23 July 2021

Grid Digitalisation Workshop

Gary Ang, Director

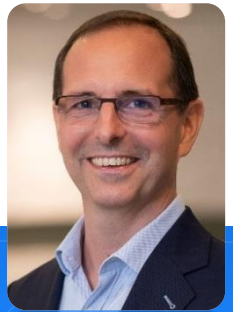
SP Group

Moderator

Gary Ang

Director,
Smart Grid & Operational Digitalisation
SP Powergrid

Panelists



Eric Jost

Partner, Advisory
Power and Utilities
Ernst & Young

Martin Hauske

Asia Pacific Energy Segment Lead
Nokia

Jayant Amresh

Project Management Lead for Global Transmission Asia
Black & Veatch

Nugroho Prananto Utomo

Senior Consultant
DNV

Future of the Grid

Combating climate change

Decarbonisation

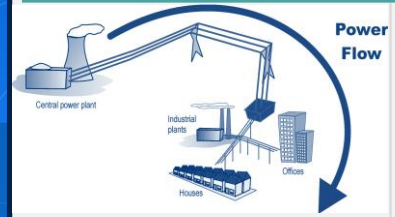
Decentralisation

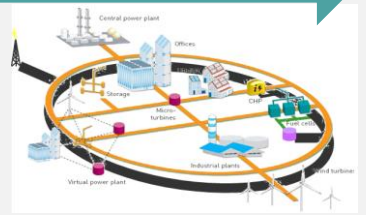
Digitalisation

Electrification

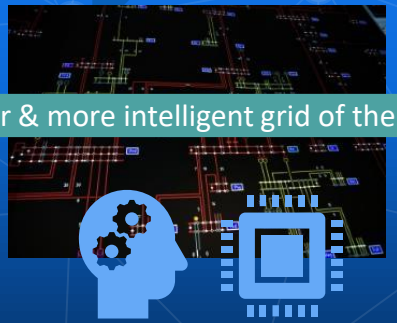
Greater decarbonisation, decentralisation, digitalisation and electrification for a greener world

Evolving system dynamics, stability and control





Upholding network reliability to maintain our position as one of the world's most reliable power grids



Smarter & more intelligent grid of the future

Energy Transition -
A customer-led and technology-enabled transformation

Eric Jost
Partner, Advisory Power and Utilities
Ernst & Young

Energy Transition

A customer-led and technology-enabled transformation

23 July 2021

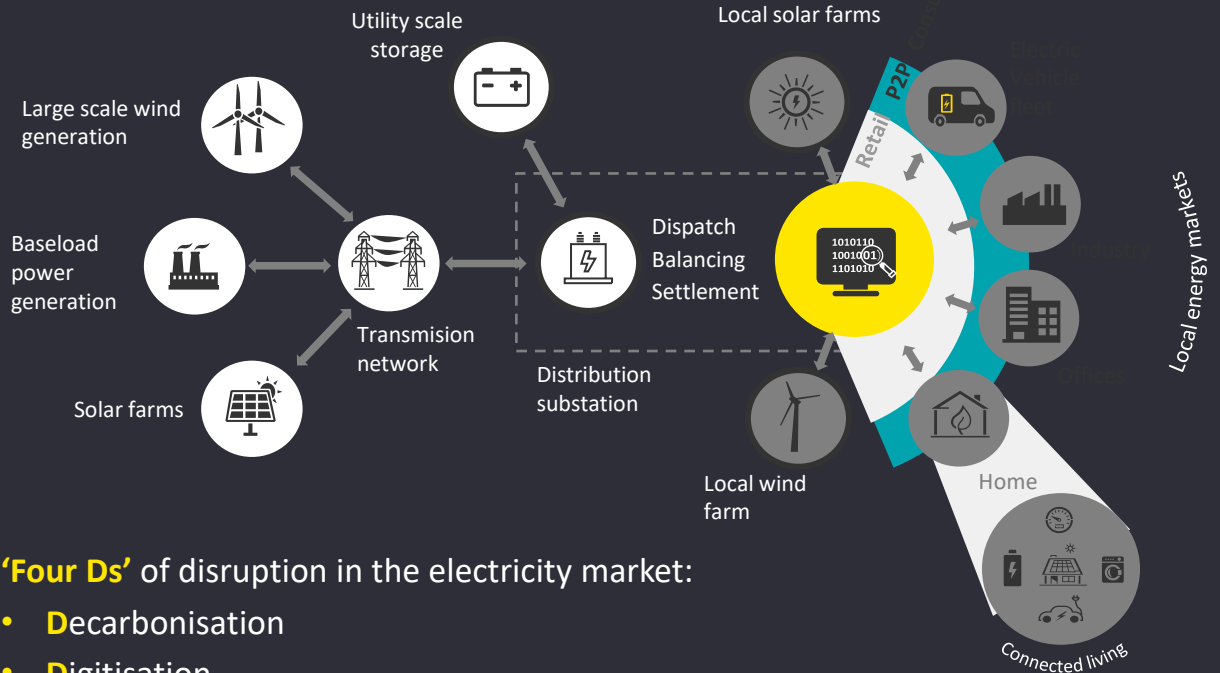
The better the question. The better the answer.
The better the world works.

