The Use of VSC-Based BtB as Grid Shock Absorber

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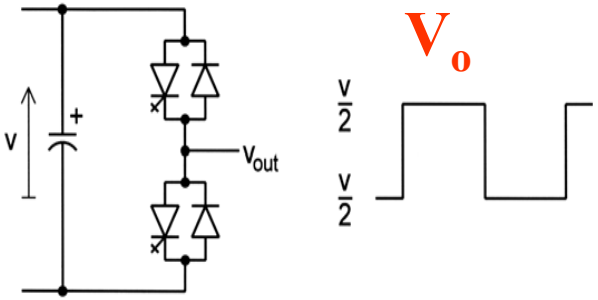
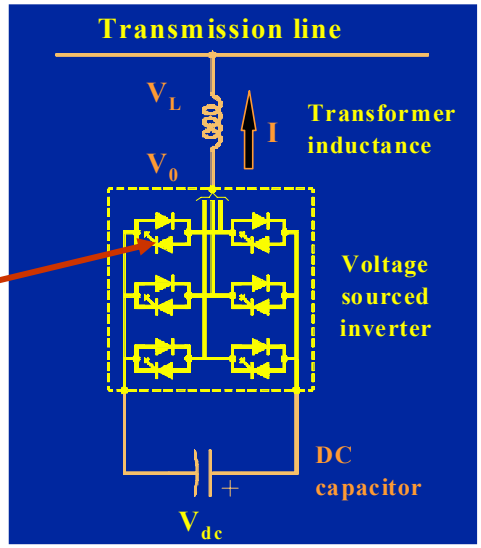
Voltage-Sourced Converter

"A Building Block for New Transmission Controllers"



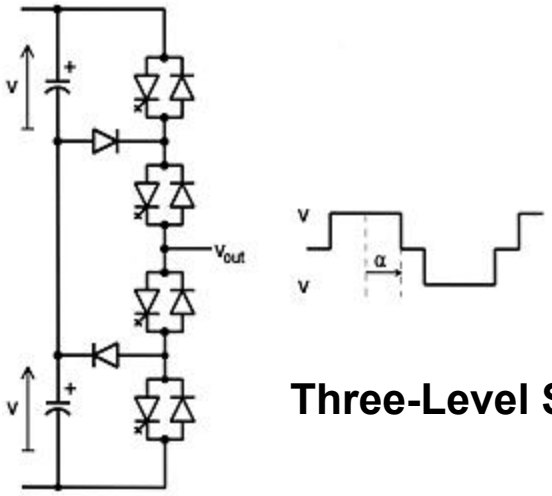
Gate Turn Off Switch

GTO, GCT, IGBT

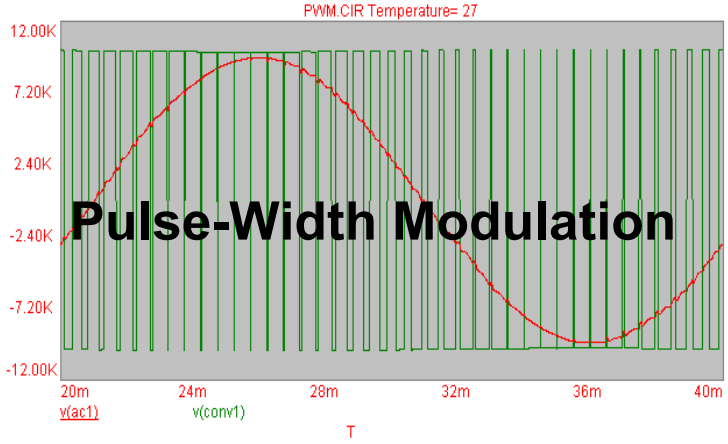


Voltage source converter with controlled output voltage

If $V_L = V_0$, I = 0
If $V_L < V_0$, I = capacitive
If $V_L > V_0$, I = inductive

