Selection of Reference Node and Angular Baselining using Synchrophasors Measurement for Real Time Operation

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Outline

Reference Node Selection

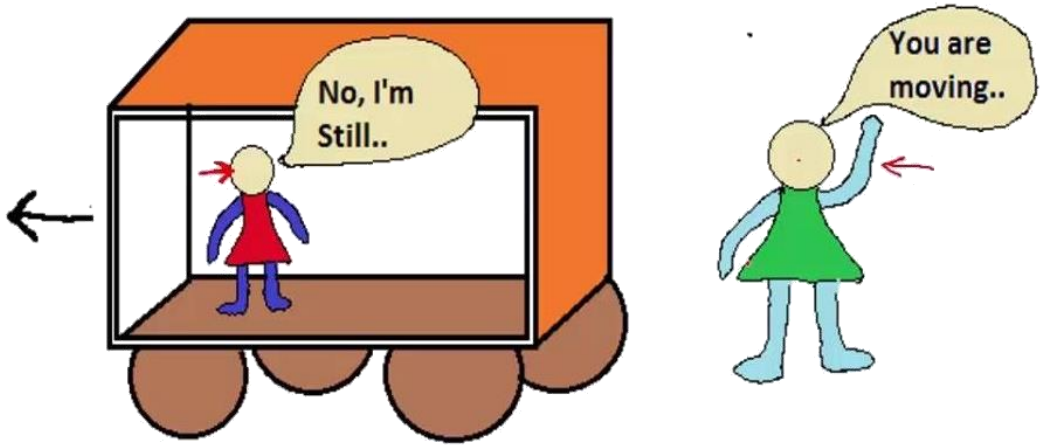
- Need for Selection of Reference Node
- Case Studies with different Reference Node
- Summary

Angular Baselining

- Angular Baselining Need & Case Studies
- Summary

Need for Reference Node Selection

- **Required for Offline Power System Simulations**
- **Required for EMS/SCADA**
- **Similarly required for Synchrophasors based analysis**



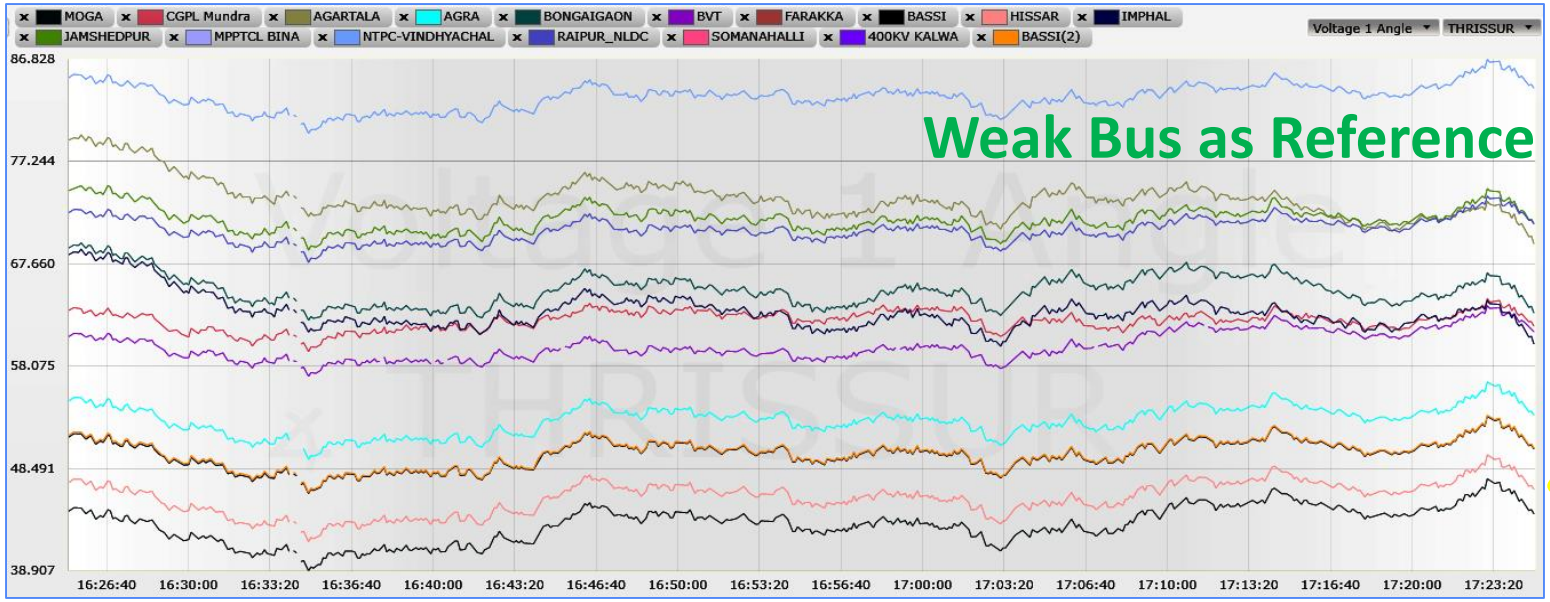
Angular separation is vital in Wide Area Monitoring System

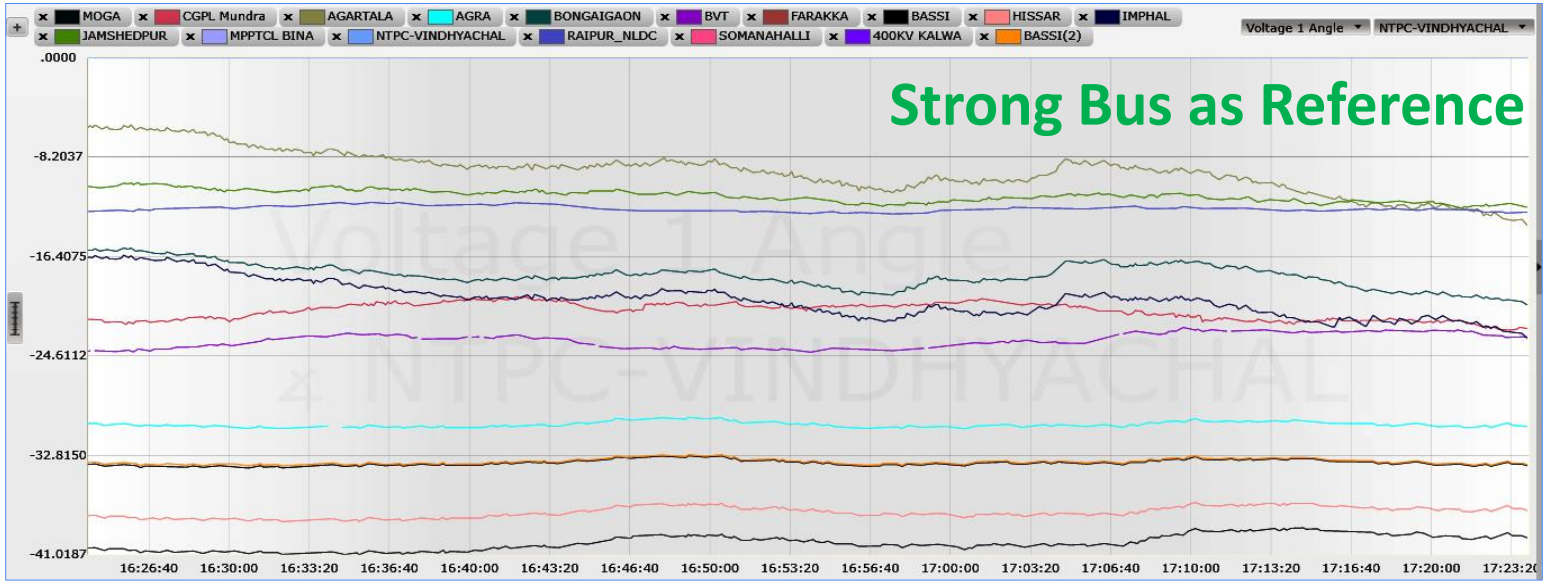
- **Assessing the stress in the grid**
- **Oscillation Monitoring**
- **Event Detection and localization**
- **Visualizing power flow pattern**

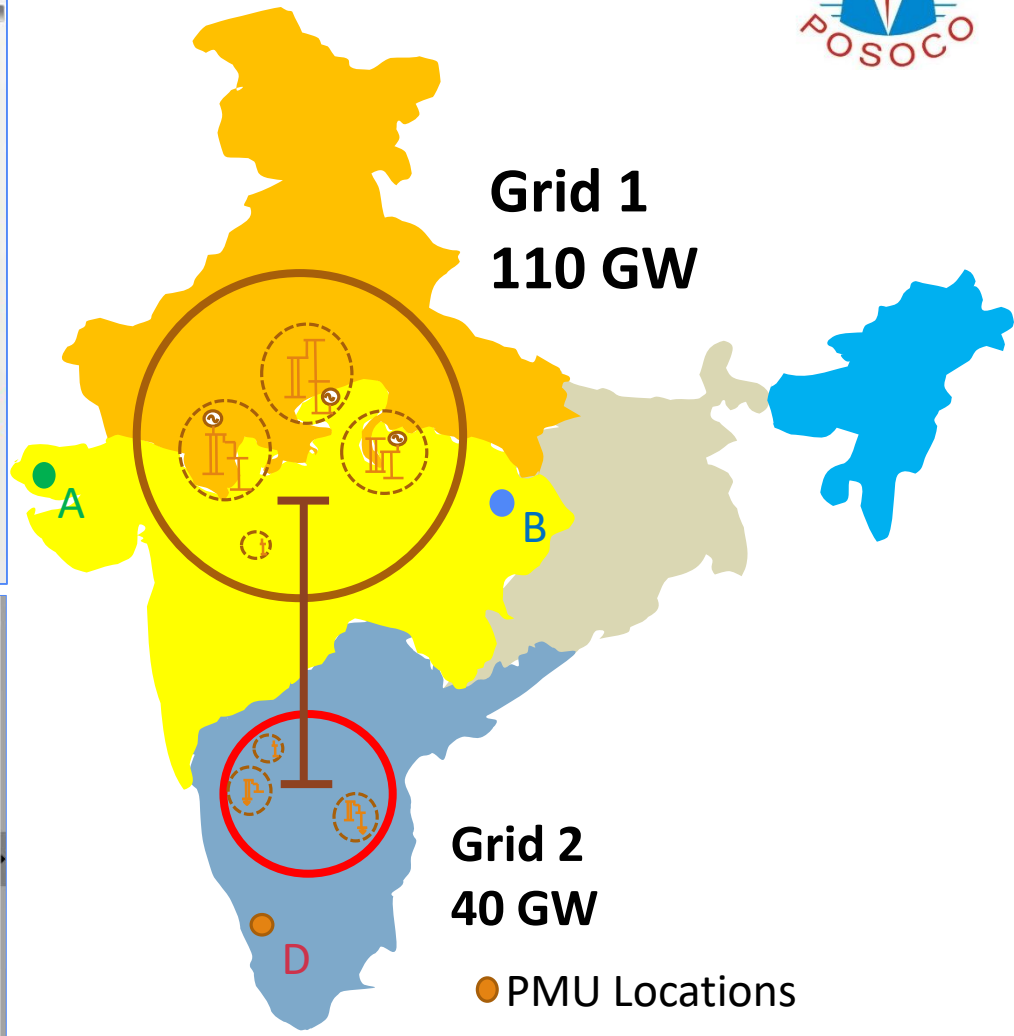
Case Studies with different Reference Nodes

