Digital Twins for Protecion Devices

Communication based protection workshop – June 2, 2022

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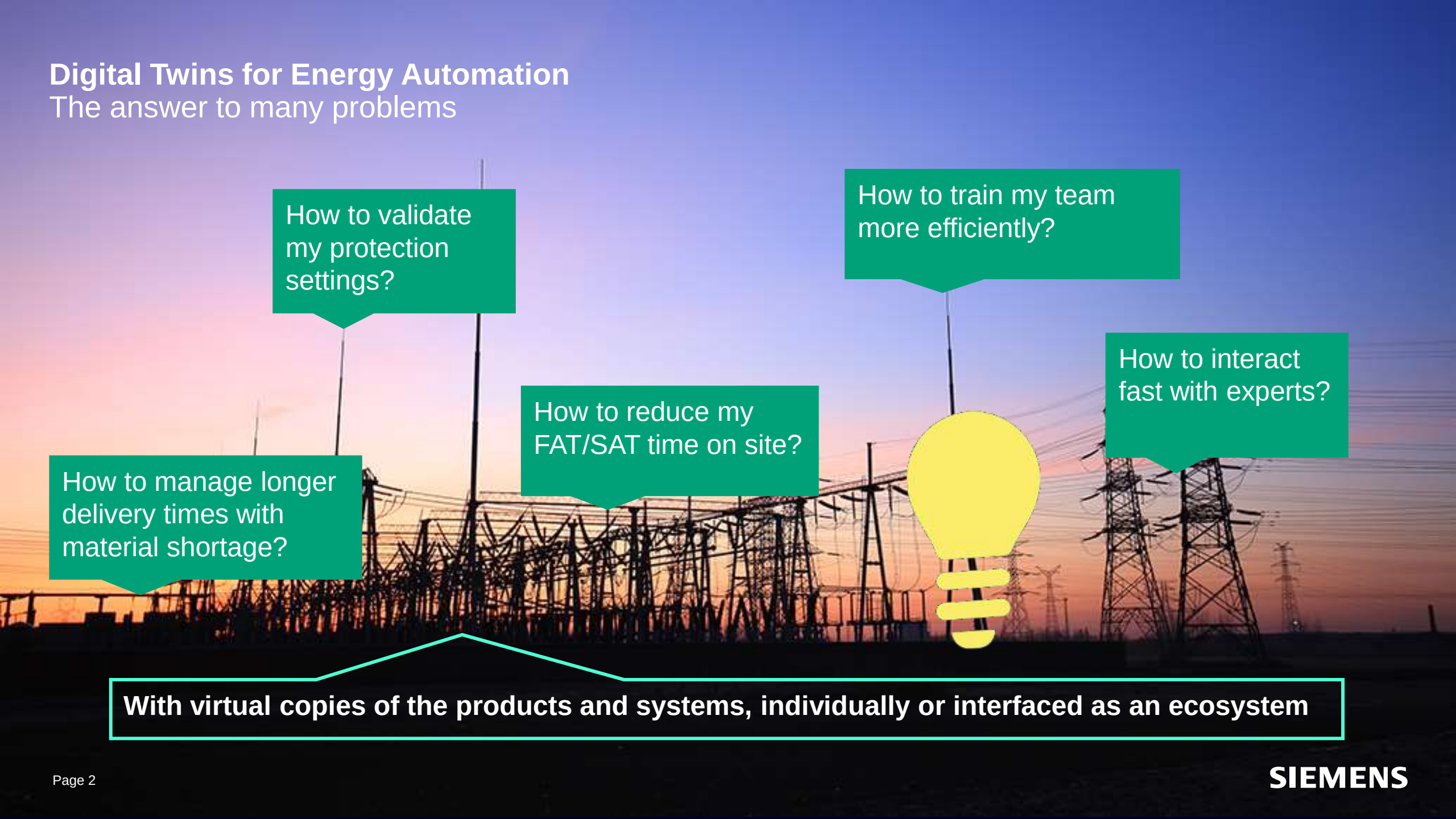
Digital Twins for Energy Automation

The answer to many problems



With virtual copies of the products and systems, individually or interfaced as an ecosystem

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Digital Twins for Energy Automation
The power of ecosystems and the role of interfaces

"The whole is more than the sum of its parts" - Aristotle

Power System Digital Twin

+

IED Digital Twin

+

Testing Digital Twin

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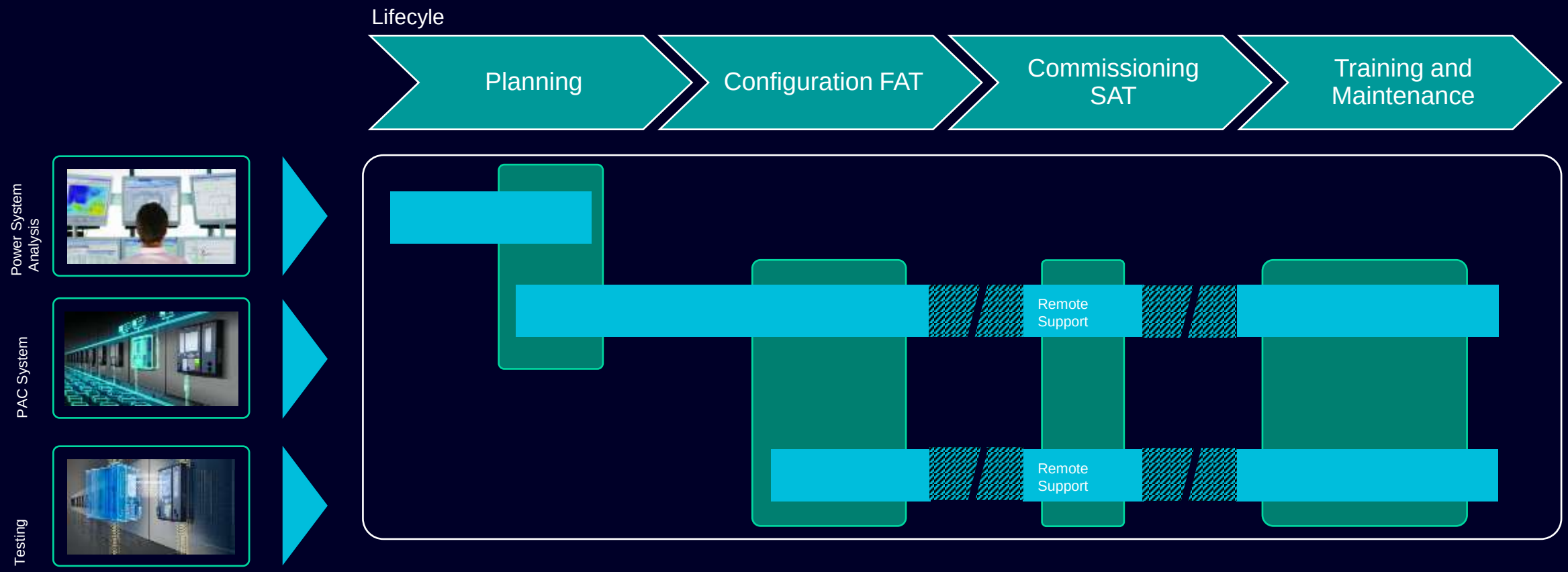
Digital Twins for Energy Automation Across the Lifecyle



