The Regional Power Grid Team

Presentation # 2: Status report

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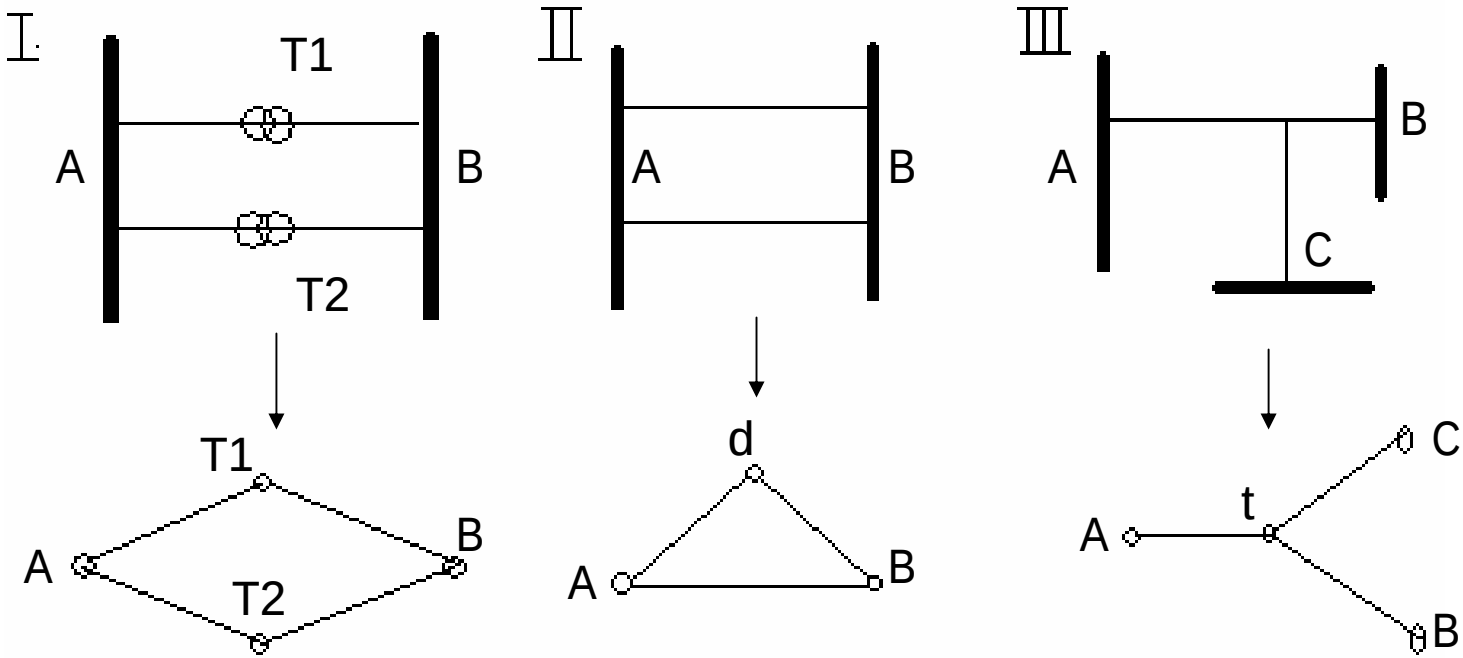
Agenda Items

- Revised method of matrix generation
- System representation
- Analyses on Power Grid
- Histograms, Degree Distributions & Metrics
- Next steps
- Expected Outputs & Conclusions

Revised Method



- I. For transformers add a new node in matrix for each one
- II. Use “dummy” node to represent all parallel paths
- III. For taps add a “dummy” node to show paths

Revised Method

Using this method our system representation changed from:

- The order of 10^3 nodes and 10^3 paths

To:

- More than 1600 nodes

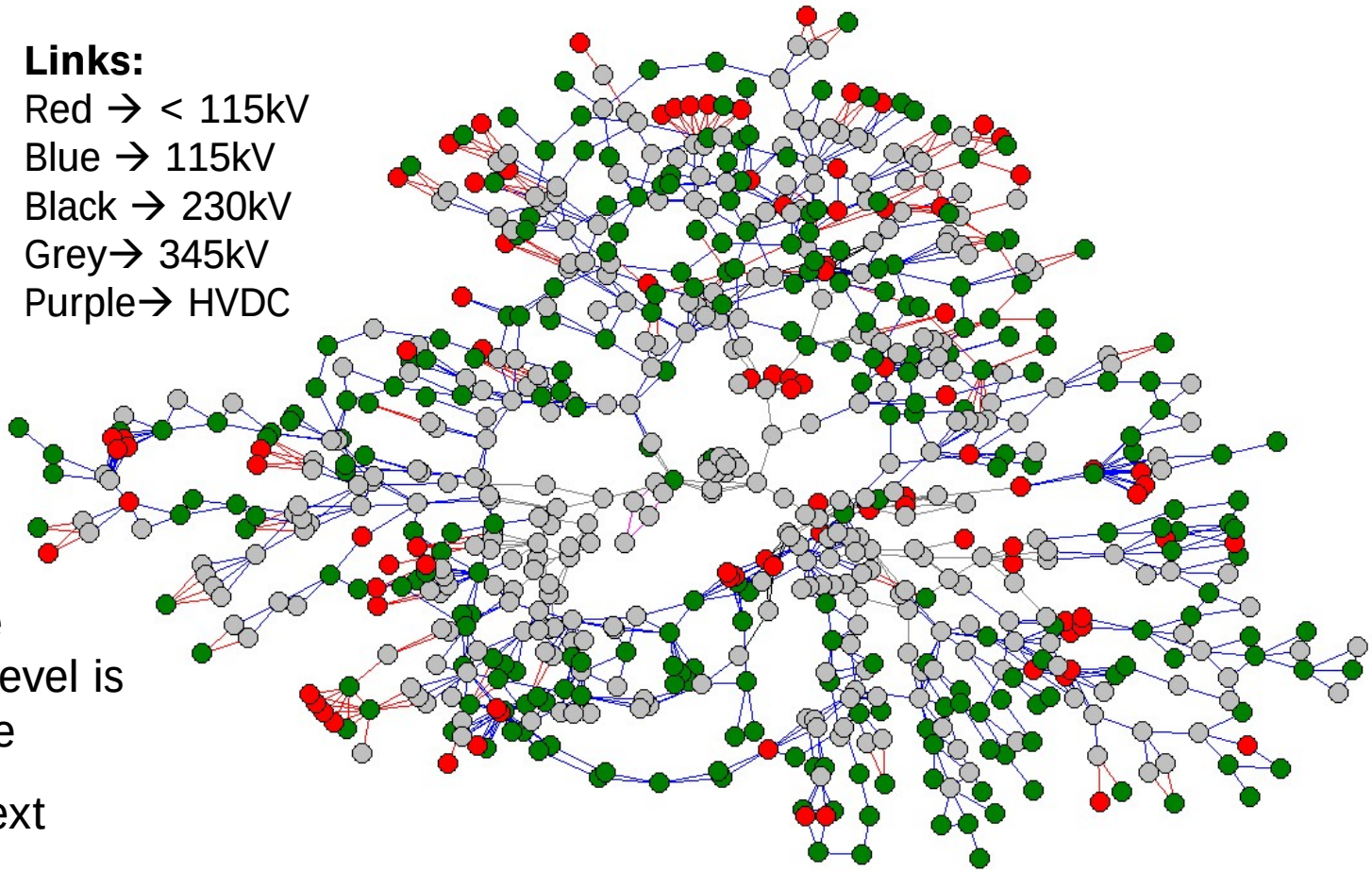
generators	286
loads	700
transformers	333
taps	115
buses	128
dummy nodes	103
others	10

- About 2400 paths (estimated)