- Case-1- Weak Vs Strong Bus as Reference Node
- Case-2- Bus with Unreliable Vs Reliable Communication as Reference Node
- Case-3- Reference Node Near Vs Far from Event Location
- Case-4- Reference Node away from HVDC
- Case-5- Reference Node near to Varying Generation Complex

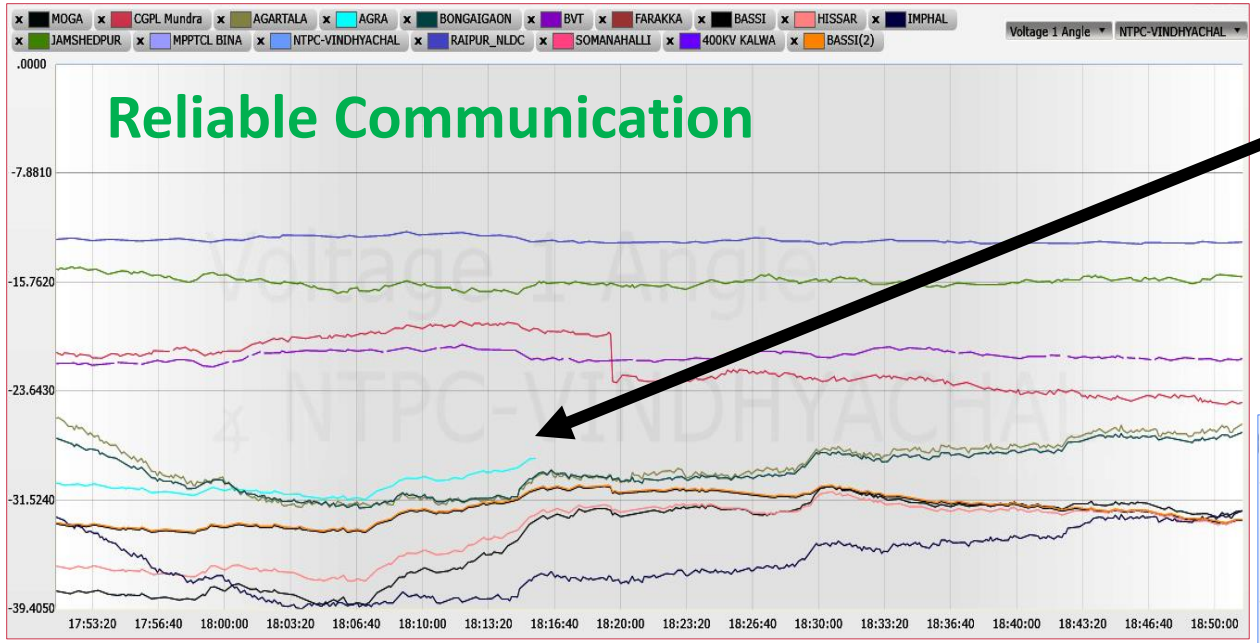
Case-1 : Weak vs Strong Bus as Reference Node





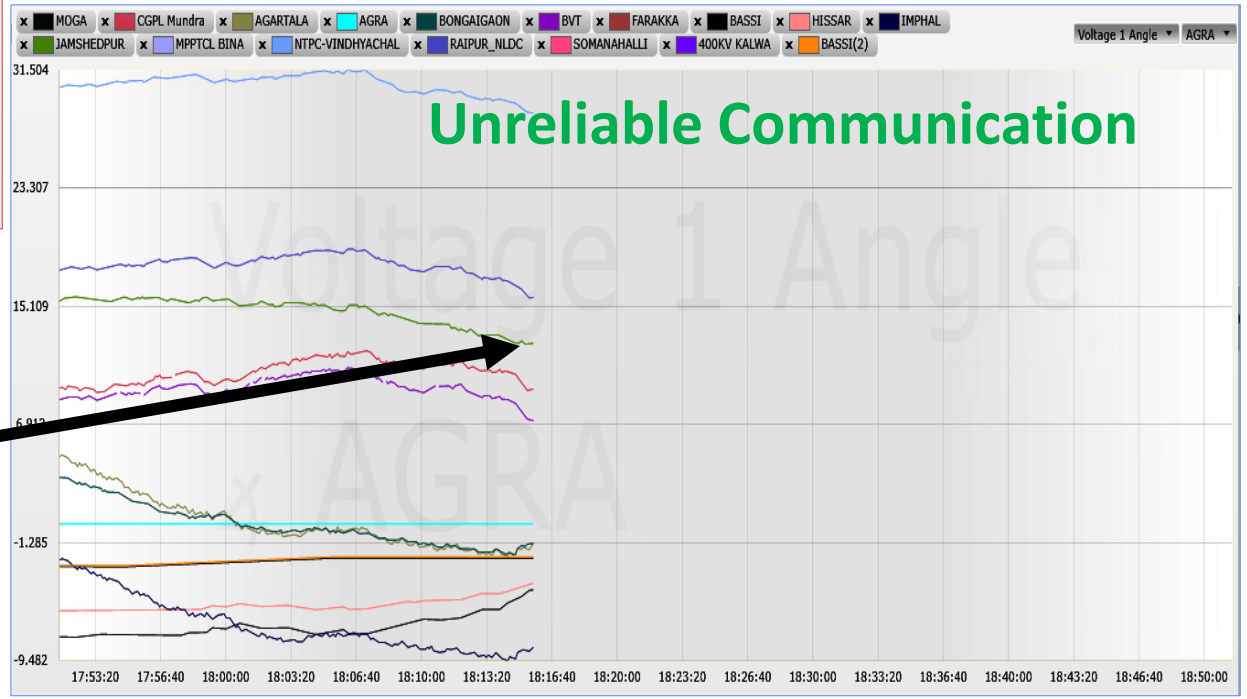


Case-2 : Bus with Unreliable vs Reliable Communication as Reference Node

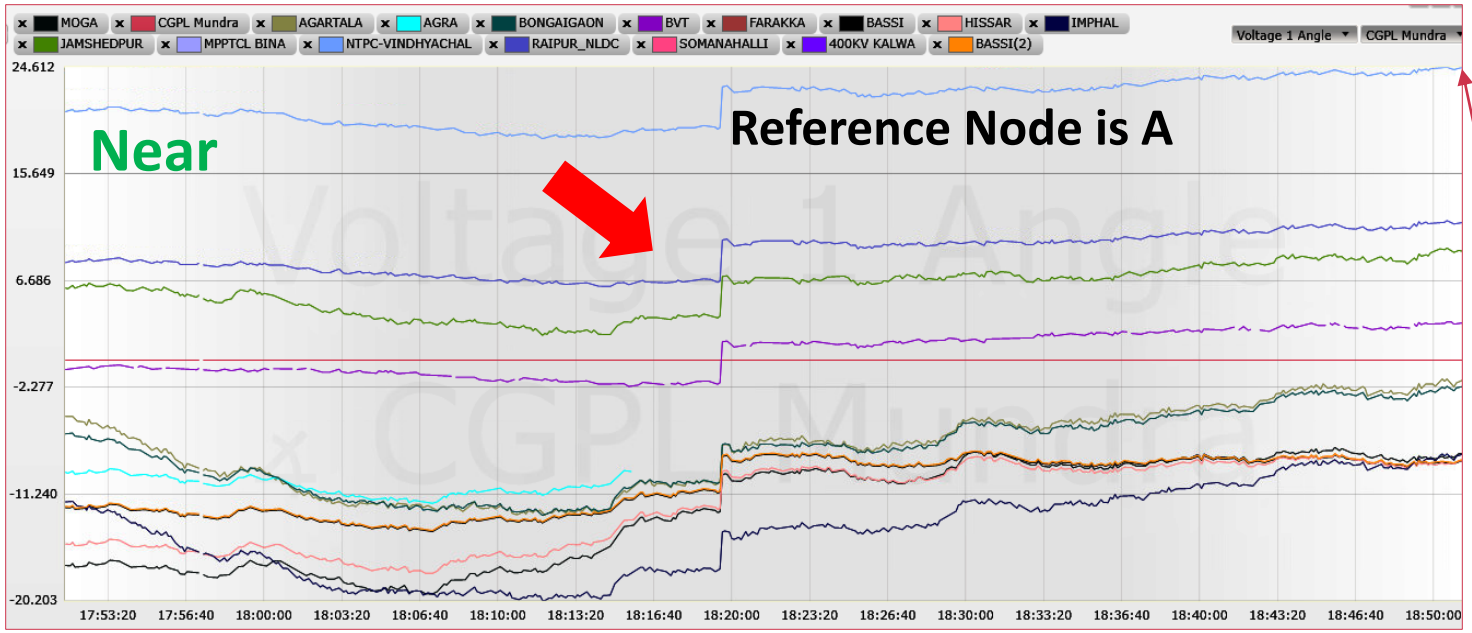


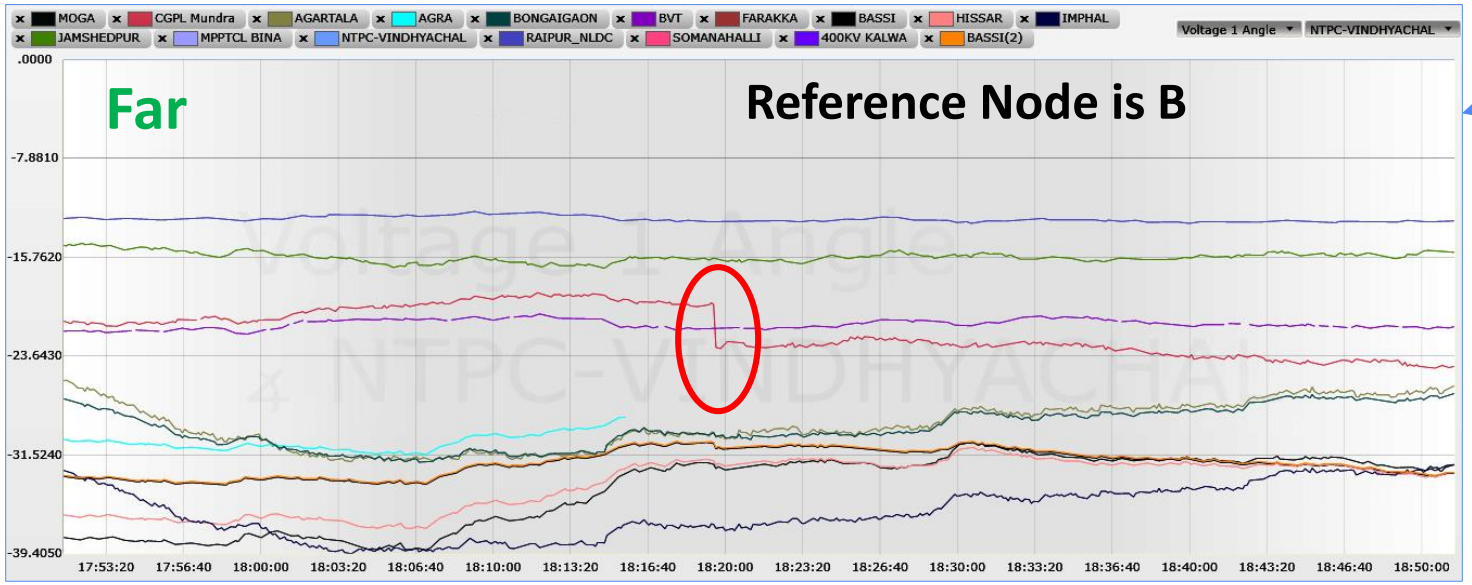
Data from one of the node is non current

