DIGITAL FACTORY

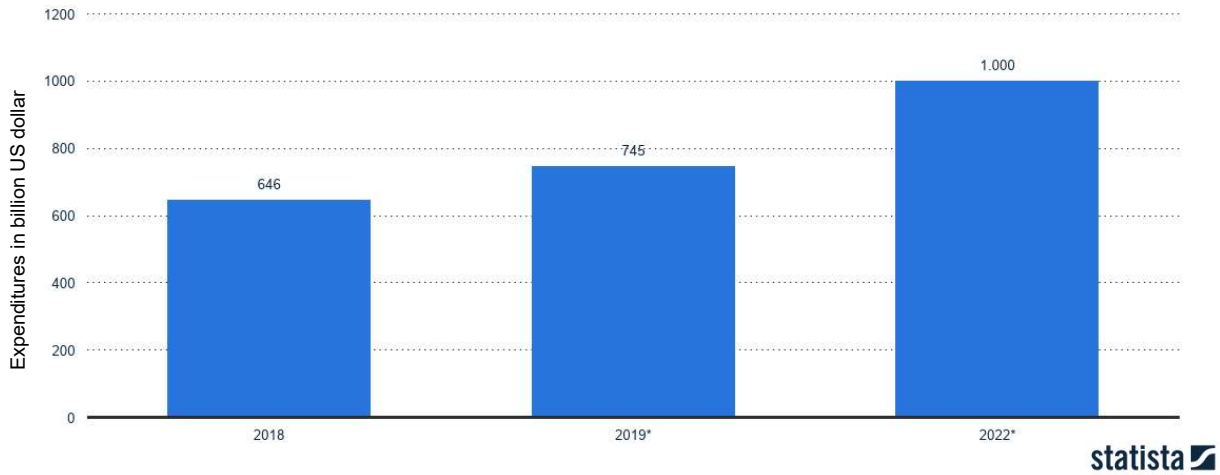
NOW

DIGITAL FACTORY NOW

The Power and Potential of Digitalization

Potential

Forecast for expenditure on the Internet of Things (IoT) worldwide in the years 2018 to 2022 (in billion US dollar)



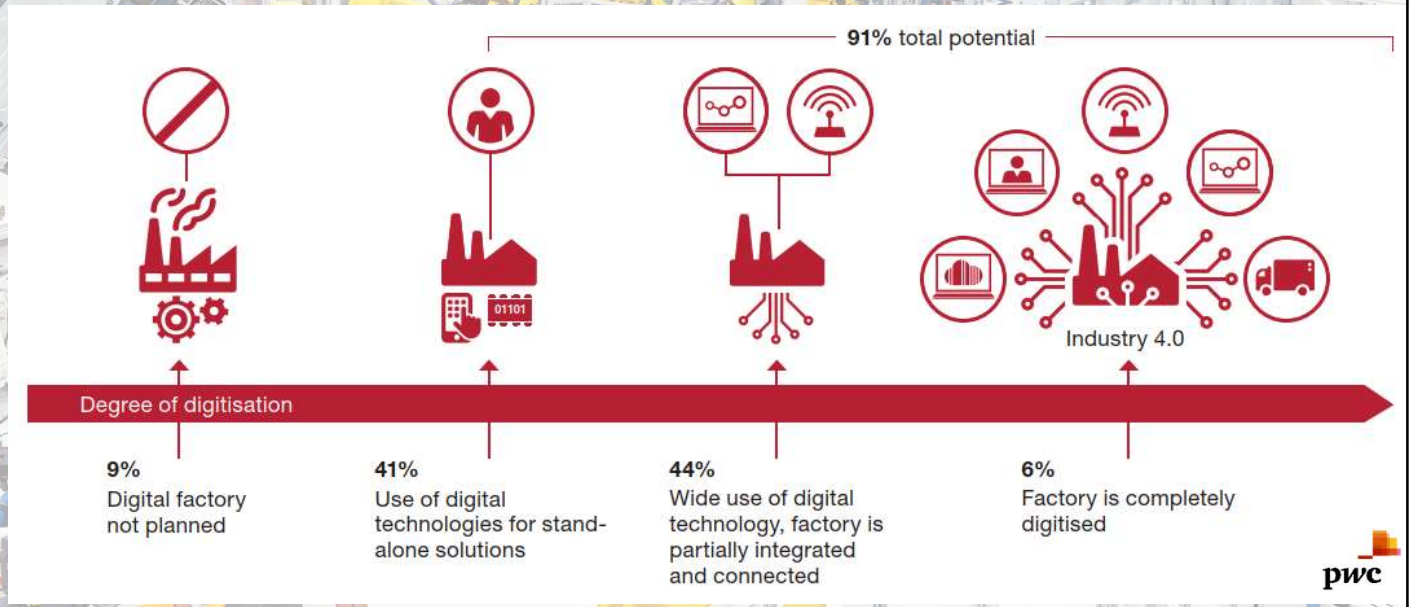
Countries all over the world are investing into digitalization

PHOENIX CONTACT
INSPIRING INNOVATIONS

Source: Statista: ID537226 (https://de.statista.com/)

Digital Factory | The power and potential of digitalization

Potential



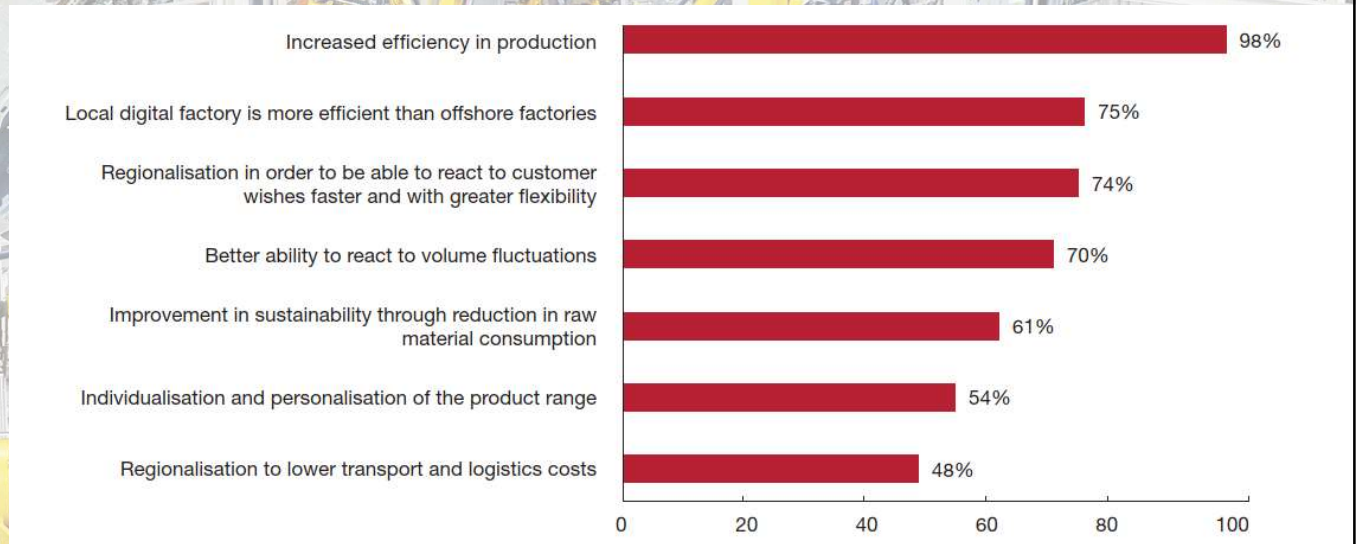
9 out of 10 companies are investing in Digital Factories

PHOENIX CONTACT
INSPIRING INNOVATIONS

Source: pwc: Digital factories 2020 - Shaping the future of manufacturing: (https://www.pwc.com/gx/en/industries/industrial-manufacturing/publications/digital-factories-2020.html)

Digital Factory | The power and potential of digitalization

Why invest in Digital Factories?



Q: What are your significant reasons for setting up or expanding digital factories?
Base: Respondents planning to set up or expand digital factories

pwc

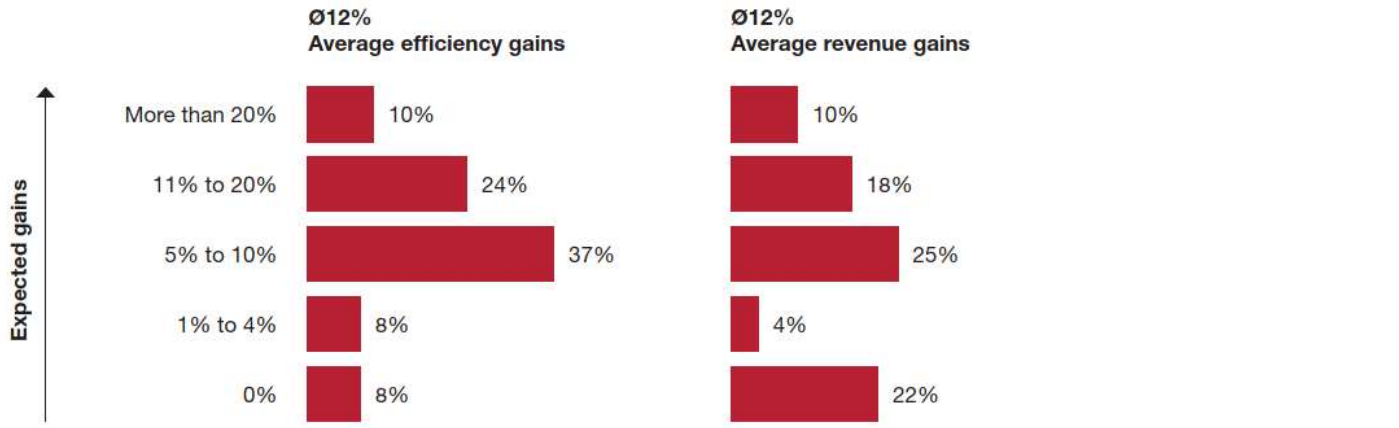
Efficiency and customer centricity are top reasons for expanding Digital Factories

PHOENIX CONTACT
INSPIRING INNOVATIONS

Source: pwc: Digital factories 2020 - Shaping the future of manufacturing: (https://www.pwc.com/gx/en/industries/industrial-manufacturing/publications/digital-factories-2020.html)

Digital Factory | The power and potential of digitalization

Why invest in Digital Factories?



Q: An efficiency gain by how many percent in comparison to now do you expect for your company over the next five years from digital factories? A revenues gain by how many percent in comparison to now do you expect for your company over the next five years from digital factories?

Base: Respondents whose companies have or are planning a digital factory or the use of at least one digital concept

pwc

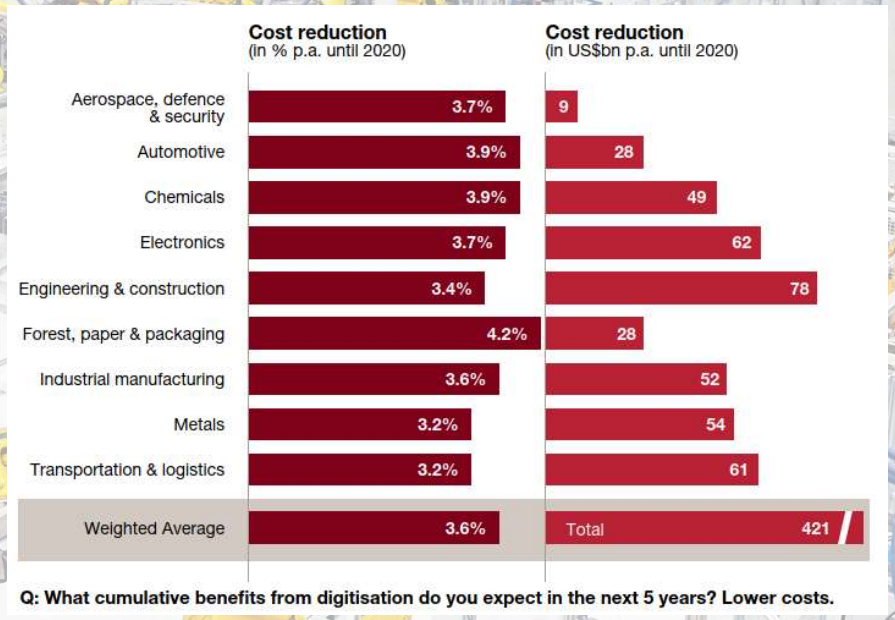
Respondents expect both efficiency and revenue gains of 12% on average over the next 5 years

PHOENIX CONTACT
INSPIRING INNOVATIONS

Source: pwc: Digital factories 2020 - Shaping the future of manufacturing: (https://www.pwc.com/gx/en/industries/industrial-manufacturing/publications/digital-factories-2020.html)

Digital Factory | The power and potential of digitalization

Why invest in Digital Factories?



pwc

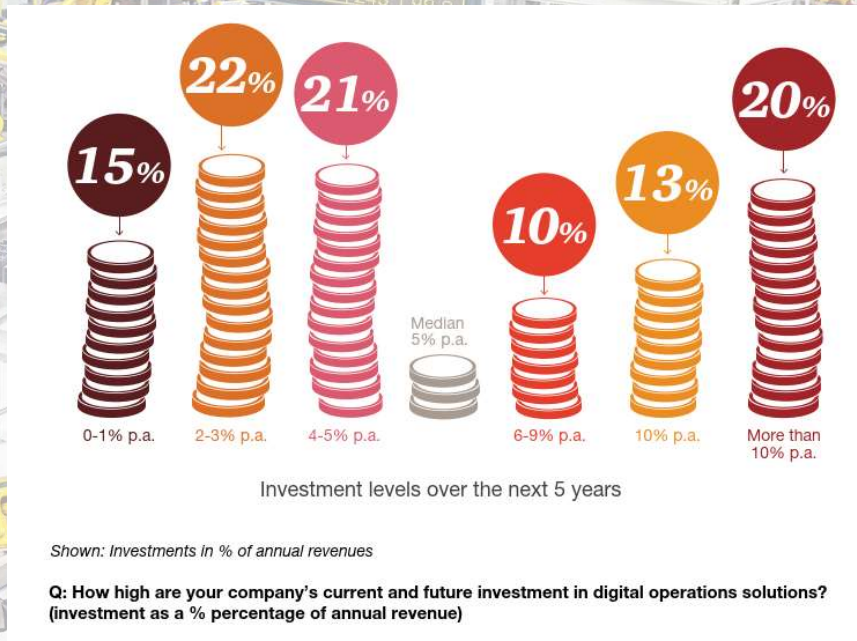
Companies in every industry sector expect significant cost reductions

