

# Tour of DataNxt and Linear State Estimation (LSE)

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Input Monitoring

- Input System
  - EPDC\_STG
    - EPDC\_STG.AA 05AMOS 01
    - EPDC\_STG.AA 05AMOS 02
    - EPDC\_STG.AA 05AMOS 03
    - EPDC\_STG.AA 05AMOS 04
    - EPDC\_STG.AA 05AMOS 05
    - EPDC\_STG.AA 05BAKER 03
    - EPDC\_STG.AA 05BEATTY 02
    - EPDC\_STG.AA 05BROADF 01
    - EPDC\_STG.AA 05BROADF 02
    - EPDC\_STG.AA 05BROADF 03
    - EPDC\_STG.AA 05BROADF 04
    - EPDC\_STG.AA 05BROADF 05
    - EPDC\_STG.AA 05CANTNC 01
    - EPDC\_STG.AA 05CANTNC 02
    - EPDC\_STG.AA 05CANTNC 03
    - EPDC\_STG.AA 05CANTNC 04
    - EPDC\_STG.AA 05CANTNC 05
    - EPDC\_STG.AA 05CANTNC 06
    - EPDC\_STG.AA 05CONES 01
    - EPDC\_STG.AA 05CONES 03
    - EPDC\_STG.AA 05COOK 01
    - EPDC\_STG.AA 05COOK 02
    - EPDC\_STG.AA 05COOK 03
    - EPDC\_STG.AA 05COOK 06
    - EPDC\_STG.AA 05CULLOD 01
    - EPDC\_STG.AA 05CULLOD 02
    - EPDC\_STG.AA 05CULLOD 03
    - EPDC\_STG.AA 05DUMONT 01
    - EPDC\_STG.AA 05DUMONT 02
    - EPDC\_STG.AA 05DUMONT 03
    - EPDC\_STG.AA 05DUMONT 04
    - EPDC\_STG.AA 05DUMONT 04[1]
    - EPDC\_STG.AA 05DUMONT 04[2]
    - EPDC\_STG.AA 05DUMONT 04[3]
    - EPDC\_STG.AA 05DUMONT 04[4]
    - EPDC\_STG.AA 05DUMONT 05
    - EPDC\_STG.AA 05DUMONT 06
    - EPDC\_STG.AA 05FOSTOR 01
    - EPDC\_STG.AA 05FOSTOR 03
    - EPDC\_STG.AA 05FOSTOR 04
    - EPDC\_STG.AA 05GAVIN 01
    - EPDC\_STG.AA 05GAVIN 02
    - EPDC\_STG.AA 05J FERR 02
    - EPDC\_STG.AA 05J FERR 04
    - EPDC\_STG.AA 05J FERR 05
    - EPDC\_STG.AA 05J FERR 07
    - EPDC\_STG.AA 05JEFRSO 01
    - EPDC\_STG.AA 05JEFRSO 03
    - EPDC\_STG.AA 05JEFRSO 05
    - EPDC\_STG.AA 05KAMMER 01
    - EPDC\_STG.AA 05KAMMER 02
    - EPDC\_STG.AA 05KAMMER 03
    - EPDC\_STG.AA 05KAMMER 05
    - EPDC\_STG.AA 05KAMMER 06

Input Status

Total Inputs: 1 Enabled: 1 Disabled: 0 ■ Active: 1 ■ Inactive: 0 ■

Inputs List

	Input Name	Status	Data Status	Expected Samples	Received Samples	Missing Samples	Availability (%)	Last Received	Last Sent	Received Packets
1	EPDC_STG	<span style="color: green;">■</span> A...	<span style="color: green;">■</span> Good D...	31068480	31061462	7018	<span style="color: green;">■</span> 99.9774	09-19-2018 0...	09-07-2...	52101675

**Data Manager Configuration:**

General | Time Validation | PMU Status Validation | Value Validation | Topology Validation | Linear State Estimation | User Algorithms