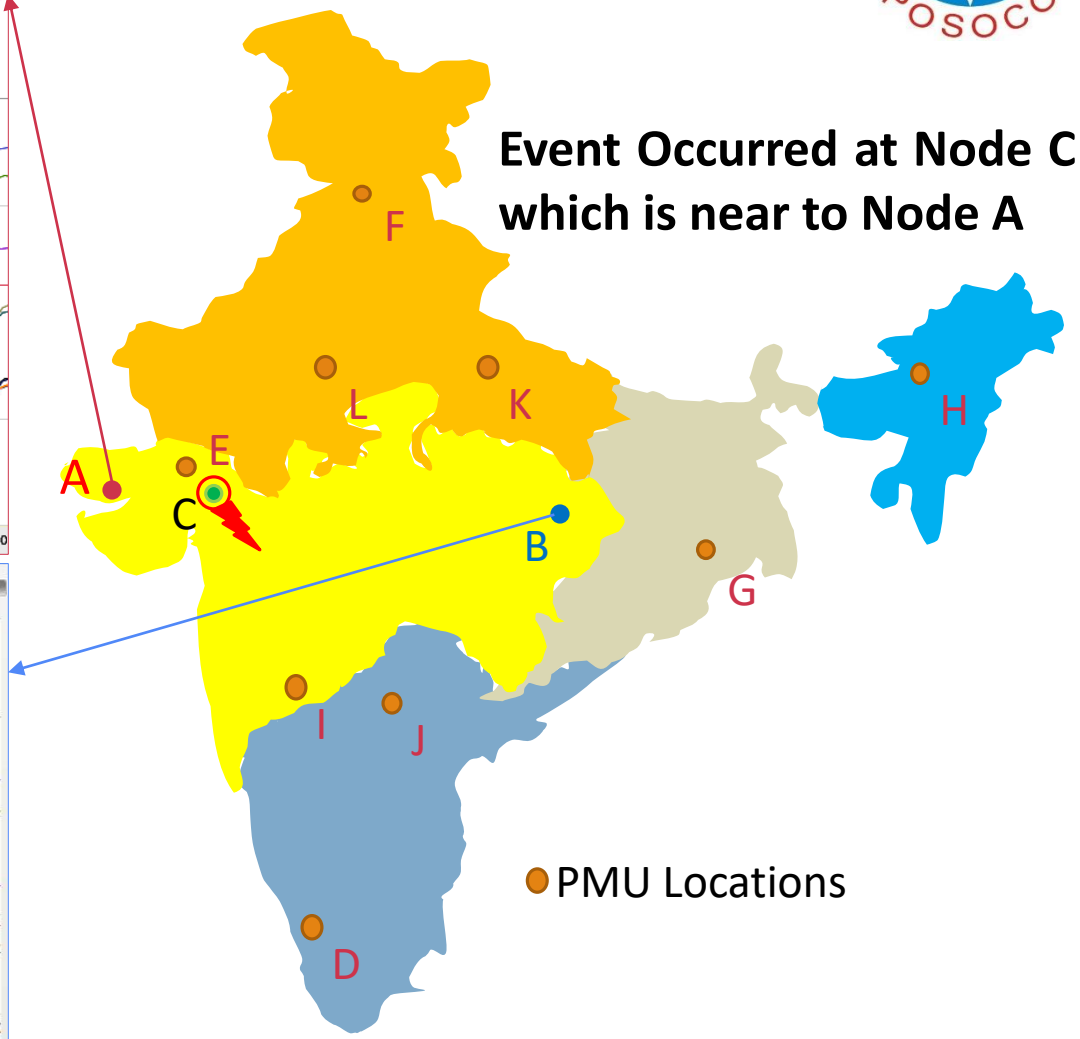
When PMU has taken as reference whose data is not updating , Rest of Angular Separation can not be visualized



