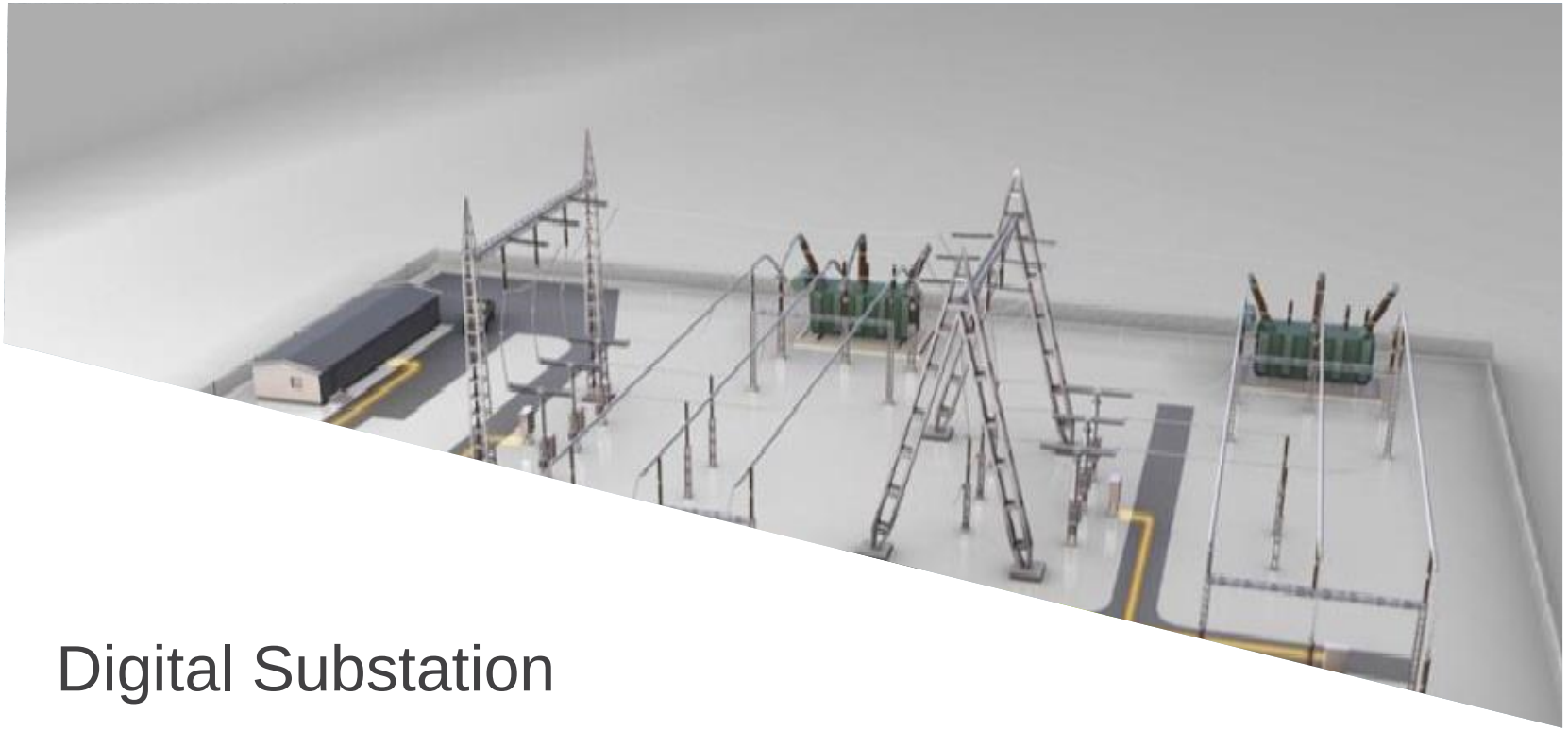


Digital Substation

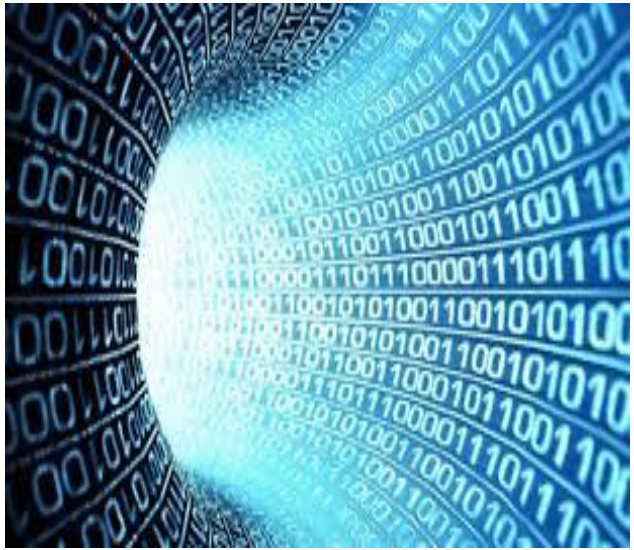
The Nordic Workshop in Power System Protection and Control

Eivind Norum
Trondheim, 23.5.2017

Statnett

Topics

- **Todays computerbased solution**
- **Digital substation**
  - What is it?
  - Key Aspects
- **R&D project**
  - The project team
  - Why digital substation in Statnett?
  - Challenges in new technology



Eivind Norum

- M.Sc from NTNU Electric power systems (Energi og miljø)
- Trainee in Statnett since august 2016
- Focus areas: Fault analysis, power system protection and control
- Currently working in the Digital Substation (DSAS) R&D project

Statnett

InnovativTeknologi
Innovative Technology

The R&D unit in Statnett

- Strategic tool to find a way for future corporate strategies
- Focus on improving safety, cost and time efficiency
- Estimated 861 million Euro in potential saving last 10 years
- Working with all parts of Statnett's organization. Involving 130 people (2016) to ensure right focus and easy implementation of new solutions and technology

Some of our projects and focus areas:


Voltage upgrading


Probabilistic security of supply


Full digital substation


Environment & Society


Next generation control center


Machine learning for system unbalances


Composite towers


Pre-fabricated steel foundation

www.statnett.no/en/Sustainability/RandD/

Colleagues in the digital substation project

Rannveig Løken –
Project manager

Nargis Hurzuk –
Project engineer

+ other internal resources from Drift og marked, IKT og Teknologi og utvikling

We are Building important competence for the future digital grid

Projects partners

Jacobsen Elektro
FOR ALL YOUR ENERGY REQUIREMENTS

sprecher automation

ABB

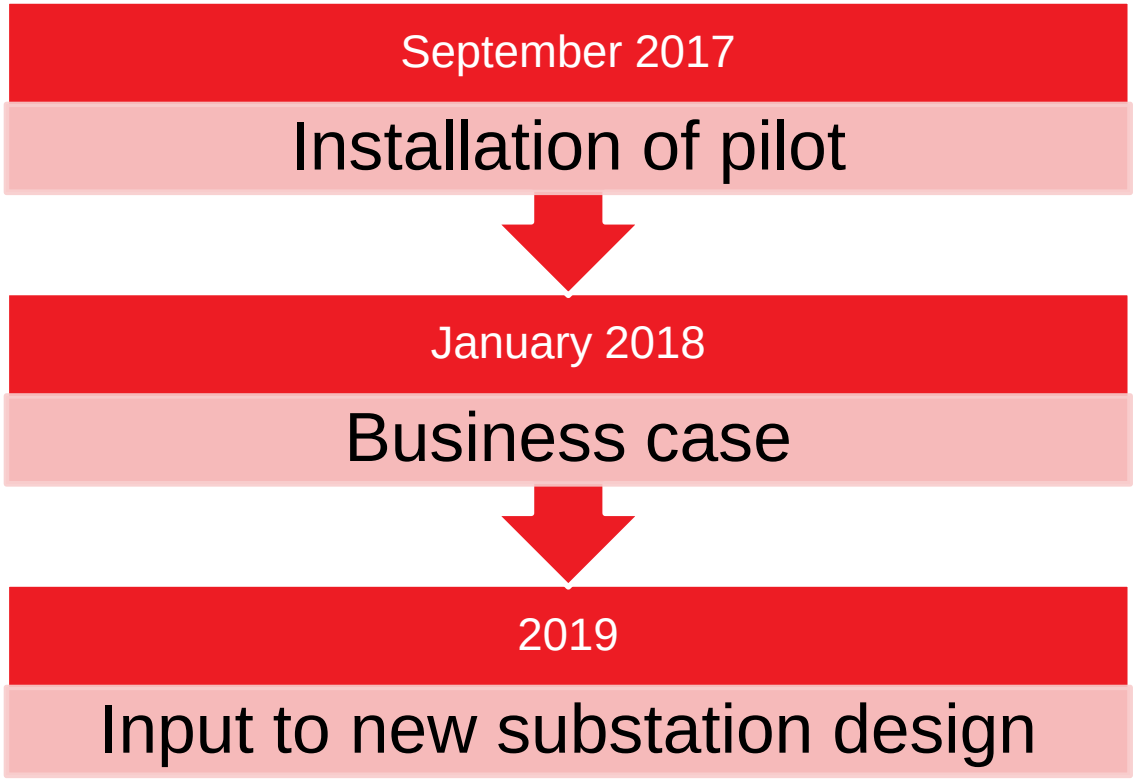
SIEMENS

arteche

Why digital substaion?

- HSE
- Cost
- Time
- Functionality

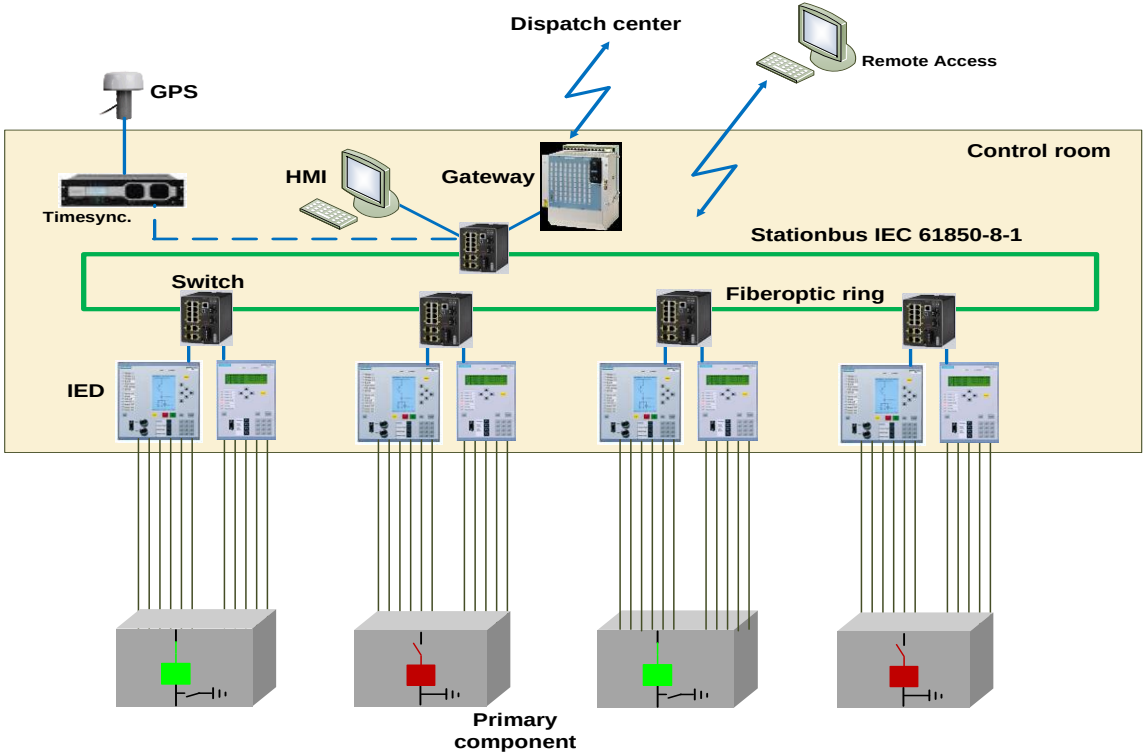
Project progress



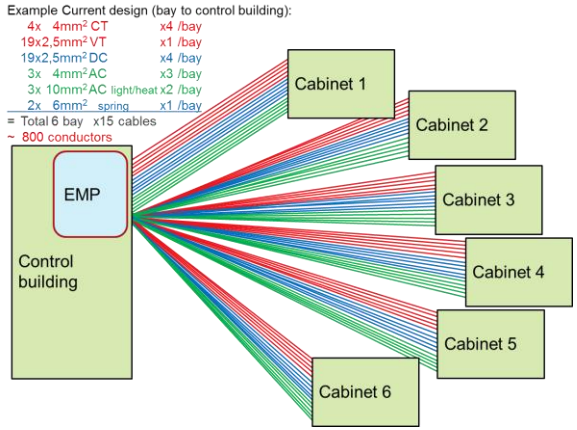
Some of the project objectives

- Gain experience from operation of digital substation pilot
- Develop next generation control system
- Develop collaboration between disciplines such as ICT and power engineering
- Develop competence
- Verify maturity of technology

