UNIVERSITY of STRATHCLYDE
PNDC
A DECADE OF INNOVATION

PNDC Workshop on Communications and Cyber Security for Smart Grids

IEEE SmartNets

University of Strathclyde Glasgow

UNIVERSITY of STRATHCLYDE PNDC

DELL

UK Power Networks Delivering your electricity

NOKIA

SIEMENS

EUTC

jrc

25/07/2023

Agenda

Opening and Welcoming

James Irvine," Distribution Network Security: Lessons from the first 10 years of PNDC"

Francesco Pititto, "Empowering the Grid: Exploring Secure Data Virtualization in Smart Grid for a Sustainable Future",

Julian Stafford, "Overview of EUTC and JRC advocacy and standardisation activities for utility smart grids",

Karl Gerhardt, "Digital Twin – Virtual IED testing of Protection and communication functions**",**

Nigel Nawacki, "IEC 61850 and private LTE for ADMS",

Mayamiko Hara, UKPN " Learnings from Designing a Smart Substation",

Agenda

Opening and Welcoming 13:00-13:05

James Irvine, Distribution Network Security: Lessons from the first 10 years of PNDC”

James has >25 years’ experience working in research and standardisation work in mobile radio and security from 2.5G to 5G. He is very active in IEEE and currently chairs the volunteer committee responsible for IEEE products

owering the Grid: Exploring Secure Data Virtualization in Smart Grid for a Sustainable Future”, 13:25-13:50

nings from Designing a Smart Substation”, 13:50-14:15

al Twin

850 and

verview of EUTC and JRC advocacy and standardisation activities for utility smart grids”, 15:05-15:30

The academic lead for the communications: systems, integration and security innovation theme at PNDC

EVOLUTION

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Distribution Network Security:
Lessons from the first ten years at PNDC

James Irvine

University of Strathclyde

25 July 2023

The big picture…

Increasing demands on the grid

- Electrification of heat, transport, etc – x3 demand in the UK for example

Low carbon generation

- Small, distributed power sources

More flexibility and better efficiencies through control

- Lay fibre not copper

More challenges for the communications network

- Comms failures now lead to power failures

The PNDC focus...

UNIVERSITY of STRATHCLYDE
SECURITY & RESILIENCE
RESEARCH CENTRE

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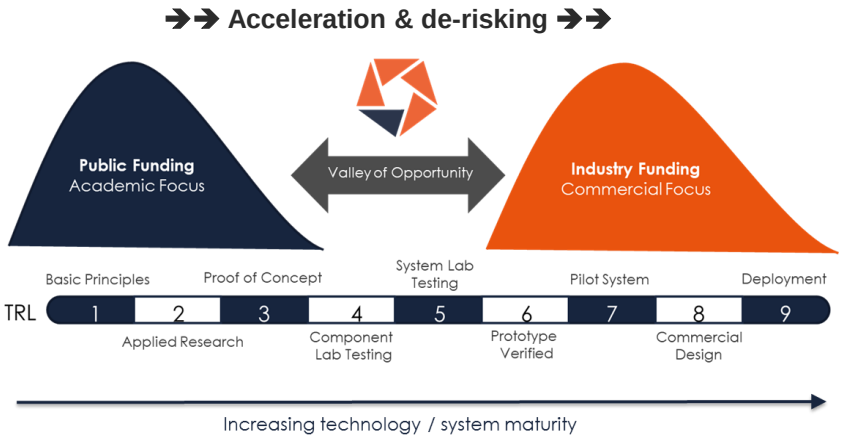
Practical, secure and **resilient** deployments which allow to **reduced costs**

- Best practices for **secure resilient communications**, supporting sensing, control, and self management (e.g. **virtualization**)
- A strategy for a **reliable wireless communications ecosystem** for the utilities sector, utilising COTS where possible

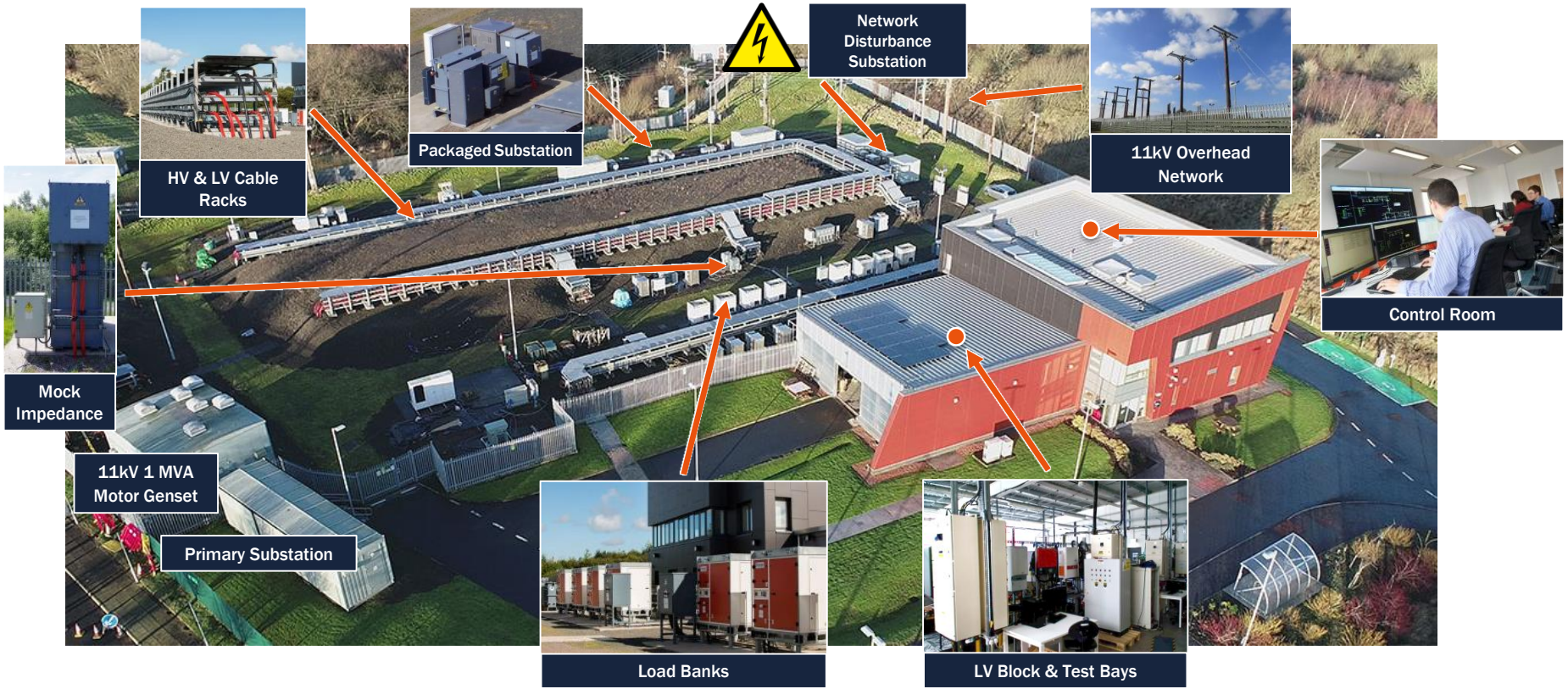
Our facility

PNDC Overview

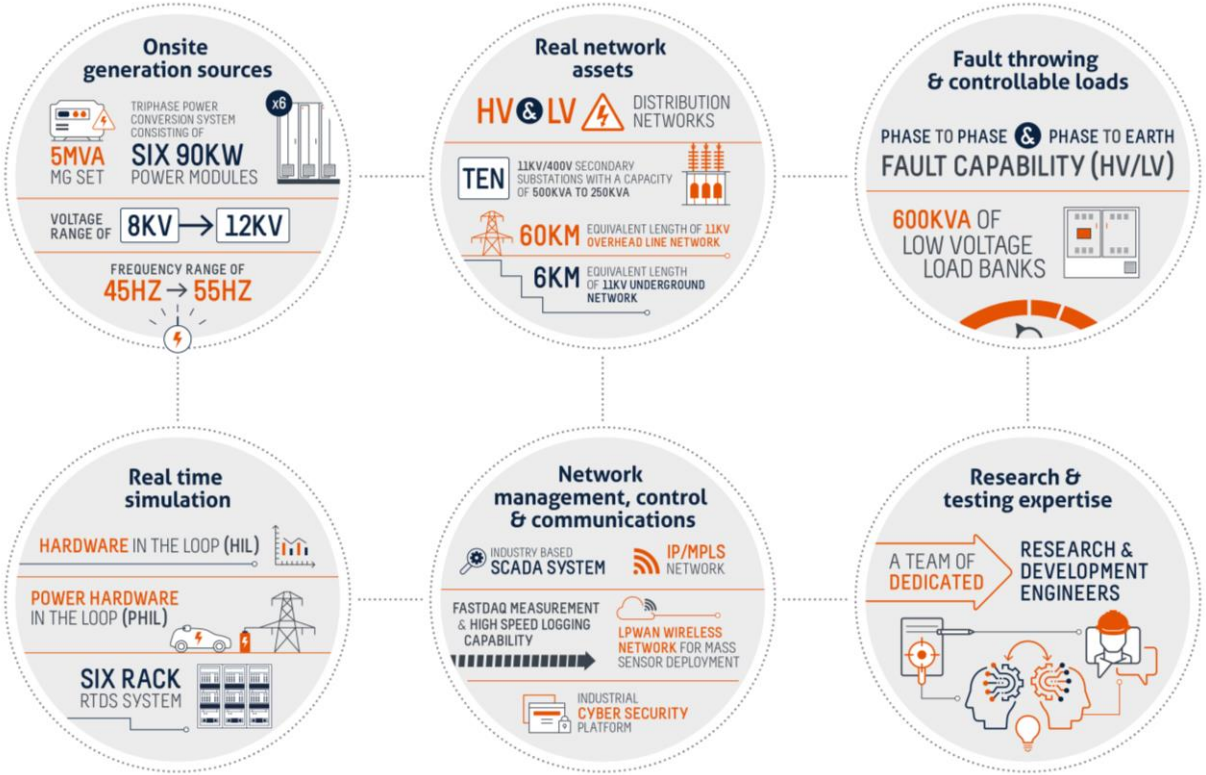
- University of Strathclyde industry-facing innovation centre opened in 2013 and currently celebrating a **decade of innovation** throughout 2023
- Focussed on accelerating the development and deployment of novel energy, marine and aerospace technologies supporting net zero initiatives
- Multiple engagement models:
  - Collaborative programmes in partnership with members
  - Open access for supporting all industry
- Dedicated expert team (~ 50 staff)
- New cutting-edge whole systems facility due in 2024



Facilities



Comprehensive Testing & Demonstration Capability



- IP/MPLS network, optical core, redundant copper rings
- WiFi and LPWAN wireless networks
- Two 5G networks being deployed
- Two SCADA networks based on industry standard configuration (from member DNOs' deployed equipment)
- Separate airgapped network for intrusion/penetration testing
- ICS equipment (RTUs and IEDs)
- Connection to wide area simulation for large scale testing
- PNDC model allows member and PNDC staff to work hand in hand on security projects; Knowledge Exchange Forums

Key learnings so far

Wide range of security design and test

- Device level security
- Security architectures
- Secure configuration and updates
- Remote access
- Security across organisational/operational boundaries
- Security analysis of next generation networks
- Operational resilience and incident response

Key lessons from our first 10 years…

- Models only go so far
  - Recognise the limitations in simulations; Exploits are based on the unexpected
  - We need more playgrounds! - Can't test on the real network…
- The OT culture is different
  - Recognise the good (and there is a lot of good in IT), work on the bad
- We need joined up thinking
  - Recognise the risks of outsourcing, however well meaning your vendors
  - Regulators need to be on board, and understanding
- Resilience **costs** – you can pay before or after…

My Personal Top 10...

Biggest challenges for Distribution Network Security

- Rapid innovation in networks
- IIoT and increased connectivity
- Secure architectures, in particular for remote access
- Virtualisation and containerisation
- Legacy equipment – and upgrades
- OT/IT cultural differences
- Third party vendors/supply chains
- Lack of knowledge of current systems
- Outsourcing
- Skills shortages

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Thank you

Stay safe and verify!

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Agenda

Francesco Pititto, "Empowering the Grid: Exploring Secure Data Virtualization in Smart Grid for a Sustainable Future",

Francesco has a technology and business expertise developed over three decades of activity in various industries, providing global IT advisory for the conception of strategic technology transformation and innovation initiatives.

The Global Chief Technology Officer for the Energy Industry at Dell Technologies

EXPLORING SECURE DATA VIRTUALIZATION IN SMART GRID FOR A SUSTAINABLE FUTURE

The demand for efficient and sustainable energy systems requires smarter grids that incorporate advanced technologies to monitor, manage, and optimize electricity generation, distribution, and consumption.

As smart grids become more interconnected and data-driven, data virtualization offers a powerful solution to streamline data access and integration in smart grids, enabling efficient decision-making processes. However, it also introduces new security concerns that need to be addressed to maintain the integrity and confidentiality of critical information.

By leveraging this approach, utilities and grid operators can enhance their operational efficiency, facilitate effective energy management, and support renewable energy integration, demand response programs, and grid resilience.

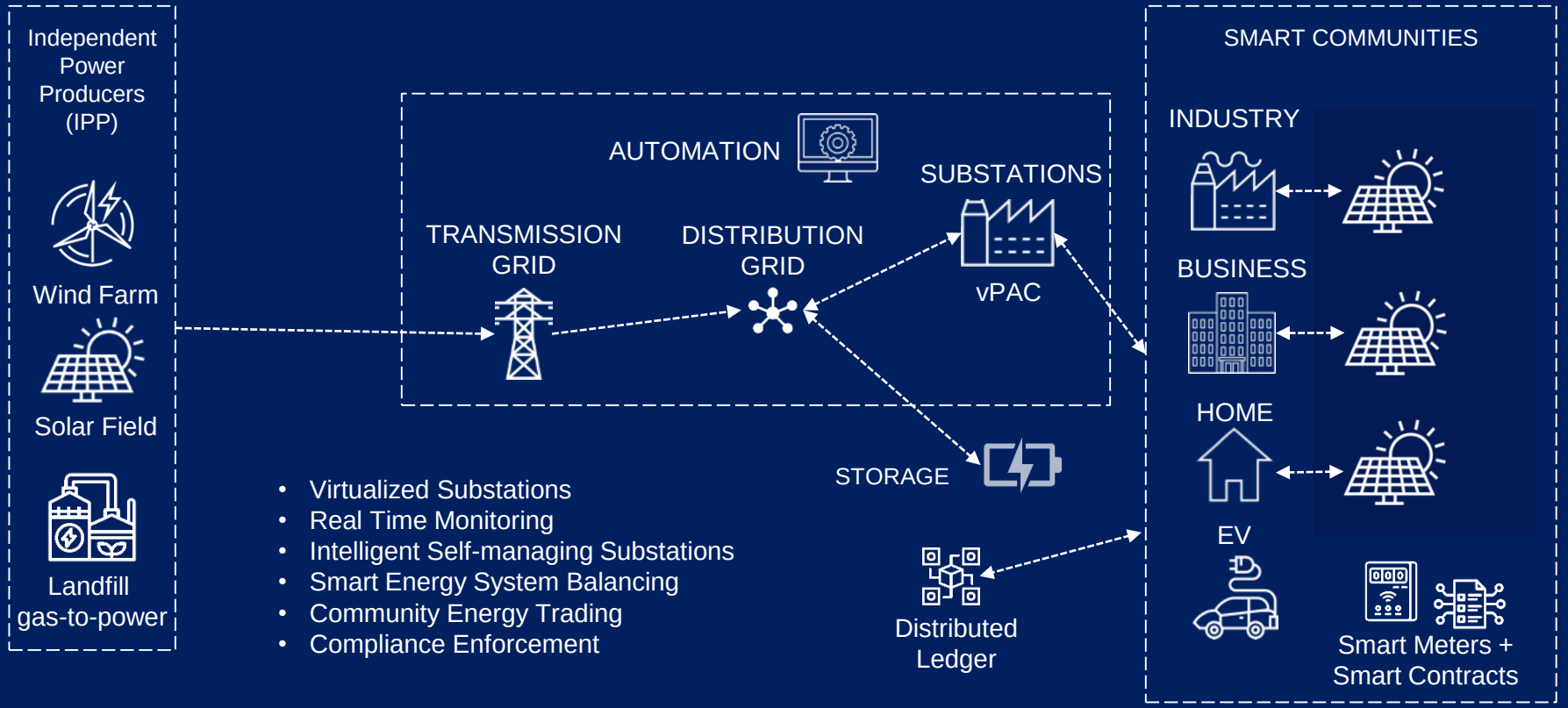
Empowering the Grid
Exploring Secure Data Virtualization in Smart Grids for a Sustainable Future