System Representation

Nodes:
Red → Generator
Green → Load
Gray → Others

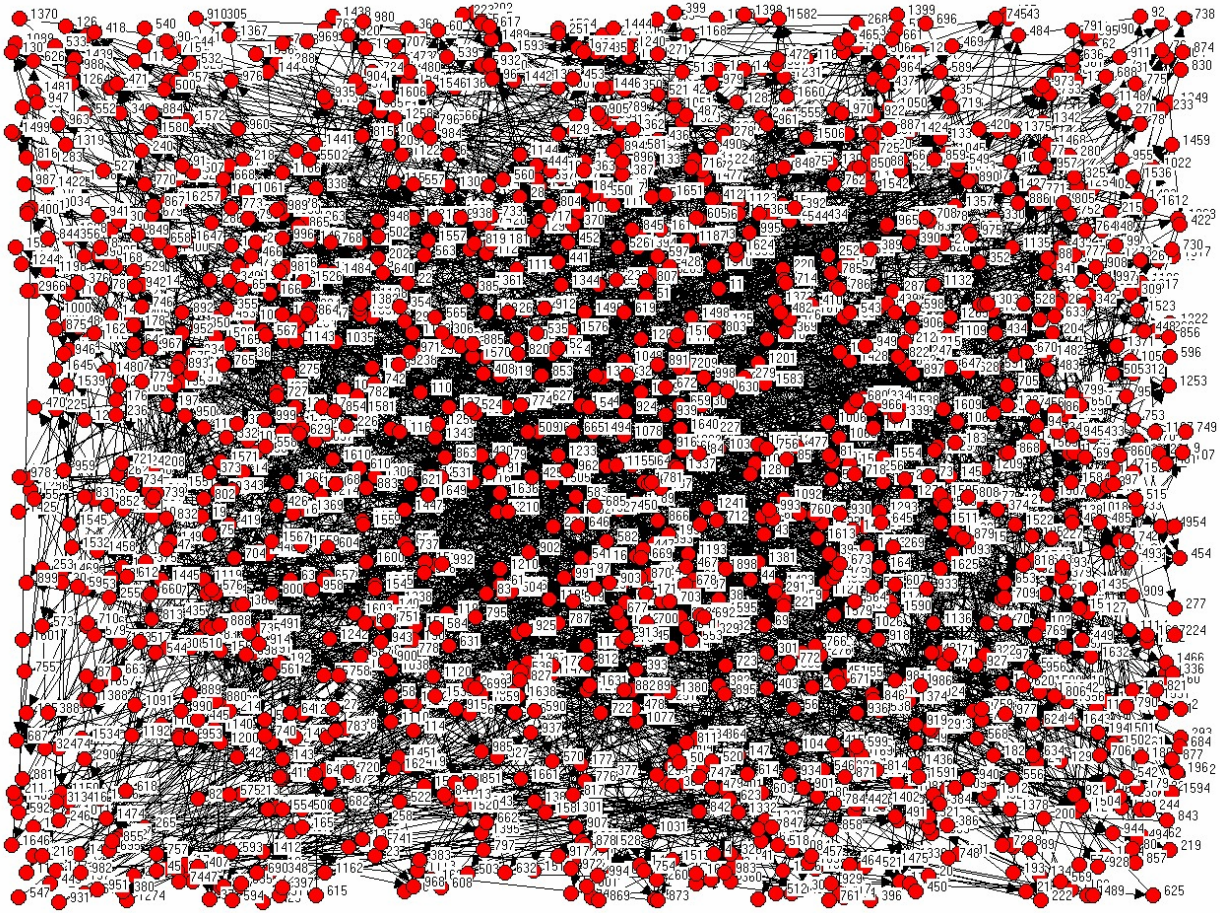
Links:
Red → < 115kV
Blue → 115kV
Black → 230kV
Grey→ 345kV
Purple→ HVDC



