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Whitepaper: IT and IT infrastructure in the context of Industry 4.0

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Executive summary

The concept of “Industry 4.0” derives from an innovative further development of production processes made possible thanks to new technologies. The aim is to harness efficiency potential and thus make production more cost-effective, but also to achieve increased flexibility, an important advantage in terms of global competition. The goal is no longer to optimise individual process or production stages separately, but to examine entire value chains that start right from the customer interface. Customer requirements need to be understood and applied at the engineering stage so as to keep product and production data consistent.

Flexibility in the production process will ideally allow these requirements to be met even in series production, without efficiency or capacity suffering. However, this necessitates full integration of all processes, from determination of requirements to production, delivery, installation and servicing for customers. Data security, consistency and integrity take on tremendous importance when value chains are linked into value adding networks through the involvement of suppliers. Data quality is just as significant as products themselves.

IT and IT infrastructures have a key role to play, as they provide the enabling technology. Industry 4.0 and the “Internet of Things” are opening up opportunities that were once reserved for industrial protocols with real-time data processing. The production environment also places challenging new demands on IT services and processes, protocols and security measures. Without flexible and scalable IT infrastructures, it will not be possible to meet the challenges posed by Industry 4.0.

Figure 1: The data center (left) as the basis for industrial production.

Introduction

The concept of Industry 4.0 was introduced to the specialist audience at the Hannover Messe trade fair in 2011. This initiated an ongoing cycle of innovation that affects both the production world and the associated IT landscape.

Establishing fully integrated value chains involves a range of challenges for both industry and IT. The historical context still has a significant impact on each of these perspectives. The key issue for industry lies in optimising production processes, the material supply and resource planning. One particularly significant concern is the large quantity of data that needs to be processed in real time.

In traditional IT, the interface with production is restricted to the provision of services and data, engineering and the necessary ERP and PDM systems. In terms of the machinery itself, interfaces were only used for industrial communication protocols. New trends and technologies such as the “Internet of Things” are revolutionising these structures. This involves machines communicating with each other based on established and therefore cost-effective internet technologies.

“To harness the potential of Industry 4.0 in Germany, it is now necessary to address the unresolved questions regarding monitoring, security, confidentiality, standardisation, legal frameworks and establishing infrastructure (building up state-of-the-art power and communication networks) – and the essence of this is not restricted to Germany or Europe.” [Ref. 2]

IT and IT infrastructure have a key role to play in the success of Industry 4.0 as they provide the enabling technology. However, the advantages that an “Internet of Things” offers must be balanced against the requirements of a production environment. It will be necessary to manage a diverse range of communication participants as well as process increasingly large quantities of data.

Data plays a central role, as data about a product (or component) is just as important as the product itself: After all, further use or processing of the product is only possible with the relevant data. The particular vulnerability of the internet in terms of security means that data integrity, security and quality represent key factors for all companies when it comes to product success.

It is therefore not just IT issues that need to be considered in the context of Industry 4.0, but also the necessary IT infrastructures. The present white paper is intended as a first contribution towards this.

Definitions

The following is an explanation of some of the key terms that are necessary for understanding this subject. For buzzwords such as Industry 4.0, the point of view (manufacturer, customer, sector) is particularly important for interpretation of the term.

"Plattform Industrie 4.0", an initiative of the three major German industry associations BITKOM, VDMA and ZVEI, defines the term Industry 4.0 as follows:

Industry 4.0

"The term 'Industry 4.0' refers to the fourth industrial revolution, a new phase in the organisation and management of the entire value chain over the full product life cycle. This cycle is increasingly oriented towards individual customer requirements and extends from ideas, orders, development and manufacturing to end-customer product delivery and recycling, including all associated services. The framework is provided by networking all the elements involved in the value chain so that all relevant information is available in real time, and using the data to derive the optimum value adding stream at all times. Linking people, objects and systems produces dynamic, self-organising and cross-company value adding networks that can be updated in real time and optimised on the basis of different criteria including costs, availability and consumption of resources." [Ref. 1]

"4.0" refers to the concept of a fourth industrial revolution:

- First industrial revolution: the use of water and steam power for industrial applications in the 18th century.
- Second industrial revolution: the use of electricity in the mass production of goods in the 19th century.
- Third industrial revolution: the use of computers for the automation of production processes in the 20th century.
- Fourth industrial revolution – Industry 4.0: the ongoing digitisation of production (cyber-physical systems, the Internet of Things) to achieve maximum flexibility and optimum resource usage and efficiency.

This is no longer about optimising individual engineering, production or logistics stages separately, but about addressing their interrelation in value chains and value adding networks so as to establish efficient, cost-effective processes with maximum flexibility and high customer benefit.

Value chain

The term "value chain" refers to all the processes within a company that are necessary for completing a customer order. Figure 1 provides an outline of the individual stages. The chain begins with the customer, with whom the company communicates through the relevant interfaces and communication channels so that the requirements can be applied to the solution portfolio. In some cases, customer-specific modifications to the engineering or fully customised designs are necessary.

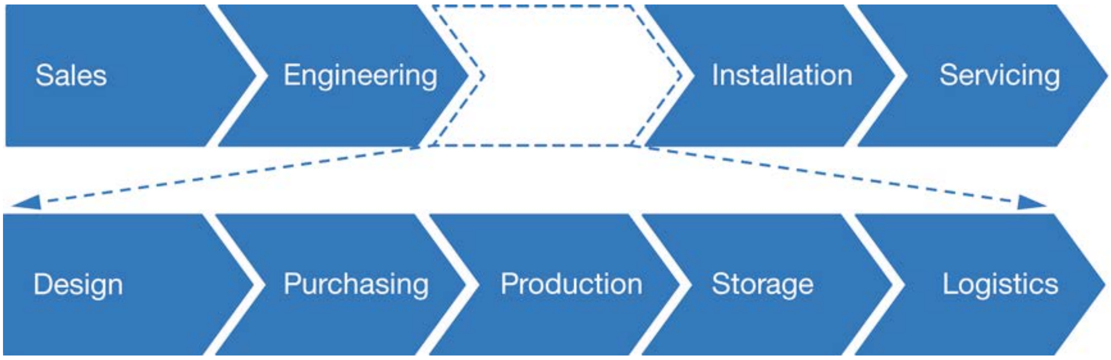


Figure 2: Value chain

Depending on customer requirements, delivery can be arranged from the warehouse or the relevant customer order can be produced in the factory. Delivery, installation and servicing (if applicable) are stages at the end of the value chain.