Building a better working world

We are seeing the birth of a new energy system and Utilities are facing a consumer-led and technology-enabled energy transition

Sector in Transformation

- Empowered Customers
- Market Reform
- Competition
- Changing Generation Mix
- New Technology & Threats



'Four Ds' of disruption in the electricity market:

- **D**ecarbonisation
- **D**igitisation
- **D**ecentralisation
- **D**eregulated

UNDERSTANDING THE EMERGING TECHNOLOGY IS CRUCIAL TO REMAIN RELEVANT AS A UTILITY

The journey towards a distributed grid will see distribution companies evolve from network operator (DNO) to system operator (DSO)

Active management of complex systems in a self-healing, intelligent and distributed grid will necessitate advanced capabilities in addition to the core capabilities of today

Network Operator (DNO)

Network maintenance through reinforcement and load management

1. Connect

Connect load and energy resources to the network

2. Fortify

Ensure the network can support load and energy resources

3. Control

Flexible connections

Control of individual DER (Generation & Load) based on business (non-market) rules

4. Steer

Discrete flexibility platforms

DSO operated platform manages DER based on market rules and constraints

5. Integrate

Integrated flexibility platforms

DSO & TSO integrated platform to manage DER allows optimization across DSO

Advanced capabilities required:

- ✓ Capturing data from DERs
- ✓ Forecast optimization
- ✓ Distribution of near-real-time forecast and dispatch requests
- ✓ Sharing of dispatch objectives across the area level
- ✓ Transaction logging into a blockchain for settlement

System Operator (DSO)

Network development by procuring flexible services; operational & planning decisions in coordination with TSO

Journey to the distributed grid

Analytics will be a key enabler for network utilities on their transformation journey

Analytics attributes that will help network utilities…

Revealing insights
Deriving deeper insights from the data collected through smart meters, SCADA and other devices

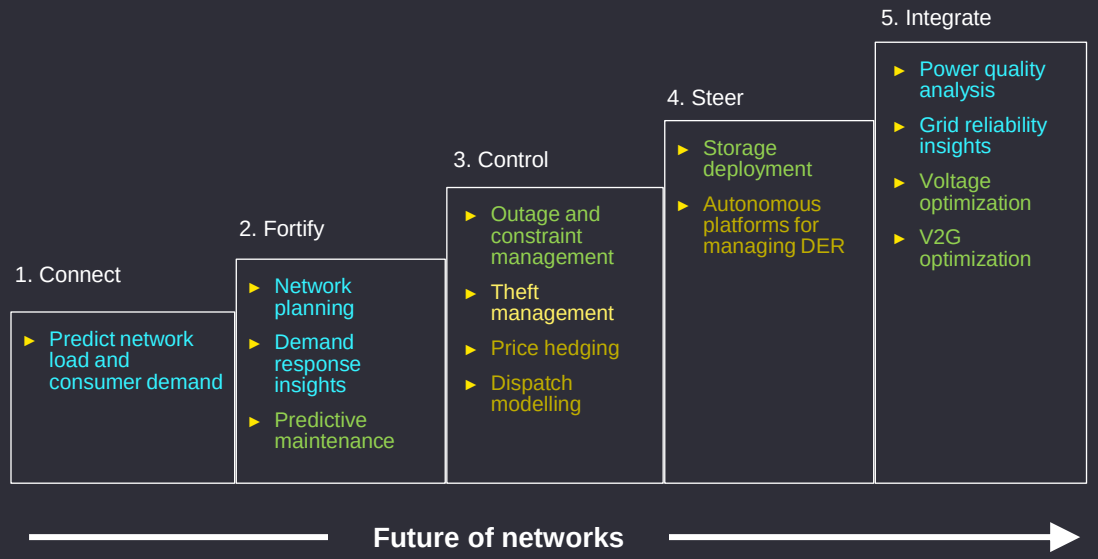
Optimizing performance
Learning newer ways to improve operational efficiencies of generation and network assets

Enhancing experience
Instant and quality experiences to the customers through digital interface and autonomous bots

Sustaining trust
Highly accurate execution of complex instructions

Intelligent automation
Integration with robotics resulting in intelligent autonomous systems

…on their journey to the future state



Would having a crystal ball to see the future help you make better business decisions?

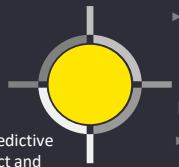
EY's definition of a Digital Twin

Digital Twin refers to a data informed, digital replica of products, processes and systems. It is analogous to the diagnostic capabilities that an X-ray or an MRI scan offers doctors prior to surgery.

