Y9.LSSS.2 Dynamic Simulation and Analysis of FREEDM Systems on Large Scale Test Feeders using OpenDSS

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Overview

Background

This task supports the validation of different concepts developed in FREEDM through dynamic simulations on large scale feeders using open source tools such as OpenDSS. This can be used to study the scalability and system level issues.

Project Goals

- Develop hybrid, differential-algebraic-equations (DAE) based simulation methods using OpenDSS, which enable simulation of very large-scale power systems with large number of power electronic converters.

- Develop models (DLL) in OpenDSS for the main FREEDM components - SST, DESD and DRER including the main controllers and IEM and IPM.

- Simulate and analyze FREEDM system performance and stability when scaled to large scale feeders with thousands of nodes
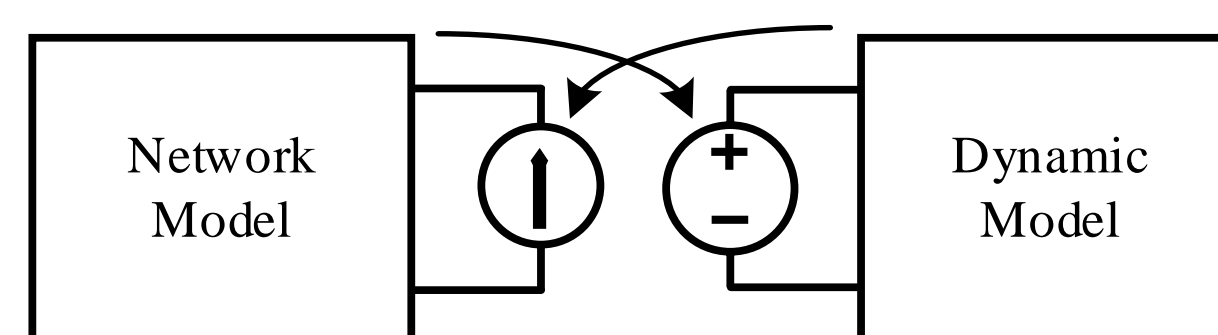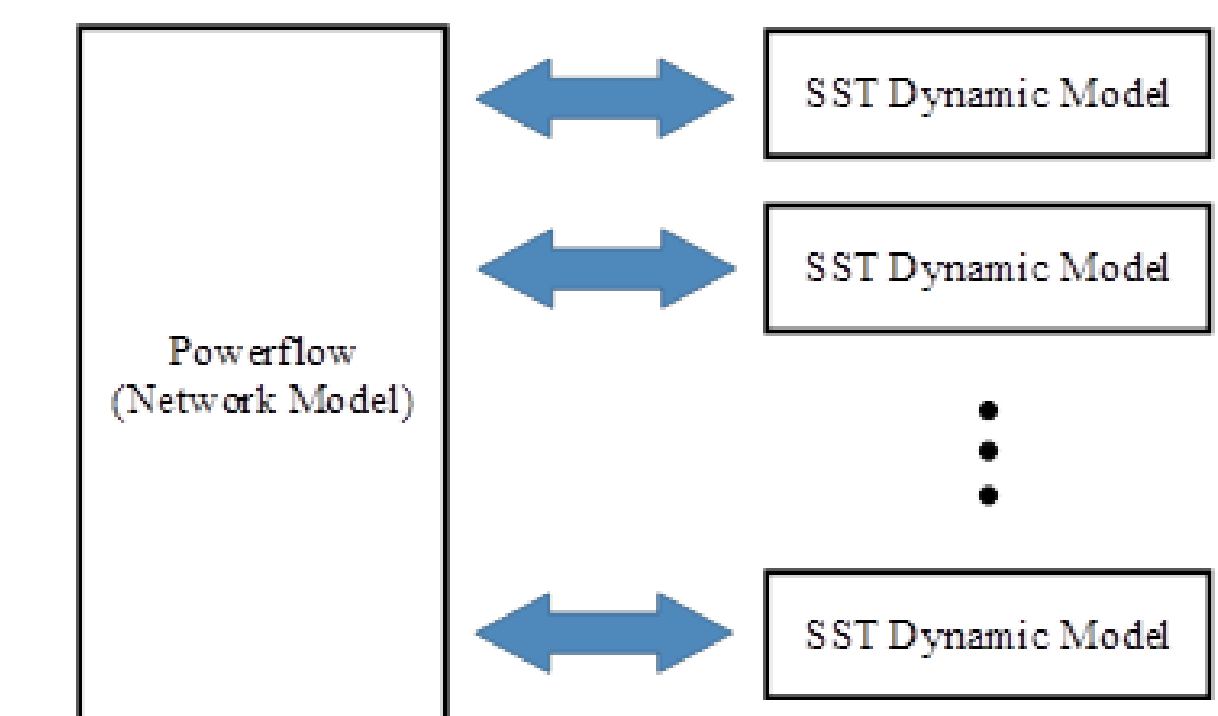