Time and Costs

Agility and Flexibility

Outage management

Training and maintenance

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Digital Twin for Planning

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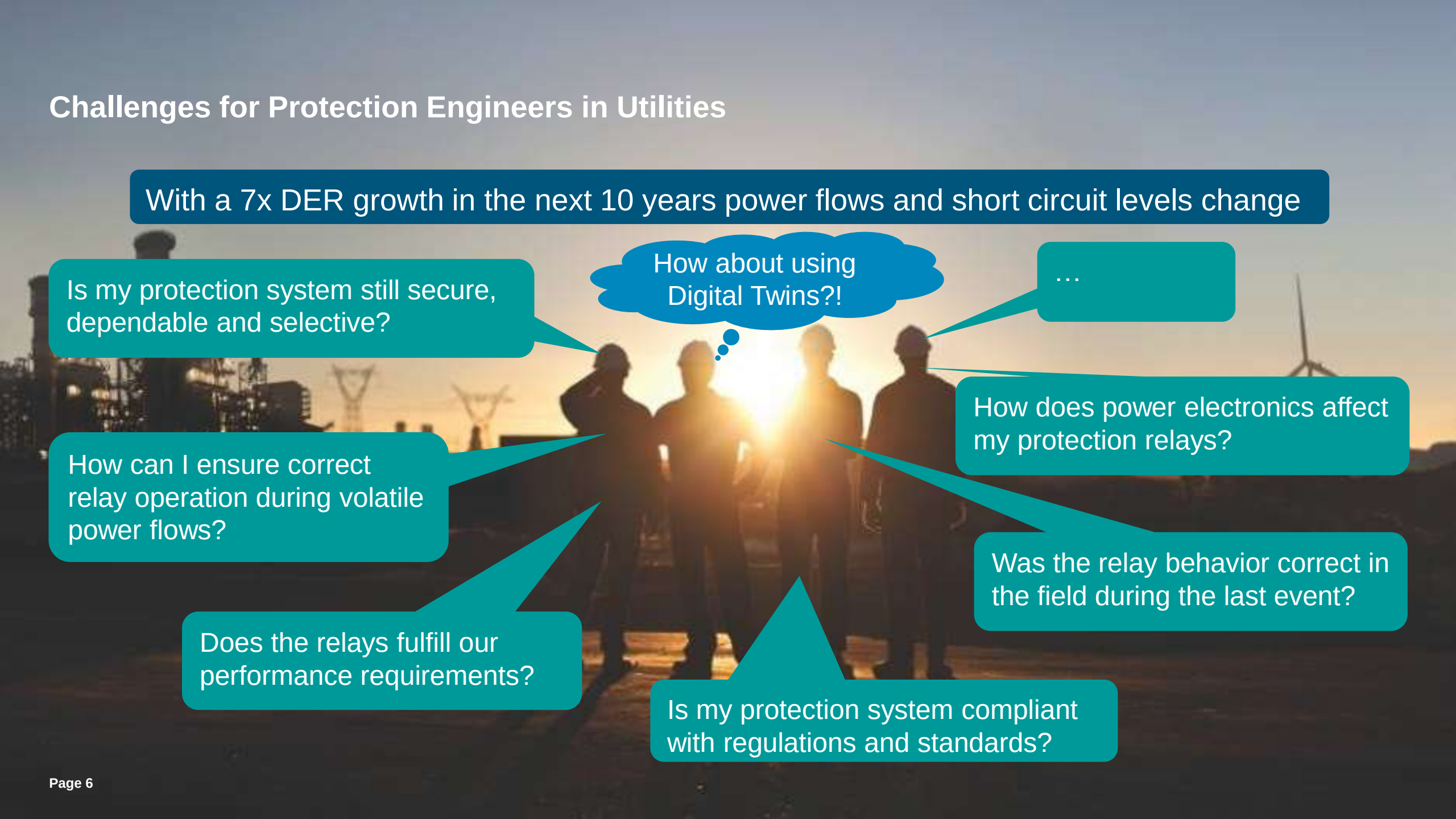
Challenges for Protection Engineers in Utilities



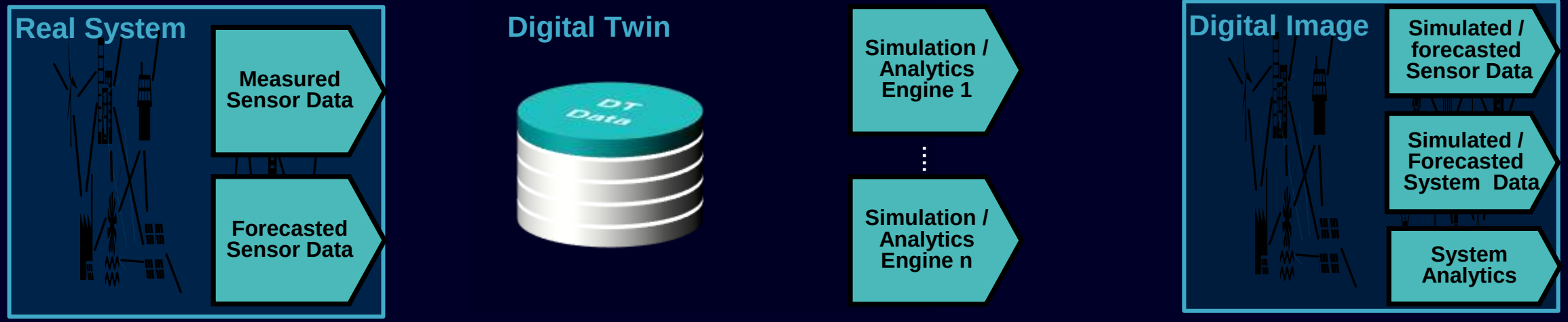
Digital Twin
Definition and Structure

A **Digital Twin (DT)** is a virtual representation of an asset, a system or a system of systems.
It can be used in design, simulation, monitoring, optimization and servicing.

The DT must be described in general as a:

DT of (what) **and for** (what purpose). E.g. DT of an IED to assess Relay Behavior

The DT consists of data, describing the real product or system in an appropriate manner for the target purpose, combined with the appropriate simulation / analytics engine. It can provide inputs for sensors, connected to the real assets and / or can simulate the outputs of sensors.



