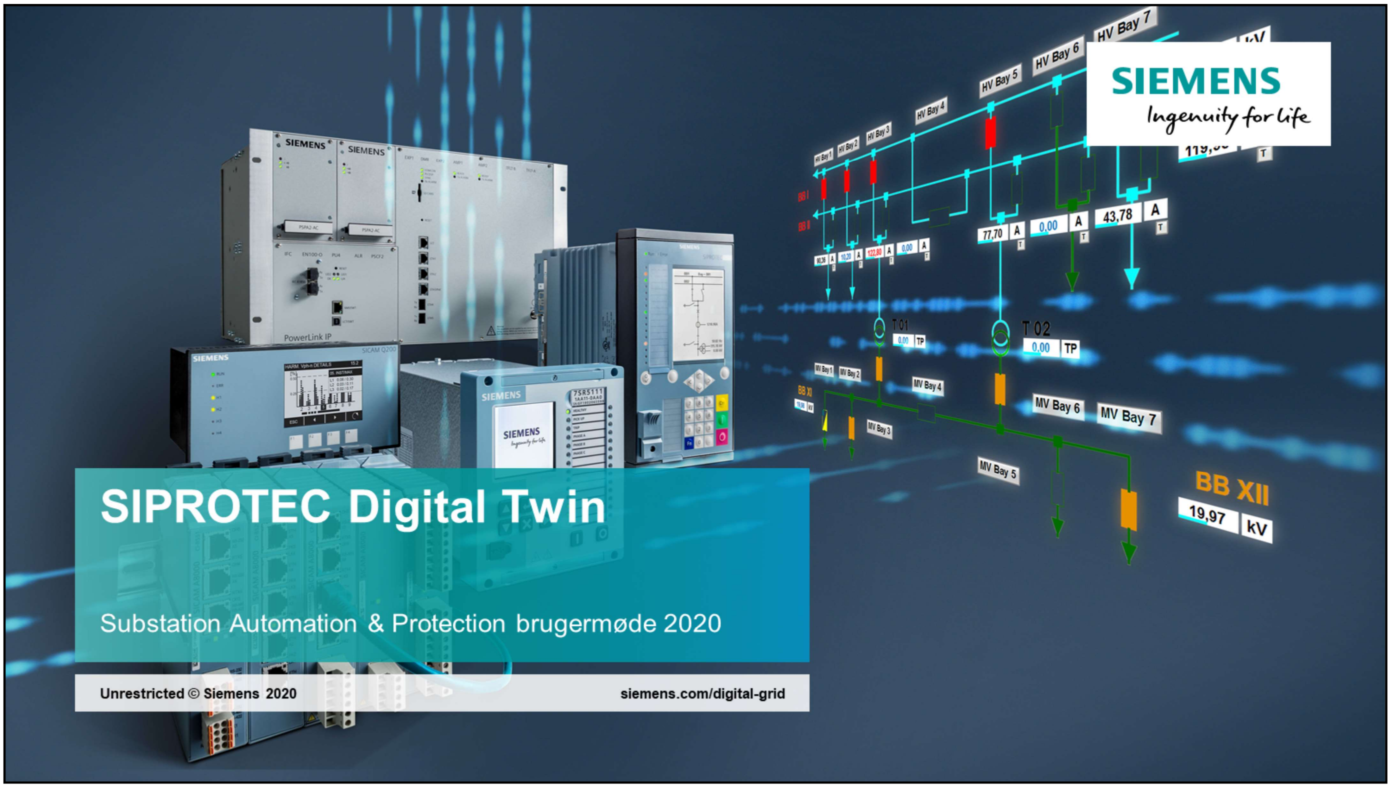

SIPROTEC Digital Twin
Substation Automation & Protection brugermøde 2020
Unrestricted © Siemens 2020
siemens.com/digital-grid
SIEMENS
Ingenuity for life
HV Bay 5
HV Bay 6
HV Bay 7
77,70 A
0,00 A
43,78 A
T 02
MV Bay 6
MV Bay 7
BB XII
19,97 kV

SIPROTEC DigitalTwin

SIEMENS
Ingenuity for life

- Introduction
- Storyline
- Product details
- Live demo
- Customer feedbacks and benefits