PHOENIX CONTACT
INSPIRING INNOVATIONS

Source: pwc: Industry 4.0 - Building the digital enterprise (https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf)

Digital Factory | The power and potential of digitalization

Why invest in Digital Factories?



pwc

Companies that do not strategically invest will lose competitive advantage

PHOENIX CONTACT
INSPIRING INNOVATIONS

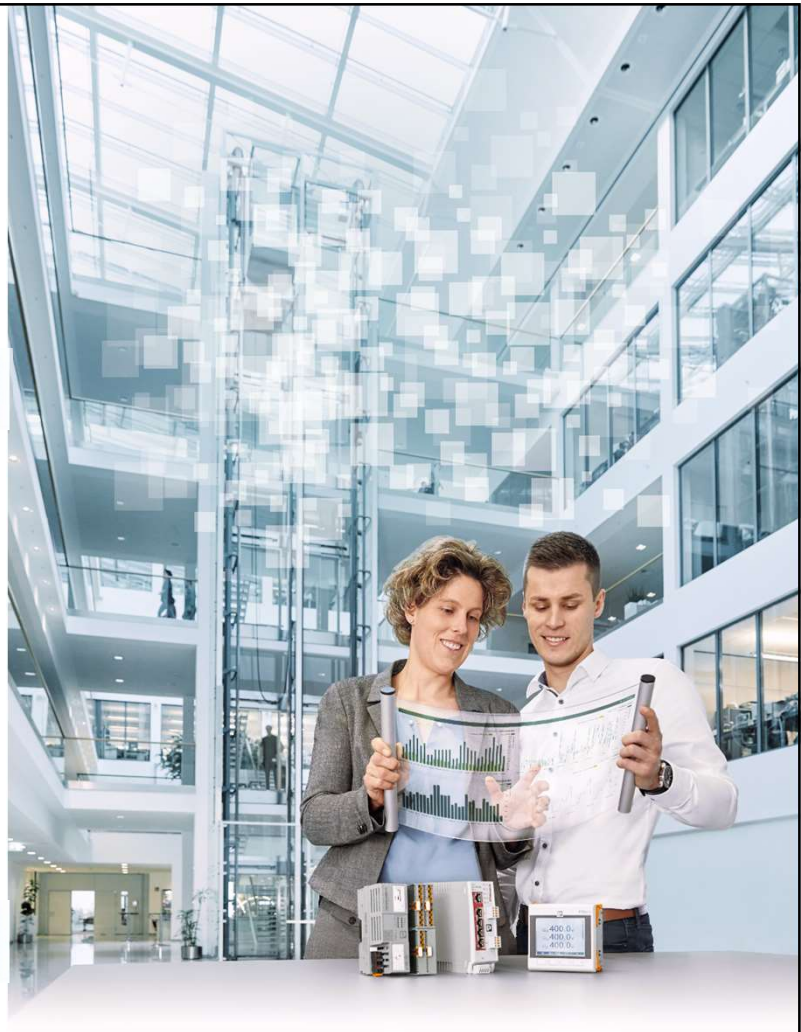
Source: pwc: Industry 4.0 - Building the digital enterprise (https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf)

Digital Factory | The power and potential of digitalization

Digitalization and mankind

Digitalization does not replace people

Digitalization creates new jobs



PHOENIX CONTACT
INSPIRING INNOVATIONS

DIGITAL FACTORY

NOW

From a Factory to a Digital Factory

Digitalization changes our world

Flexible consumption

New, data centric business models

Mass customization

Economic production with batch size one

Smart devices / IoT

Networked systems as a basis

Knowledge sharing

Lack of skilled workers and efficient development processes

PHOENIX CONTACT
INSPIRING INNOVATIONS

Goals of Digital Factory

1. **Optimized production**
2. **Reduced costs**
3. **Idea-to-cash**

PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | From a factory to a Digital Factory

Customer requirements and benefits

Enable new ideas

The Digital Factory transfers data into information. This information will be used to optimize processes and reduce costs.

- New business models
- Idea-to-cash

Flexible infrastructure

Our solutions are scalable to respond quickly to growth potentials. Independent on the factory and production size and amount of data – we are able to adapt a solution to every industry.

- Optimized production
- Update capability

Proof-of-concept

Everything was proven in our own production facility. From concept to maintenance, we provide finished and tested use cases.

- Reduced engineering costs
- Benefit from experience

PHOENIX CONTACT
INSPIRING INNOVATIONS

Challenges

- Extract relevant information from a huge amount of data automatically
- Get more information output with lower investment
- Reduced engineering costs by increasing automation and communication

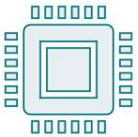
Technological aspects (technology push)

Industrial revolution

1.	Mechanical production	18th century
2.	Mass production	1870
3.	Automation of production	1969
4.	IIoT	Currently

- Steam machine
- Simplify and accelerate hard work

- Sequential work flow
- Increased production rate



- From relay to PLC
- Flexible control adaptions

- **Every device is connected**
- **Big data**

Illustration according to:
G. Reinhart, Handbuch Industrie 4.0, S.XXXI

PHOENIX CONTACT
INSPIRING INNOVATIONS

Changes through Digital Transformation

BEFORE INTERNET

- Clipboard
- Stack lights
- Memos
- Meeting
- Scheduler board
- Push buttons
- Phone calls
- Bells
- Daily reports

DIGITAL TRANSFORMATION

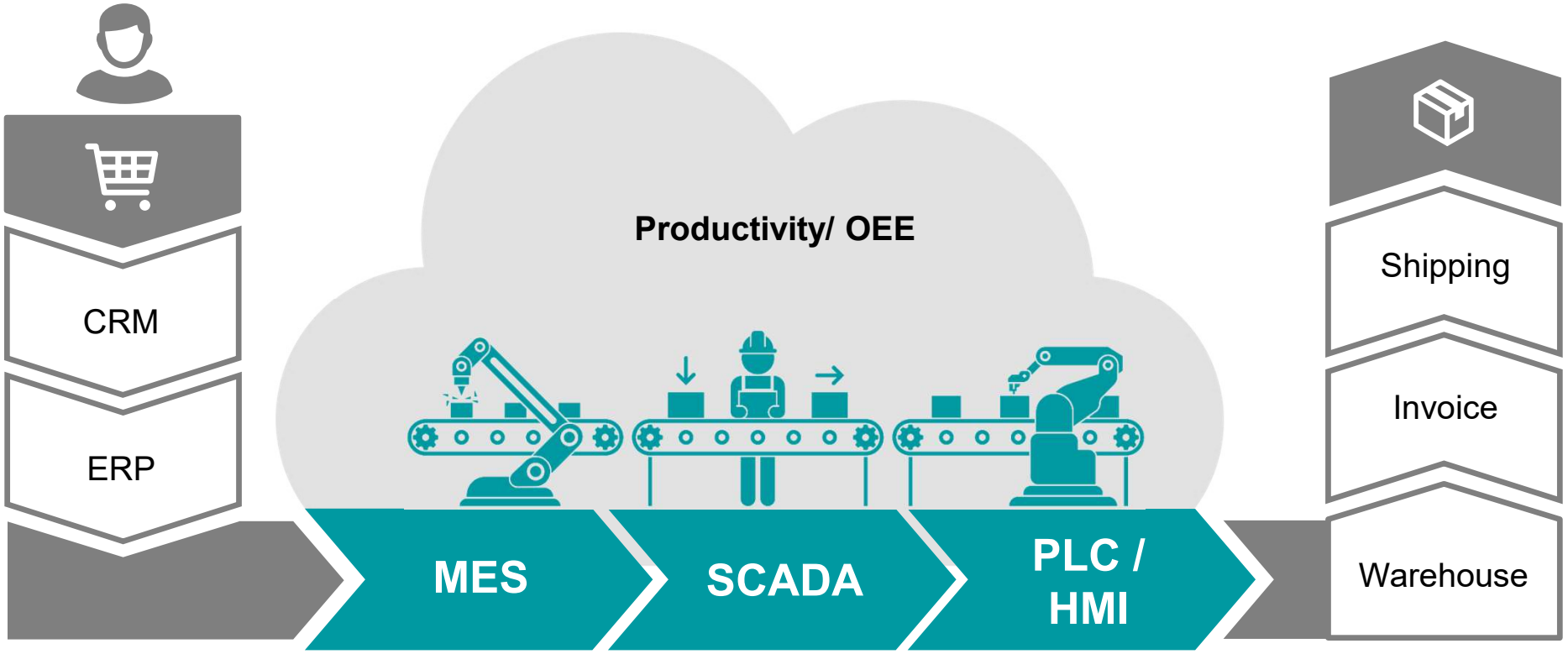
Process information available and accessible from everywhere
– No PAPER –

How to do the move to a Digital Factory?

WITH INTERNET

- E-mail/ SMS
- Andon board/ notification
- Digital comments (MES)
- Webpage (machine)
- Teams/ Zoom (Flow)
- Digital/ realtime
- Control room/ MES/ SCADA
- Video messaging
- Realtime opportunities

Why do many digitalization strategies fail?



OEE = Overall equipment effectiveness

PHOENIX CONTACT
INSPIRING INNOVATIONS

How to calculate OEE (overall equipment effectiveness)

1. Locate source of inefficiencies
2. Quantify the degree of inefficiency

OEE combines three factors:

Availability (**A**)	100% machine is available at scheduled time
Performance (**P**)	100% performance at max. speed
Quality (**Q**)	100% of all parts are OK

$$OEE = A * P * Q$$

PHOENIX CONTACT
INSPIRING INNOVATIONS

The six big losses of OEE

A. Planned output

B. Gross output

C. Net output

D. Valuable output

5. Start up scrap
6. Scrap

3. Idling
4. Reduced speed

1. Breakdowns
2. Set-ups & changeover

$$\underbrace{\frac{Gross\ output}{Planned\ output}}_{\downarrow\ Availability\ rate\ \boldsymbol{A}} * \underbrace{\frac{Net\ output}{Gross\ output}}_{\downarrow\ Performance\ rate\ \boldsymbol{P}} * \underbrace{\frac{Valuable\ output}{Net\ output}}_{\downarrow\ Quality\ rate\ \boldsymbol{Q}} = \boldsymbol{OEE}$$

PHOENIX CONTACT
INSPIRING INNOVATIONS

How to move to a Digital Factory?

Digital Transformation

- Digitization of business
  - No paper
  - Unified data
- Gather information with actual data
- Use of digitalization **to inform and guide** people

Industry 4.0

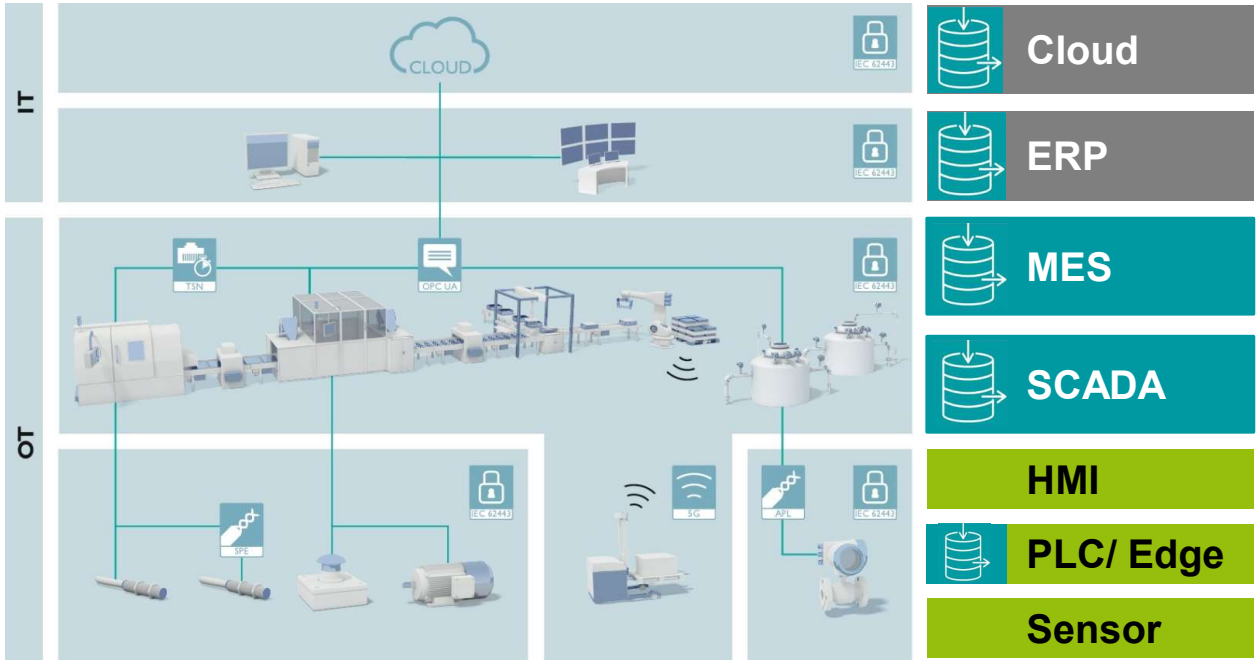
- 4th industrial revolution
  - Network/ technology
  - Standards/ protocols
- Smart production principles
  - Connection of all machines and systems
  - Open architecture

Digital Factory

- The result of Digital Transformation and Industry 4.0
- Information from each producer to each consumer
- Available data anytime, everywhere
- Translation of data into information

PHOENIX CONTACT
INSPIRING INNOVATIONS

Why does the current architecture prevent innovation?