Third virtual PNDC workshop on Smart Grid communications

Francesco Pititto, CTO Energy @ Dell Technologies

DELL Technologies

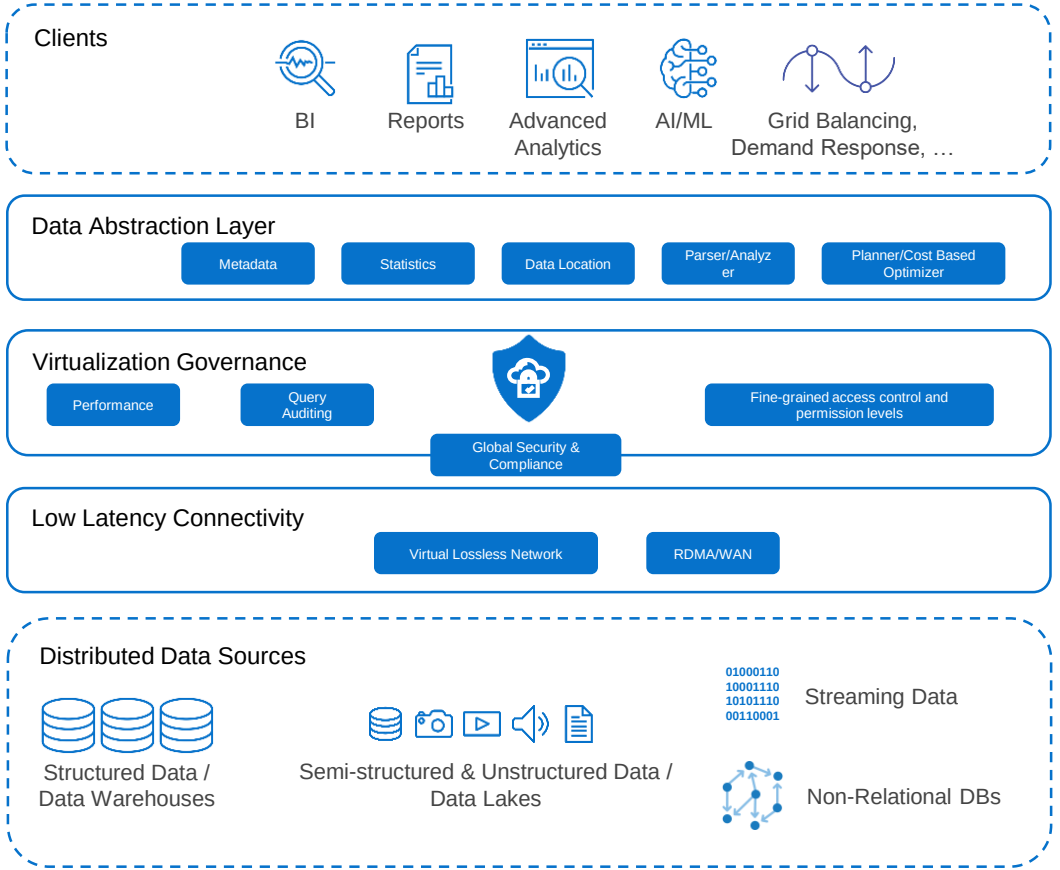
The Digital Electric System: Intelligence at the Edge



Secure Data Virtualization

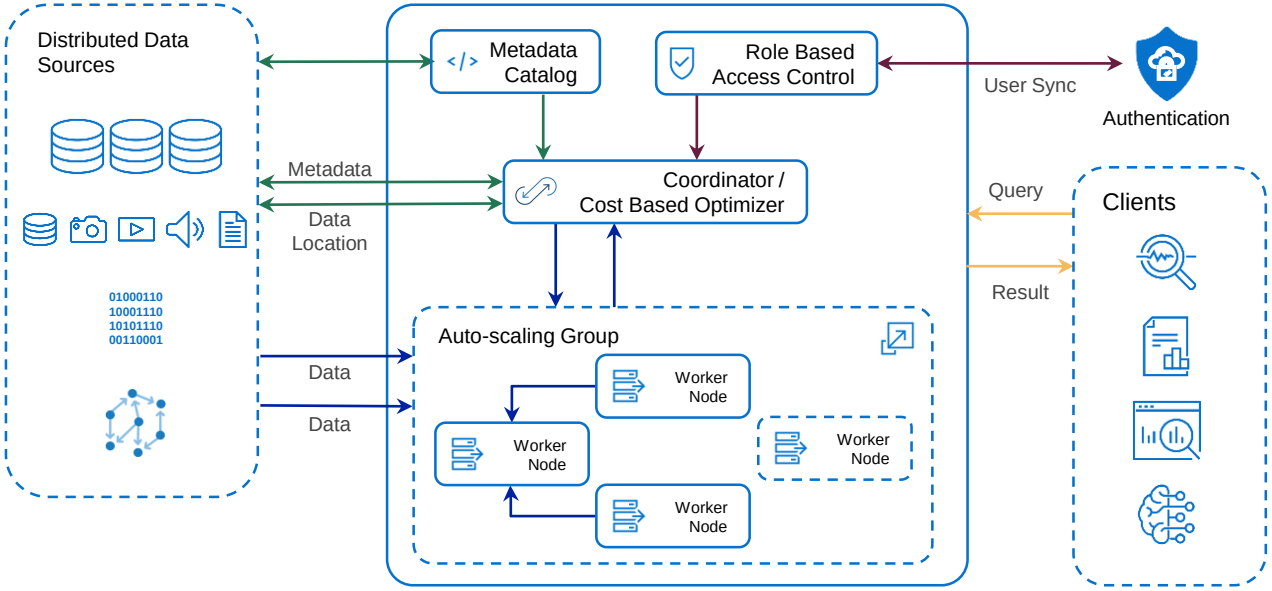
Enable integration, abstraction, and secure management of heterogeneous data sources in the smart grid domain

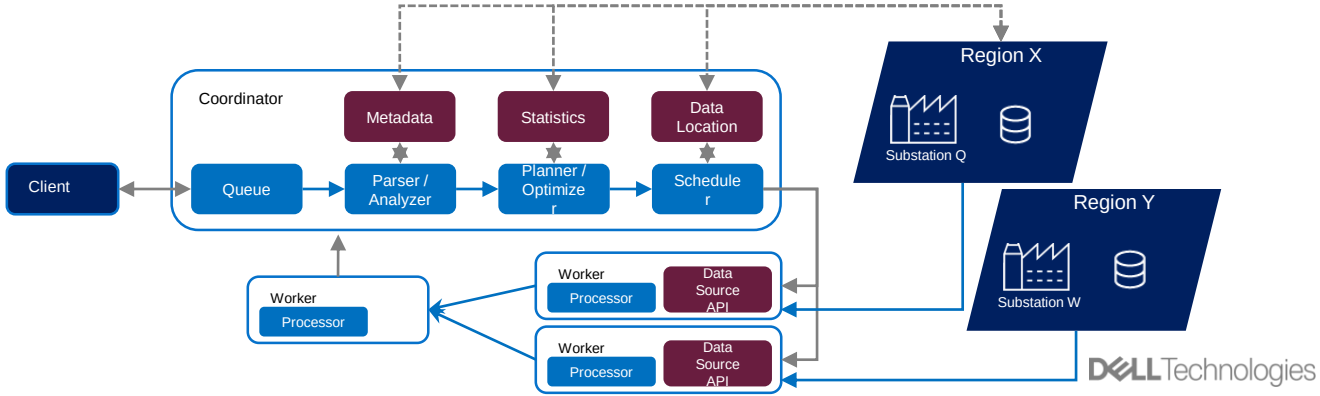
Establish a unified and logical view of data without physically moving or replicating it, while ensuring confidentiality, integrity, and availability of sensitive information



Secure Data Virtualization

Logical View & Execution Flow

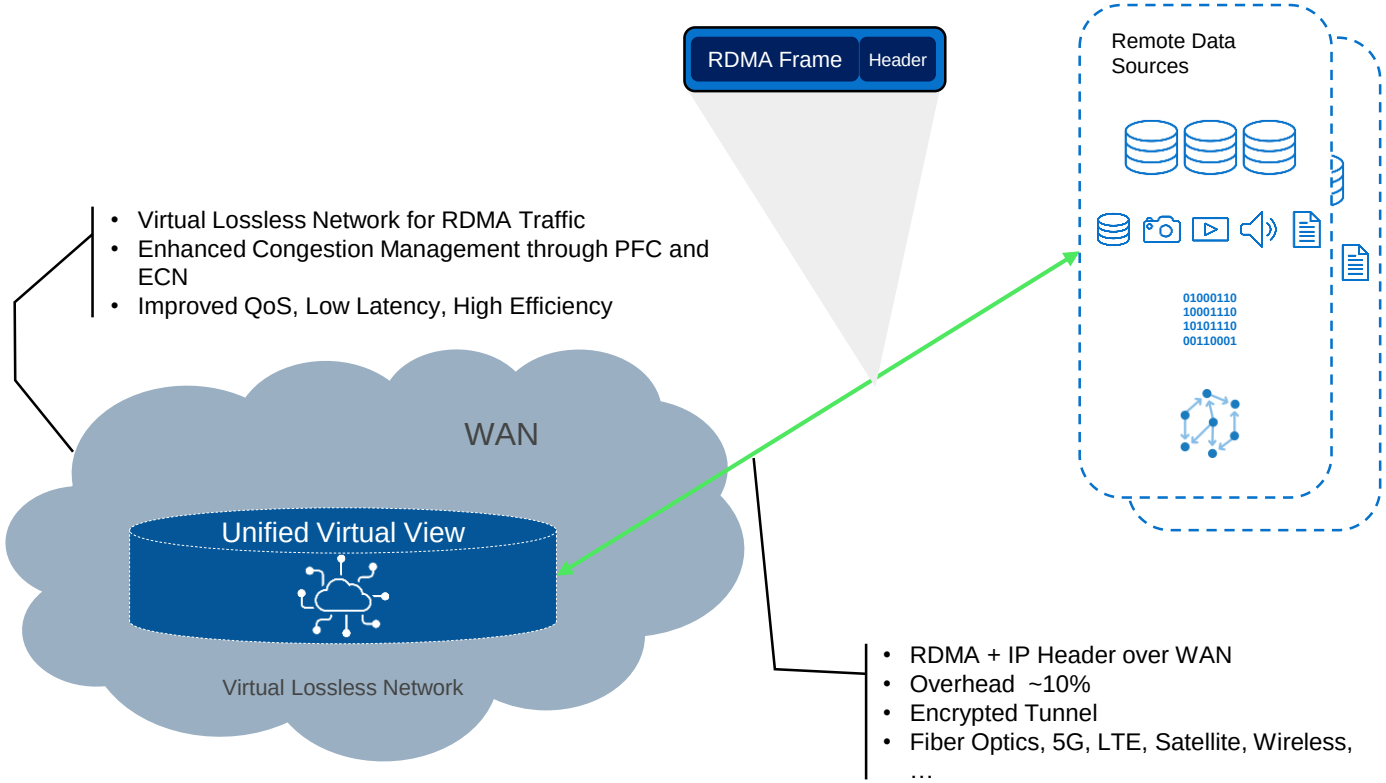




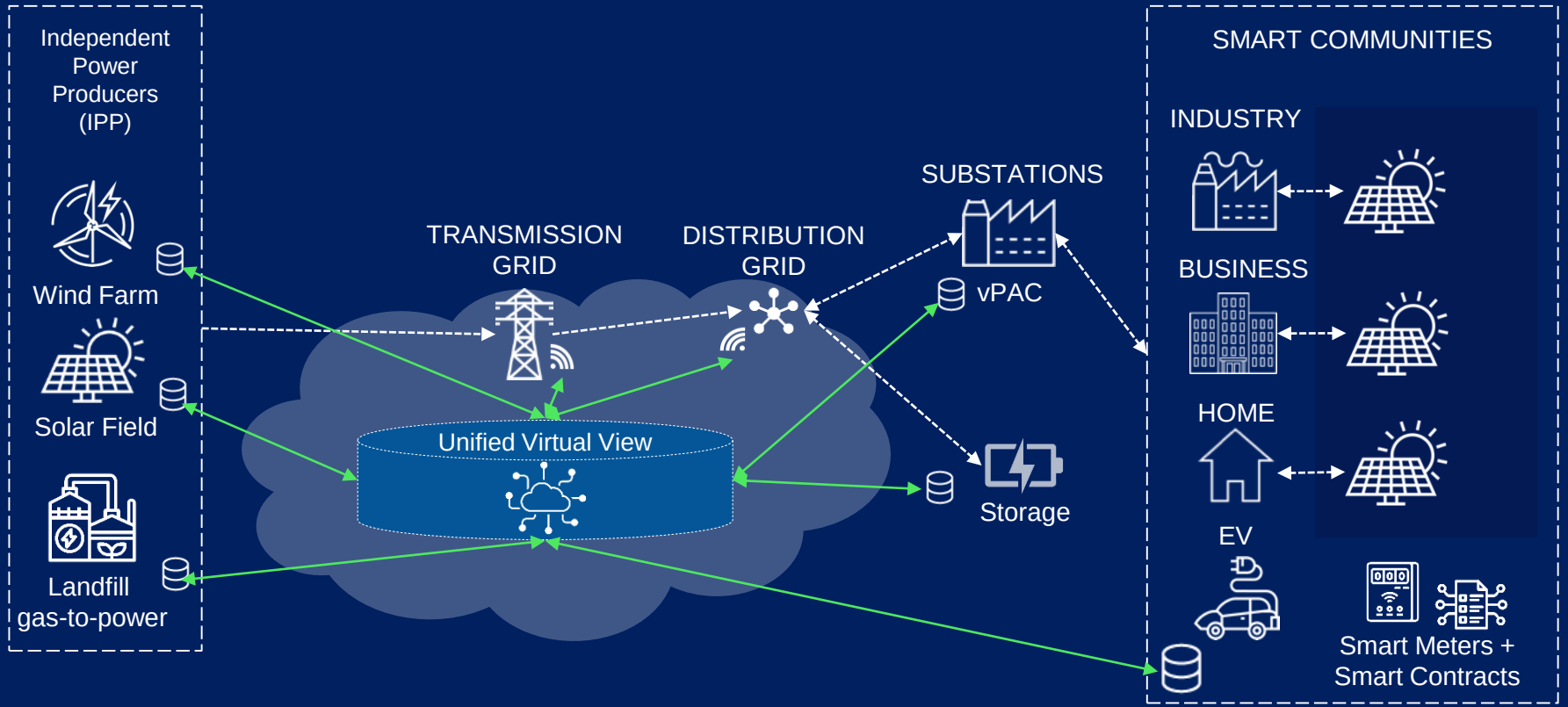
Efficient Networking

IP encapsulated RDMA Traffic over WAN

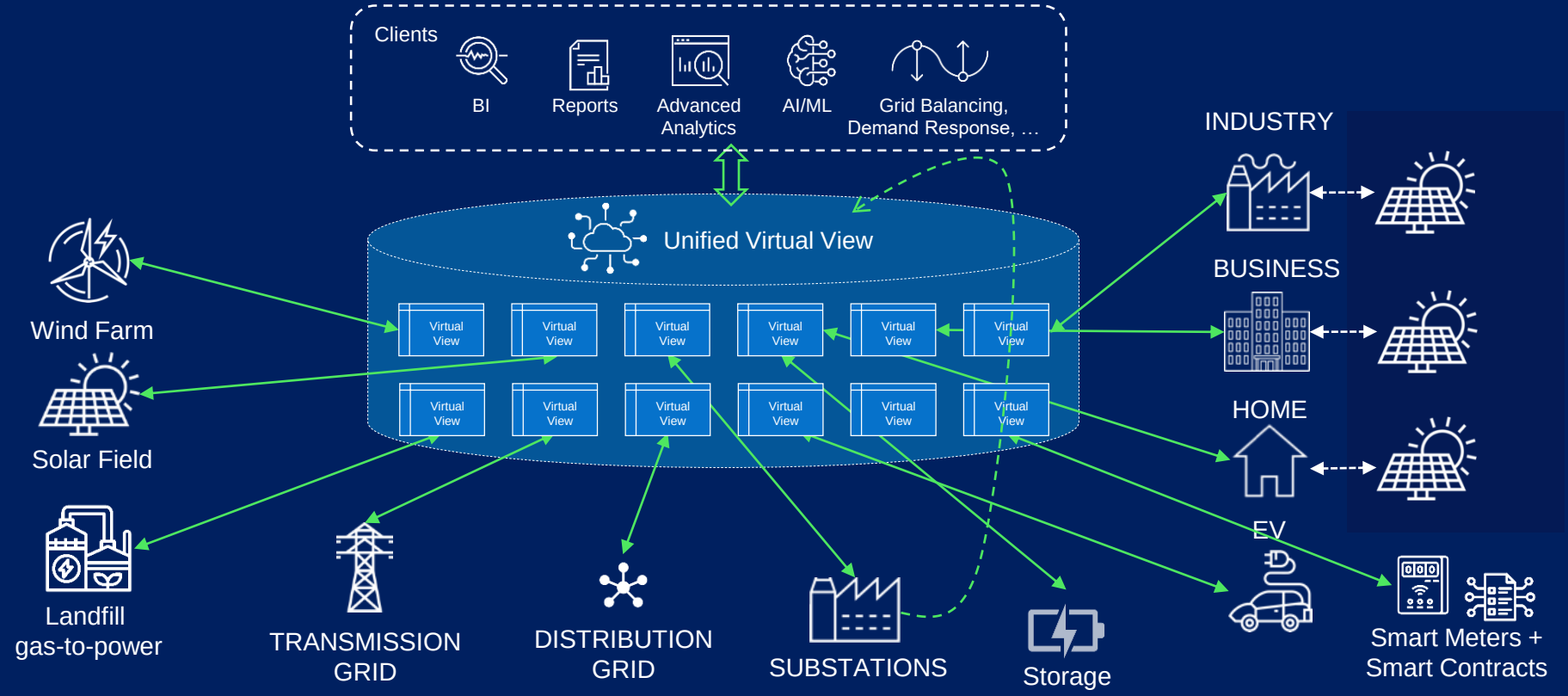
Low overhead and latency



Data Virtualization in Smart Grids



Data Virtualization in Smart Grids



Use cases

Virtualized Renewable Energy Data

Provide a unified view of renewable energy generation across different locations and technologies

Monitor and analyze overall renewable contribution to the grid, optimize dispatch strategies, make informed decisions on grid balancing and demand response programs

Virtual Metering & Billing

Estimate energy production based on generation data rather than deploying physical meters at every site

A unified virtual view of all data can be used for accurate billing, grid monitoring, and renewable energy incentive programs

Demand Response & Flexibility Management

Use virtualized data from multiple sources to monitor and analyze real-time energy usage profiles

Design demand response programs, incentivize energy conservation, and leverage local flexibility in response to grid conditions and renewables availability

Grid Monitoring & Predictive Analytics

Create a virtualized data view of the grid

Monitor performance, anticipate anomalies or faults, predict future grid behavior and stability, optimize energy flow, plan maintenance activities, and improve grid resilience


DELL Technologies

Agenda

Opening and Welcoming

James Irvine," Distribution Network Security: Lessons from the first 10 years of PNDC"

Julian Stafford, "Overview of EUTC and JRC advocacy and standardisation activities for utility smart grids"

Julian has worked in the fields of utilities and mission critical telecommunications for 30 years, having started work in the design and implementation of wired and wireless systems in the UK energy sector.

