

Microgrid Operation and Protection

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by

S. S. (Mani) Venkata
Alstom Grid Inc.

Tel: 520-820-8005 (cell)

E-mail: mani.venkata@alstom.com

Outline of Presentation

- Definition and concept of microgrid
- Microgrid operation and control
- Current schemes for microgrid protection
- Modern schemes for microgrid protection
- Conclusions

Microgrid Operation

- Stand alone operation, not ever connected to the larger grid
- Statically connected to the legacy system
- Dynamically connected to the legacy system
 - Grid-connected mode
 - Islanded mode
- Localized controller for DER dispatch

Microgrid Concept

- Section of distribution system
- Contains multiple Distributed Energy Resources (DER)
 - Controllable loads
 - Storage systems
 - Distributed Generation (DG)
- Seen as an aggregate source or load by the system
- Can be dispatched if seen as source
- Less than 100 MVA capacity
- Usually connected to the primary or secondary distribution system depending on the capacity

Potential Microgrid Protection Schemes

- Microgrid trips offline with the grid
 - Advantages
 - Least expensive
 - Easiest to implement
 - Disadvantages
 - No additional reliability benefits
 - Provides overcurrent and overvoltage protection per IEEE 1547 Standard
- Island the microgrid during a grid fault
 - Advantages
 - Additional customer reliability
 - Disadvantages
 - More expensive
 - Requires adequate protection of islanded microgrid

Protection Issues with Microgrids that can Island

- If microgrids can island and reconnect with the system no legacy protection system is adequate because of:
 - Extremely large variation of load and fault currents between grid connected and islanded modes
 - Bidirectional line flows of current depending on the operating state
- New protection paradigms are therefore required for islanding microgrids

Two Protection Philosophies

- Trip microgrid offline with detection of any fault when islanded
- Trip faulted line to continue microgrid operation
- **Advantages**
 - Increased reliability, especially for loop connected microgrids
- **Disadvantages**
 - More Expensive
 - Coordination may be difficult
- **Challenges**
 - Distributed sources
 - Fault current limit of inverter based sources

Communication Assisted Microgrid Protection Schemes

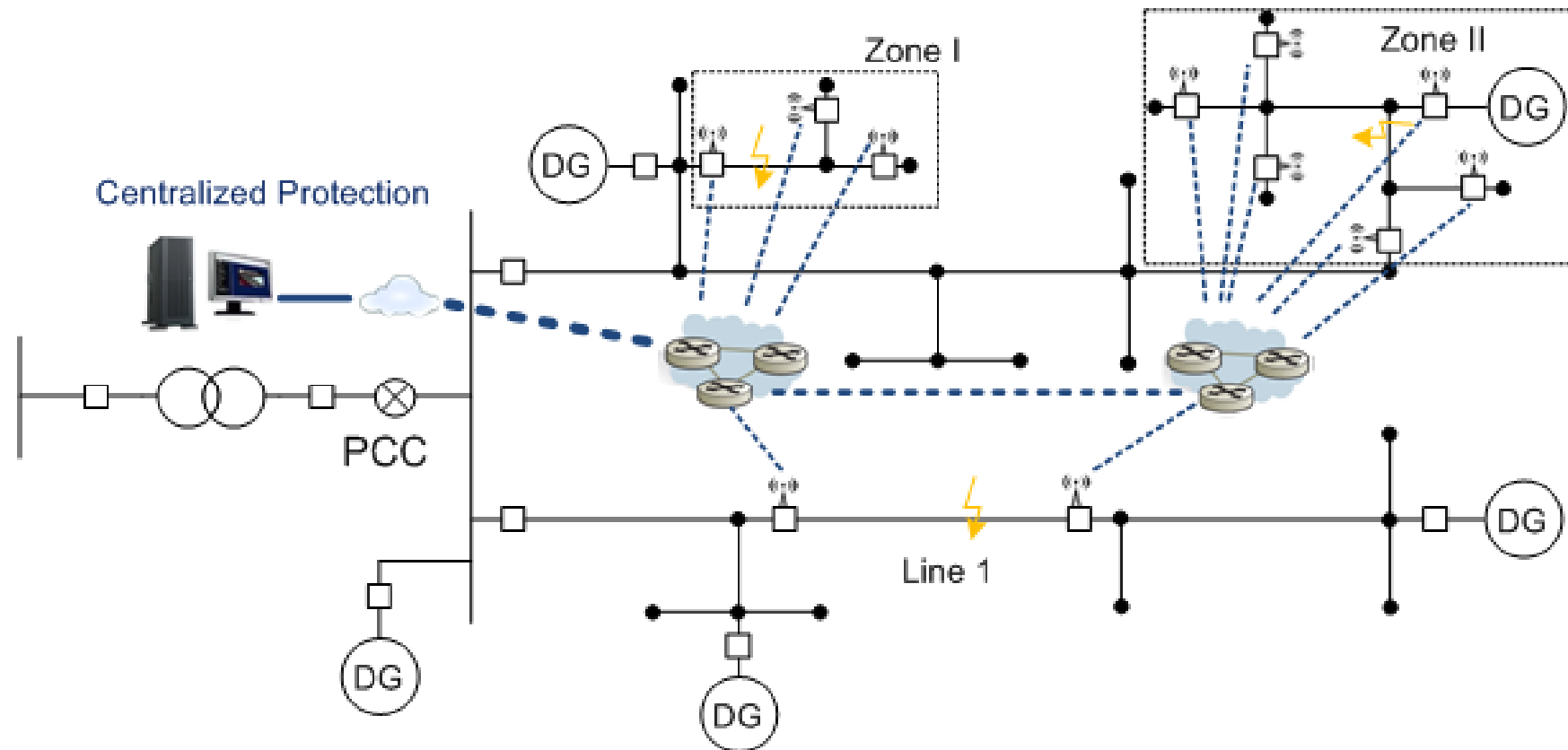
- Differential protection on every line
 - Uses digital relays on the end of each line segment for detection and isolation
- Differential zones using sensors and breakers
 - Can use PMUs or other sensors
- Other centralized protection schemes using PMUs
 - Can be used for unit or zone protection

Optimization of Sensor and Breaker Placement

- Because of the tradeoff between costs of protection equipment and customers effected an optimization can be formulated
- The objective is to minimize the total cost of the protection system:
 - Capital costs from equipment
 - Customer costs from outages

A Centralized Protection Scheme Using Synchronized Measurements

For Unit or Zone Protection



Thank you!

Questions?

S. S. (Mani) Venkata
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Tel: 520-820-8005 (cell)
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