HITACHI
Inspire the Next

Hitachi Energy

cigre | PARIS 2022

Study Committee B5

SC B5 – Protection and automation

10675

Virtualization as an enabler for digital substation deployment

Peter Kreutzer, Julio Oliveira, Vladimir Nogueira

Hitachi Energy Switzerland and Brazil, Qair Energy Brazil

peter.kreutzer@hitachienergy.com

Motivation

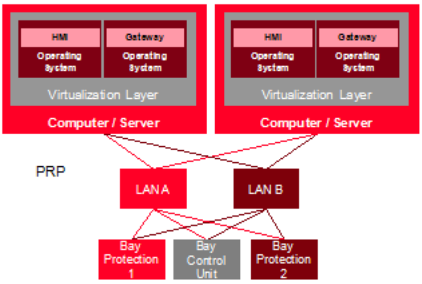
The operation technology separated from the IT related parts of the substation infrastructure. Utilities face the following challenges with these architectures:

- Vastly growing complexity of OT/IT system on station level
- Huge amount of interface wired connected from process large spending CAPEX/OPEX
- Long delivery time of projects related to complex interfaces, lack of standardization, time consuming design, testing, installation commissioning
- Large footprint due to large amount of separated system and Limited monitoring capabilities of the primary assets lead to unknown asset health condition and unnecessary maintenance efforts
- Box per function philosophies leads to big variations and large inventory on spare parts
- Testing of control and protection exposes service engineers to high risk, e.g.: open Current Transformers, high voltages from process cables
- Increasing demand for cybersecurity for OT infrastructure to comply to regulation

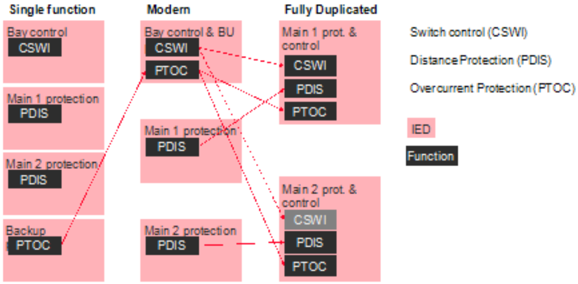
Method/Approach

- Implementing the virtualization and functional integration can be applied in different ways.
- 3 step approach to gradually achieve a better functional decomposition by means of virtualization and functional integration

1 Reference architecture for digital substation station level virtualization



2 Functional integration of bay level functions



http://www.cigre.org

Study Committee B5

SC B5 – Protection and automation

10675

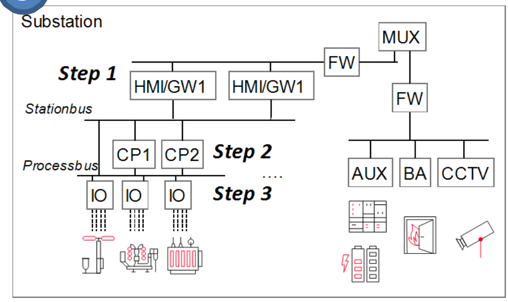
Virtualization as an enabler for digital substation deployment

Peter Kreutzer, Julio Oliveira, Vladimir Nogueira

Hitachi Energy Switzerland and Brazil, Qair Energy Brazil

peter.kreutzer@hitachienergy.com

3 Decoupling I/O

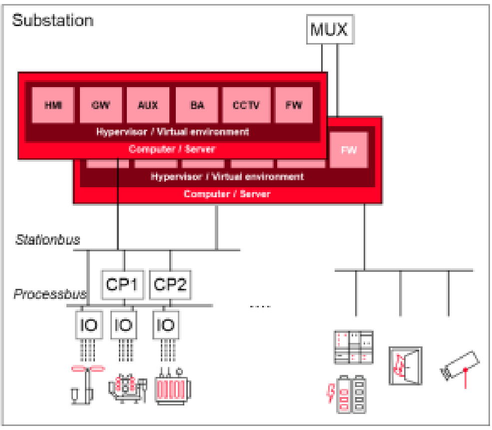


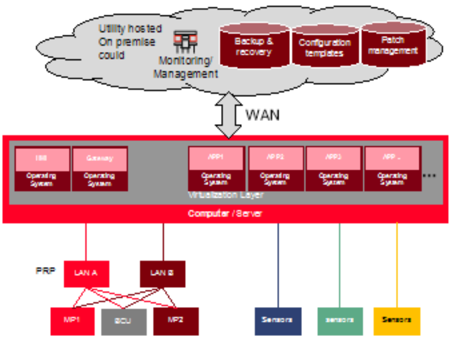
MUX	Multiplexer
FW	Firewall
HMI	Human Machine Interface
GW	Gateway
CP	Combined control and protection IED
IO	Processbus I/O IED
AUX	Auxiliary system
BA	Building Automation
CCTV	Closed Circuit Television

