

EMT Initiative: Solvers WG

Sarina Adhikari, PhD, Principal Consultant

Ricardo Orfei, Managing Principal Consultant

Mitsubishi Electric Power Products Inc.

ORNL is managed by UT-Battelle, LLC for the US Department of Energy



U.S. DEPARTMENT OF
ENERGY

Context: Use Cases of EMT Simulation

- EMT simulation time frame depends on the type of the phenomenon to be studied

Table 2: Classification of frequency ranges

Group	frequency range for representation	shape designation	representation mainly for
I	0.1 Hz - 3 kHz	Low frequency oscillations	Temporary overvoltages
II	50/60 Hz - 20 kHz	Slow front surges	Switching overvoltages
III	10 kHz - 3 MHz	Fast front surges	Lightning overvoltages
IV	100 kHz - 50 MHz	Very fast front surges	Restrike overvoltages

Image source: Guidelines for Representation of Network Elements when Calculating Transients: Cigre Working Group 02 (Internal Overvoltages of Study Committee 33 Overvoltage and Insulation Coordination)

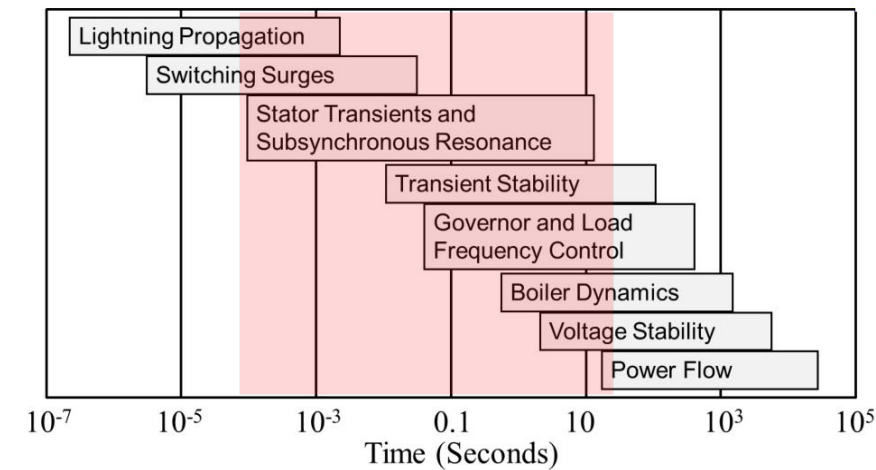
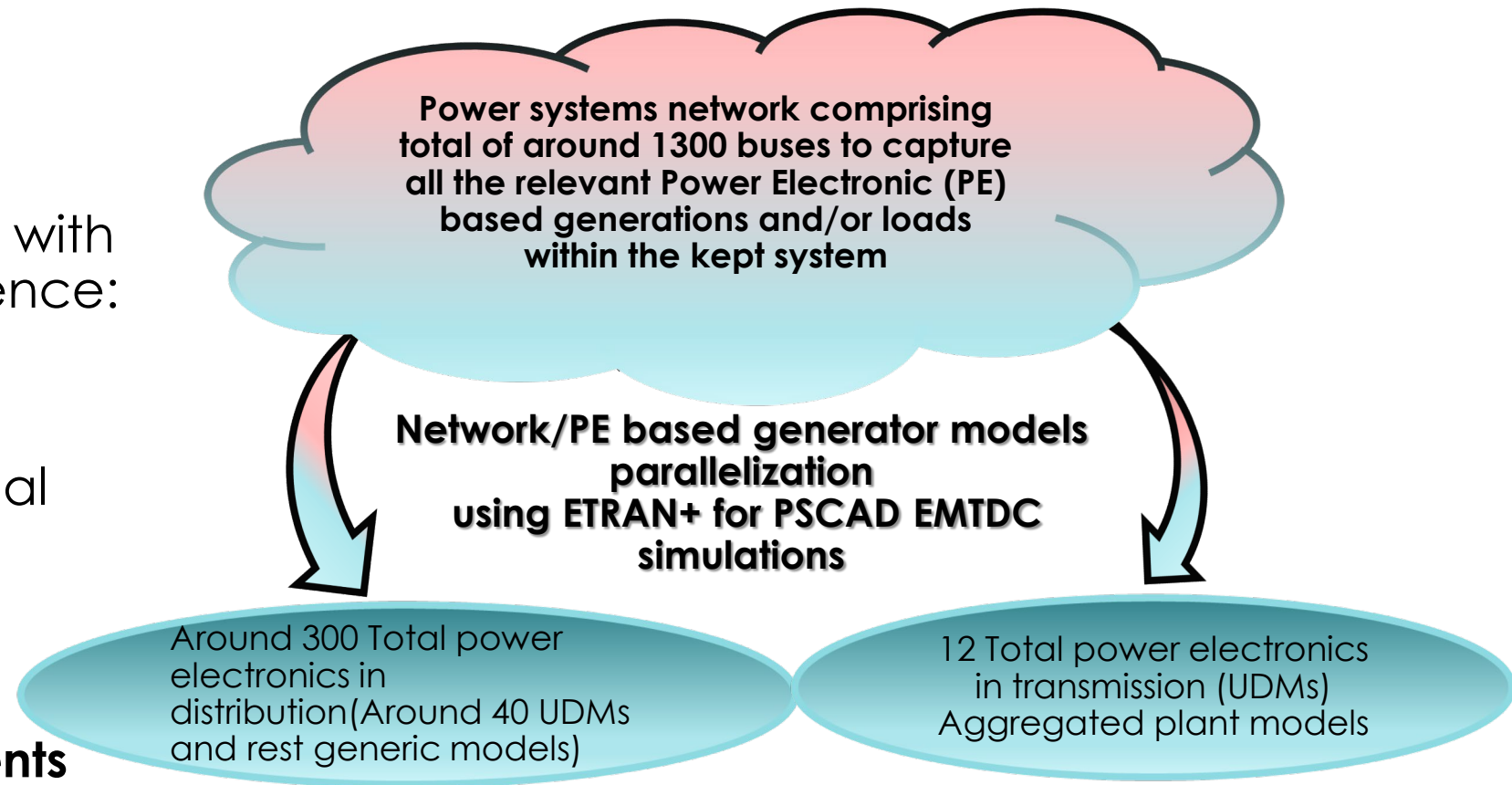


