SDN NFV Challenges Summary Power System Context

Abhilash Gopalakrishnan

Power Technologies R&D

ABB India Development Center

ABB Global Industries & Services Ltd.

Contribution to IEEE SRPSDVE Study Group

8 April 2015

Agenda

- Monitoring: Use Case1
- Context Setting: Microgrid
- Monitoring: Use Case 2
- Network as a Service : Use Case 1
- Focus of Standardization

Monitoring: Use Case-1

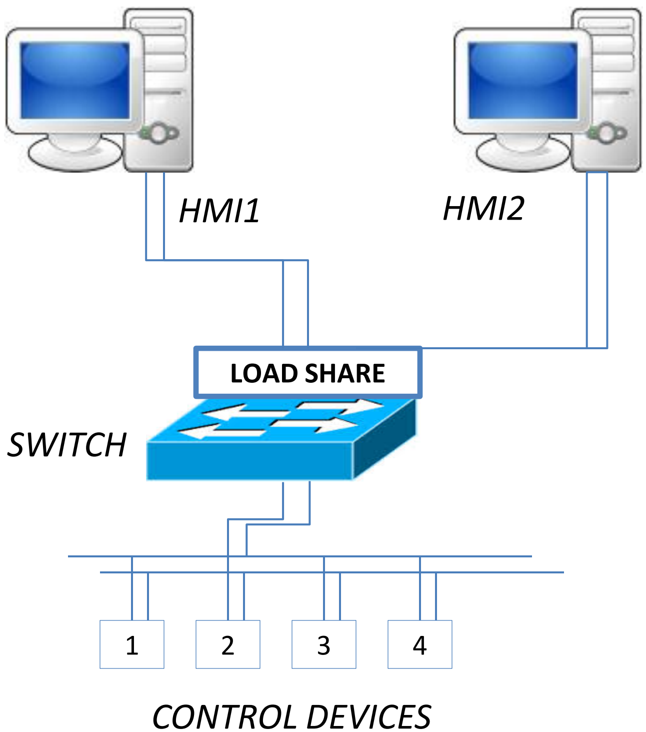

Figure 1: SDN Switch with Load Sharing as Network Function

Case: SDN Supported Switch with Virtual Network Function – Load Sharing to support Multiple HMI's running.

Description: Control Devices having field information related to Electrical System/Process would sent information related to Health, Control Signals, which are Periodic or Transaction oriented. A high-level picture of the traffic is shown in the table below. Multiple HMIs would require the data is sent based on how much load they can handle. Load sharing support can ensure intelligent availability of HMI (Visibility).

Data Type	Data Volume	Priority	Latency	Reliability	Interval
Control Signal	<100 bytes	Low	Low	Informative	ms
File	<1 KB	Medium	Low	Important	Seconds
Informational	<1MB	High	Medium	High	minutes
Network Protocol	>1MB		High	Critical	hours

Reliability of the System need to consider Quality of Control and Visibility

Context Setting: Microgrid

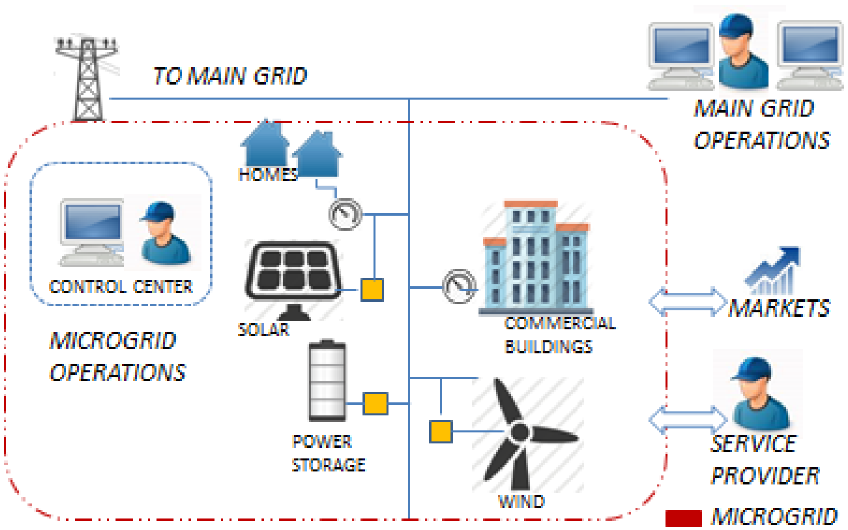

Figure 2: Microgrid And Interfaces

Comprise of distribution systems involving distributed energy resources (micro turbines, PV fuel cells, together with storage devices (flywheels) in order to satisfy the demands of energy consumers.