CTO of JRC in the UK and Secretary General of the European Utilities Telecoms Council

Sm@rtNets
For Smart Connected Life and Business...

IEEE

3rd PNDC Workshop
Smartgrids and Cybersecurity
IEEE Smartnets Istanbul

Julian Stafford

CTO Joint Radio Company &
Secretary General
European Utility Telecoms Council, Brussels
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Julian.Stafford@jrc.co.uk

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Julian.Stafford@eutc.org

joint radio company
jrc

EUTC

What is EUTC? (European Utilities Telecom Council)

- Representing technical and regulatory interests of Electric, Gas and Water Utilities – critical national infrastructure.
- Membership driven – with major utilities, from large and small countries including Spain, France, Netherlands, Germany, Portugal, Ireland and UK.
- Engaging with stakeholders including vendors and operators to ensure alignment of new products, standards and spectrum allocations with utility requirements.
- Responding to consultations from the European Commission, Energy and Telecom Regulators and National Administrations about digitalisation of the energy sector.
- Interacting with European Parliament and Policy Groups.

EUTC

Close Working Partnership Between Key Players -

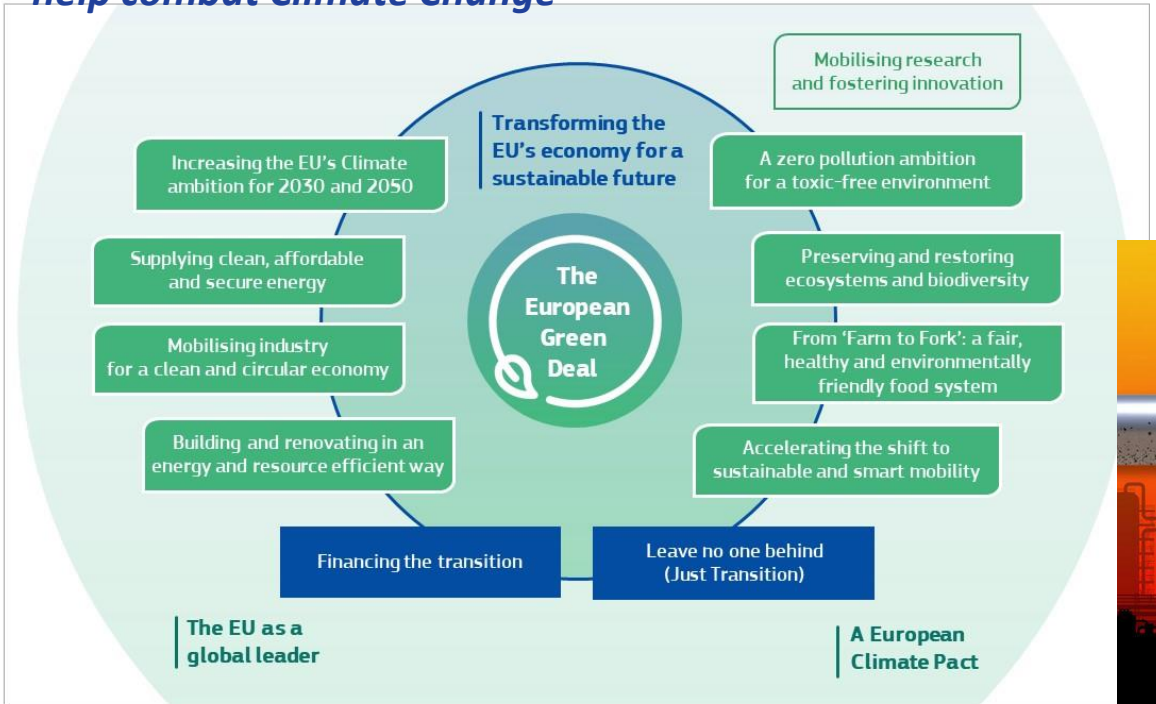
Why so many interactions and MOUs?

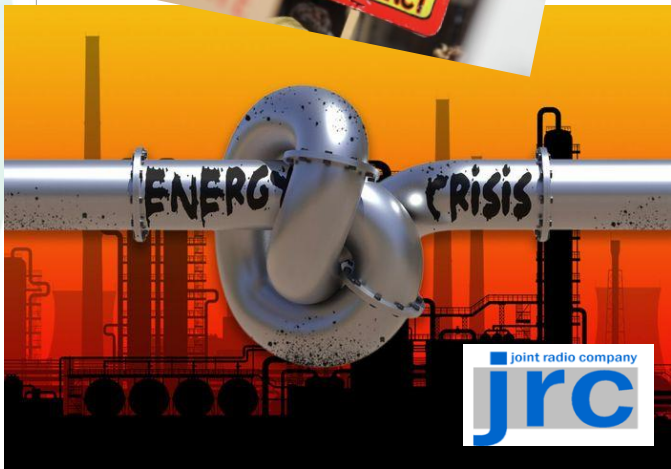
- Overlaps between all of these groups
  - User requirements & Sharing workload
  - Ownership
  - Global Ecosystem
  - Cyber Security
  - Leverage individual strengths of each group
  - Government requirements / obligations
  - Larger market if volumes combine – resulting in a healthy supplier base and economy of scale
  - All require electricity supply to operate
  - Intersection of all mission critical users – blue light, transport, utilities and connectivity of the general public

Motivation for Enhanced Connectivity of Utility Assets…

Carbon Neutral Aspirations the main driver

Role of Radio Spectrum Policy and digitalisation to help combat Climate Change





Spectrum Allocation Success for Utilities…

Ireland (2019) 

Germany (2021) 

Spain (2021) 

Poland (2019) 

- *Advanced trials and consultations under way in France, Brazil, Saudi Arabia, Netherlands and United Kingdom (some specific challenges)…*

Some uses of 410-470 MHz spectrum in Europe

EUTC

450-470 MHz spectrum held by Norwegian Power & Telecoms Group in 2022

410-414/420-424 MHz allocated to ESB for LTE Smart Grid in 2019

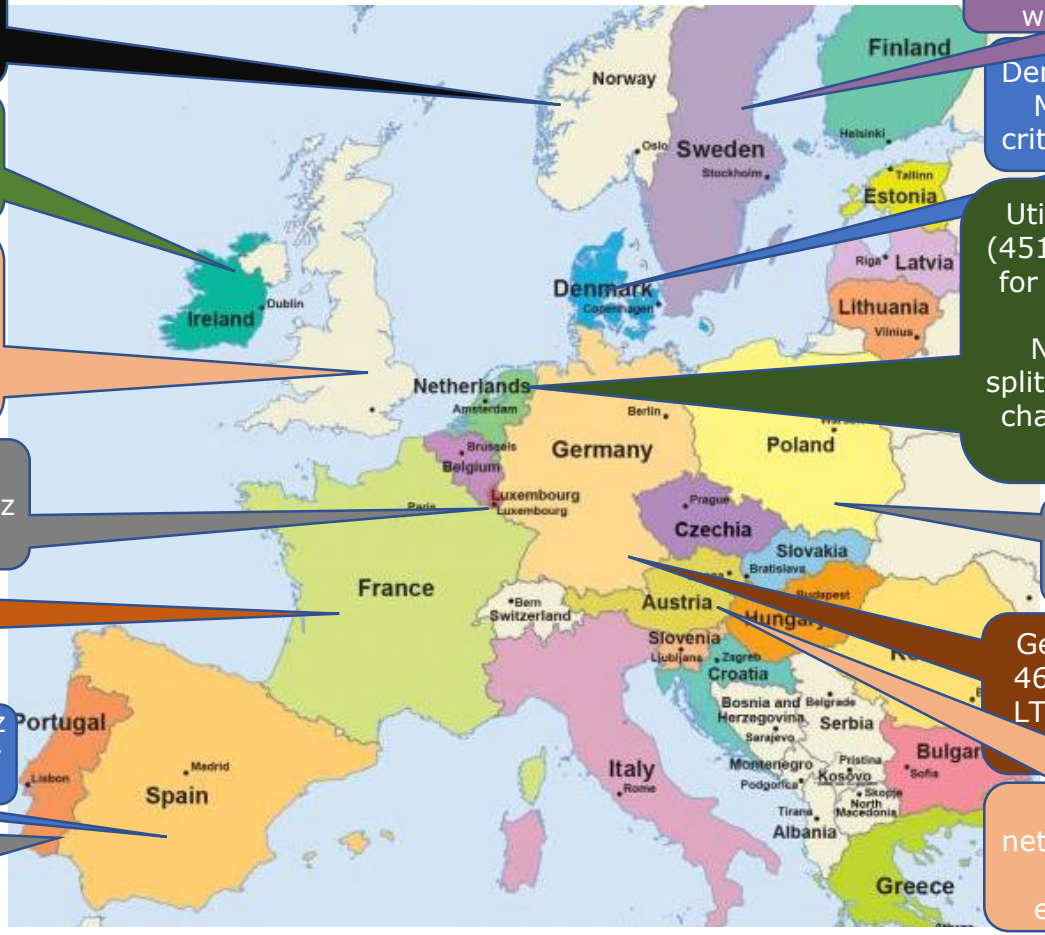
UK: Utilities have narrowband allocation in 450-470 MHz but congested with private & government users: 412-414/422-424 MHz used for smart metering

Legacy Utility Tetra network installed by CREOS in 2 x 2MHz in 450-470 MHz

Consultation on introducing LTE into 450-470 MHz band

Spain: Current use of 400 MHz by military and PPDR: unlikely to change

450-470 MHz spectrum empty and sought by utility E-REDES



Sweden:2 x 5 MHz LTE system in 450-470 MHz for public safety to which utilities have access.

Denmark:453-457.5/463-467.5 MHz Spectrum awarded for critical communications in 2021

Utility Connect has 2 x 3 MHz (451.8-454.8/461.8-464.8 MHz) for a CDMA network, currently being converted to LTE. Netherlands consulting on splitting licence into two 1.5MHz channels and licensing one for North Sea LTE Network.

Poland: PGE Systemy LTE 450-470 MHz for electricity network control

Germany: 451–455.74 MHz / 461–465.74 MHz awarded for LTE utility network in 2021 to 450Connect

Austria: Argonet telco network migrating 2x4.4MHz from CDMA to LTE for exclusive use by utilities

UK Focus – JRC Leading…

- *Energy Networks Association Strategic Telecoms Group*
- *Political engagement at multiple levels in collaboration with Instinctif Partners*
- *Gemserv Study of economic rational behind spectrum allocation for private LTE smart grid network*
- *Multiple Ofcom consultation engagements*
- *NGED (WPD) LTE trials in Portishead and Taunton (now on tour – NEC & Liverpool)*
- *NCSC / GCHQ activity around future cyber security challenges*
- *Northern Ireland Initiative*
- *Ongoing meetings with BEIS & DCMS (now DSIT & Department for Energy Security & Net Zero)*

UK Focus – JRC Leading…

Department for Science, Innovation & Technology

Policy paper

Spectrum statement

Published 11 April 2023

Spectrum and Net Zero

Spectrum has an important role to play in helping the UK reach our target of Net Zero emissions by 2050. We will work with UKSA, Ofcom and the wider earth and space science community, to ensure the continued availability and appropriate protection of spectrum for climate science, weather and related high impact services. We are also working closely with the Department for Energy Security and Net Zero, Ofcom and Ofgem to assess the energy and wider utility sector's communications requirements and ensure that timely decisions are taken on any resulting spectrum needs.

Assessing the energy sector's communications requirements

Spectrum also plays an important role in enabling the digital connectivity needed for future low carbon energy networks. Reaching Net Zero requires fundamental changes to the way we generate, transport and consume energy. We are moving towards a smarter, more flexible and more integrated energy system which will require significantly enhanced connectivity and digitalization throughout the network to support the coordination, automation and control of energy network assets. This increased connectivity requirement will likely require a variety of telecommunications technologies including fibre, satellites, and public and private mobile networks. Certain communications functions may require enhanced power resilience and reliability. If meeting these or other requirements is best served by private wireless networks, the identification of suitable and sufficient spectrum may be necessary.

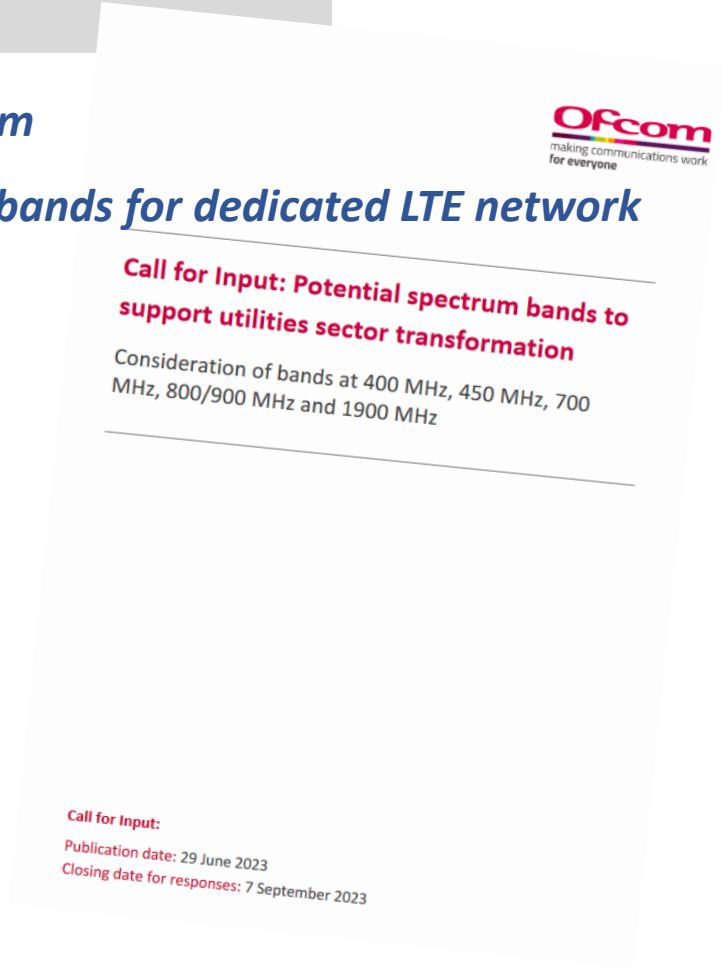
We are working closely with the Department for Energy Security and Net Zero, Ofcom and Ofgem to assess the energy (and wider utility) sector's communications requirements and ensure that timely decisions are taken on any resulting spectrum needs.

EUTC

joint radio company jrc

UK Focus – JRC Leading…

- *Major consultation just issued by Ofcom*
- *Considering four candidate frequency bands for dedicated LTE network*
- *Submission deadline 7th September*


Ofcom
making communications work for everyone

Call for Input: Potential spectrum bands to support utilities sector transformation

Consideration of bands at 400 MHz, 450 MHz, 700 MHz, 800/900 MHz and 1900 MHz

Call for Input:

Publication date: 29 June 2023
Closing date for responses: 7 September 2023

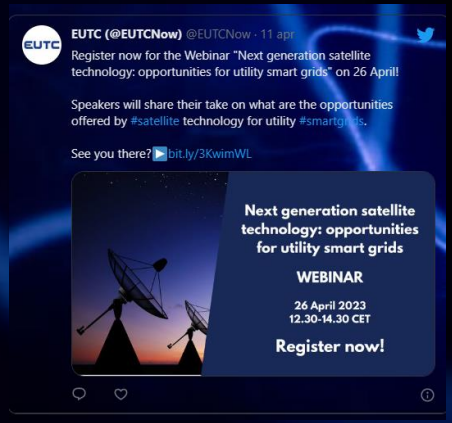
Current Advocacy Activities…

- EU 5G event – Brussels (March)
- UTCAL annual event Rio (March)
- ITU WP 5A Mexico City
- 3GPP activity – online and in person (Greece, Netherlands, Taiwan)
- 450 MHz Alliance event London 18th & 19th April
- Next generation satellite webinar (April)
- TCCA annual summit (May) Helsinki
- CIGRE 5G presentation – London (June)

28 a 31 de Março de 2023
UTCAL Summit 2023

joint radio company
jrc

Thank you for listening !



