

An aerial photograph of a large industrial complex, possibly a factory or warehouse, with several large buildings and a parking lot filled with trucks. Overlaid on the image are various digital and futuristic elements: blue wireframe boxes and lines representing data or security boundaries; red laser-like lines and circular patterns indicating scanning or monitoring; and vertical columns of hexadecimal code (e.g., 60, 88, F1, E3, 9F, F7) floating in the air. The overall theme is industrial security and digital transformation.

Operational Guidelines for Industrial Security

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Version 2.1

Operational Guidelines

Operational Guidelines provide recommendations to general security measures for the secure operation of plant and machinery in industrial environments. Based on these, machine builders and system integrators can evaluate their systems accordingly and apply improvements if necessary.



1 Overview

2 Risk Analysis

3 Security Concept: Defense-in-Depth

3.1 Plant Security

3.2 Network Security

3.3 System Integrity

4 Validation and Improvement

5 Summary

Industrial Security

protection goals & value added aspects



1 Availability ✓

Increased plant availability through reduced interference from attacks or malware.

2 Integrity ✓

Increased protection of system and data integrity to avoid malfunctions and production errors

3 Confidentiality ✓

Protection of confidential data and information as well as intellectual property

**Protecting productivity
through risk minimization**



Secure Availability, Integrity and Confidentiality at reasonable risk

Industrial Security – from risk to resilience



Unprotected business

- People and assets exposed to risk
- Business vulnerable to disruptions, sabotage and theft
- Costs and liability
- Reputational damage

Secure business

- Safer and more resilient environments
- More sustainable business, resume operations faster
- Improved plant uptime to maximize profitability
- Trust with customers and shareholders

Industrial Security

Risk in industrial automation

Information technologies are used in industrial automation

- Horizontal and Vertical integration



- Open standards
- PC-based systems



Increased security threats demand actions to avoid:

Loss of intellectual property, recipes ...

Plant standstill, e.g. due to viruses or malware

Sabotage in the production plant

Manipulation of data or application software

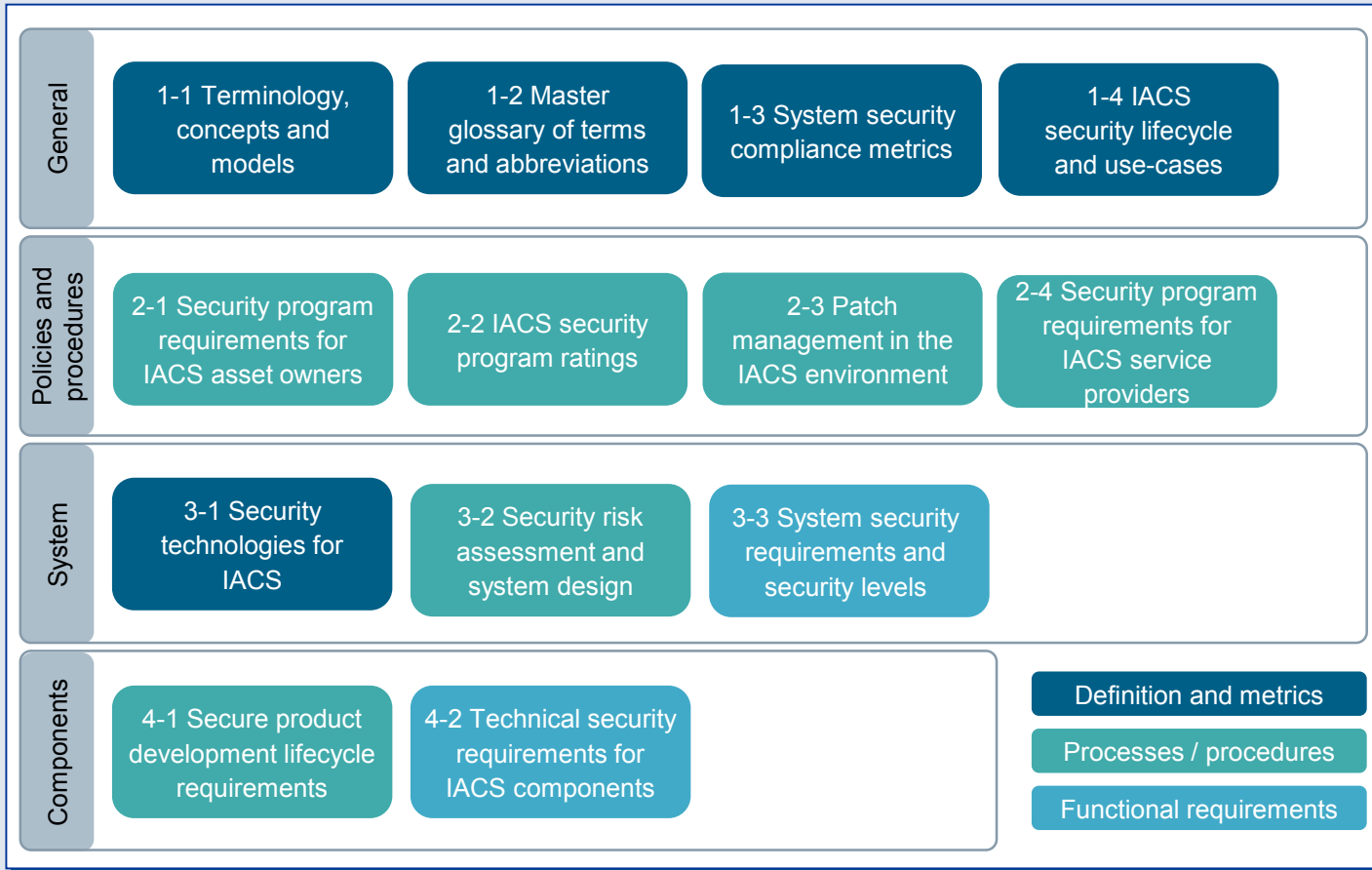
Unauthorized use of system functions

Noncompliance with standards and regulations

➔ **Establishment of security measures required – according to the individual risks**

Industrial Security works only with cooperation between plant operators, system integrators and component manufacturers

IEC 62443 – Standard for Industrial Security



Roles

Product Vendor:

- Products (Components, Systems) with integrated and configurable security features

System Integrator:

- Secure configuration and Integration of products into the entire system

Plant operator:

- Security Management, incl. Maintenance and update of security functionality according to changing circumstances (e.g. new known security vulnerabilities, changes of topology of networks, etc.)

The Industrial Security Concept from Siemens: Defense in Depth - based on IEC 62443

Defense in depth

Security threats
demand action

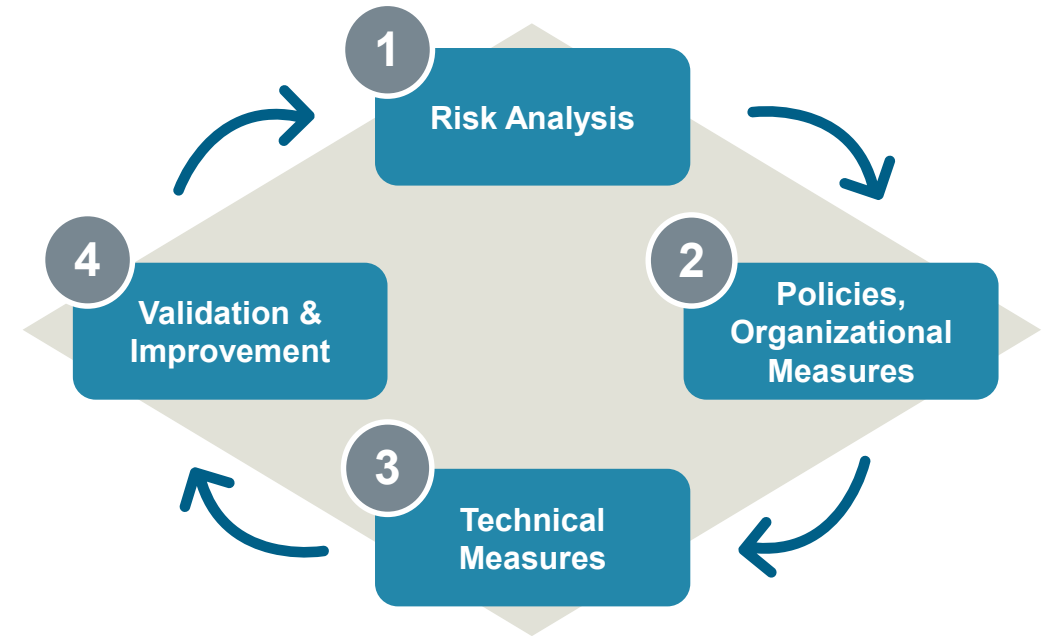


**Security solutions in an industrial context
must take account of all protection levels**

Security measures in a plant must be continuously checked and realigned

Security Management Process

- Security Management forms a **major part of any Industrial Security concept**
- Definition of Security measures **depending on hazards and risks identified in the plant**
- Attaining and maintaining the necessary Security Level calls for a rigorous and **continuous Security Management** process with:
 - Risk analysis including definition of countermeasures aimed at reducing the risk to an acceptable level
 - Coordinated organizational / technical measures
 - Regular / event-driven repetition
- Products, systems and processes must meet applicable duty-of-care requirements, based on laws, standards, internal guidelines and the state of the art