Types of digital twins

Component level
- Highlight most crucial and essential component in manufacturing process
- Examples: rotor, blade

System level
- Improvising entire production line with the whole fleet of products in the system
- Examples: combined-cycle plant, crude unit



Asset/product level
- Design, monitoring, predictive maintenance of product and analysis of product life cycle
- Examples: turbine, motors

Process level
- Connecting multiple organizations across the supply chain, across the production environment
- Examples: manufacturing process

Application of digital twins

- Predictive Asset Maintenance
- Managing Distributed Energy Resources
- 3D simulation design platform
- Engineering planning
- Workflow optimization
- Network collaboration

EY's views on the use of digital twins

Our approach to building a digital twin begins with business knowledge and opportunities, the insights that can be generated and the business value of those insights

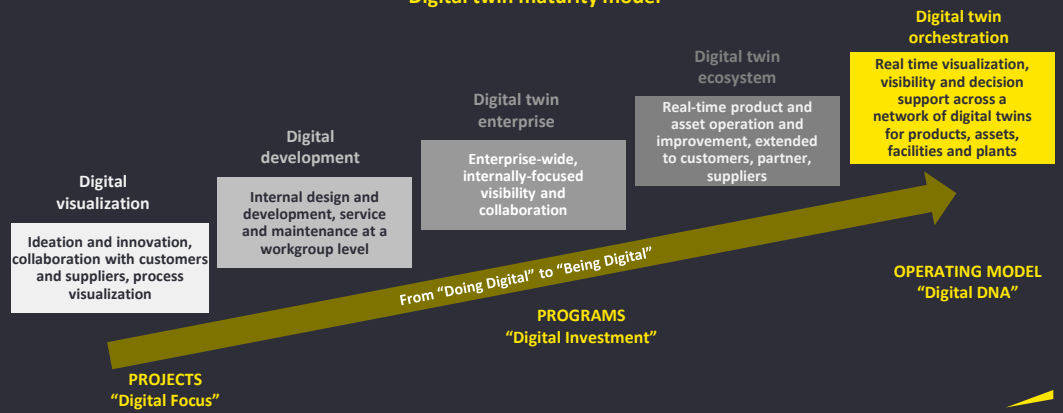
We focus on creating a canonical data model that enables different systems and applications to connect and exchange enterprise information

Use of open, interoperable and hardware-agnostic IoT systems makes it easier to introduce digital twins at different stages of asset lifecycle

The potential from digital twins is greatly enhanced when combined with use of technologies like machine learning, edge computing, etc.

Building a virtual connected network of distributed digital twins will enable efficient integration of growing DERs

Digital twin maturity model



enel

Launched a new initiative, URBAN FUTURABILITY, to transform the city of São Paulo, by deploying a Digital Twin of the electricity networks, to facilitate grid inspections and enable preventive asset maintenance

Enel-X's digital twin of the network helps facilitate grid inspections and enable preventive asset maintenance

Enel-X's digital twin of the network helps facilitate grid inspections and enable preventive asset maintenance

https://www.youtube.com/watch?v=9AW_lt3FAd8

Enel-X's digital twin of the network helps facilitate grid inspections and enable preventive asset maintenance

Network Digital Twin in Brazil

BENEFITS

Digital twin solution

Creating a digital twin of the electric network of Vila Olímpia, South Zone of São Paulo, in an all-in-one comprehensive platform

Real time laboratory

Use this platform as a laboratory of more than 40 digitalization and artificial intelligence initiatives

Technology-powered

Use of AI, RPA, data analytics, image collection, digital 3D modelling, augmented reality, etc. for remote identification of outages, anomaly detection, etc. to create a sustainable megacity

EY | Building a better working world

EY exists to build a better working world, helping to create long-term value for clients, people and society and build trust in the capital markets.

Enabled by data and technology, diverse EY teams in over 150 countries provide trust through assurance and help clients grow, transform and operate.

Working across assurance, consulting, law, strategy, tax and transactions, EY teams ask better questions to find new answers for the complex issues facing our world today.

ey.com

Next Generation Communication and IoT

Martin Hauske

Asia Pacific Energy Segment Lead

Nokia

NOKIA

Go Allwhere.

Networking solutions for the new age of industry.

Next Generation Communication and IoT

Martin Hauske Asia Pacific Energy Leader

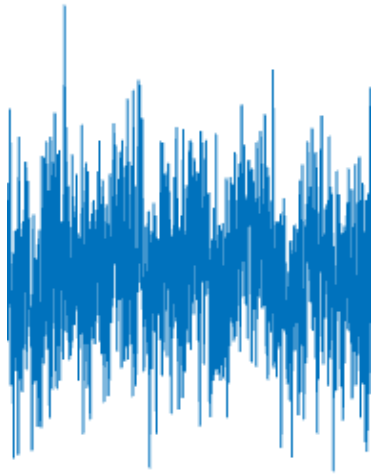
07-23-2021

Energy Key Trends

Bulk

Distributed

Rapidly improving economics of renewable generation & storage



Time (sec)