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EUTC

joint radio company jrc

Agenda

Opening and Welcoming

James Irvine," Distribution Network Security: Lessons from the first 10 years of PNDC"

Karl Gerhardt, "Digital Twin – Virtual IED testing of Protection and communication functions**",** SIEMENS

Karl has worked at Siemens in the UK in various roles since May 2003. Karl has been a member of the Technical Committee for the IET Developments in Power System protection (DPSP) Conference since 2006

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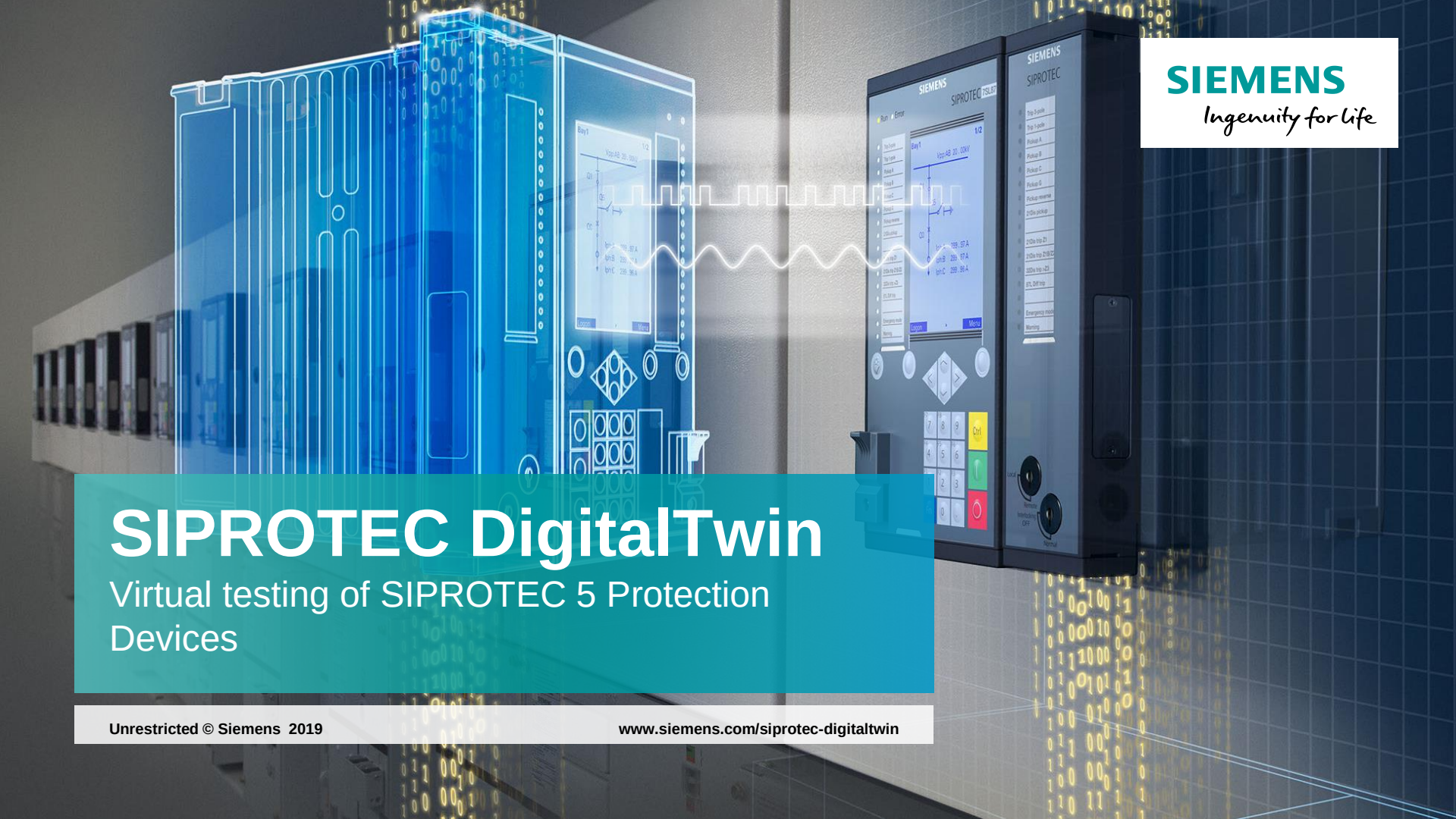
power

850

" Learnings from Designing a Smart Substation",

Portfolio Manager at **Siemens** (Electrification and Automation)



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SIPROTEC DigitalTwin

Virtual testing of SIPROTEC 5 Protection Devices

www.siemens.com/siprotec-digitaltwin

SIPROTEC DigitalTwin

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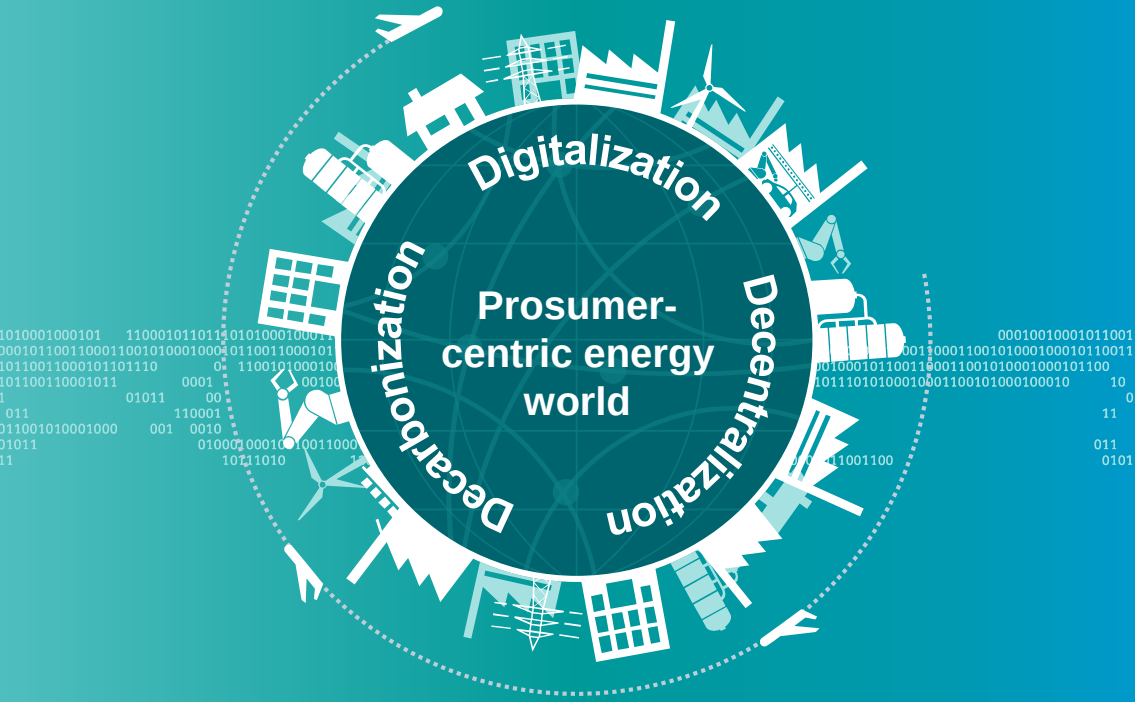
- Introduction
- System details
- Testing of Low Impedance Centralised Bus Zone
- Testing of IEC61850 Based Operational Tripping Scheme

Market – Major factors driving the revolution of energy systems …



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Decarbonization

“All electric world” – Fluctuating infeed – e-Mobility

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

Decentralization

Distributed generation – Microgrids – Energy autonomy

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

Digitalization

Connectivity – Edge computing – End-to-end

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 %

The “Digital Twin” –
A virtual copy of a physical asset

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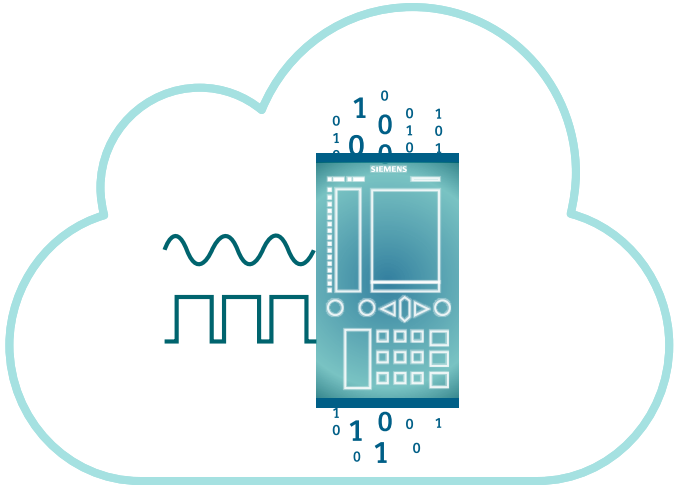

- The **digital twin** integrates all data, models, and other information of a physical asset generated during engineering, commissioning, operation, or service.

- 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

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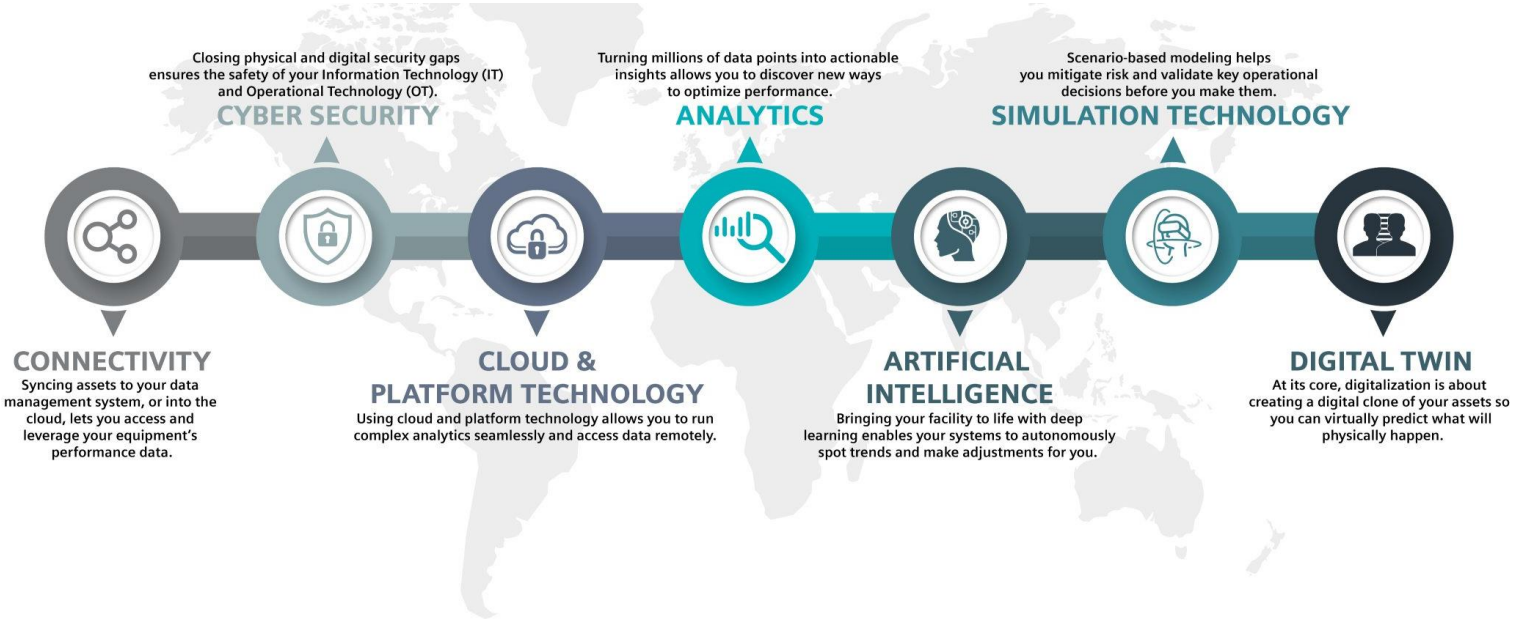

SIPROTEC DigitalTwin

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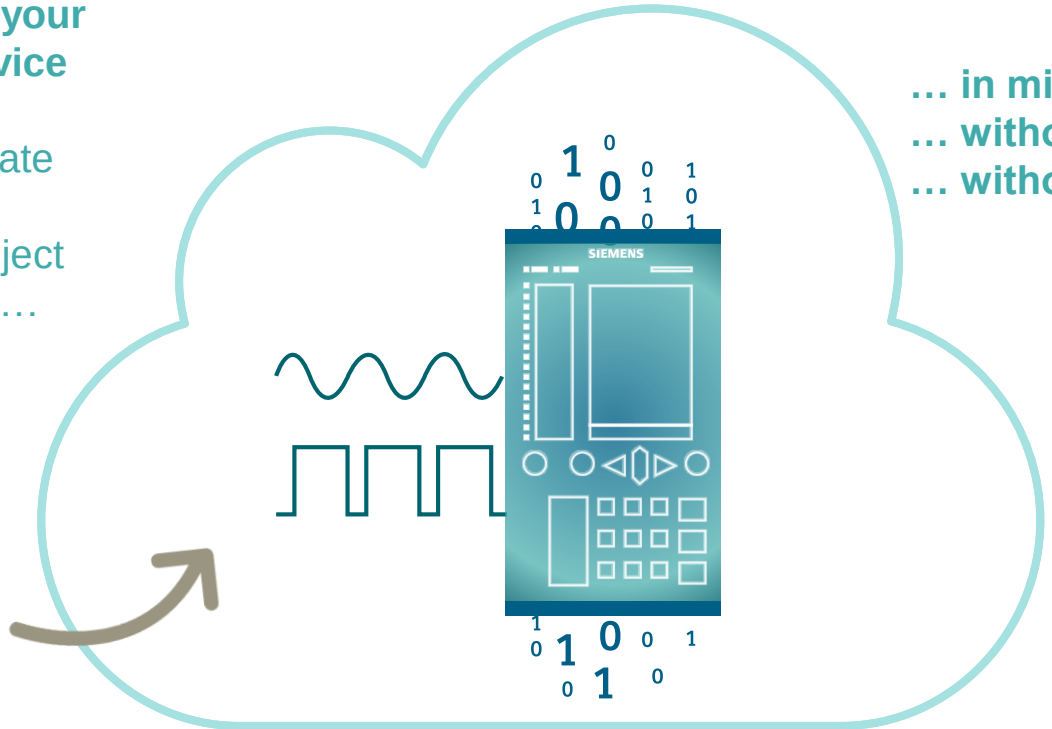
A digital twin of your SIPROTEC 5 device

Individually simulate and test your SIPROTEC 5 project data in the cloud …



… in minutes
… without hardware
… without additional efforts

SIPROTEC DigitalTwin

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Virtual Testing of SIPROTEC 5 protection devices in the cloud

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.

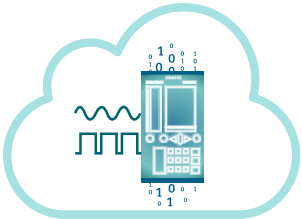
It shortens your time-to-operation significantly.

