

Visual and Persistent PDEVS Statecharts Models with Support for Super-Ports and Super-Connections

Shivam Ravindra Deotarse, MS Computer Science (Thesis)

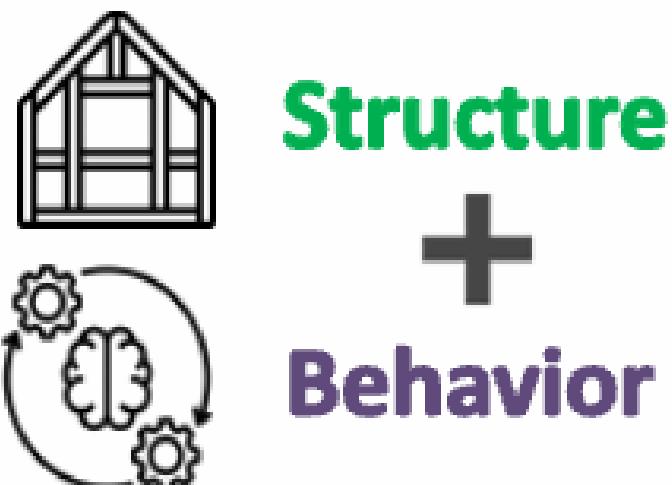
Mentor: Dr. Hessam Sarjoughian

Arizona Center for Integrative Modeling & Simulation | School of Computing and Augmented Intelligence | Ira A. Fulton School of Engineering



Research Question

Difficult to visualize



> 100 interacting components visualization challenge !!

Complex and large-scale Smart Grids

Background

Real systems: large & complex



More components + connectors

Multi-layer structure and behavior



Flexible navigation (view & change)

Goal: Introduce a Persistent Visual Modeler (PVM) [1] tool extension that supports **super-ports** and **super-connectors** for concise, scalable visualization of system **structure** and **behavior** – Parallel Discrete Event System Specification (PDEVS) [2] formalism