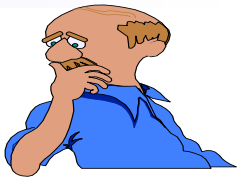


Three-Level Switching

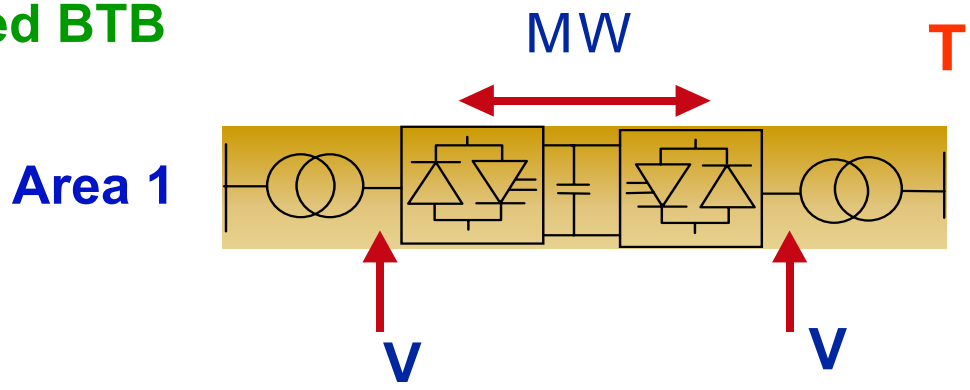


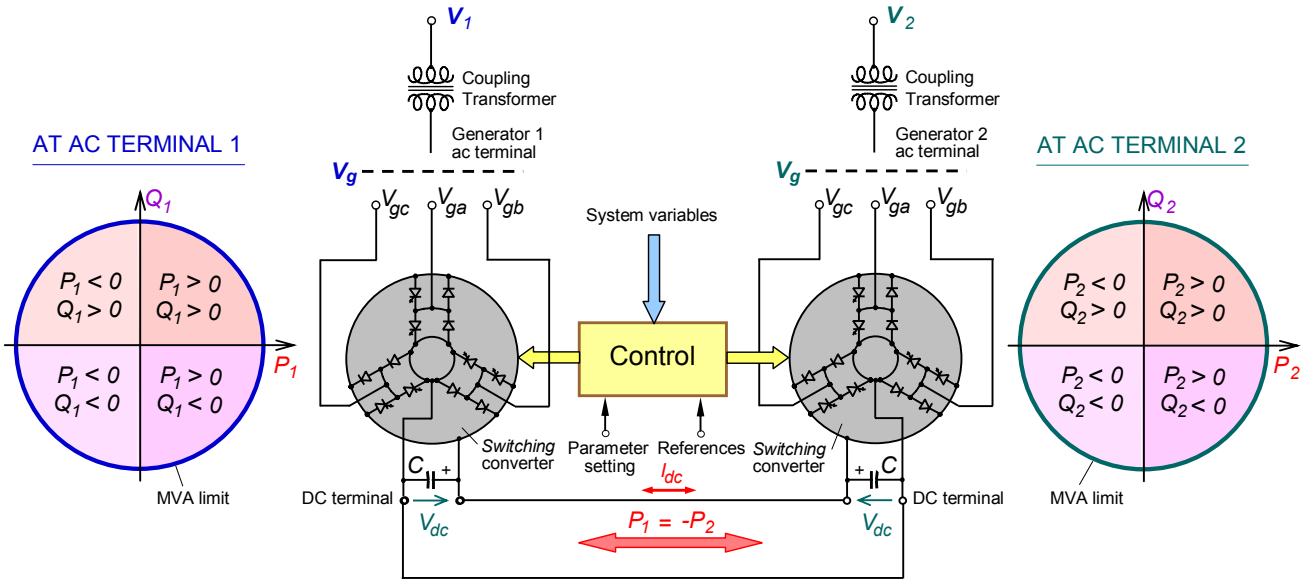
VSC-Based BtB as a Grid Shock Absorber (GSA)