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

Lower Total Cost of Ownership



SIPROTEC DigitalTwin

SIPROTEC DigitalTwin
Application Scenarios

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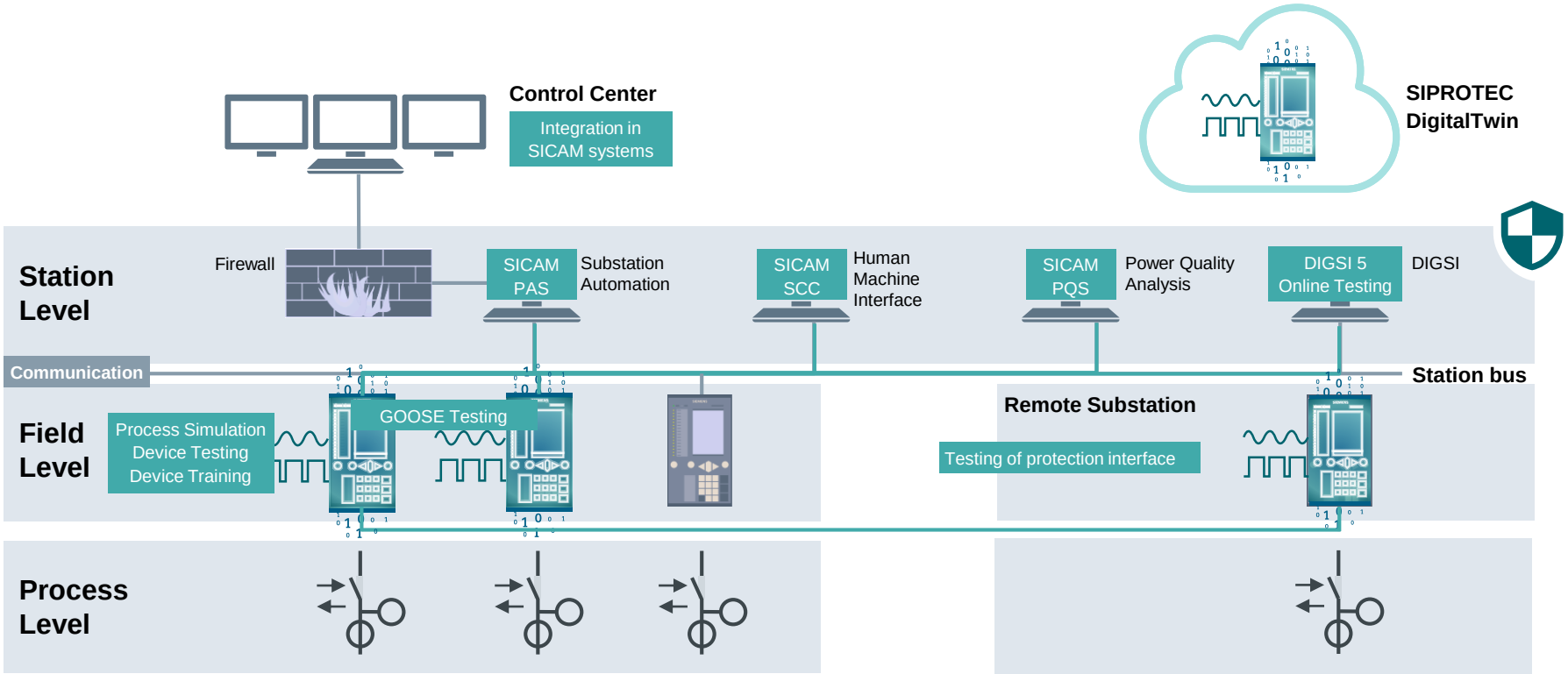

Product Details

SIPROTEC DigitalTwin within the entire energy automation system

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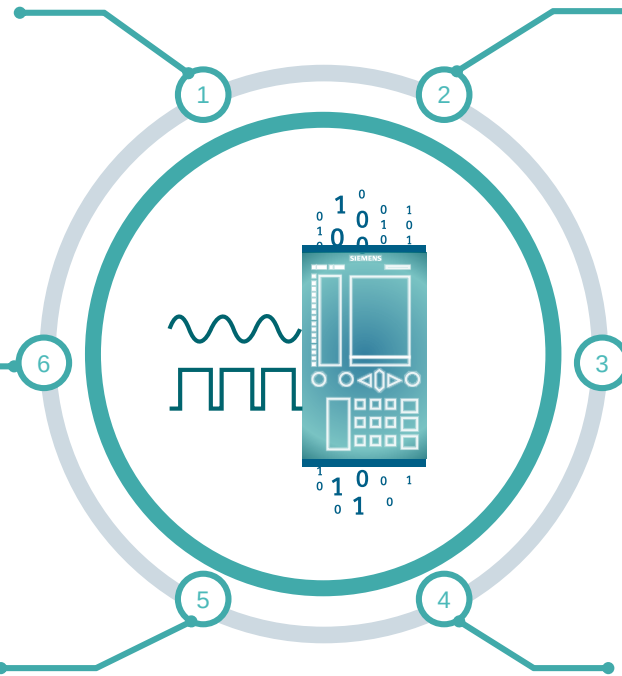
Visualize and Interact with the simulated device
- Device operation
- Analog values
- Binary inputs and outputs

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

Access your SIPROTEC DigitalTwin in 5 Steps

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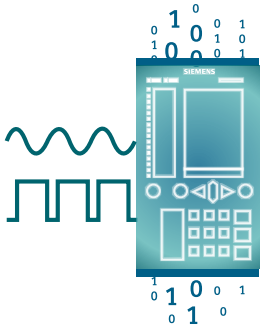
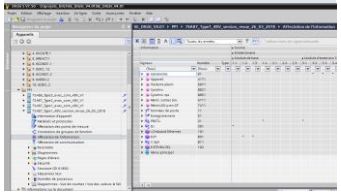
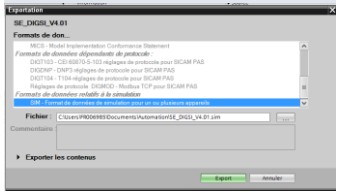


1
Open DIGSI 5 project

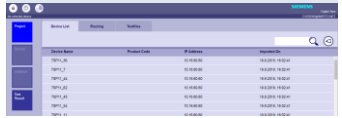


2
Export SIM file



3
Connection to the Cloud

4
Import SIM



5
SIPROTEC DigitalTwin

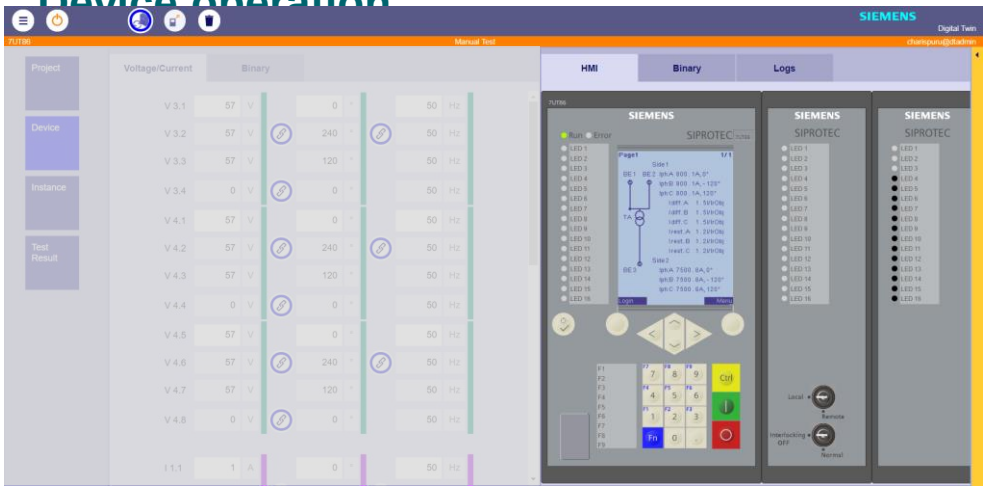
Import of SIM configuration file from DIGSI 5

- Add several devices by importing the SIM file
- SIM files can be updated/overwritten
- SIM files include the TEAX-file for displaying texts of binary in-/output and LEDs

5

Visualize and interact with the simulated device

– Device operation

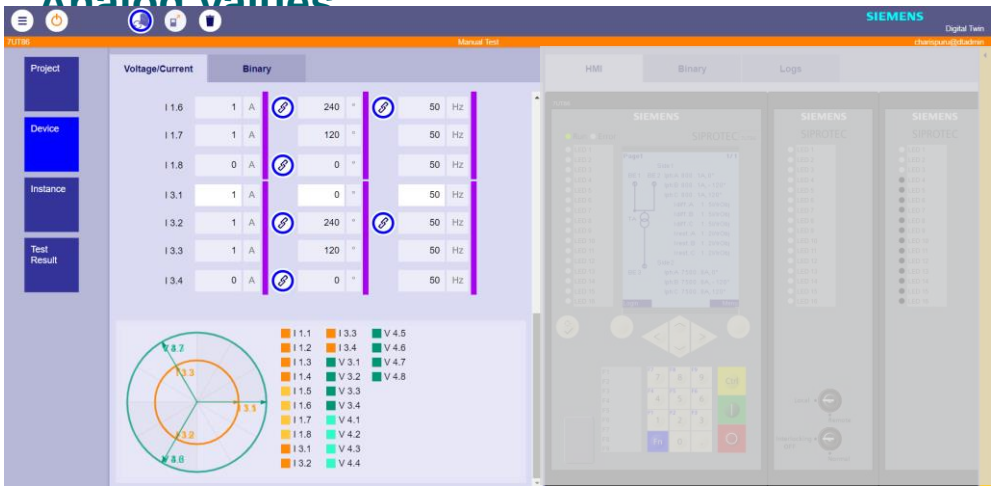


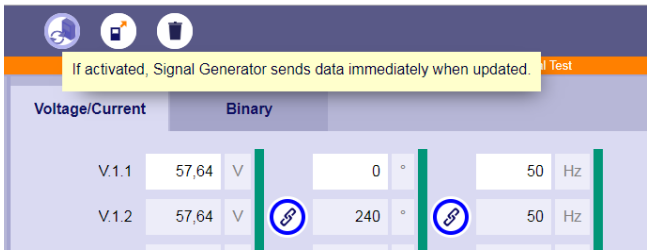
- Device view
- Operating via SIPROTEC 5 operation panel
- Testing all protection algorithms
- Testing of automation logic (CFC)
- Interaction of several devices

5

Visualize and interact with the simulated device

– Analog values

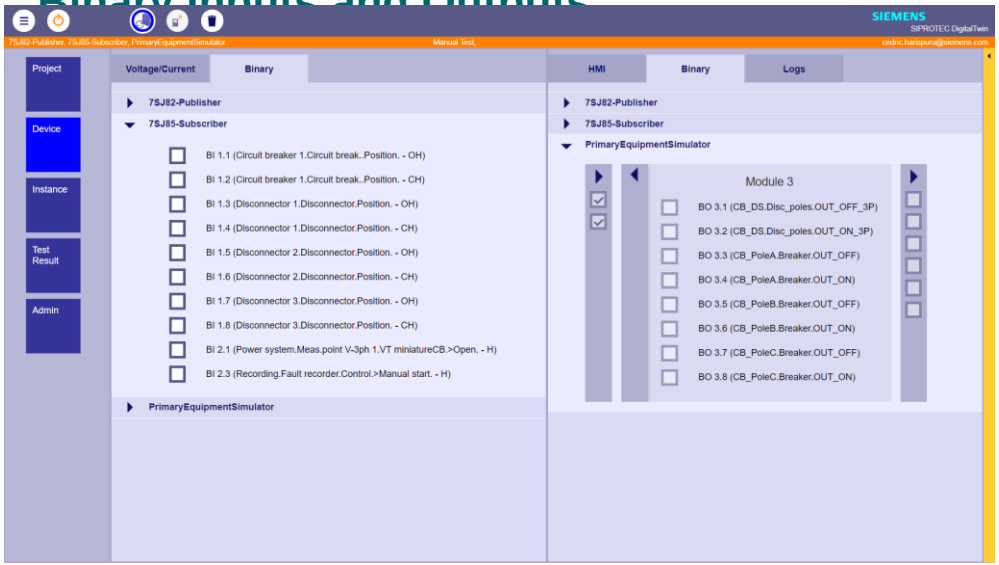




- Injection of process data (I/V)
- Setting of equal amplitudes for 3 phases
- Settings of the symmetrical phases
- Automatically calculation of I4, V4
- Visualization of the vectors
- Definition of binary and analog profiles

5 – Visualize and interact with the simulated device

Binary Inputs and Outputs



- Overview of available inputs and outputs
- Display status of in-/ outputs and the life contact
- Setting of inputs
- Definition of binary and analog profiles
- Numbering according DIGSI 5 e.g. BO 3.2
- Displaying of texts
- Hide unused binary outputs

Virtual wiring between simulated devices

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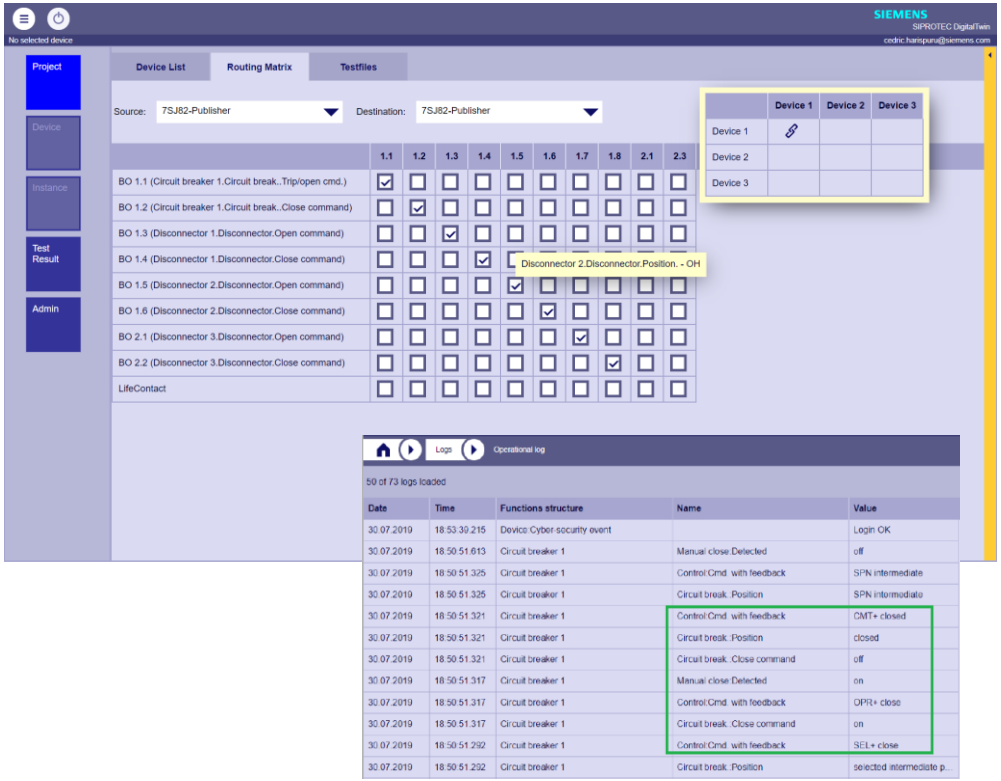

- Virtual wiring from Binary outputs to Binary inputs
- Mapping of 1 binary output to 1 or several binary inputs from same or multiple devices
- Closed loop for same simulated device (e.g. for very basic behavior of a primary equipment)
- Wiring between several devices
- Matrix overview of configured wirings between devices

Example of device operational log for the application of testing controls (via front display or via IEC 61850 MMS) based on closed loop virtual wiring on same device

COMTRADE replay

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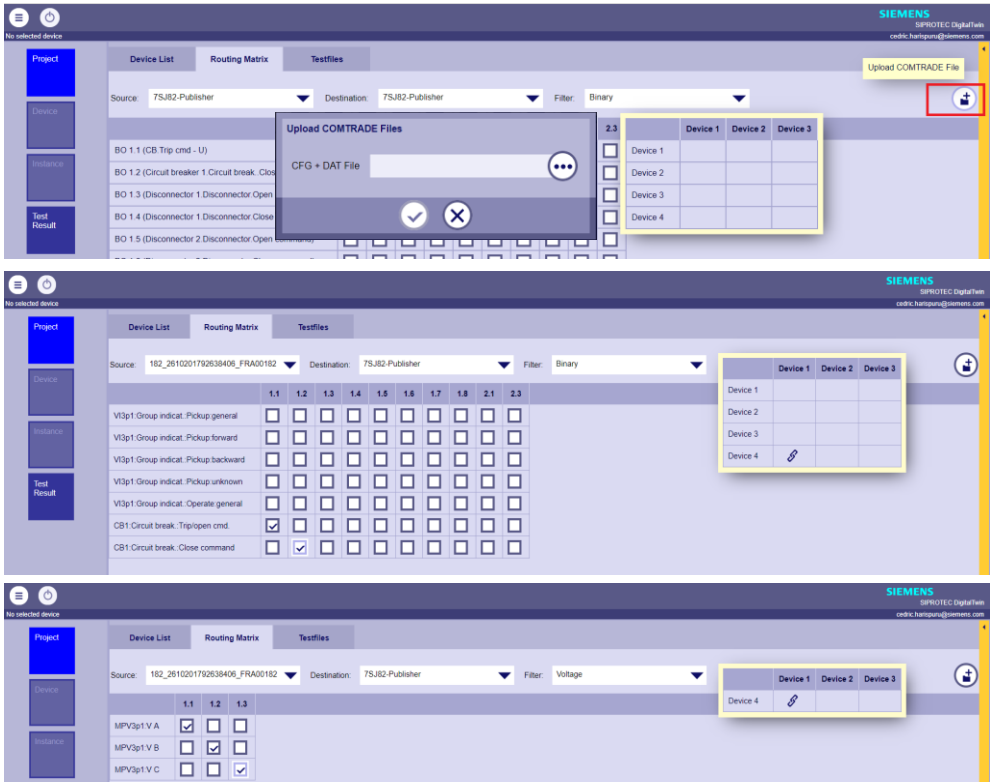
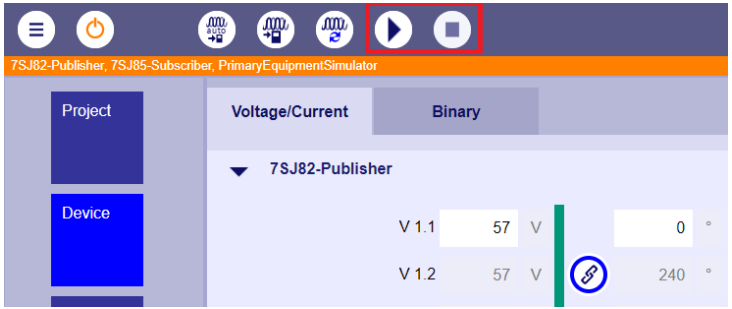


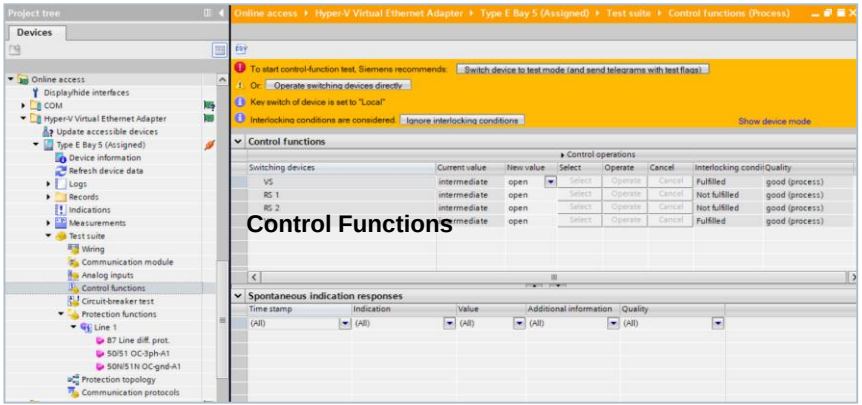
- Standard COMTRADE files (1999, 2013) can be:
  - Uploaded,
  - Mapped to binary, voltage or current inputs of one or several simulated devices
  - Replayed into the device(s)

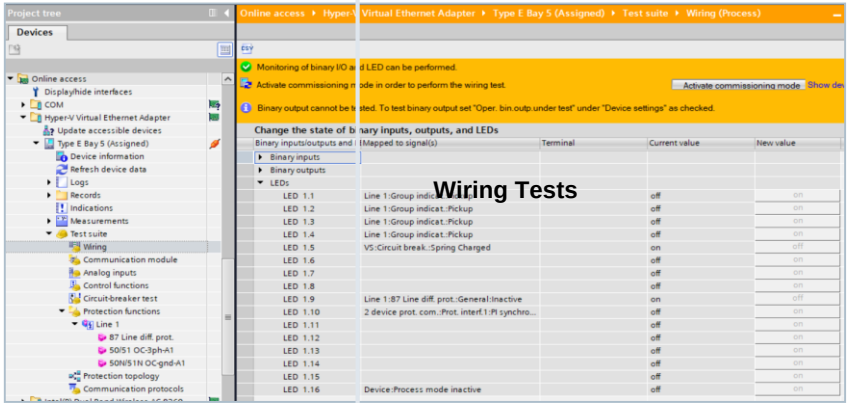
- COMTRADE file from:
  - Real protection device (fault analysis)
  - Test tool (PSS SINCAL, RTDS, Omicron Test Universe, etc.)