Contents

1 Overview

2 Risk Analysis

3 Security Concept: Defense-in-Depth

3.1 Plant Security

3.2 Network Security

3.3 System Integrity

4 Validation and Improvement

5 Summary

Risk analysis is the first step to determine security measures

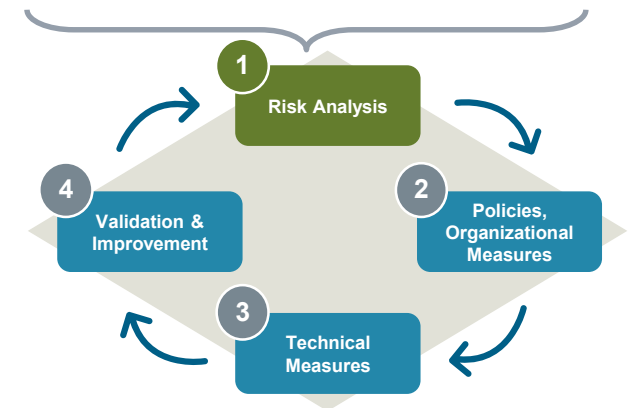
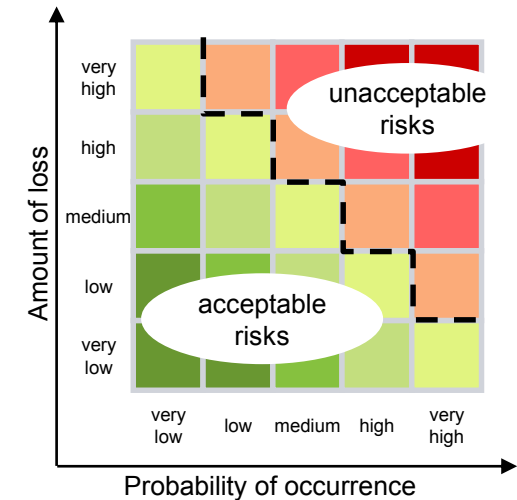
The risk analysis is an important precondition for Security Management relating to a plant or machine, aimed at identifying and assessing individual hazards and risks.

Typical content of a risk analysis:

- Identification of threatened objects
- Analysis of value and damage potential
- Threat and weak points analysis
- Identification of existing security measures
- Risk assessment

The identified and unacceptable risks must be ruled out or reduced by applying compensating measures.

Which risks are ultimately acceptable can only be specified individually for the application concerned. However, neither a single measure nor a combination of measures can guarantee absolute security.



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2 Risk Analysis

3 Security Concept: Defense-in-Depth

3.1 Plant Security

3.2 Network Security

3.3 System Integrity

4 Validation and Improvement

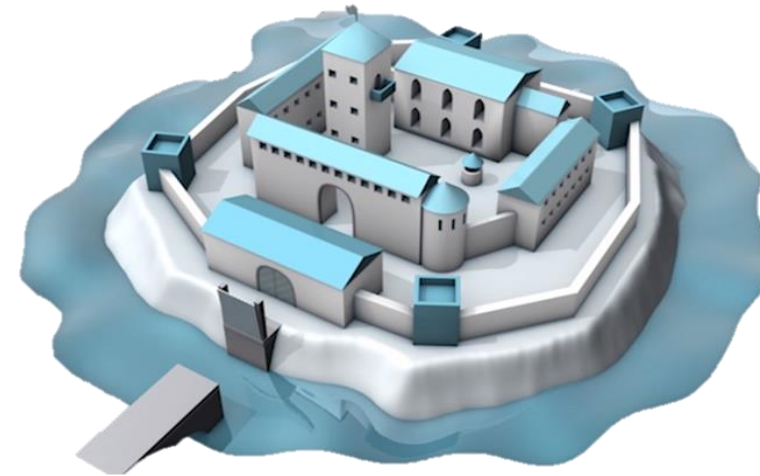
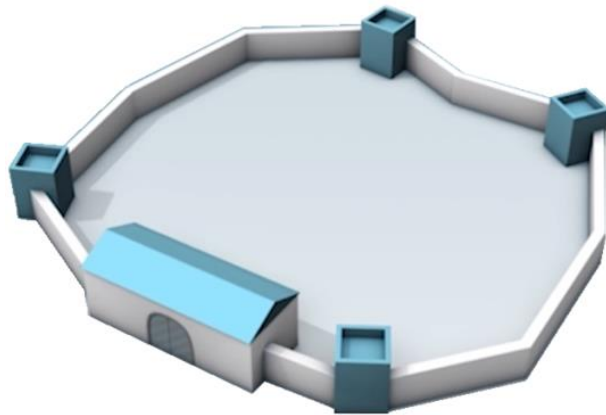
5 Summary

Protecting productivity – but how?

The solution: with a holistic Defense-in-Depth concept

Wall

- A single defense layer
- Easy to overcome – just one successful attack can be enough



Defense-in-Depth

- Multiple, independent security layers
- Hard to overcome – attacker needs to invest tremendous time, effort and know-how to have a chance for success

A single layer of defense does not provide adequate protection!

The Industrial Security Concept from Siemens: Defense in Depth - based on IEC 62443

Defense in depth

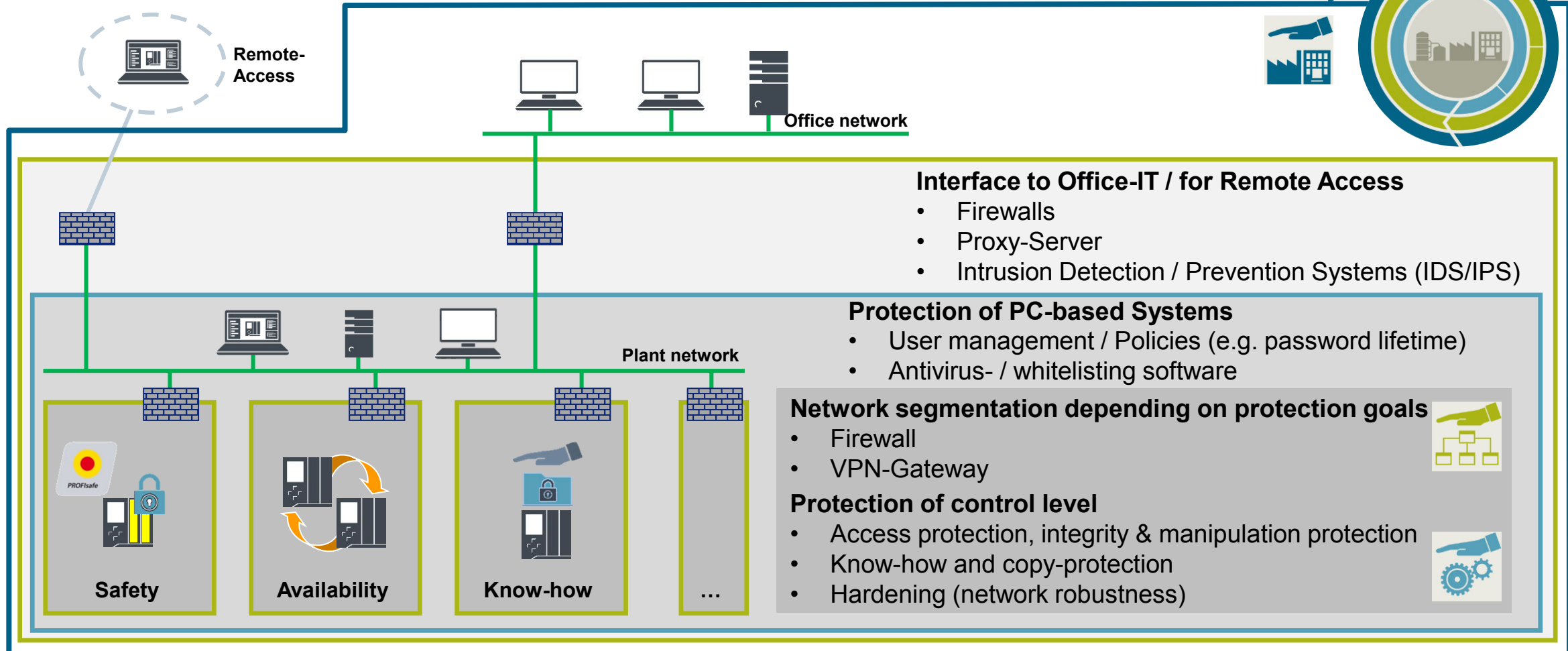
Security threats
demand action



**Security solutions in an industrial context
must take account of all protection levels**

Defense-in-Depth security architecture to protect automated production plants

Plant Security



- 1** Overview

 - 2** Risk Analysis

 - 3** **Security Concept: Defense-in-Depth**

 - 3.1** **Plant Security**

 - 3.2** Network Security

 - 3.3** System Integrity

 - 4** Validation and Improvement

 - 5** Summary
-

1. Plant Security

Establishing Security in the organization

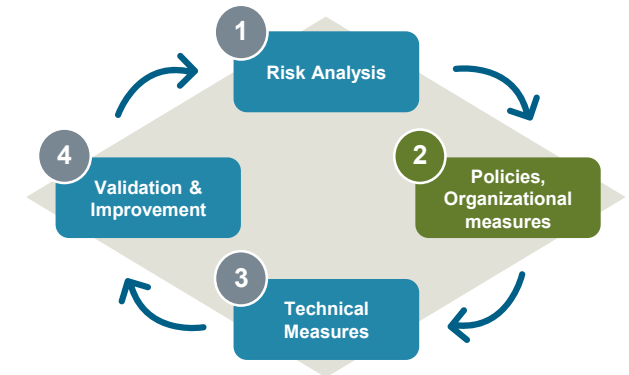
Industrial Security cannot be put into effect by technical measures alone, but has to be actively applied in all relevant company units as a continuous process.