Buffer Size:	30 Seconds
Data Rate:	30 Samples/Second
Deviation Limit (Too Late):	17.000 Seconds
Deviation Limit (Too Future):	5.000 Seconds
Sort by Arrival Time Reference:	Any input's good data time
Progressive Padding Samples:	0
Progressive Padding Method:	Same as last received sample
Historical Samples Ready Assertion Delay:	2 Samples
Number of Historical Samples:	0 Samples
Time Alignment Maximum Latency:	0.500 Seconds

**Data Manager Configuration:**

General | **Time Validation** | PMU Status Validation | Value Validation | Topology Validation | Linear State Estimation | User Algorithms

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Enable Sample Shift Detection

Forward Shift Limit:

Backward Shift Limit:

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Enable Latency Detection

Forward Shift Resolution:

Backward Shift Resolution:

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Enable Data Frame Interval Inconsistency Detection

Data Frame Interval Inconsistency Assertion Delay:

Data Manager Configuration:

General | Time Validation | **PMU Status Validation** | Value Validation | Topology Validation | Linear State Estimation | User Algorithms

PMUs:

	Name	Data Invalid	PMU Error	Out of Synch	Sort by arrival	Time Quality	Planned Outage
1	EPDC_STG.AA 05AMOS 01	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
2	EPDC_STG.AA 05AMOS 02	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
3	EPDC_STG.AA 05AMOS 03	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
4	EPDC_STG.AA 05AMOS 04	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
5	EPDC_STG.AA 05AMOS 05	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
6	EPDC_STG.AA 05BAKER 03	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
7	EPDC_STG.AA 05BEATTY 02	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
8	EPDC_STG.AA 05BROADF 01	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
9	EPDC_STG.AA 05BROADF 02	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
10	EPDC_STG.AA 05BROADF 03	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
11	EPDC_STG.AA 05BROADF 04	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
12	EPDC_STG.AA 05BROADF 05	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
13	EPDC_STG.AA 05CANTNC 01	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
14	EPDC_STG.AA 05CANTNC 02	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
15	EPDC_STG.AA 05CANTNC 03	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
16	EPDC_STG.AA 05CANTNC 04	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
17	EPDC_STG.AA 05CANTNC 05	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
18	EPDC_STG.AA 05CANTNC 06	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled
19	EPDC_STG.AA 05CONES 01	Enabled	Enabled	Enabled	Enabled	Enabled	Disabled

Validate PMU Status Word Bits:

- Data Invalid (Bit 15)
- PMU Error (Bit 14)
- Out of Synch (Bit 13)
- Sort by Arrival (Bit 12)
- Time Quality (Bit 08-06)
- Planned Outage

Planned Outage Start Time:

Planned Outage End Time:

Apply to Selected PMUs ...

Save Config

Data Manager Configuration:

General | Time Validation | PMU Status Validation | Value Validation | Topology Validation | Linear State Estimation | User Algorithms

Voltage Magnitude | Current Magnitude | Frequency

	Name	Base KV /	Range Check	PB Low	PB High	Freq Correlated	Stale Check	V Limit	Duration	Noisy Check	H Frequency
1	EPDC_STG.AA 05AMOS 02.V1YPM	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
2	EPDC_STG.AA 05AMOS 04.B76505AMOS 5V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
3	EPDC_STG.AA 05BEATTY 02.L34505GREENE 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
4	EPDC_STG.AA 05BROADF 01.L76505BAKER 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
5	EPDC_STG.AA 05BROADF 02.L76505J.FERR 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
6	EPDC_STG.AA 05BROADF 03.B76505BROADF 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
7	EPDC_STG.AA 05BROADF 04.B76505BROADF 4V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
8	EPDC_STG.AA 05BROADF 05.V1LPM	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
9	EPDC_STG.AA 05CANTNC 01.L34505SCANTO 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
10	EPDC_STG.AA 05CANTNC 02.L34505SECANT 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
11	EPDC_STG.AA 05CANTNC 03.L34502HANNA 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
12	EPDC_STG.AA 05CANTNC 04.L34505TIDD 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
13	EPDC_STG.AA 05CANTNC 05.B34505CANTNC 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
14	EPDC_STG.AA 05CANTNC 06.B34505CANTNC 2V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
15	EPDC_STG.AA 05CONES 01.L34505OHIOC 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
16	EPDC_STG.AA 05CONES 03.L34505CORRID 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
17	EPDC_STG.AA 05COOK 01.L34505OLIVE 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96
18	EPDC_STG.AA 05COOK 02.L34505TWIN B 1V1	500	■ Disabled	0	0	■ Disabled	■ Disabled	0.001	60	■ Disabled	7.96