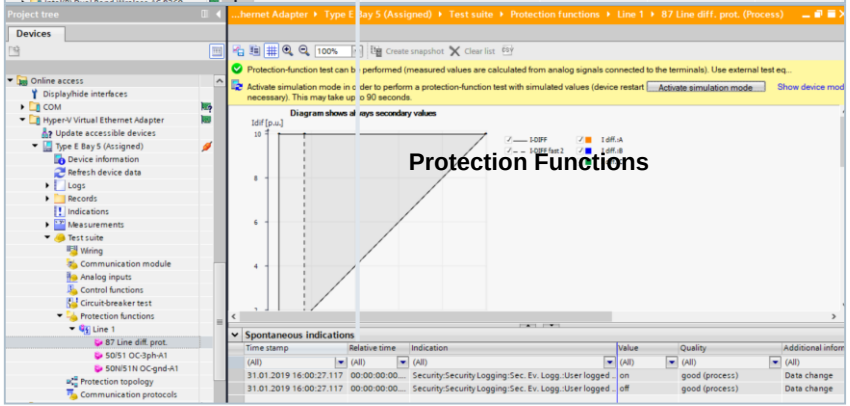


DIGSI 5 Online Testing

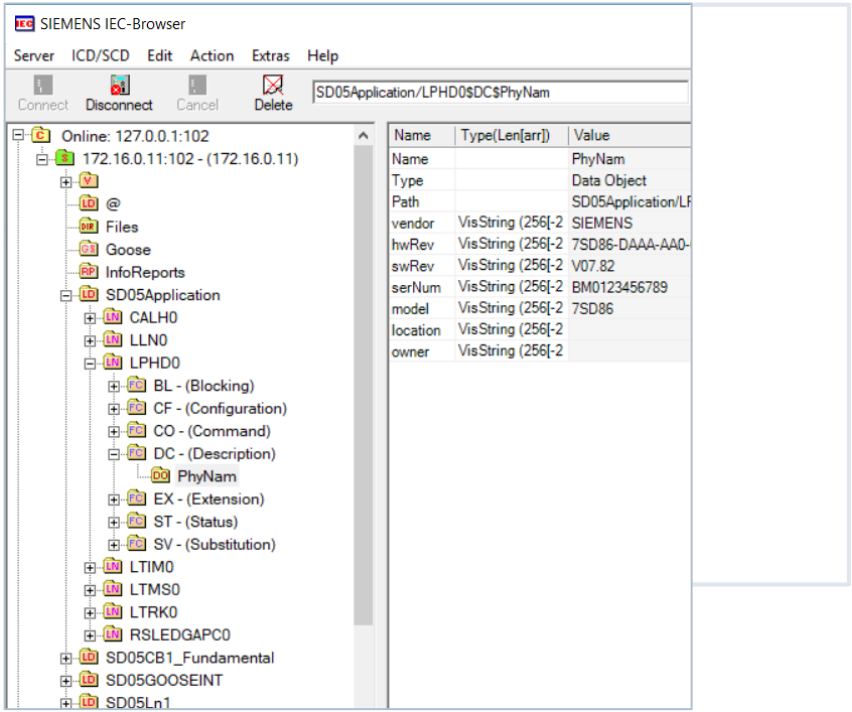
- Download logs and fault records
- Test and diagnostic functions
- Online CFC debugging
- Test sequence
- Plug & Play







Communication Interfaces



Communication interfaces…

- IEC 61850
- IEC 60870-5-104
- DNP3 TCP, Modbus TCP

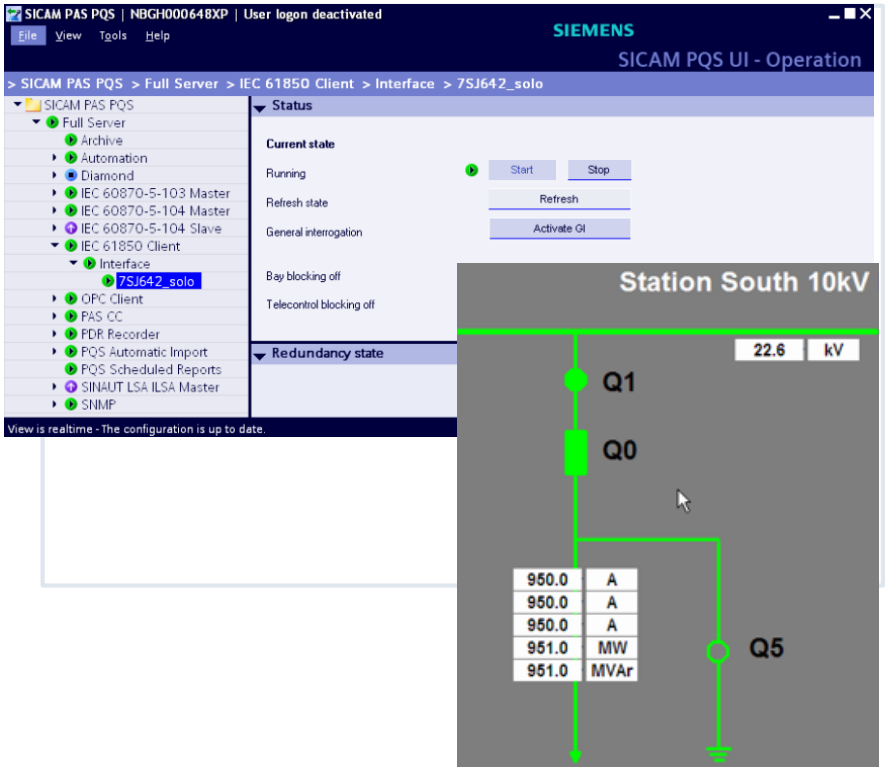
Protection Interface PI

- Establishment of the communication
- Testing of Differential Protection
- Messages sent via protection interface

PMU

VPN

Integration into substation automation system



Integration into Substation Automation …

- SICAM A8000
- SICAM PAS
- SICAM PQS
- SICAM SCC

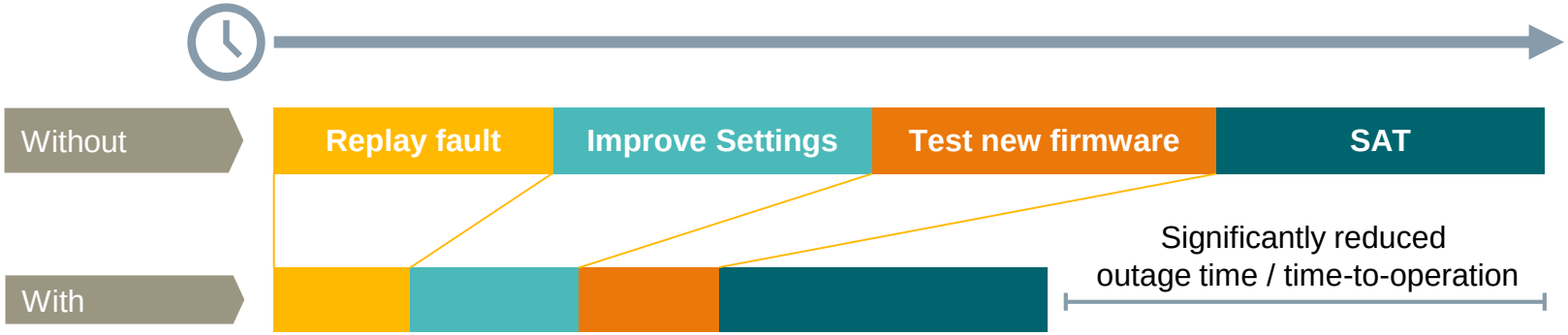
IEC 61850 Goose Simulation

- IEC 61850 communication
- Messages can be sent via Goose communication

Benefits

Save time & increase quality throughout the system lifecycle

Example scenario: Fault analysis, system optimization and upgrade



… and all this with higher quality, flexibility and more customer confidence in our products and systems

Benefits

Investment cost reduction for test lab usage

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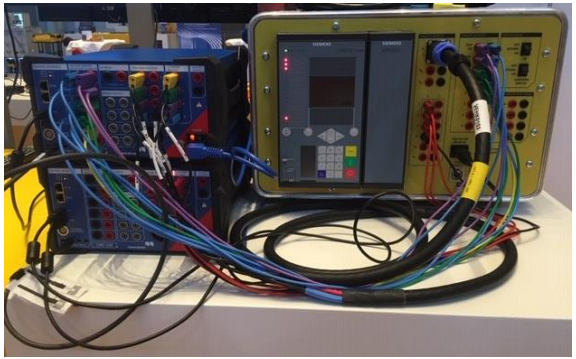

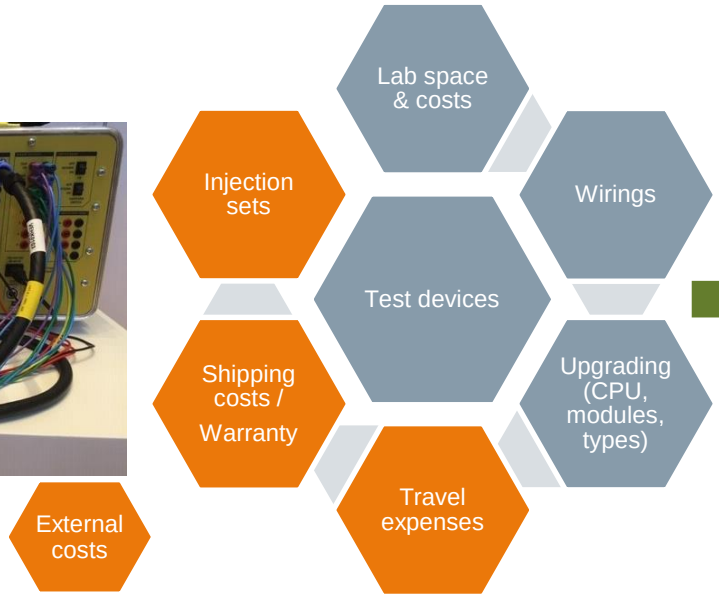

- Reduce your test lab CAPEX investments by typically 80%
- Test your external dependencies and reduce external costs by 100%

Low Impedance Centralised Bus Zone Protection Testing

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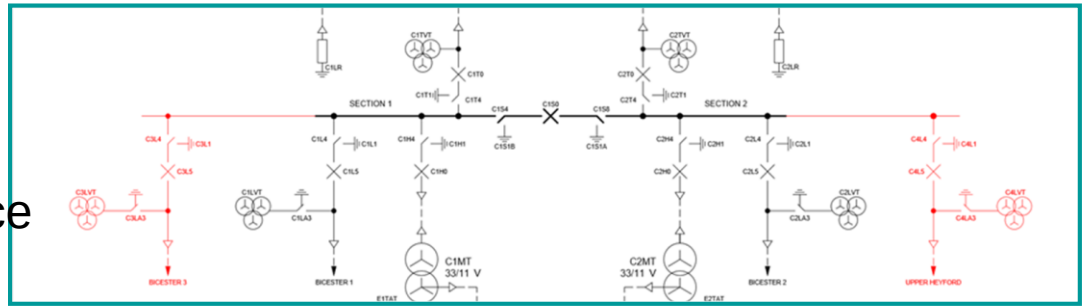
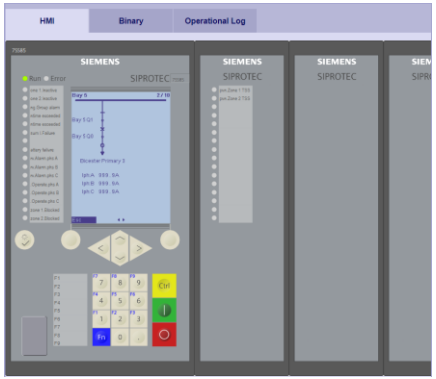
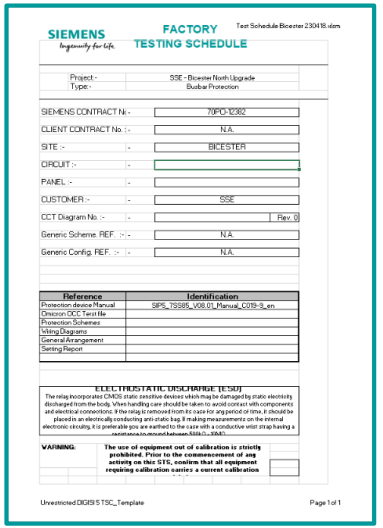
Existing Busbar Protection scheme

- Commissioned and put into service in 2018.
- Two new circuits were to be added to the scheme.
- Required minimal disruption/downtime to relay on site.



- **Digital Twin was used to "soft" test the new configuration.**
- **As the scheme is already protecting, general spot checks were performed to check I/O routing, CT routing and simple busbar checks. Check of Operation/Restraint.**
- **New test document written around Digital Twin checks.**
- **These form the new tests for the standard schemes going forward.**

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FACTORY TESTING SCHEDULE

Project -	SSE - Bicester North Upgrade
Type -	Busbar Protection
SIEMENS CONTRACT No -	70PO-12362
CLIENT CONTRACT No. : -	N.A.
SITE -	BICESTER
CIRCUIT :-	
PANEL -	
CUSTOMER :-	SSE
CCT Diagram No. :-	Rev. 0
Generic Scheme. REF. :-	N.A.
Generic Config. REF. :-	N.A.