Increased variability in supply & demand

Climate Change

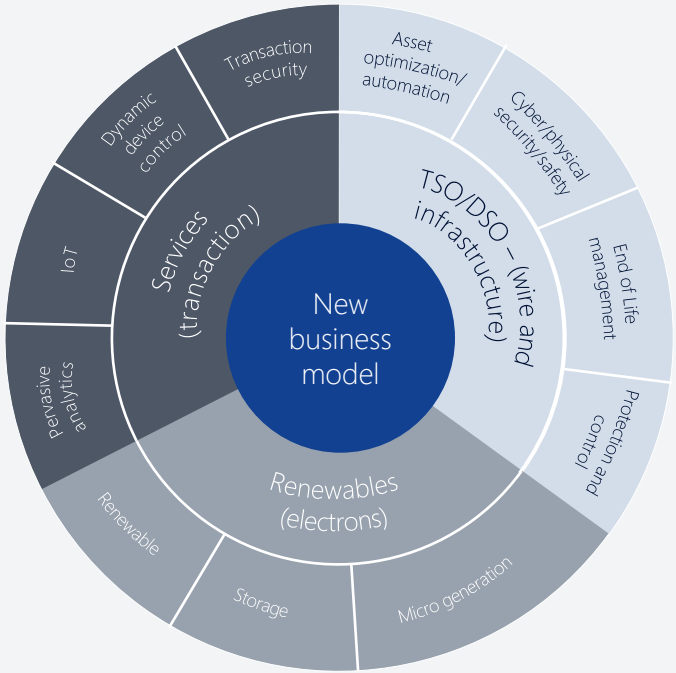
NOKIA

Power Utility of the Future

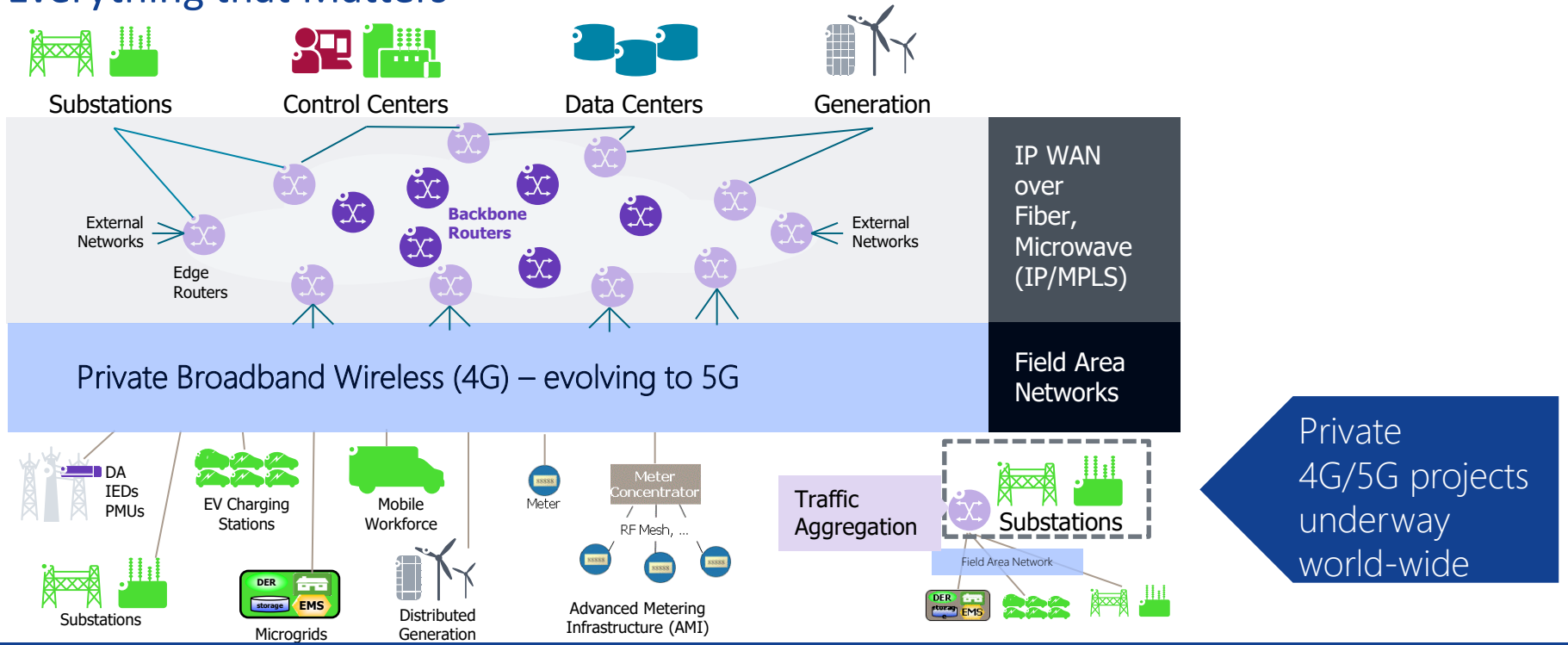
Opportunities

New Business Model

- Digitize
- Automate



Network, Store, Compute & Control
Everything that Matters



Private 4G/5G projects underway world-wide

Utilities must build a ubiquitous wired + wireline network → New revenues

SDH/PDH network modernization for mission-critical OT applications

Project background

- A verticalized power utilities in Hong Kong
- Replacing part of the existing SDH/PDH network covering control center and ~100 power substation locations with IP/MPLS to provide a high-availability, efficient, lower total cost of ownership and future-proof network to minimize impacts on the technology transformation
- All legacy TDM interfaces need to be supported and better manageability
- Critical applications include teleprotection, SCADA and operational voice in the initial phase.