Validation Settings

Base kV Settings

Stale Check

Enable Apply to Selected Signals ...

Variation Limit:

Duration:

Noisy Check through High Pass Filter

Enable Apply to Selected Signals ...

Cutoff Frequency:

Amplitude Average Interval:

Violation Limit:

Range Check

Enable Apply to Selected Signals ...

Passband Low:

Passband High:

Frequency Correlated

Planned Outage

Enable Apply to Selected Signals ...

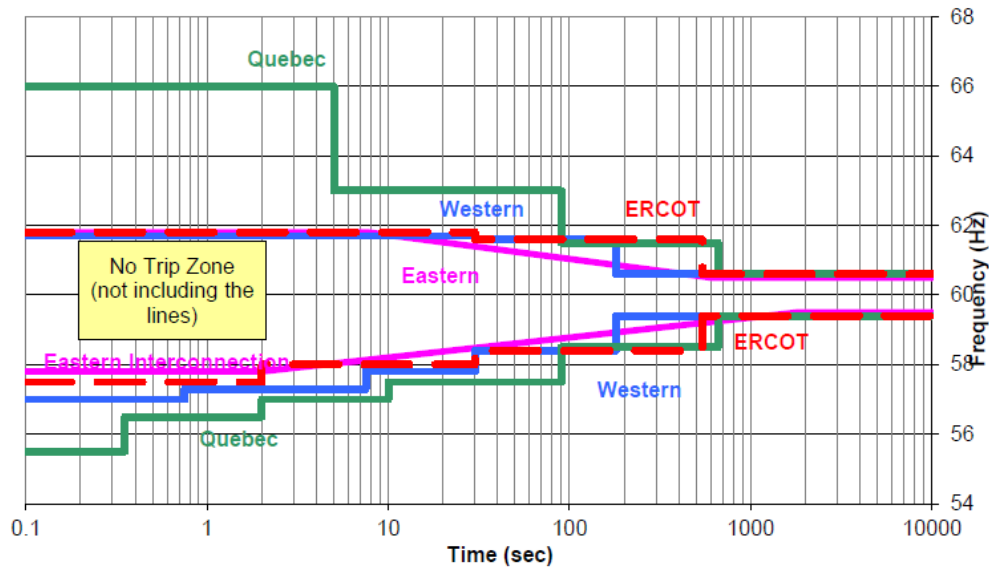
Start Time:

End time:

Apply Above to Selected Signals ... Export ... Import ...

PRC-024 — Attachment 1

## OFF NOMINAL FREQUENCY CAPABILITY CURVE



### Curve Data Points:

#### Eastern Interconnection

High Frequency Duration		Low Frequency Duration	
Frequency (Hz)	Time (Sec)	Frequency (Hz)	Time (sec)
$\geq 61.8$	Instantaneous trip	$\leq 57.8$	Instantaneous trip
$\geq 60.5$	$10^{(90.935-1.45713*f)}$	$\leq 59.5$	$10^{(1.7373*f-100.116)}$
$< 60.5$	Continuous operation	$> 59.5$	Continuous operation

- Current Magnitude: 1.5 \* load dump
- Voltage Magnitude: tbd

Data Manager Configuration:

- General
- Time Validation
- PMU Status Validation
- Value Validation
- Topology Validation
- Linear State Estimation
- User Algorithms

enhanced Linear State Estimation

Enable eLSE:

eLSE Service IP Address:

eLSE Service Port:

eLSE Network Model:  ...