Industrial Security as a management duty

- Support for Industrial Security by Senior Management
- Clearly defined and agreed responsibilities for Industrial Security, IT Security and physical security in the company
- Establishing a cross-disciplinary organization / network with responsibility for all Industrial Security affairs

Enhancing Security awareness

- Drafting and regular holding of training programs for production-related Security topics
- Security assessments with Social Engineering aspects



1. Plant Security

Policies and Processes

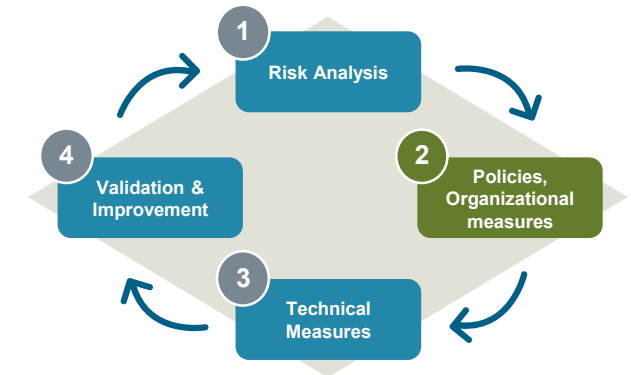
Policies and processes must be defined to ensure a uniform procedure and to uphold the Industrial Security concept.

Examples of Security-relevant policies

- Uniform stipulations for acceptable Security risks
- Reporting mechanisms for unusual activities and events
- Communication and documentation of Security incidents
- Use of mobile PCs and data storage in the production area (e.g. forbidding their use outside this area / the production network)
- Policies for suppliers of products, solutions or services

Examples of Security-relevant processes

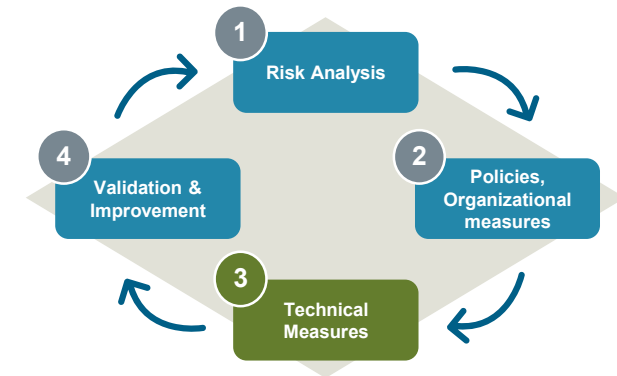
- Dealing with known / corrected weak points in components used
- Procedure in the event of Security incidents (Incident Response Plan)
- Procedure for restoring production systems after Security incidents
- Recording and evaluation of Security events and configuration changes
- Test / inspection procedure for external data carriers before use in the production area



1. Plant Security

Physical access protection of critical production facilities

- Measures and processes to prevent access by unauthorized persons to the plant
- Physical separation of various production areas with differentiated access authorizations
- Physical access protection for critical automation components (e.g. locked control cabinets)
- Coordinated guidelines for physical security and plant IT security required



Physical access protection of critical production facilities

Risks

- Access by unauthorized persons to production premises / building
- Physical damage to or changing of production equipment
- Loss of confidential information through espionage

Measures

Company Security

- Company premises fenced off and under surveillance
- Access controls incl. logging, locks / ID card readers and / or security staff
- Visitors / external personnel escorted by company staff

Physical production security

- Restricted production areas with limited access
- Critical components in securely lockable control cubicles / rooms including surveillance and alarm facilities

Contents

1 Overview

2 Risk Analysis

3 Security Concept: Defense-in-Depth

3.1 Plant Security

3.2 Network Security

3.3 System Integrity

4 Validation and Improvement

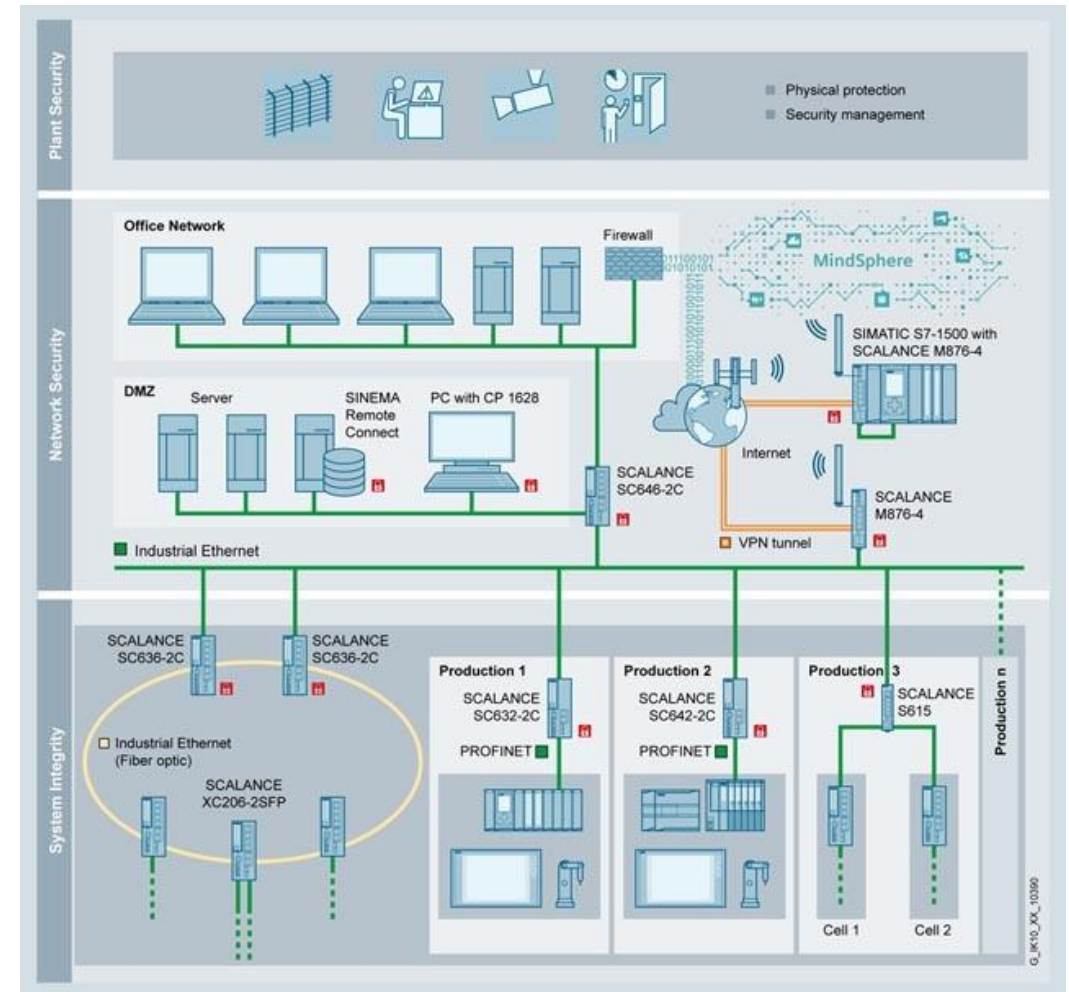
5 Summary

2. Network Security

Secure network design for protection of automation systems

Continuous communication from control to field level is more important than ever, reflected in current trends such as digital twin or industrial IoT. However, complete connectivity presents higher levels of risk, which have to be addressed with security measures:

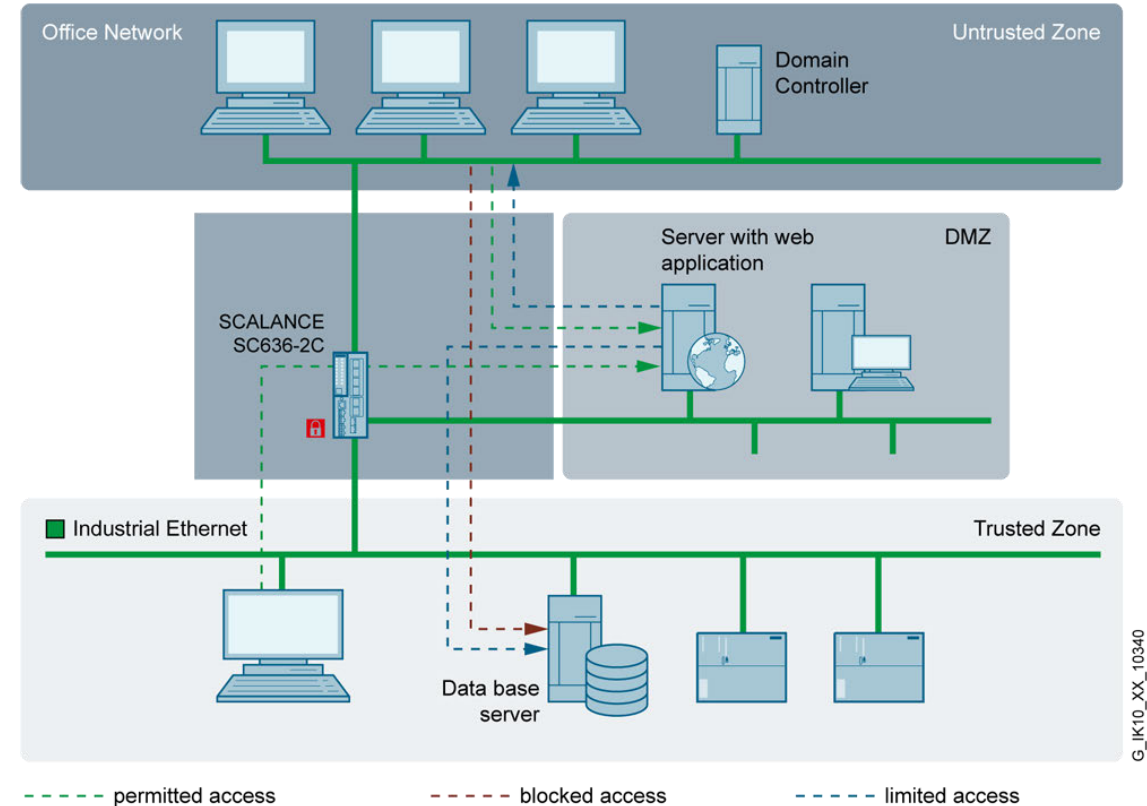
- **Separation between production and office networks**
→ Secure access via demilitarized zone
- **Usage of cell protection concept**
→ Segmentation of production in protected cells
- **Secured remote control for service and maintenance**
→ Authenticated and authorized access
- **Secured connection to cloud solutions**
→ Access protection and secured data transfer



2. Network Security

Separation of production and office networks

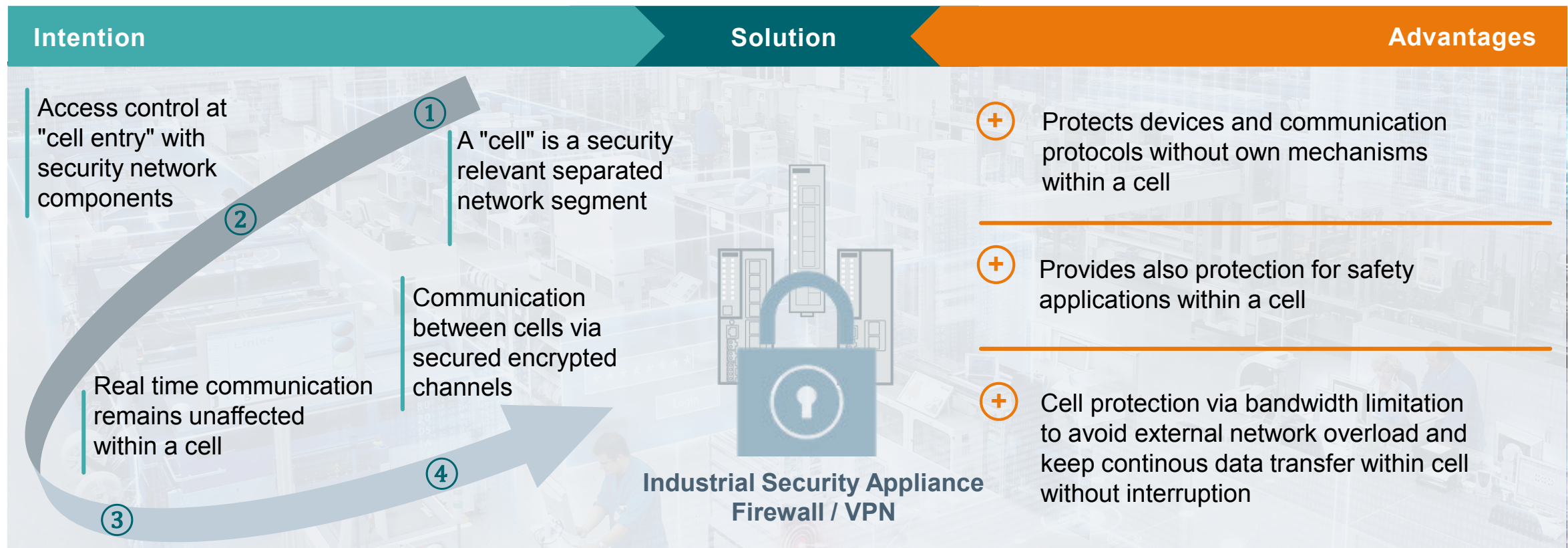
- The first step in network segmentation is strict separation between the production networks and the other company networks
- In the simplest case, separation is provided by means of a single firewall system that controls and regulates communication between the networks
- In the more secure variant, the link is realized via a separate network, the so called demilitarized zone (DMZ), respective perimeter network.
- Direct communication between the production and the company networks is completely blocked by firewalls; communication can take place only indirectly via servers in the DMZ network



2. Network Security

Usage of cell protection concept

Segmentation of production network into multiple secured automation system cells for protection of components against unauthorized access, network overload and other threats:



2. Network Security

Criteria for Network Segmentation

- With a cell protection concept a network segment **is protected from external** unauthorized access.
- Data transfer **within a cell is not controlled** by a Security Appliance and is assumed to be secure or complemented with protection measures within the cell.
- A cell contains only components with the **same protection requirements**.
- Network structure should be **derived from the production process**. This allows for the definition of cells with less communication across cell borders and with minimum firewall approvals.

Recommendation for network size and network segmentation

- All devices of a PROFINET system belongs to a single cell
- Devices with a high rate of communication should be combined in a common cell
- External components that only communicate with devices in a single cell should be integrated into the cell if their protection requirements allow.
- Limit communication based on actual need
➔ **„Need-to-connect“ principle**

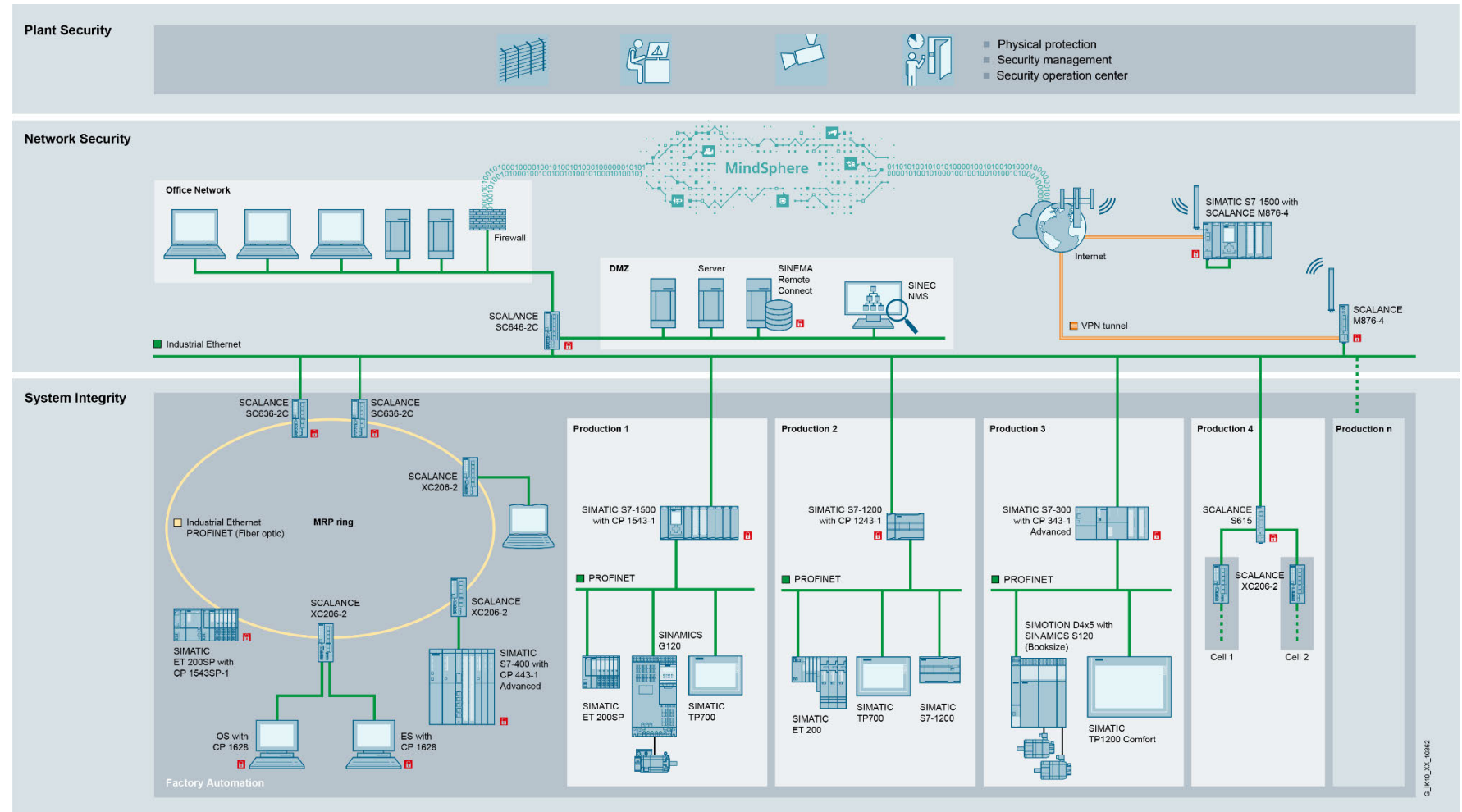
2. Network Security

Example: Network segmentation with Security Appliances

Alternatively or complementary to Industrial Security Appliances, SIMATIC S7 and PC Communication Processors (CP) can be used with **"Security Integrated"**  functionality (firewall and VPN) for the protection of automated devices and cells.