Case-3 : Reference Node Near vs Far from Event Location



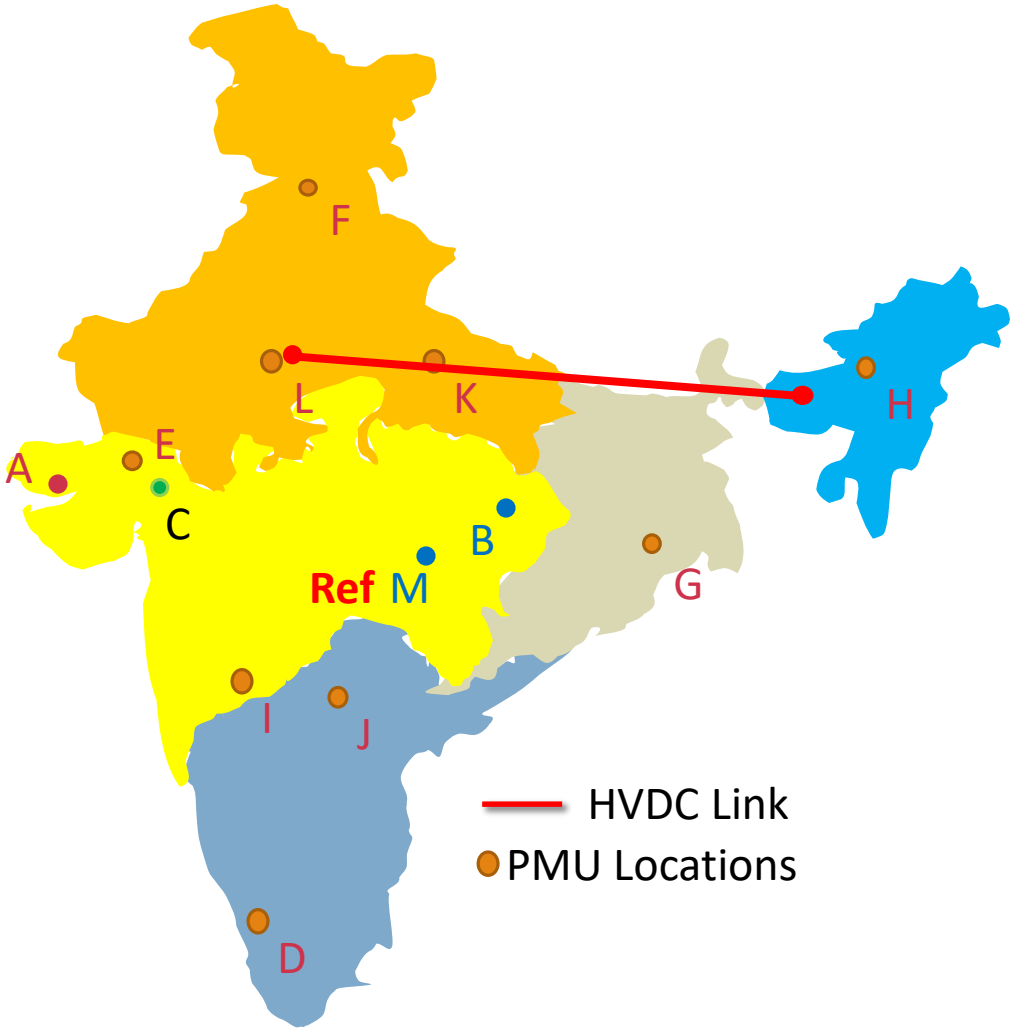


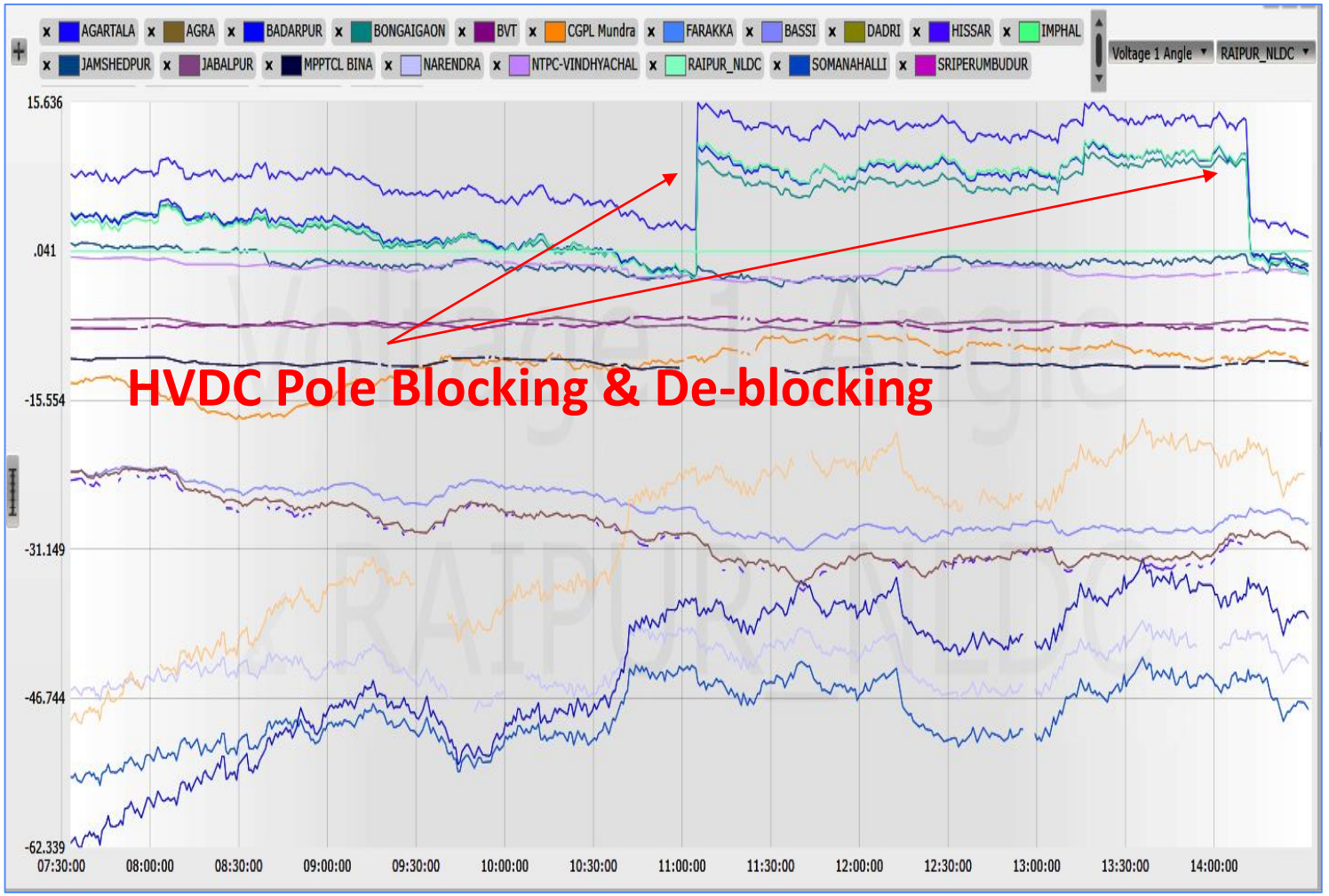


Event Occurred at Node C which is near to Node A

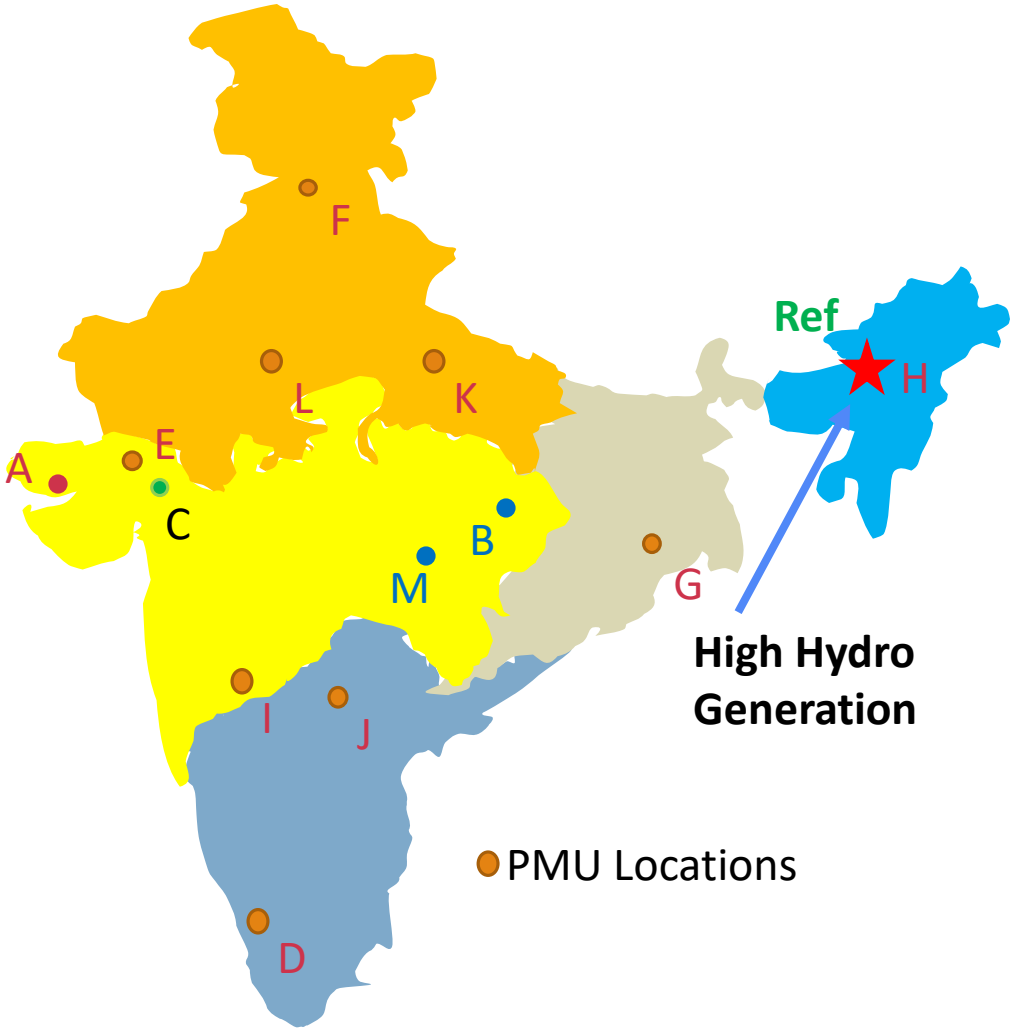
Reference node distant from Event node Helps in identifying the event location

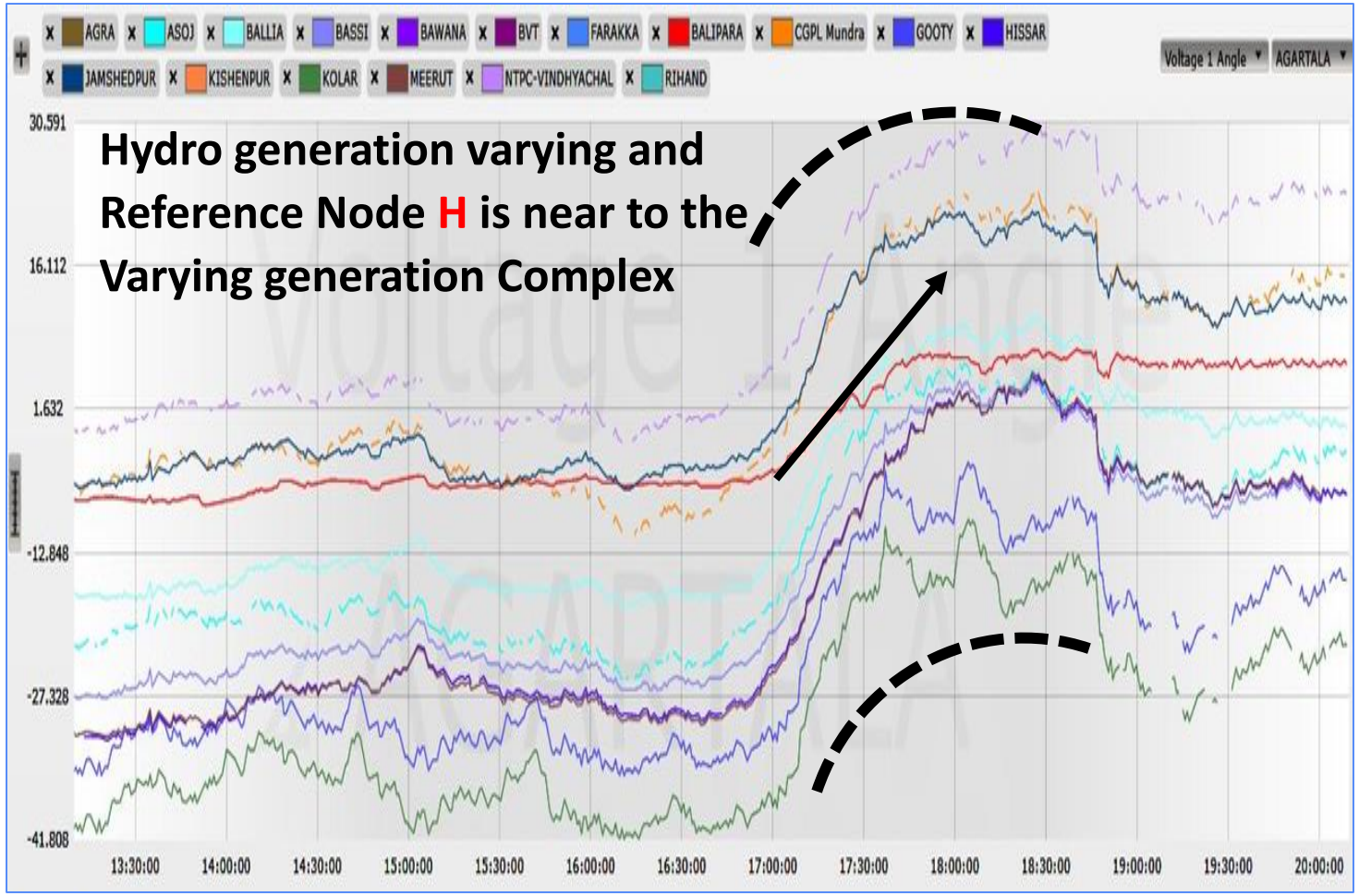
Case-4 : Reference Node away from HVDC





Case-5 : Reference node near to Varying Generation Complex





Summary

- **Preferred locations for reference node**
  - Node with strong Interconnections
  - Nodes with reliable communication
  - Node close to base load Generation Complex
  - Node with High fault level
  - Nodes consistent with offline simulation/EMS studies
  - Should be system-wide available and reliable
- **Nodes to be avoided**
  - Nodes with Low inertia, Weak tie lines, Low fault level,
  - Nodes located in Oscillation prone area,
  - Nodes near to HVDC Bus,
  - Nodes near to Varying Generation Complex

Summary Contd…

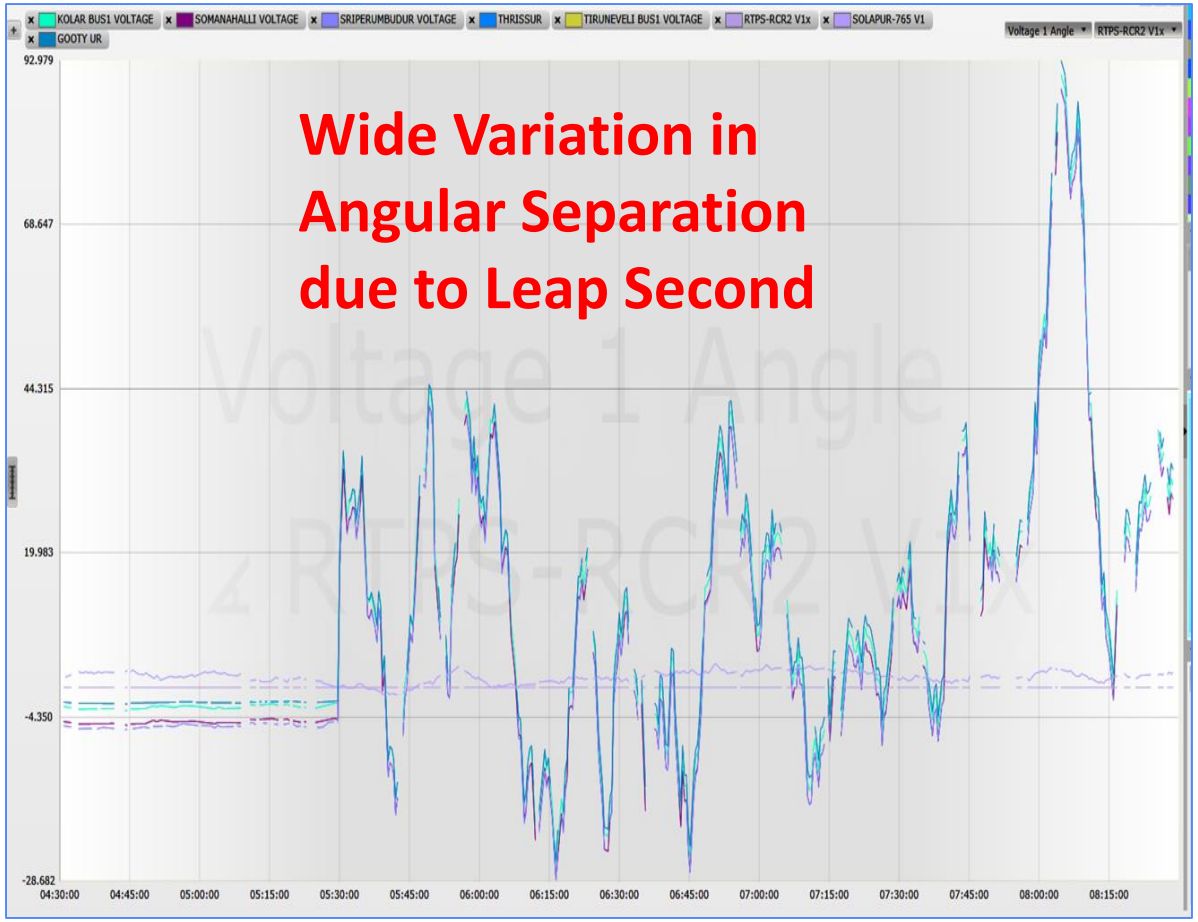
- **Reference node selection lookup table to be prepared**
  - Priority list for reference node selection based on above experiences.
  - To be reviewed depending on Visualization and Application Requirement and
  - To be reviewed periodically