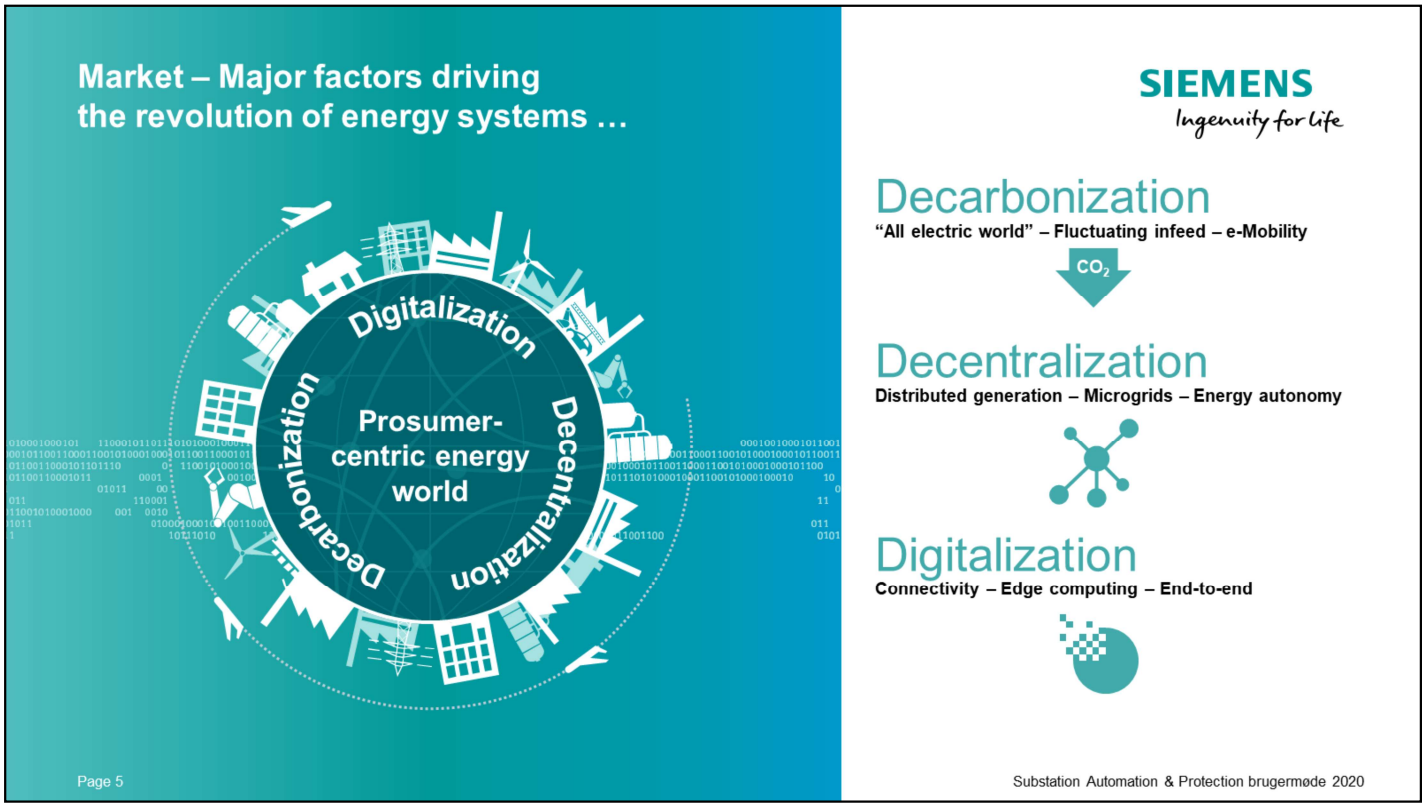
Notes 2

Introduction

A 3-minutes Video say more than a thousand words…

https://www.youtube.com/watch?v=1vveVXJZTSY


SIEMENS
Ingenuity for life
Storyline

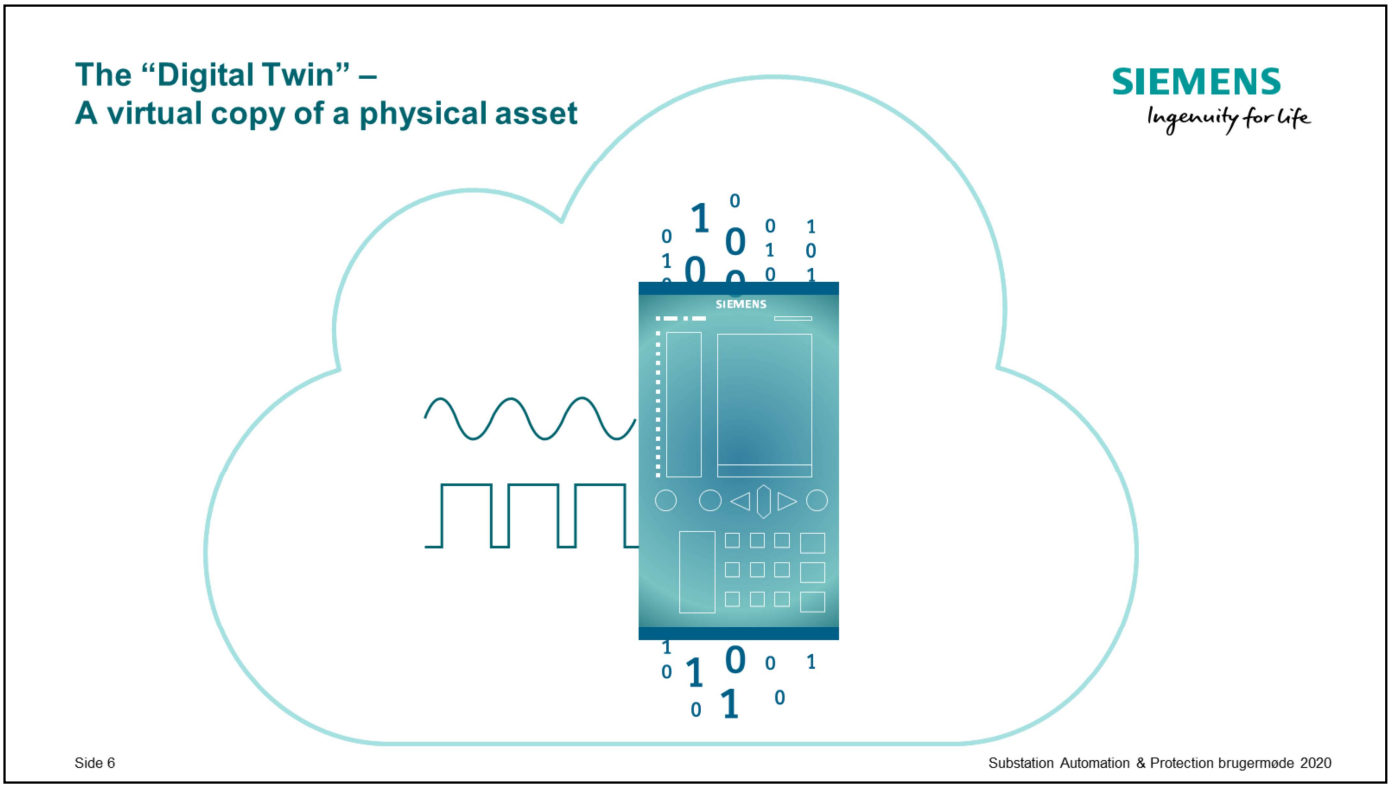


Decarbonization
Power production from renewables increases by over 300% between 2010 and 2030
Share of renewables goes up to 40% in 2030

Decentralization
New installations distributed power generation increases by over 150% between 2010 and 2030
Share of distributed goes up to 67% in 2030

Digitalization
Major industrial companies will using virtual avatars.
By 2021, half of the major industrial companies will be using virtual avatars, resulting in productivity gains of up to 10 %

Market
- Protection, control, monitoring, and measuring applications in electrical energy systems are highly complex topic
- Urbanization and climate change necessitate an optimized energy system - from generation to distribution and consumption.
- Half of major industry use Digital Twin in 2021 : 10% increase of effenctiveness. Target: 30%

