State Estimation for Advanced Distribution Automation

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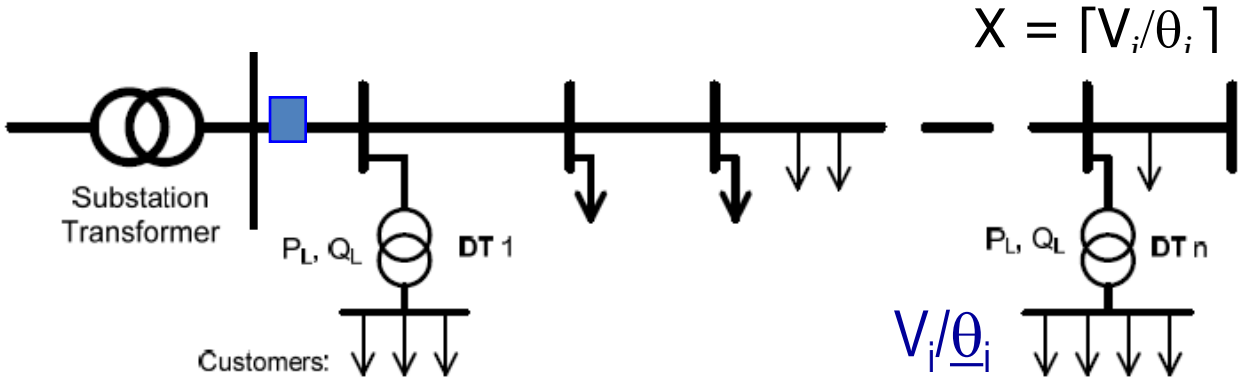
State Estimation: Main Tool for System Monitoring and Control

SE Problem:

Given a set of measurements z, estimate x



- Basic Requirements:

-Need accurate system model

-Need redundant measurements

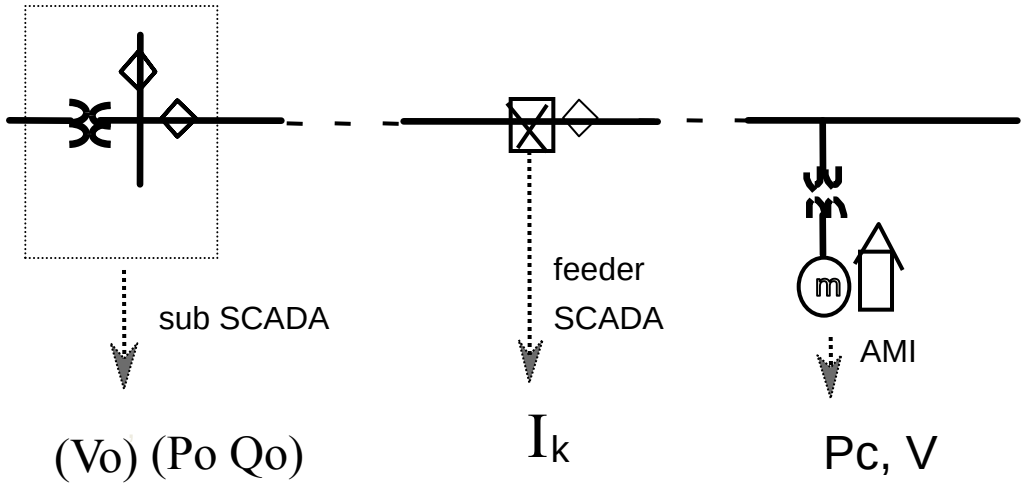
- for radial feeders

  x ←> load

  SE ←-> Load Monitoring

SE Challenges for DS Application

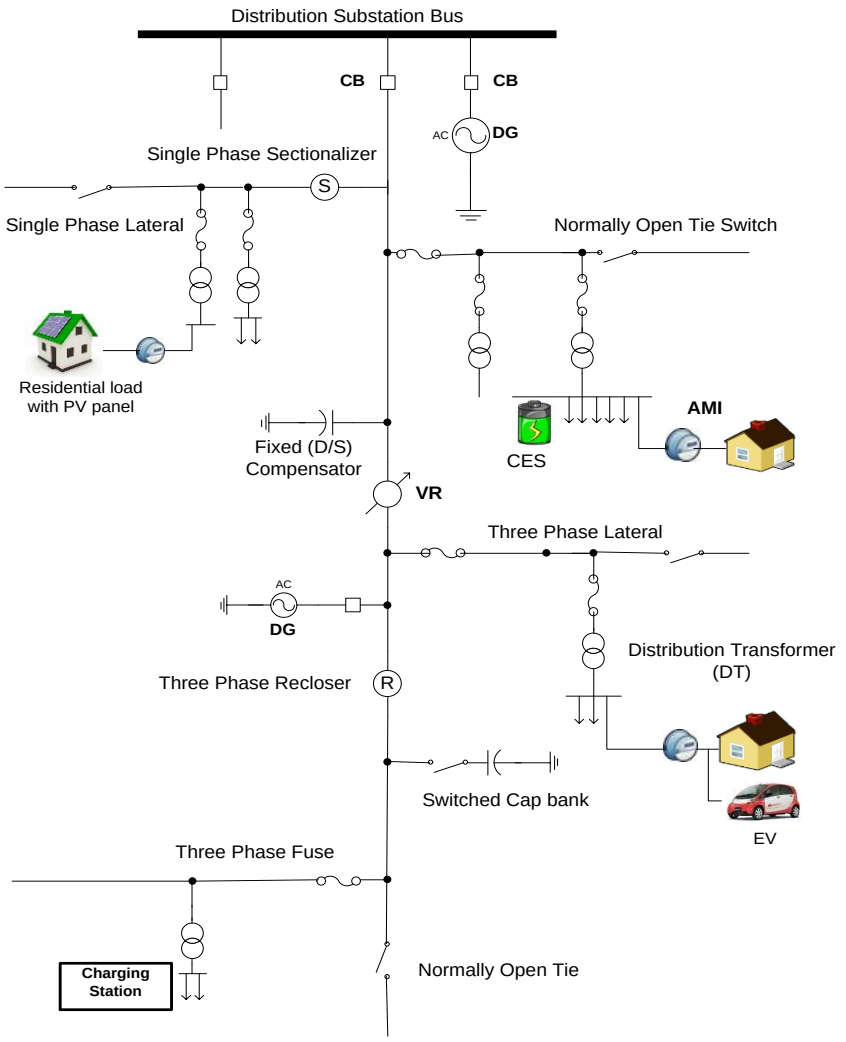
- Very Limited Measurements



- Load Data requires full scale AMI

SE Challenges for DS Application

- Accurate System Model
  - accurate system data
    - Lines, DT
  - Need monitoring
    - Switches
    - Volt/Var devices
    - DG and Storage



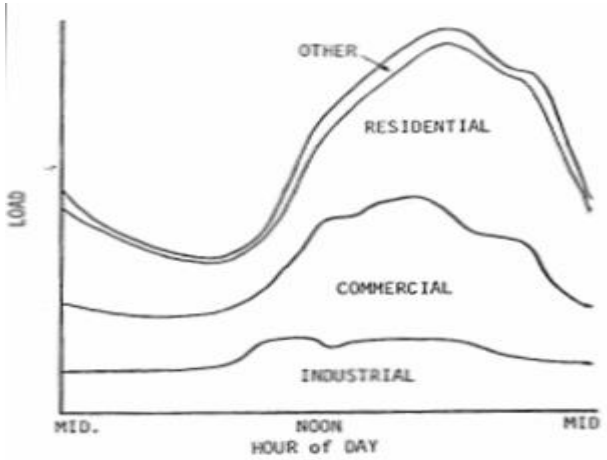

System Specifics:
-7 Feeders
-7 Circuit Breakers
-331 Fuses
-2194 Nodes

DSE: State of the Art

- Limited Real Time Data:

  Use Load Data as pseudo-measurements

  Load Data: Historical Data
  - Customer Billing --> class, kWh
  - Load Surveys --> Load Curves