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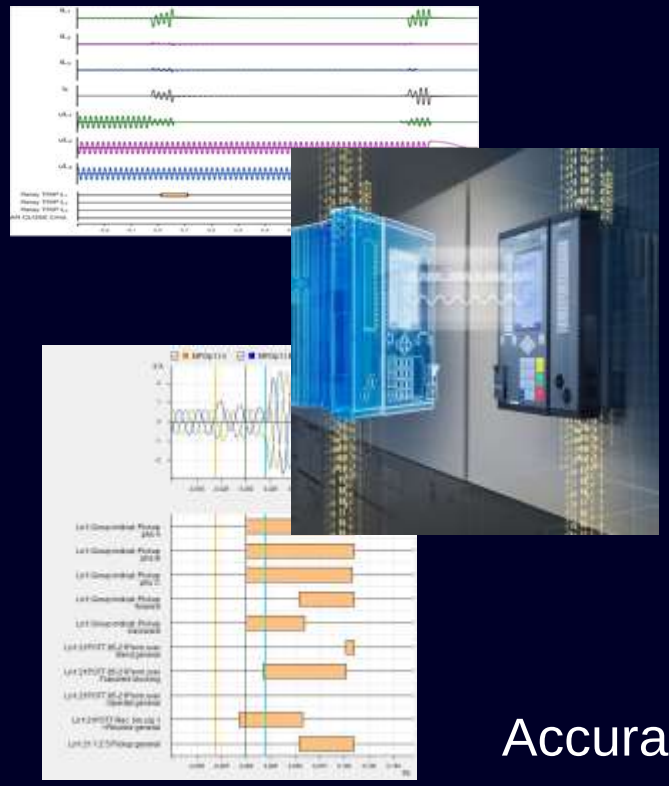
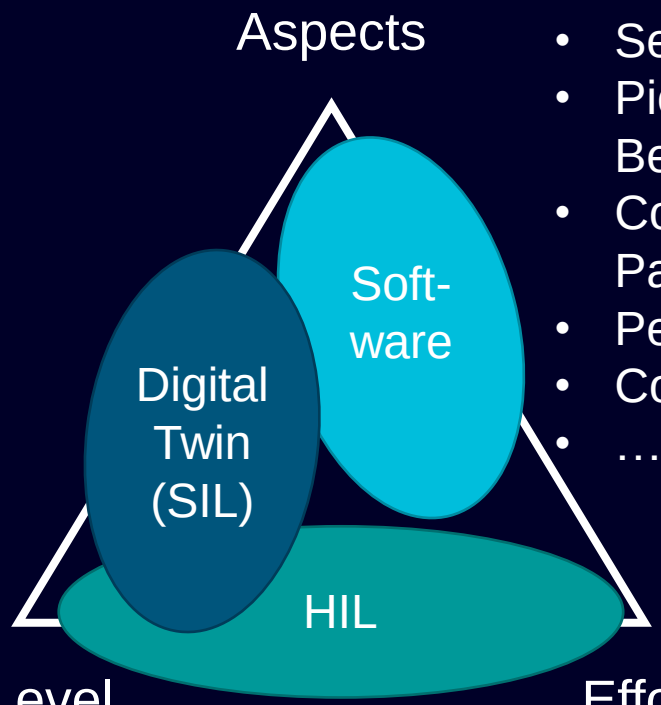
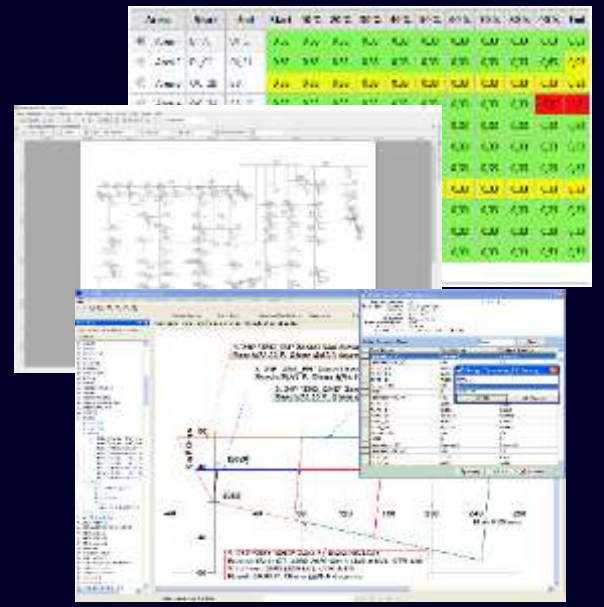
Tension Triangle: Assessment of Protection System





- Selectivity + Sensitivity
- Pick-up and Operation Behavior
- Configuration and Parameters
- Performance
- Communication
- …

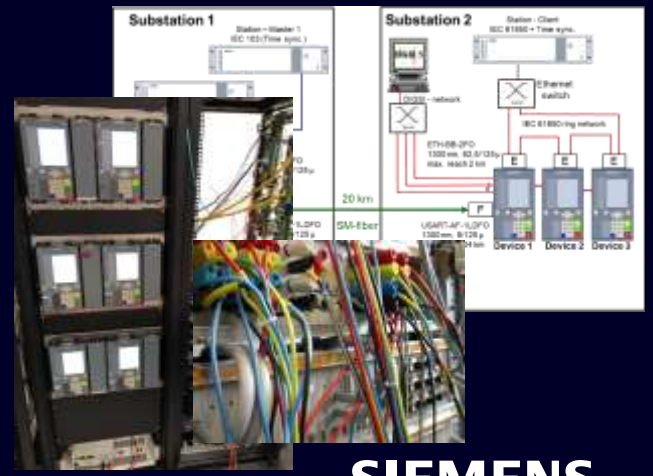


Accuracy Level

- Physical Phenomena
- System Approval
- Dedicated Function
- ...

Effort

- Simulation
- Hardware Laboratory
- Experts + Equipment
- …



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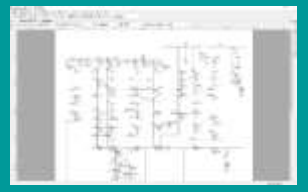
Digital Twin Approach for the Assessment of Protection Systems

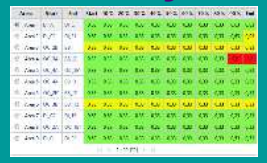
Digital Twin of Power System

Protection Coordination

Simulate



Verify



Protection Security Assessment

Design & Optimize

Settings calculation

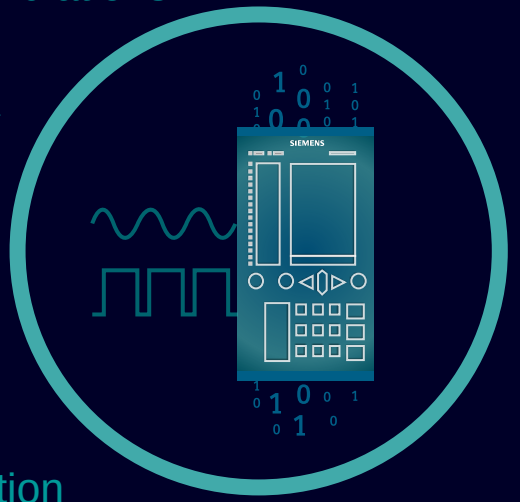
Power Flow & Short Circuit Calculations
Relay Settings Study

Engineering-Tool

Configuration
Firmware Version
Communications

SIPROTEC Digital Twin

Fault Simulations



Vendor-specific Relay behavior

Comparison of Firmware versions

- Assessment of Performance
- Approval of firmware versions
- Reduction of Effort

Optimization of Parameters

Interlockings
Auto-reclosing cycles
Inrush detection
Teleprotection
…

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Digital Twin for virtual FAT