Value adding networks

This term describes the interrelation of interdependent value chains, e.g. by linking up sub-suppliers. In the example above (Figure 1), this is symbolised with “Purchasing”, which involves linking up sub-suppliers who supply similar value chains. An important condition for this process is having intelligent, adaptable production systems in place – i.e. “smart factories”.

Smart factory/smart production

The term “smart factory” describes a production environment in which all the elements involved in the production process (e.g. machinery, workpieces, logistics chains, engineering) communicate with each other to ensure as much flexibility as possible coupled with the efficient use of resources. Harmonising the individual production processes so as to minimise both downtime and energy consumption is key in this.

Important framework technologies here include cyber-physical systems, which form the basis for value chains, and the Internet of Things, as it is vital to ensure standardised, high-performance and secure communication between all the elements involved.

Cyber-physical systems

A group of elements such as machinery, tools and workpieces is described as a cyber-physical system if the individual elements communicate with each other in a targeted way.

Electrical, electromechanical and hydraulic systems and system components have their own intelligent features (control, sensors, actuators) and communication interfaces. Data is exchanged between these individual system components over the internet protocol (Internet of Things).

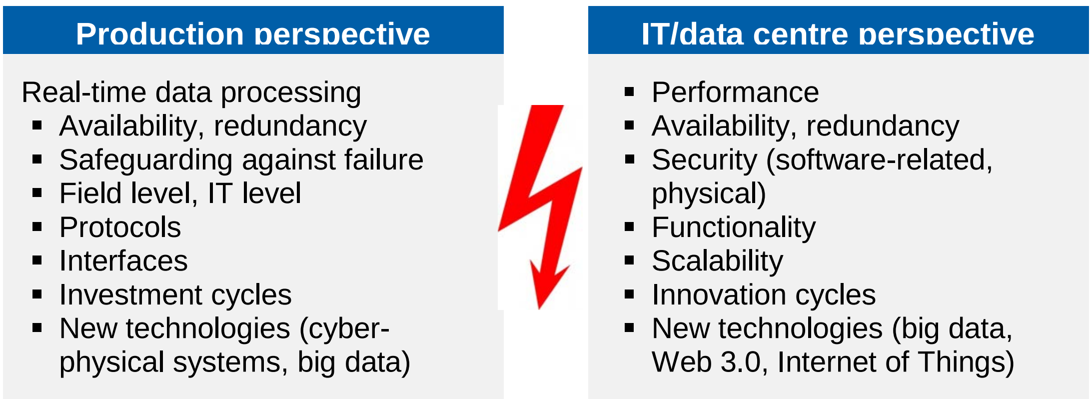
Internet of Things

The Internet of Things is an expansion of internet use that enables people, machines and elements including workpieces and objects to make use of new technological possibilities. All participants, computers and machines require distinct identification and communicate on the same basis. This makes the exchange of information (identification, addressing, data formats, transfer) standardised and uniform. Established technologies (hardware, software) from the IT domain can thus be used in new domains such as production processes and logistics chains.

IT requirements

Identification of requirements

Despite many of the terms being the same or similar, the requirements that production and data centre applications make in terms of IT differ considerably, as shown in Figure 2.



The two fields will be examined in more detail in the following sections.

Production perspective

The production perspective gives rise to a range of IT infrastructure requirements based on the fundamental principles illustrated in Figure 3. Machinery and machine controllers are contained within an enclosure that communicates with the outside world via data interfaces. These enclosures must have a reliable power supply and thus also require sufficient and appropriate climate control. It is also crucial that the enclosures are monitored in terms of criteria such as temperature, humidity and access. In some circumstances, there are other security requirements that also need to be taken account (protection category, fire extinguishing system, etc.).

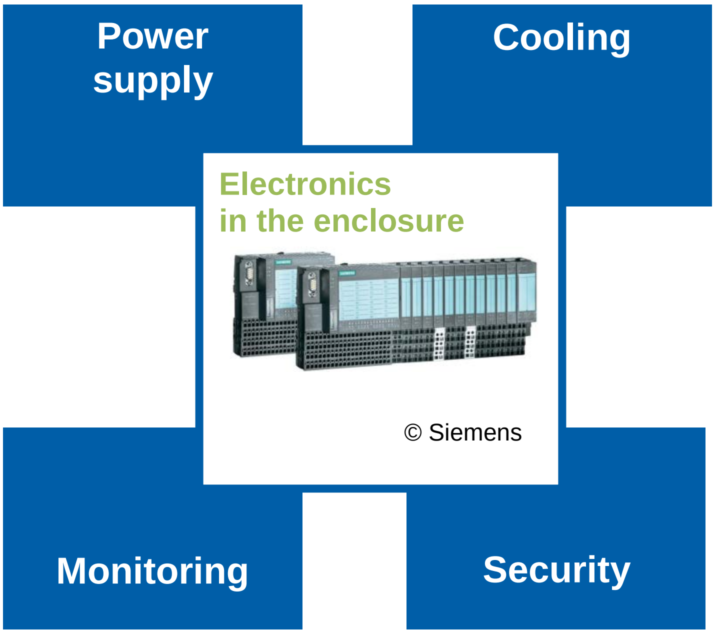


Figure 4: Requirements from an industrial perspective

This is the basis for the IT requirements, which can be categorised as follows:

- Real-time data processing
- Availability
- Safeguarding against failure, design redundancy all the way up to machine level
- Field level, IT level
- Industrial interfaces and protocols
- New technologies (cyber-physical systems, big data)
- Investment cycles as a function of product life cycles

Data centre perspective

The same fundamental principles apply to IT infrastructures in the data centre environment (see Figure 4). The enclosures (IT racks) contain switches, servers and storage systems that need to have a reliable power supply. These sensitive devices require appropriate cooling systems to keep them within a specified temperature and humidity range. Operating parameters, statuses and alarms all require careful monitoring. Protection from physical risks (access, fire, smoke, dust, water, etc.) is also necessary.