Technical requirements

- Support of various TDM interfaces from the MPLS router, e.g. C37.94, 64k G703 co-dir, RS-232, E&M, FXO/FXS
- Stringent requirements in e2e latency (< 4ms) and delay asymmetry (<200 us) for teleprotection service
- Management solution for network, equipment and services
- RCA, alarm correlation and ML (future)

Solution

- 7705 SAR-8/18 MPLS router solution to provide TDM (C37.94, G703 64k co-dir, FXS/FXO, E&M, RS-232, E1 and STM-1 interfaces)
- Nokia patented ADC feature for delay asymmetry control. NGE for security.
- NFM-P premium package to provide network and service management, as well as analytic.

Customer benefits

- Proven OT transformation solution and experience from Nokia
- Rich legacy interface and service support in SAR-8/-18 to provide smooth migration and no multiple-box solution required
- Advanced management capabilities with NFM-P to provide network, service and security management

New Services, New Capabilities – IP/MPLS, pLTE

San Diego Gas & Electric, USA

"Every month a large number of customers are introducing Solar and we need to find a way to support that"

California's major utilities have reached the state's 2020 renewable energy target of 33%,

On track to hit 2030 target of 50% by 2020

Challenges

- Reduction in demand
- Managing large amount of solar
- Supporting government and communities push for green power
- EV charging
- Innovative business model

Solutions

- Increase monitoring and control capability – upgrade IP/MPLS
- Increase number of endpoints to 200,000 end points (vs 3.6m customers)
- Awarded Private LTE contract to Nokia (as a managed service)

Benefits

- Improved integration of renewables
- Gain new revenue from service business – islands, green communities, etc.
- New business model – DSO
- Platform

IIOT connectivity, Analytics, Edge Cloud for Wind Farm

Background, challenges and drivers

- Requirement for very wide area coverage in very remote locations (no CSP commercial network coverage)
- Secure, plug-and-play and reliable connectivity in all conditions
- Solution approach – more than just connectivity: Commercial collaboration with OSIsoft (data infra), Advantech (sensor GW in turbine) and Dianomic (OSIsoft stack in sensor GW)

Initial application(s)

- Connect wind turbine sensors data for monitoring the health of wind turbine pitch mechanisms and assembly
- Early warnings give opportunity to perform predictive maintenance and save up to 90% of turbine pitch assembly repair.

Next steps

- Advanced analytics solution by Nokia
- High frequency PMU control data over Nokia DAC platform
- Multiple video uses for e.g. worker safety and site surveillance

Crane blades pitch system repair is extremely costly

Video: Private LTE use case – pervasive connectivity
Press release: Nokia and OSIsoft collaborate to boost analytics capabilities with high-capacity infrastructure

New York Power Authority, USA

(Source: New York Power Authority)

Private LTE trial

"The goal of this project is to build a secure, robust, and reliable wireless LTE network to enhance our operational and programmatic capabilities and leverage all the benefits of the ever-evolving innovation in wireless technology. We believe that this network will advance NYPA along the path to becoming the nation's first end-to-end digital utility. "

– Gil C. Quiniones, NYPA President and CEO

Press release – drone tests

Press release – pilot/trial plans

Drone's view of NYPA private LTE field trial webinar

Drone tests video

Challenges

- Become nation's first end-to-end digital utility
- Highly reliable, secure wireless communications to support multiple applications: drones, workforce mobility, deep metering services, WiFi telephony/PTT and more

Solution

- Nokia Digital Automation Cloud (DAC) P-LTE network using Bands 71 & 8 to test uses cases:
  - Drones
  - Digital utility worker
  - VoLTE
- Nokia Drone Networks

Benefits

- Enhance operational capabilities
- Communications platform for end-to-end digital utility for transmission lines and generating facilities
- Optimize performance and simplify deployment with integrated communications and applications (drones and voice) solution

IoT and revolutionary engine enable reliable power supply

Lower Cost, Higher reliability and SLA for (Mission Critical) Networks and DER

1. Low number of parts reduce cost and ensure high reliability
2. Sensors allow remote monitoring, management by Nokia

https://www.reuters.com/article/nokia-aquarius-electricity/israels-aquarius-nokia-to-supply-micro-generators-to-southeast-asia-idUSL8N2DD07Z