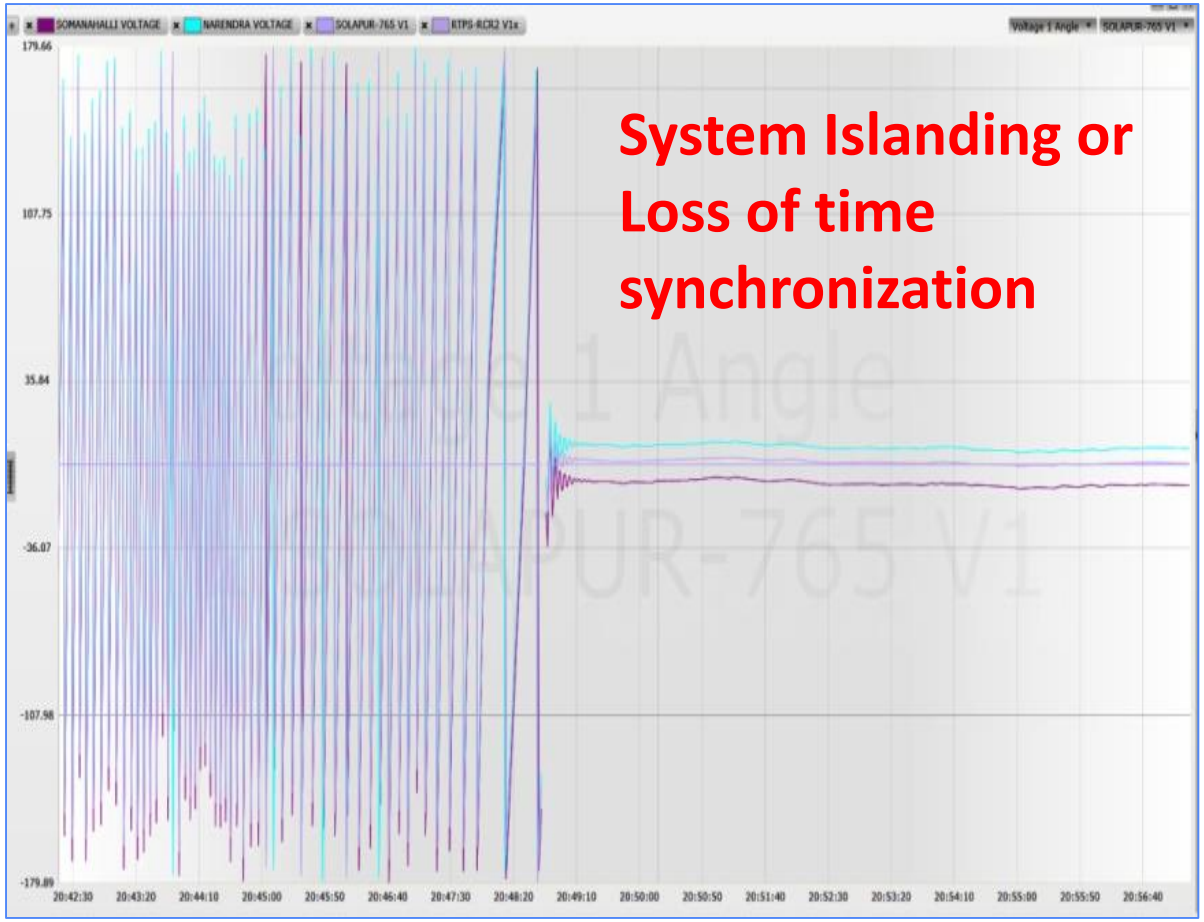
Angular Baselining

Need for Angular Baselining

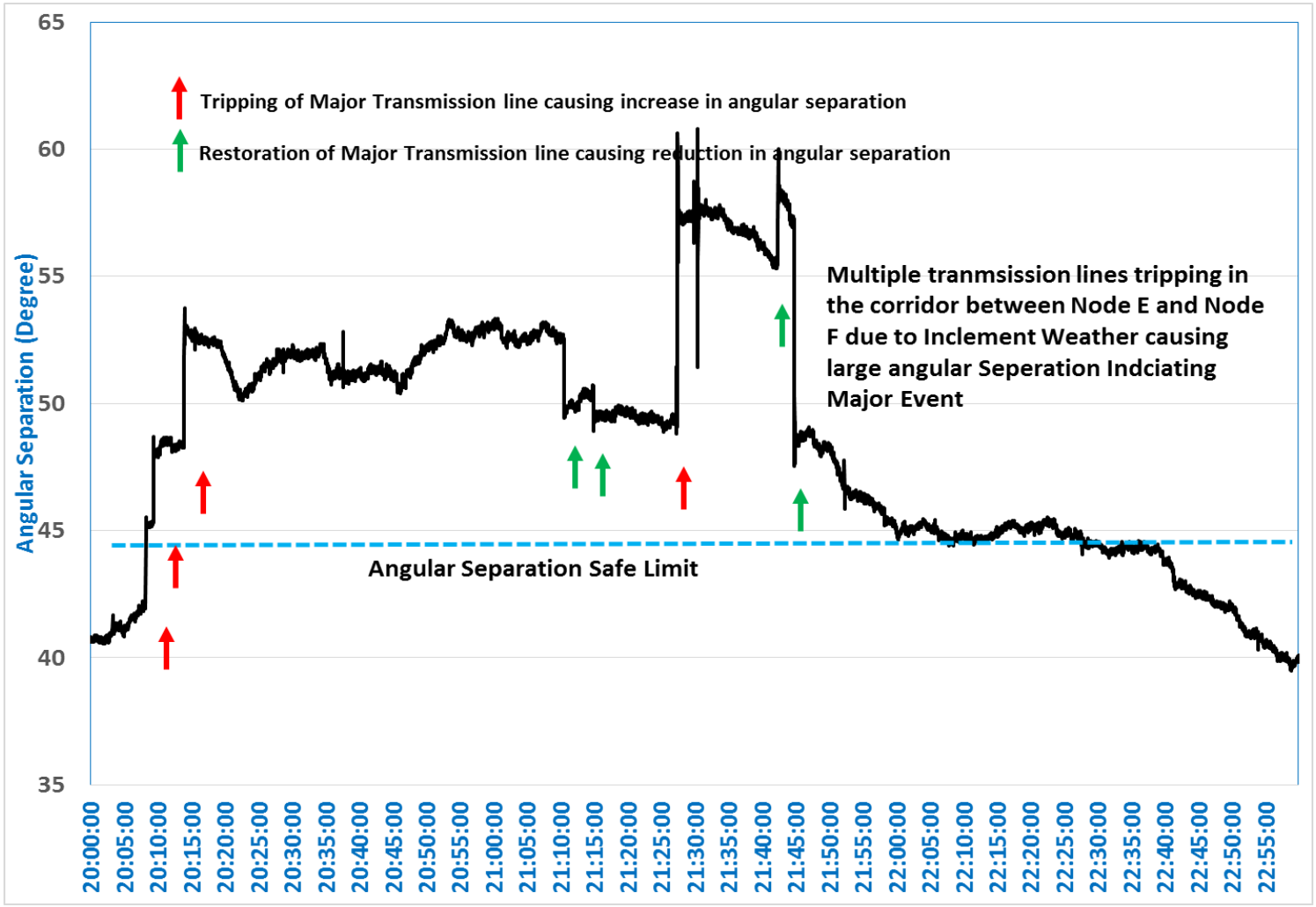
- **Validation of the data/Plausibility check**
  - To compare and validate angle limits with the state estimator and offline load flow studies
- **To distinguish between normal and abnormal grid conditions-**
  - Discriminate seasonal off peak and peak stressed conditions
- **For alarm generation to alert the operator**

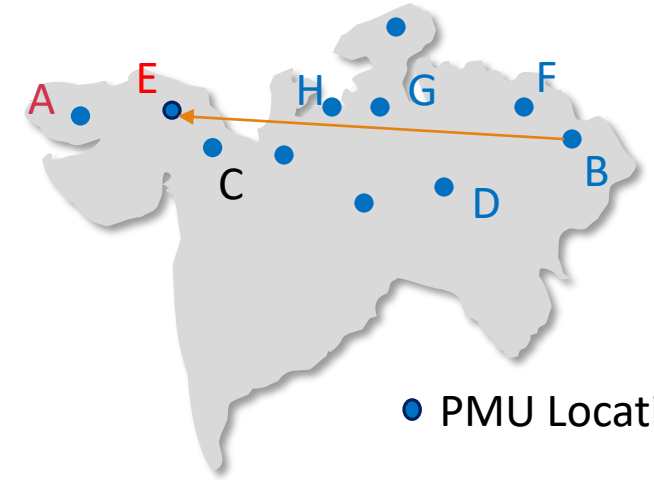
Validation of the data/Plausibility check

