Ali Abur Personal Info

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- **Research Interests: State Estimation, Fault Location, Modeling and Simulation**
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2020-2021 Research Projects

1. Modal Decoupled Three-Phase State Estimation for Non-symmetrical Unbalanced Power Grids
2. Network Model Parameter Error Identification in Three-Phase Power Grids
3. Multi-Area State Estimation of Three-Phase Power Grids
4. Topology Error Identification in Large Three-Phase Power Grids
5. Fault Location in Systems with Many Inverter-Based Renewables Using a Limited Number of DFRs

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PMU-Based Decoupled SE for Unsymmetrical Power Systems

Ramtin Khalili and Ali Abur

Project Goals

- Maintain the existing decoupled state estimation algorithm for three-phase power systems with un-transposed transmission lines.
- Extend the method to distribution systems with mixed-phased branches.

Barriers

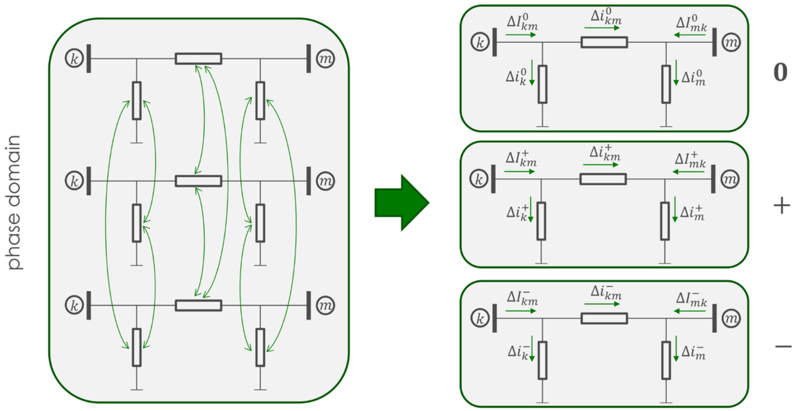
- Three-phase coupled model complexity
- Non-symmetrical lines which cannot be decoupled

Methodologies to Overcome Barriers

- Use the modal transformation
- Apply compensation method to make the decoupling work for non-symmetrical and mixed-phase power systems

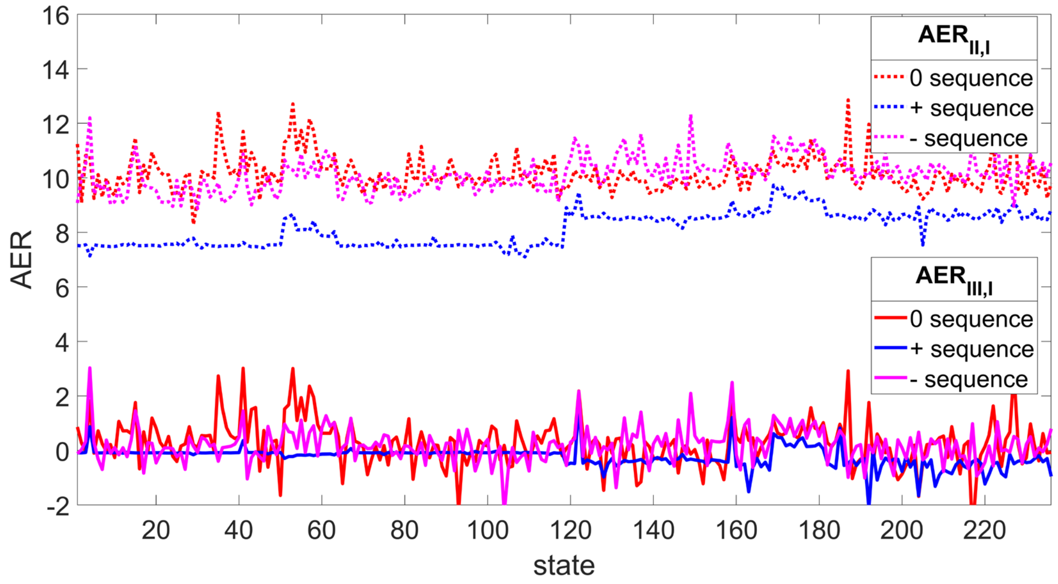
Research Achievements

- Fast and accurate SE that can be implemented using existing SE code for three-phase non-symmetrical power systems.



Coupled three-phase transmission line

modal domain + compensation



Parameter Error Identification and Estimation in Three-phase Networks

Ramtin Khalili and Ali Abur

Project Goals

- Develop a computationally efficient method to detect and estimate network parameter errors for unbalanced three-phase systems.