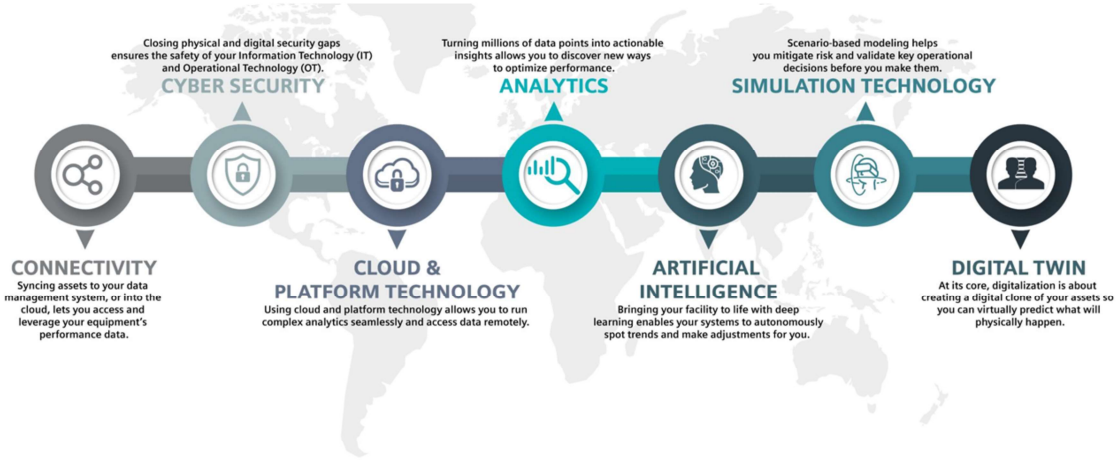


- The **digital twin** integrates all data, models, and other information of a physical asset generated during engineering, commissioning, operation, or service.

- Role of the digital twin is to **predict and optimize performance** of a physical asset (whether for design, production or operation).
  To this purpose we use **simulation methods** and/or data-based methods.

Seven Elements of Digitalization – The Digital Twin links the physical and virtual worlds

SIEMENS
Ingenuity for life

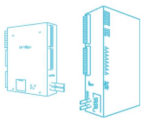


Innovation

- Digital Twin and Simulation is one of the top 9 defined focus topics in Corporate Technology
- Digitalisierung, Industrie V4.0 (IIoT und Edge Computing, Digital Twin)
- Siemens DF/PD is already strongly promoting e.g. Siemens PLM Digital Twin
- Focus on functional simulation, can scale up step-by-step in an agile way

SIPROTEC DigitalTwin – Digitalization meets Energy

SIEMENS
Ingenuity for life



SIPROTEC 5 process bus and digital substation

2015

Cloud based applications for SIPROTEC

2018

More than 1.6 million devices installed base

2011

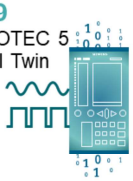
SIPROTEC 5 benchmark for protection, automation and monitoring

2017

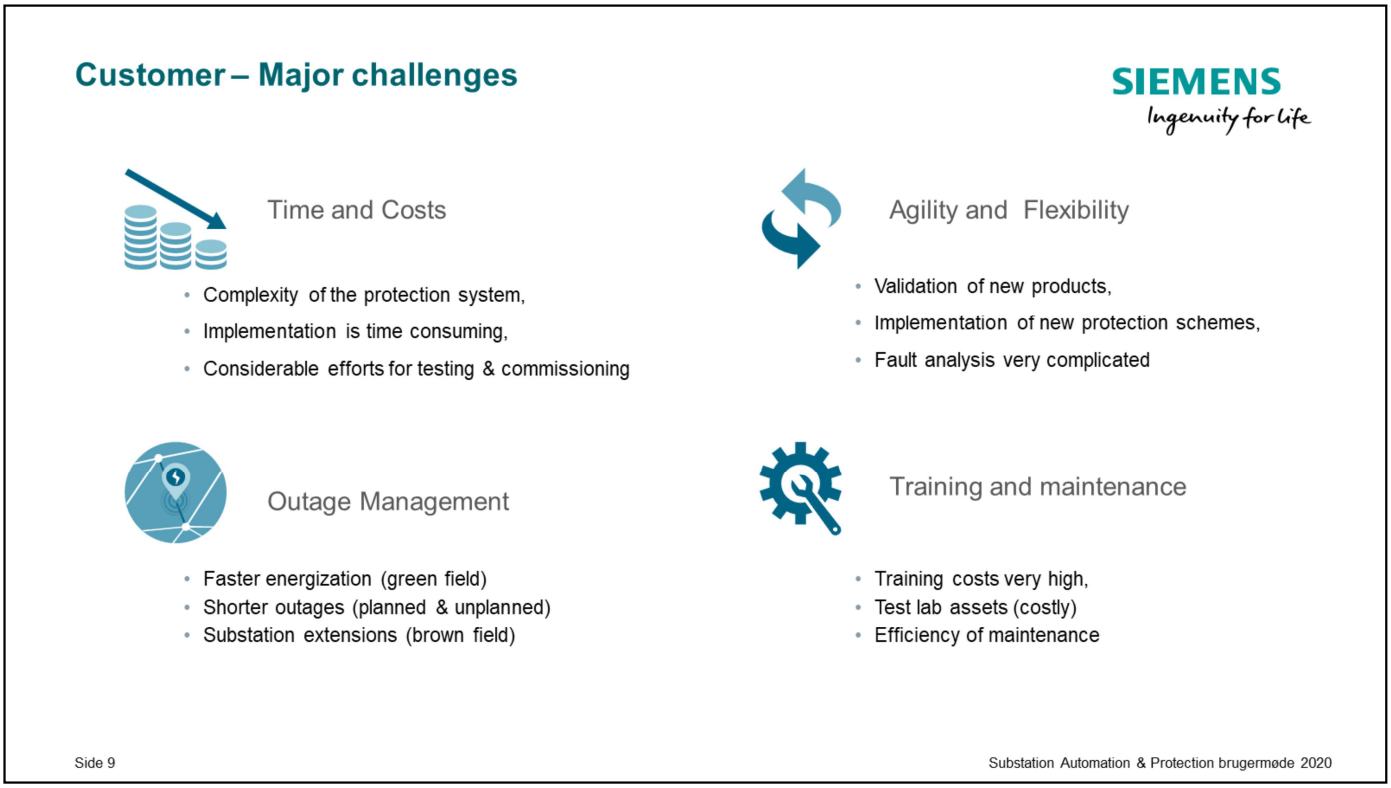
SIPROTEC 5 IoT connectivity to MindSphere

2019

SIPROTEC 5 Digital Twin



Notes 8



Time and Costs

The design up to the commissioning of a complex energy automation system with a lot of protection and automation devices and systems involved is **time-consuming**, especially the engineering and testing.

In most cases testing is only possible **after** all devices and systems are set-up physically and connected among each other and wired process signals. We are talking about days and weeks before you are able to test in the field.

Agility and Flexibility

Long and complex approval process (Type tests, RTDS tests, interoperability tests)

"Decentralized generation will call for changes to the electricity network and, to ensure flexibility, the power sector will need to become more intelligent."