S7 communication processors protect underlying networks by an **integrated firewall**.

Additionally, **encrypted VPN connections** can be established directly to the PLC itself (S7-300, S7-400 or S7-1500).



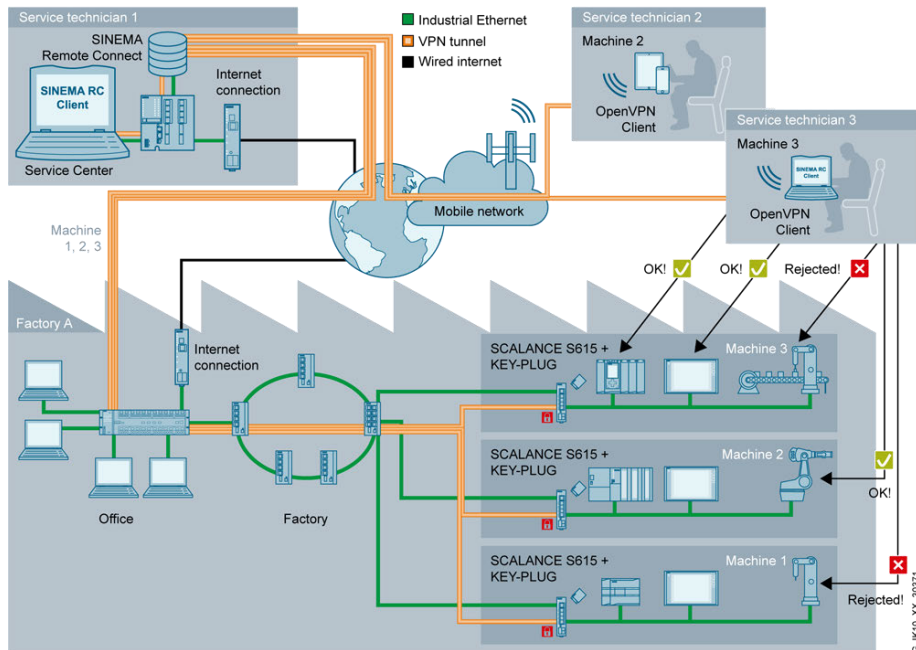
2. Network Security

Secure Remote Control for Service and Maintenance



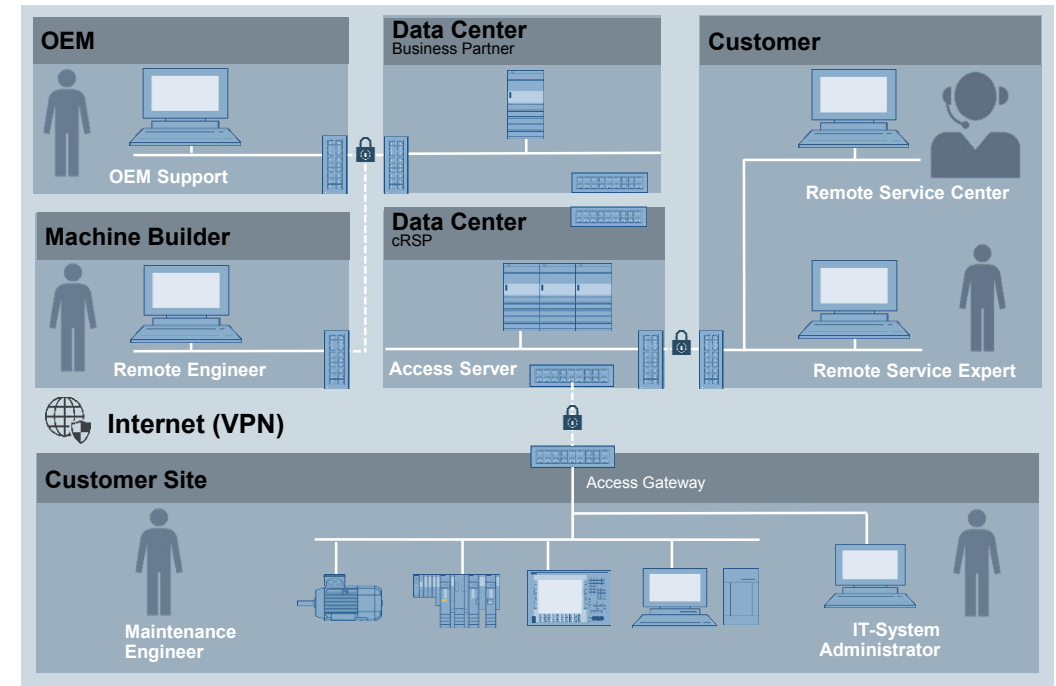
SINEMA Remote Connect

- Operation and management of a **company owned rendezvous server** for secured remote access
- **Device independent access control** via granular user and group management



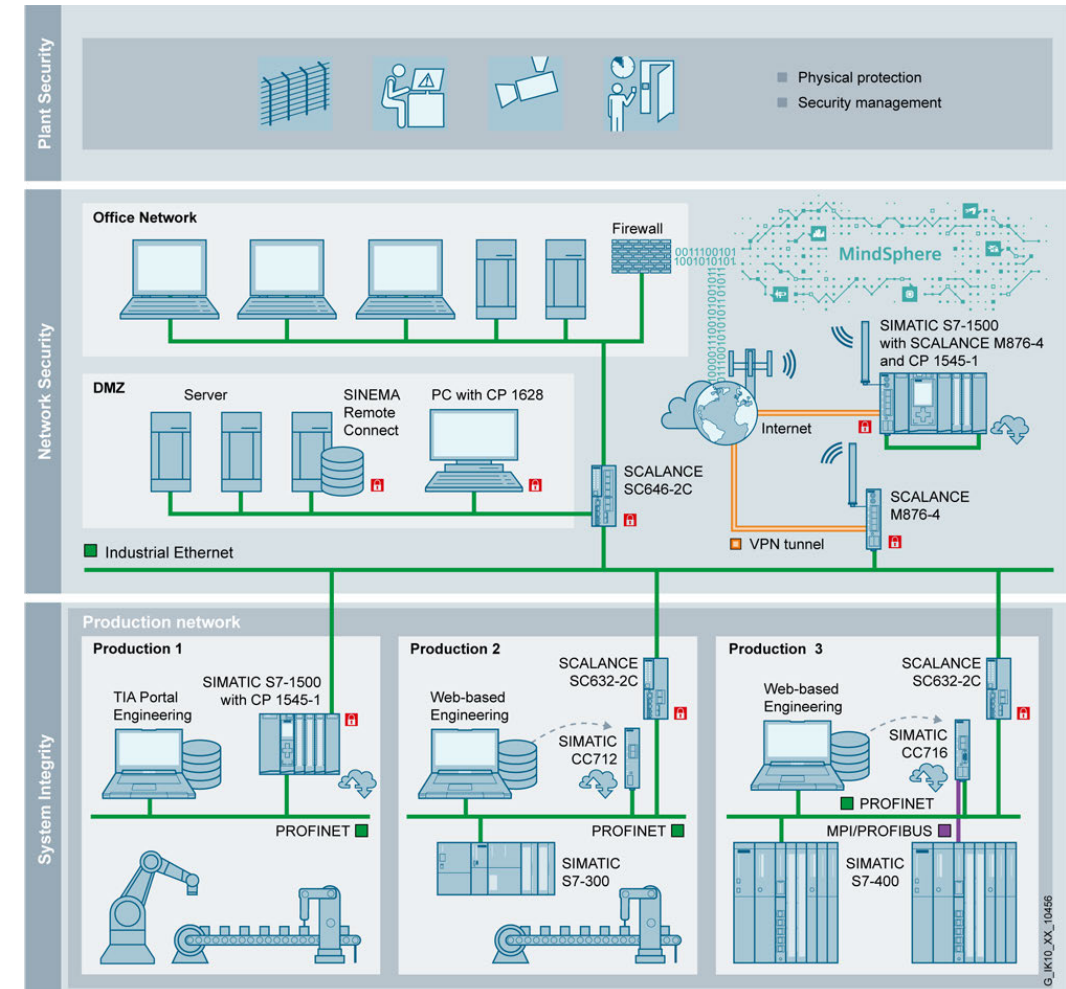
Siemens common Remote Service Platform – cRSP