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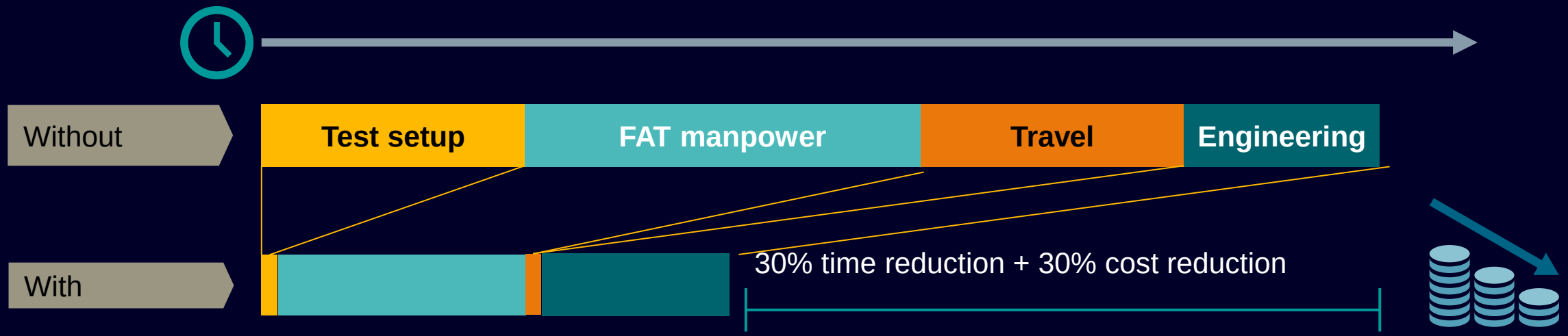
Digital Twins for virtual commissioning
Save your time and costs for Factory Acceptance Test (FAT)



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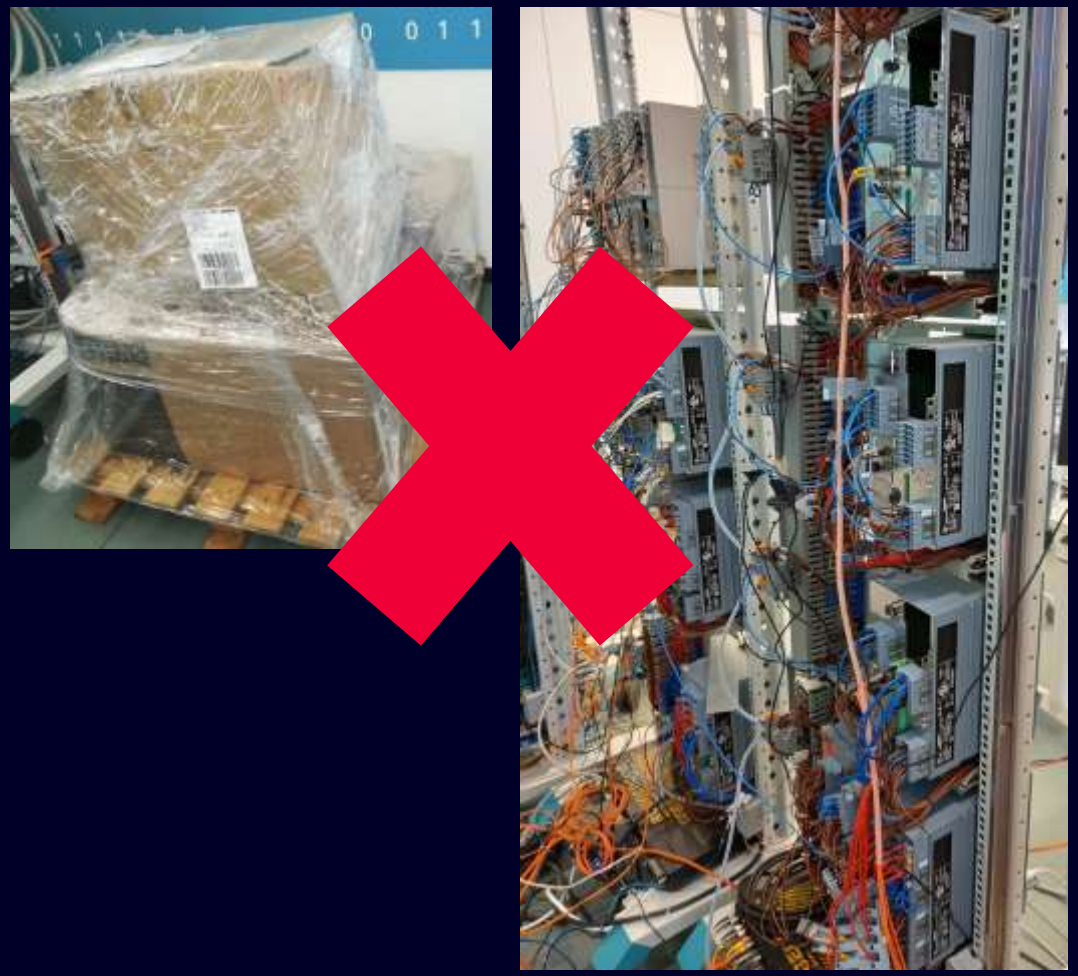
Virtual FAT
Disruptive without physical test setup



- No logistics of protection devices,
- No waiting for panel production,
- No temporary installation and wirings,
- No additional test hardware

- Virtual devices,
- Virtual wirings

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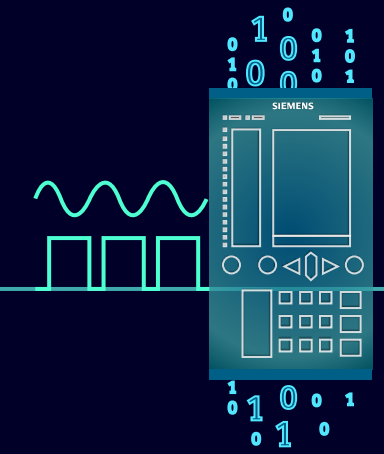
Virtual FAT
Access within minutes to your protection system