Complex fault analysis through changed network topologies like sea Cable Application in Offshore Wind Farms, asymmetric faults, smaller fault currents, decoupling of systems, load shedding, voltage stabilization

Outage management

Economic efficiency "Over the past century, affordable energy has been a significant component of global economic growth and development."

Reliable power supply "Inefficient, antiquated energy supply stifles productivity."

Tailored outage management:

Approval process for shutdowns, very short duration for real shut down -> updates to be planned in detail

Training and maintenance

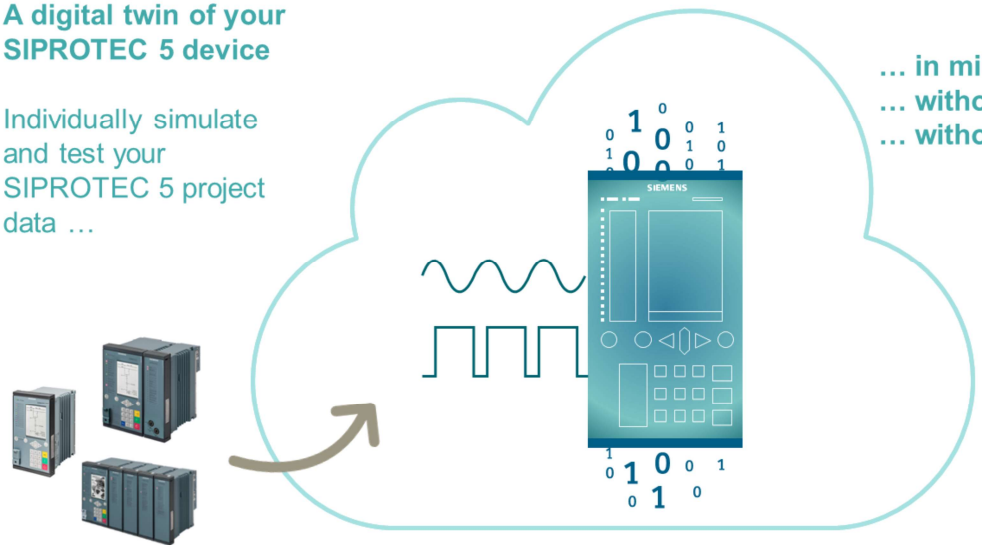
Scalable and customized trainings during the entire life cycle (operators, service personal)
Costs and efforts for maintaining test labs, e.g. updates, patches
Training goes digital (presence vs online seminars)
Organization: Central maintenance and service teams for remote support -> travelling costs,..

Our Solution – SIPROTEC DigitalTwin

SIEMENS
Ingenuity for life

A digital twin of your SIPROTEC 5 device

Individually simulate and test your SIPROTEC 5 project data …



… in minutes
… without hardware
… without additional efforts

Notes 10

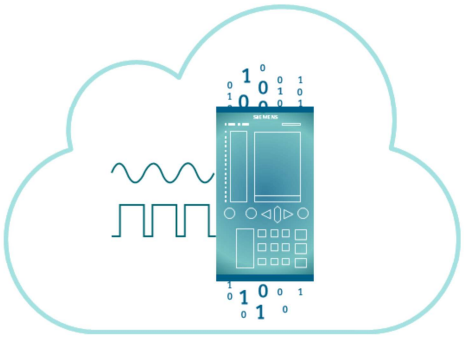
Our Solution – SIPROTEC DigitalTwin

SIEMENS
Ingenuity for life

Virtual Testing of SIPROTEC 5 protection devices

- Test in the cloud
- Connect to HW
- Reduce risk in projects
- Start testing in minutes

The three steps to success
- Upload
- Simulate and test
- Get reports



Lower Total Cost of Ownership

Side 11

Substation Automation & Protection brugermøde 2020

With the **SIPROTEC DigitalTwin** you can test your engineered energy automation system in the cloud,
in parallel or before you set-up the real hardware.

It shortens your time-to-operation significantly and reduces risk in projects by being able to test early – before HW is delivered and installed.

All devices to be tested from a bay or from a full substation are set-up virtually in minutes!

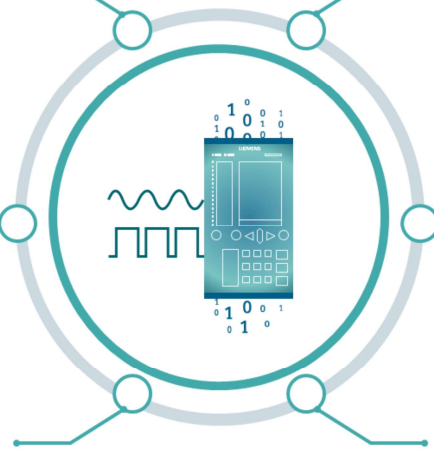
The three steps to success
- Upload your engineering data and your automated test cases
- Simulate and test your energy automation system in the cloud
- Get test reports of your engineered system

Saves time, increases quality throughout the entire lifecycle of your system

SIEMENS
Ingenuity for life

Maintenance and Service
- Patch management

Pre-sales and Design
- Information and Presentations
- Application concept and testing
- Design Specification
- Approvals