VSC-Based BTB

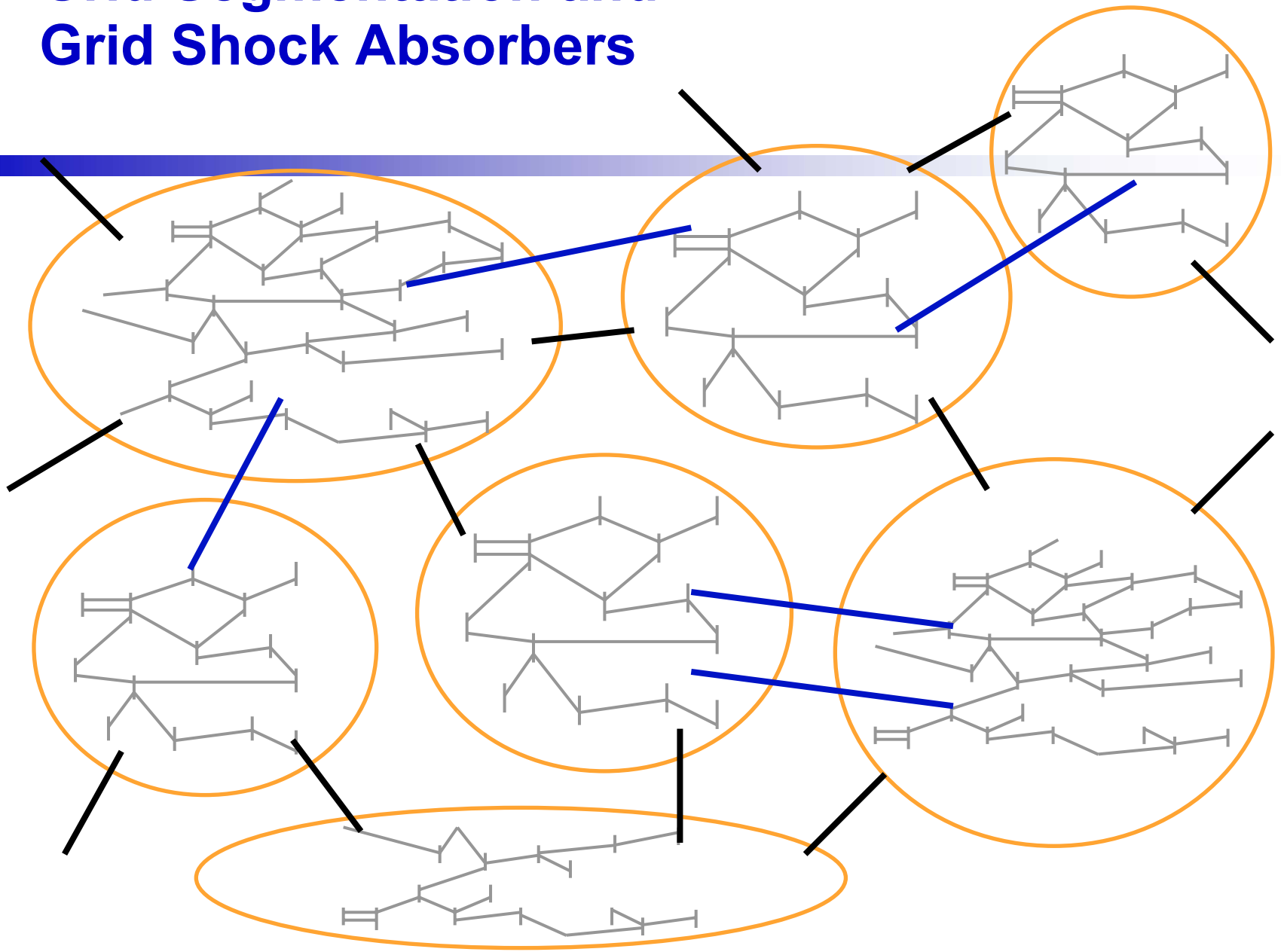


The idea !