Method

### Dynamic Simulation of Large-scale Distribution Feeders Using OpenDSS

- OpenDSS is an open source distribution system analysis tool which can run DAE based dynamic simulation for large-scale unbalanced systems.

- By using DAE based dynamic simulation the overall system is simplified and requires less computational resources to simulate.

Create Dynamic Model of FREEDM Components for DAE Simulation Using OpenDSS

- In OpenDSS, dynamic model can be developed for user-defined components by using dynamic link library (DLL).

- The analytical model are derived for FREEDM components including circuit and controller dynamics.

- Functions based on derived model equations and simulation algorithm are written in Embarcadero Delphi to create the DLL.
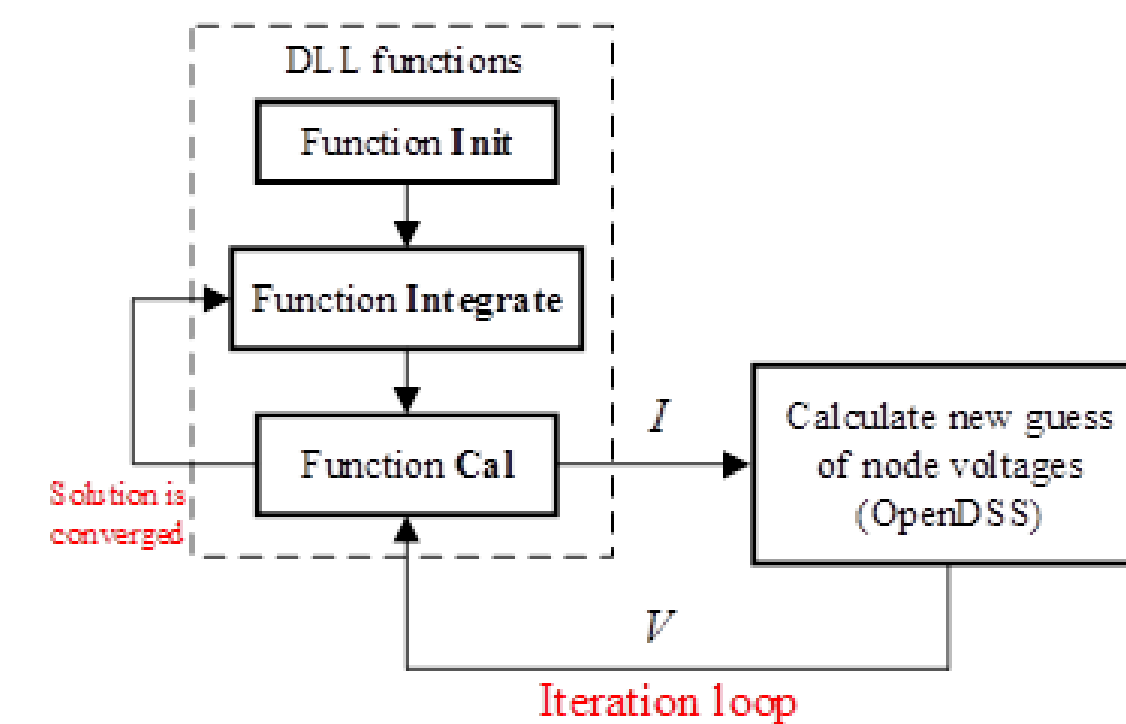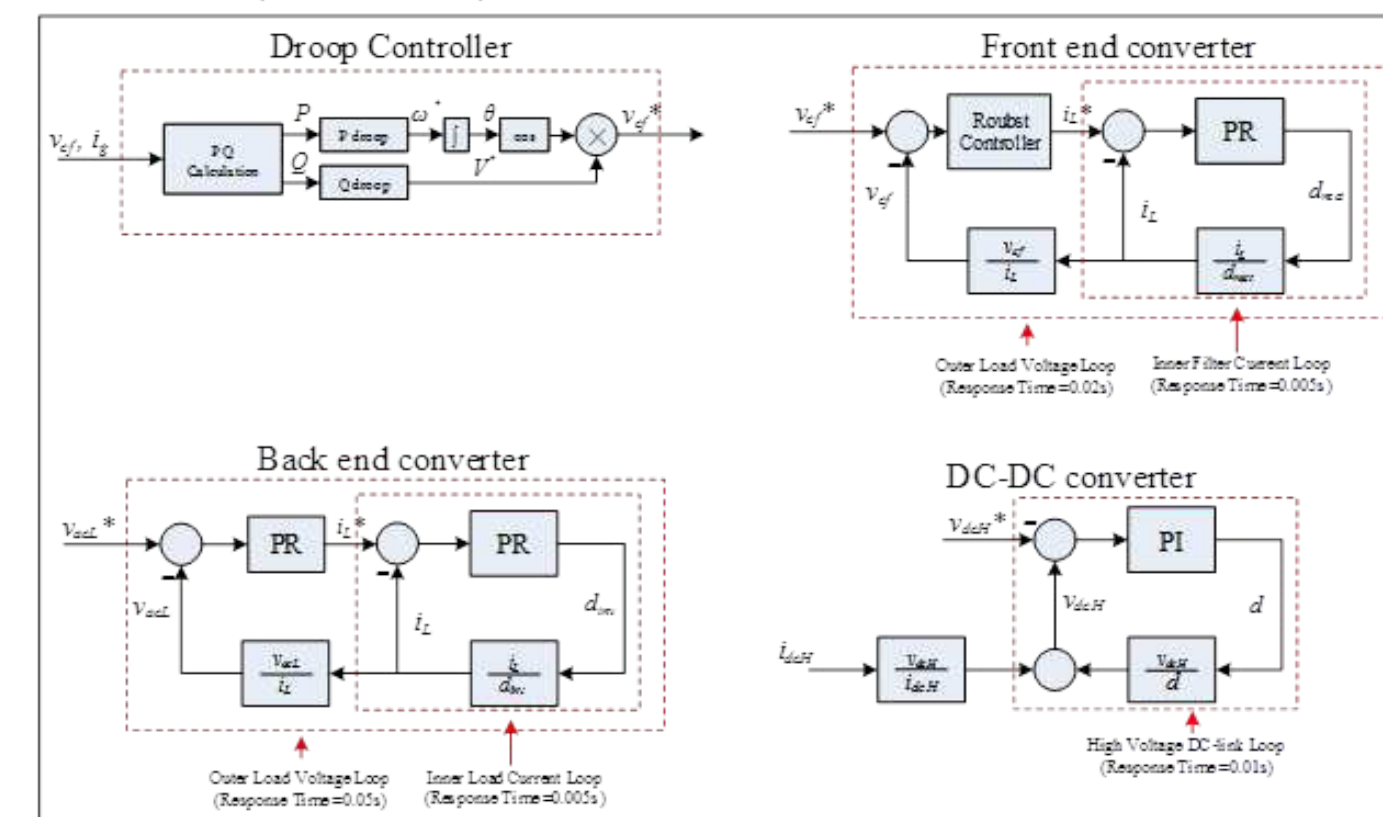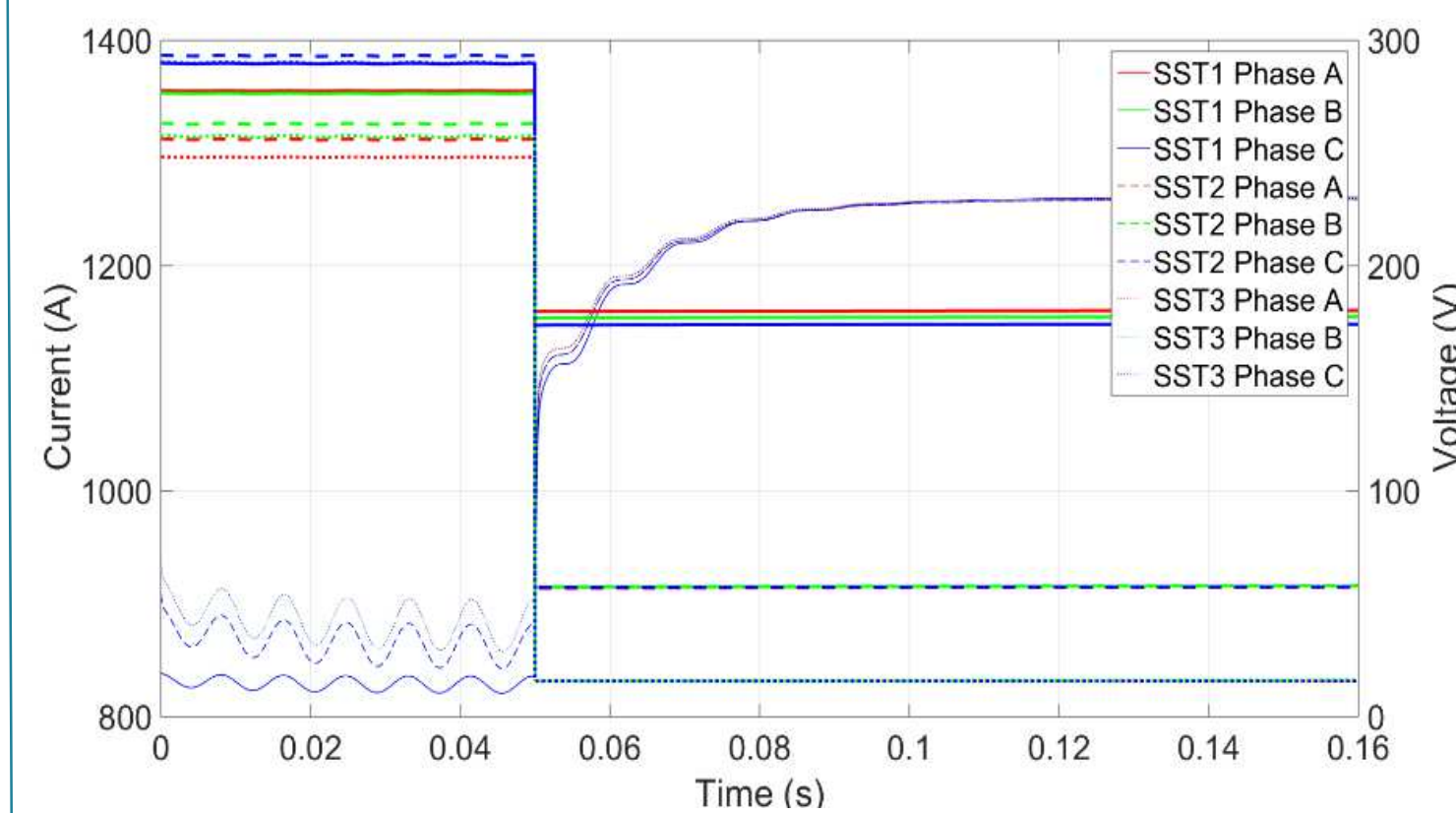