Cloud

ERP

MES

SCADA

HMI

PLC/ Edge

Sensor

Solut ntered

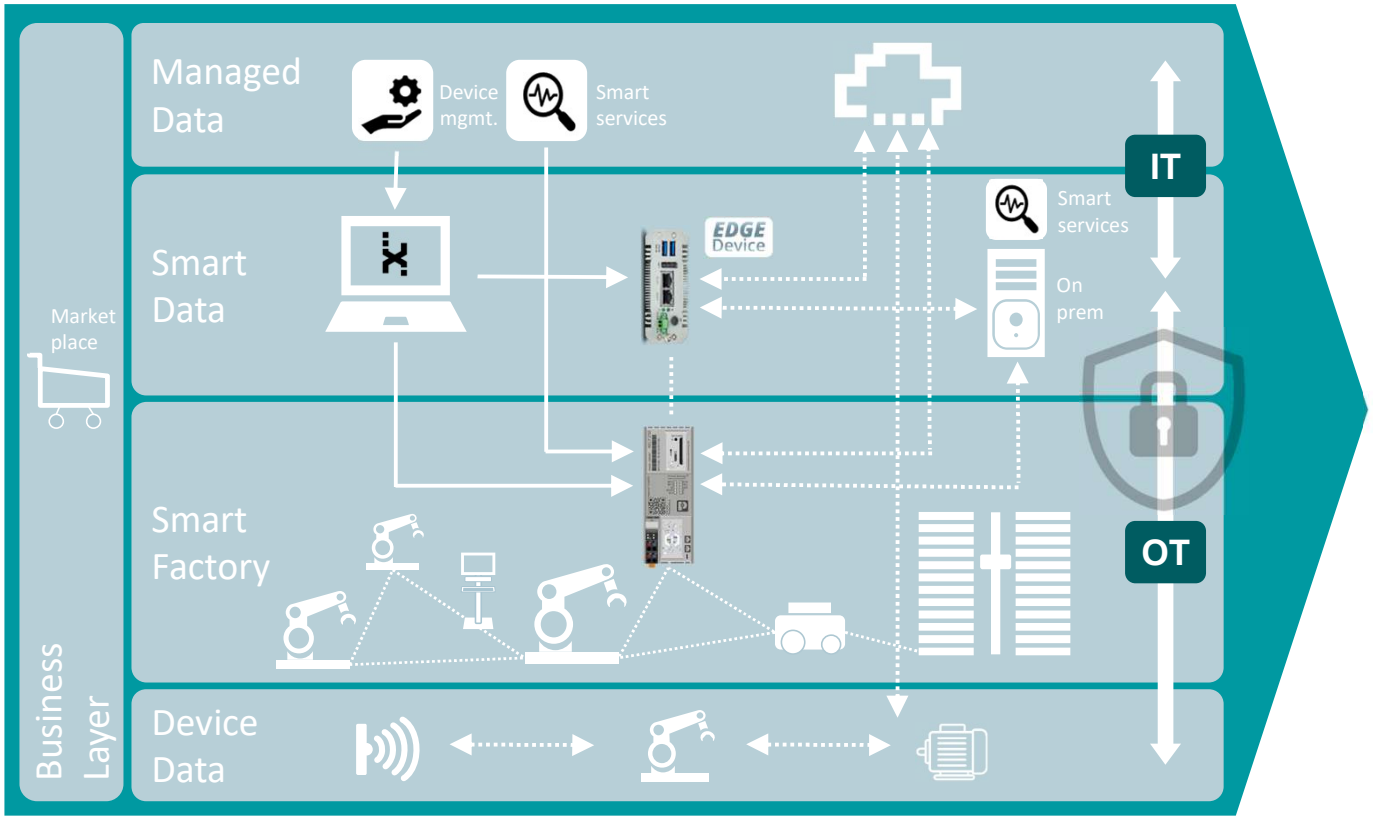
- No normalization
- No abstraction
- No standard
- Only high-value projects
- Data silos

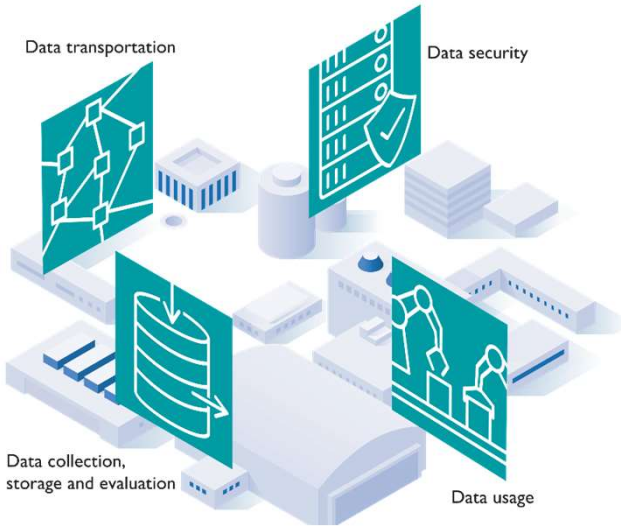
Show stopper for optimization projects !

PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | From a factory to a Digital Factory

Create a solution to enable factory optimization

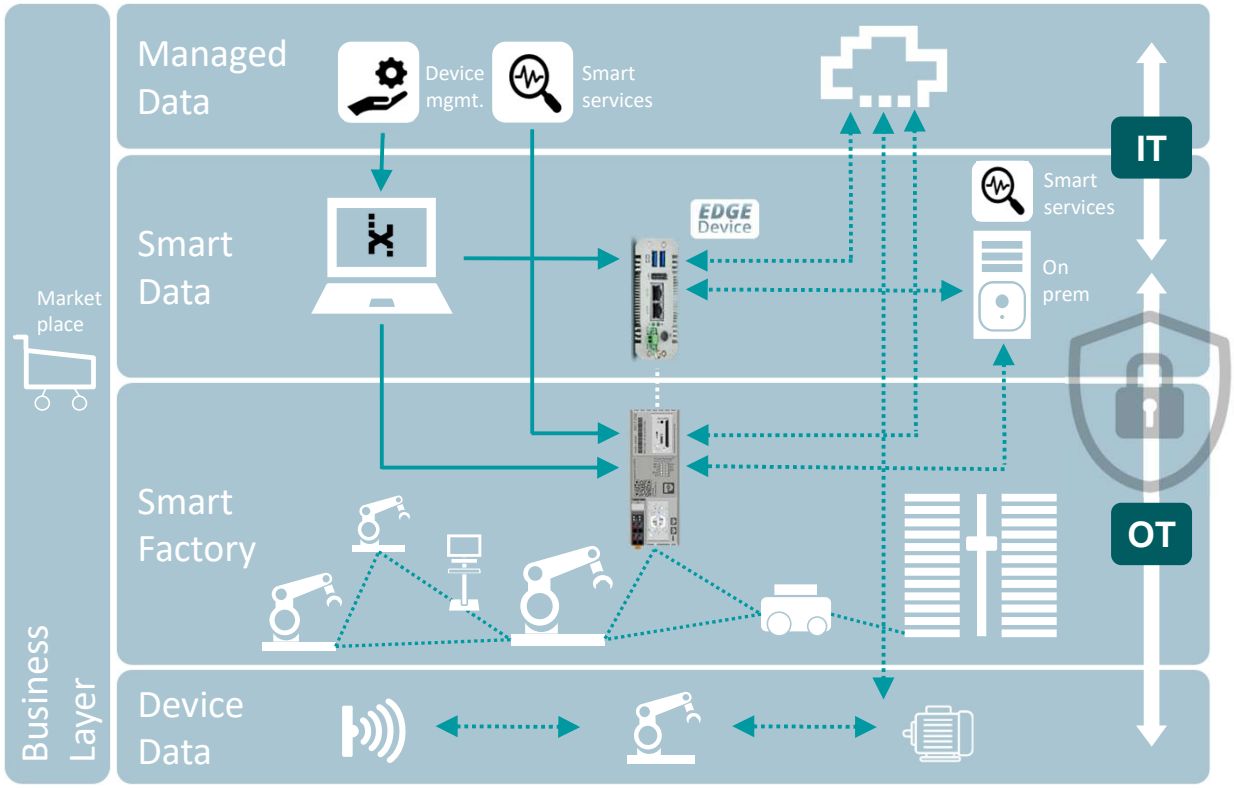




PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | From a factory to a Digital Factory

Application-oriented customer approach



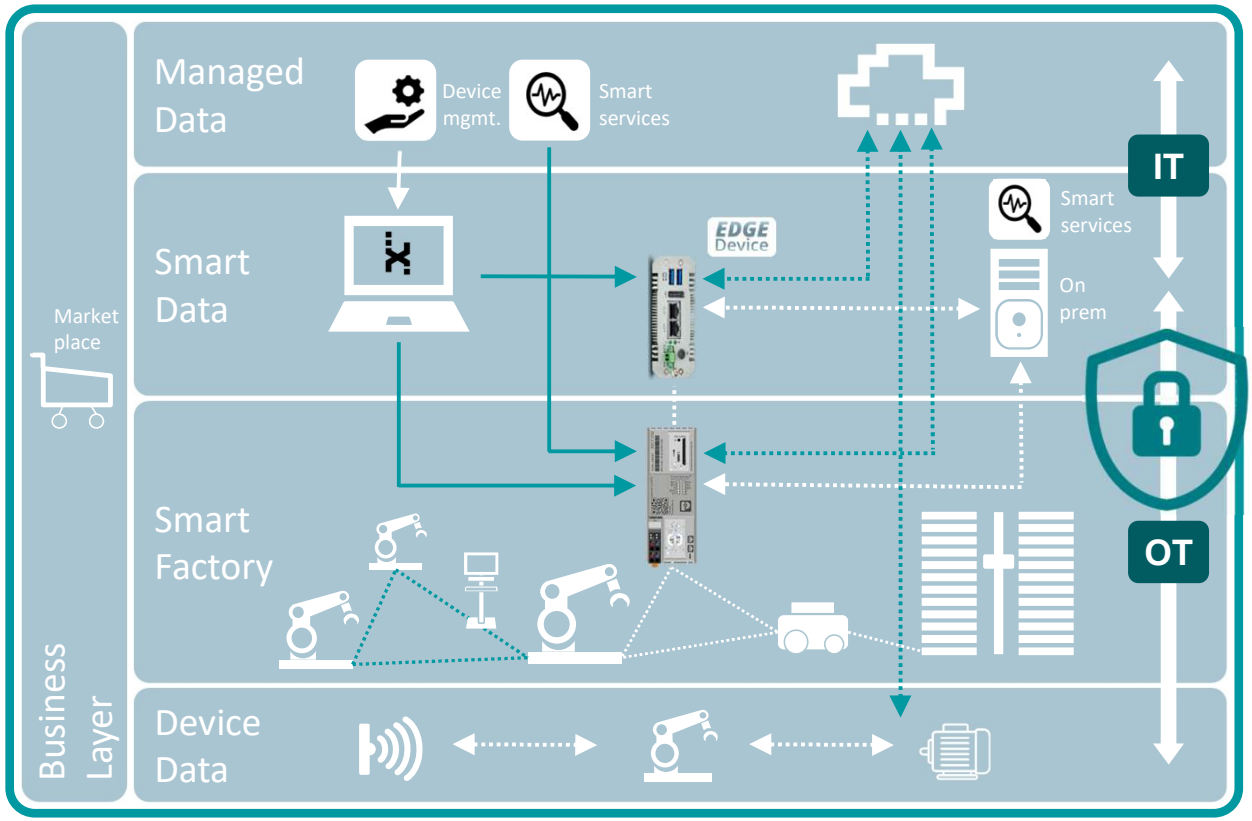
Data transportation

- Network structuring and management
- Ensure data quality and bandwidth
- Select the ideal digital infrastructure

PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | From a factory to a Digital Factory

Application-oriented customer approach



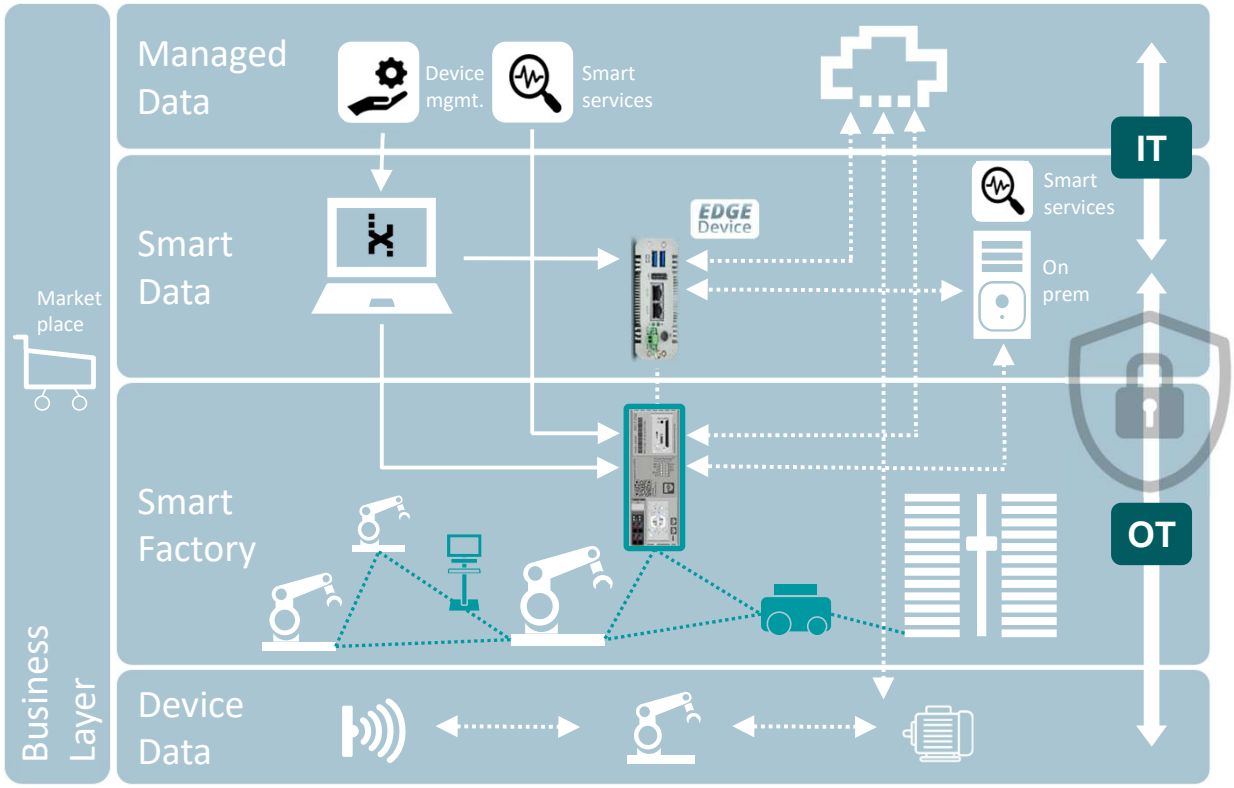
Data security

- Protect the factory against hacker attacks
- Ensure a state-of-the-art protection
- Worldwide support

PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | From a factory to a Digital Factory