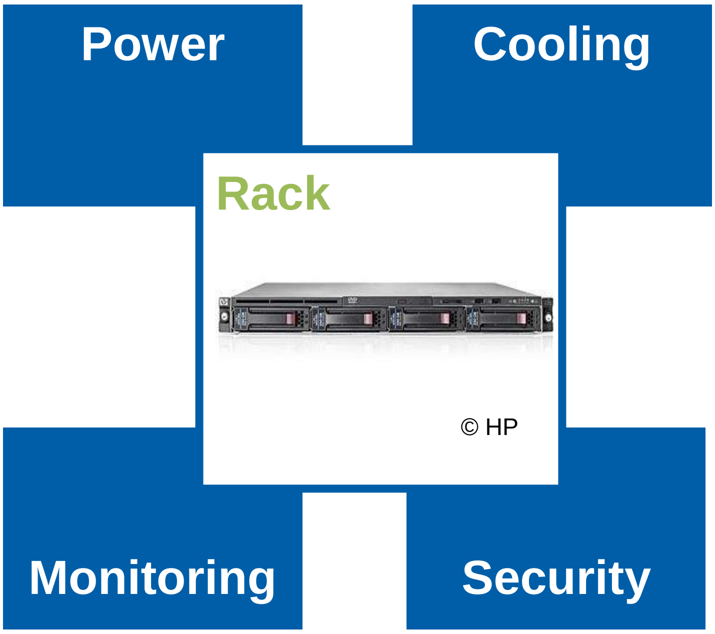


Figure 5: Requirements from an IT/data centre perspective

The system administrator therefore faces similar challenges to the production management:

- Performance
- Availability, redundancy (hardware or application)
- Security (software-related, physical)
- Functionality
- Scalability (pay-as-you-grow)
- New technologies (big data, Web 3.0, Internet of Things)
- Innovation cycles (dependent on applications, software updates, server generations and development of the storage systems)

This examination of the two perspectives shows a subset of in part identical requirements, although there are significant differences at field and machinery level. These have been identified as one of the main challenges by the Industry 4.0 working group of the “Industry and Science” research alliance (Forschungsunion Wirtschaft-Wissenschaft) between the German Federal Ministry of Education and Research and acatech.

“Cross-company usage of CPS platforms by providers of IT, software and services as well as users will require an Industry 4.0 reference architecture that addresses the different perspectives of the ICT and production sectors.” [Ref. 3]

In the context of Industry 4.0, the two fields must therefore be drawn closer together and the following focus points considered:

- **Data volumes**
  Production environments involve particularly large volumes of data (cyber-physical systems, big data, etc.). Processing this data does not just enable more efficient machinery planning, which in turn makes more efficient production possible. It also ensures that discrepancies can be identified early and servicing can be arranged proactively. At the customer interface (sales/service), the analysis of data provides insights into purchasing patterns and product use.

- **Data integrity and security**
  Data is just as important as products. A machine, as a product, is a complex structure made up of a large number of individual components. Each component is defined by a data record. This data must be complete and consistent so that a design planned with CAE tools and based on CAD models from libraries can also be applied in practice. Data records contain all the relevant product information and must therefore be protected. Data integrity ensures consistency between customer requirements and the manufacturing of a product based on these needs.

- **Object orientation** (allocation of data)
  Products, components and individual parts cannot be used without the relevant data records. This data can be managed centrally. However, it is also possible to mirror this on a decentralised level. RFID technologies make it possible to transfer intelligence all the way to the individual workpiece. This enables the workpiece to “know” how it is to be used in the production process. The product itself knows how it will be structured and how it will be configured for an end customer if required.
  In the ideal “smart” production environment, the optimised production processes thus enable individual customer solutions to be supported even in a series process (key word: demand-driven production, batch size 1).

- **Performance & archiving**
  The growing volumes of data to be processed create new requirements for IT system performance in terms of transfer and processing speeds. Effective archiving must also be ensured through intelligent algorithms so that the costs of storage systems can be kept to a minimum. Delivery times are not only dependent on production times, but also on the duration of the engineering process within the value adding network that is responsible for providing the data required. Data about a purchased part is just as important as the part itself.

- **Interfaces and data exchange**
  The relevant interfaces between the “real-time production world” and the “data centre/internet world” need to be used to ensure secure data exchange.

Data quality is key to the success of Industry 4.0 and is therefore a fundamental part of securing a competitive advantage. IT and IT infrastructures provide an enabling technology for linking processes and applications in the different domains (production, data centres).

Horizontal integration

Horizontal integration (Figure 5) of a company's processes means optimising the interrelation between all process stages within the value chain. IT and IT infrastructures play a key role here, as they enable communication between the individual stages and provide a targeted means of managing them. Crucial to the success of horizontal integration is the application of customer requirements to a specific product. This involves a sequence of measures that depend on the relevant CAD/CAE support in the consulting, sales and engineering phases:

- Planning (standardised data, data sheets, models, libraries, interfaces)
- Project planning, virtual product structure (mechanical, electrical, hydraulic, etc.)
- Design and configuration (mechanical/electrical checks, climate control, etc.)
- Calculation and validation (simulations, FEM, CFD, etc.)
- Provision of all relevant product and production data