Residue Limit:

Confidence Limit:

Phase:

Breaker Status

- PMU
- ICCP

PMU Digital Channels :

	SignalName	BreakerName
1	EPDC_STG.111 345 L11120.PSV49,PSV50,PSV51,PSV52,PSV53,PSV54,PSV55,PSV56,PSV57,PSV58,PSV59,PSV60,PSV61,PSV62,PSV63,PSV64.PSV49	
2	EPDC_STG.111 345 L11120.PSV49,PSV50,PSV51,PSV52,PSV53,PSV54,PSV55,PSV56,PSV57,PSV58,PSV59,PSV60,PSV61,PSV62,PSV63,PSV64.PSV50	
3	EPDC_STG.111 345 L11120.PSV49,PSV50,PSV51,PSV52,PSV53,PSV54,PSV55,PSV56,PSV57,PSV58,PSV59,PSV60,PSV61,PSV62,PSV63,PSV64.PSV51	
4	EPDC_STG.111 345 L11120.PSV49,PSV50,PSV51,PSV52,PSV53,PSV54,PSV55,PSV56,PSV57,PSV58,PSV59,PSV60,PSV61,PSV62,PSV63,PSV64.PSV52	
5	EPDC_STG.111 345 L11120.PSV49,PSV50,PSV51,PSV52,PSV53,PSV54,PSV55,PSV56,PSV57,PSV58,PSV59,PSV60,PSV61,PSV62,PSV63,PSV64.PSV53	
6	EPDC_STG.111 345 L11120.PSV49,PSV50,PSV51,PSV52,PSV53,PSV54,PSV55,PSV56,PSV57,PSV58,PSV59,PSV60,PSV61,PSV62,PSV63,PSV64.PSV54	
7	EPDC_STG.111 345 L11120.PSV49,PSV50,PSV51,PSV52,PSV53,PSV54,PSV55,PSV56,PSV57,PSV58,PSV59,PSV60,PSV61,PSV62,PSV63,PSV64.PSV55	

Breaker Names :