Application-oriented customer approach

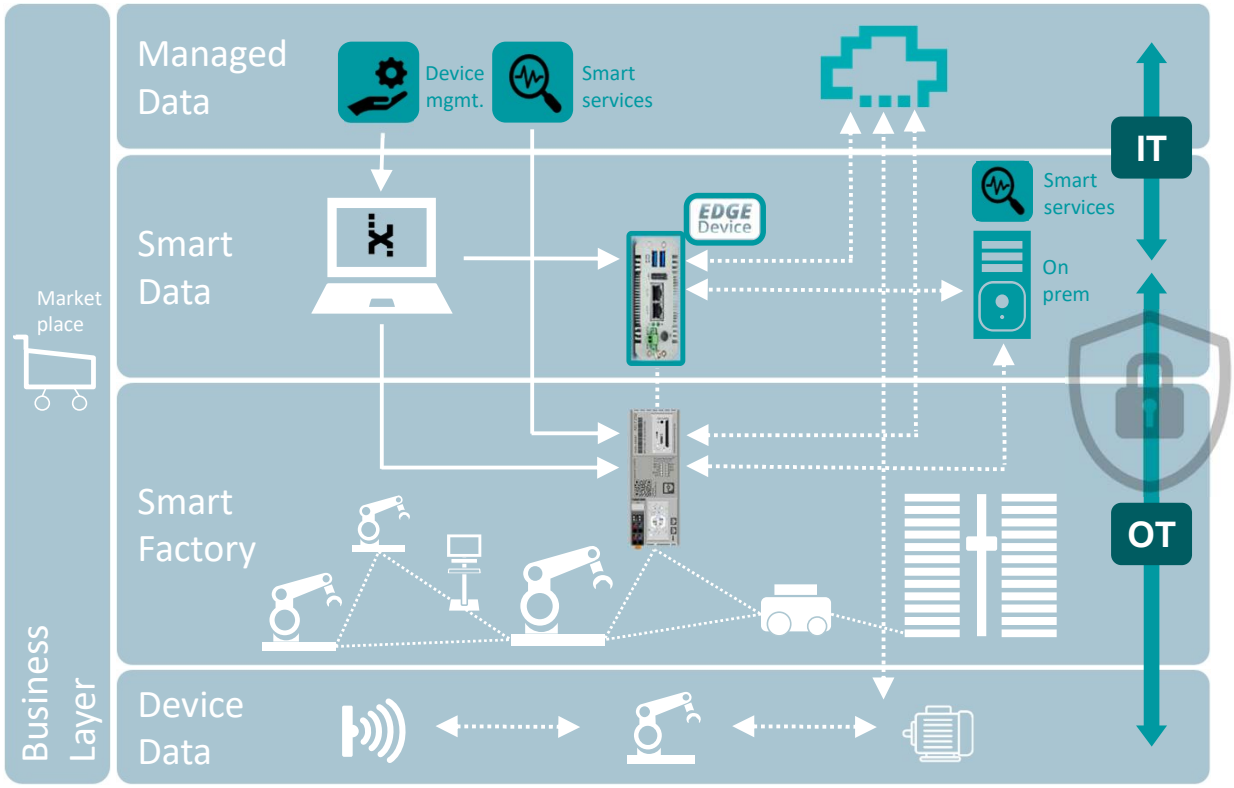


Data usage

- Smart production
- Horizontal and vertical integration – easy and fast
- Ensure openness to other systems

PHOENIX CONTACT
INSPIRING INNOVATIONS

Application-oriented customer approach



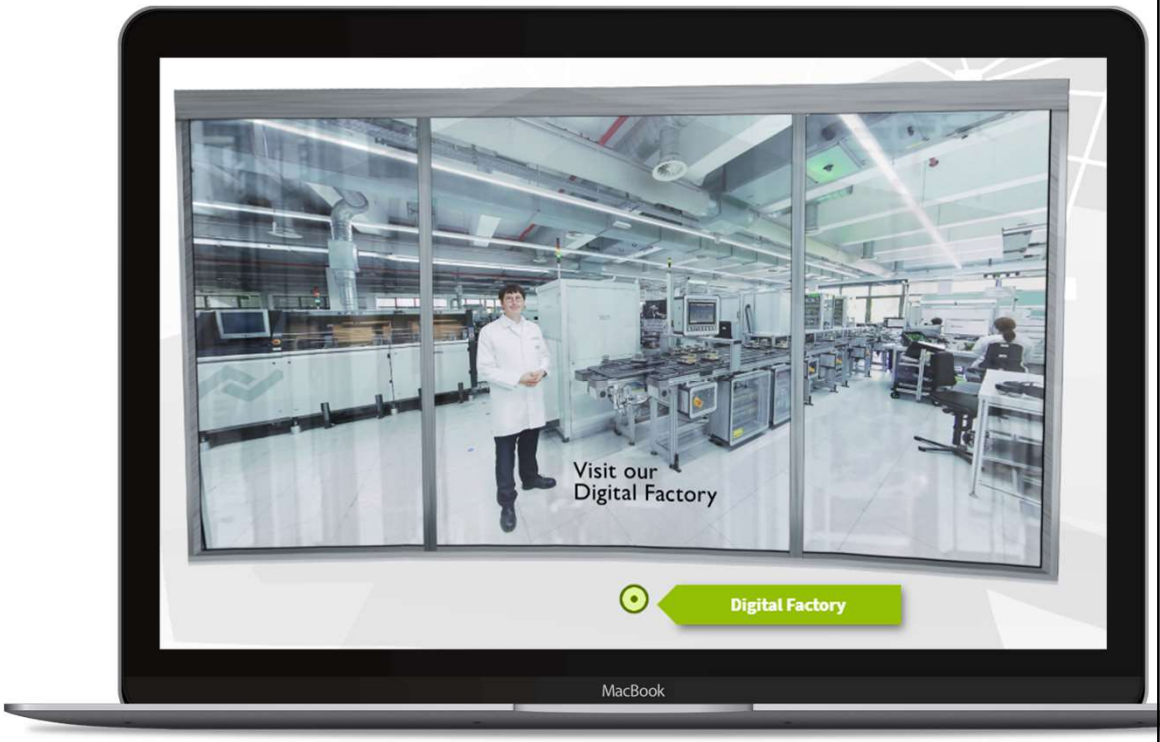
Data collection, storage and evaluation

- Data acquisition with full connection from OT to IT
- Ensure normalized data
- Transform data into information

PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | From a factory to a Digital Factory

Proof-of-concept in our own Factory in Bad Pyrmont



PHOENIX CONTACT
INSPIRING INNOVATIONS

DIGITAL FACTORY

NOW

Our Uses Cases for your Productivity Increase

Segments of Digital Factory

Data transportation

Network structuring and management

Data collection, storage and evaluation

Data conversion into information

Data security

Investment protection against unwanted access

Data usage

Simple horizontal and vertical integration

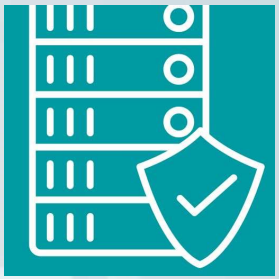
PHOENIX CONTACT
INSPIRING INNOVATIONS

Why is ICS security so important?

PHOENIX CONTACT
INSPIRING INNOVATIONS

DIGITAL FACTORY

NOW

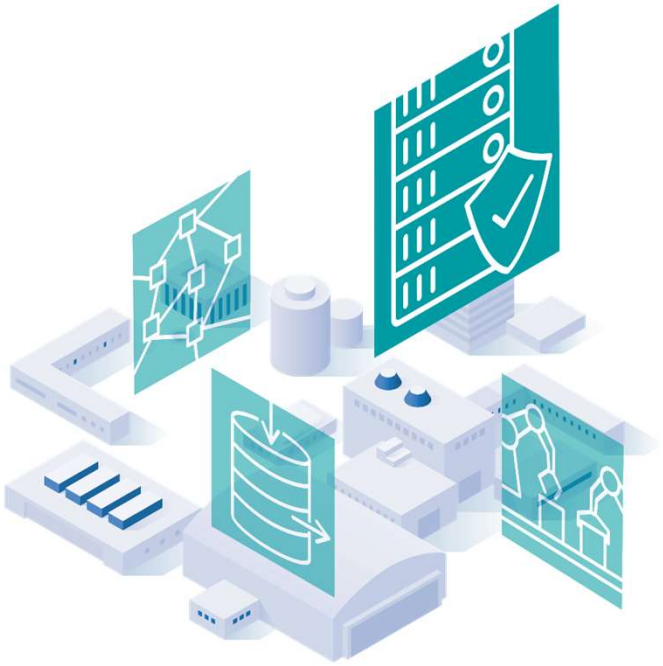


Data Security

Digital Factory

Data security

- Location-independent access to production
- Secure and protect the production with a holistic security solution, support and service offer
- Secure horizontal communication between new and old machines
- Integration of outdated machines into production



Securely networked production

Security evaluation

Secure machine integration

Manipulation detection

PHOENIX CONTACT
INSPIRING INNOVATIONS

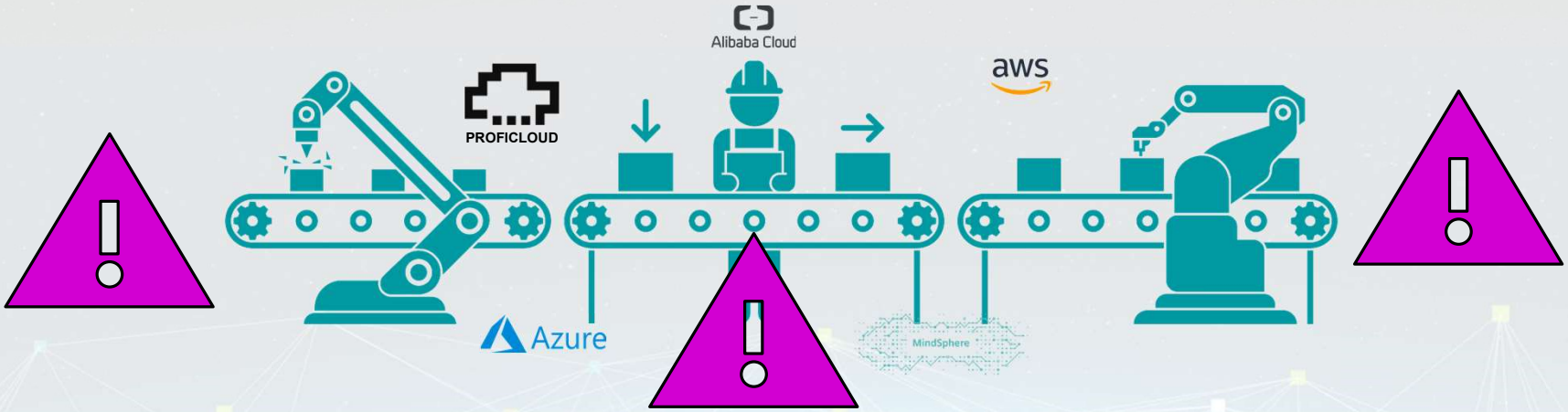
Why?

To prevent

- **multi-million-dollar damages**
- **reputational damage**
- **huge blackouts …**

Digital Factory | Data security

Data data data …



1 TB of data is being generated

PER DAY in an average factory.

PHOENIX CONTACT
INSPIRING INNOVATIONS

Source: https://alfapeople.com

Digital Factory | Data security

Most common cyber attacks and terms

Malware, malicious software
(topic for damage, steal information or assume control)

Phishing, spam e-mails
(malicious links or e-mail attachments)

Ransomware
(bitcoins)

Denial-of-service (DoS) attacks
(unavailability, network/ server overload)

PHOENIX CONTACT
INSPIRING INNOVATIONS

Phishing

92% of all attacks on companies start with a **phishing e-mail …**!

The boundaries between IT and OT **are dissolving with the advancing digitalization**!

PHOENIX CONTACT
INSPIRING INNOVATIONS

Source: SoSafe Cyber Security

Ransomware

- The very first ransomware attack:
  - **AIDS was a trojan horse** programmed in QuickBasic, which was distributed in **1989** via mailed floppy disks.
  - The use of this malware is the **first known case** of ransomware extortion.

Ransomware WannaCry

- Do you remember 2017 and **WannaCry**?
  - Deutsche Bahn and the National Health Service (NHS) in the UK were attacked!
  - In just one day, WannaCry infected more than **230,000 computers** in more than **150 countries**, according to Europol!
  - The damage incurred amounted to **several million US dollars**!

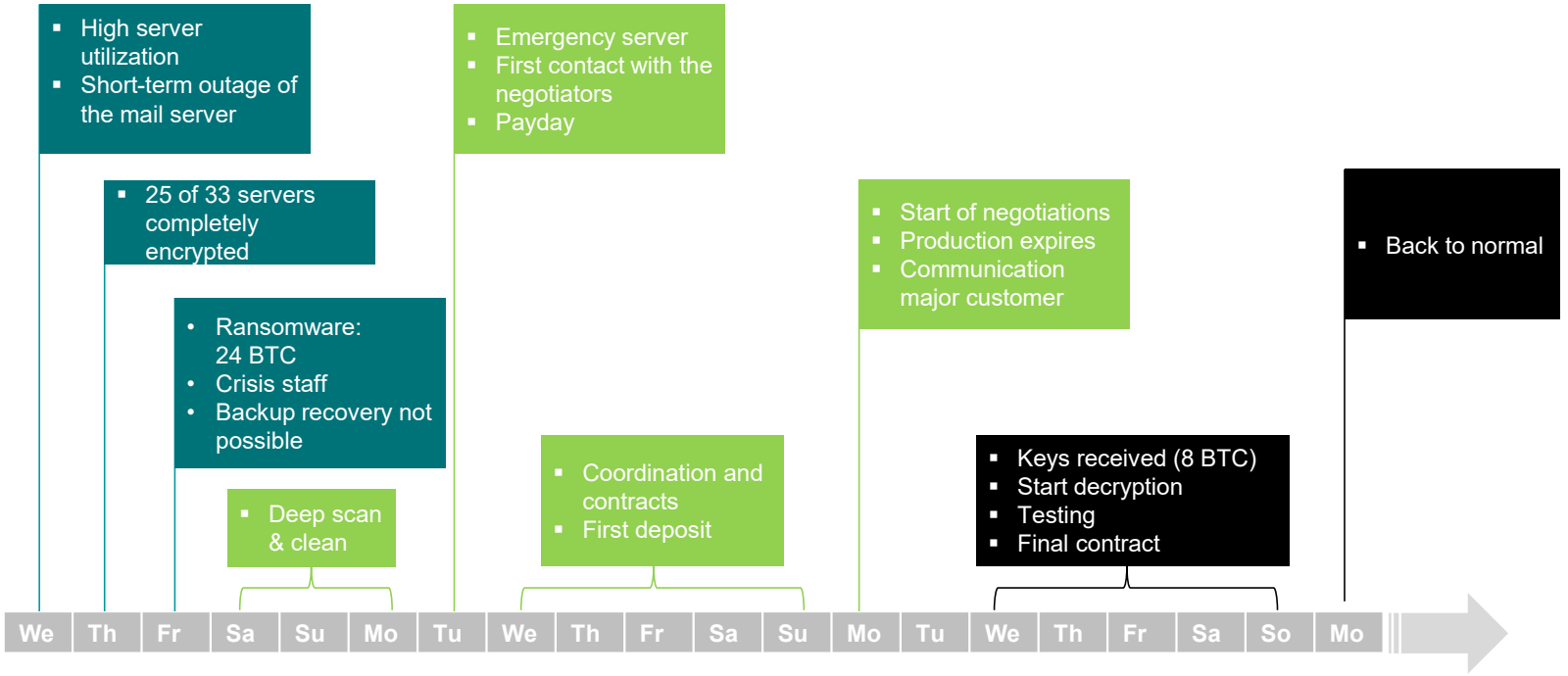
Incident response / ransomware attack

- Ransomware report from a Switzerland company
  - **How long can it take for all systems to run again ... and be recovered?**

Source: Funk, CH./Cyber-Crime+in+Schweizer+Unternehmen_Printout

Digital Factory | Data security

Incident response / ransomware attack



Detect	3 days
Respond	11 days
Recover	5 days

Recovery time: 19 days

PHOENIX CONTACT
INSPIRING INNOVATIONS

Source: Funk, CH./Cyber-Crime+in+Schweizer+Unternehmen_Printout

Incident response / ransomware attack

Loss of income	€ 463,000
Additional costs	€ 65,000
Ransom demand	€ 83,000
Forensics	€ 32,000
Emergency server	--
Restoration	€ 51,000
Improvements	€ 185,000
Total	**€ 879,000**

… but cyber attacks can not only cause financial damage they can also harm the company‘s

image and reputation!