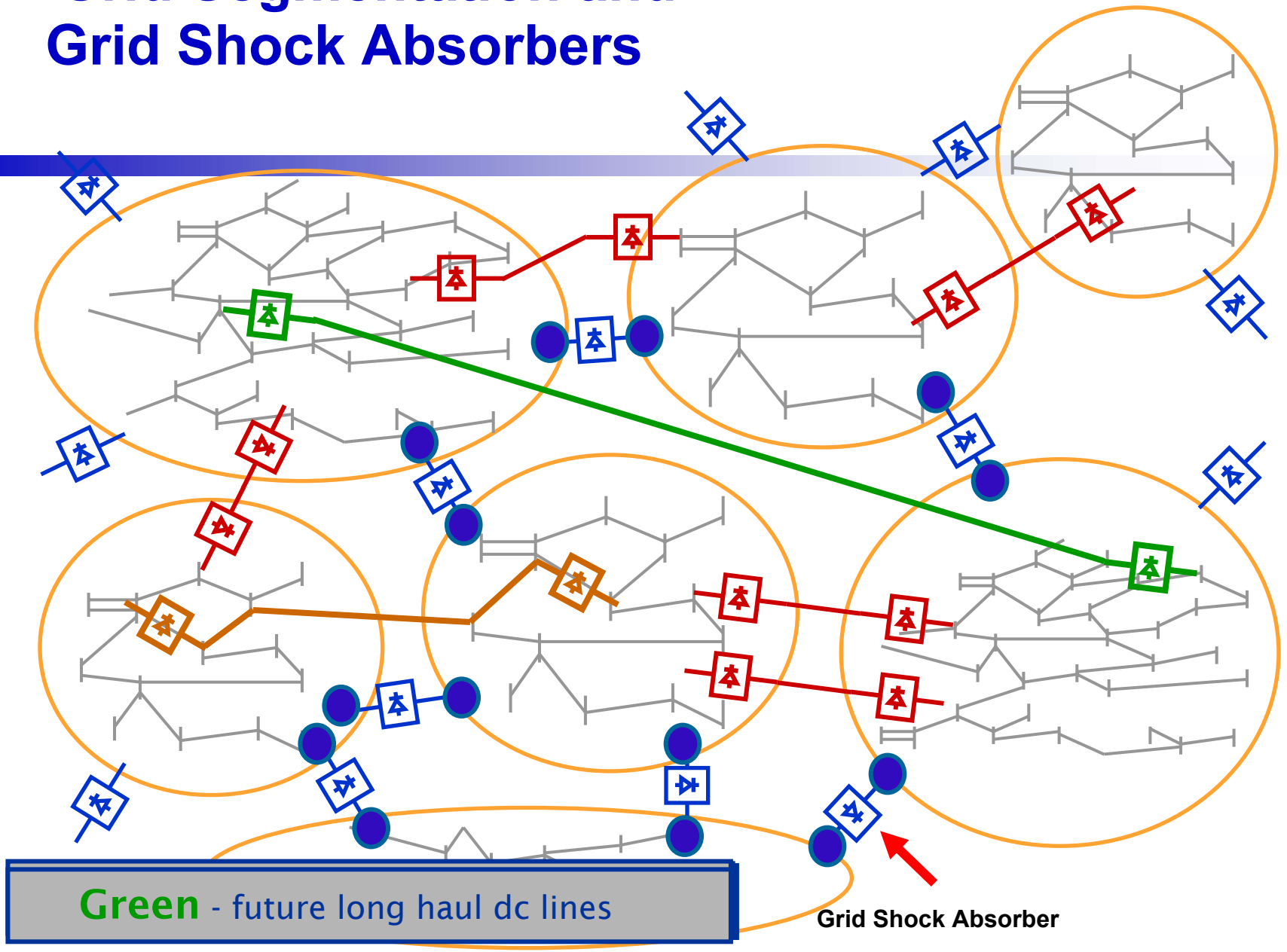