Today's computer based solution in Statnett



Major Leap in communication design



Conventional design:

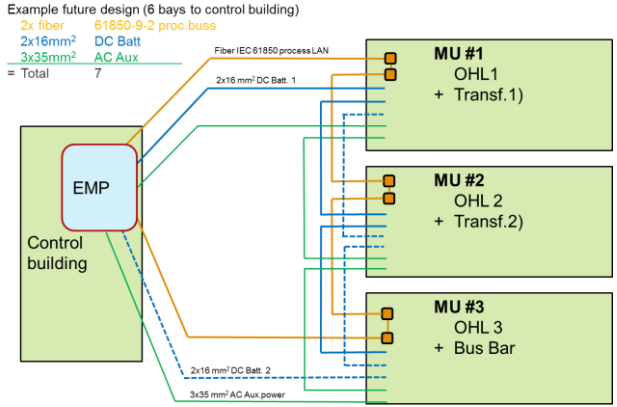
App. 800 power & signal conductors

- from bay to control room

Prosess bus: Maximum footprint reduction potential (Ring structure):

7 powercables & fibers

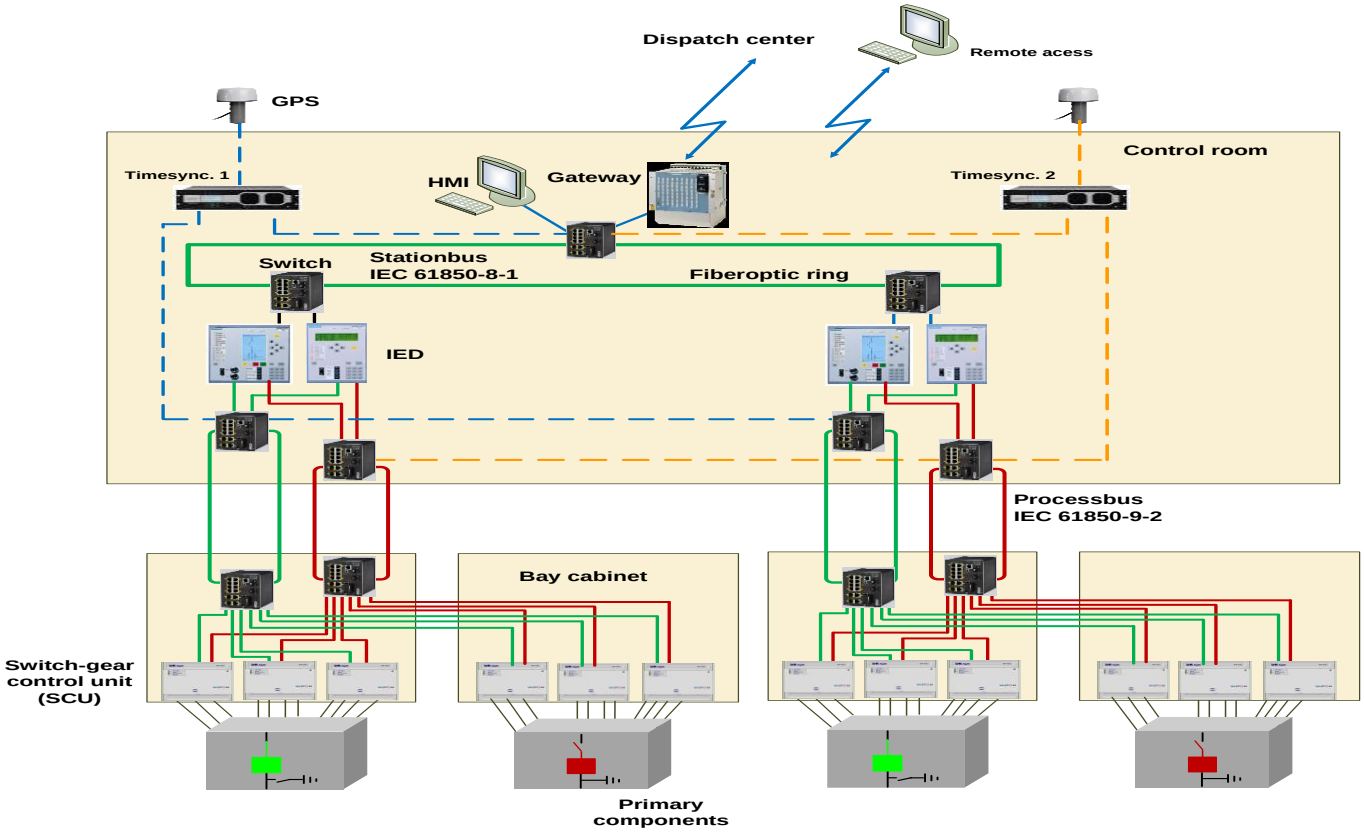
- from bay to control room



What is the essential of a digital substaion?

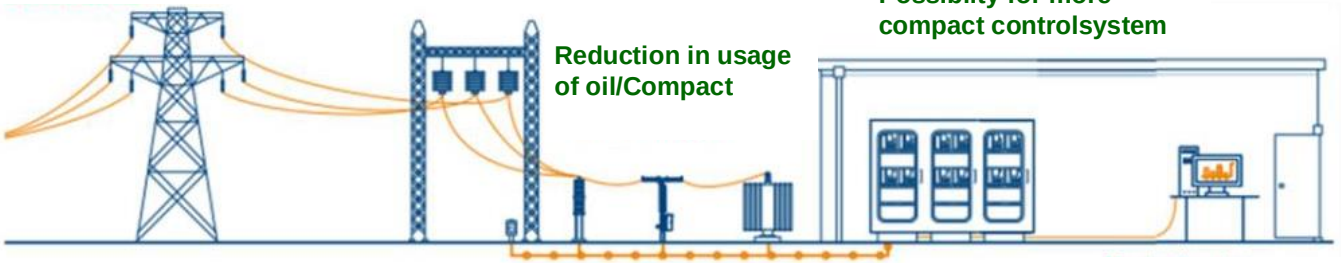
- All measuring is digitized *in* or *close to*
  the primary equipment in the bay – Sampled measured values (SMV)
- All breaker control commands and signals to/from the bay is digitized with process bus based on IEC 61850-9-2 - GOOSE