Barriers

- Model complexity in three-phase networks

Methodologies to Overcome Barriers

- Use the modal decoupling for detection
- Use compensation to handle line asymmetry

Research Achievements

- An efficient three stage parameter error identification tool is implemented for unsymmetrical three-phase power systems.
- Parameters of the three-phase line are estimated simultaneously.

IDENTIFICATION, AND ESTIMATION OF SINGLE PARAMET

	Test A	*Test B*
r^{N0} r^{N+}	10.44 27.9	20.9 103.2
λ^{N0} λ^{N+}	12.57 **34.85**	34.75 **127.43**
suspect TL	15 – 19	41 – 42
suspect Par.	R	X
$\lambda^{N\phi}$	$\begin{bmatrix} \mathbf{70.34} & 44.48 & 40.52 \\ & 9.16 & 16.55 \\ & & 12.75 \end{bmatrix}$	$\begin{bmatrix} 73.02 & 62.63 & 188.18 \\ & 77.07 & 133.76 \\ & & \mathbf{287.63} \end{bmatrix}$
True value	0.020	0.225
Err. value	0.026	0.2925
Est. value	0.020	0.225
Est. Iter	1	2

- *Test A*: r^{aa}_{15-19}, +30% error, PMU at bus 15
- *Test B*: x^{cc}_{41-42}, +30% error, PMU at bus 41

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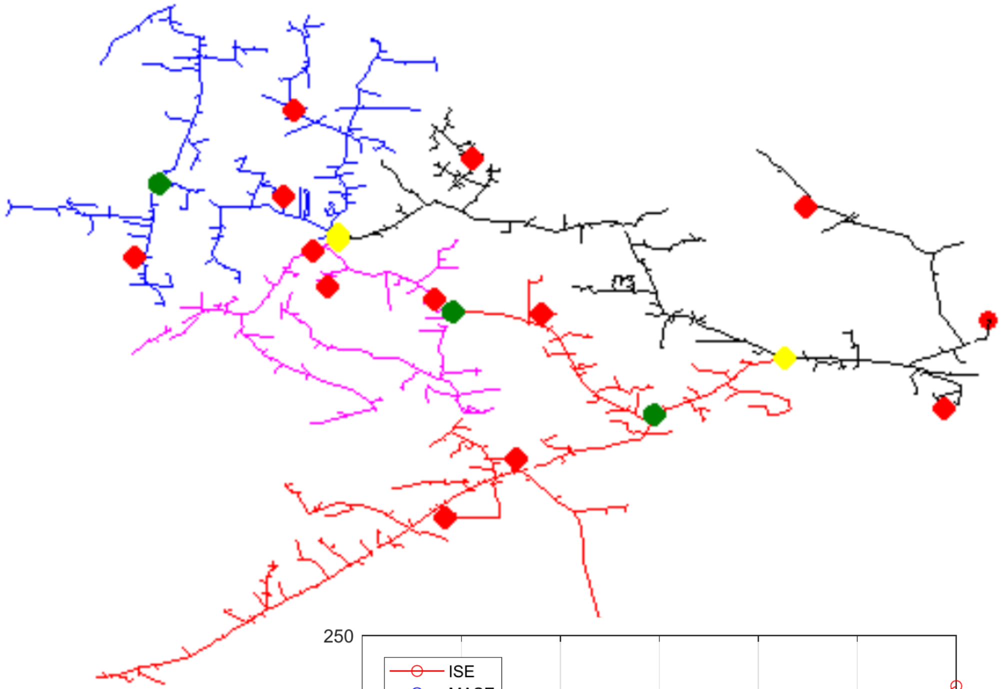
Multi-Area Distribution State Estimation
Andre Langner and Ali Abur