These systems can be operated in semi-autonomous manner if interconnected to the grid or in autonomous made (islanding mode) if disconnected from main grid.

The sizes and capacities of these systems vary from residential to campus or community wide systems.

Benefits could include microgrid providing an aggregation platform to handle the complexity of operation of the whole energy system, as well as reduced losses due to local consumption and mitigation of voltage variation. Benefits also include reduced peak shaving due to better scheduling, islanding in case of failure and features like Virtual Power Plants.

Monitoring: Use Case 2

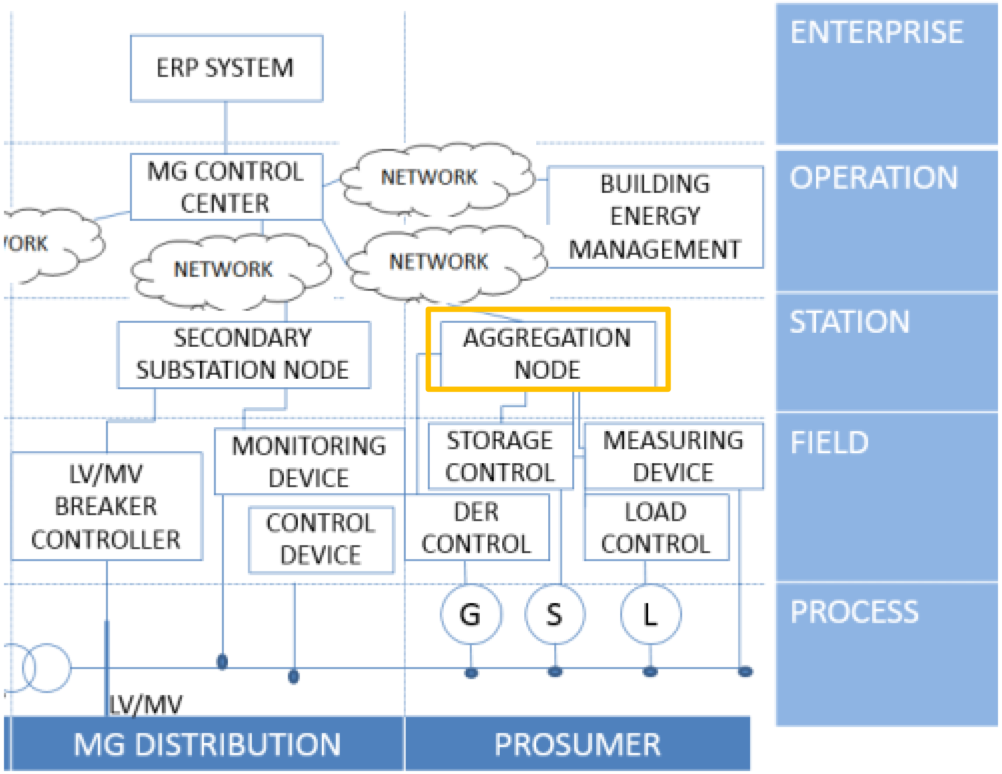

Figure 3: Data Concentrator/Aggregator in Microgrid Communication (Aggregation Node highlighted)

Case: Data Aggregator plus Protocol Gateway as Virtual Function supporting remote protocol gateways in Microgrid to Overlay grid Control Center.

Description: Functions done remotely include: Station Initialization, Acquisition of Events, Clock Synchronization, Command Transmission, Parameter Loading, Test Procedure. QoS overview can be found in the table below.

