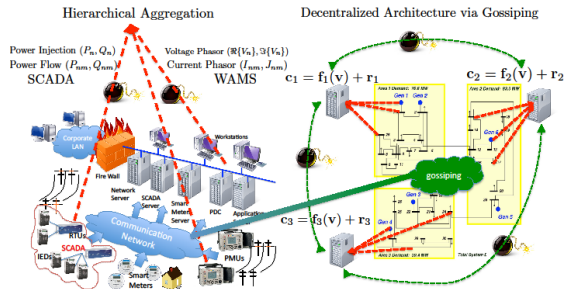


GOALS

Design of decentralized adaptive re-weighted state estimation (DARSE) scheme for hybrid PMU and SCADA measurement systems

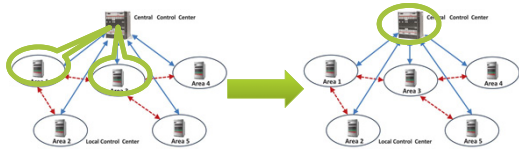


Merits of the peer to peer architecture:

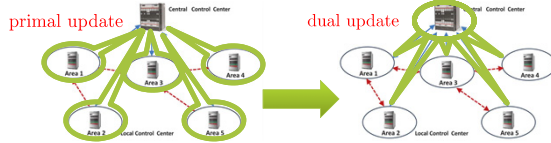
- Adaptive, robust to random network/sensing failures and attacks;
- Uses local historians to compute and cache global state.

State of the art:

- Hierarchical approach with centralized refinement

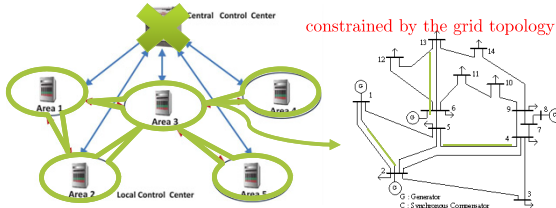


- Distributed local estimation via dual decomposition



- **local observability & hierarchical comm. (not robust to attacks)**

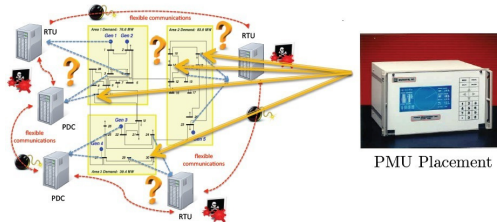
- Distributed local estimation via ADMM



- **rigid communications susceptible to attacks and failures!**

FUNDAMENTAL QUESTIONS/CHALLENGES

- **Where do PMUs offer the most benefits?** → where they give fast **convergence, observability, and performance** of the algorithm.

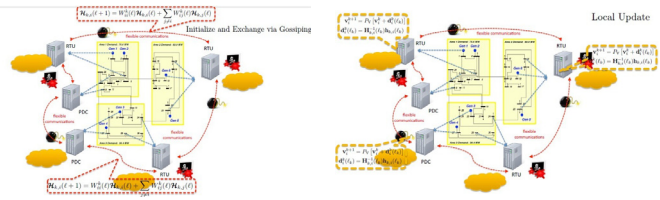


- What are the **dependencies** among **measurement placement, grid topology/parameters, communication networks, and performance?**

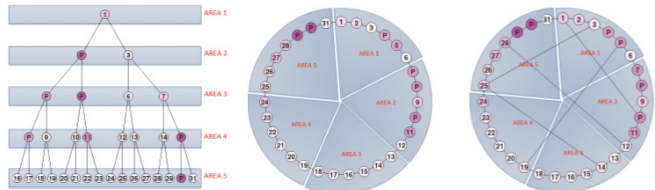
RESEARCH PLAN

- Distributed estimation via network diffusion/gossiping.
 - Flexible communication topology irrespective of physical topology.
 - Fast algorithm that outperforms first-order diffusion schemes.
 - Optimal measurement placement that stabilizes and improves the algorithm performance.

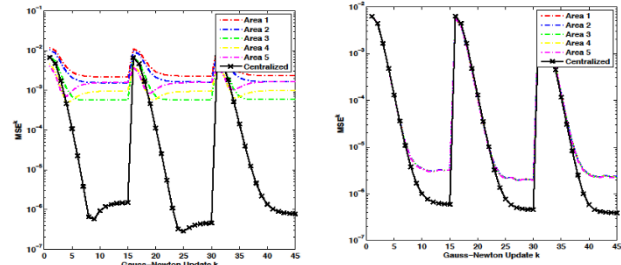
RESEARCH RESULTS



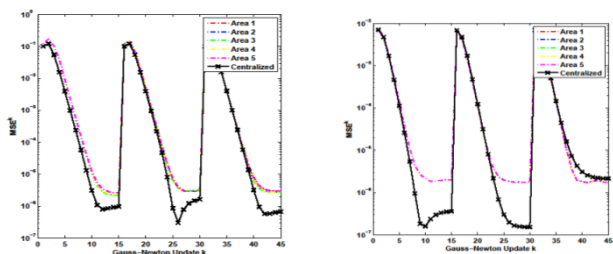
- Convergence speed of **gossip** → **network algebraic connectivity**
 (tree) $\lambda_2 = 0.38$ (ring) $\lambda_2 = 1.38$ (small world) $\lambda_2 = 1.38$



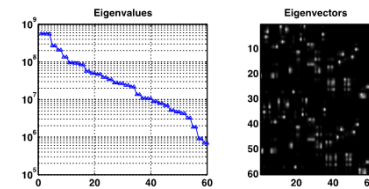
- Performance on tree networks with low (100 gossip) and high (300 gossip) communications between every two updates



- Performance on ring/small world networks with low communications.



- Insights from the optimal PMU placement: optimization tends to pick buses with high electrical "centrality," i.e., buses that connect to most other buses.



BROADER IMPACT

- First step towards robust designs for wide-area state awareness.
- Robust decentralized architecture balances network communication flows and streamlines deployment.

INTERACTION WITH OTHER PROJECTS

- TCIPG activity on "PMU-Enhanced Power System Operations."

FUTURE EFFORTS

- Improve nonlinear hybrid regression to tackle heterogeneous sampling rates and timing errors in hybrid measurement systems.
- Tackle Optimal Power Flow in a decentralized fashion.