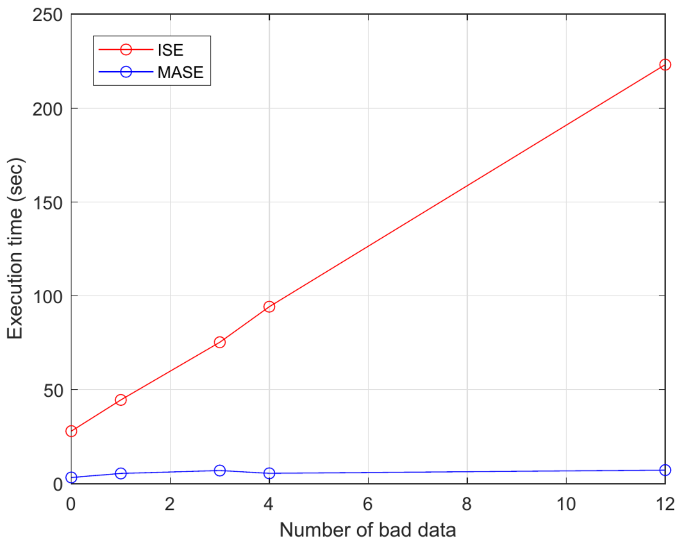
- 8500-node system
- 4 areas;3 DGs



Base Case

- Integrated SE
  - 3 iterations
  - J-index: 0.7524
  - 28.03 sec
- MASE
  - 3.36 sec

Area	no iterations	J-index
1	3	0.2663
2	4	0.1951
3	6	0.1909
4	4	0.1727
Coord.	11	1.9908



Multiple bad data

- 3 BD/area – single phase

- Integrated SE
  - 13 cycles
  - J-index: 0.6612
  - 223.09 sec
- MASE
  - All areas identify their errors
  - 7.28 sec

Topology Error Identification via Multi-Area Generalized State Estimation

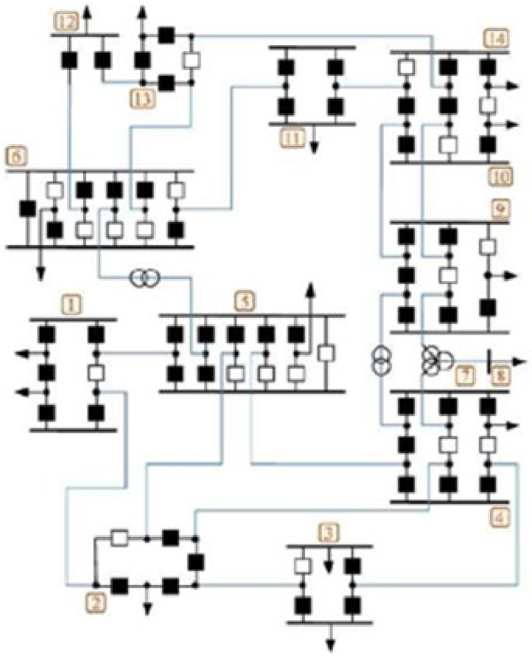
Andre Langner and Ali Abur

Topology errors

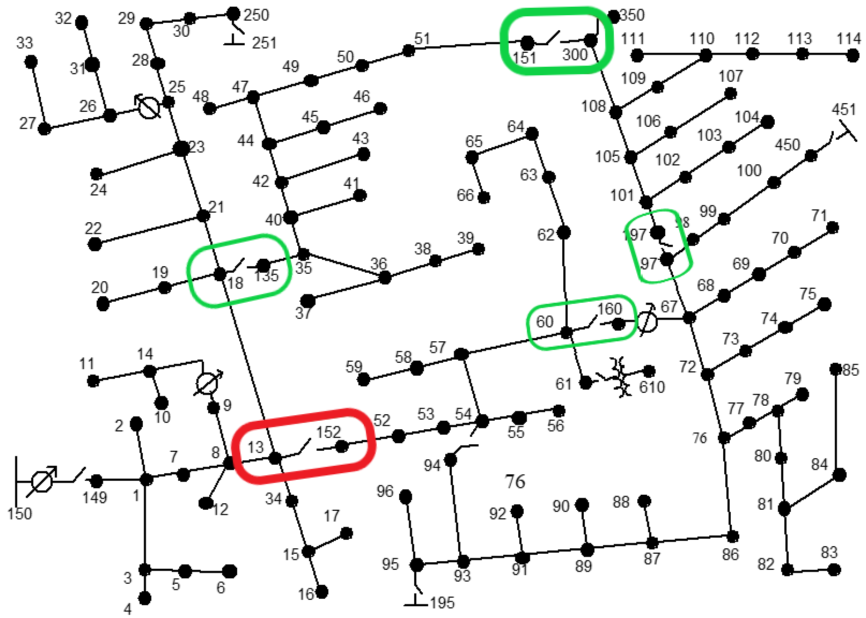
- Causes divergence
- Incorrect BD detection
- Switching miscommunication

Generalized State Estimation

- Explicit modeling switching devices
- Power flows as state variables
- Computational burden



- NC 13-153 opens
- NO 151-300 closes



Centralized SE:

- Converges in 11 cycles
- Incorrect bad data
- J-index: $\mathbf{57.536}$
- RMSE: $\mathbf{3.019 \times 10^{-2}}$

MASE:

Switch	Phase	P^{true} (kW)	P^{est} (kW)	P^N	Reported Status	Estimated Status
	a	0.0	1.1	0.08	Closed	Open
13-152	b	0.0	8.9	0.63	Closed	Open
	c	0.0	6.4	0.46	Closed	Open
	a	340.6	171.7	9.92	Open	Closed
151-300	b	254.6	133.9	7.73	Open	Closed
	c	276.6	151.8	8.76	Open	Closed

Fault location in power networks using a small set of digital fault recorders

Cesar Galvez and Ali Abur

Project Goals

- Develop a robust fault location method that can be used for radial and meshed power networks containing inverter-based power sources.

Barriers

- Impedance based methods have limitations of fault location in the presence of IBPSs, unknown fault resistance, and asymmetry of the distribution and transmission lines.

Methodologies to Overcome Barriers

- Use of traveling waves to extract time of arrivals and model the network as a directed tree graph to estimate the fault distance.

Research Achievements

- Accurate Fault Location for any type of power networks.
- Robustness against bad data, time-synchronization, and measured errors

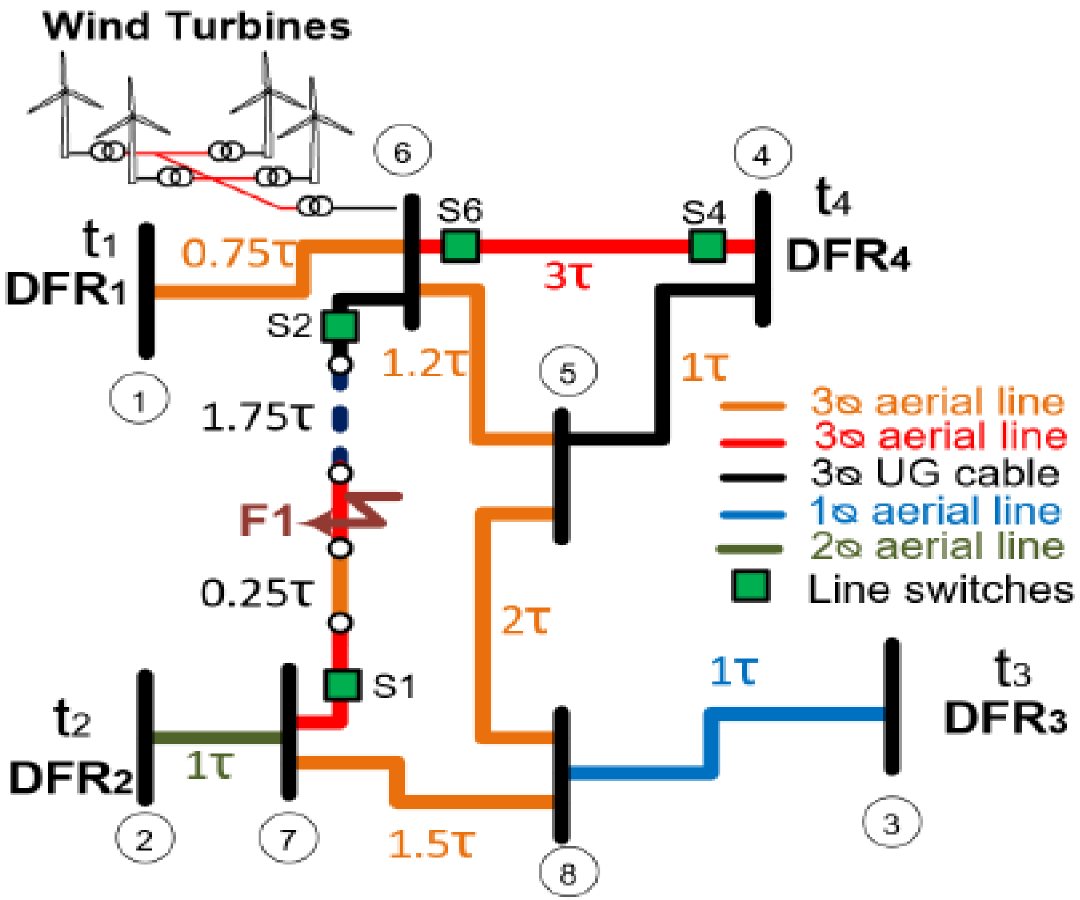


Fig. 1: 8-Bus Example System

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