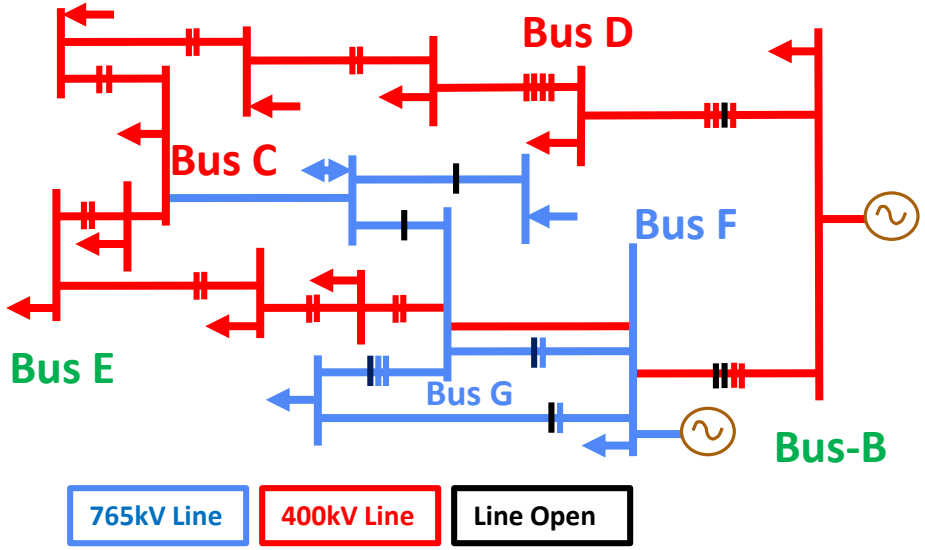




Normal and Alert Grid Operation



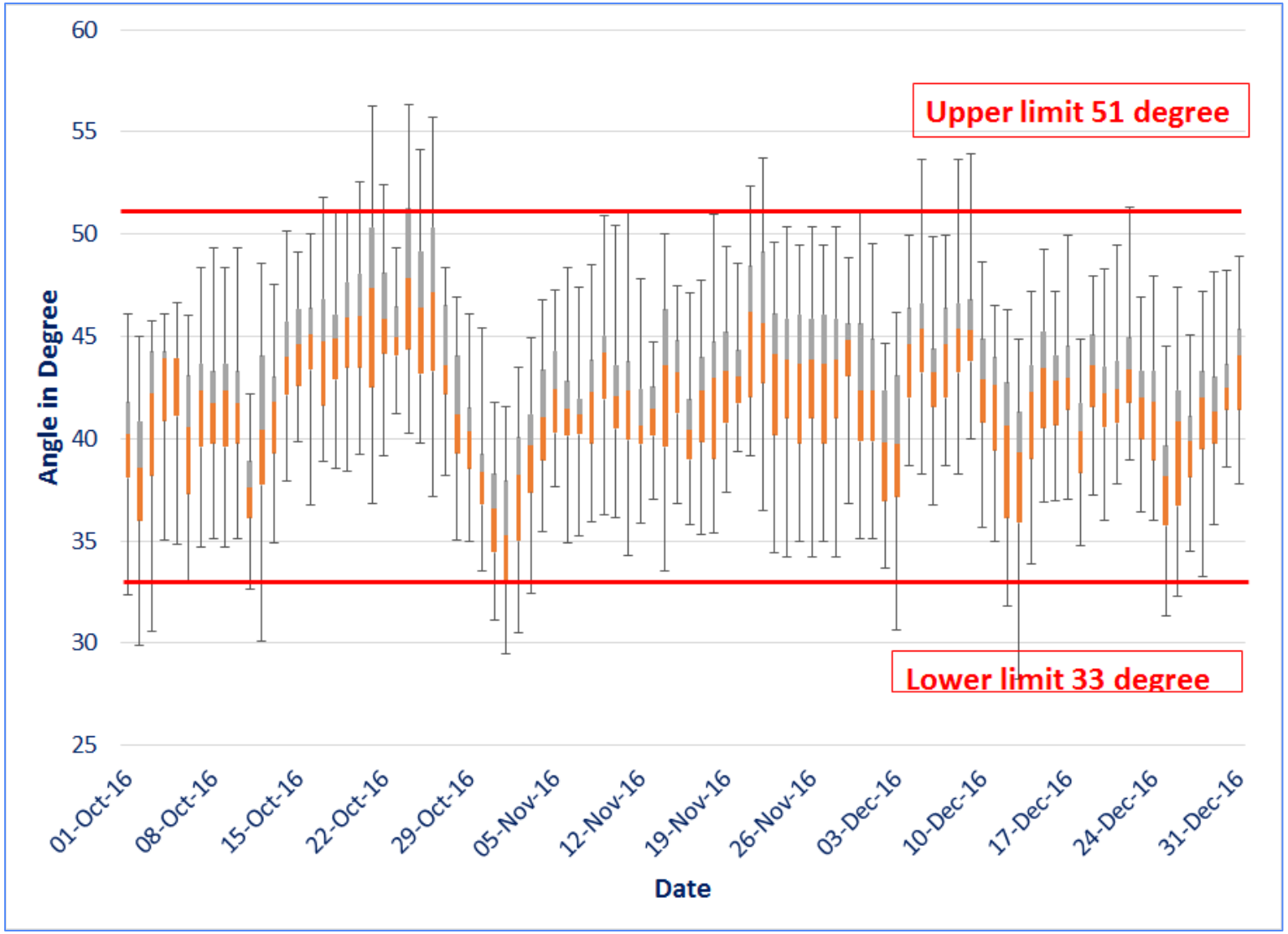


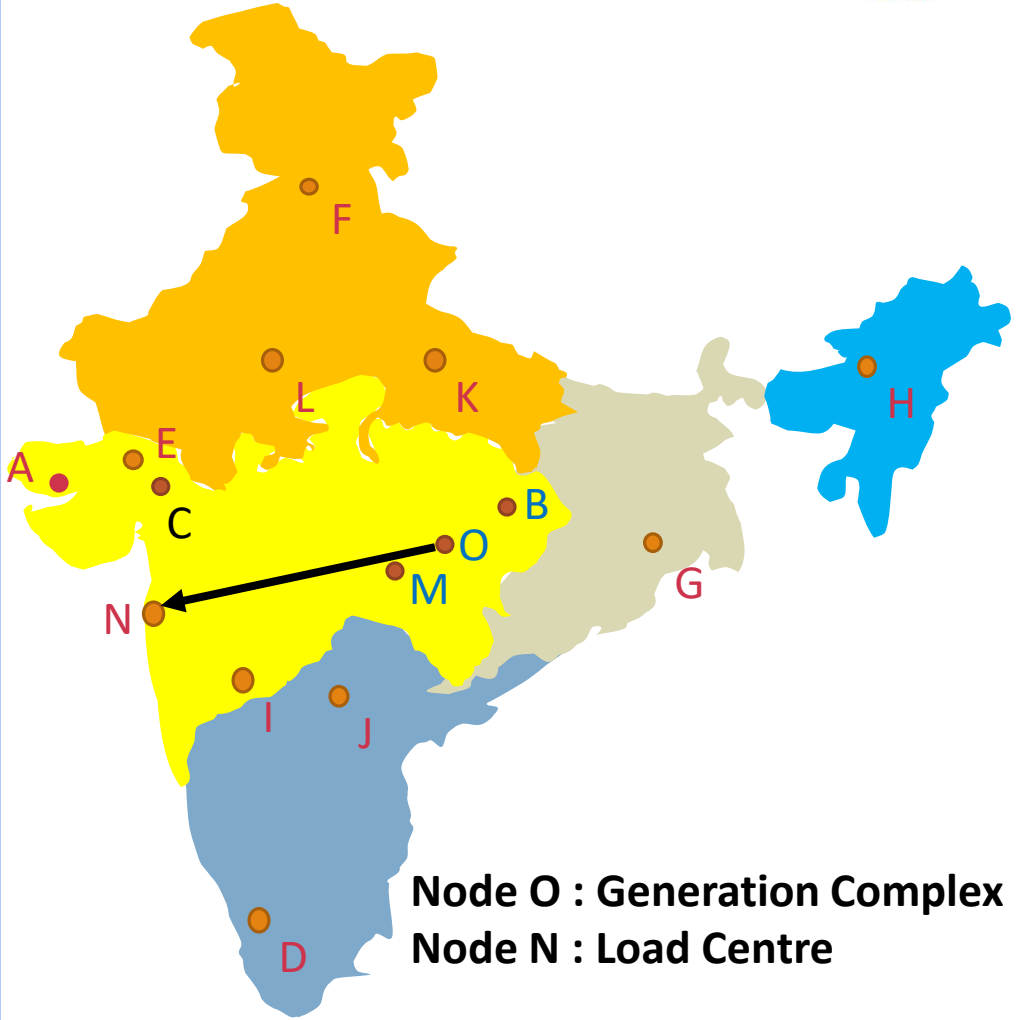


Criteria for Selection of Angle Node Pairs

- **Wide Area Node Angle Pair**
  - Generation complex to load complex
  - Power Corridors/Flow Gates
  - Power Corridors from One Region to Other.
  - Maximum Angular Separation in the Grid(wide distant node).
- **Adjacent Node Angle Pair**
  - Both ends angle should be available