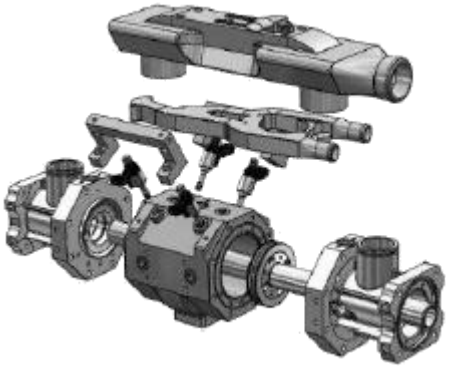
https://markets.ft.com/data/announce/detail?dockey=600-202101281017PR_NEWS_USPRX____LN62760-1

High Reliability

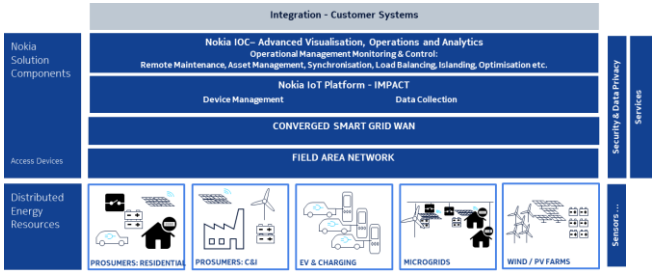
Load Balancing

Redundancy Control

0.9L Engine 16kW



- 15 main parts
- 1 moving part
- No oil filter
- Maintenance every 2000+ hrs
- Weight 10.5 kg
- Efficiency > 30 %



NOKIA


NOKIA

Emerging Trends in Digital Substations

Jayant Amresh

Project Management Lead for Global Transmission Asia

Black & Veatch

BLACK & VEATCH

Emerging Trends in Digital Substations

Jayant Amresh
Global Transmission

21 July 2021

BLACK & VEATCH

What is Digitalization?

Digital Networks and Smart Devices

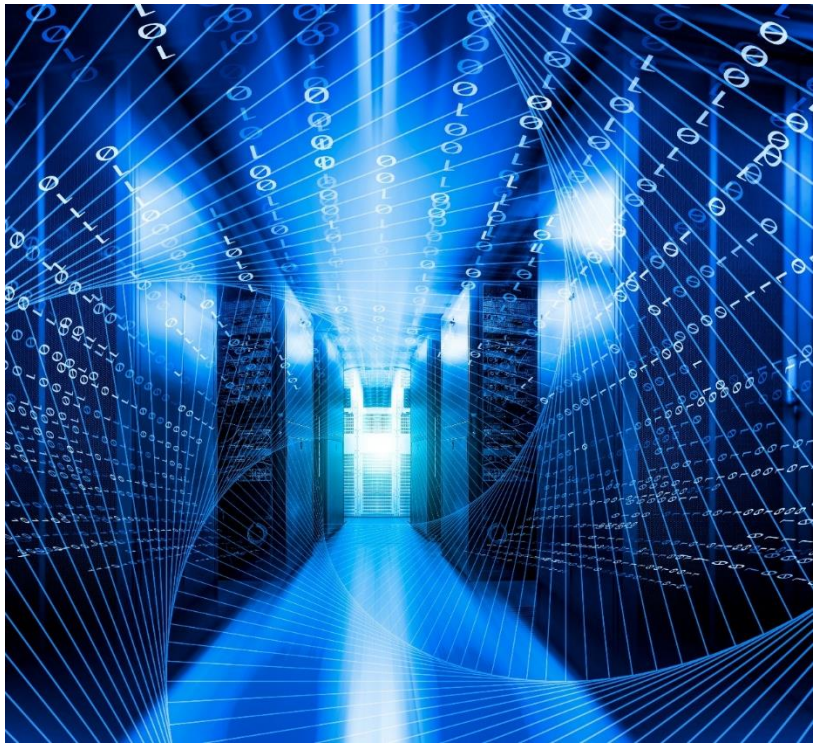
Replace

Analog Signaling and Infrastructure

Advancing from Substation Automation to a Complete Substation Digitalization

Why Digitalization?

- Expansion of Available Information and Analytics
- Streamlined construction deployment
- Increased immunity to EMP (Electromagnetic Pulse)
- Safety Enhanced



Risks and Challenges

- Cyber attacks
- Technician skillset alignment with the new equipment
- Knowledge base to inform reliable designs still minimal
- Hardware evolution cycle accelerates

Future Developments

- Protection Virtualization
- Predictive Analytics
- Digital Twins
- Augmented Reality