- By **SIEMENS** managed **Cloud Platform** for secured remote access
- Fine-grained user rights, complete audit capability and **certification to ISO 27001**



2. Network Security Secured Cloud Connection

- Only **TLS-based communication protocols**, such as HTTPS or MQTT over TLS, are recommended for device access and data transfer.
- **Authenticated devices and data access** via password or certificates should be used instead of anonymous access
- Existing **network segmentation** and **cell protection concepts** via firewalls or network separation should be maintained.
- The IIoT gateway **SIMATIC CloudConnect 7** allows existing plants with PROFINET or PROFIBUS to be cloud connected.
- Further information: [MindSphere Security Whitepaper](#)



Risks

- Unauthorized access to automation devices without their own Security Mechanisms
- Deterioration in equipment availability due to network overload
- Espionage / manipulation of data transfer between automation systems

Measures

- Division of the automation network into appropriate network segments and control of incoming and outgoing data traffic by a firewall (perimeter security). For example, critical network protocols can be blocked.
- Bandwidth restriction, for example in a cell firewall or in switches. Network overload from outside the cell cannot affect devices inside the cell.
- Data transfer via non-secure networks, e.g. between cells or from clients to cells, can be encrypted and authenticated with the Security or VPN Appliance that controls access to the cell.

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3 Security Concept: Defense-in-Depth

3.1 Plant Security

3.2 Network Security

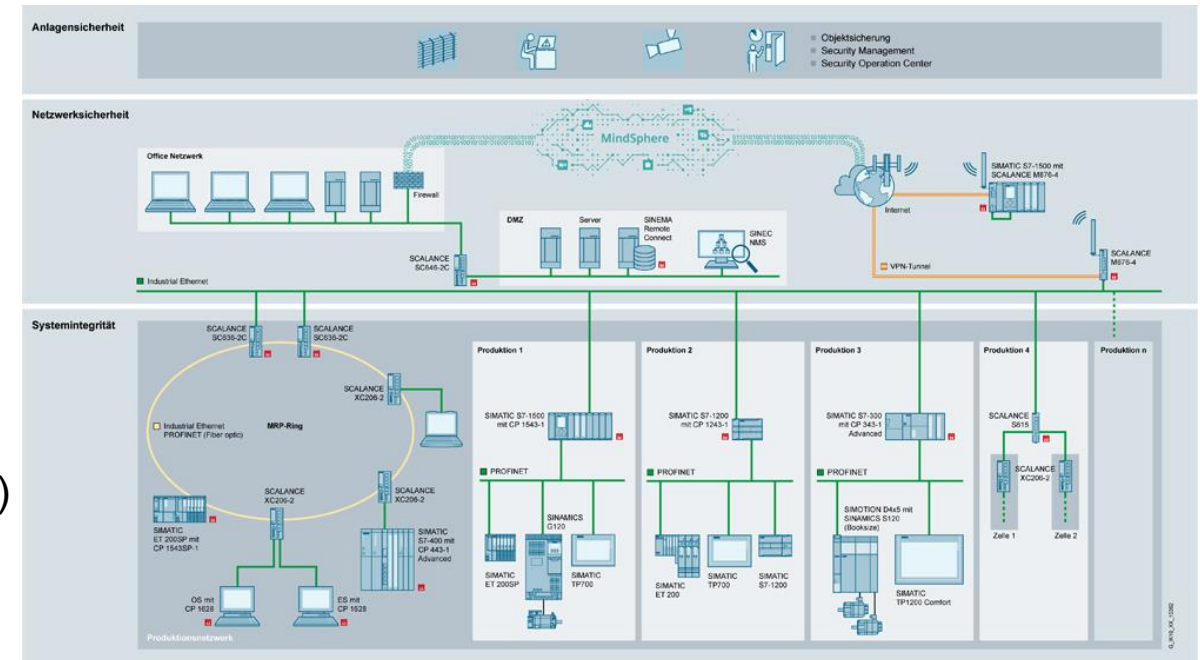
3.3 System Integrity

4 Validation and Improvement

5 Summary

Access protection for configuration (Engineering)

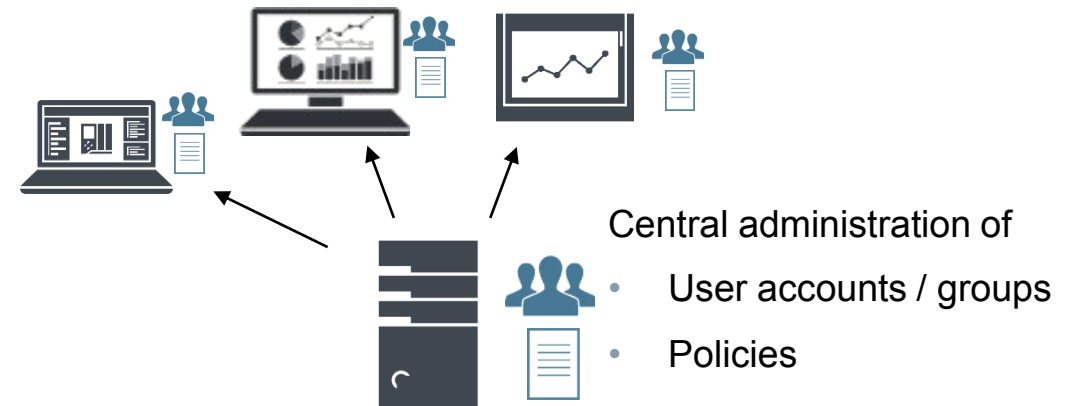
- In order to prevent unauthorized configuration changes to automation components, it is highly recommended to make use of the integrated access protection mechanisms.
- This includes for example:
 - Firewalls (User authentication)
 - WLAN Access Points (User authentication)
 - Managed Switches (User authentication)
 - HMI Panels (Access protection for device settings)
 - PLCs (Protection levels for configuration and HMI access)
 - Drives (Know-how protection)
- Use of components with integrated security features such as the S7-1500 controller or SINUMERIK ONE
- Use various passwords that are as secure as possible (if possible at least 12 upper- and lower-case characters, numbers and where applicable special characters)
- For easier password handling a common password manager is recommended. In case of coordination among multiple persons this one should be stored on a central network share including access rights.



3. System Integrity

Access protection for operations (Runtime)

- Since a plant or machinery is usually operated by more than one person, central user administration is recommended.
- This is based on user accounts of a Windows domain or a Windows Active Directory.
SIMATIC (HMI) runtime applications are connected via SIMATIC Logon or UMC.
- Specifying / enforcing security guidelines (e.g. password validity, monitoring of incorrect logging on, etc.)
- Central user administration simplifies regular review of access authorizations (e.g. identifying disused accounts)
- Independent Windows domains can be used to meet the security requirements of segregated networks.
- Depending on required roles (operator, administrator, etc.) user accounts can be restricted to the minimum required operating rights.



3. System Integrity

Access protection for network components (Network)

- **Access protection for networks by means of**
 - Port Security with Switch Ports: MAC or IP access lists restrict access
 - Port Security with central device administration and RADIUS authentication (802.1X)
 - Perimeter security of a network in relation to other networks (e.g. Internet) with firewalls
- **WLAN Security**
 - Safeguarding of data transfer in accordance with at least WPA2
 - Advanced Encryption Standard (AES) for encoding data
 - Central device administration with RADIUS authentication (in accordance with 802.1X)
 - Protected configuration accesses via HTTPS web interface and SSH sessions

3. System Integrity

System hardening reduces possible attack scenarios

Network Services

- Active network services are a potential security risk in general
- To minimize risks, only the services that are actually required should be activated on automation components.
- All activated services (especially Webserver, FTP, Remote Desktop, etc.) should be taken into account in the security concept
- Hardening measures (network robustness) in automation and drives products enhance security without the need for separate user configuration



[Industrial Security Services](#)

HW & System Interfaces

- Hardware interfaces constitute a risk if unauthorized access via them to equipment or the system is possible. Therefore unused interfaces should be deactivated:
 - USB, Ethernet/PROFINET ports
 - WLAN, Bluetooth, Mobile Comm.
- Protection by deactivation or at least mechanical blocking
- Deactivate booting and Autostart mechanisms of external media
- Activate access protection to BIOS- / UEFI settings
- Only use remote management, like AMT, in a secured manner

User Accounts

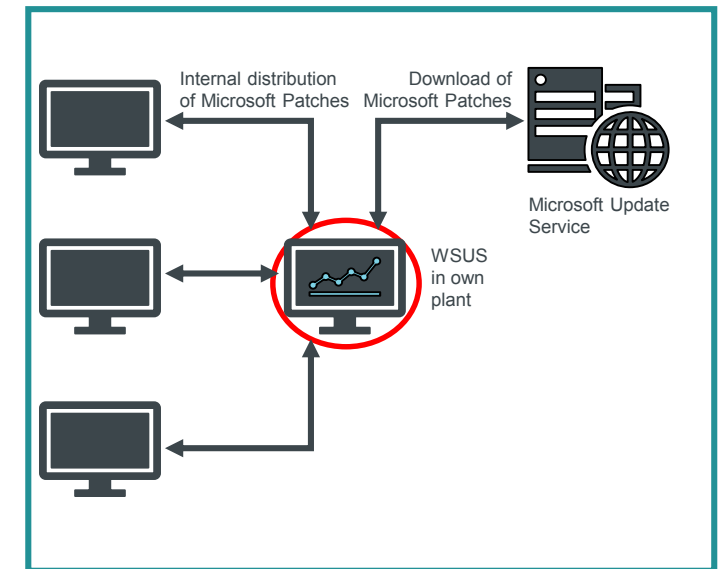
- Every active user account enables access to the system and is thus a potential risk
- Reduce configured / activated user accounts to the minimum necessary
- Use secure access data for existing accounts
- Audit accounts, particularly locally configured user accounts, regularly
- **Important:** If predefined default passwords are present, they must be changed during system commissioning.