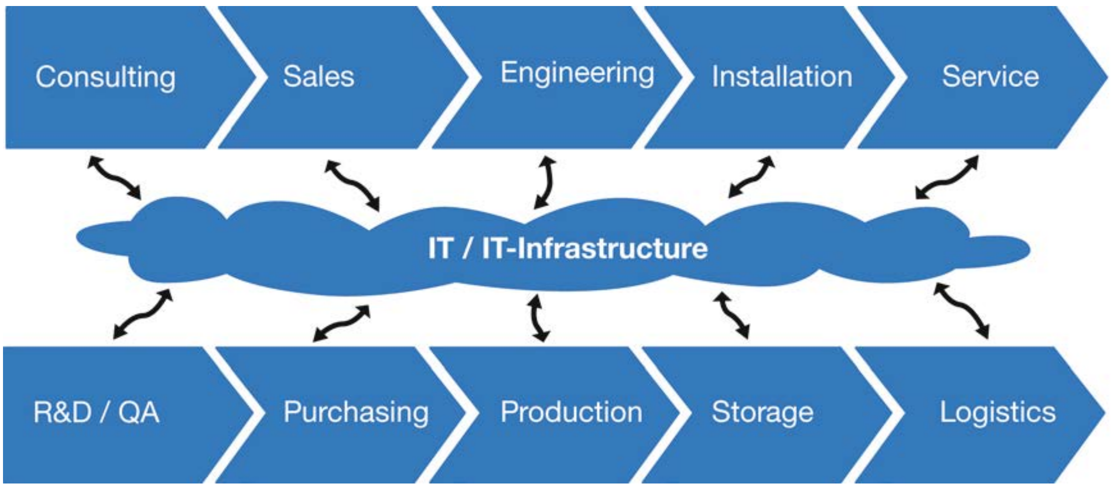


Figure 6: Horizontal integration

The downstream phases from production/design to installation at the customer's site also involve completing a series of measures:

- Machining
- Setup and assembly of mechanical components
- Setup and integration of hydraulic systems
- Setup and integration of electrical systems
- Conducting and documenting the required checks

- Documentation of all part systems
- Documentation of the product (and its integration into customer environment if necessary)

Depending on the type of product in question, logistics (delivery time, delivery capacity, international shipping) and the relevant service processes are an important part of the service commitment:

- Installation
- Training
- (Proactive) maintenance
- Servicing

Vertical integration

Another way of looking at the production landscape is the automation pyramid displayed in Figure **6.** This is a vertical view of the interaction between various processes according to their respective logical levels.

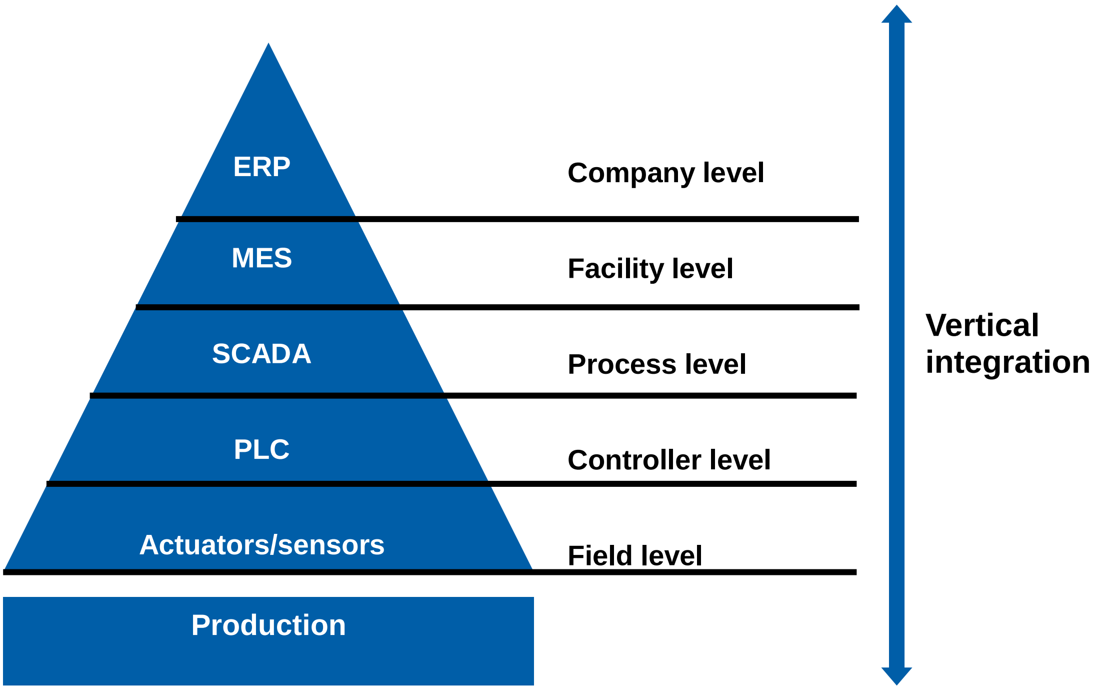


Figure 7: Vertical integration

The production hall houses the machinery that is used to process workpieces and assemble components. Sensors record all the relevant parameters. The production procedures are conducted using actuators. This level of production and communication is known as the “field level”. Data collection and control are provided via industrial computers – PLC systems (programmable logic controllers). This is where the term “controller level” comes from.

Controlling several PLC systems within one production stage is handled by industrial processing computers, which usually already communicate on the basis of a TCP/IP protocol.

Real-time controlling for an entire production process is provided by an MES system (manufacturing execution system). This includes administrating all the necessary resources:

- Staff
- Facility and production resources
- Product and production data
- Delivery parts, (part) components

The manufacturing execution system is usually embedded within an overarching ERP system that is used to plan and manage all of a company’s resources. The infrastructure for providing and processing data plays a key role here.

The Rittal perspective on Industry 4.0

Figure 7 outlines an example of the IT infrastructure of a company, which can be broadly divided into the fields of office (IT) environment and factory (production) environment.