Building a World of Difference.®

Nugroho Prananto Utomo

Senior Consultant
DNV

Control System Architecture: From Flat Network to Zero Trust

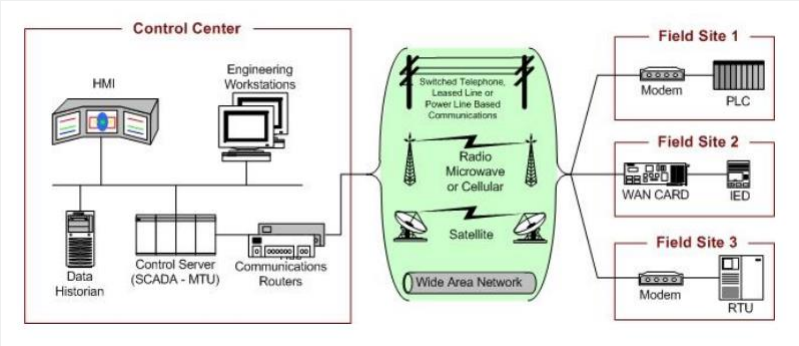
Control System Architecture: From Flat Network to Zero Trust

Energy Innovation 2021

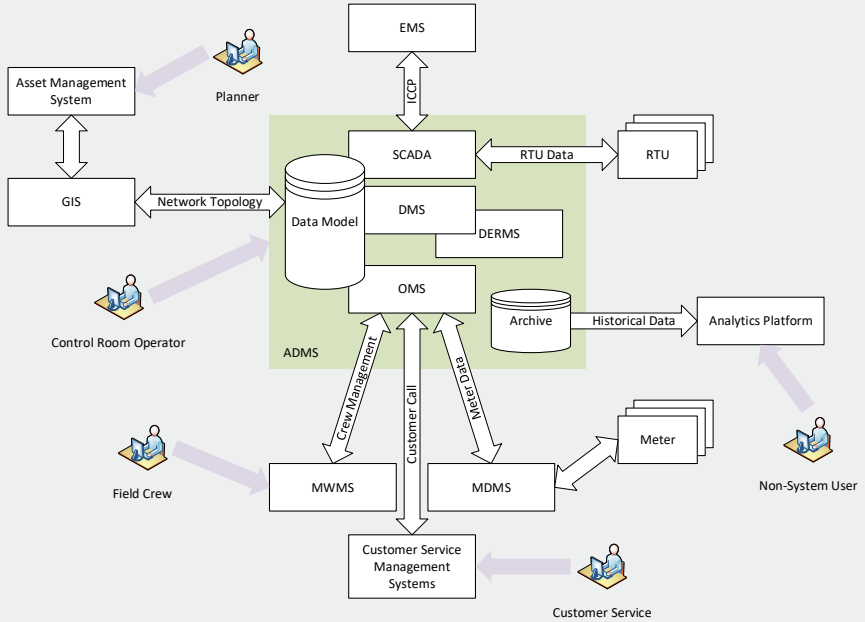
Nugroho Prananto Utomo

23 July 2021

Control System Network Evolution



- Reference: NIST 800-82

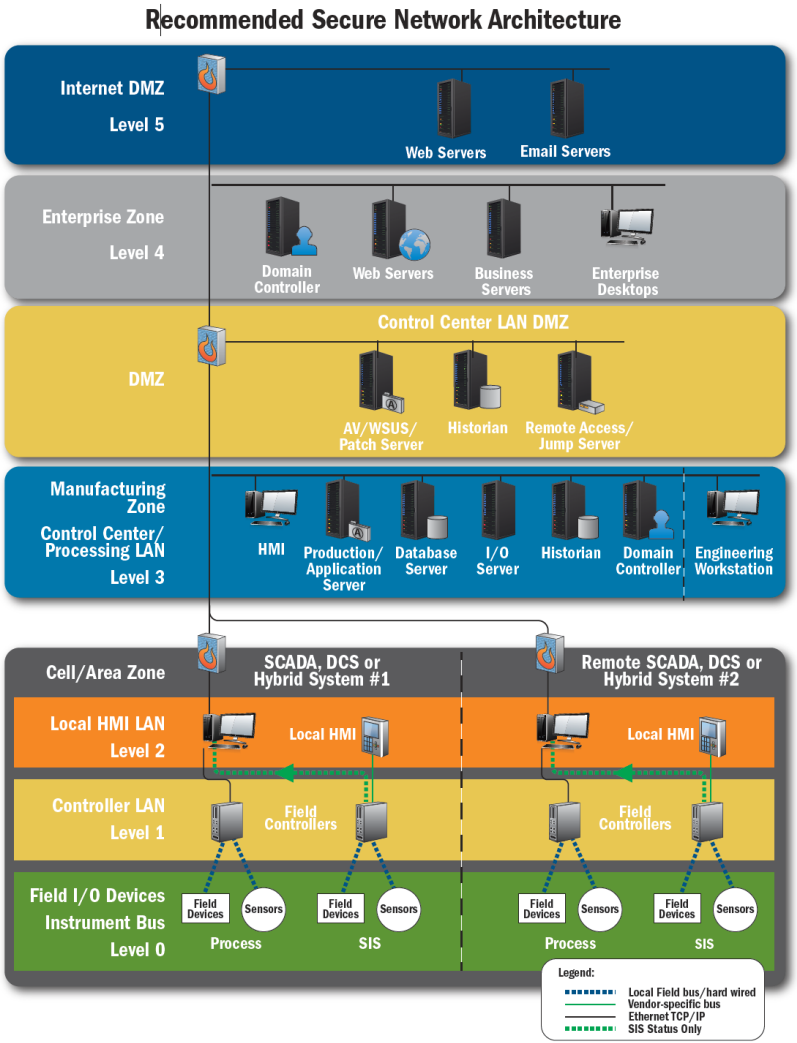


- Advance Distribution Management System (ADMS) conceptual design

Securing Control System Network

Purdue Enterprise Reference Architecture

IEC 62443 Zones and Conduits



- Recommended secure network architecture from DHS ICS-CERT Défense-in-Depth Recommended Practice