Digital substaion with process bus



Simplified section of conventional and digital station

Conventional Substation



Digital substation

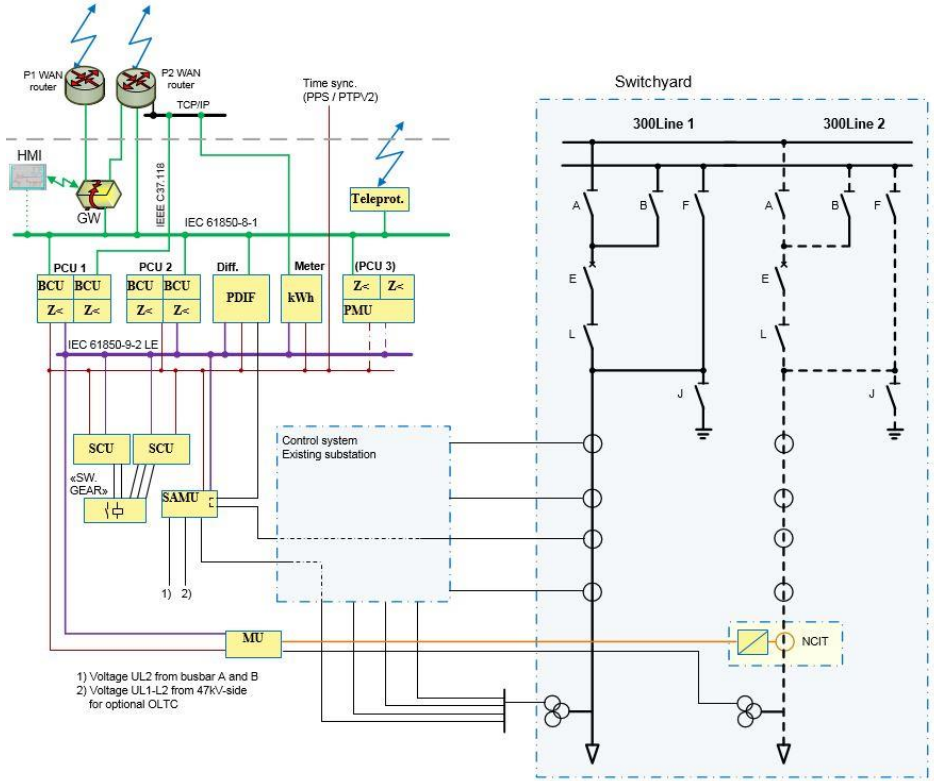
Reduction in usage of oil/Compact

Possiblity for more compact controlsystem

Reduction in usage of copper

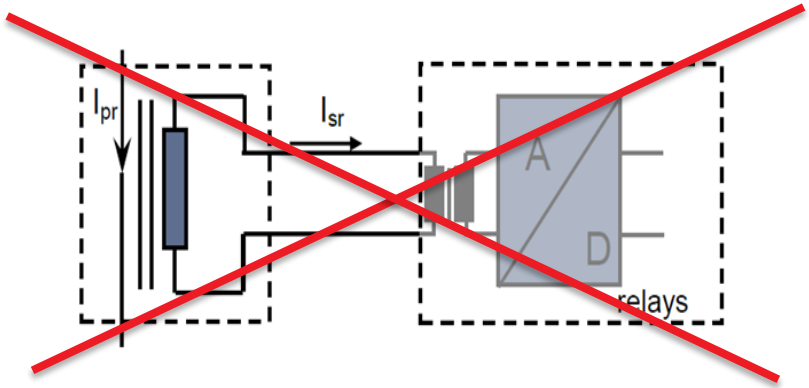
Reduction in substation footprint

Digital Substaion pilot



Digital Substaion pilot – some key aspects

- Protection and Control IEDs without Input transformers, low-pass filter, converter and binary I/O-compact
- Elimination of CT secondary circuits with NCIT
- Protection and control for more than line in one IED/protection relay



Process bus in digital substaion pilot

- Critical signals are digital
- GOOSE and sampled meassured (SMV) using IEC protocol 61850
- VLAN