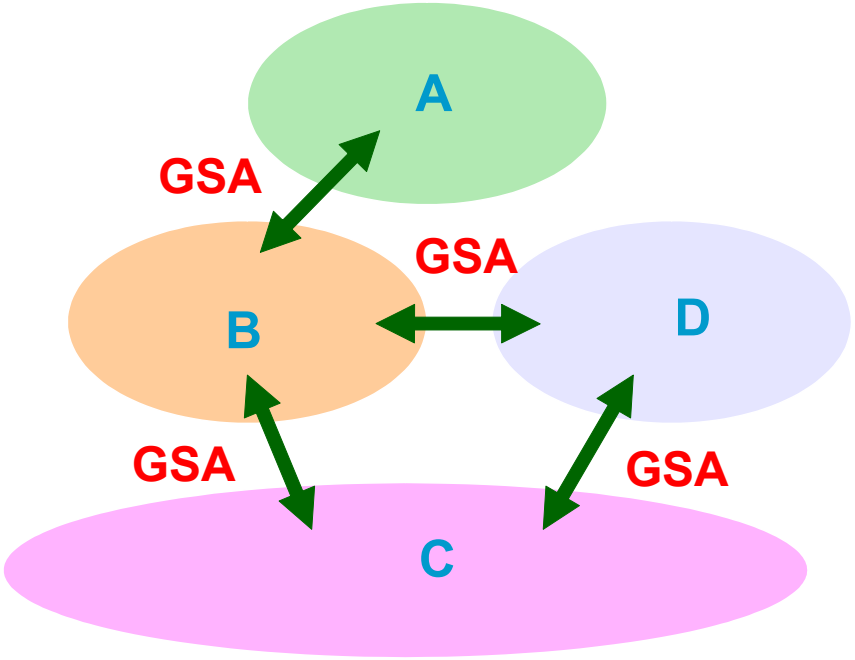
Grid Segmentation and Grid Shock Absorbers