Representing the system at zonal level is easier to visualize

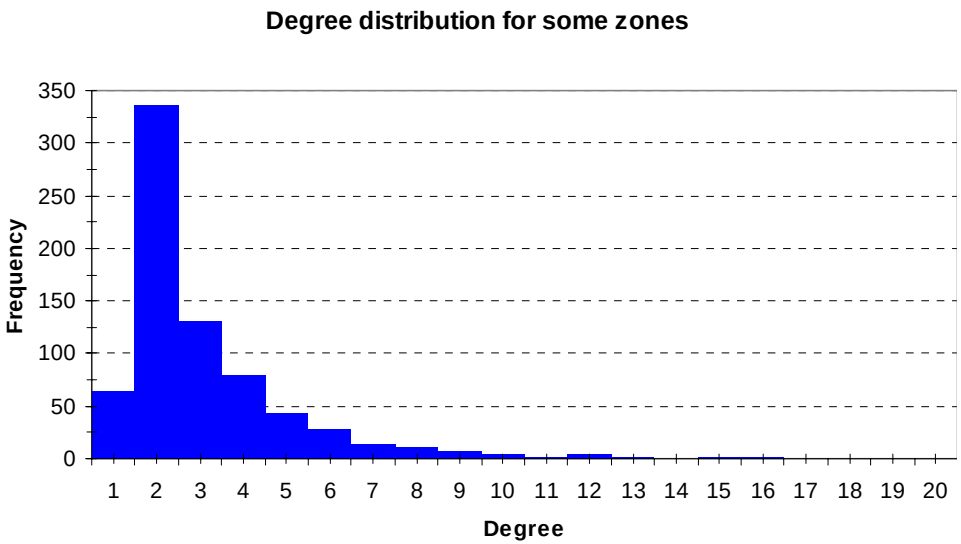
→ Grid shown next

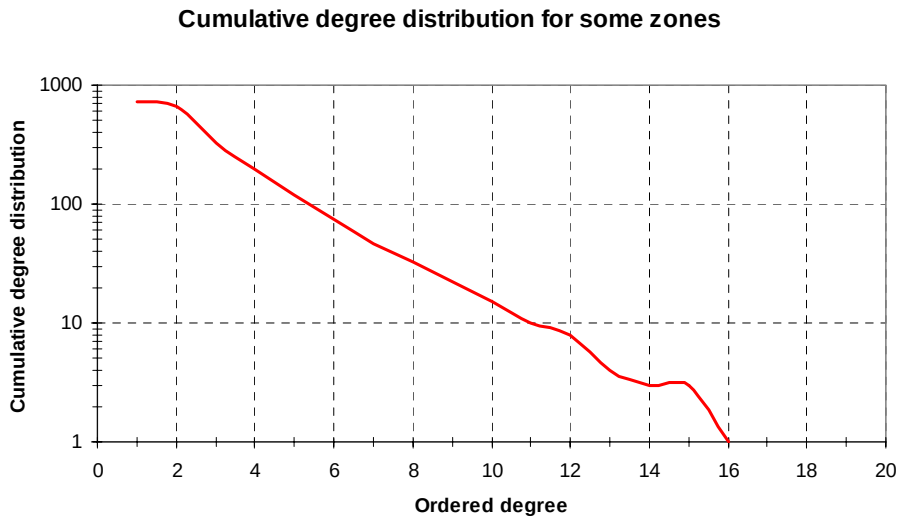
The Overall Power Grid



- Impossible to visualize and difficult to analyze in UCINET
- MATLAB more suitable
- Clustering Coeff. = 0.06
- Edge/node ration ~ 1.5
- For sub-sets of network, edge/node ratio varies:
  - ratio (low population density) = 1.37
  - ratio (high population density) = ~ 3
- About 40 inter-connections with other zones and grids

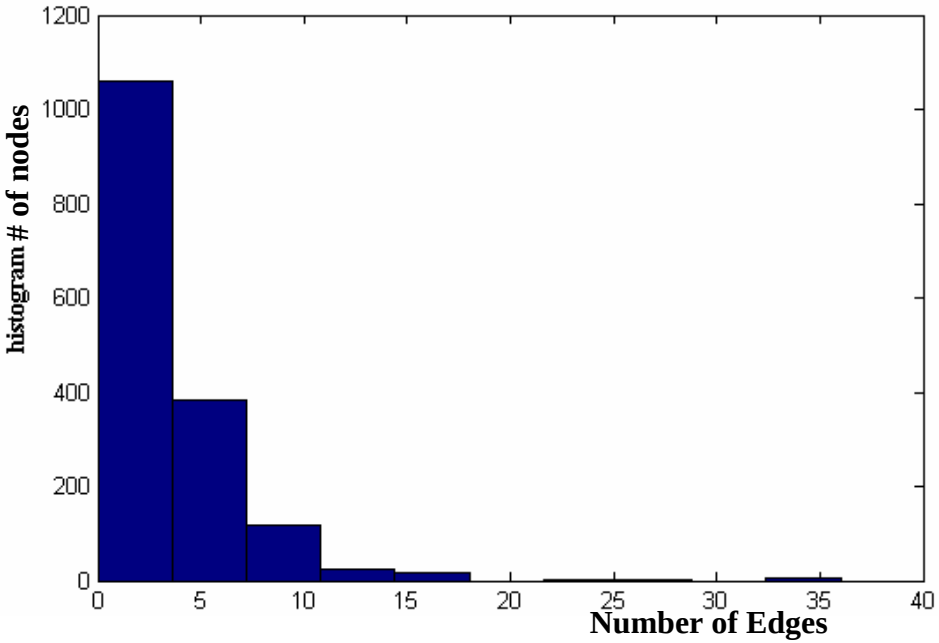
Zonal Degree Histogram and Cumulative Distribution Plots