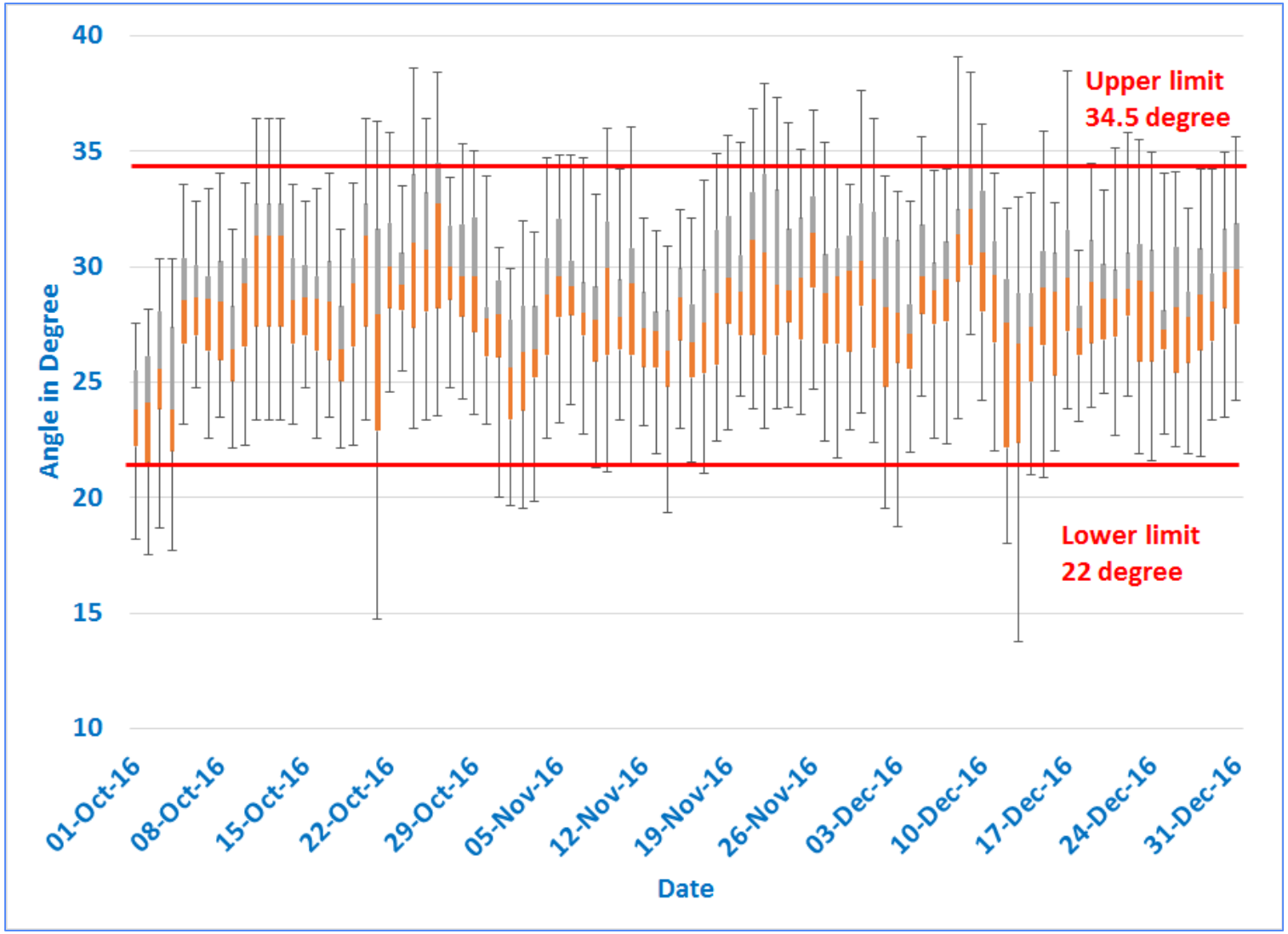
Typical wide angle pair for baselining

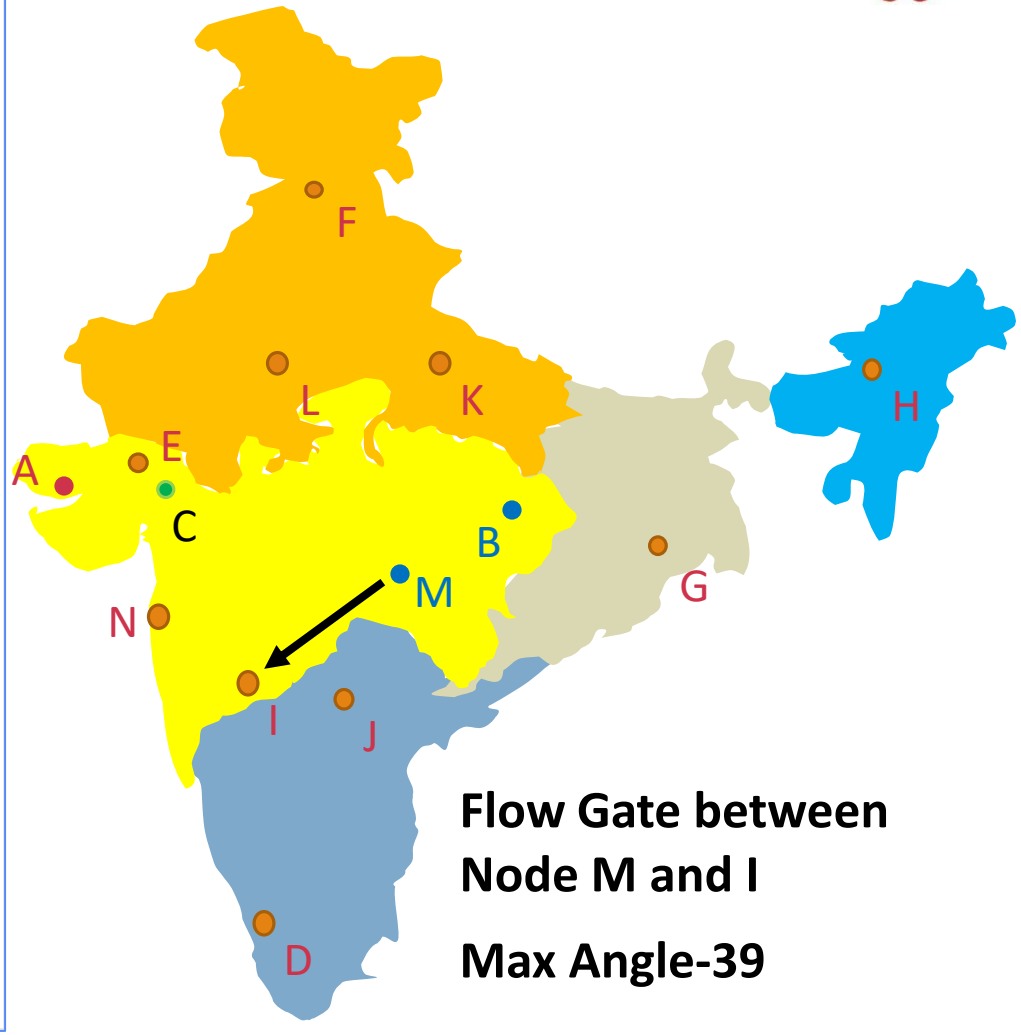




Node O : Generation Complex
Node N : Load Centre

Typical wide angle pair for baselining Contd……



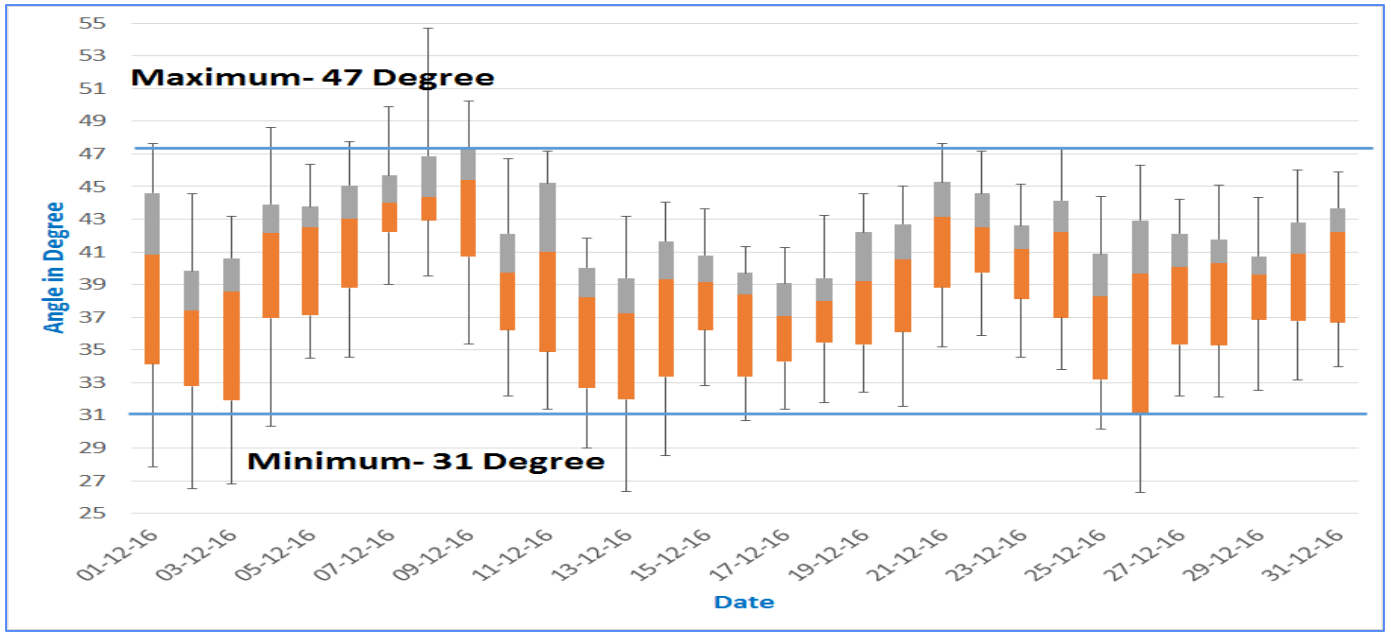


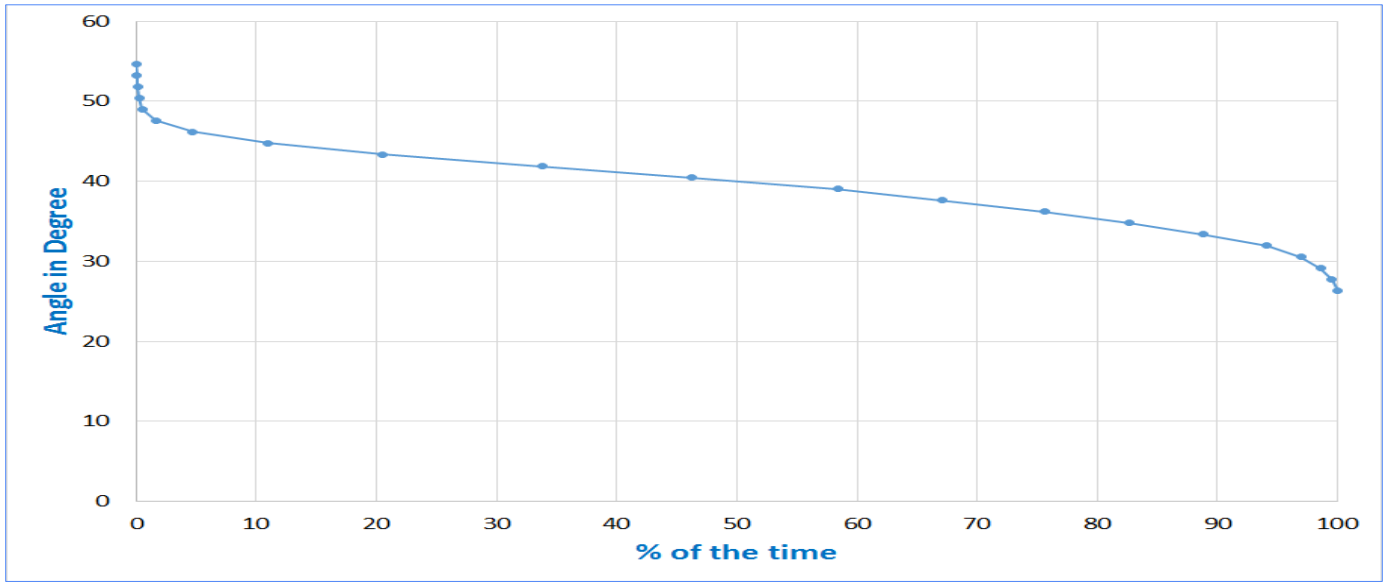
Flow Gate between Node M and I

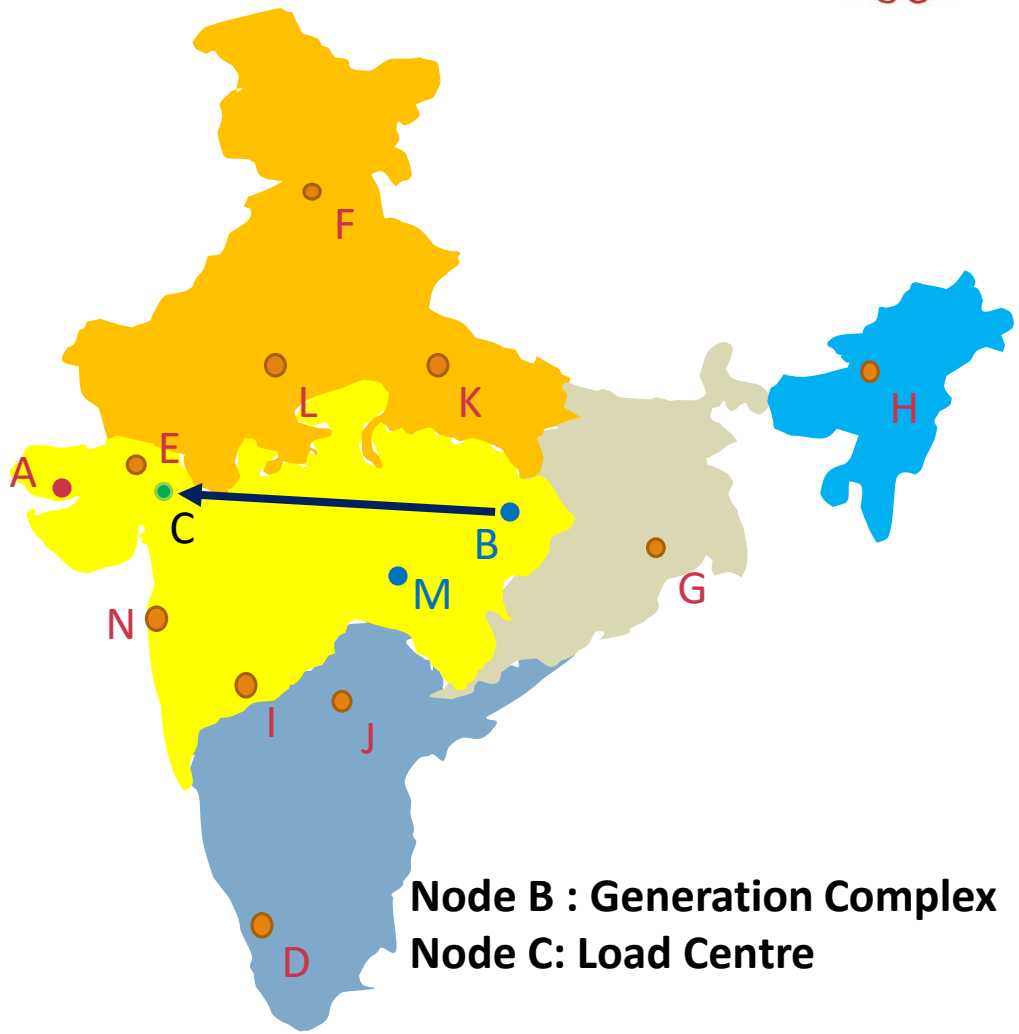
Max Angle-39

Min Angle-14

Typical wide angle pair for baselining Contd……

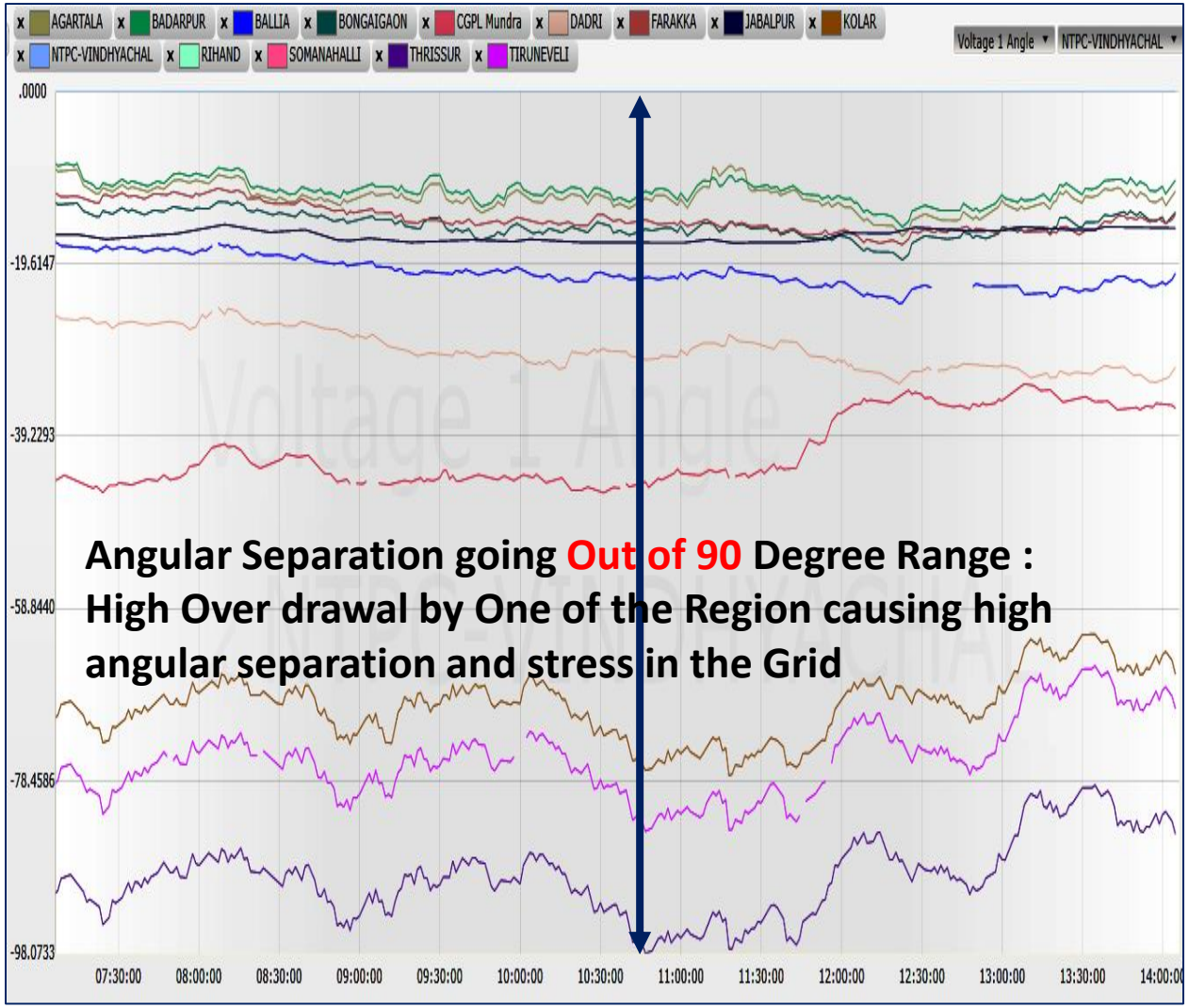