Reference	Identification
Protection device Manual	SIPS_TSS8S_V08.01_Manual_C019-3_en
Omicron OCC Test File	
Protection Schemes	
Wiring Diagrams	
General Arrangement	
Setting Report	

ELECTROSTATIC DISCHARGE (ESD)

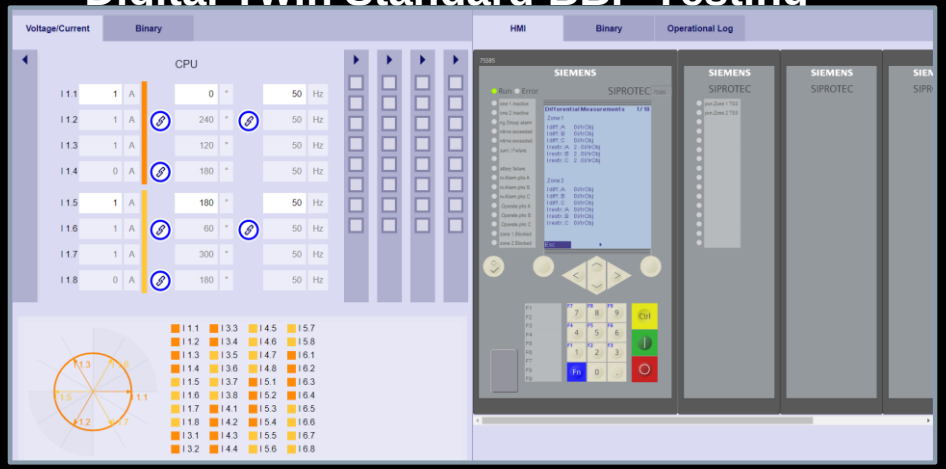
The relay incorporates CMOS static sensitive devices which may be damaged by static electricity discharged from the body. When handling care should be taken to avoid contact with components and electrical connections. If the relay is removed from its case for any period of time, it should be placed in an electrically conducting anti-static bag. If making measurements on the internal electronic circuitry, it is preferable you are earthed to the case with a conductive wrist strap having a

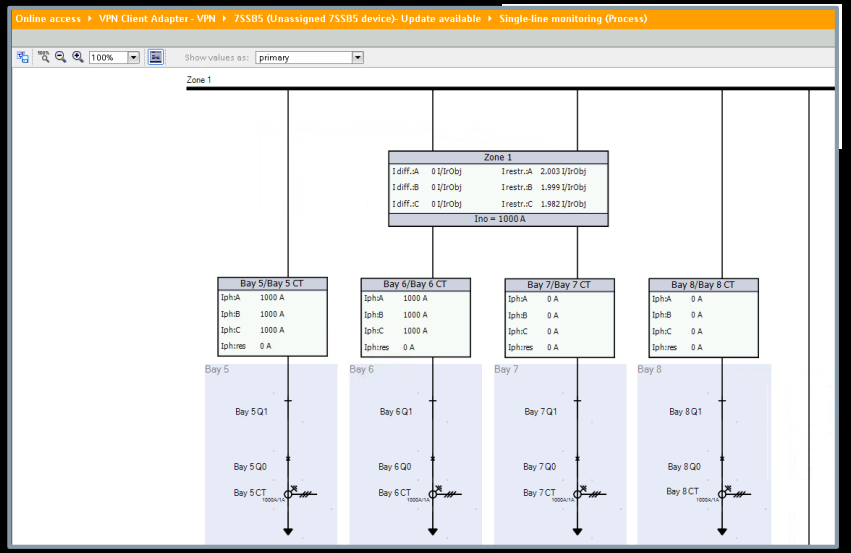
WARNING: The use of equipment out of calibration is strictly prohibited. Prior to the commencement of any activity on this STS, confirm that all equipment requiring calibration carries a current calibration

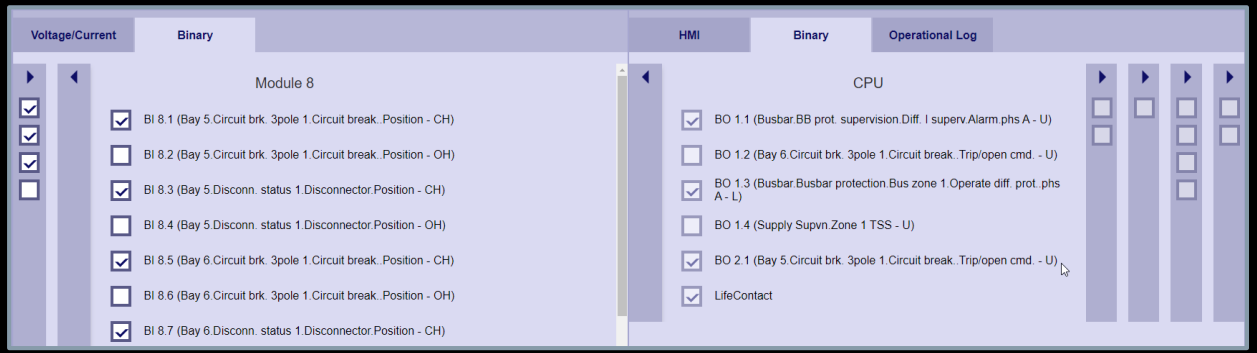
Unrestricted DIGITS TSC_Template

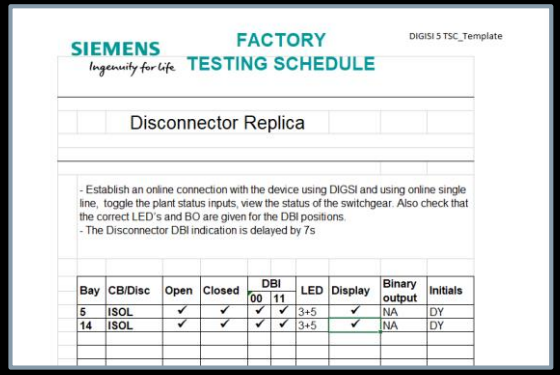
Page 1 of 1

Digital Twin Standard BBP Testing









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FACTORY TESTING SCHEDULE

DIGISI 5 TSC_Template

Disconnector Replica

- Establish an online connection with the device using DIGSI and using online single line, toggle the plant status inputs, view the status of the switchgear. Also check that the correct LED's and BO are given for the DBI positions.
- The Disconnector DBI indication is delayed by 7s

Bay	CB/Disc	Open	Closed	DBI		LED	Display	Binary output	Initials
				00	11				
5	ISOL	✓	✓	✓	✓	3+5	✓	NA	DY
14	ISOL	✓	✓	✓	✓	3+5	✓	NA	DY

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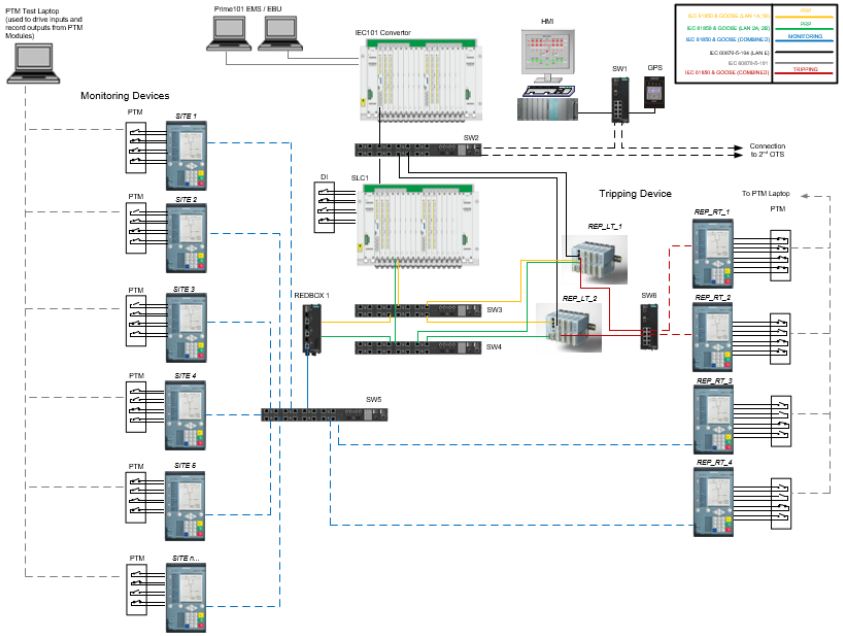
Testing of IEC61850 Based Operational Tripping Scheme

Virtualised Testing of Operational Tripping Scheme

Operational Tripping Scheme (OTS)

Wide area monitoring of strategic sections of the 400kV transmission network monitoring circuit open/closed and trip conditions to trip or de-load connected generation to prevent instability or thermal overload of the network.



Current Solution

- Central site – SICAM AK3 and A8000
- Remote sites – SIPROTEC 5 5MD85
- Communication with remote monitoring and tripping sites via IEC61850 & GOOSE
- Remote monitoring sites send circuit status to central site

Virtualised Testing of Operational Tripping Scheme

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Operational Tripping Scheme (OTS)

- Schemes with a minimum of 30 6MD85 devices
- E&U projects need representative test kit to prove functionality

Options prior to DT

- Full representative hardware
  - A lot of time setting up test system
  - A lot of space needed in test lab
  - A lot of storage requirements when hardware is not in use
- Minimal representative hardware
  - Reduced time setting up hardware and space requirements
  - Increased time required for testing activities for changing over configurations
  - Inefficient and doesn’t offer full functionality testing

Testing of the OTS
Use of DT Large License

- Replicate part of the system with 1 engineering laptop replacing 20 physical 6MD85.
- Saving 5 – 10 days of test set-up
- Provides efficiencies in project delivery
- Enables full functionality testing

Future Use

As scheme expands, greater number of devices needed to replicate system:

- Option 1: Use of multiple licenses
- Option 2: XL License…

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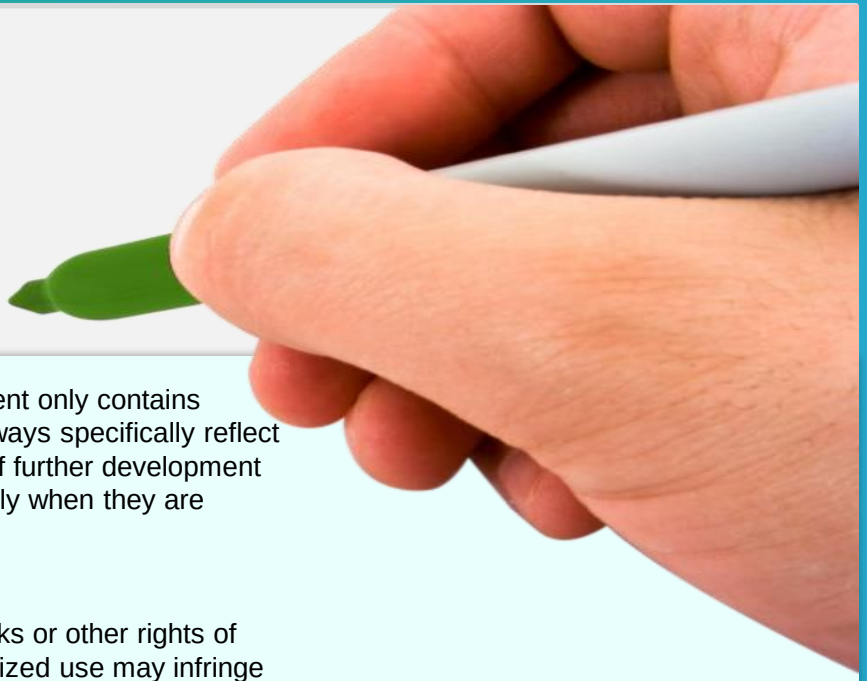
Disclaimer!



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SIPROTEC DigitalTwin

Thank you!

Agenda

Opening and Welcoming

James Irvine," Distribution Network Security: Lessons from the first 10 years of PNDC"

Nigel Nawacki, "IEC 61850 and private LTE for ADMS", NOKIA

Nigel working life has Several decades of experience in operational telecoms, previously Nigel worked at Nortel , Cisco , and Huawei. He is Energy Utility Consulting CTO for Nokia , bringing the best practices to grid protection systems with MPLS, Security and to Power utility solutions for distribution automation to UK/EU

Energy Utility Digital Industry CX CTO at Nokia EU/UK

Agenda

Opening and Welcoming

James Irvine," Distribution Network Security: Lessons from the first 10 years of PNDC"

Mayamiko Hara, UKPN " Learnings from Designing a Smart Substation",

Mayamiko worked in the South African utility industry for 8 years, and joined the UK Power Networks Innovation team in 2021 as part of the Constellation delivery team. His key role on the project is to oversee the delivery of the hardware, software and communications infrastructure for the project,

Innovation Workstream Lead at UKPN

Constellation

Learnings from Designing a Smart Substation

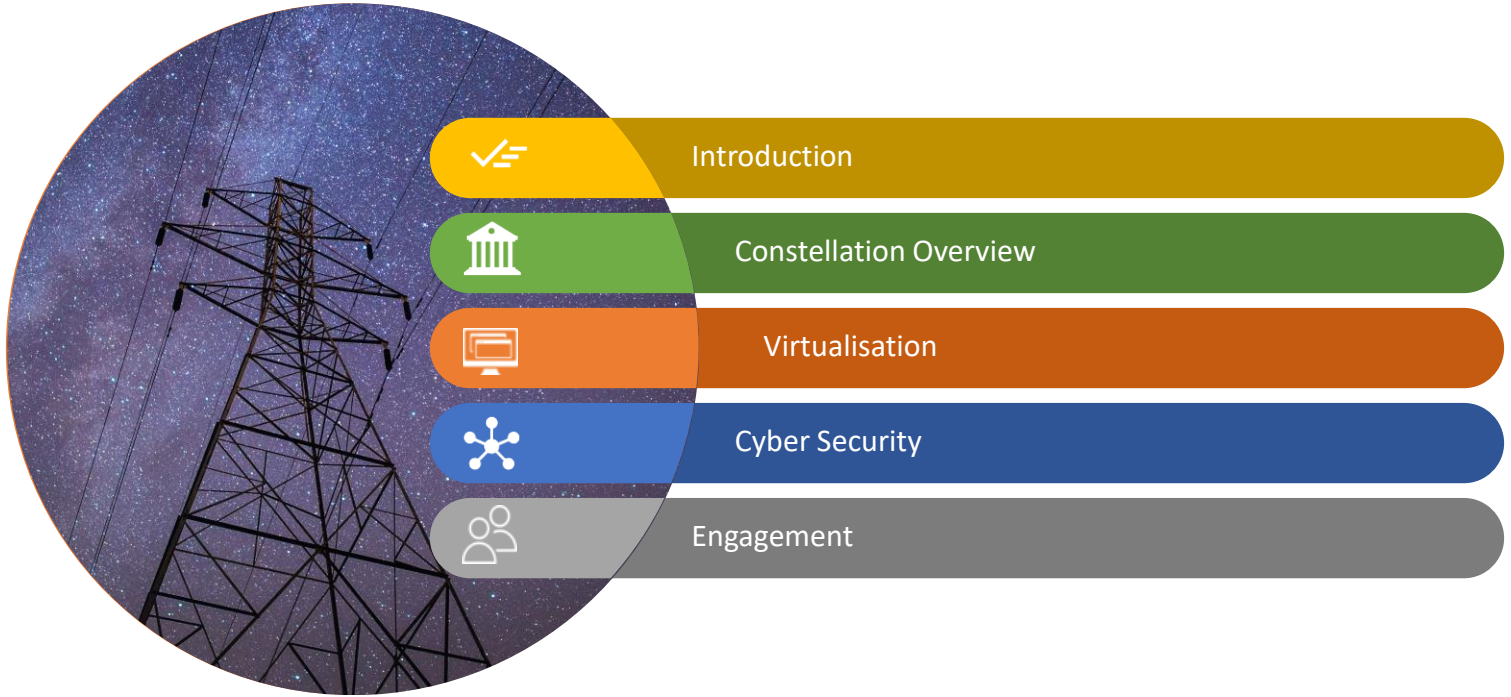
Mayamiko Hara – Innovation Workstream Lead, UK Power Networks

UK Power Networks
Delivering your electricity

INVESTORS IN PEOPLE™ We invest in people Platinum

NES NATIONAL EQUALITY STANDARD

Agenda



UK Power Networks
Delivering your electricity

About UK Power Networks

8.4M homes and businesses

29% of UK Total

9.8GW Distributed Generation Connected

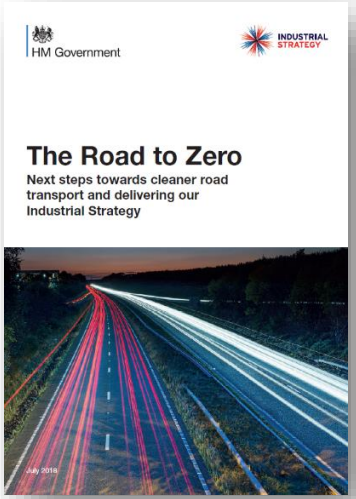
32% of UK Total

70,888GWh electricity distributed

28% of UK Total

UK Power Networks
Delivering your electricity

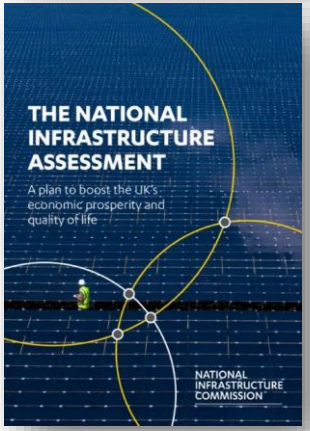
Net Zero



News story

UK becomes first major economy to pass net zero emissions law

New target will require the UK to bring all greenhouse gas emissions to net zero by 2050.



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Situation and Complication

Keeping generation connected in a Net Zero future

Situation	Complication
DSO service resilience	Unnecessary disconnection of DERs
Increase in low carbon generation and load	Network capacity availability
Hardware based solution roll out	Scalability across a large network

Constellation overview

Constellation will facilitate Net Zero by:

- Increase resilience of operation
- Release capacity for more low carbon generation
- Enable scalable deployment of smart functionality

We will achieve this by:

Enhancing our substations by making them digital, interoperable and future-proof and enabling secure communication between them

Constellation Partners

ABB

GE

UNIVERSITY of STRATHCLYDE PNDC

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vodafone

Constellation Solutions Overview

Three solutions were identified to address the challenges identified and deliver solutions that would create a more resilient and digital network that can support the increased proliferation of DG.