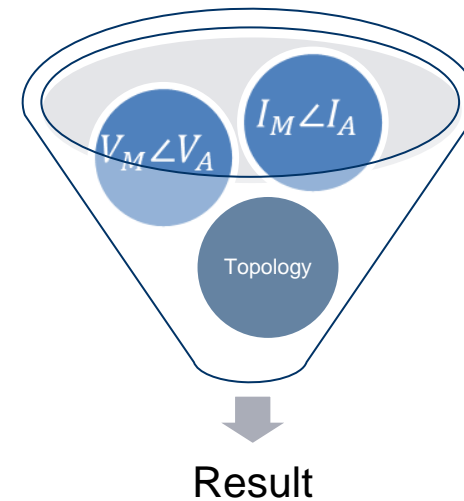
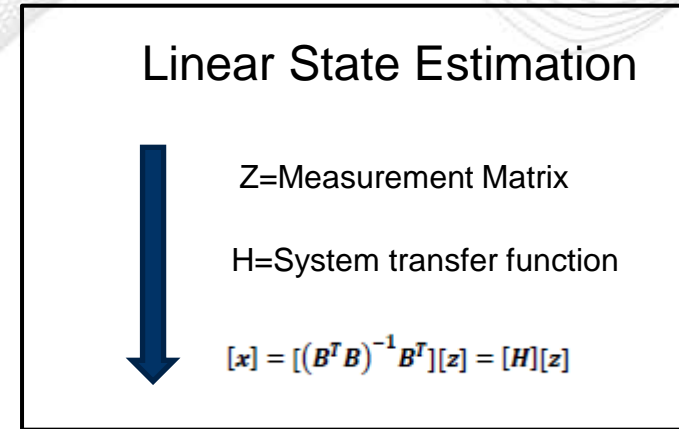
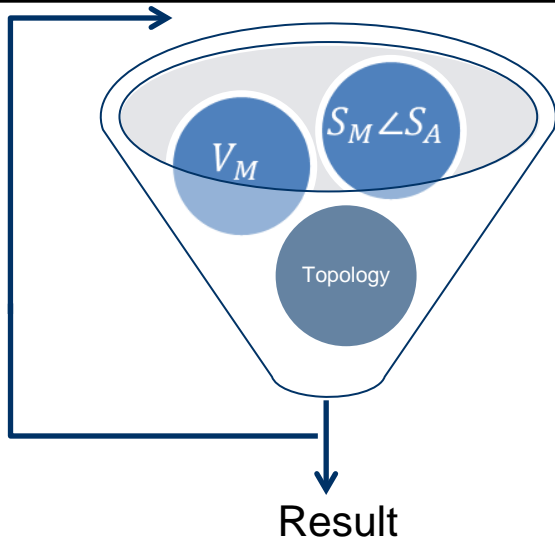
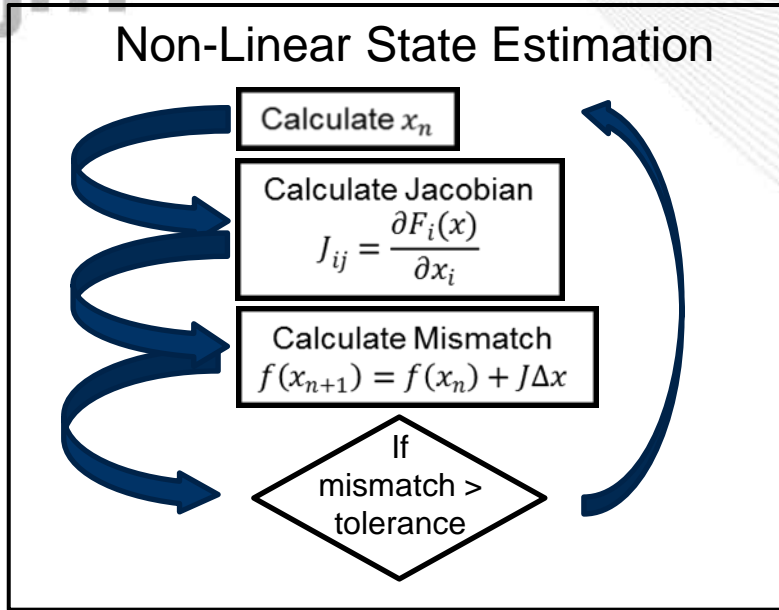
Auto Map Breaker Names