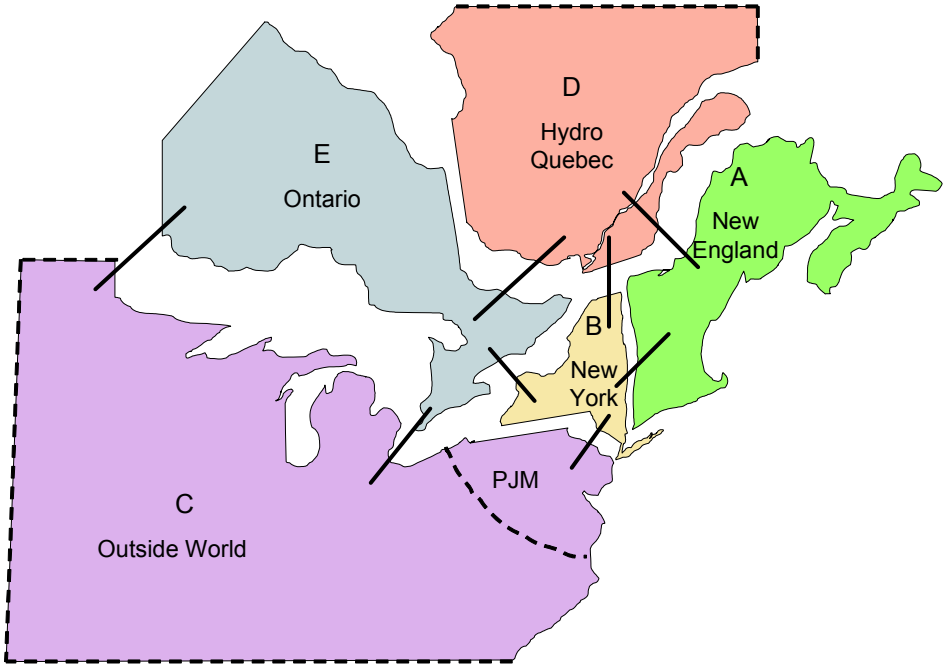


Grid Segmentation and Grid Shock Absorbers

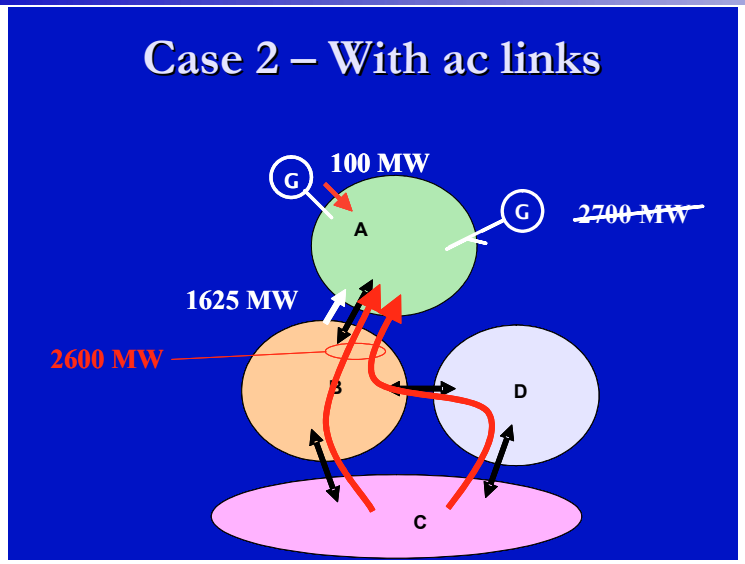


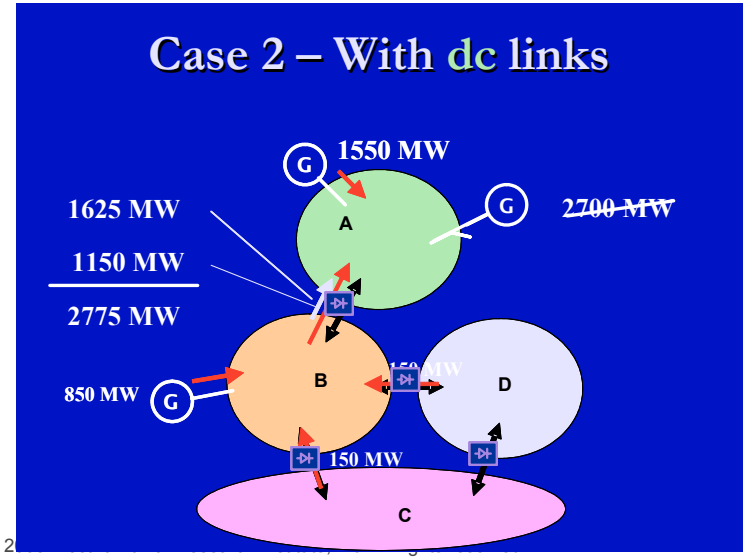
"Proof of Concept" Study On Eastern Interconnection (EI)