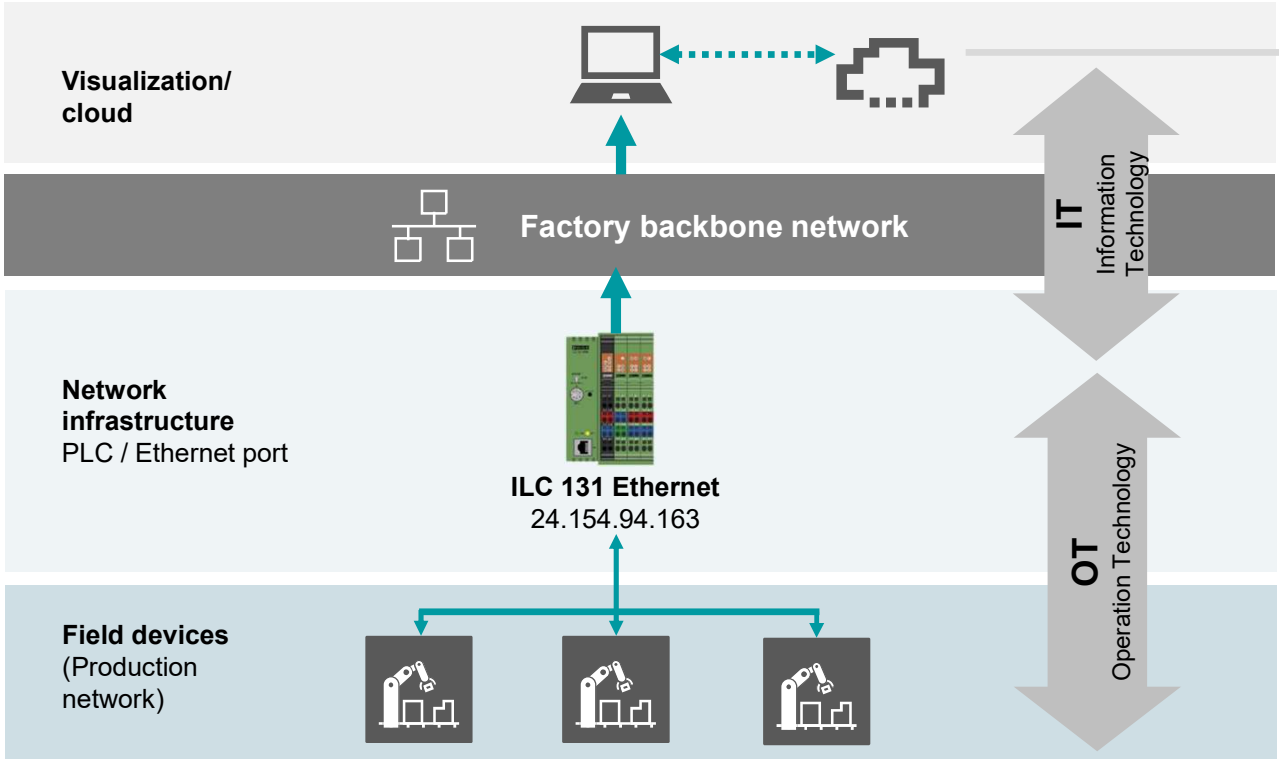
PHOENIX CONTACT
INSPIRING INNOVATIONS

Source: Funk, CH./Cyber-Crime+in+Schweizer+Unternehmen_Printout

Incident response / ransomware attack

- **Manufacturing recovery costs** due to production stops
- **Data reconstruction** costs
- **Loss of image** and reputation to partners and customers
- **Economically damage** due to loss of know-how and sensitive data
- **Ransom costs** mostly in bitcoins

Accessing PLCs over www? Possible?



Shodan (www.shodan.io/)
Shodan is the world's first search engine for internet-connected devices.

PHOENIX CONTACT
INSPIRING INNOVATIONS

Summary cyber attacks

The examples show clearly the need for a holistic security concept:

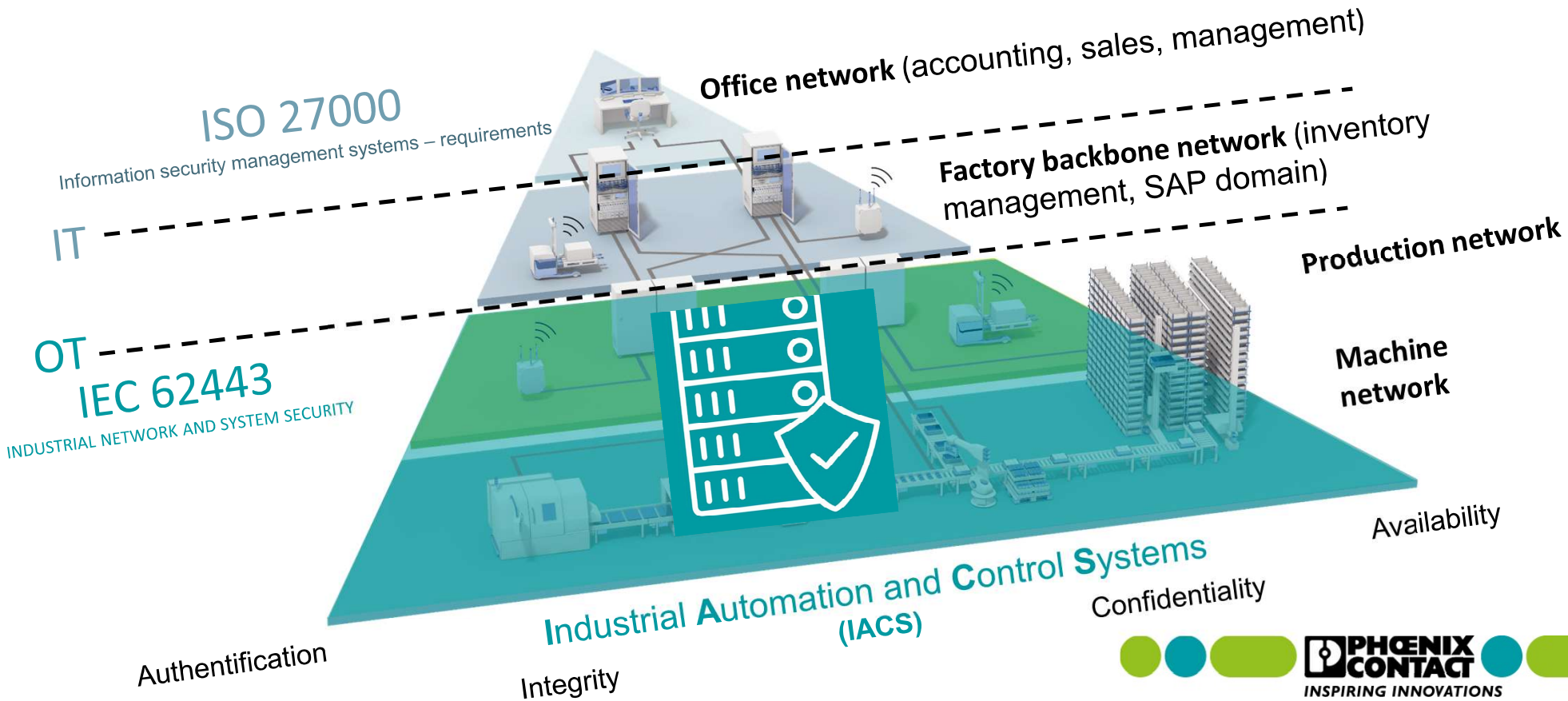
- Knowledge transfer and awareness-raising
- Keep continuity during a hack
- Secure and protect productivity, investments and your assets
- Regulatories and directives
- Keep competitiveness during a hack

PHOENIX CONTACT
INSPIRING INNOVATIONS

PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | Data security

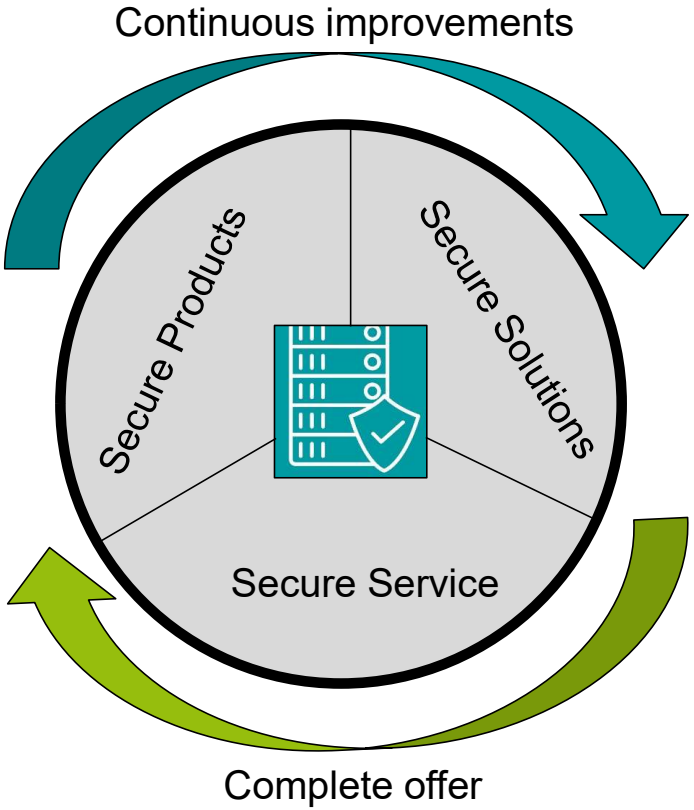
IT and OT, even if different, are getting closer



PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | Data security

360° security: a complete offer for any industry



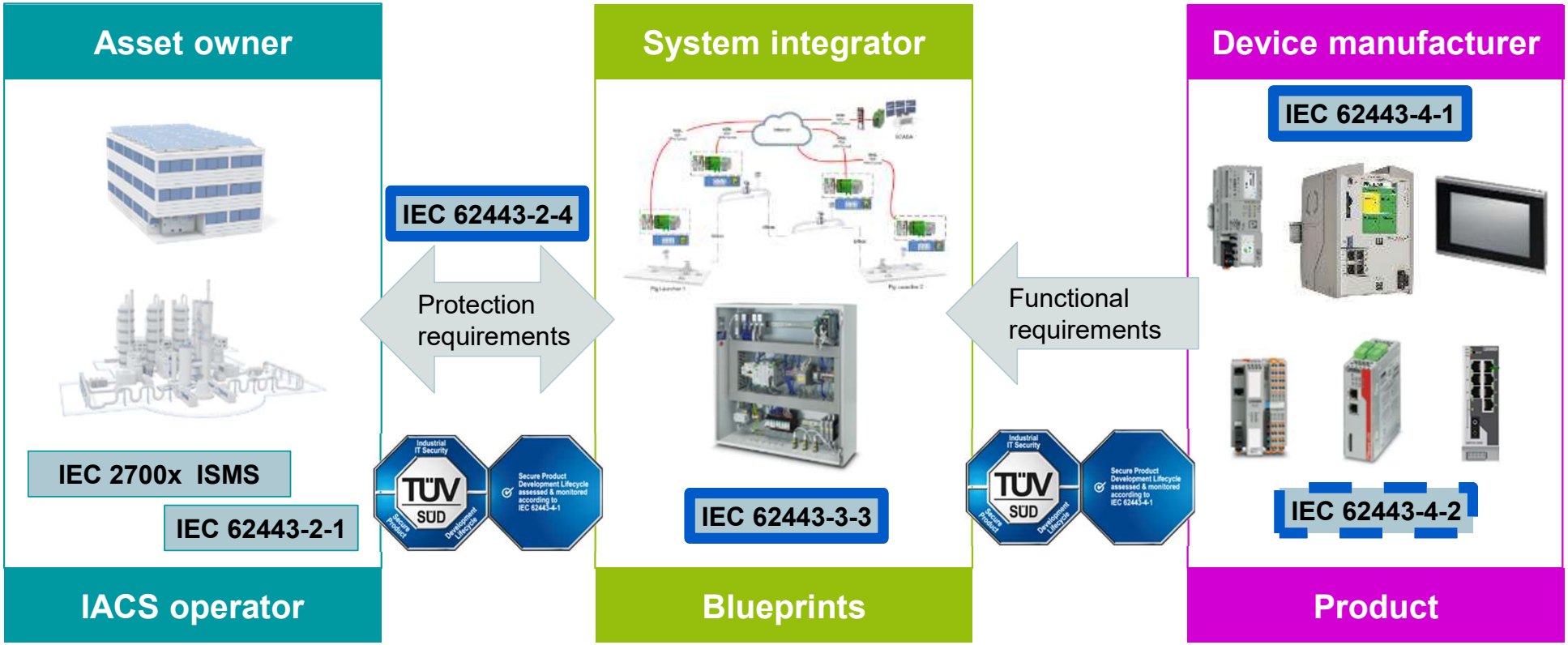
Certified Security
IEC62443

Security-by-design

PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | Data security

360° security: a complete offer for any industry



PHOENIX CONTACT
INSPIRING INNOVATIONS

Cyber Security acts are worldwide on the rise

- **Cyber Security Information Sharing Act** from 2015
- **IoT Cyber Security Improvement Act** of 2020 (public law no: 116-207) to take specified steps to increase Cyber Security for Internet of Things