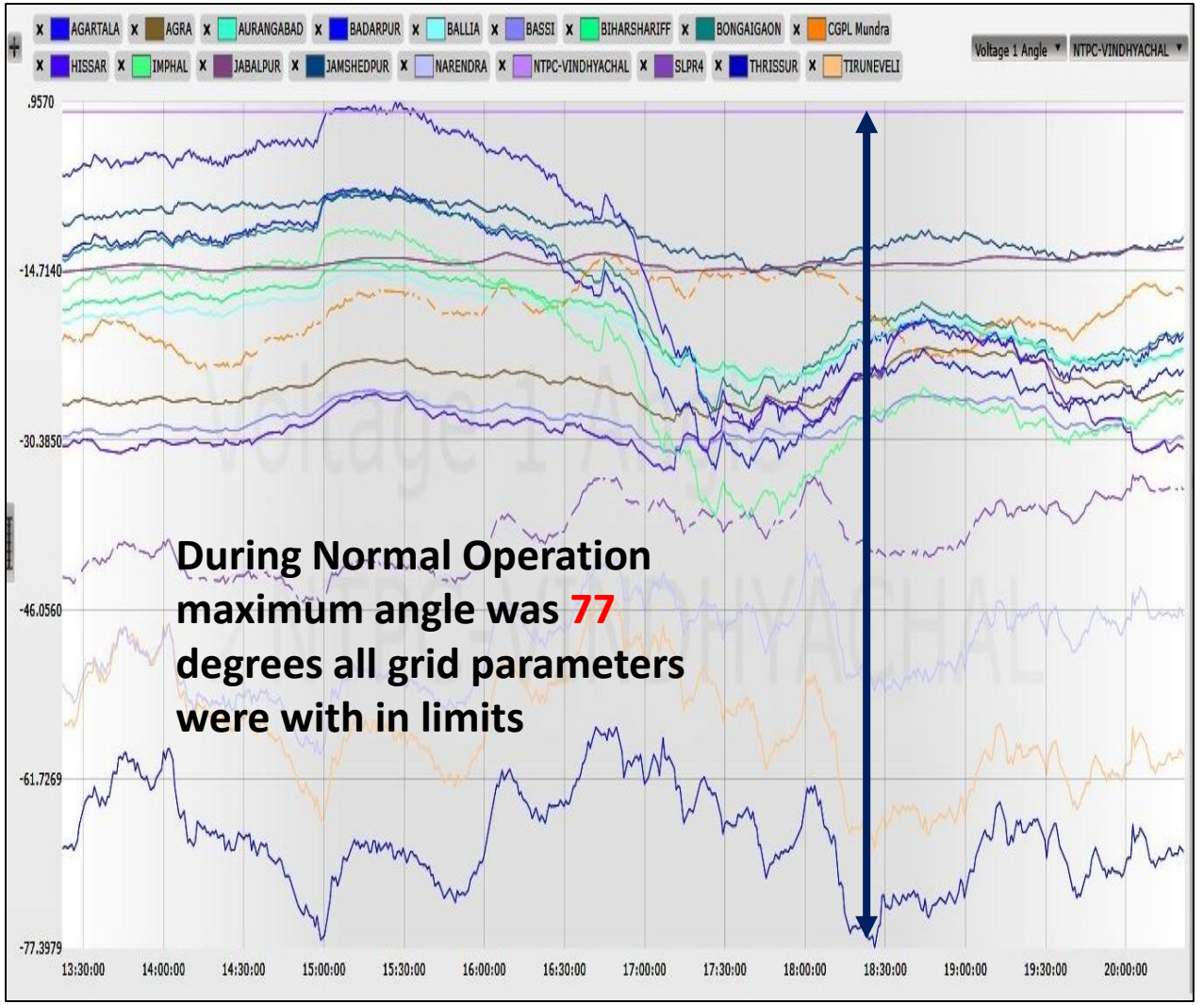




Node B : Generation Complex
Node C: Load Centre

Maximum Angular Separation Monitoring in the Grid





Summary

- **Angular Baselining helps in understanding the grid condition during operational horizon.**
- **It helps in finding the various threshold for angle pairs for monitoring and alarm generation.**

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Thank You

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