Reset

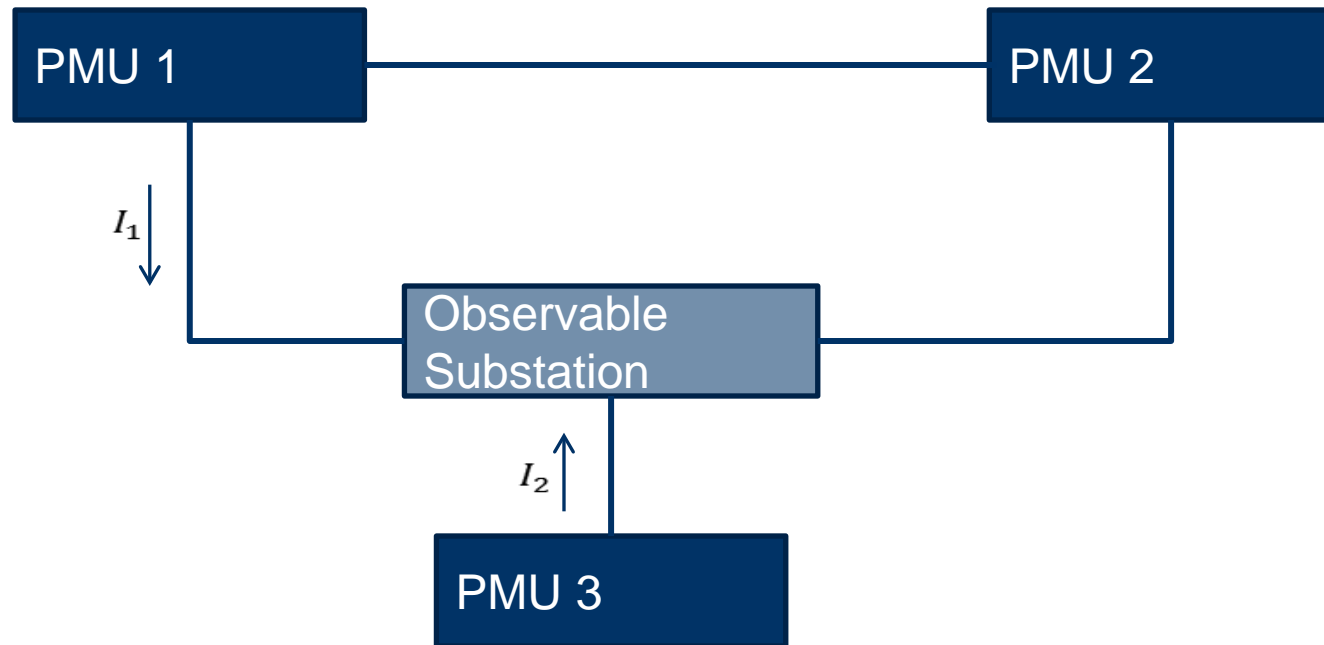
Reset All

Save Config

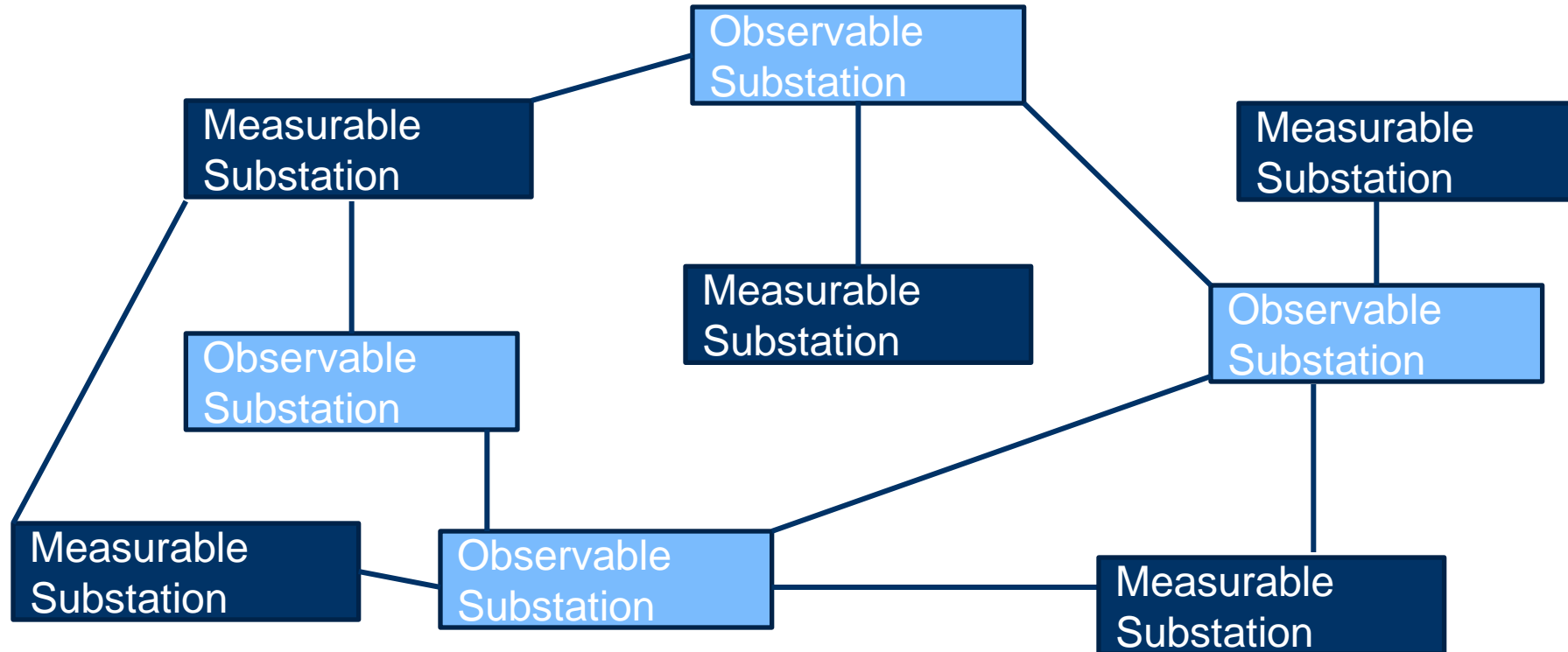




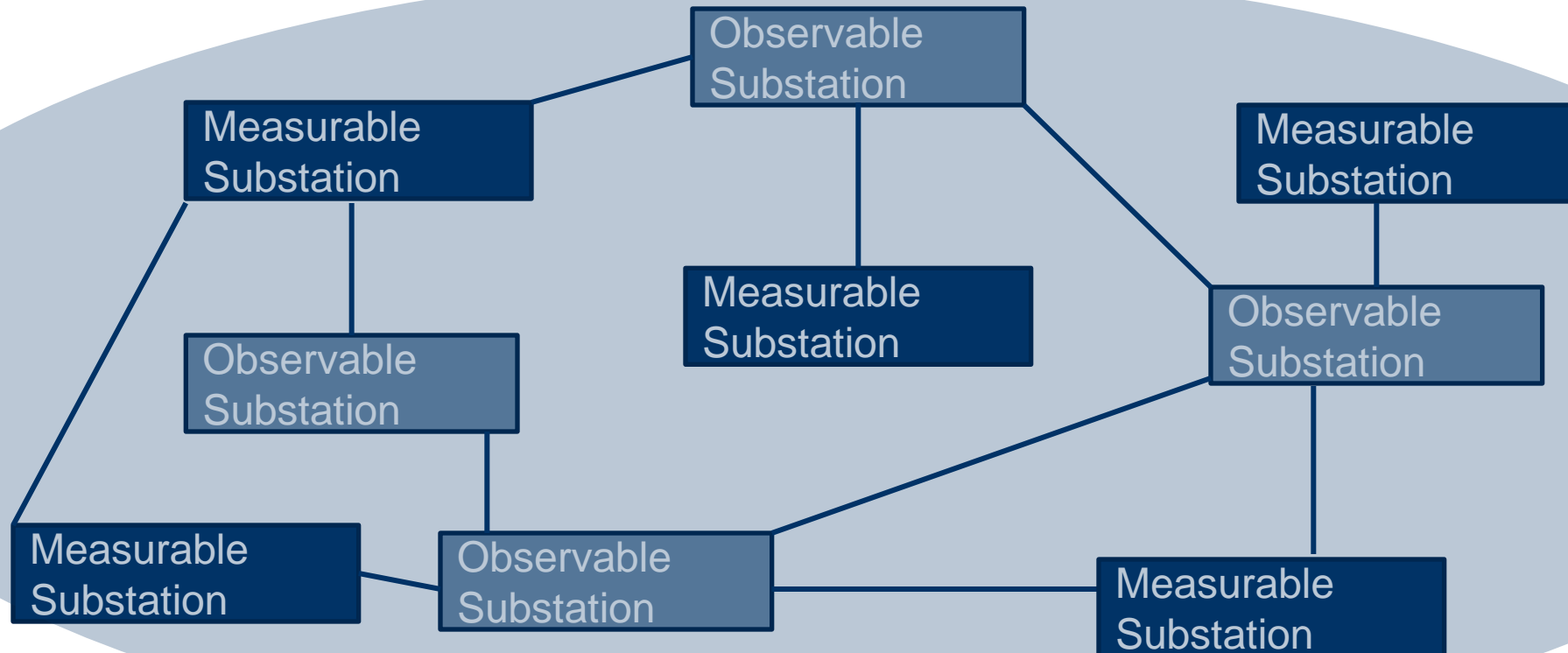
- A Linear State Estimator can be used to infer PMU equivalents, where substations without PMU measurements can still be monitored