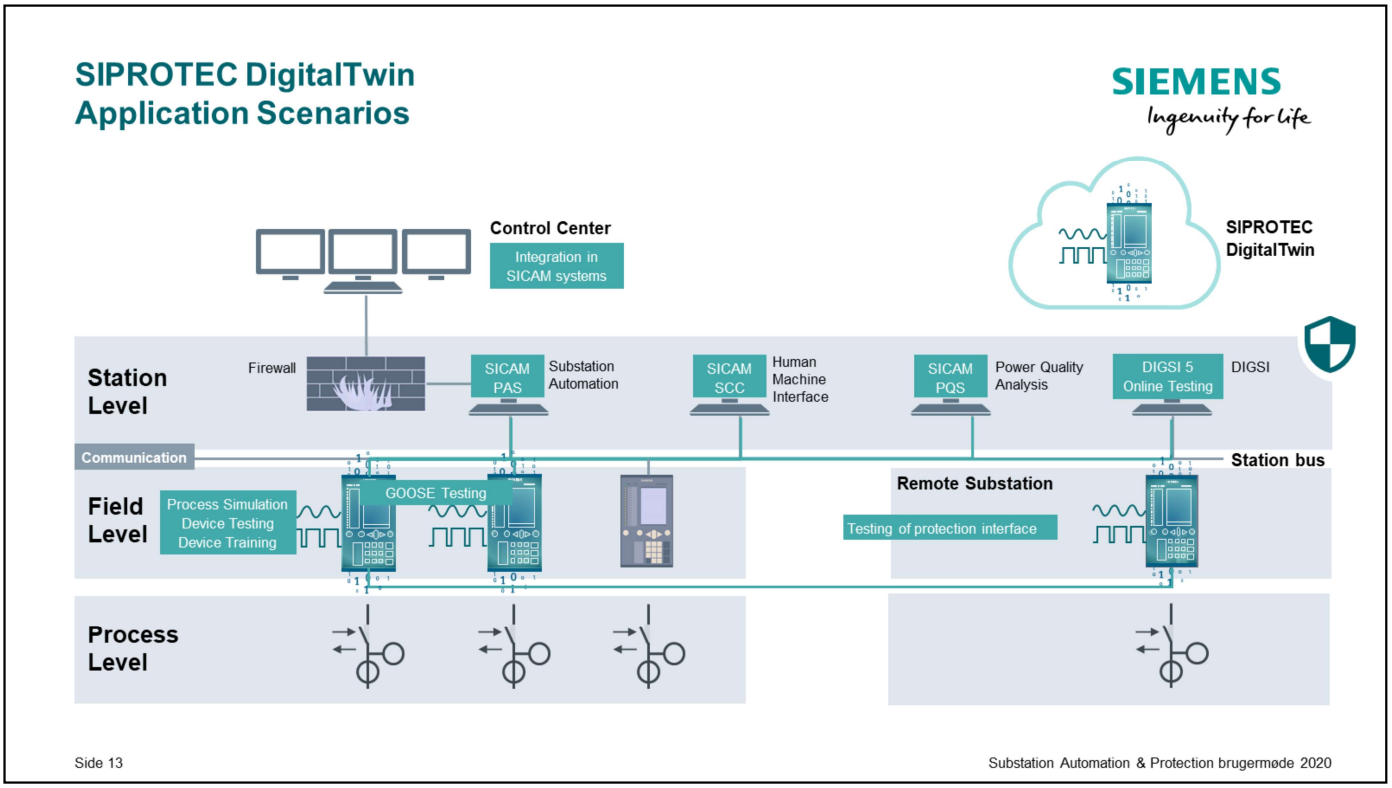


Training
- Device handling
- Operators
- Flexible at any place & without HW

Implementation
- Planning
- Algorithm
- Settings
- Pre-testing

Operation
- Device handling
- COMTRADE replay
- Fault analysis

Commissioning
- FAT
- SAT, Field test



- Front display visualization and operation (menu navigation, function keys, …)
- Injection of currents, voltages, binary inputs, e.g. for protection trips
- Visualize and interact with the emulated SIPROTEC 7SS85 with static process simulation
- Virtual wiring between simulated IEDs
- DIGSI 5 communication
- SIPROTEC 5 WebUI
- CFC switching sequences with function keys
- CFC Online debugging
- Replay of COMTRADE files
- IEC 61850 GOOSE between simulated devices
- GOOSE communication with e.g. tap changer
- Protection data interface between simulated devices
- SIP4-SIP5 line Diff compatibility
- Substation communication to SICAM A8000, SICAM PAS/SCC and 3rd party SCADA with the Ethernet protocols IEC 61850, DNP3, Modbus TCP, IEC 60870-5-104
- PMU and Power Quality system like SICAM PQS
- Cyber Security communication (SysLog, RADIUS, ..)
- IoT connectivity to MindSPhere0

Benefits –
The customer value proposition

SIEMENS
Ingenuity for life

Testing of the energy automation system within minutes, without hardware and without additional effort

- Simulation and validation
- Faster energization
  - Increase engineering quality
  - Virtual testing
  - Shortest commissioning times
- Reduced OPEX
- Efficient, scalable trainings
- Fast and realistic fault analysis


Agility and Flexibility


Time and Costs


Training and maintenance


Outage management

Testing of the energy automation system within minutes, without hardware and without additional effort

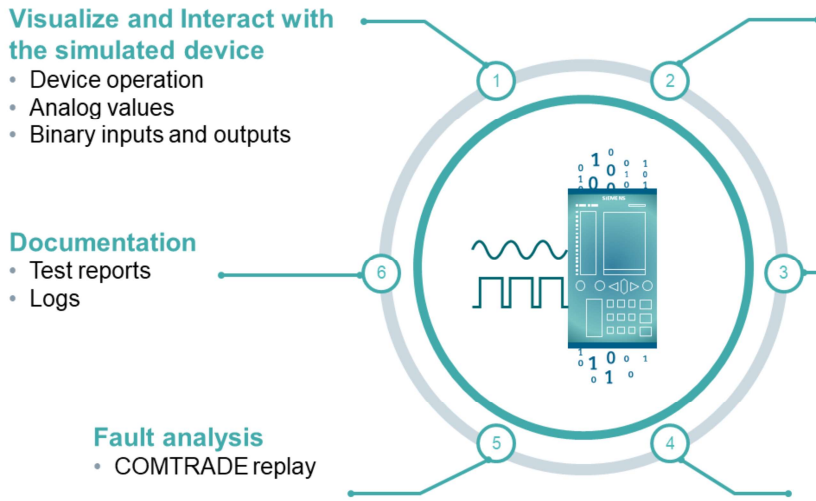
- Simulation and validation of product properties
- Faster energization of new systems thanks to shorter project lifetimes
  - Increase engineering quality
  - Virtual testing before start of commissioning
  - Shortest commissioning times
- Reduced OPEX with shorter outages for higher availability thanks to better pre-testing
- Efficient, scalable trainings on the job
- Fast and realistic fault analysis by easily reproducing the behavior of products and systems

SIEMENS
Ingenuity for life

Product Details

SIPROTEC DigitalTwin within the entire energy automation system

SIEMENS
Ingenuity for life



Visualize and Interact with the simulated device
- Device operation
- Analog values
- Binary inputs and outputs

DIGSI 5 Online Testing and Web Browser
- Online CFC Debugging
- Download Logs and Fault records
- Test sequence
- Plug & Play

Documentation
- Test reports
- Logs

Communication interfaces
- IEC 61850
- IEC 60870-5-104
- DNP3 TCP, Modbus TCP
- Protection Data Interface

Fault analysis
- COMTRADE replay

Integration into substation automation system
- SICAM A8000
- SICAM PAS, SCC and PQS
- 3rd party systems
- Interlockings via GOOSE