1
Open DIGSI 5 project

2
Export SIM file

3
Connection to the Cloud

4
Import SIM

5
SIPROTEC DigitalTwin

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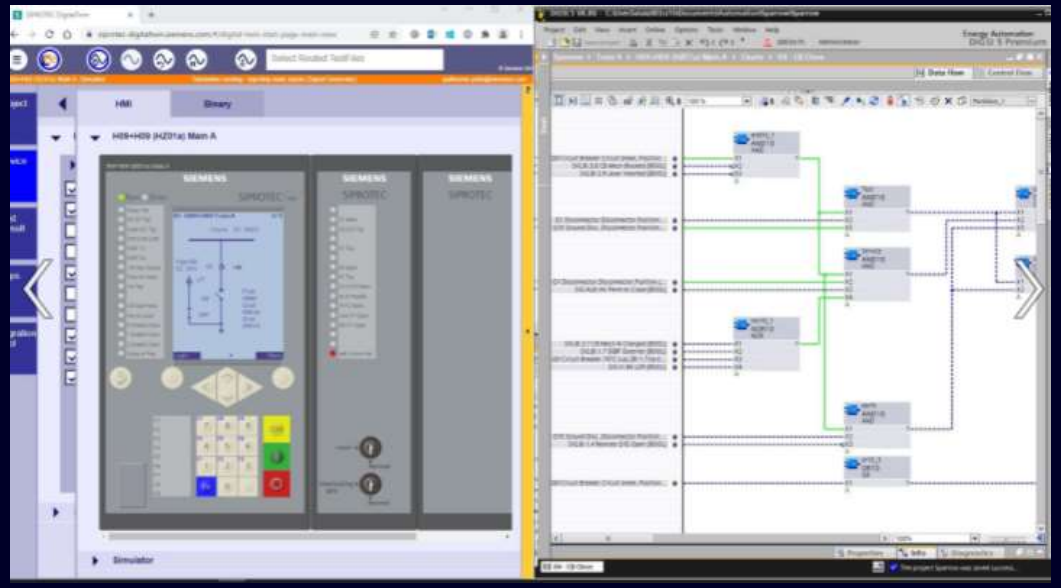
Virtual FAT
Same functional scope but more benefits



- Same functional test scope
  - Front display,
  - Programmable logic
  - GOOSE communication (interlockings, trips,..)
  - Protection schemes (51, 59, 21, 25, 87, 87B, 90V …) with static or transient input values

=

- Several people can work.
  - In parallel on same or different devices
  - Without travel,
  - Safe from home / office

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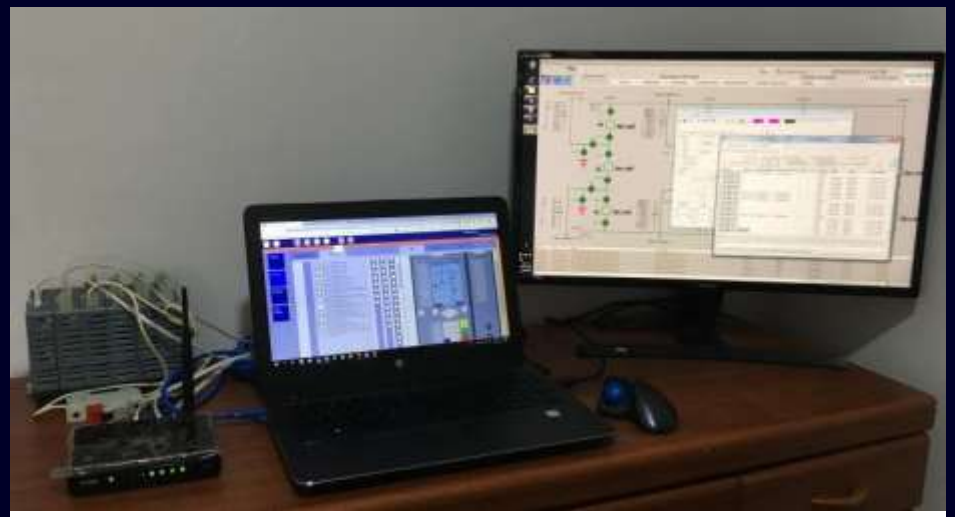
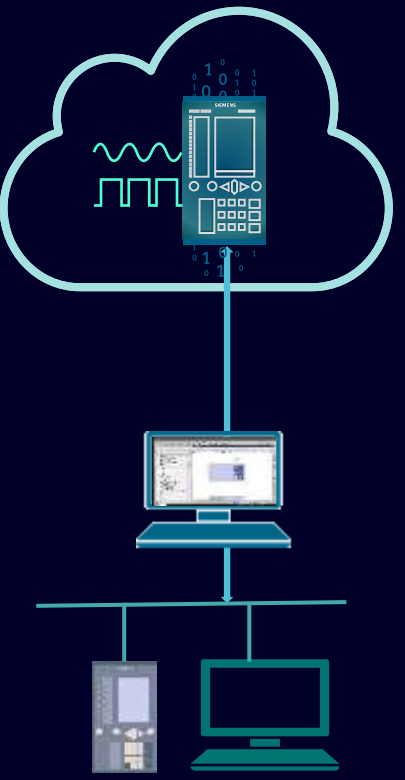
Virtual FAT
Including Ethernet interfaces to other components anywhere



Jaime Andrés Morales Rincón • 1st
Systems Specialist at Siemens Energy and Automation
1yr • Edited •

Today, I finished testing a breaker and a half configuration for an electrical substation from the comfort of my home. Thanks to a Siemens Digital Twin, I was able to simulate all the protection relays of my substation with IEC61850 such as 6MD85 (bay controller), 7SL87 (line differential and distance protection), 7VK87 (circuit breaker management device) and 7SS85 (busbar protection). I used a little communications switch that we use to access the Internet at home, a Sicam A8000 as a gateway (controller substations) connected to an IHM (Wincc) and to an IEC 60870-5-104 simulator (remote control center), both applications they run on my laptop. The tests were as follows: interlocks, protection signals, binary input / output signals, measurements and Goose between protection relays. I have a complete substation testing lab at home thanks to a Siemens Digital Twin.

- Interface to real hardwares via VPN:
  - RTU for DCS signal tests,
    e.g. via IEC 61850 MMS
  - Local HMI
  - GOOSE with available IEDs
    or simulated via SCL