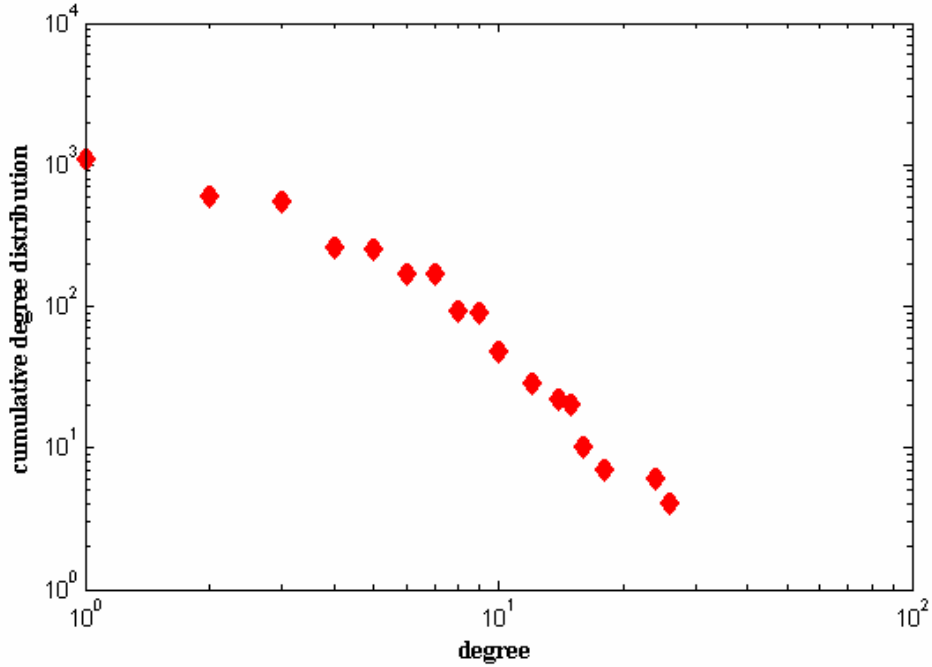




- **Most of the nodes are connected to few edges – is this scale-free?**
- **As we will see, sub-set (i.e. zonal) distributions look similar to overall grid**
- **This specific "subset" is one of two congested ones among three "subsets"**
- **Not a simple graph: has double edges and self-loops as expected in a grid**
- **A lot of redundant paths for network reliability and unseen contingencies**

Overall Degree Histogram and Cumulative Distribution Plots





- **Pearson coefficient 0.04 (almost zero); metrics comparable to western grid**
- **West grid: edge/node = 2.6; degree correl. = 0.03; clustering coeff. = 0.08**
- **Cumulative degree distribution similar to western grid (Newman's paper)**
- **Kmax = 36 → i.e. at node in a very congested zone (also high LMP $/MWh)**

Next Steps

- Validate all Data and Interconnections!
- Identify clusters and sub-sets of network
  - Identify existing clusters (using algorithms like Newman-Girvan in UCINET^{tm}) and filtering
  - Study the reasons for existence of clusters
    - Geographical
    - Sociological (industrial zones, high populations)
    - Contingency-based (addition of nodes & links)

More Next steps

- Compare with other grids
  - See if network topology can be mapped across
  - Find potential similarities in clustering
- Study degree distributions
  - Find if network follows a power or other law
  - Compare other known degree distributions
- Define “critical” nodes & identify examples

Expected Output & Conclusion

- This grid seems to follow trends similar to the western power grid (from what we know and can compare so far). More to follow...
- The edge to node ratio (zonal and overall), clustering and Pearson coefficients have low values typical to large technological networks
- We expect to get insights to grid topology, empirical structural models and metrics...

Questions and Comments?

Contact information

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