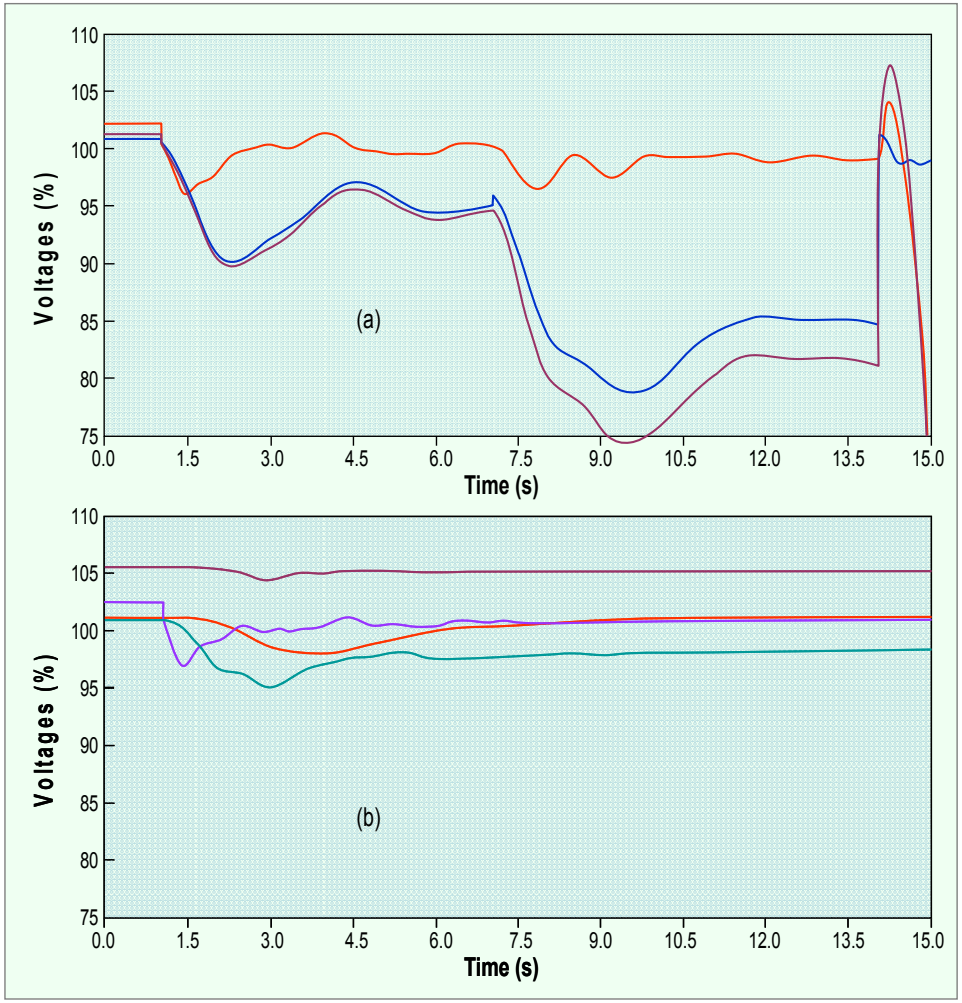




Impact of "Substantial" Generation Trips on Power Flows



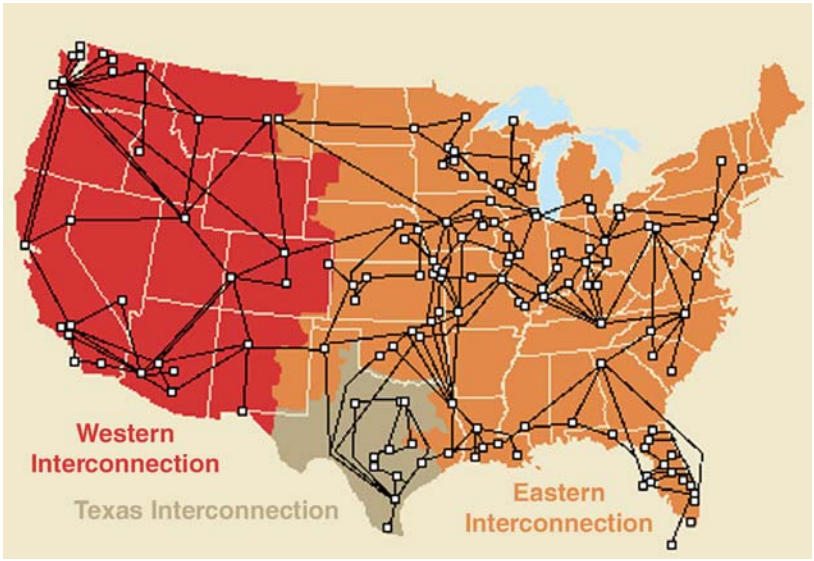


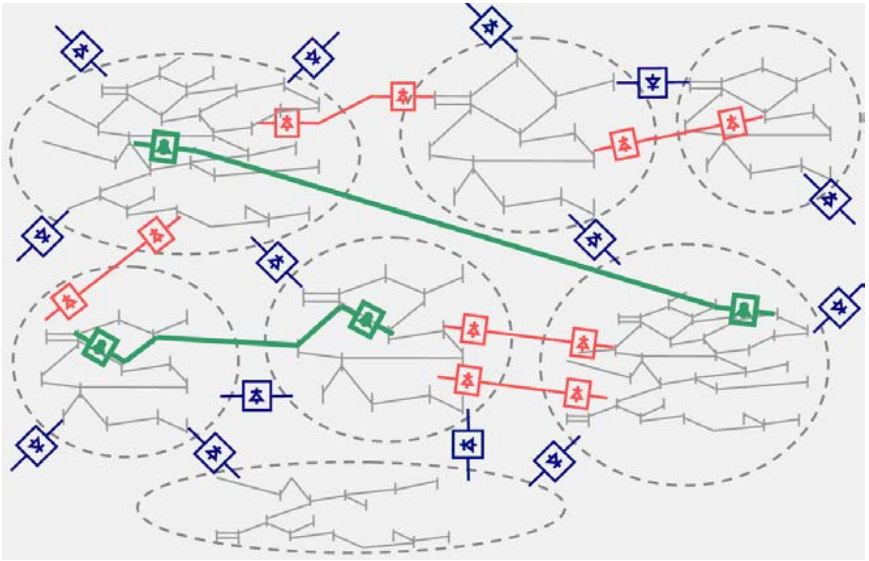


Selected bus voltages with ac ties (a) and dc links (b) in place. Voltages are not from the same buses in the two cases.

Segmentation and Grid Shock Absorber: R&D Project Opportunity

Grid Reliability and Efficiency Enhancement Network (GreenTM)





Transmission Interconnection

Overall issue or problem to be addressed

- Increased robustness and integrity of transmission grid
- Increased transmission efficiency
- Green House Gas (GHG) management.

Proposed Tasks

- **S**elect a benchmark transmission grid, representing a Transmission Interconnection, e.g. Western Interconnection
- Identify cascading failure risks under particular operating conditions and contingencies
- Identify boundary configurations for improved robustness of the grid against cascading failures. These boundaries determine candidate sectors to be asynchronously linked using the Grid Shock Absorber concept, Voltage Sourced Converter (VSC)-based ties.
- Run test simulations to assure expected segmented behavior
- Assess grid reconfiguration costs and benefits
- Evaluate economic feasibility with Improved market operations

Research and Development Opportunity

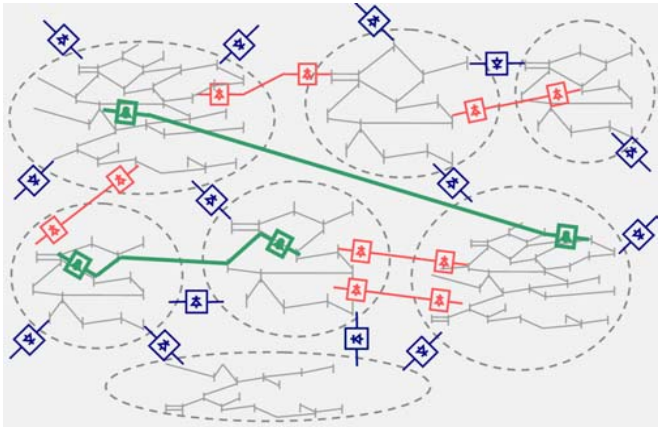
Help the industry meet the following transmission needs:

- **Reliability enhancement:** Minimizing grid exposure to cascading system failures and outages
- **Efficiency enhancement:** Facilitating efficient scheduling and power trade by improving grid utilization at reduced costs of service
- **GHG management:** Least-cost access to distant resources to meet pending limits on GHG emissions

The proposed R&D effort will be guided by four design principles:

- Maximum utilization of existing and planned ac transmission infrastructures
- Superposition of a network of HVDC gates within the targeted grid to meet the three requirements **Reliability, Efficiency and GHG Management**
- The quality of the transmission services provided by the modified grids will equal or exceed what is expected without the implementation of the **GREEN™** Project
- Meeting all existing NERC, regional, and local planning and operating criteria

Grid Reliability and Efficiency Enhancement Network (GREEN)



Expected Results:

- Inter-sector power-flow controllability
- Higher line loadings
- Increased ROW power densities
- Consolidation of investments in reliability and market enhancements
- Reduced cascading blackouts
- Improved access to resources for better GHG management

Project Status

- Proof of Concept Product ID # 1014494

"Technical Assessment of Grid Shock Absorber Concept",

- IEEE Power & Energy Magazine, January/February 2008

"Segmentation with Grid Shock Absorbers for Reliability of Large Transmission Interconnections"

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THANKS FOR YOUR ATTENTION

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