- This new architecture brings the following advantages and benefits:
- Decoupling IO from the control and protection, leads to increase safety and easier replacements of bay level functions.
- Reduce hardware variants for control & protection, leads to reduced design time and amount of spare parts
- Reduce bay level application by duplication of applications, leads to reduced testing
- Increase availability by functional integrating of control and protection
- Reduce station level hardware by functional integration of Human machine interface and gateway leads to reduced design and testing time and amount of spare parts

Further integration

- Integrate the additional station level functions in virtualization platform will reduce hardware on station level and leads to reduced amount of spare parts
- Virtualization increases availability and reliability of integrated functions by clustering
- Central management of the virtualized application on enterprise level with remote deployment of changes
- Easy deployment of future functions on station level
- Easy backup and recovery when system fails of need roll back
- Easy patch management on the virtualized applications





Study Committee B5

SC B5 – Protection and automation

10675

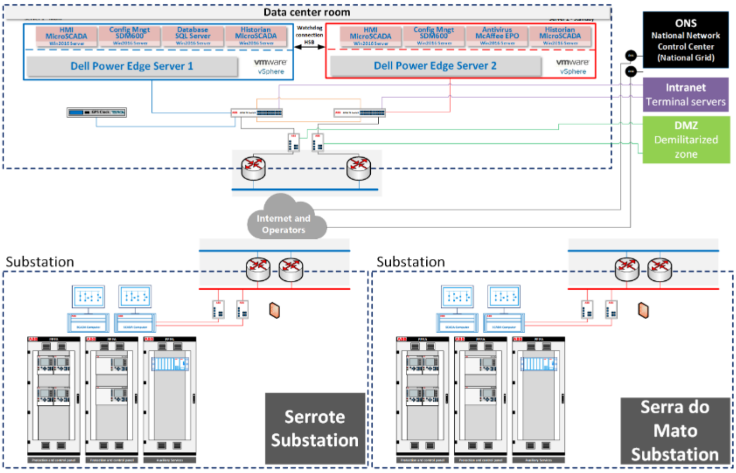
Virtualization as an enabler for digital substation deployment

Peter Kreutzer, Julio Oliveira, Vladimir Nogueira

Hitachi Energy Switzerland and Brazil, Qair Energy Brazil

peter.kreutzer@hitachienergy.com

Use case: Qair Brazil Network Control Center for renewables



Process	Functions involved	Measured time
Application startup	▪ Application moves from cold to hot state ▪ Communication established (all protocols) ▪ Database updated (valid datapoints) ▪ HMI signaling updated ▪ SOE & alarm lists ready ▪ HMI ready to operate ▪ Operation consoles ready	Approximately 95 seconds Considering an application over 30.000 datapoints. Additional information: On an application of a Level 2 SCADA installed in a industrial computer with a non-virtualized approach and with 2500 datapoints, the average times for such process was 60-65 seconds.
Hot-standby switchover	▪ Server 1 in hot state, server 2 in standby ▪ Server 2 in hot state, server 1 in standby ▪ Switchover on both directions (failure sim.)	30-35 seconds until the application is ready to operate Additional information: This is the same result observed with two industrial computers with Level 2 SCADA applications (non-virtualized)
Application shadowing	▪ Server 1 in operation ▪ Server 1 sends the application to Server 2 ▪ Server 2 assigns the standby state	70 seconds Additional information: There's a watchdog dedicated Ethernet interface on both servers dedicated executing such function and monitoring of hot-standby mechanism.

Conclusion

- Virtualization is a technology that offers many benefits to counter today's challenge of utilities.
- A pathway to introduce functional integration and virtual environments in digital substation and envision many potential benefits that can be achieved with the new concepts.
- Introducing the new concepts will requires deep domain knowledge and design consideration of the operation technology to ensure that mission critical applications are not compromised availability, reliability and performance. First tests been having proven that the benefits can be achieved.