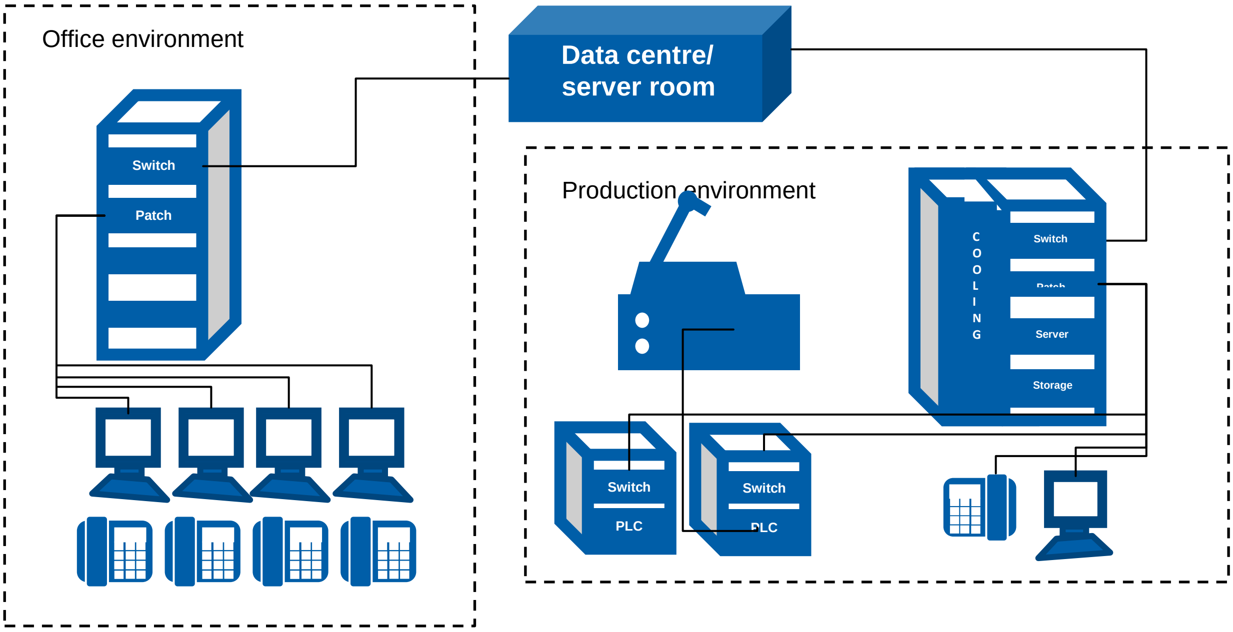


Figure 8: Example of a company's IT infrastructure

IT infrastructures in the data centre/office environment

Figure 8 outlines the IT infrastructure environment typical for office applications. The individual network enclosures for each floor of the office building are connected to a central data centre – in small companies, a server room. There is a switch for establishing and providing the network connections. The active components in the office environment are connected via patch panels:

- Desktop PCs, notebooks
- Thin clients
- Printers
- Fax machines
- (IP) telephones
- Smart devices (BYOD, WLAN, etc.)

In a few rare cases, servers and storage systems are also used if local computing power/data storage is essential for applications.

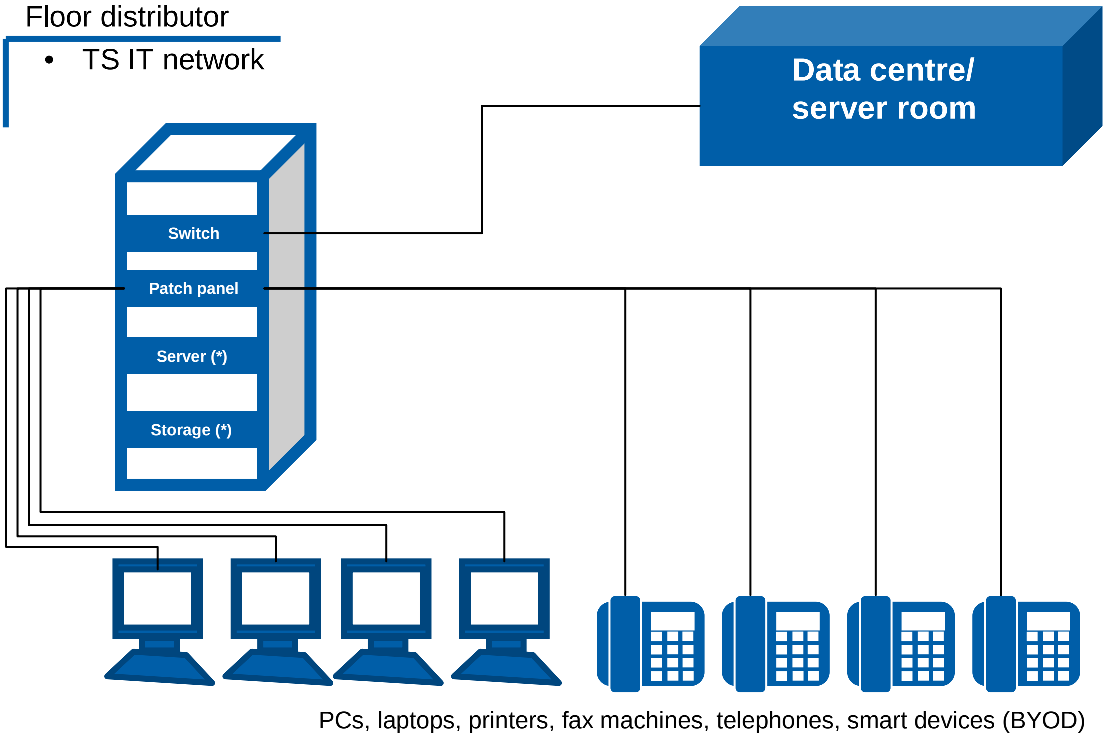


Figure 9: Example of office environment

IT infrastructures in the production environment

A section of the IT infrastructure in the production environment is provided in Figure 9. The production facilities are connected to the central data centre.
In the production facilities, there is a hall distributor that may contain servers and storage systems if local computing power/data storage is crucial to production applications. Physical security, cooling and power backup are particularly important in such cases.

