Analysis of an Offshore Medium Voltage DC Microgrid Environment – Part II: Communication Network Architecture

Velin Kounov, David Tipper
Brandon M. Grainger, Gregory F. Reed

University of Pittsburgh
Pittsburgh, PA USA
Electricity Chasing Electricity

Telecommunication Subsystem

Time

1s 100ms 10ms 1ms

.001 .01 .1 1 10 10^2 10^3 10^4 ... 10^6

Power Frequency (Hz)

Harmonics

Electromechanical Phenomena

(Power System Control & Dynamics)

Electromagnetic Phenomena

(Transients & Surges)
Microgrid Communication Challenges

Fundamental Requirements of Microgrid

- Capability of operating in islanding and/or grid connected modes with high stability
- Mode switching with minimum load disruption and shedding during transitions
- After a transition, stabilize in a certain amount of time

Challenges of Microgrid Communication

- Real-time communication (IEC 61850)
- Secure real-time communication (IEC 62351)

Research Challenges of Microgrid Communication

- Limited hardware performance - 600 MHz processors
- Extremely long life-time of equipment - measured in tens of years
- Wide-area communication with high-availability (99.999%)
- Scalable secure communication - broadcast, confidentiality, authentication
DC Microgrid

- 5 MW Supply (PMSG Based)
- AC/DC Three Level Multilevel Rectifier (NPC)
- DC/DC Converter
- DC/AC Three Level Multilevel Rectifier (NPC)
- Diesel Generator
- Voltage Regulator
- AC Cable
- MVDC Collection Platform

Off-Shore Wing Generation

IEEE PES
Power & Energy Society
Delay, Availability, Security and Scalability

Delay
- Within microgrid: less than 1 micro-sec per single link
- Outside the microgrid: ~5-120 micro-sec per single link

Availability
- Within microgrid: ~0.9999 per single link
- Outside the microgrid: ~0.6-0.999 per single link

Security
- 1000 packets/sec, 600 MHz IEDs, 1Gbps links
- Multicast communication with individual signatures
- End-to-end delivery within 3ms
- Scalable for up to more than 300 receivers
Concluding Remarks

- Power network vs communication network
- Microgrid communication architecture was presented
- The challenges of delay and availability were discussed
- The challenges of security and scalability were discussed
- Please see you at the poster session
Contact Information

Dr. David Tipper
Associate Professor and Director
Graduate Telecommunication and Networking Program
School of Information Science
University of Pittsburgh
E-mail: dtipper@pitt.edu

Velin Kounev
PhD Candidate
School of Information Science
University of Pittsburgh
E-mail: vkounev@pitt.edu