- Time synchronization – PTP
- Redundancy - PRP
- IT security

Optical current transformer-NCIT

HSE:
Elimination of secondary current circuit

Optical sensor – faraday effect

Free of magnetic saturations effects

Lower weight -transport
Reduction in in usage of oil and gas- 80%

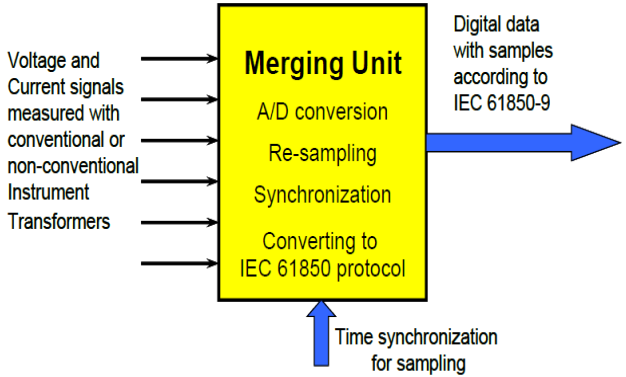
Reduced substation footprints

Merging Unit(MU)

From Optical/Analog to IEC 61850-9-2 (process bus)

Stand Alone Merging Unit(SAMU)

From Analog to IEC 61850-9-2 (process bus)



IEDs in the pilot (PCU1)

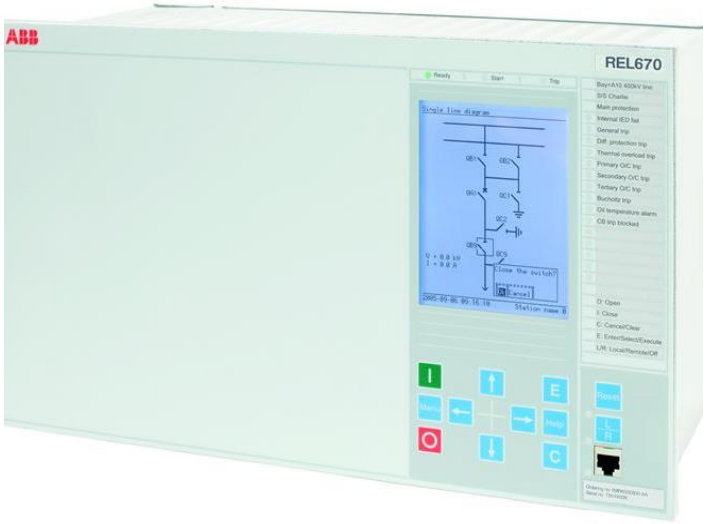
- Protection and control unit
- Distance protection for 2 lines
- Bay control unit (Objektmaskin) for 2 lines
- Autoreclosure (IKA) for 2 lines
- Fault and disturbance recorder for 2 lines
- All functions in one IED
- Based on 7SA87 -Siemens