Image source: P.W. Sauer, M.A. Pai, Power System Dynamics and Stability, 1997, Fig 1.2 modified.

- For a time step between 10 and 20 micro secs typically, the phenomenon under analysis are temporary and slow front transients
- **Use Case**: PSCAD Dynamic Interconnection Studies (Transient Stability Studies)

Context: Use Cases of EMT Simulation

- Total network and models compilation time: 1 hour
- Total simulation time for a 60 seconds dynamic simulation with different types of fault sequence: 12 hours
- Our experience on factors affecting total computational time
 - **Size of the grid**
 - **Number of static elements**
 - **Number of dynamic elements (generic or UDMs)**
 - **Type of studies**
 - **Available CPU cores**



IBRs: Inverter Based Generators

DERs: Distributed Energy Resources

Pain Points: Key Challenges in Current EMT Tools & Practices

- Fidelity compromise between User Defined Models (UDMs) and generic Power electronics models
- Computational challenges (hardware structure: number of cores, clock speed, RAM memory and total data storage)
- Extensive computational hours for large scale EMT studies
- Large volume of data to be post processed to understand the results
 - Debugging a large EMT model for ongoing issues
 - Delay in understanding the reliability impacts of the interconnecting generation (inverter-based)
 - Delay in decision making process

Industry Approach: Ongoing Actions and Next Steps

Ongoing Actions:

- Reasonably size the power system network without losing the needed fidelity
- Parallelize the network model into multiple cases that can be run in multiple CPU cores
- Split the vendor supplied models for power electronics into separate cases so that they can utilize multiple CPU cores
- Increase network model simulation timestep to a reasonable number between 10 and 20 microsec without losing fidelity required by the study
- Consider using a combination of generic and UDMs dynamic models without compromising the validity of the study conclusions

Next Steps:

- Reducing the total simulation time with reasonable accurate results

Thank you

Sarina Adhikari

sarina.adhikari@meppi.com

Ricardo Orfei

ricardo.orfei@meppi.com