All active components are connected via patch panels:

- Line distributors (PLC systems)
- PLC systems
- PCs
- Printers
- Fax machines
- (IP) telephones

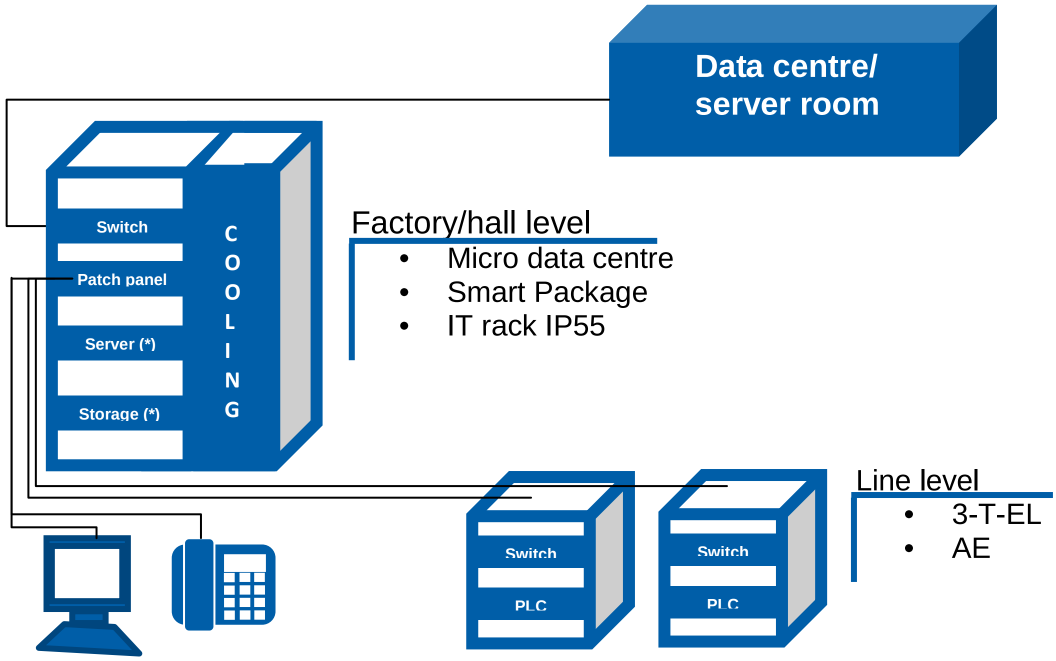


Figure 10: Example of industrial environment

Figure 9 shows that different solutions can be used at the factory or hall level depending on the type of application and the IT configuration:

- **Micro data centre**: This is a complete data centre housed within a shell that benefits from all the necessary features in terms of power backup, cooling, monitoring and security. This ensures that the relevant requirements are fulfilled for protecting local server and storage systems in harsh production environments. (See also “Micro data centre” section)

- **Smart Package**: A Smart Package is an IT enclosure that also covers the fundamental aspects of power backup, climate control and monitoring, and thus offers a complete IT infrastructure for the active components.

- **IT rack (IP55)**: This network enclosure has a high IP level to provide protection from foreign bodies/contact (first digit) and water (second digit). In the event of possible contact with dust (IP 5x) and water jets (IP x5), an IP55 enclosure is recommended for use as a network enclosure or hall distributor.
(See also “TS IT enclosure platform platform” section.)

Depending on the quantity and type of IT components, enclosures of various sizes are used at the line level in production, including large, compact and small enclosures.

One important property for a comprehensive IT infrastructure solution is that it is scalable and flexibly adaptable to the relevant requirements of a particular company. This is shown in the context of the value chain in Figure 10 below.

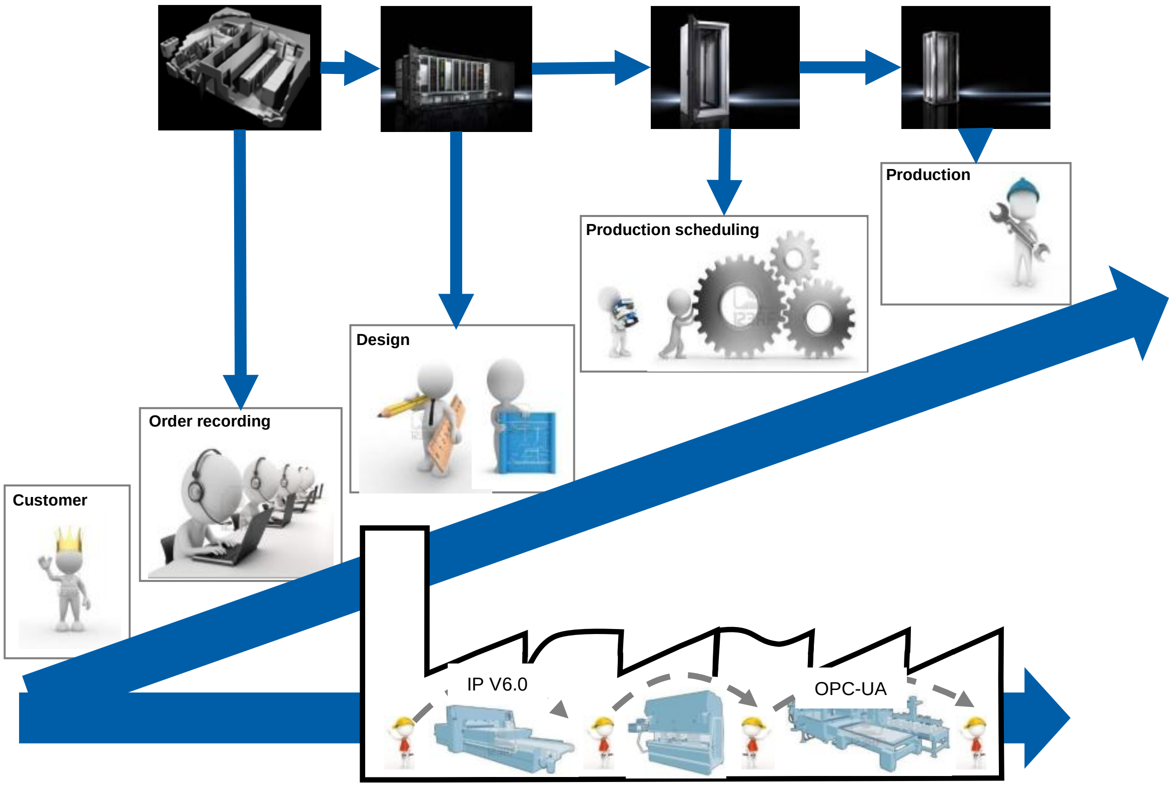


Figure 11: Value chain in IT context

The most important elements here are:

- **Company data centre/backup data centre:** All central processes and central data storage take place here. In the example below, the customer interfaces, the CRM system, are centrally allocated (see “Custom-built data centres (RiMatrix)”).

- **Subsidiary/branch:** There is a smaller data centre here that is set up on the basis of predefined, standardised data centre modules. Local customer requirements can, for instance, be turned into actual production data here (see “Standardised data centres (RiMatrix S)” section).

- **Manufacturing, production hall:** A micro data centre is used to successfully protect local, production-relevant IT components (see “Micro data centre” section).

- **Hall/line level:** A range of enclosure and housing systems are used here (see “TS IT enclosure platform platform” section).

IT infrastructure solutions

Custom-built data centres (RiMatrix)

The design of a particular data centre depends on the requirements of the customer. The key aspects to consider are functionality, performance features, security, availability, efficiency, scalability and future-proofing. Investment and operating costs should also be taken into account. A data centre is made up of several elements: it includes services and applications, active components such as servers, switches and storage systems, and the entire IT infrastructure necessary for operating these systems. The supply paths for power and climate control are particularly important.

The individual components in the power supply path are: Infeed, emergency backup system, main and sub-distribution, power backup, sub-distribution to bayed enclosures and distribution in the enclosures via passive or active socket strips. In addition to the functional interfaces that ensure the current flow, the monitoring interfaces used to forward measurements and alarm signals to a central management console also need to be taken into account.

Figure 12: Custom-built data centre

The supply path for climate control also needs to be considered. This comprises generation and transportation of cooling energy, distribution of cooling energy in the data centre and removal of waste heat. Here, too, a monitoring network needs to be in place that forwards parameters and alarm signals to the monitoring console.

In addition to this, mechanical components (server and network enclosures, raised floor, aisle containments) and safety equipment (sensor network, early fire detection system, fire extinguishing system, access protection) as far as the data centre shell (container, security room, drywall construction) must also be included.

Planning, installing, operating and servicing a customised data centre is less complicated if the components are selected from a modular system such as RiMatrix. This ensures that the individual part-systems are compatible and form a single functional entity.

The advantages of a custom-built data centre stem from the high degree of freedom involved:

- Choice of cooling technology and combinations of different solutions if several climate zones need to be provided within one data centre

- Modularity and scalability, as existing infrastructures can simply be expanded (pay-as-you-grow)

- Integration of third-party devices, as long as these meet international standards (also in terms of communication interfaces)

A customised data centre requires customer-specific implementation planning. Providing information on efficiency and operating costs is difficult and time-consuming, otherwise it will be necessary to resort to estimates. Standardised data centres provide an alternative.

Standardised data centres (RiMatrix S)

A modular system of compatible data centre modules (Figure 12) opens up new prospects for planning, implementing and operating data centres [Ref. 4]. Individual server modules are integrated with central supply modules (power supply, cooling) using defined and standardised interfaces to create complete solutions.

Figure 13: Standardised data centre, cooling container

This not only simplifies the planning phase but also significantly reduces delivery and commissioning times. The individual modules are optimally designed to complement each other and thus ensure excellent energy efficiency. The data sheets for the data centre modules enable comprehensive ROI (return on investment) analysis. This takes into account both the investment sum and a detailed evaluation of the expected operating costs. Particular focus is attached to energy costs, as these can be significantly reduced by using an intelligent climate control system.

Micro data centres

A micro data centre is a complete data centre within a protective safe and provides all the essential features of an IT infrastructure (see Figure 13):

- Power distribution and cooling
- Early fire detection and fire extinguishing system
- Monitoring of operating parameters and alarms

The shell design provides appropriate protection from potential physical threats such as intrusion, vandalism, fire, smoke, water and dust.

Figure 14: Micro data centre

The key features are:

- Two designs for the protective shell with different levels of protection against potential physical threats
- Energy-efficient cooling concept
  - performance-controlled cooling output from 5kW to 30kW
  - range of climate control options
- Future-focused due to expansion possibilities
  - can “grow” as IT requires thanks to bayable design
- Cost-effective security concept for small data centres
  - scalable product range

– wide range of accessories from RiMatrix IT modular system

Particularly for small companies, but also for workshops and remote locations, a micro data centre offers complete all-round protection for important IT devices such as servers, switches and storage systems.

TS IT enclosure platform

Server and network enclosures are the backbone of every data centre as they contain all the active components, including servers, switches and storage systems. Enclosure systems ensure stability for these sensitive devices. They also supply the hardware with cooling, power and connection technology precisely where this is needed. They serve as an interface for the selected cooling concept and provide an insight into the current status of the data centre via intelligent management functions.

The TS IT enclosure platform [Ref. 5] provides the basis for both custom-built and standardised data centre solutions. No tools are needed to adjust the 19” (482.6 mm) levels, and further system accessories such as component shelves and cable ducts can be mounted using innovative snap-in technology. The flexibility of the mounting dimensions that are supported makes the system ideal for use as an enclosure for server and network technology.

