**Topic: Distributed Alternating Current (AC) power flow with limited information**

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Description: Power flow is a numerical method used to compute the state variables of the electricity grid in the nominal operating condition. Given the demand for electricity, the production of power plants and the topology of the transmission grid, the power flow algorithm computes the voltages and phase angles in the transmission grid.

Since electricity grids span across countries, no single entity possess the entire information of the generation, demand and the topology. Thus, distributed algorithms are essential to accurately find the solution of the power flow problem. Distributed formulation of the power flow assumes that one grid owner knows its own generation, demand, grid topology and the solver used to compute power flow. Besides this, the only information available coming from the other grid owners is the value of the voltage (magnitude and angle) on the interface nodes between the two grids. The information on the solver and the grid topology of the neighboring grid is not known.

Possible approaches:

1. Start with a linear (DC) approximation of the power flow for simplicity.
2. Use analogies and establish links with domain decomposition methods for large scale PDEs
3. Use Portable Extensible Toolkit for Scientific Computation (PETSc)
4. Use methods based on sparsity to increase performance
5. Start with small IEEE topologies and work your way up to large grids
6. Extend the work to three phase AC power flow
7. Use of Message Passing Interface (MPI) or High Level Architecture (HLA) to implement solvers

Some objectives of interest:

* Analyze the implications of the distributed solver connectivity (tree-like vs. mesh vs. list) on the performance (convergence rate, error decay, etc.)
* Analyze the impact that the initial condition of the shared interface variables has on the performance. Decide on the best initial condition setting.
* Analyze the impact of the accuracy on the convergence rate (is it necessary to let the distributed solvers to fully converge or can the information be shared after only a few iterations)
* Analyze the impact of the interface node type (voltage controlled node vs. PQ node) on the convergence rate

References:  
[1] Pieter Schavemaker, Lou van der Sluis, “Electrical Power System Essentials”  
[2] Goran Andersson, “Power System Analysis”, ETH script, Sept 2012.  
[3] Y. Saad, “Iterative Methods for Sparse Linear Systems: Second Edition”, Society for Industrial and Applied Mathematics, 2003.  
[4] B. F. Smith, P. O. Bjorstad, W. D. Gropp, “Domain Decompostion: Parallel Multilevel Methods for Elliptic Partial Differential Equations”, Cambridge University Press, 1996.