- Possible to temporary share the access
  to any substation system provider

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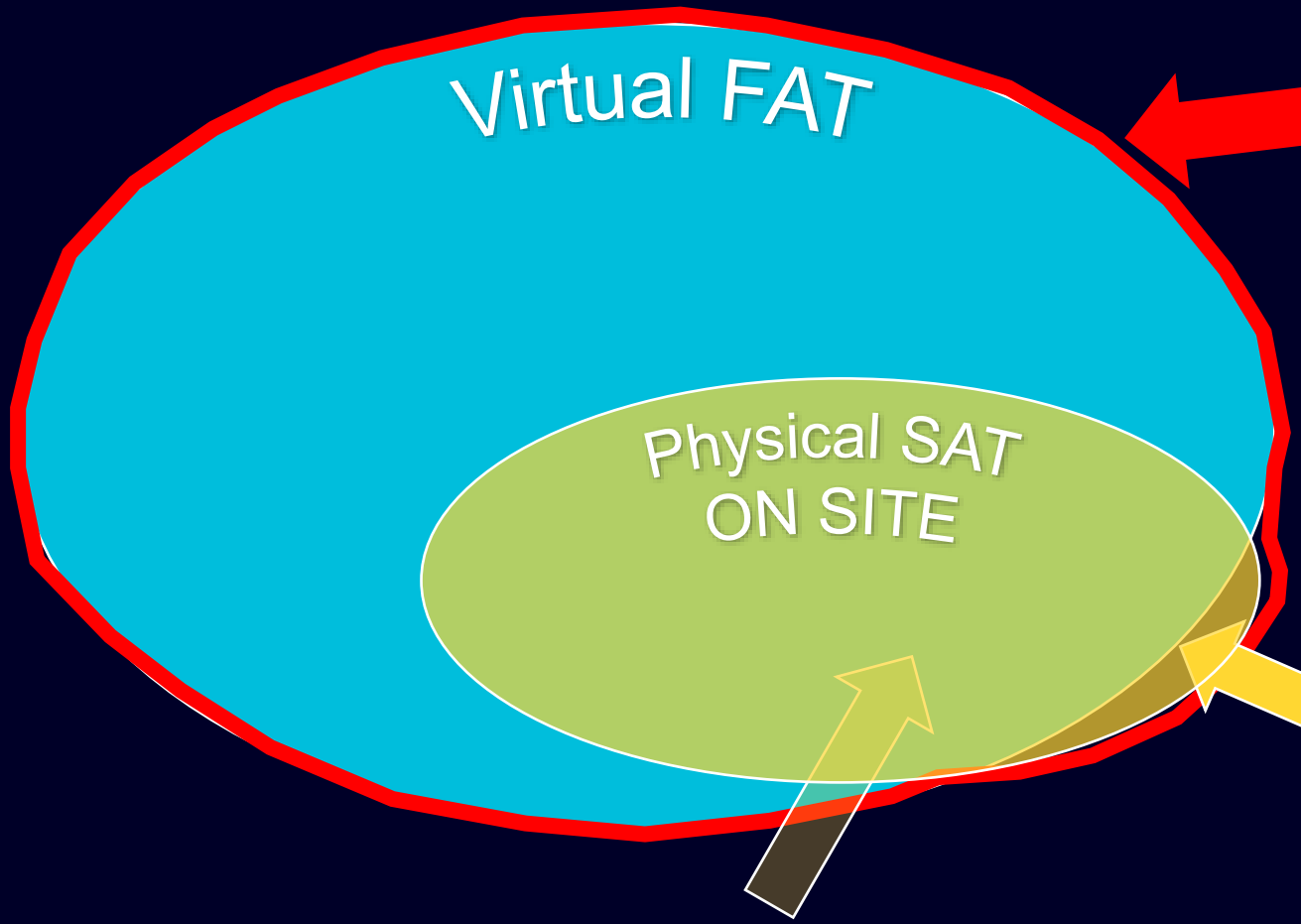
Virtual commissionning
Best preparation for Site Acceptance Test



All these tests were done AT SITE earlier!

Some physical tests will still remain at site, like connection check, functionality of I/Os etc

The number of commissioning tests is a **subset** of the virtual tests

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Digital Twin for Commissioning

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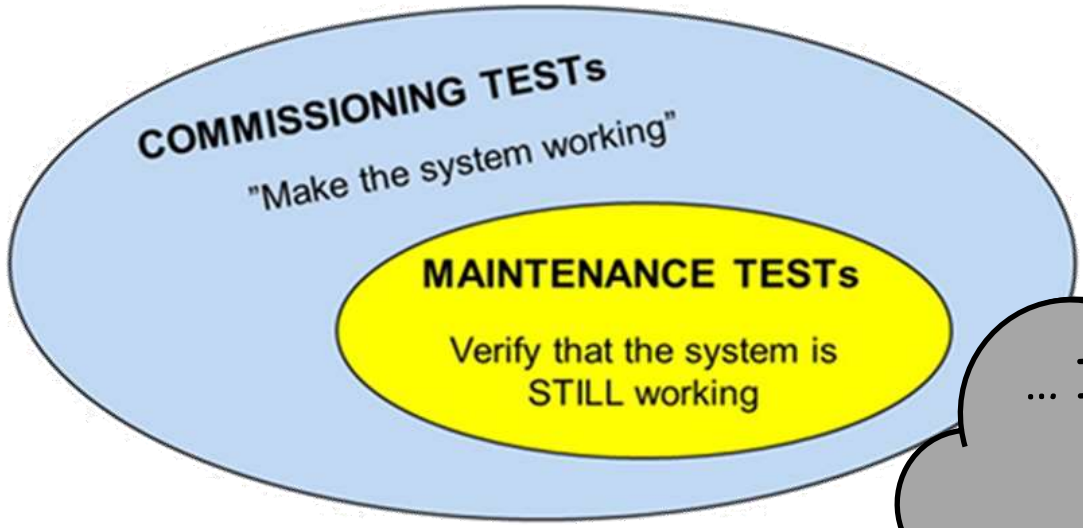
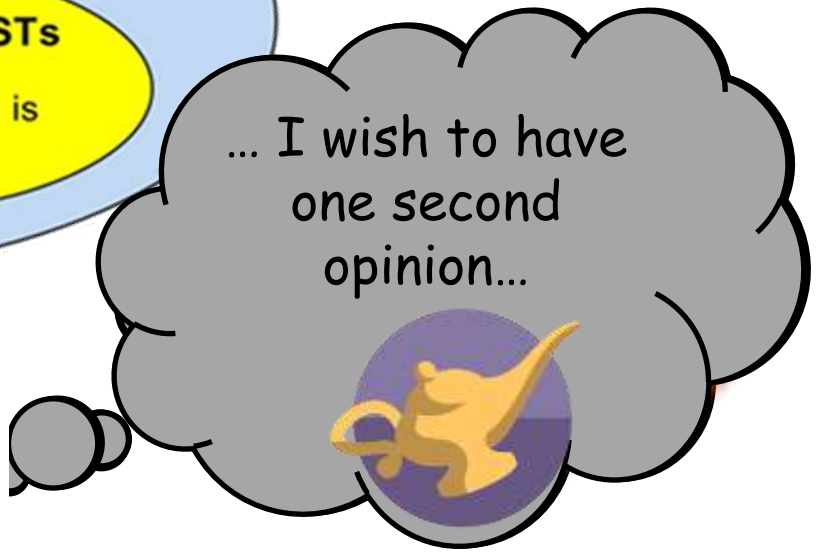
The commissioning activities have a strong responsibility





The specialist travels to the site

- Very expensive
- Specialists are very busy!

GETTING A SPECIALIST HELP TODAY

To help, the specialist needs to be able to analyse the situation as if he/she “was there”

This is an investigation process, where the expert must really be able to filter out any possible noise or biased information, no matter if given in good or bad faith.

Help by mails, video calls

- Many mails
- Misunderstandings…
- What time is it there?