Constellation Solutions

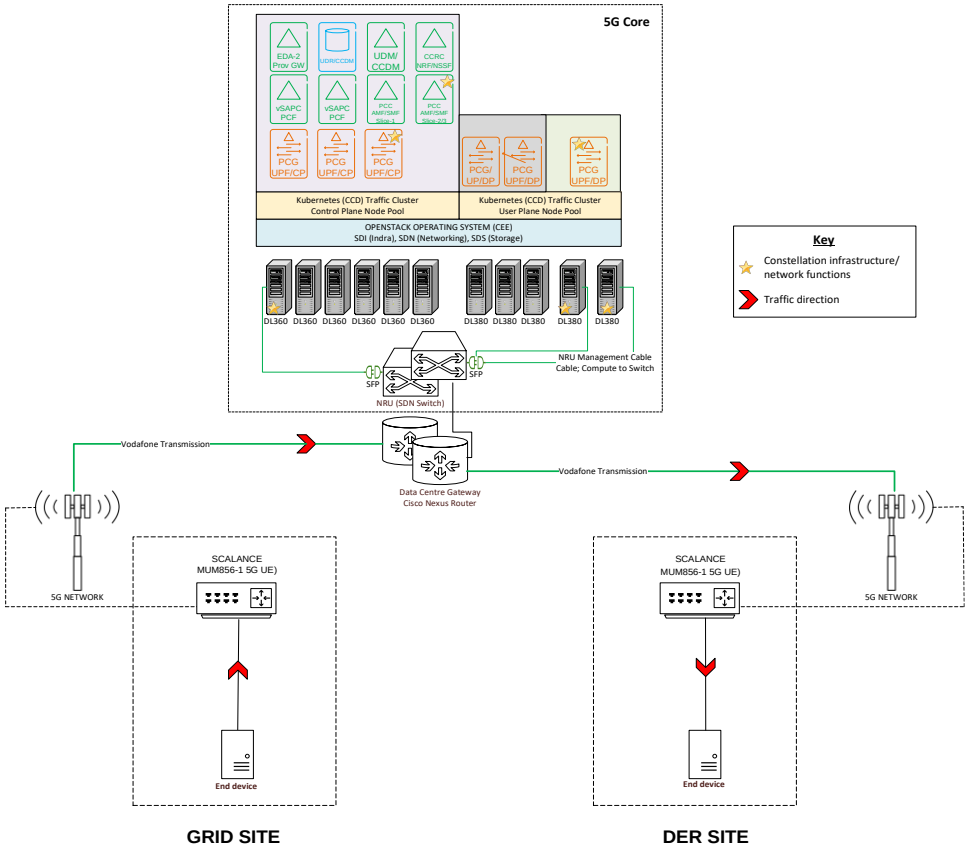
Local Active Network Management (ANM)
Optimise network operation and DER output when communication links to Central ANM are unavailable

Wide Area Protection
Dynamic management of Loss of Mains (LoM) protection settings leveraging local intelligence obtained through site-to-site communication

Adaptive Protection
Increase network capacity through the application of adaptive protection that appropriately respond to dynamic changes in the network

Project Duration: 2021 - 2025

Vodafone 5G Slice for Site-to-Site Communications



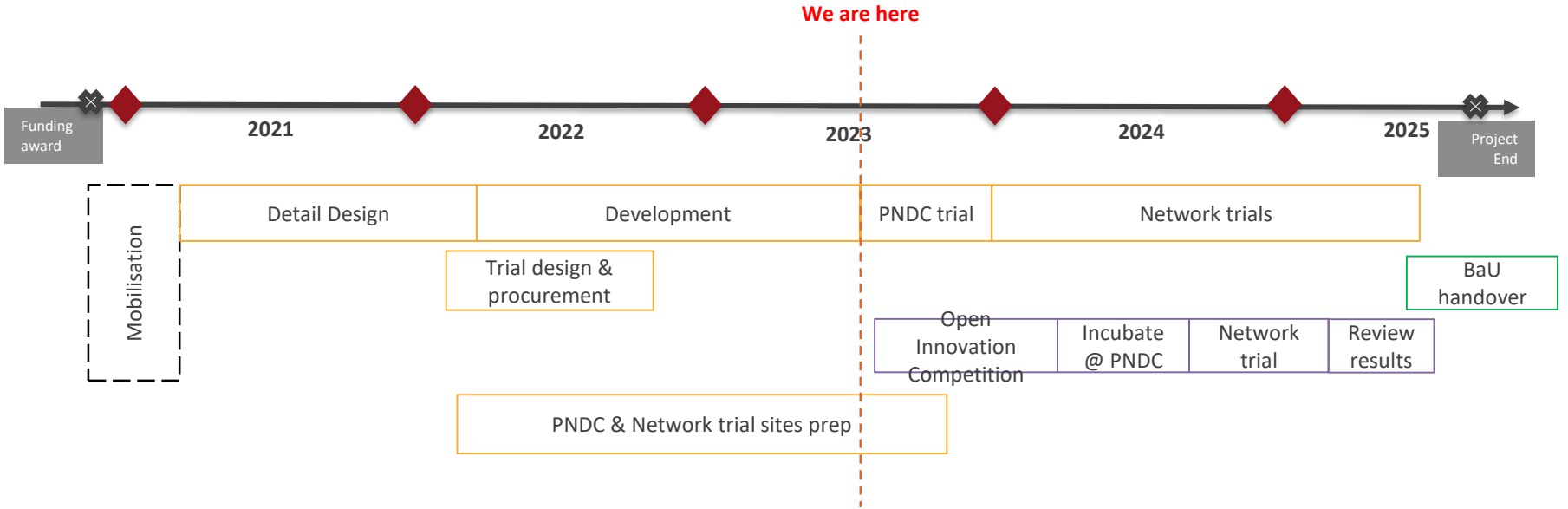
Purpose

- To provide site-to-site comms for Constellation – Local ANM and Wide Area Protection.
- To test the use of public 5G networks with network slicing
- To test use cases for areas with limited high-speed communications infrastructure

Learnings to date…

- Sub 30ms latencies are possible
- Long-term testing is required to ensure performance is consistent in different scenarios.

Constellation timeline



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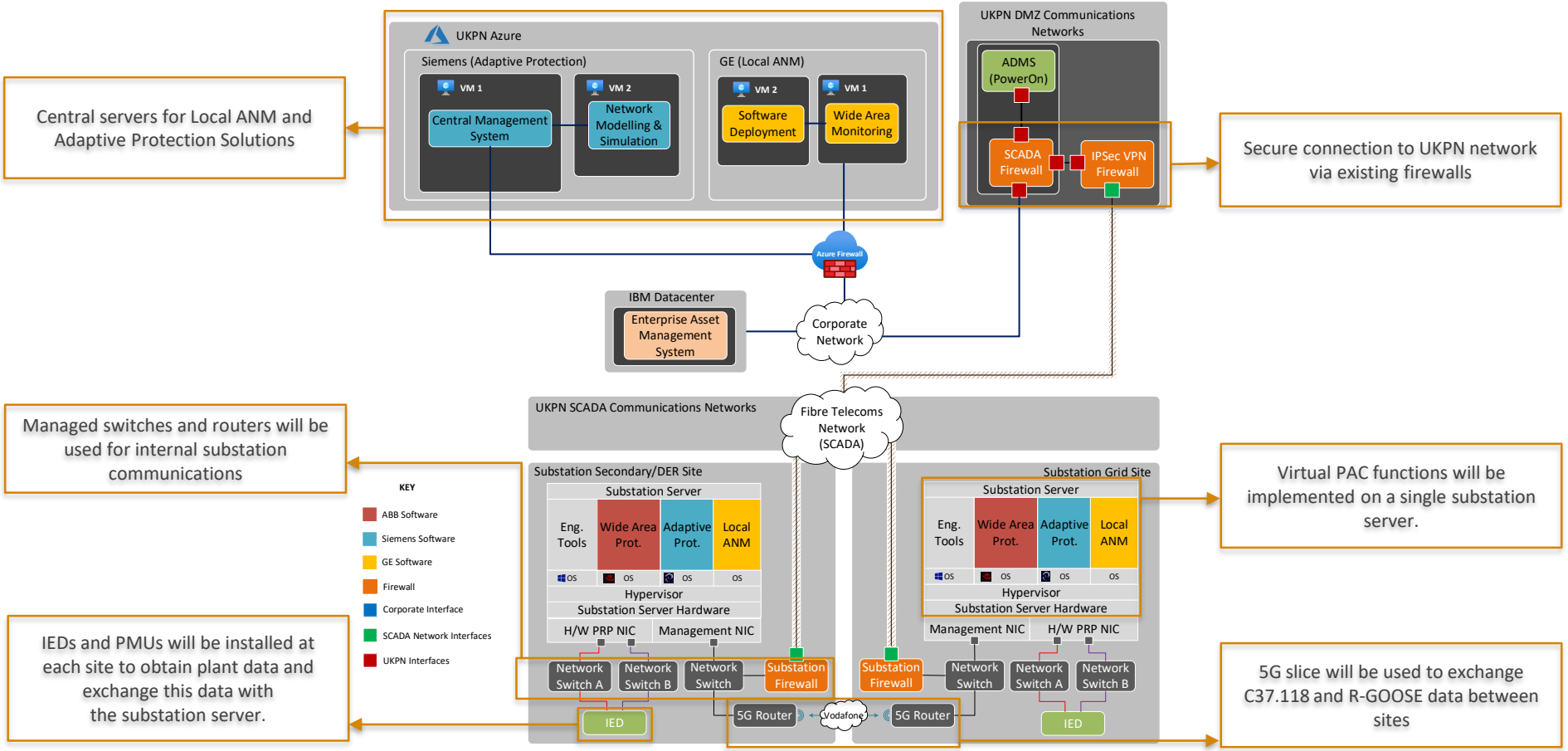
Constellation Architecture & Substation Environment

Constellation architecture defines the integration between the IEDs, substation-based computers and where required centrally located servers.



Requirements for Virtualisation

Requirements

- Academic research
- Relevant industry experience

01

Standards

- UK Power Network Specs
- ENA TS
- IEC 61850-3

02

Use-case Req

- Solutions will include multiple applications
  - Real time and non-real time
  - Storage: TBs of data on SSDs
- Each solution requires dedicated environment
- Data flow: Phasor data, MMS, (R-)GOOSE, enterprise asset data

03

Virtualisation Req

- Hardware in harsh operating environment
- Powerful processing capabilities
- Redundancy:
  - Software
  - Power supply
- Use-case performance guaranteed from shared resource

04

Opportunities of Virtualisation

Pace of roll-out of solutions

Benefit for: DNO, Connecting Customer

Quicker and more efficient deployment of new smart solutions across all voltage levels of the network

Increased interoperability

Benefit for: DNO

Benefit of convergence of IT & OT

Security and management

Benefit for: DNO

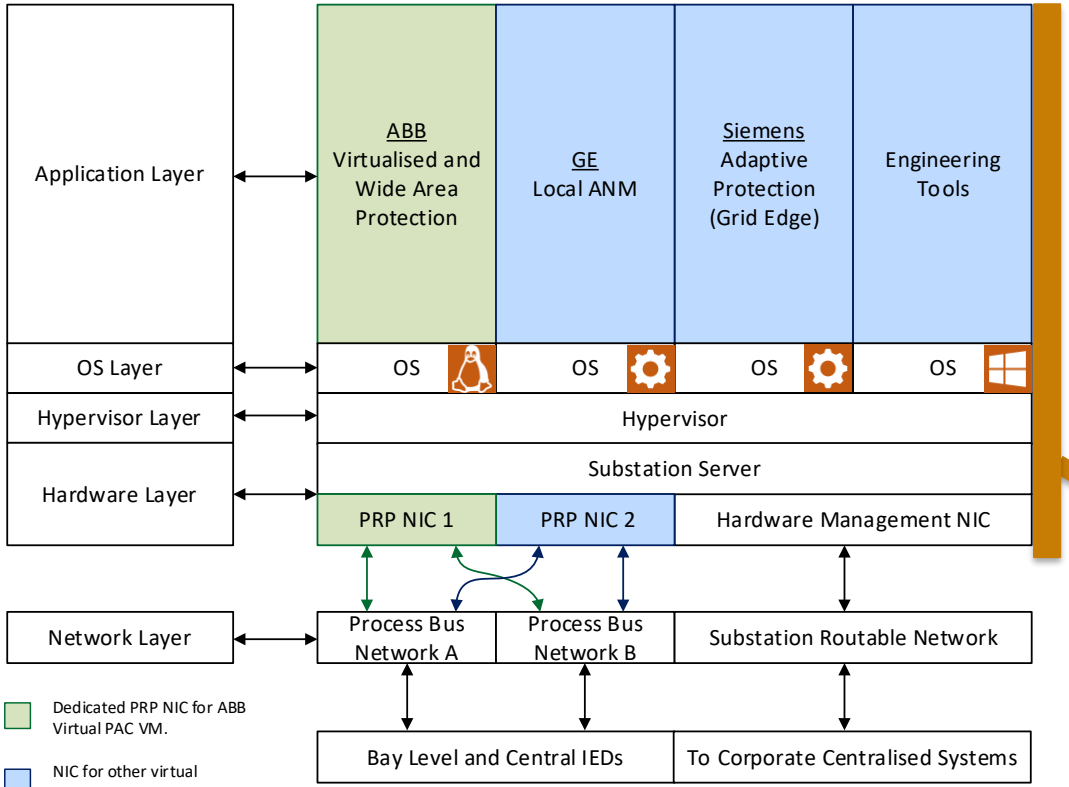
Opportunity to enhance asset maintenance and intrusion detection and prevention

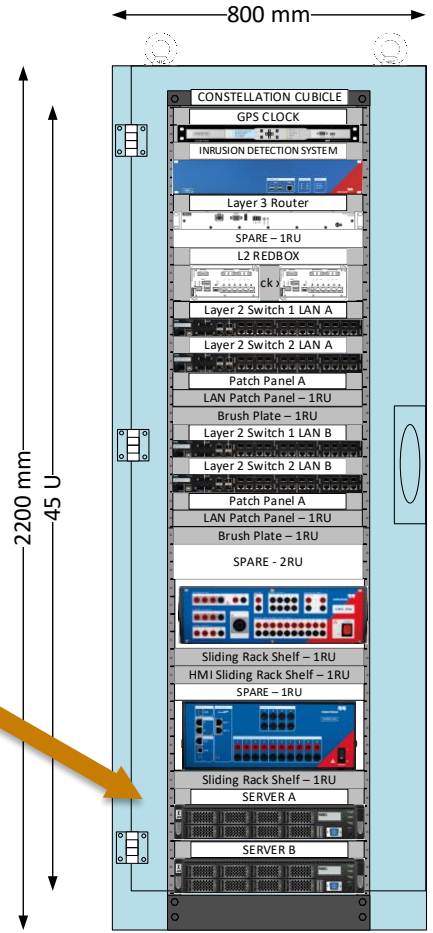
Standardisation of design and operation

Benefit for: DNO, Connecting Customer

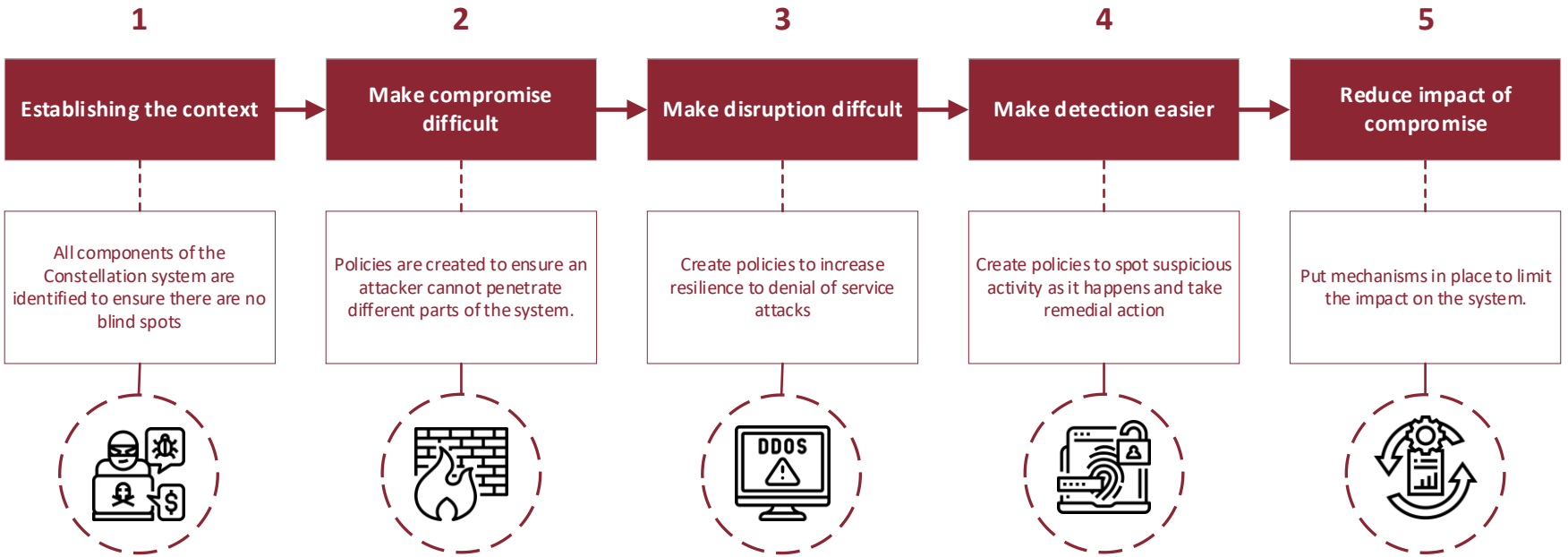
Benefit of reducing the physical footprint of sites and simplifying the engineering

Virtualised Environment within Substations





Cyber Security – Secure by Design



Engagement with the Industry

Wider Industry Review Question:

Architecture and substation environment:

"What do you think will be the key challenges of maintaining the software and hardware in the substation environment?"

Resilience

Security

Software Updates

Testing

The maintenance of IT hardware and software in an OT environment will require a paradigm shift away from the traditional approach of only updating when it becomes necessary. In Constellation we will test and document the management requirements for digital substations.

Thank you

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