The TS IT system is available in several different variants. This is thanks to the extensive choice of different enclosure dimensions (width, height and depth) and the different design options in this range (see Figure 14). Two main options for the 19” (482.6 mm) technology are available:

In standard 19” TS IT systems, 19” mounting angles are attached to the enclosure chassis with depth stays, enabling the enclosure in this design to hold up to 1,500 kg in equipment. TS IT in this design is approved for a total load capacity of 15,000 N/1,500 kg without additional screw fastening. This is possible thanks to the depth stays, which transfer the load to the TS frame. Tool-free assembly of mounting angles is not often found in 19” enclosures, precisely because of the heavy loads that need to be supported. TS IT quick-release fasteners with snap-in technology save time during assembly and also make subsequent conversions easier.

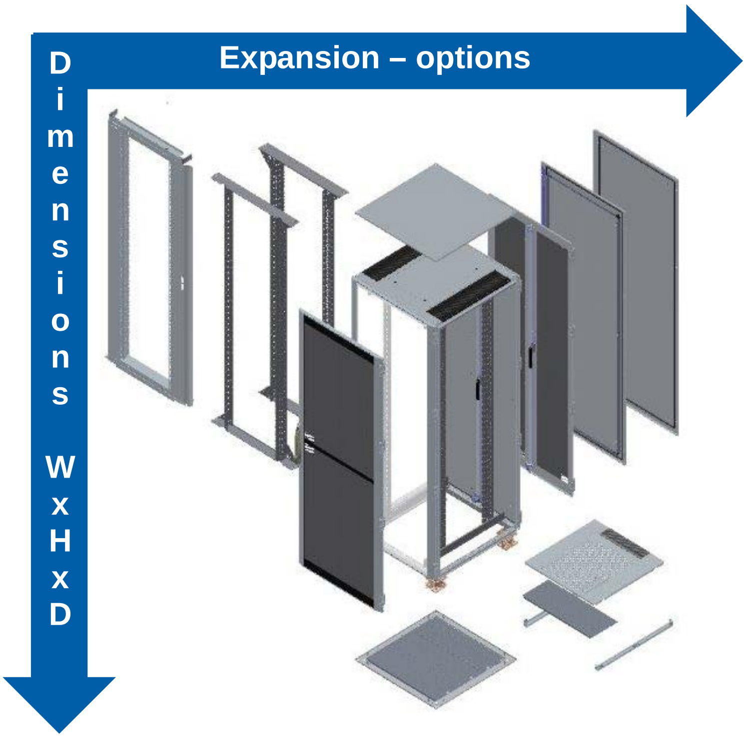


Figure 15: TS IT enclosure platform

Alternatively, a welded 19” mounting frame without additional configuration rails can be used, enabling particularly flexible cabling. When used with this mounting frame, the TS IT is approved for a total load capacity of 10,000 N/1,000 kg at the 19” level. The 19” mounting frame uses the same profile form as the mounting angles, thus ensuring a high level of compatibility for accessories. Also available are preconfigured enclosures (complete packages focused on practical needs), empty enclosures for customised expansion and high-protection enclosures for use in harsh environments.

Computer Multi Control III monitoring system

Monitoring systems are now used for data centres that enable IT managers to monitor all data centre environmental conditions from a centralised position. As the size of a data centre increases, so too does its complexity. Cabling the individual components and the monitoring system itself also becomes more complicated. The Computer Multi Control (CMC) III system [Ref. 6] solves this problem by using a CAN bus to enable serial connection of multiple monitoring sensors to a central point. The most important features are:

- Monitoring and control
- Protocols: TCP/IPv4 and TCP/IPv6, SNMP, OPC-UA
- Alarm via email, SMS, SNMP trap
- Data logger via SD memory card or USB stick
- Integrated temperature and access sensors, two digital inputs and relay output

- Climate control applications: temperature, humidity, fans, filter mat, climate control unit malfunction
- Control/regulation: fans, heating, climate control unit over door, door opening
- Integrated redundant power supply

The CAN bus and redundant power supply provide security and error detection as required.

Figure 16: CMC III monitoring system

CMC III is designed for large-scale IT applications but the compact version is also recommended for use in smaller systems and single-enclosure applications. The reduced requirements profile also reduces the range of functions, ensuring optimum value for money. CMC III can be integrated into virtually all control centres via OPC and make the data collected available at higher management levels.

The author Bernd Hanstein is Vice President Productmanagement IT at Rittal in Herborn, Germany.

List of abbreviations

BITKOM	Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V. (German Federal Association for Information Technology, Telecommunications and New Media)
BYOD	Bring your own device
CAD	Computer-aided design
CAE	Computer-aided engineering
CAN	Controller area network
CFD	Computational fluid dynamics
CMC	Computer Multi Control (Rittal IT management system)
CPS	Cyber-physical systems
ERP	Enterprise resource planning
EtherCAT	Ethernet for Controller and Automation Technology – a real-time Ethernet used for real-time applications in automation technology.
Ethernet Powerlink	A real-time Ethernet mainly used for transferring process data in automation technology.
FEM	Finite elements method
HW	Hardware
ICT	Information and communication technology
IP	Internet protocol
IP 55	International Protection Code (here: 55)
IT	Information technology
MES	Manufacturing execution system
M2M	Machine to machine (communication)
OLE	Object linking and embedding
OPC	OLE for process control

OPC UA	OPC Unified Architecture is an industrial M2M protocol that makes it possible for machine data not only to be transmitted but also written in a machine readable way.
PLC	Programmable logic controllers
PROFINET	Process field network – an industrial Ethernet standard for automation. Profinet is based on TCP/IP and is used to construct fieldbus systems.
RFID	Radio frequency identification
SCADA	Supervisory control and data acquisition
SD	SD card – secure digital memory card
SMS	Short message service (text messaging)
SNMP	Simple network management protocol
SW	Software
TCP/IP	Transmission control protocol/internet protocol
TS IT	Rittal IT enclosure platform
USB	Universal serial bus
VDMA	Verband Deutscher Maschinen- und Anlagenbau e.V. (German Engineering Federation)
WLAN	Wireless LAN (local area network)
ZVEI	Zentralverband Elektrotechnik- und Elektronikindustrie e.V. (German Electrical and Electronic Manufacturers’ Association)

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