Results

Achievements

- DLLs of SST have been created including various SST control schemes.

- The developed SST DLLs have been used to implement dynamic simulations in OpenDSS for several test cases on large-scale systems.
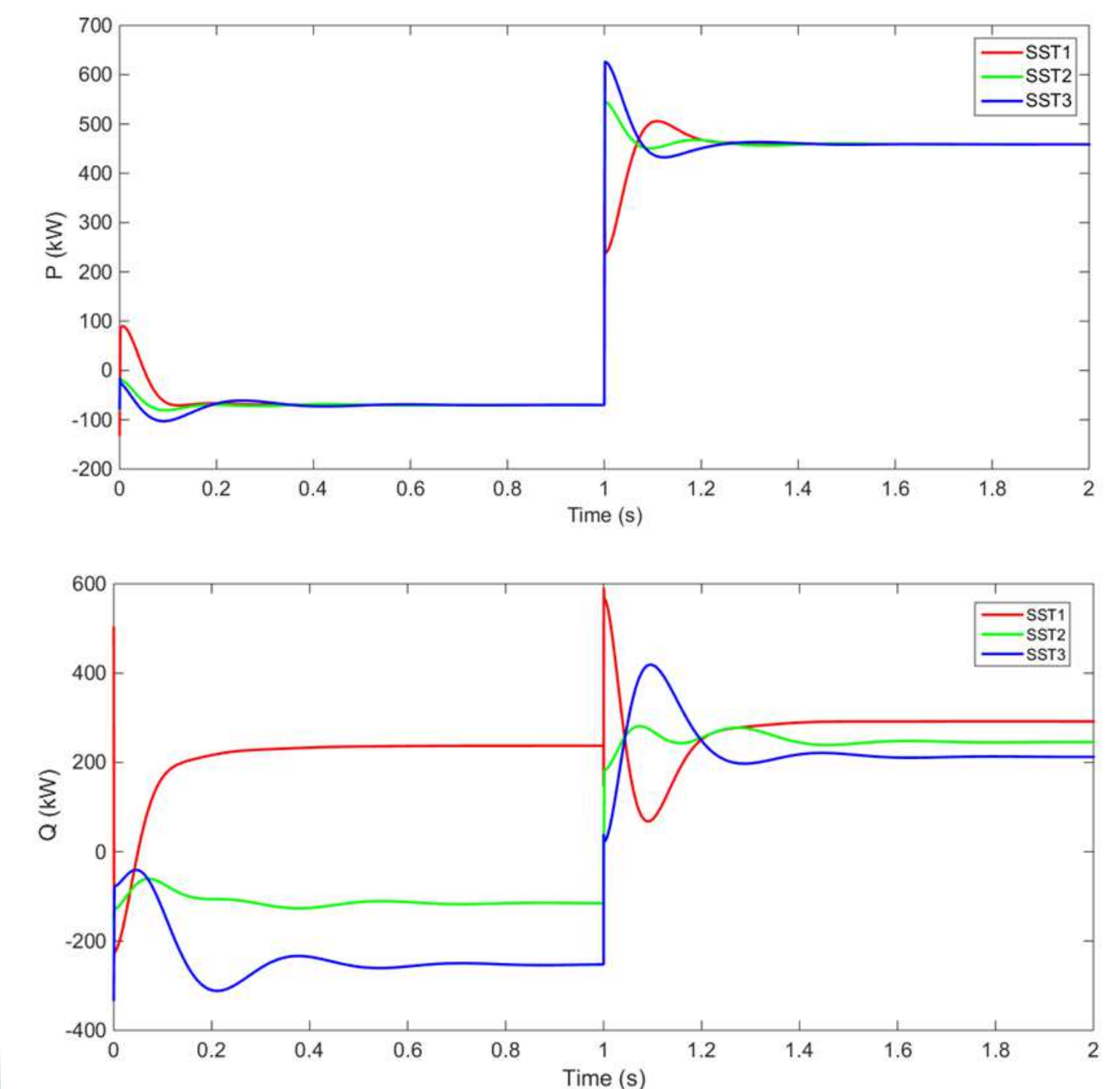

Fault analysis on IEEE 8500 node test feeder

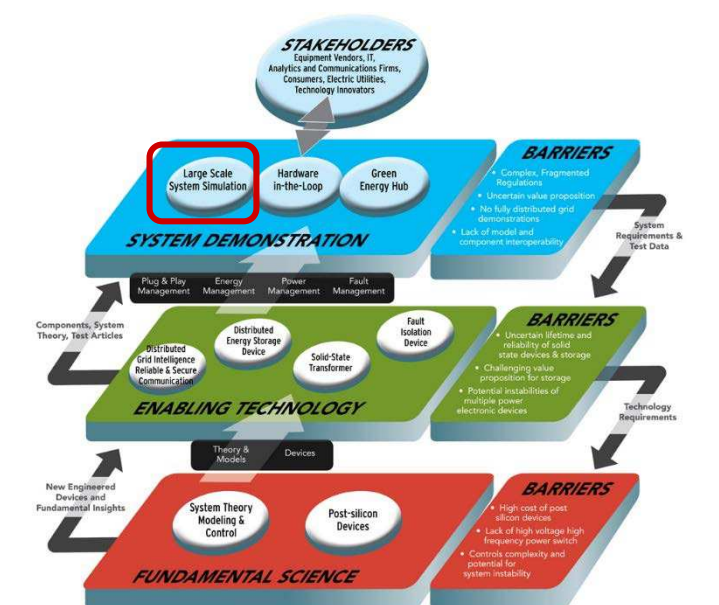Testing over-voltage mitigation schemes on a real feeder in Arizona