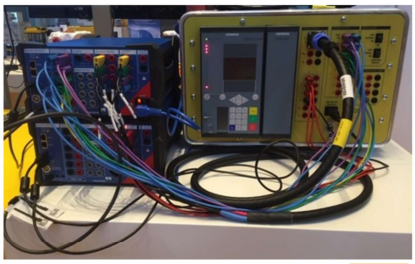
3rd party systems with the Ethernet protocols IEC 61850, IEC 60870-5-104, DNP3, Modbus

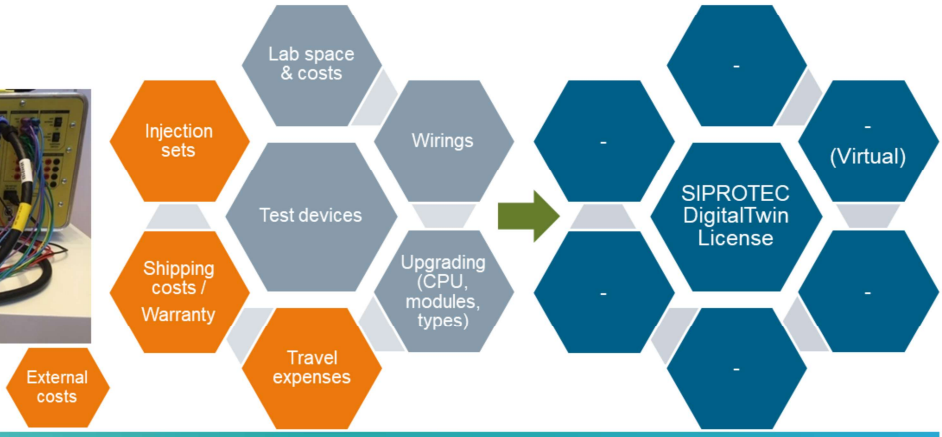
Benefits and Customer Feedbacks

Benefits

Investment cost reduction for test lab usage

SIEMENS
Ingenuity for life





- Reduce your test lab CAPEX investments by typically 80%
- Test your external dependencies and reduce external costs by 100%

Special surface for lab + Special measures needed
Wirings + time + Special measures needed

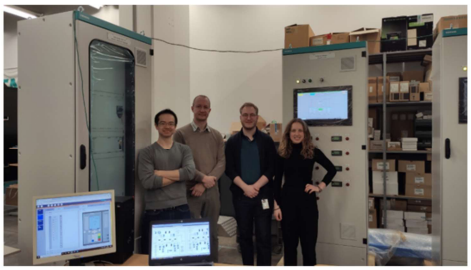
Customer Feedbacks
Virtual FAT within Siemens Belgium

SIEMENS
Ingenuity for life

First virtual FAT with Ivorian customer in Belgium – "Confident in the solution"
The week from 02.03.2020, Siemens Belgium with colleagues Le, Yun Kang (RC-BE SI DG EA OP PM 1), De Temmerman, Geert (RC-BE SI DG EA OP PM 1 C&P) and Gybels, Frie (ext) (RC-BE SI DG CS&D OP) realized its first virtual FAT in presence of the customer, who was confident and satisfied in our solution.
The scope was the delivery of:

- 4 SIPROTEC 5 protection devices with multiple customer-specificities (CFC logic, breaker failure protection, etc.)
- SICAM A8000 and SICAM SCC substation automation

Pre-testing during 2 weeks significantly reduced the error rate (100% correct configuration of all signals in SICAM SCC, correct CFC logic in SIPROTEC 5, proper interactions between devices) and helped to get high customer satisfaction.
The used M license was able to simulate all devices, including virtual wirings to circuit breaker simulator.
Waiting for the next FAT, and the coming improvements for an even higher availability of the application. ‹ collapse



https://www.yammer.com/siemens.com/threads/579173033934848

Notes 35

Customer Feedbacks
TSO Pilot Project

SIEMENS
Ingenuity for life

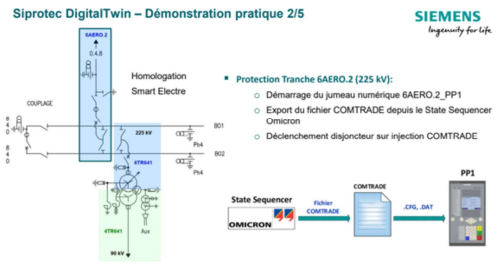
"We want to be more agile, the product fits our needs" - Successful 1-day workshop with major European TSO

On 03.03.2020 with 8 participants on customer side (all with advanced SIPROTEC 5 experiences: project managers, approval responsible, substation technicians, settings expert, ...), Zeyeni-Languaroudi Mehdi (RC-FR SI DG S) did excellent demos from end customer applications (some videos attached, and slides in French):

- Monitoring and control via SICAM PAS & SCC connection to virtual SIPROTEC devices
- COMTRADE replay (exported from Omicron OCCs)
- Full transformer application with 4 devices (primary and secondary side) involving virtual wirings and GOOSE to trip the primary side
- DIGSI 5 connection to retrieve logs, visualize indications and debug CFC online
- Simulation of 20 virtual devices (preview feature) to test advanced distributed station functionalities

During more than 2 hours brainstorming of scenarios from customer, all participants wanted it:

- to train both their new employees (operators and technicians), as well ad the older ones on the newer technologies deployed, to be more efficient on site
- to analyze fault records (without lab access nor electrical authorization)
- to define better settings
- to reduce/avoid commissioning steps on site (gaining time and reducing costs) when bays are migrated setp by step
- to better test big distributed functionalities
- to prepare next configuration/firmware updates
- to reduce travel time and costs to FAT



https://www.yammer.com/siemens.com/threads/577757415972864

Notes 36

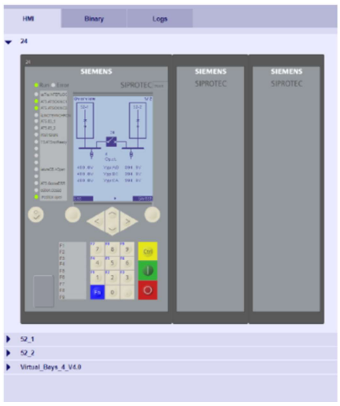
Customer Feedbacks
MV Collaboration for O&G Customer