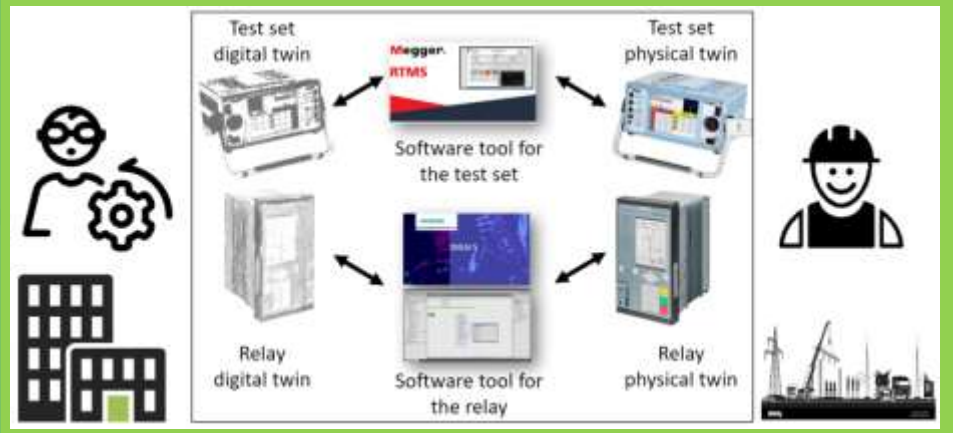
Use of hardware relay clones

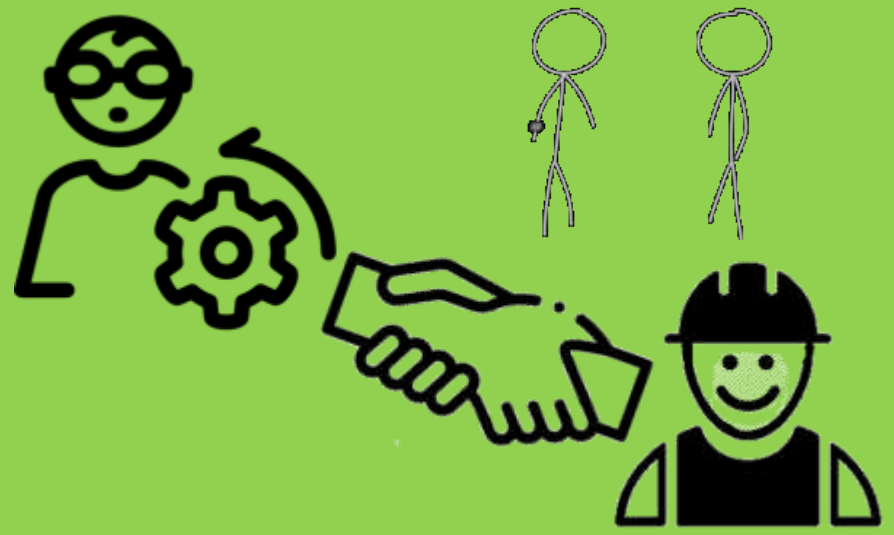
- Needs many HW equipment (relay manufacturer?

The specialist work from home or office

- No travel cost
- Time of specialists is used more efficiently

GETTING A SPECIALIST HELP WITH DT technology

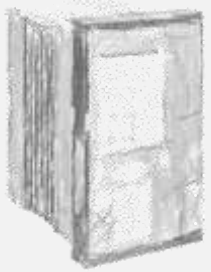


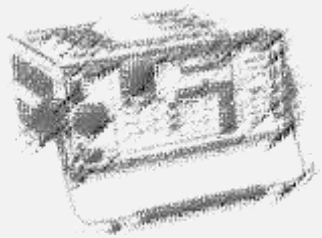


Only few important mail messages

- No misunderstanding. Just “SAME DATA”
- Work in your time zone!

Use of software clones (digital twins)





- Fast support
- Accessible to any relay specialist

Digital Twin for Training

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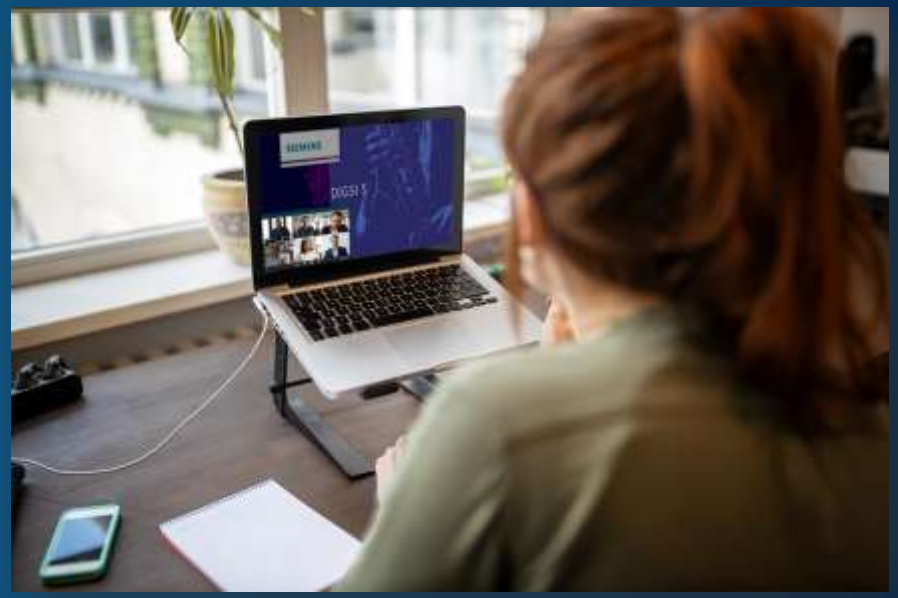
Train your team

The key for a safe and secure operation



- Learn about protection relays and full digital substations with IEC 61850
- For any role from planner to engineer, operator or maintenance

Virtual benefits are real:

- Practice setup for each trainee
- No software installation required
- Safe operation with your own devices
- Simulation of currents and voltages
- Possible remotely, and outside training hours

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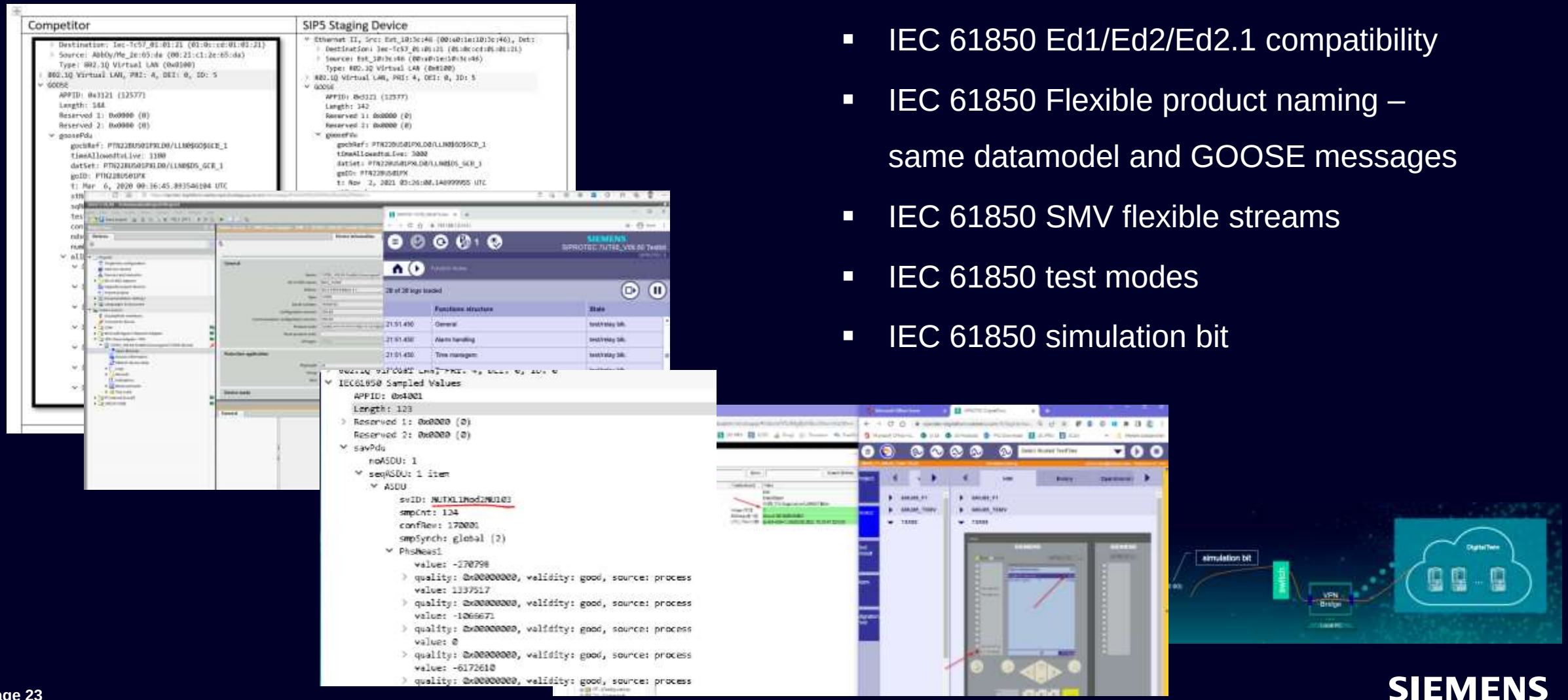
Trainings
Easy Practice with modern IEC 61850 possibilities