Conduit Devices between Zones

- Next-Generation Firewall
  - Application layer firewall
  - Packet inspection and control
- Unidirectional Gateway
  - Only support specific protocol

- **Challenges:**
  - Increasing number of required remote connection that required as part of Control System business process, e.g:
    - Field Crew access via public internet
    - IoT penetration that can help to gather more data
  - Increasing number of IT-based system integration, makes the “advance” conduit design more complicated

- *“Hard and crunchy on the outside, soft and chewy in the middle”*

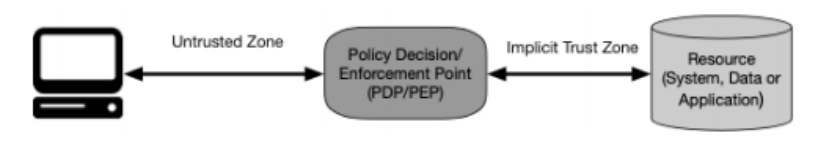
Zero Trust Architecture

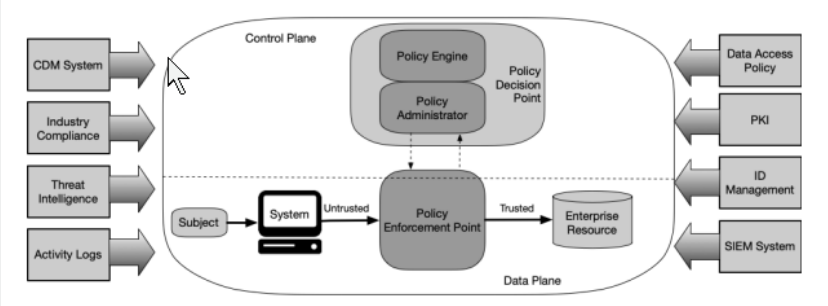
“A security model, a set of system design principles, and a coordinated cybersecurity and system management strategy based on an acknowledgement that threats exist both inside and outside traditional network boundaries”

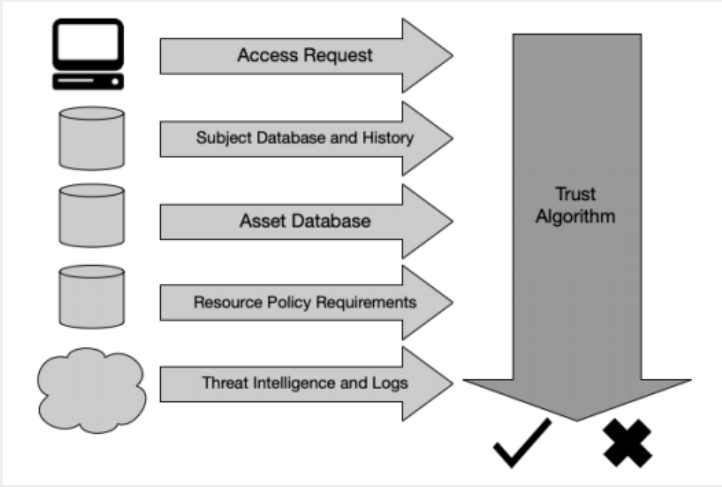
- US Executive Order on Improving the Nation’s Cybersecurity (May 2021)

- All data sources and computing power are considered resources
- All communication is secured regardless of network location
- Access to individual enterprise resources is granted on a per-session basis
- Access to resources is determined by dynamic policy – including the observable state of client identity, application/service, and the requesting asset – and may include other behavioral and environmental attributes
- The enterprise monitors and measures the integrity and security posture of all owned and associated assets
- All resource authentication and authorization are dynamic and strictly enforced before access is allowed
- The enterprise collects as much information as possible about the current state of assets, network infrastructure and communications and uses it to improve its security posture

Zero Trust Architecture
NIST SP 800-207







- Zero Trust Logical Component
- Trust Algorithm Input

Zero Trust Architecture

- Benefit
  - Eliminates implicit trust
    - Improve the scalability of the system and integration
  - Provide real-time assessment to determine access
    - Improve the security and limit the “lateral” attack

- Challenges
  - Introducing ZTA to a Perimeter-Based Architected Network will need additional efforts to identify assets, subjects, data flows and workflow

Nugroho Prananto Utomo

nugroho.prananto@dnv.com
+65 9771 9081

www.dnv.com


SPgroup