- **EU N**etwork **and I**nformation **S**ecurity **Directive** (**NIS**-Directive 2.0)
- To be integrated into all EU countries till 2023 and not just for critical infrastructures (Energy, Transport, Banking, …)
- Certification schemes for automation technology to be developed starting in 2021

- **Important industries reg. NIS are:**
  - Food production, processing and distribution
  - Manufacturing
  - Machinery and electrical equipment
  - …
- **Possible administrative fines:**

At least **10,000,000 Euro** **or** **up to 2 % of global annual turnover!**

PHOENIX CONTACT
INSPIRING INNOVATIONS

Central device and patch management

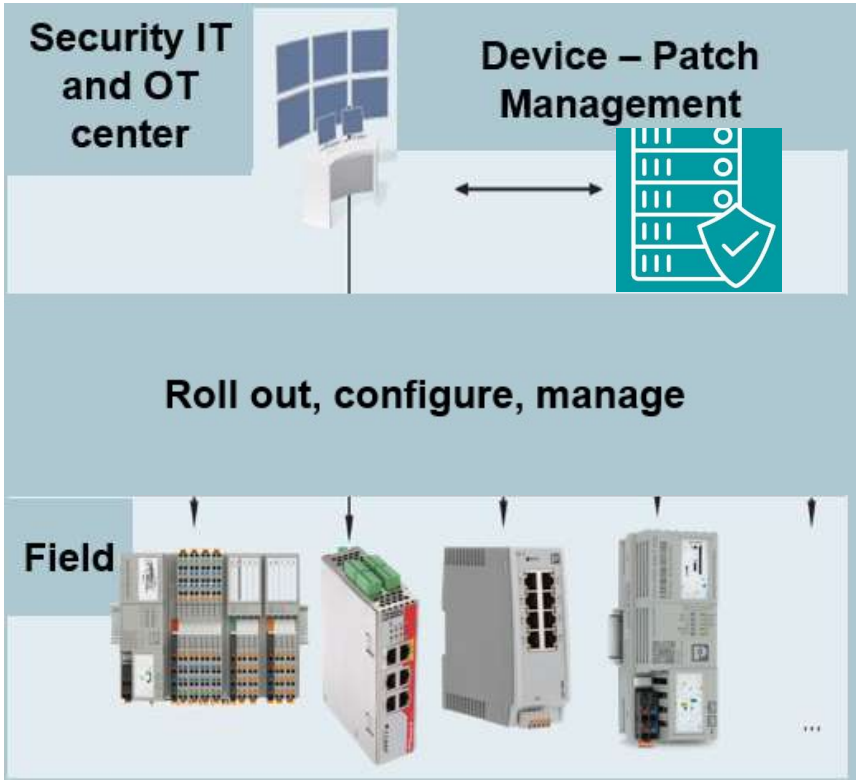
… closes the vulnerability, fixes bugs and prevents the success of malware attacks

- Looking back to **WannaCry (ransomware)**…
- *„The software **patch** that would have prevented the attack **had already been released at the time** – and had been for two months …“*

PHOENIX CONTACT
INSPIRING INNOVATIONS

Central device and patch management

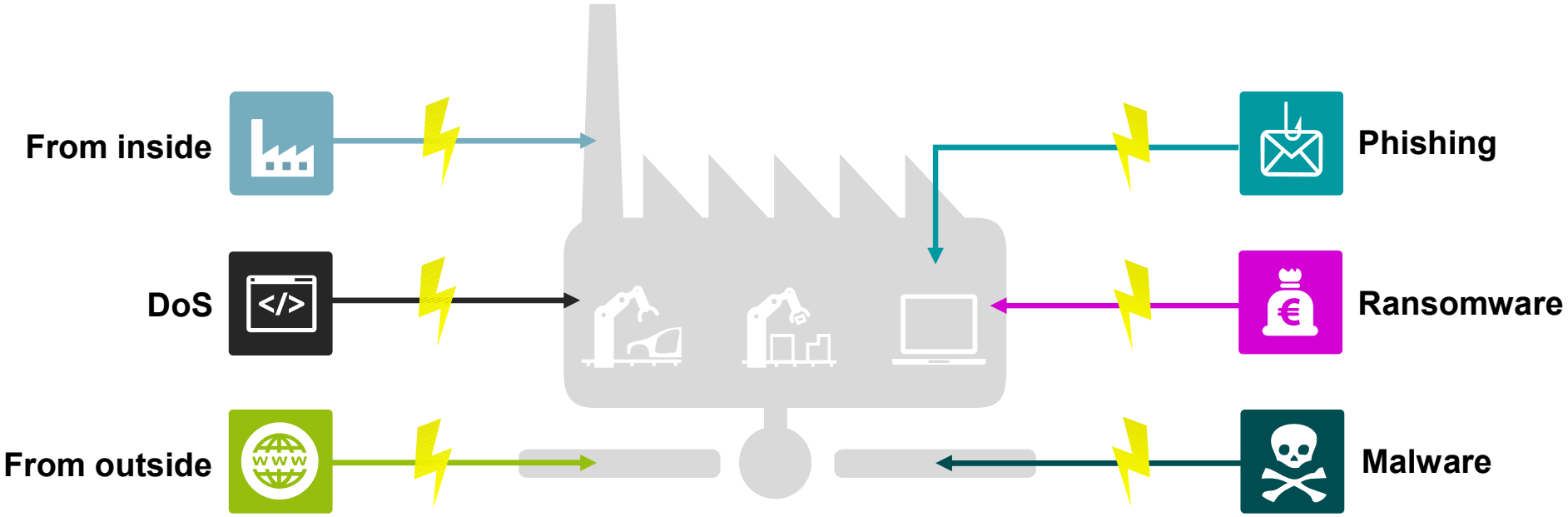
- Is a key feature to secure the whole **lifecycle** of products.
- Centralized patch and device management helps **configure, roll out and manage devices**.
- End-to-end system from product data **to update on the device**.
- Already required by large operators or by **law and regulations**.



PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | Data security

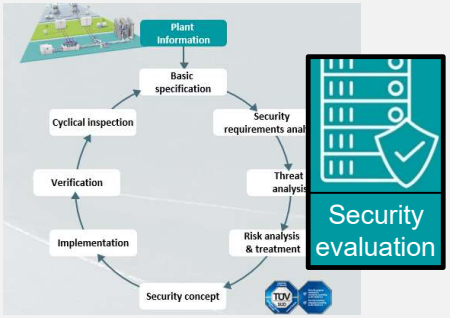
Attack possibilities



PHOENIX CONTACT
INSPIRING INNOVATIONS

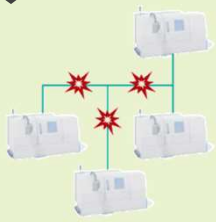
Secure solution portfolio

Risk analysis



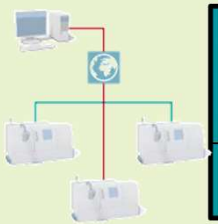
IEC 62443
Security service and evaluation concept

Malware/ ransomware



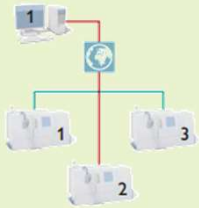
Limiting communication
CIFS – Integrity monitoring

From IT to OT / Difficult integration of new machines



Security router
(mGuard)

Open internet connection/ Hacking



Encrypted data transfer/
Secure remote access/ zones

. . .

Digital Factory | Data security

Secure solution portfolio

Security evaluation

Assessment service in order to protect the factory against hacker and virus attacks

Secure machine integration

Vertical but also secure horizontal integration of any machine into production

Securely networked production

Secure remote access to all machines of the production

Manipulation detection

Secure integration of not updatable PCs/ devices into the Digital Factory

PHOENIX CONTACT
INSPIRING INNOVATIONS

Firewall rules

Seq.	Protocol	From IP	From port	To IP	To port
1	UDP	10.10.10.130	any	192.168.108.101	80
2	TCP	192.168.108.101	any	10.10.10.120	80

?

?

?

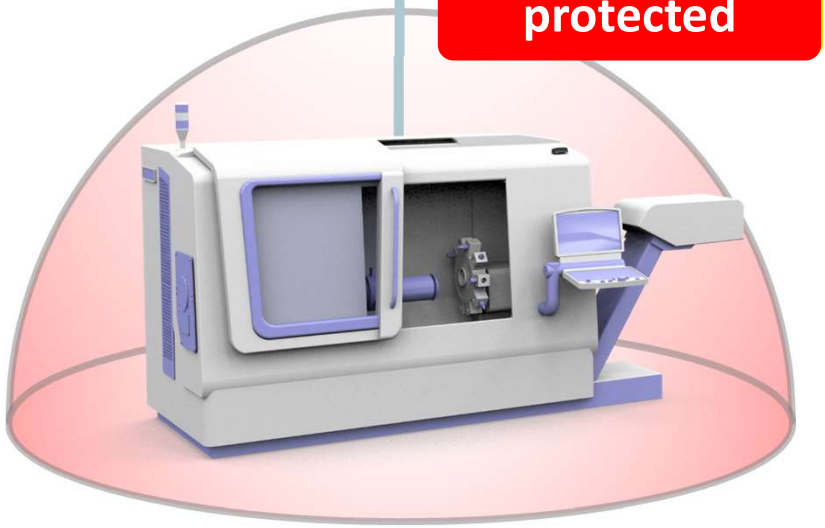
?

self-learned rule

From: Service-PC to Machine-PLC

Firewall-Assistent: **OFF**

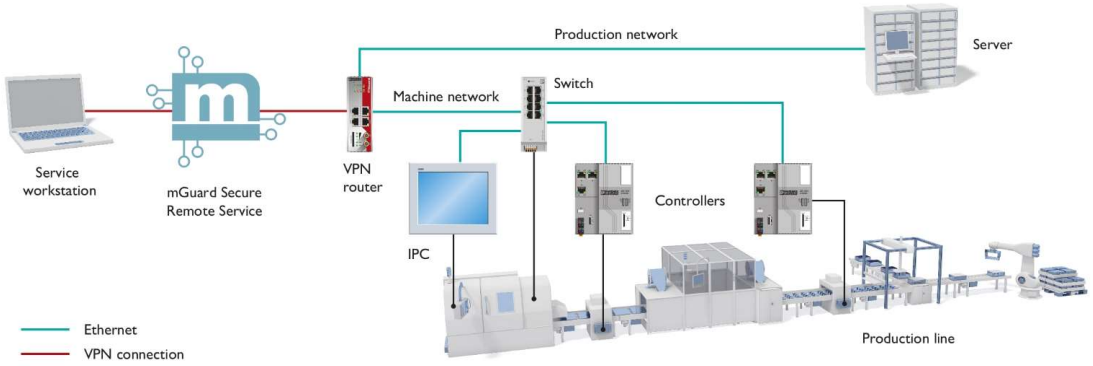
protected



PHOENIX CONTACT
INSPIRING INNOVATIONS

Digital Factory | Data security | Secure networked production

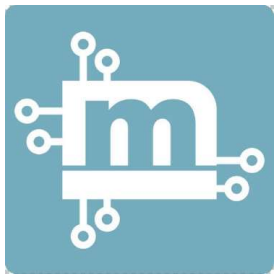
Solution: Global VPN connection to complex machines



- **Highly secure instant remote service**
  for the production plant
- **Separation into risk zones**
  in line with IEC62443
- **VPN connection control**
  directly at the application
- **Reduction of complexity**
  by NATing and masquerading
- **Time saving exchange**
  by SD cards
- **Manipulation control**
  by door switch
- **Fast launch of zone networks**
  by predesigned cabinets

PHOENIX CONTACT
INSPIRING INNOVATIONS

System component overview



mGuard secure remote service

via mGuard cloud and web browser

- Establish instant remote service
- Authentification
- Information about the service network
- Overview of possible VPN connection

FL MGUARD Router

as a stateful inspection firewall

- Hardware based protection
- VPN router
- NAT routing
- Integrity monitoring of windows file system

