

# GridNode Interconnection Protection Solutions

GE's GridNode interconnection protection solution, provides network interconnection protection for transmission utilities and operators of interconnected networks. Based on GE's proven System Integrity Protection Schemes (SIPS), these automated solutions delivered through validated application function blocks provide operators with real time actions, visibility and advanced notifications of impending interconnected network separation. Within these solutions GE will provide complete system analysis, scheme development and validation testing to deliver an operational system.

## Interconnection Challenges

Losing a major transmission line or a load in a network can result in excess generation causing over voltage, over frequency or send too much generation and overload the interconnection between two networks. In the same way, losing a major generation source in a network can result in a lack of local generation causing under frequency, under voltage within a network or draw too much generation and overload the inter connection between two networks. Additionally, large disturbances in a network can cascade to the interconnected network causing inter-region oscillations which if grow big enough, can cause both the interconnected networks to collapse. Utilities need to have plans in place to address these disturbances in the network to prevent them from cascading and causing all the interconnected networks to collapse.

## GE's System Integrity Protection Schemes

GE offers two approaches for reducing instabilities and overloads on interconnected networks to provide safety and reliability to these networks. These approaches may be combined or used separately.

- **Contingency action solutions**
- **Detection and dampening of system oscillations**

The contingency action solutions detects network disturbances and either sheds load or drops generation across the network, to prevent overloads and instabilities in the interconnected network. Similarly, detection and dampening solution will detects inter-area oscillations, takes actions to dampen the oscillations and if necessary, trip the interconnections to prevent networks from collapsing. Systems Integrity Protection schemes (SIPS) based functions are used in both the solutions for detecting network re-configurations and oscillations and for taking control actions to mitigate these effects.

## Key Benefits

- **Improves system stability** – enables interconnection of two power systems for sharing of excess generation.
- **Enhanced reliability** – prevents instabilities from cascading to other parts of the interconnected networks.
- **Enables more renewable energy integration** – detects and prevents small signal oscillations associated with integration of these new energy resources.



## Contingency action solutions

- Detect disturbance and interconnection overloading
- Load shedding / restoration
- Generation dropping
- Interconnection cut off

## Detection & dampening of oscillations

- Detect inter area oscillations
- Trigger network dampening circuits
- Temporary shed network loads
- Temporary drop generation
- Trip interconnect if above actions cannot stop oscillations

## Proven SIPS algorithm

- Automated network protection solutions
- Typically 250 milli-second response time
- Supports complex network topologies
- Notification to operator of SIPS actions
- Balances load vs generation upon disturbance situation
- Advanced visualization tools and HMI for operator interface

## GE's solution includes

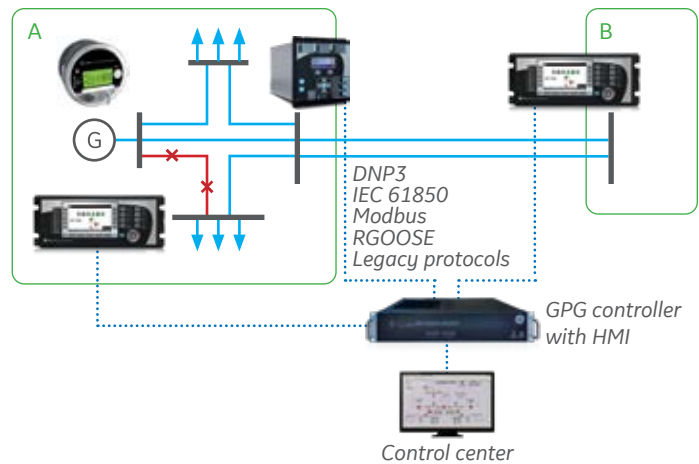
- System modeling
- Contingency action development & test
- Oscillation dampening response development
- Hardware
- Validation & verification of application
- Bi-annual system model review

## Contingency action solutions

GE's contingency action solution measures the power flow at key points in the network, detects disturbances in the network and takes action to stabilize the load and generation across the network.

### How the solution works

- Detect major changes in any of the connected networks (faults)
- Measure overload in interconnect and associated voltage and frequency changes
- Shed load to reduce load on interconnect
- Drop generation to reduce overvoltage, over frequency
- Trip the interconnect if required
- Automatic actions under 250 milliseconds



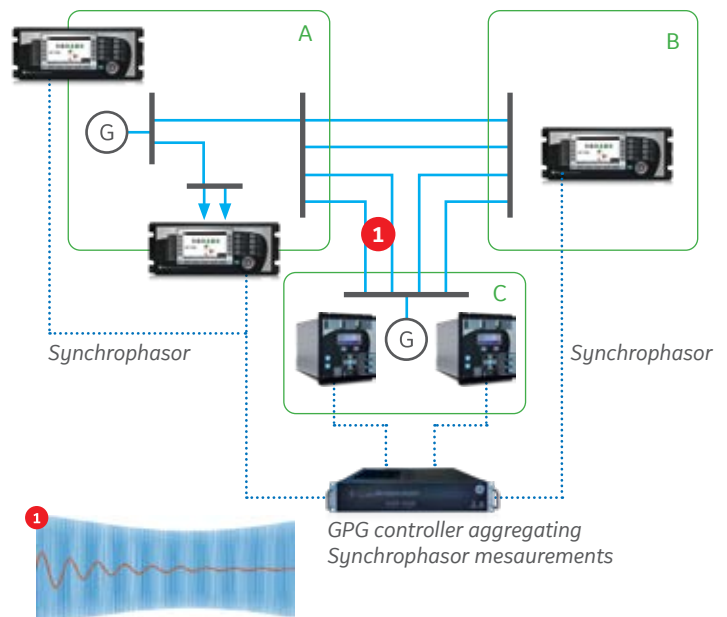
Intelligent monitoring devices put across the networks connected centrally to GridNode controller to execute contingency actions

## Detection and dampening of system oscillations

Using Synchrophasor, GE's oscillation detection and dampening solution measures the power flow across the interconnect and detects network oscillations. When it is determined these oscillations will not heal itself, the solution will attempt to dampen the oscillations and if needed trip the interconnect.

### How the solution works

- Detect prolonged/growing interconnect oscillations
- Trigger network damping circuits such as Power System Stabilizers (PSS) to dampen oscillations
- Temporary shed load to dampen large oscillations
- Temporary drop generation to dampen large oscillations
- Trip the interconnect
- Millisecond to second response time



PMU's detecting oscillations put across the networks connected centrally to GridNode controller to trigger dampening actions

## Solution development process

The process involves following a fixed project lifecycle as briefly summarized below:

1. Determine and define the system configuration, involving simulations of the power network.
2. Design and implementation SIPS based solution
3. Develop technical solution and system architecture including protection relays with PMUs, phasor data concentrator, communications network.
4. Collect and process real system data.
5. System validation and verification.
6. Simulate power network in RTDS and run multiple simulations over the design to validate solution.
7. Factory acceptance tests and commissioning



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