IEC 61850
ENGINEERING PROCESS
IN
OFFSHORE WIND FARMS

Saeed Nemati
27 September 2017
IEC 61850 in Offshore Wind Farms
About Dong Energy

- Main Business Units
  - Bioenergy & Thermal Power
  - Distribution & Customer Solutions
  - Wind Power

- Headquartered in Denmark
- Market Leader in Offshore Wind Power
  - 3.8 GW in operation
  - 3.6 GW under construction
DONG Energy activities

- Wind in operation
- Wind project under construction
- Wind project under development
- Heat and electricity generation
- Electricity generation, gas-fired power station
- Sale of power and/or gas
- Electricity distribution
- Inbicon bioethanol plant
- RENescience bio plant under construction
- Biogas plant under construction
- DONG Energy office

* Expected on stream in 2017
** Expected on stream in 2018
*** Expected on stream in 2019
**** Expected on stream in 2020

1) Nine central power stations in Denmark
Offshore Wind Farm
IEC61850 in Dong Energy Offshore Wind Farms – Part 1

- Different components: Bay Controller Units, Protection Relays, RTUs, SCADA Servers
- Multi Vendor Multi Edition
- Between Substations: Onshore Substation and Offshore Substation(s)
- Between different entities: Generating System Owner and Offshore Transmission System Owner

- Foundation of Communication: Optical Fibres in Export cables and Line of Sight (as backup)
GOOSE applications
- Only for Non-critical processes e.g.
  - Circuit Breaker Failure Protection
  - Cascade Tripping
  - Operational Tripping System
  - Fault Recorder Initiation
  - CB Close Lockout

WHY only non-critical?
- Proven reliability by hardwire signals
- Less dependent on O&M skills/knowledge
Design Issues – Two Entities in One Substation

- Two entities: Generating System Owner (GEN) and Offshore Transmission System Owner (OFTO)

- Requires two separate Substation Automation Systems (SAS) and two separate networks

- Means no GOOSE between OFTO and GEN or Using special switches/gateways to communicate ONLY GOOSE
Design Issues – One system covering several Substations

- Two or more substations in each wind farm

- Requires two or more SAS because
  - Independency between substations
  - Possibility for different divestment scenarios in future

- Results in two or more separate networks between substations

- Means no GOOSE between substations or using Routable GOOSE
Design Issues – Network Architecture: RSTP, HSR or PRP

- Preferred architecture is the combination of all
Design Issues – Remote Monitoring

- Remote connection or Web client

- Cyber security requirements
  - DMZ
  - Jump Host
  - VPN
  - User Management
  - …
Design Issues – Engineering Process

- Making a System Specification (= .SSD file) in text format
- Procurement
- Detail design in IED level and producing .IID files
- Integrating the IEDs in SAS using .IID files and a signal list
- Integration tests at one of the suppliers’ factory
- Modifications based on .IID files
Design Issues – Engineering Process (Bottom-Up Approach)

- **Advantage**
  - Possibility of late design freeze
  - More flexibility to work in parallel
  - No need for deep in-house knowledge
  - best practice (so far)

- **Disadvantage**
  - Higher probability for Interoperability problems
  - Specification in high level and not deep in details,
  - more dependency on vendors engineering knowledge,
  - more efforts in the interface management

- More freedom for Vendors!
Advantage
- Lower probability for Interoperability problems
- Specification in details,
- Vendor independent engineering
- Easier interface management
- Easier information exchange between projects

Disadvantage
- Lack of knowledge in vendors execution team
- Deeper in-house knowledge is required (both in execution team and O&M team)
- Immaturity in the market to understand the standard
The Way Forward…

- More training for vendors project teams
  - To understand the standard
  - To use the standard properly (e.g. right LNs instead of GGIO)
  - To accept .SCD file as input

- More training for O&M teams
  - To understand the standard
  - To understand the alarms
  - To be able to conduct a proper service and maintenance