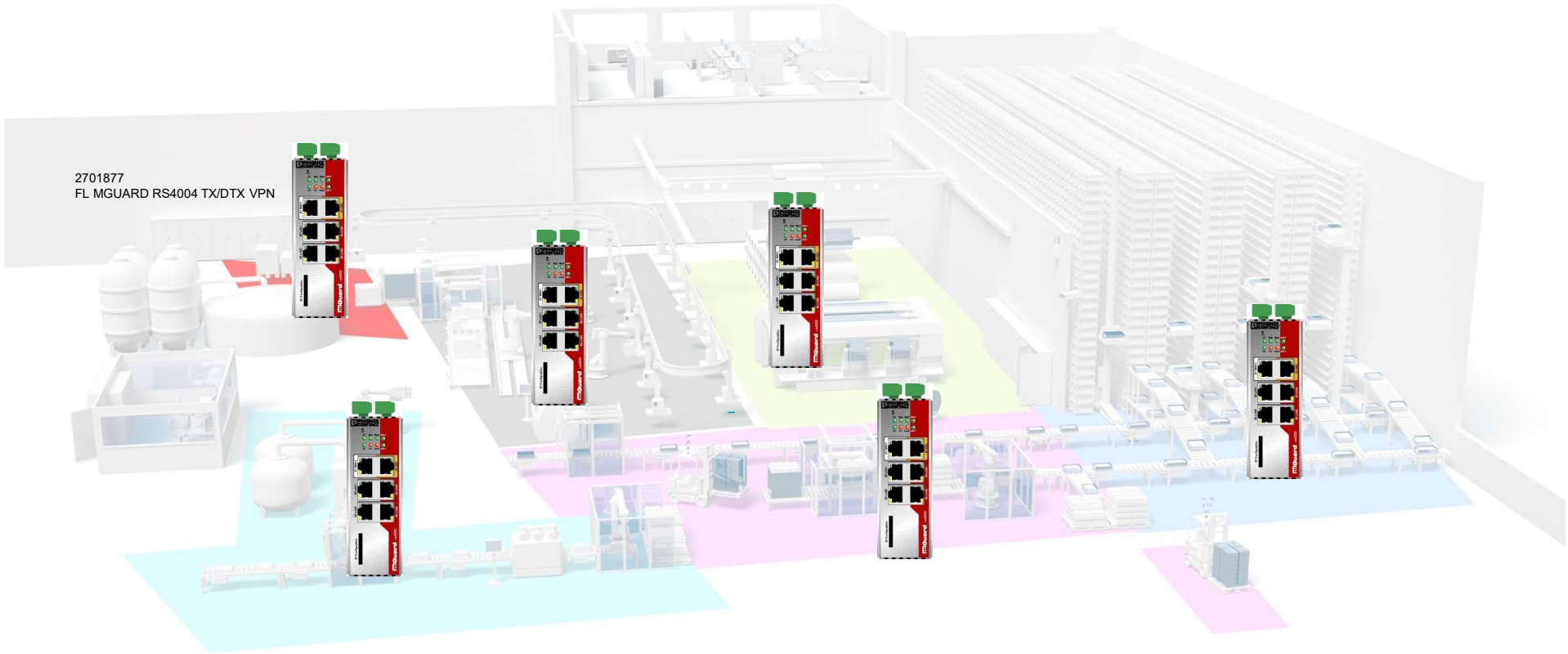
FL Switch 2xxx

Managed switch

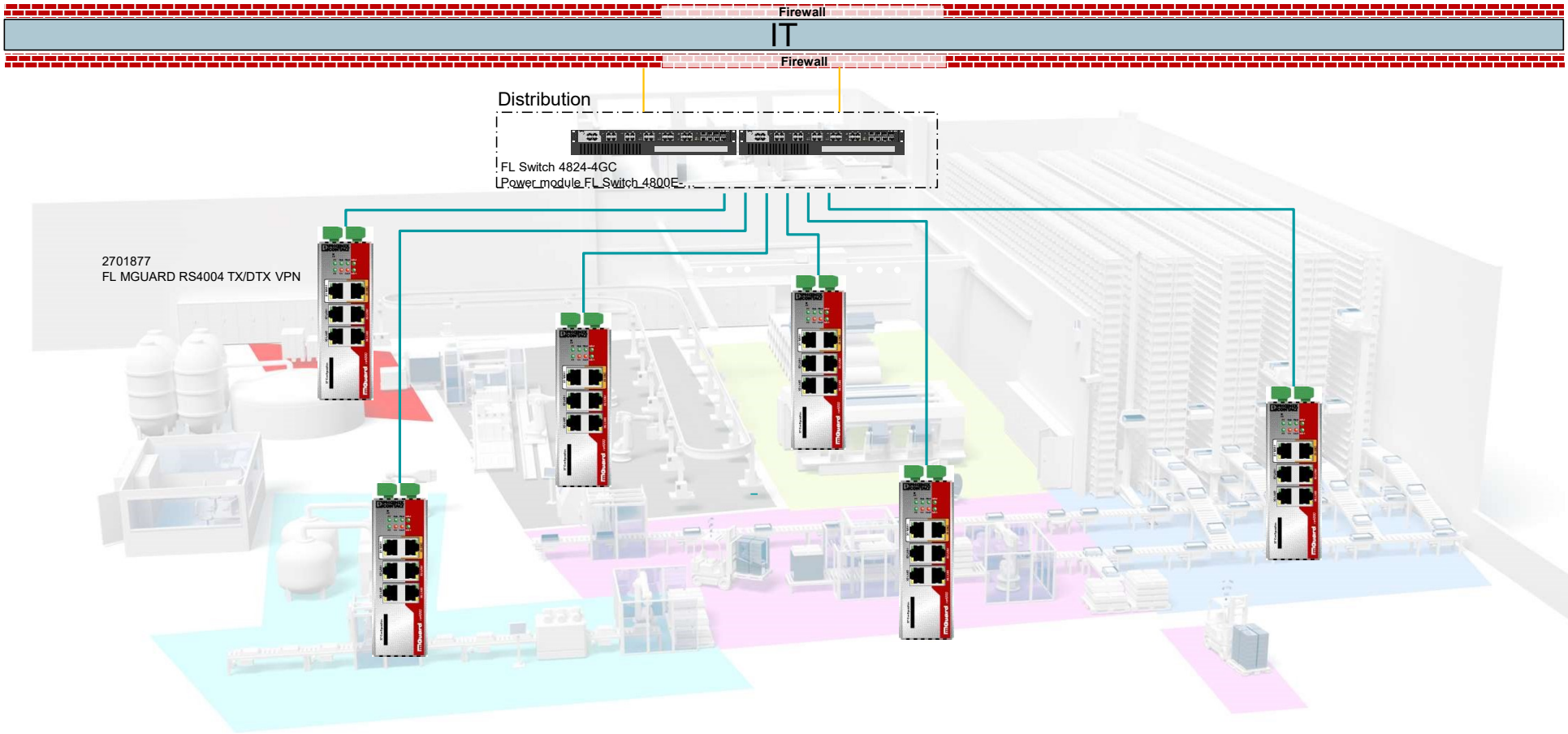
- Distribution of secure data
- Class B Profinet networks
- Ring redundancy
- Media range RJ45 to fibre optic

PHOENIX CONTACT
INSPIRING INNOVATIONS

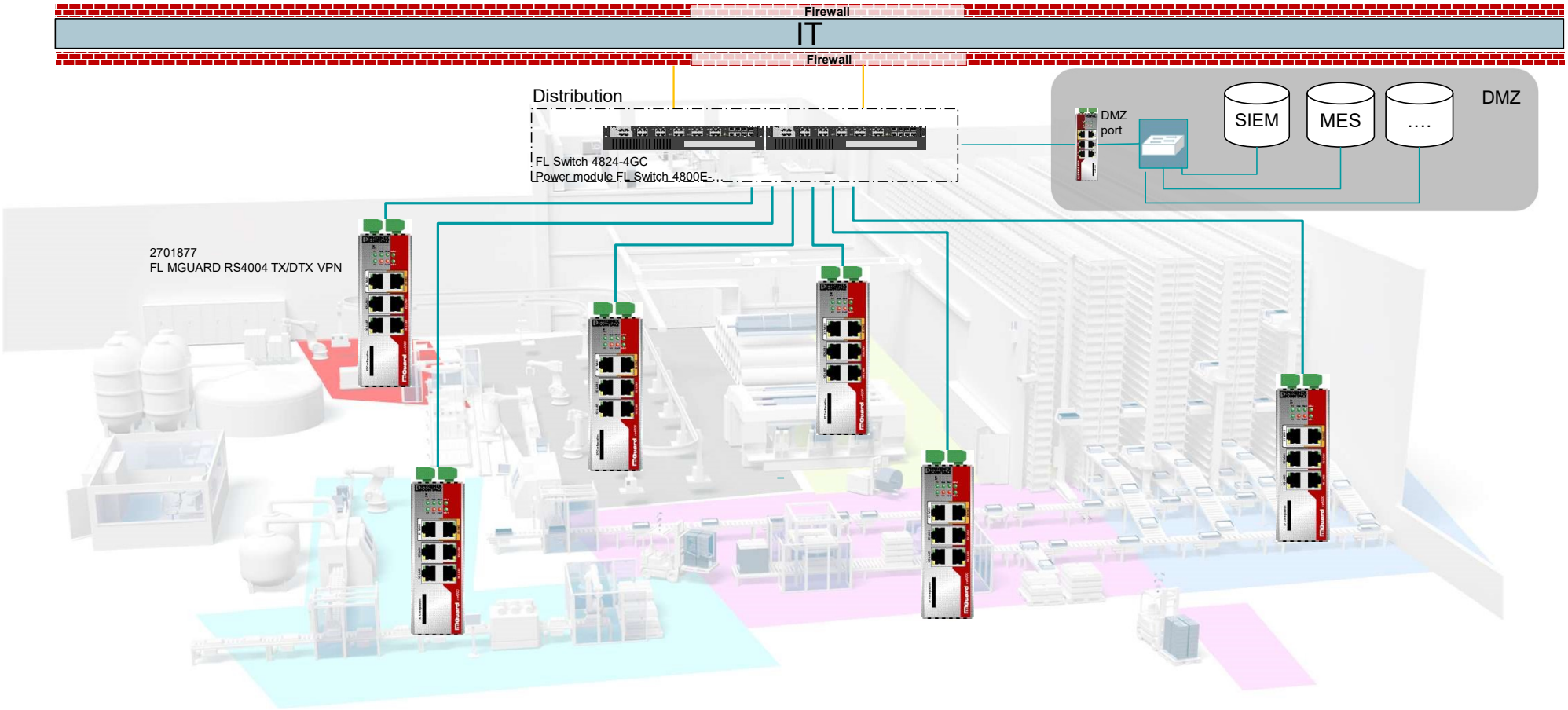
Zones minimize risks



Distribution to the office IT

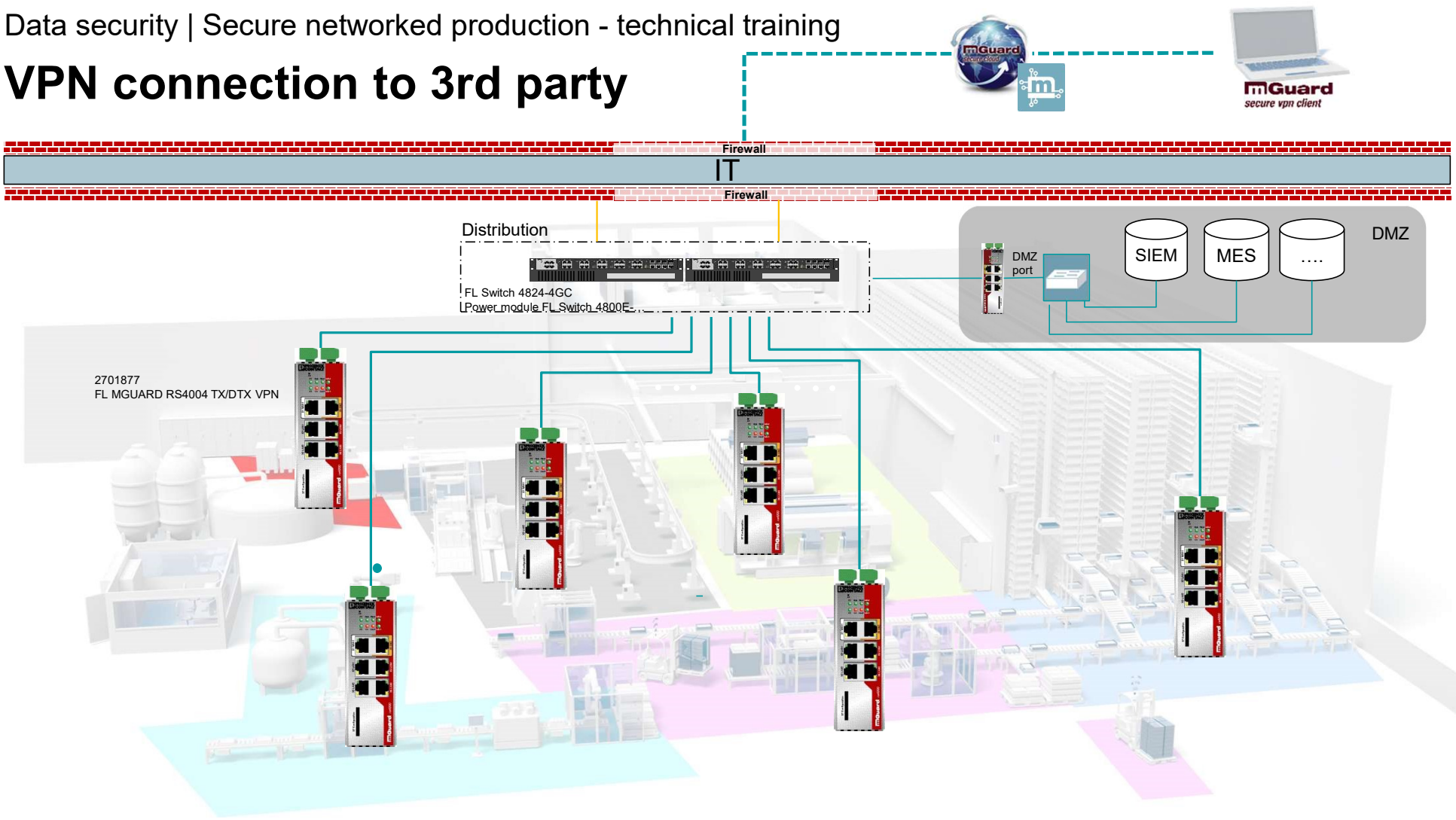


Special zone – DMZ



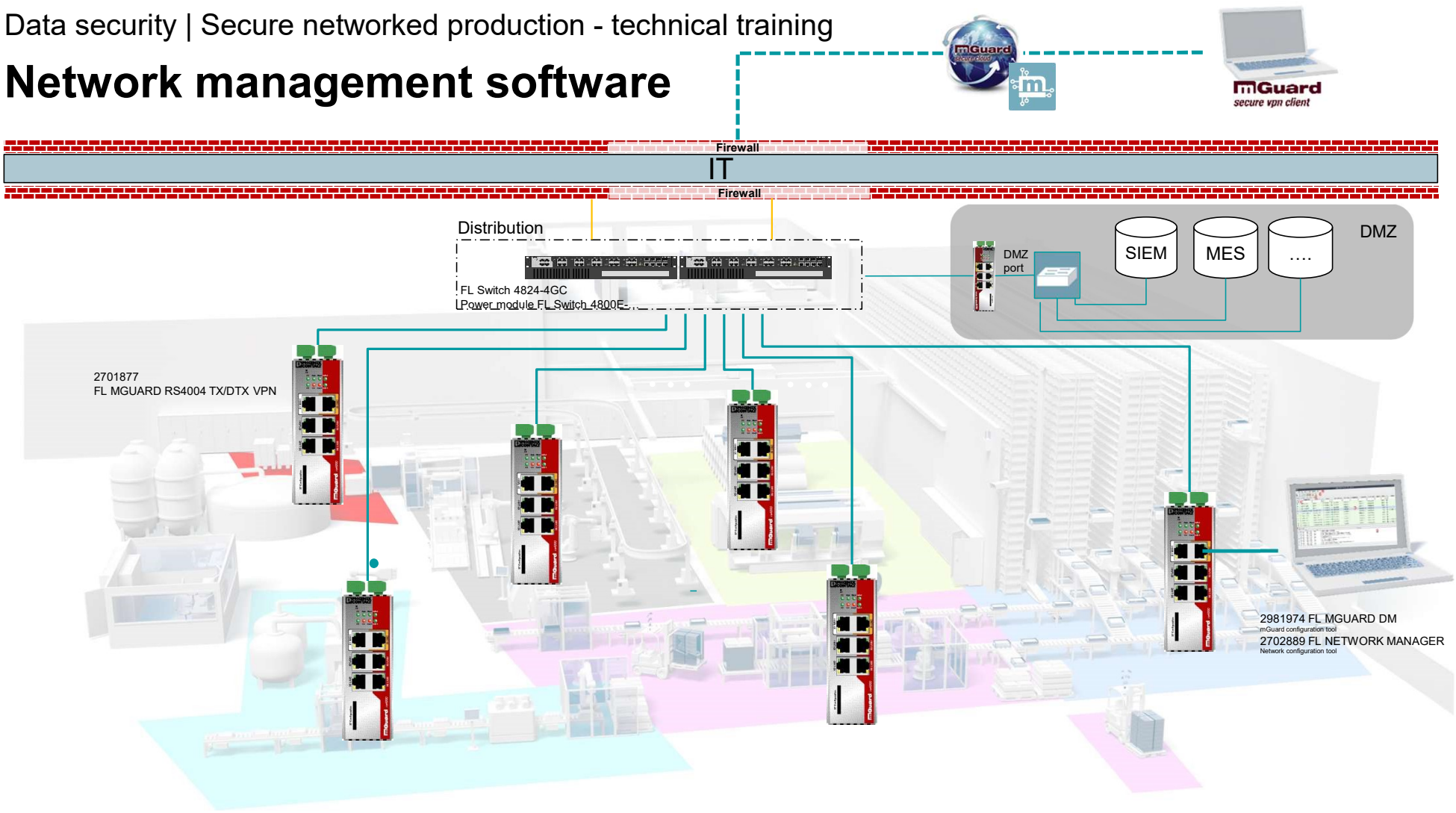
Data security | Secure networked production - technical training