- IEC 61850 Ed1/Ed2/Ed2.1 compatibility
- IEC 61850 Flexible product naming – same datamodel and GOOSE messages
- IEC 61850 SMV flexible streams
- IEC 61850 test modes
- IEC 61850 simulation bit

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University partners

Technologies to attract the next generation of power engineers

- Increase the attractiveness of our niche market
- Increase practical experiences during studies
- Reduce training-on-the-job

- Where can Digital Twins provide value:
  - Professor for lectures
  - PhD students for industry research
  - Students for lab practices

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Digital Twin for the future

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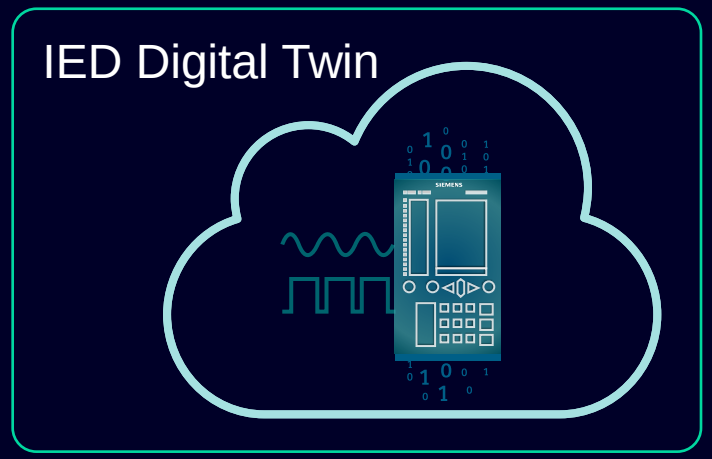
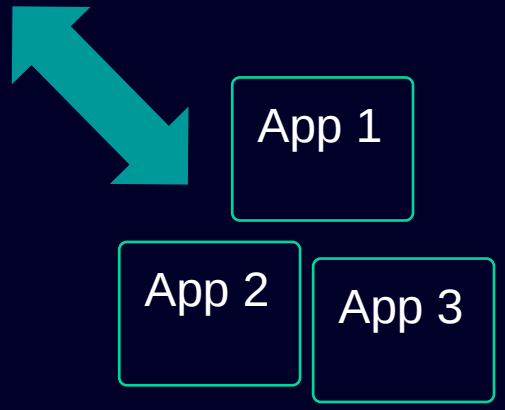
From manual interactions and assessments to open API
Be part of the pioneering journey





- Secure authentication
- File Exchange (e.g. COMTRADE)
- Communication exchange (e.g. GOOSE, SMV)
- Virtual Time and Time Synchronization between components
- …

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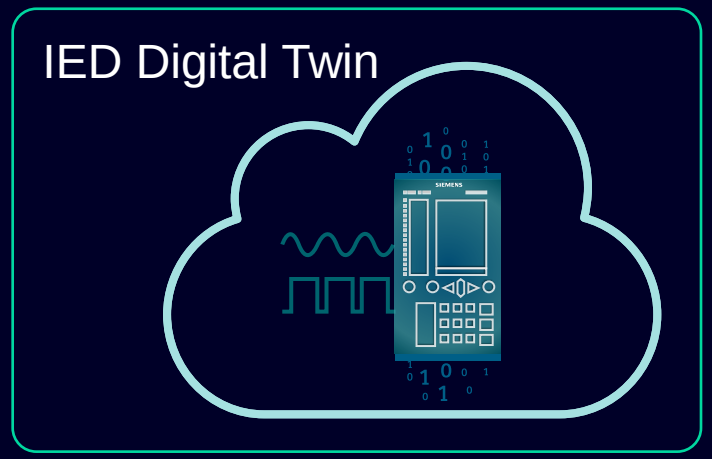
From manual interactions and assessments to open API
Be part of the standardization journey



Vendor 2

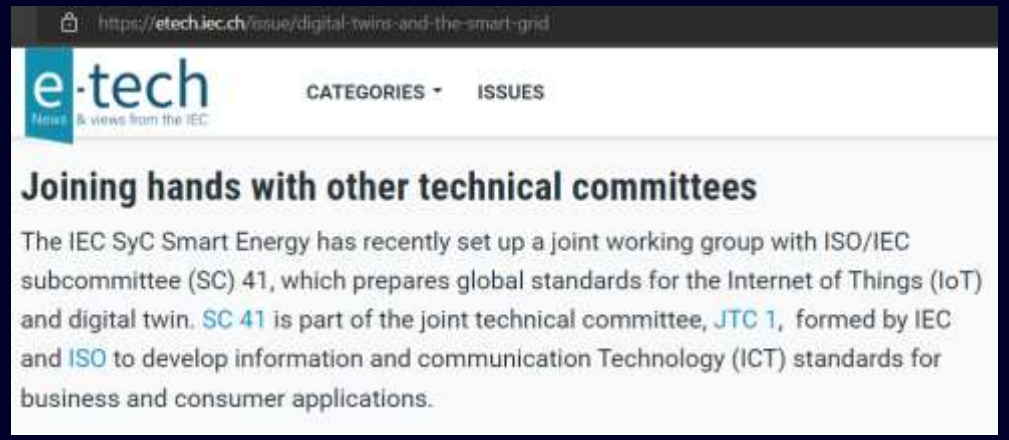
Vendor 3

App 1

App 2

App 3

Standards to be shaped



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Summary and Outlook
Digital Twins for Energy Automation

- A game changer in the power industry, for for protection and automation engineers involved in planning, engineering and operation of power grids
- Join the pioneering team and scale further the ecosystem of Digital Twin for Energy Automation!
- Ready to onboard? Start with a free trial

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Contact

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