

Automation of Power System Reliability: Remote Monitoring as Case

Abhilash Gopalakrishnan

Power Technologies R&D
ABB India Development Center
ABB Global Industries & Services Ltd.

Contribution to IEEE SRPSDVE Study Group
8 December 2014

Agenda

- Reliability: Power System Communication
- Can Monitoring be a case of SDN/NFV?
 - Remote Monitoring and Data Aggregators
 - Comparing with Industrial Ethernet-Managed Switches for Example

Reliability: Power System Communication



Wide Area Networks
Remote Control Center
to and from
Protection/Control Devices


MAIN GRID OPERATIONS

Field Area Networks
Distribution Management System




CONTROL CENTER

Home Area Networks
Customer Premises functions
E.g. , Automatic metering



Electric Meter

Measurement Systems & Networks
Wide Area Measurement(WAMS)
Automated Metering Infrastructure



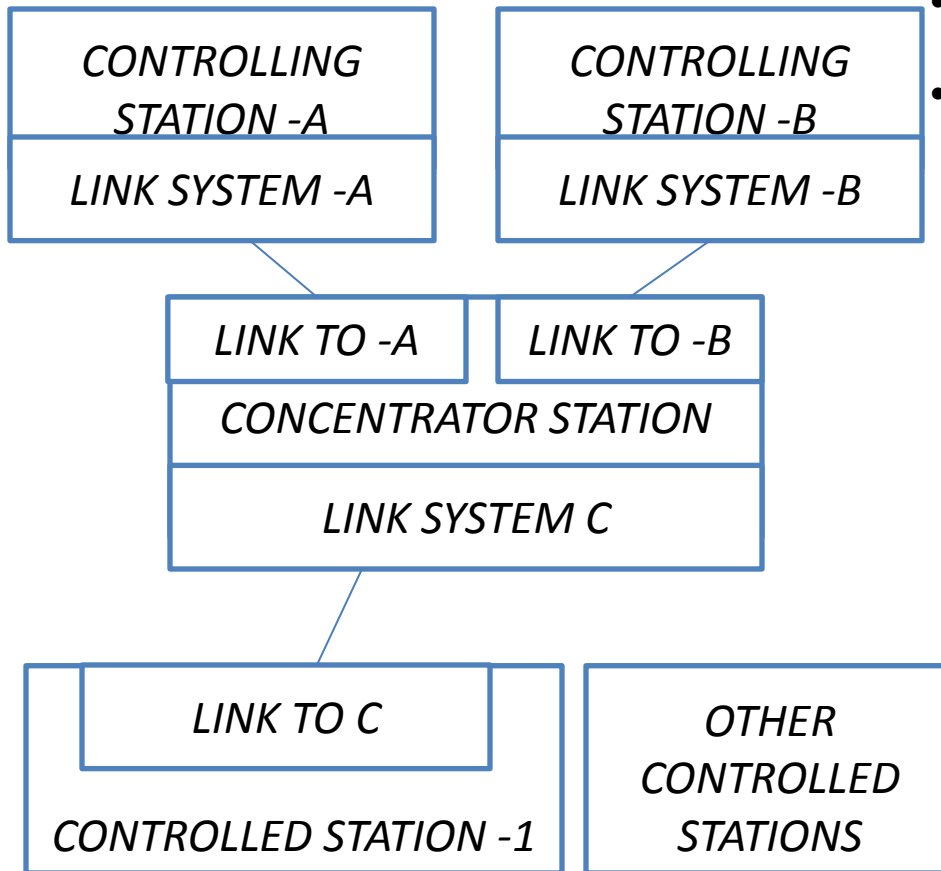
PMU
Electric Meter

Power System Functions can be classified as Protection, Control and Monitoring and based on IEEE Std. 2030-2011, Smart Grid Interoperability Reference Model States.

Type of Function	Protection	Control	Monitoring
Reach	2km	2km	2km
Data occurrence interval	Millisecond	Second	Second
Method of broadcast	All	Unicast	Multicast
Priority	High	Medium	Low
Latency	Low-Low (<3ms)	Low-Low (<3ms)	High (>160ms)
Synchronicity	Yes	No	No
Availability	High	Medium	Medium
Information reliability	Critical	Important	Important

Figure 1: Communication Aspects in Smart Grid

Can Monitoring be a case for SDN/NFV in Power System Communication



- IEC Standard 60870-5 (IEC 104) in particular discusses the functions supported by these aggregators.
- Data Concentrators/Aggregators in Power System Communication Networks could be seen as remote monitoring interfaces, which can possibly be the initial step to be approached for applying Network Functions Virtualization. This is due to the fact that achieving the QoS as well as redundancy can be handled here, especially in cases where the cost is as well important (for example in community grids). Functions done remotely include:

- Station Initialization
- Acquisition of Events
- Clock Synchronization
- Command Transmission
- Parameter Loading
- Test Procedure

Function	Quality Factor	Importance
Acquisition of Events	Visibility	High
Clock Synchronization	Quality of Control	High
Command Transmission	Quality of Control	High

Figure 2: Data Concentrator in Power System Communication

Reliability of the System need to consider Quality of Control and Visibility (Part of Dependability of System)

Comparison with Industrial Ethernet – Managed Switches

- As a measure of success the SDN/NFV based approach would be most probably compared with Industrial Ethernet equipment today.
- An Example of such a switch has:
 - Plug-n-play Turbo Ring (recovery time < 20 ms), RSTP/STP (IEEE 802.1w/D) for Ethernet redundancy
 - QoS, IGMP snooping/GMRP, VLAN, LACP, SNMPv1/v2c/v3, RMON supported
 - MTBF like , 392,000 hrs & 1,102,845 hrs
 - Some support IEEE 1588 for Time Synchronization

References

- [1] IEEE Std. 2030-2011 “IEEE Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), End –Use Applications and Loads”.
- [2] IEC 60870-5 Standards for Tele-control (supervisory control and data acquisition).
- [3] IEEE 1588 Precision Time Protocol.
- [4] NIST “Guide to Industrial Control System Security” U.S. Department of Commerce Special Publication 800-82, June 2011.
- [5] ABB Review – Special Report – IEC 61850 C. Nayar, “Innovative Remote Micro-grid Systems,” International Journal of Environment and Sustainability, vol. 1, no. 3, pp. 55–63, 2012.
- [6] Kryzysztof Iniewski et al “ Smart Grid Infrastructure & Networking”, Mc Graw Hill, ISBN-13:978-1-25-902939-4, 2012.
- [7] “Towards Comprehensive Modeling of Reliability for Smart Grids: Requirements and Challenges”, 2014, IEEE International Symposium on High Assurance Engineering.
- [8] NFV Requirements Drafts.
- [9] “Are we ready for SDN”, IEEE Communication Magazine, June 2014.

Thank you!

Questions & Discussion