VPN connection to 3rd party

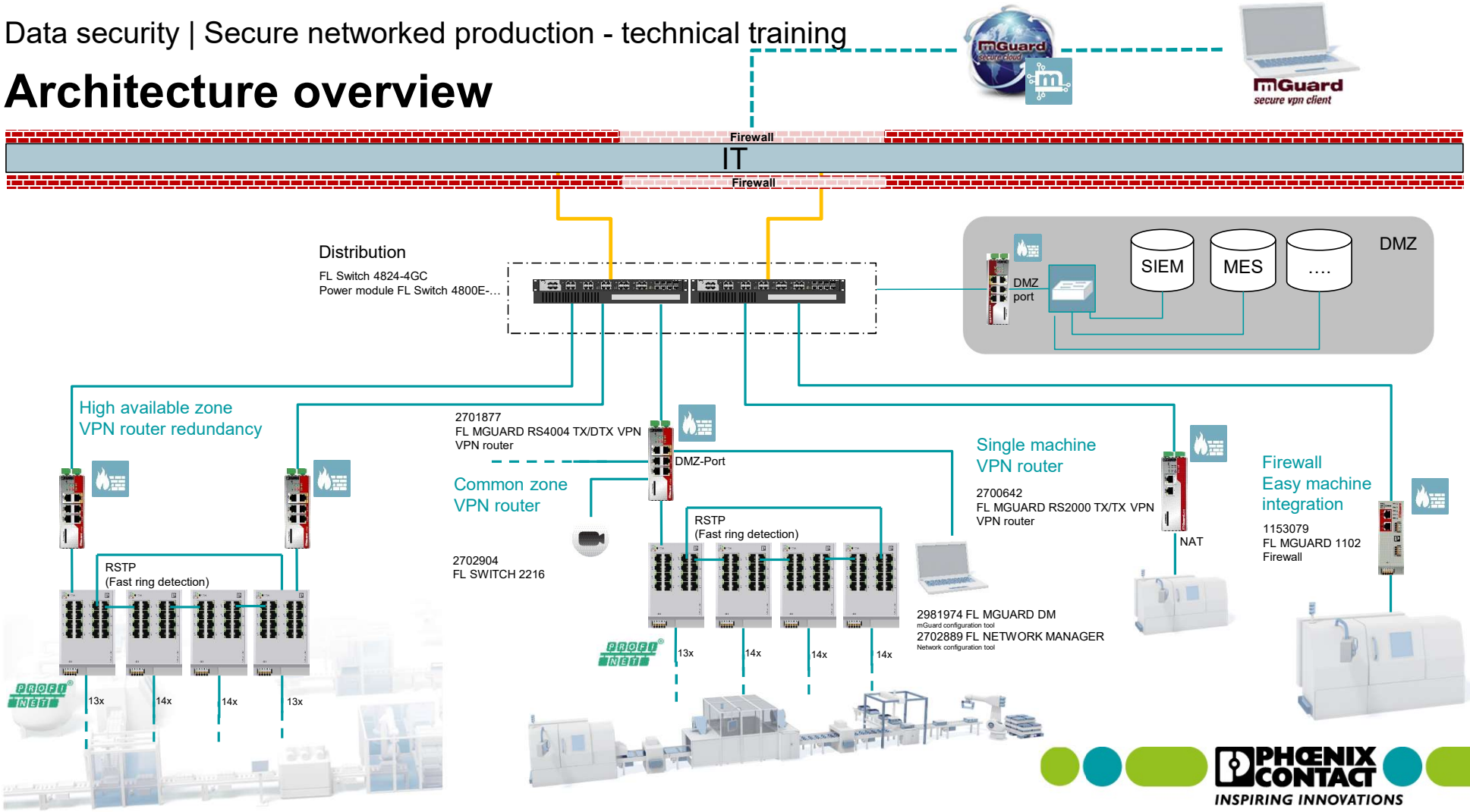


Data security | Secure networked production - technical training

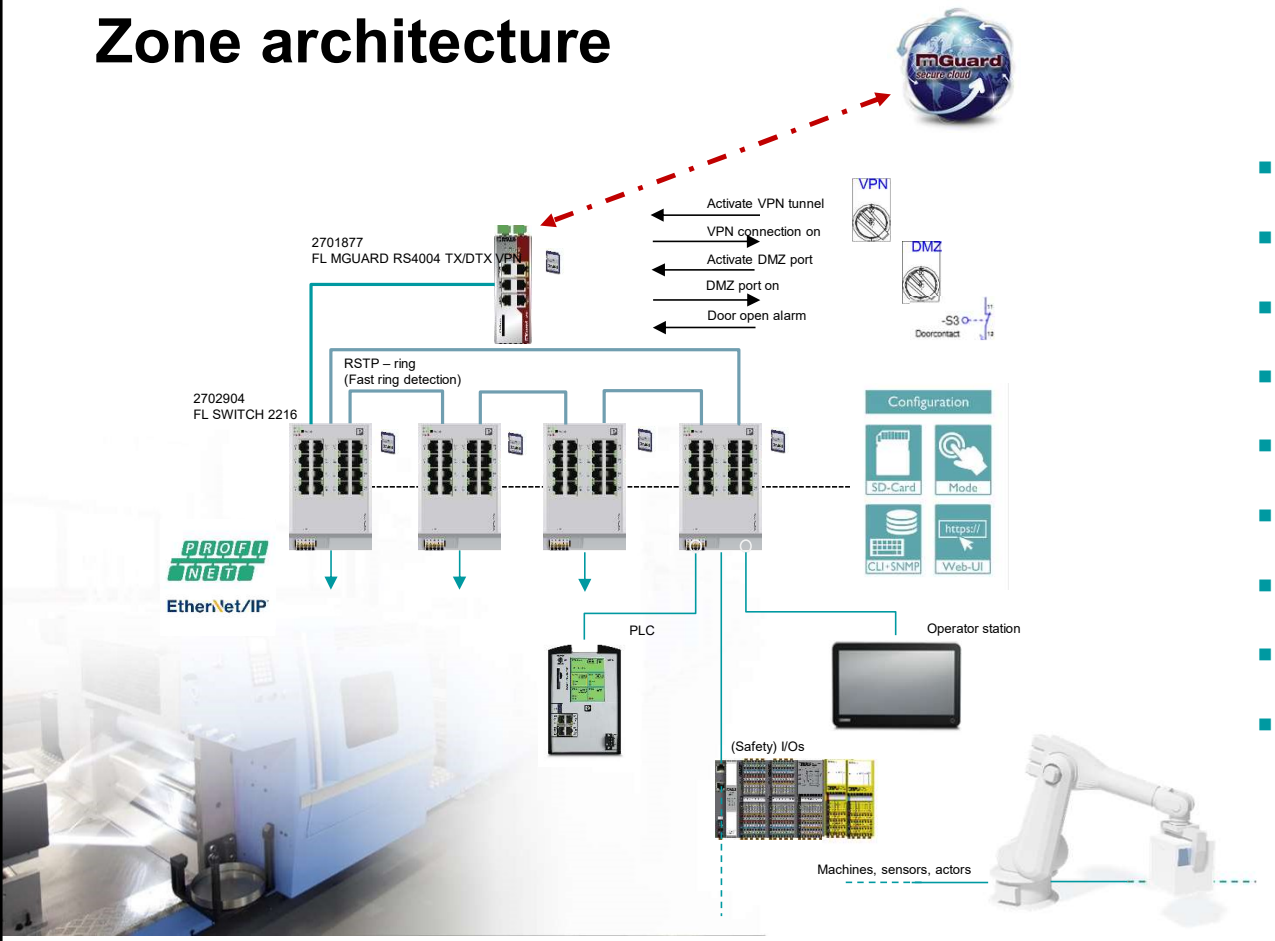
Network management software



Architecture overview



Zone architecture



mGuard

- VPN via mGuard cloud
- mGuard VPN /firewall /NAT
- Redundant power supply
- Control switch for activating VPN
- Monitoring VPN state via digital output
- Control switch for activating DMZ port
- Monitoring cabinet door via digital output
- QoS / DHCP / NTP / DNS
- SD cards for fast device replacement and roll-out

PHOENIX CONTACT
INSPIRING INNOVATIONS

DIGITAL FACTORY

NOW

Summary

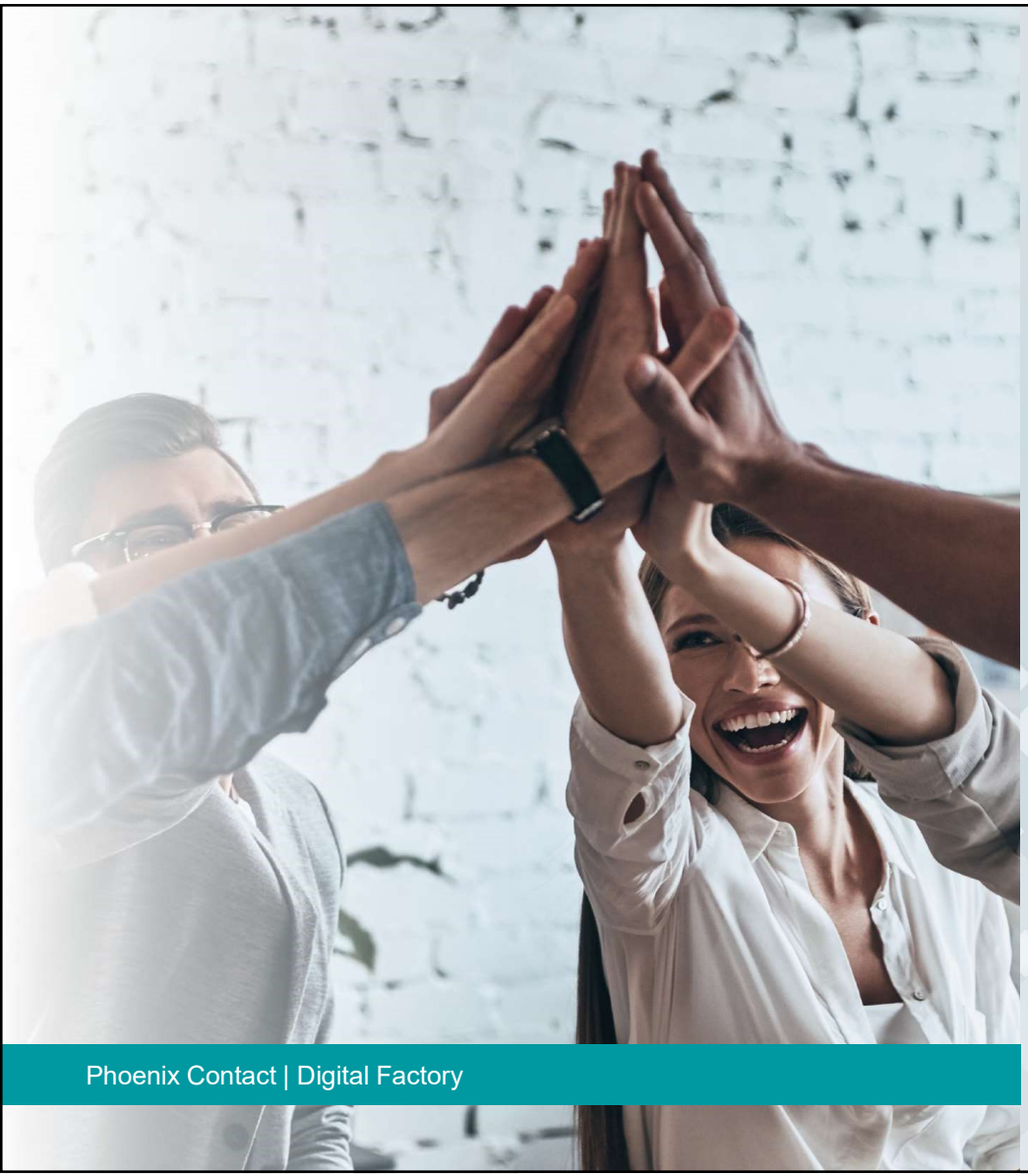
Our value proposition for your Digital Factory

In order to meet today's digitalization requirements and profitably realize opportunities, our solutions offer you the following added values:

- Scalable – individually tailored your requirements
- Tested and validated – in our own production
- Ready-to-use – benefit from the Digital Transformation today

With goal-oriented consulting, we find together the right solution for your Digital Factory. Let's tackle the challenges of digitalization together and seize the opportunities.

PHOENIX CONTACT
INSPIRING INNOVATIONS



Phoenix Contact | Digital Factory

DIGITAL FACTORY

NOW