3. System Integrity

Patch management fixes security vulnerabilities in operating system and applications

Many security attacks nowadays take place via weak points for which the manufacturers already have patches. Zero day exploits are encountered rarely, where the weak point is not yet known or updates are not available.

- The installation of patches and updates is an important measure to enhance security
- Siemens supports compatibility tests of Microsoft security patches:
 - SIMATIC PCS 7: <http://support.automation.siemens.com/WW/view/en/22754447>
 - SIMATIC WinCC: <http://support.automation.siemens.com/WW/view/en/18752994>
- System-specific compatibility tests recommended
- Patch distribution via central patch server in DMZ and Windows Server Update Services (WSUS)
 [Industrial Security Services](#)
- Set up of update groups and processes for online update simplifies patch distribution (e.g. for redundant systems)



3. System Integrity

Firmware updates for more security within automation devices

- Even such automation components that do not use a standard PC operating system may require software updates to fix security related vulnerabilities.
- Information is available at our Siemens Industrial Security website (<http://www.siemens.com/industrialsecurity>) as well as our product newsletters or RSS feeds.



[Industrial Security Services](#) (Industrial Vulnerability Manager)

- As soon as information on a vulnerability becomes available, it should be evaluated for relevance to the application concerned
- Depending thereon, it can be decided whether further measures should be taken:
 - No action, as existing measures provide sufficient protection
 - Additional external measures in order to uphold the security level
 - Installation of latest firmware updates to eliminate the weak point
- The procedure is comparable with a risk analysis, as described earlier in the presentation, but with restricted focus
- **Tip:** Tools like SIMATIC Automation Tool or SINEC NMS also support software updates for automation and network components

3. System Integrity

Identifying / preventing malware with virus scanners

- Suitable antivirus software should be used to identify malware and to prevent further spreading
- Depending on the particular case, certain aspects should however be taken into account:
 - Performance loss due to scan procedure (e.g. only automatic scan of incoming data transfer and manual scan during maintenance periods)
 - Regular updating of virus signatures – if applicable via central server
 - Availability must generally be assured even in the case of infection with malware. This means that the virus scanner must under no circumstances:
 - Remove files or block access thereto or move into Quarantine
 - Block communication
 - Shut down systems
- Siemens supports with compatibility tests with *) :
 - McAfee Endpoint Security  [Industrial Security Services](#)
 - Symantec Endpoint Protection
 - Trend Micro Office Scan
- Further information is available in the Siemens compatibility tool : <http://www.siemens.com/kompatool>

*) Please note the compatibility must be verified for each specific configuration

3. System Integrity

Identifying / preventing malware by whitelisting

Basic principle

- Whitelisting mechanisms provide additional protection against undesired applications or malware, as well as unauthorized changes to installed applications
- Whitelisting software creates or contains a list of programs and applications that are allowed to run on the PC
- Software that is not listed in this “white list” is prevented from running

Advantages

- No regular or delayed pattern updates
- Additional protection mechanism
- Higher Protection against specific types of malware

- Siemens supports with compatibility tests with *) :

- McAfee Application Control



[Industrial Security Services](#)

- Further information is available in the Siemens compatibility tool :
<http://www.siemens.com/kompatool>

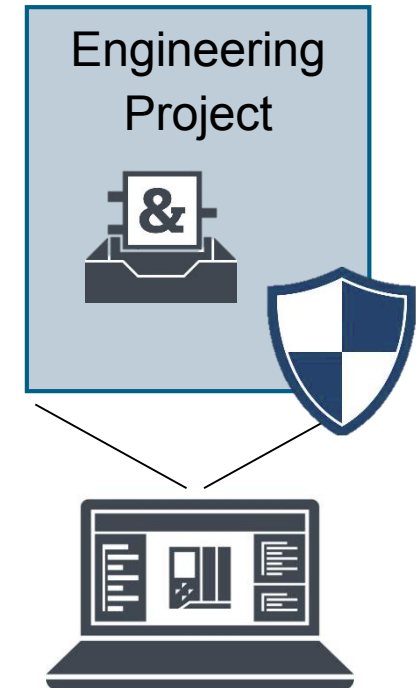
*) Please note the compatibility must be verified for each specific configuration

3. System Integrity

Access protection of industrial project files

Project files for industrial automation solutions (e.g. Engineering Project files) often contain internal know-how, which shall not fall into foreign hands. You should therefore protect and prevent from disclosure industrial project files by consider the following guidelines:

- Protect project files at rest (e.g.: access protection using file system rights; storage in an encrypted drive container)
- Encrypt project files when they are in transit (e.g. via e-mail encryption or encrypted ZIP archives)
- Enforce the need to know principle
- Assess and configure security measures that are connected with online services to test for malicious files carefully. Otherwise industrial project files might be uploaded unintentionally and automatically to external systems. This is for example related to 3rd party automated e-mail gateway scanners, Endpoint Protection Systems, DLPs or IDSs.



Risks

- Manipulation / espionage via unauthorized access to devices configuration
- Unauthorized operating activities
- Limited device availability due to malware installation and replication
- Unauthorized/public access to project files

Measures

- Utilization of access control mechanisms in automation components, which limits access to configuration data and settings to authorized persons only
- Implementation of individual hardening measures for each automation component to reduce targets
- Installation of available updates in case of fixed security vulnerabilities or establishing alternative protection measures
- Usage of antivirus and whitelisting mechanisms as protection mechanism against malware
- Usage of protection mechanism for project files during their whole lifecycle (encrypted storage and transfer; access control; prevent them from being uploaded to online scanning engines; safe deletion of outdated files)

Contents

1 Overview

2 Risk Analysis

3 Security Concept: Defense-in-Depth

3.1 Plant Security

3.2 Network Security

3.3 System Integrity

4 Validation and Improvement

5 Summary

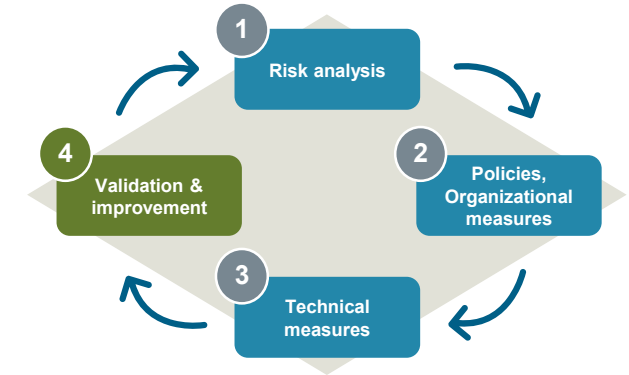
Review of measures

Reviews and improvements

After implementation of all planned measures a Security Audit is conducted to ensure that

- measures have been put into practice as scheduled,
- these measures reduce the identified risks as expected.

Depending on the results, measures can be changed / added in order to attain the necessary security.



Repeat the risk analysis

Due to the changes in security threats, regular repetition of the risk analysis is required in order to ensure the security of plant / machinery

- Following certain occurrences (expansion of or changes to plant / machinery, significant changes in security threats, etc.)
- Annual check of whether a new risk analysis is required

ProductCERT is a dedicated team of seasoned security experts that manages the receipt, investigation, internal coordination, and public reporting of security issues related to Siemens products, solutions, or services.