Function	Data Volume	Priority	Latency
Safety Critical	<1500 bytes	High	<10-100ms
Monitoring	<100 Kbps	Medium	<1s
Background	Best effort	Low	Best effort

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

Network as Service: Use Case 1

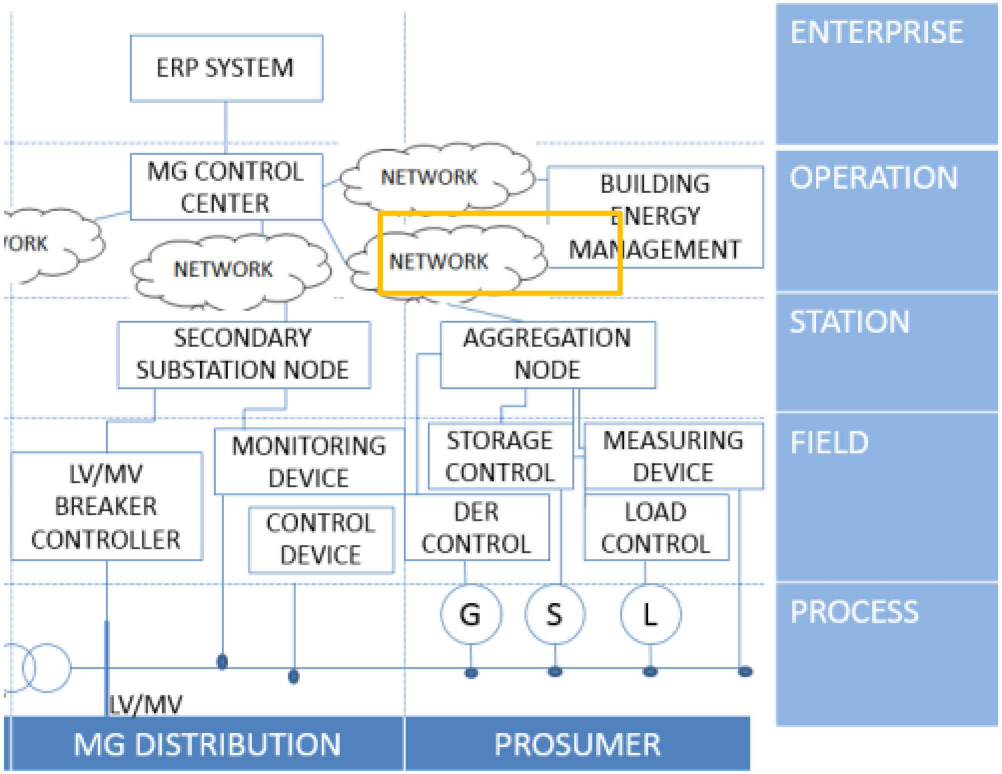

Figure 4: Communication Network Infrastructure connected to Microgrid (Can be virtualized)

<u>Case:</u> The network connecting aggregation node to the Control Center networks can possibly be using virtual network infrastructure as to reduce cost.

<u>Description:</u> Microgrid can be in islanded – disconnected from main grid and in autonomous modes. The communication happening across control center and the aggregation node is mostly okay with fault tolerance and not high on reliability.

Possible Support: Recovery time <20ms - 100ms, RSTP/STP for Ethernet redundancy, VLAN and support for SNTP as Time protocol.

Focus of Standardization

- **Reliability**
  - Most of these cases involve Fault Tolerant System architecture (i.e., more focus on availability - 99.999%).
  - Unplanned failures but should get repaired in timeframes ranging from 20 ms to 100 ms. Recovery or resilience using possibly checkpoint based on forward recovery schemes.
  - Failure isolation instead of failure leading to system failure.
  - Isolated redundancy, which allows failed component to be repaired when the rest of system continues to function and concepts like primary and backup can test each other.
  - Heartbeat and the concepts need to be standardized.
- **Network Planning and Deployment**
  - The fidelity of the systems used for testing could be good to be defined. Today, we have varied platforms ranging from python-based to C/C++ and haskel-based. Based on a defined environment, some guideline would be beneficial.
  - Deployment of domain-specific communication stacks and ability to ensure their reliable running by monitoring could be a focus area.

References

[1] S. Bukowski, S. J. Ranade, “Communication Network Requirements for the Smart Grid and a Path for an IP Based Protocol for Customer Driven Microgrids”, Energytech, 2012 IEEE.

[2] vConductor: An Enabler for Achieving Virtual Network Integration as a Service, IEEE Communications, Feb 2015.

[3] C. Nayar, “Innovative Remote Micro-grid Systems,” International Journal of Environment and Sustainability, vol. 1, no. 3, pp. 55–63, 2012.

[4] Kryzysztof Iniewski et all “ Smart Grid Infrastructure & Networking”, Mc Graw Hill, ISBN-13:978-1-25-902939-4, 2012.

[5] SDN/NFV Requirements Drafts.

Thank you!

Questions & Discussion