for operations. An example is reading data from a programmable logic controller (PLC) through the ISO protocol and the simultaneous collection of extended sensor data in the system through Modbus RTU. The data is normalized and provided to different applications by OPC UA. The system protects computing resources of the PLC and can also prepare data from other sources. The close proximity to the machine has a positive influence on the communication infrastructure because only necessary information is exchanged. Management of these systems can be performed with Cisco Fog Director, which takes over the task of administering software versions and configuration parameters.

Data communication and security are important components of digitalization in production. The development of concepts that facilitate a safe and scalable transition between departments should have higher significance to make sure that the advantages of Industry 4.0 developments are implemented in a timely manner.

For More Information
For more information, visit the following websites:
- Cisco Industrial Ethernet Switches Portfolio: [www.cisco.com/go/ie](http://www.cisco.com/go/ie)

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