ProductCERT

- cultivates strong and credible relationships with partners and security researchers around the globe
- acts as the central contact point to report potential Siemens product security vulnerabilities
- coordinates and maintains communication with all involved parties, internal and external, in order to appropriately respond to identified security issues
- publishes Security Advisories, which allows customers to
 - get information about affected products
 - receive detailed vulnerability description (CVE)
 - determine relevance for own solutions, e.g. based on CVSS score
 - obtain information about required steps for a protected plant operation



<https://www.siemens.com/cert>

Contents

- 1** Overview

 - 2** Risk Analysis

 - 3** Security Concept: Defense-in-Depth
 - 3.1** Plant Security

 - 3.2** Network Security

 - 3.3** System Integrity

 - 4** Validation and Improvement

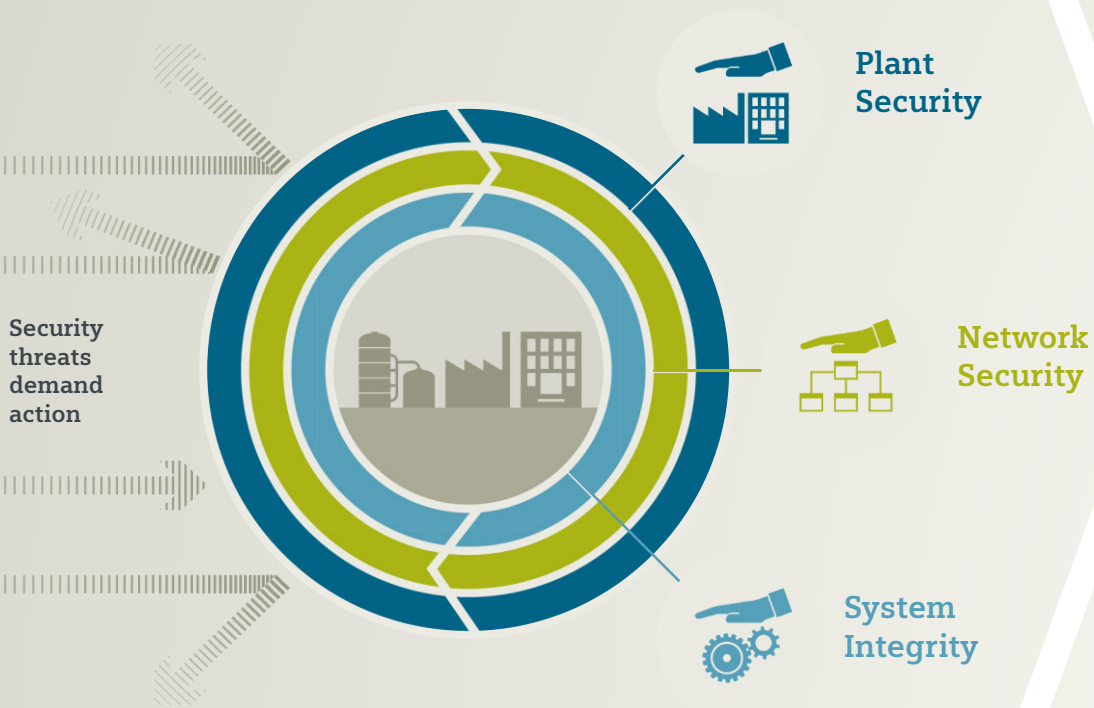
 - 5** **Summary**
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Industrial Security

Our offering for comprehensive Security solutions



The Siemens security concept – “Defense in Depth”



Siemens products and systems offer integrated security



Know-how and
copy protection



Access protection
and user
management

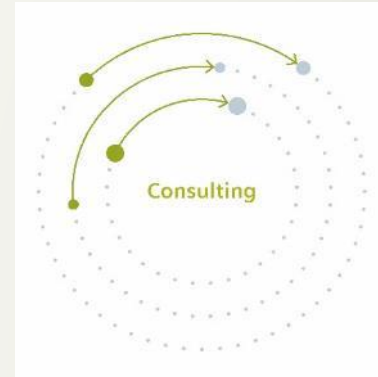


Firewall & VPN
(virtual private
network)



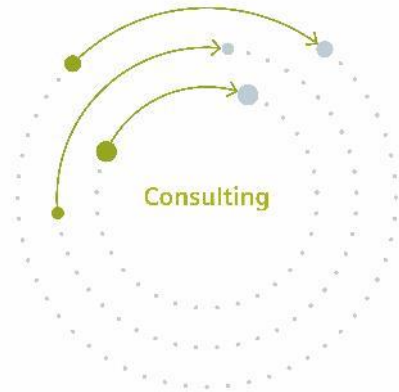
System hardening

Siemens Industrial Security Services



Industrial Security Services

A holistic approach



Security Consulting

Evaluation of current security status in industrial environment

- Security Assessments
- Scanning Services
- Industrial Security Consulting



Security Implementation

Risk mitigation by implementation of security measures

- Security Awareness Training
- Automation Firewall
- Endpoint Protection e.g. hardening measures (network robustness)



Security Optimization

Increased protection by Managed Services

- Industrial Anomaly Detection
- Industrial Security Monitoring
- Remote Incident Handling
- Industrial Vulnerability Manager
- Patch Management
- SIMATIC Security Service Packages

<https://support.industry.siemens.com/cs/en/en/sc/4973>

Industrial Security



- Industrial Security is not just a question of technical implementation, but rather an ongoing process which also has to be understood as a management task
- Depending on the particular risks inherent in the automation system, appropriate organizational and technical measures must be taken and regularly reviewed
- Maximum security is only possible in close cooperation between all involved parties
- Siemens Industry Automation provides products and systems as well as Security Services, in order to ensure comprehensive Industrial Security solutions for our customers

Industrial Security – ... discover more – Concepts, Products and News

SIEMENS
Ingenuity for life



Internet



Detailed concept information and news to vulnerabilities

- News/Alerts
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Further Security Guidelines

- **Security guidelines for SIMATIC HMI devices**
<https://support.industry.siemens.com/cs/ww/en/view/109481300>
- **Recommended Security Settings for IPCs in the Industrial Environment**
<https://support.industry.siemens.com/cs/ww/en/view/109475014>
- **Security with SIMATIC S7-Controller**
<https://support.industry.siemens.com/cs/ww/en/view/90885010>
- **SIMATIC Process Control System PCS 7 Security concept PCS 7 & WinCC (Basic)**
<https://support.industry.siemens.com/cs/ww/en/view/60119725>
- **SIMATIC Process Control System PCS 7 Compendium Part F - Industrial Security**
<https://support.industry.siemens.com/cs/ww/en/view/109756871>
- **SINUMERIK / SIMOTION / SINAMICS Industrial Security**
<https://support.industry.siemens.com/cs/ww/en/view/108862708>



Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks. In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

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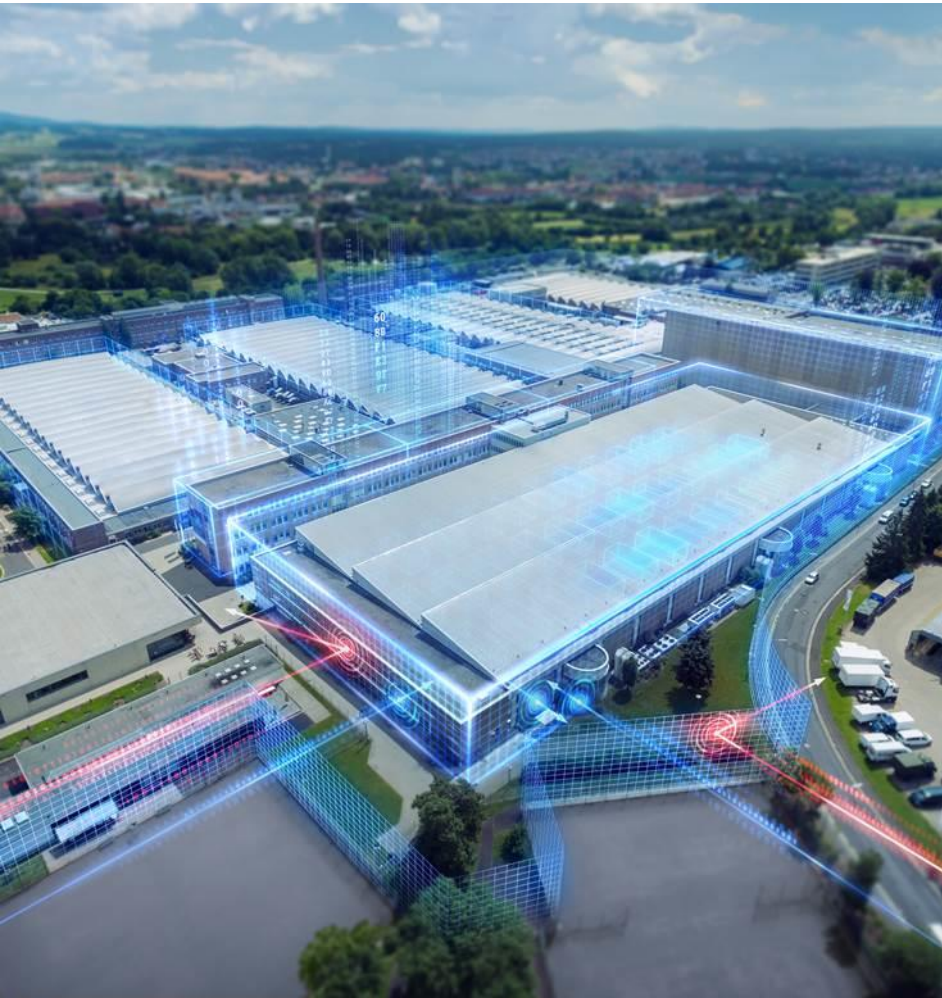
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