- Model:

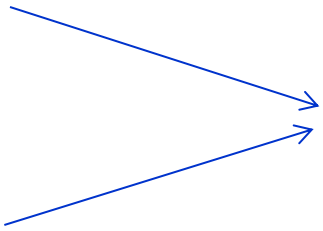
  Feeder topology is updated manually

- SE methods: - Power Flow
  - WLSE nodal, WLSE branch current
  - Others

DSE for System Monitoring & Control

- **DSE enables on-line monitoring of**

  - Load & Voltage profiles
    - ➢ system loading
    - ➢ control actions
      - Volt/Var Control
      - Conservation Voltage Reduction
    - ➢ Feeder restoration
  - Feeder Topology
    - ➢ switch operation
    - ➢ Cap bank



BCSE Application

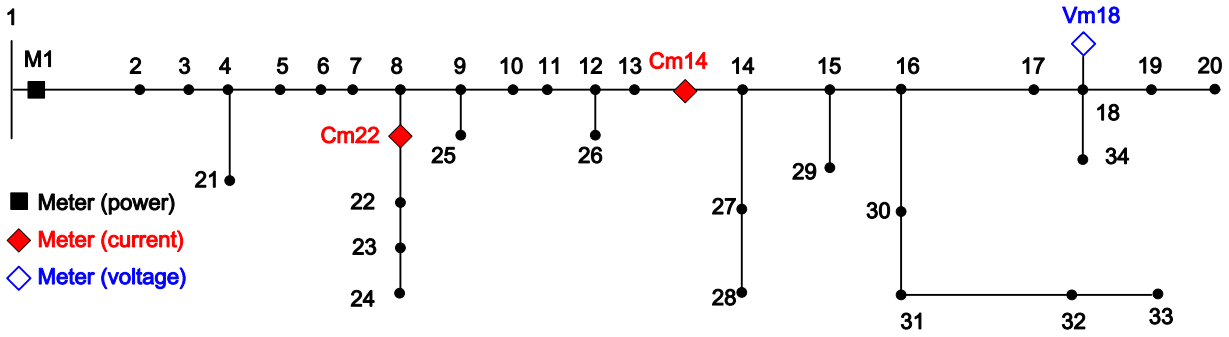
Goal: Conservation Voltage Reduction

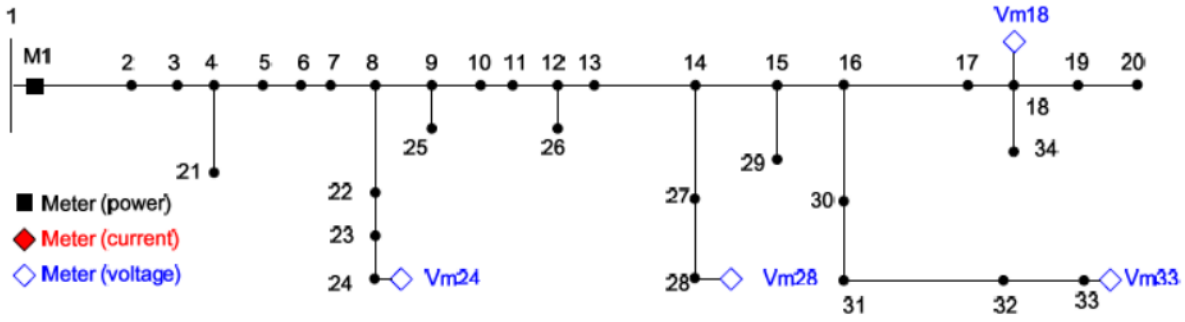
→ Estimate Voltages with 120 +/- 2 V accuracy