SIEMENS
Ingenuity for life

Digitalization as USP - workshop with Siemens Medium Voltage and major O&G customer
Thanks to Otto, Dirk (SI DS S PLM-EH), Schaller, Kerstin (SI DS S VA OW), Obenaus, Sven (SI DS O AIS LPZ OM) for getting the first licenses of SIPROTEC DigitalTwin at Siemens Medium Voltage and inviting me to present it today to their O&G customer, with a virtual **demo of an Automatic Transfer Scheme** with 3 devices communicating via GOOSE, with interlockings and synchrocheck, and with a circuit breaker simulator.
Very interested audience, and also first financial benefits/savings immediately recognized:

- No need to adapt customer configuration on available lab devices
- Online CFC debugging for more efficient engineering
- Reduced travels with pre-FAT clarifications via Circuit Live demo of the SIPROTEC configuration
- Pre-testing of the IEC 61850 DCS, saving several days on site

We will follow-up during project execution in 2020, further improve the solution and roll-out the solution to more customers!



https://www.yammer.com/siemens.com/threads/463623794270208

Customer Feedbacks
Home Office due to the COVID-19

SIEMENS
Ingenuity for life

Morales Rincon, Jaime Andres (RC-CO SI DG CS&D EN SC SYS) Follow – 17 hours ago

In Colombia we have restrictions to enter to the office due to the COVID-19, but with Digital Twin application, a Sicam A8000, and IECTEST simulation protocol, I have tested at home signals from protection relays to the Control Center and fulfilled my test plan agreed with customer. Thanks to Digital Twin, our pretests of the substation control system are virtual

https://www.yammer.com/siemens.com/#/threads/inGroup?type=in_group&feedId=232742912

Notes 38

Customer Feedbacks and Benefits – What customer say about the SIPROTEC DigitalTwin …

SIEMENS
Ingenuity for life

5 As a training participant, I can always work with exactly the right device that fits my application.

1 With the SIPROTEC DigitalTwin, I can demonstrate the devices to my customers in the exactly fitting version without having devices on site.

1 2 3 As an EPC I can plan, engineer and test my complete station automation system without having to order a single device in advance. As soon as everything is in place, I order the exactly fitting devices directly onto the system on schedule. This gives me security and saves money.

6 As a service engineer, I can read the exact data of the field via DIGSI 5 in the event of a network failure and then test and analyze it from my office with exactly the same hardware. That makes it pleasant and efficient.

1 Pre-Sales and Design
2 Implementation
3 Commissioning
4 Operation
5 Training
6 Maintenance and Service

Customer Feedbacks and Benefits – What customer say about the SIPROTEC DigitalTwin …

SIEMENS
Ingenuity for life

2 When creating automation functions (CFC), I can test them immediately with the exactly fitting device. Especially helpful is the simulation of process signals and the inclusion of GOOSE information.

1 2 As part of device approvals, I can perform the entire test with the SIPROTEC DigitalTwin without having devices on site and having to wire them. I then carry out a final, short test on a real device.

3 I can implement the commissioning of the system much faster, since the device parameterization and the integration into the station automation have already been tested. This saves us time and money and enables us to put the system back into operation quickly.

3 6 As a commissioning engineer I am on the road a lot and don't always have the right hardware with me. With the SIPROTEC DigitalTwin I can easily test the complete engineering from anywhere with DIGIS 5 and Internet access.

1 Pre-Sales and Design
2 Implementation
3 Commissioning
4 Operation
5 Training
6 Maintenance and Service

Notes 40

Customer Feedbacks and Benefits – What customer say about the SIPROTEC DigitalTwin …

SIEMENS
Ingenuity for life

3 Especially when testing and commissioning line differential applications, the devices and systems are often far away from each other. IBS requires a lot of time and staff. With the SIPROTEC DigitalTwin I can very easily test them completely in advance from the office. Testing the protection interface and the messages is also very simple.

2 As a switchgear manufacturer, we always order the SIPROTEC 5 devices on time for installation in the switchgear. To save costs, we integrate more and more automation functions into the devices. With the SIPROTEC 5

3 DigitalTwin we can check the parameterization and especially the automation in advance in the office without the hardware. A short final test in the system is then sufficient.

2 The integration and testing of the protective devices in the station automation with system interlock and interface has been very complex to date. With the SIPROTEC 5 DigitalTwin it is much easier and cheaper to do it in advance in the engineering department without devices.

1 Pre-Sales and Design
2 Implementation
3 Commissioning
4 Operation
5 Training
6 Maintenance and Service

Notes 41

Benefits –
The customer value proposition

SIEMENS
Ingenuity for life

Testing of the energy automation system within minutes, without hardware and without additional effort

- Simulation and validation of product properties
- Faster energization of new systems thanks to shorter project lifetimes
  - Increase engineering quality
  - Virtual testing before start of commissioning
  - Shortest commissioning times
- Reduced OPEX with shorter outages for higher availability thanks to better pre-testing
- Efficient, scalable trainings on the job
- Fast and realistic fault analysis by easily reproducing the behavior of products and systems


Time and Costs


Agility and Flexibility


Outage management


Training and maintenance

Notes 42

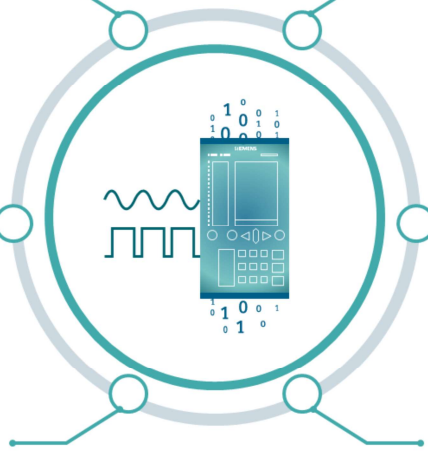
Benefits – Lower Total Cost of Ownership

SIEMENS
Ingenuity for life

Agility and productivity
- Faster pre-sales for promotion and clarifications
- Less logistics and cabling
- Better after-sales support with COMTRADE replay
- Reduced Non Conformance Costs for System Integration

Faster project execution
Virtual commissioning speeds up the project phase – parallelization from engineering and HW

Always up-to-date
- Lower barriers with the cost-effective pre-testing of latest upgrades (enhanced and more secure)
- Deployment comfort: Feature extensions/updates on centralized Cloud server



Minimum system downtime
Faster site interventions and system energization thanks to optimal preparation for greenfield, changes or system extensions

Trainings
- Scalable trainings
- Customer-focused tests
- Remote (refresher) trainings
- Lower test lab investments