a. Constant power factor scheme

b. Volt-VAr scheme
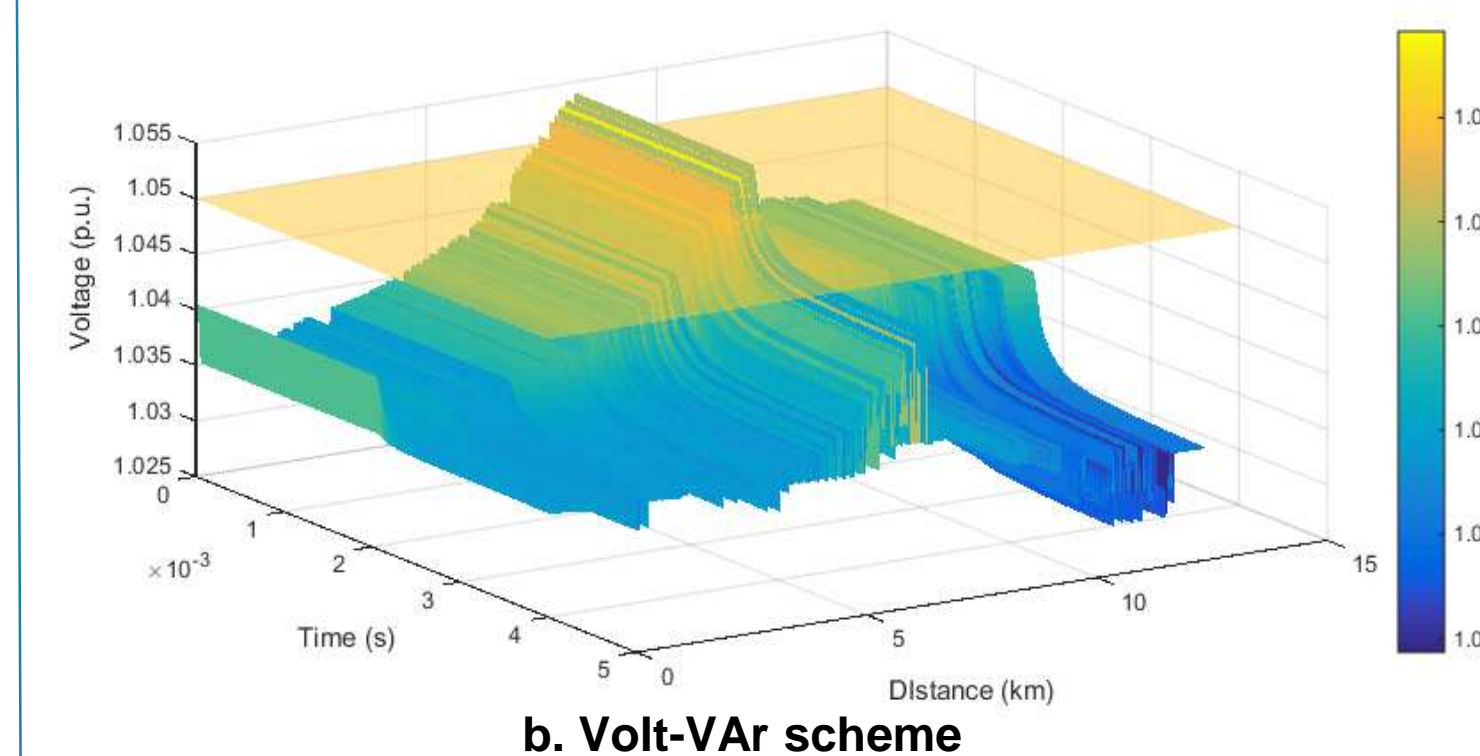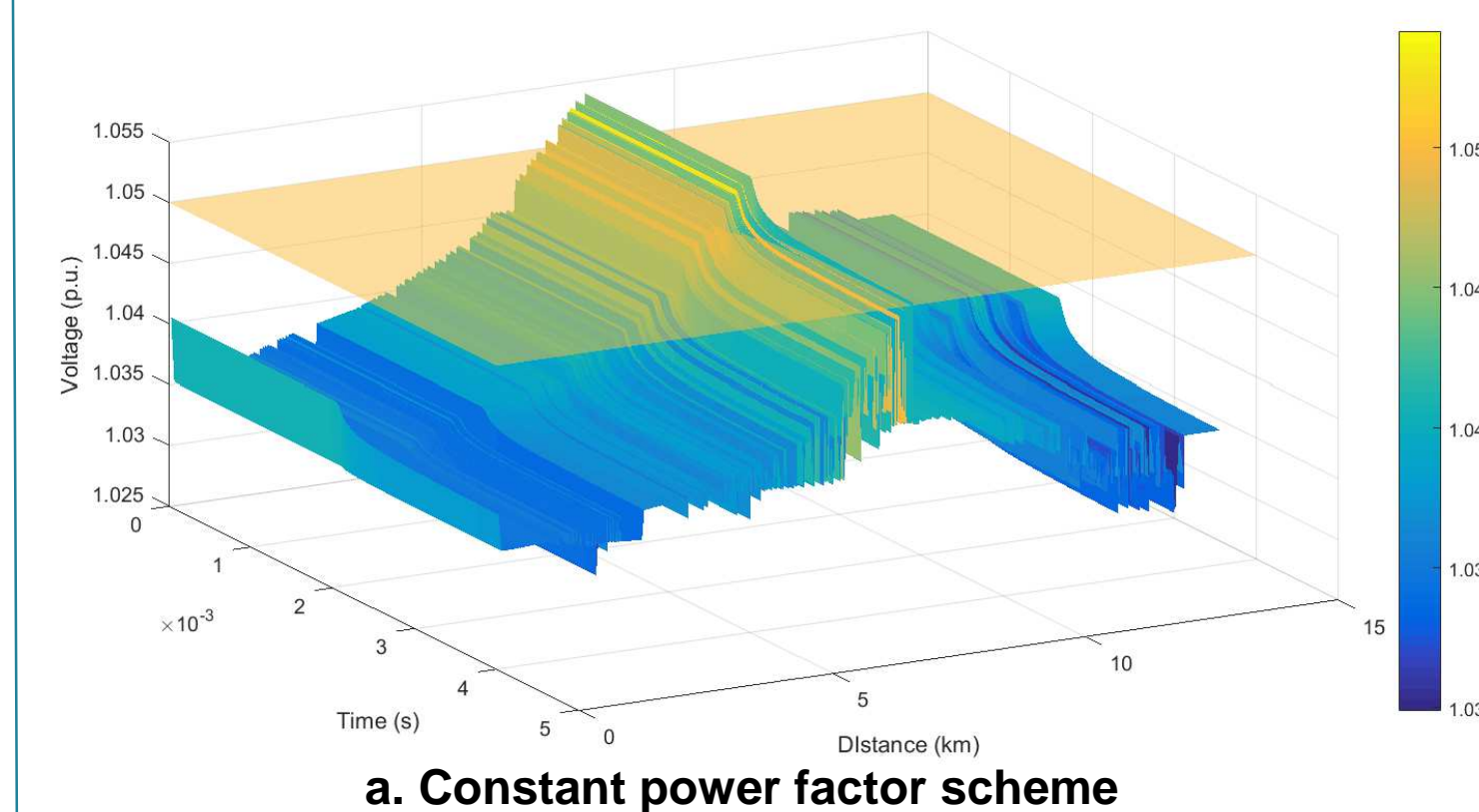
Testing Islanded mode control of SST on IEEE 123 node test feeder

Future Work

- Refine the models (DLLs) based on the continuous development in other thrusts.

- Create DLLs for other FREEDM components such as DESD and DRER.

Partners