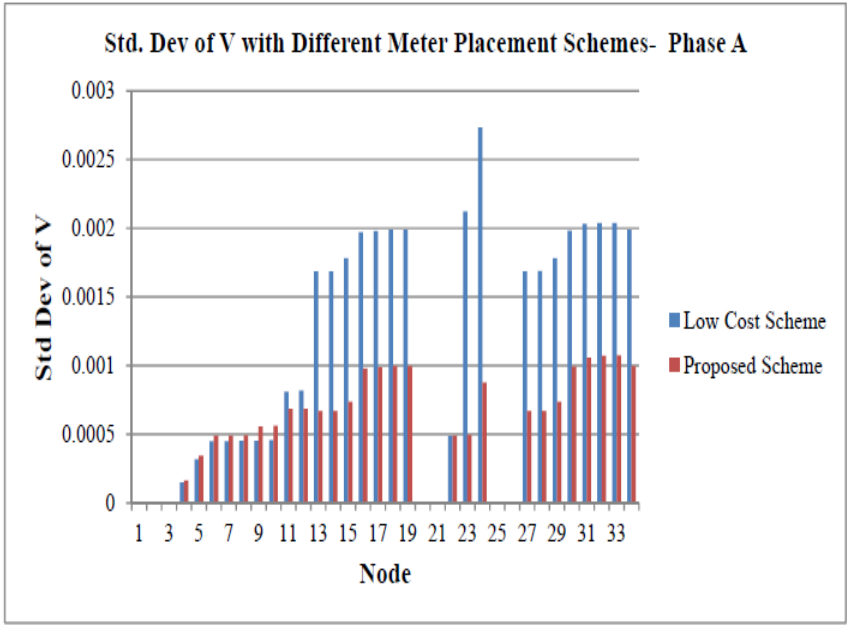
⇩

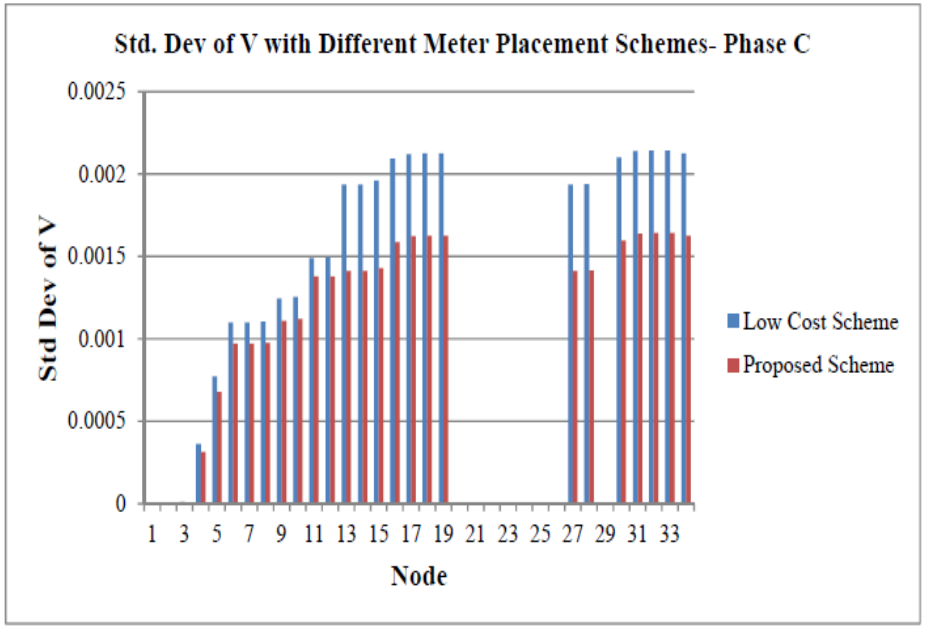
SE performance: estimate Vs with accuracy of +/- 2V →

$$\tilde{\sigma}_V \cong 0.0028\ p.u.$$




1
M1
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Vm18
21
22
23
24
Vm24
25
26
27
28
Vm28
29
30
31
32
33
Vm33
34
Meter (power)
Meter (current)
Meter (voltage)


Std. Dev of V with Different Meter Placement Schemes- Phase A
Std Dev of V
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
Node
Low Cost Scheme
Proposed Scheme


Std. Dev of V with Different Meter Placement Schemes- Phase C
Std Dev of V
0.0025
0.002
0.0015
0.001
0.0005
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
Node
Low Cost Scheme
Proposed Scheme