Engineering recommendations
Configuration hints

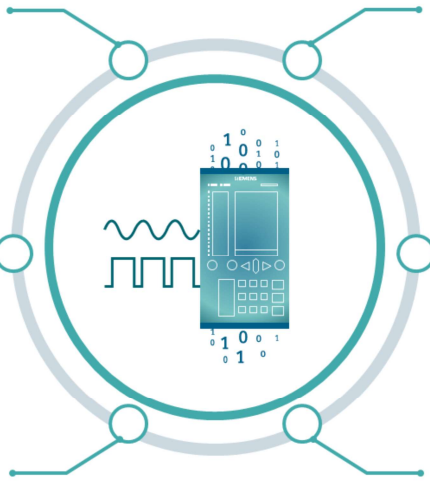
Benefits – Cloud application

SIEMENS
Ingenuity for life

No IT constraints
- Standard HTTPS connection → no firewall issues
- No OS constraints (version, 64bit availability, increased RAM …)

Access from everywhere
- Remote (refresher) trainings
- Lower investments

Always up-to-date
- Deployment comfort: Feature extensions/updates on centralized Cloud server → no SW freeze
- Continuous improvements → no need to wait for longer release cycles (e.g. >6 months)



Scalability
Computing power for running full substations[1]

Data protection
Core aspect during the solution design

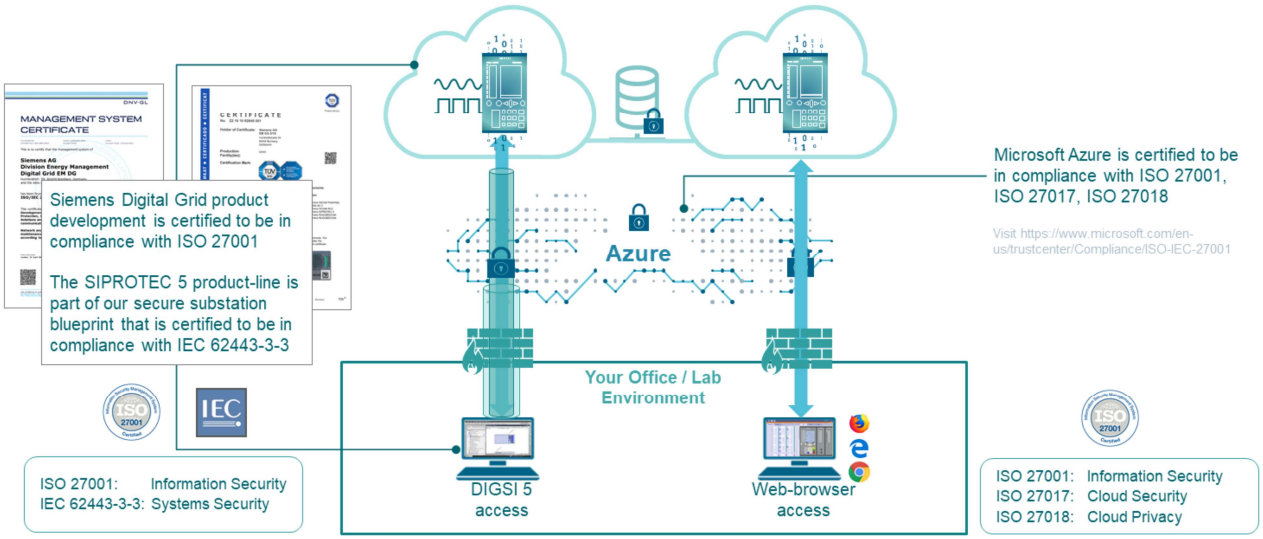
Flexible payments[1]
Starting with yearly contracts, options to have other billings

1) On request

Notes 44

Benefits -
Cybersecurity based on International Standards

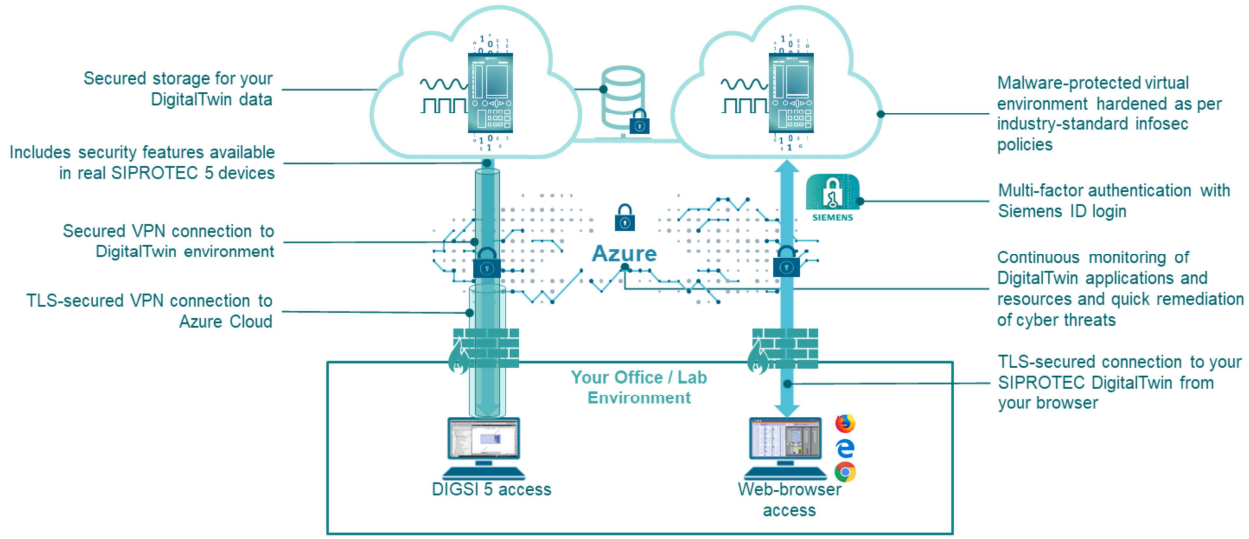
SIEMENS
Ingenuity for life



Notes 45

Benefits -
Defense-in-Depth Measures That Protect Your Data

SIEMENS
Ingenuity for life



Conclusion

SIEMENS
Ingenuity for life

“The SIPROTEC DigitalTwin has the great benefit that you always have the protection device you need in your pocket”

Hans Kristian Muggerud
Technical Supervisor, Norway

Kontaktoplysninger

SIEMENS
Ingenuity for life

Anders Dahl Johnsen
Salgsspecialist
Tlf: +45 21 55 11 71
E-mail: anders.johnsen@siemens.com

siemens.com/digital-grid