IEDs in the pilot (PCU2)

- Based on SPRECON supplied by Jacobsen Electro/Sprecher Automation
- Industry based LINUX computer hardware instead of supplier IED
- Distance protection for 2 lines
- Bay control unit (Objektmaskin) for 2 lines
- Autoreclosure (IKA) for 2 lines
- Fault and disturbance recorder for 2 lines
- All functions in one IED

IEDs in the pilot (PCU3)

- Protection and control unit (PCU)
- Distance protection for 2 lines
- Fault and disturbance recorder for 2 lines
- Phasor measurement unit (PMU)
- Based on REL670 from ABB
- All functions in one IED



Pdiff. -DANEO 400

- Continuous comparison of currents from conventional and optical power measurement
- Fault and disturbance recorder

SCU- Switchgear Control Unit

- I/O for converting analog values to IEC 61850 telegrams
- I/O for converting IEC 61850 telegrams to analog values
- Fault and disturbance recorder

Publications

- NEF teknisk møte (may 2017)
- PAC world (june 2017)
- Cigre (august 2018)

Expected benifits

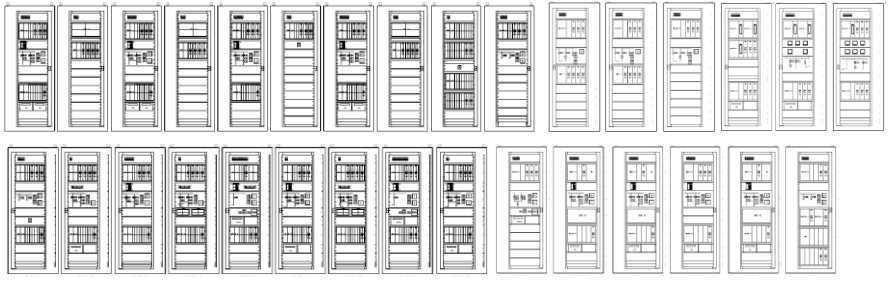
- Improved personal safety
- Reduction in cost connected to copper cables
- Reduction in cost for IEDs through omission of analog measuring inputs and binary I / O
- Takes less space both indoors and outdoors
- Reduced time required to build and test facility
- Greater degree of self-monitoring that provide better quality of utility
- Easier data retrieval from the primary facility for maintenance purposes
- Improved ability to perform remote access / remote diagnostics providing reduced operating costs
- Reduced electromagnetic interference due to transition to the fiber optic connectors

Some challanges

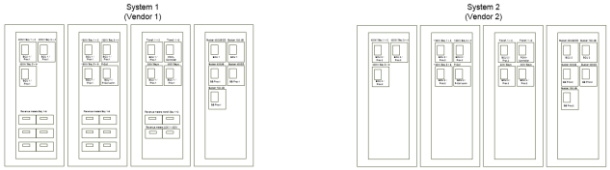
- Regulatory Compliance – Accredited measurement circuit control, EMP protection and demands for redundancy/duplication
- Climatic conditions / life of IEDs in the field, working out in the field
- Commercial availability of components (NCVT)
- Properties in protective function entrusted to NCIT?
- Interoperability between components of different vendors
- ICT security and control of accesses
- Competence building - Organization change
- Time synchonisation for SMV is crucial

Control system in digital substation – step 1 and 2

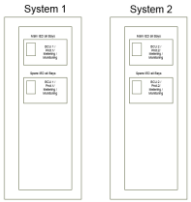
- Substation control system today



- **Digital substation Step 1** – Greater degree of integration –This R&D project



- **Digital substation Step 2** –Greater degree of integration –Future?



Questions?


Thank you for your attention!
The future is electric (and digital)