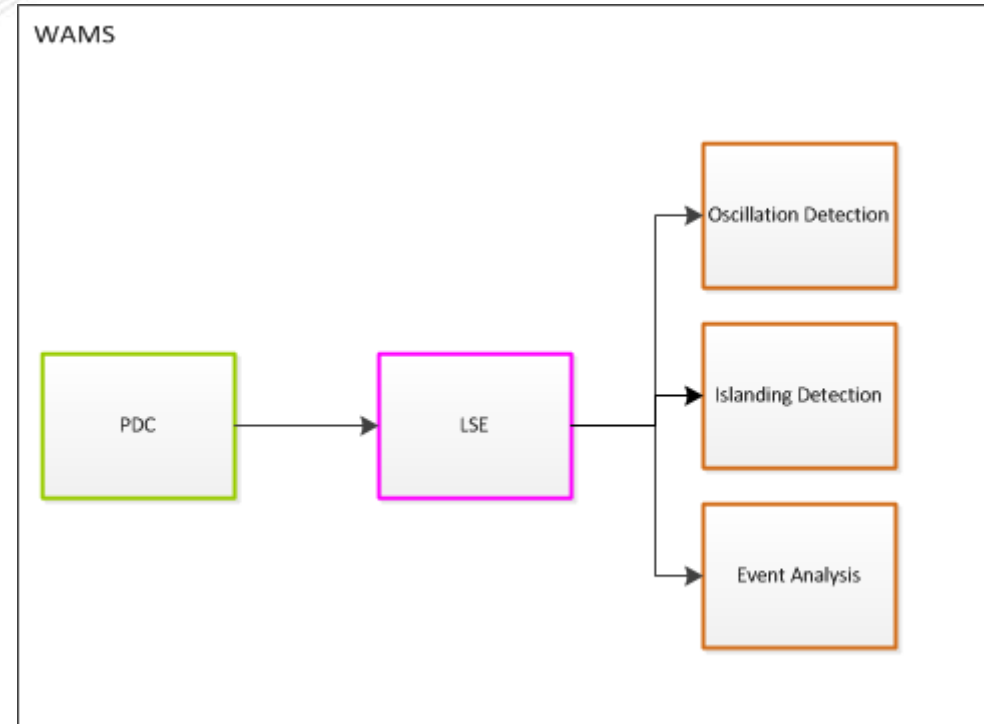
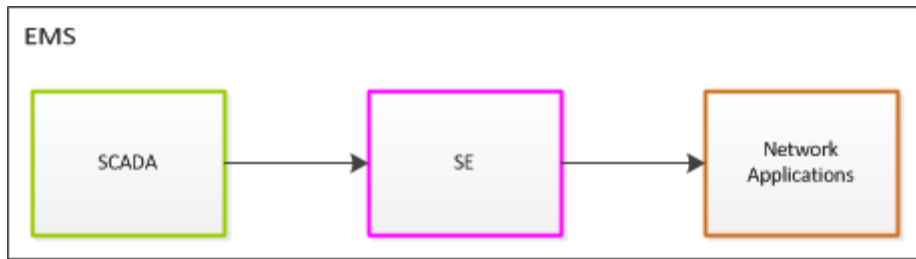


- A Linear State Estimator fills-in the picture of our grid.
- A Linear State Estimator is an advanced step to improving data quality.



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- A Linear State Estimator is an advanced step to improving data quality.





- Uses of Synchrophasor data are growing and maturing
- Management of data can be difficult
- To chart a path forward;
  - PMU data quality needs to be defined and measured
  - PJM must provide guidance for PMU installations