Methodology

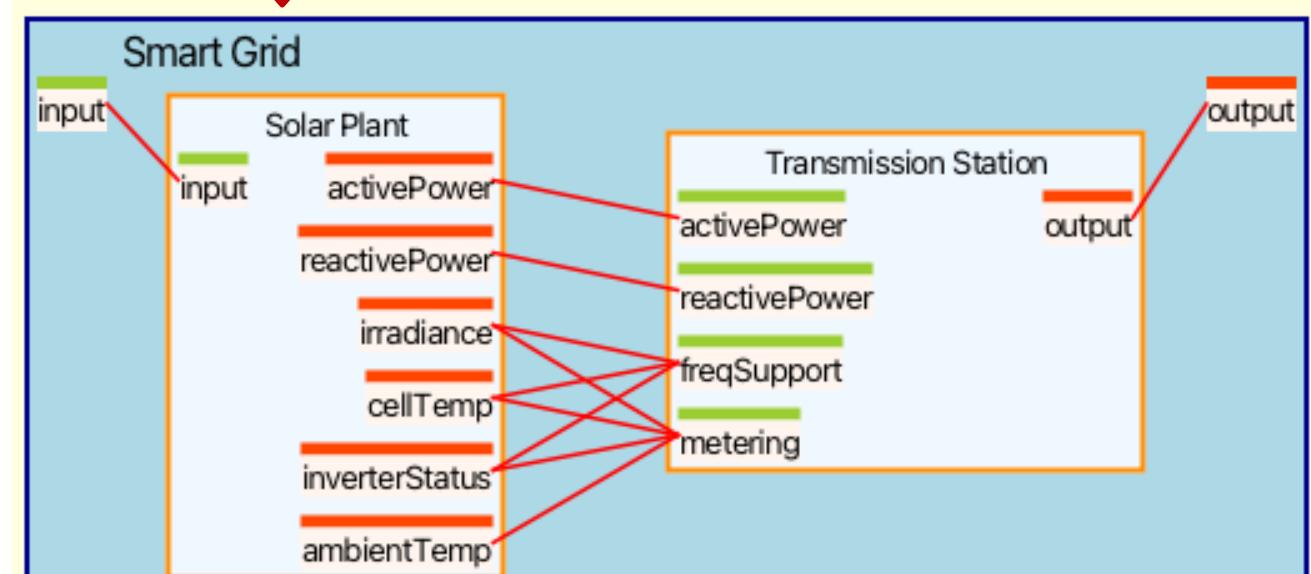
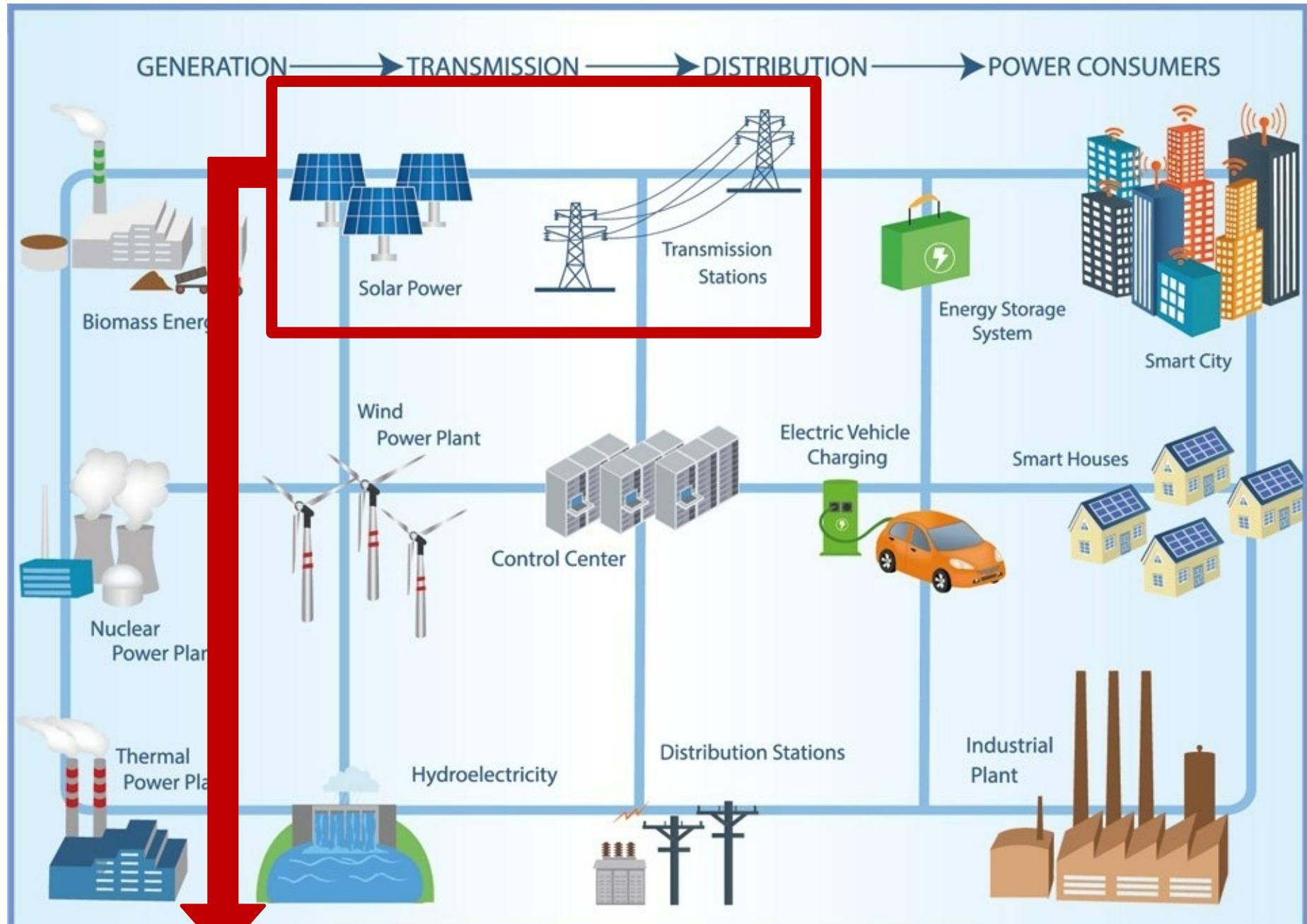
Selected Subsystem from Smart Grid:

Solar Plant → generates power + telemetry

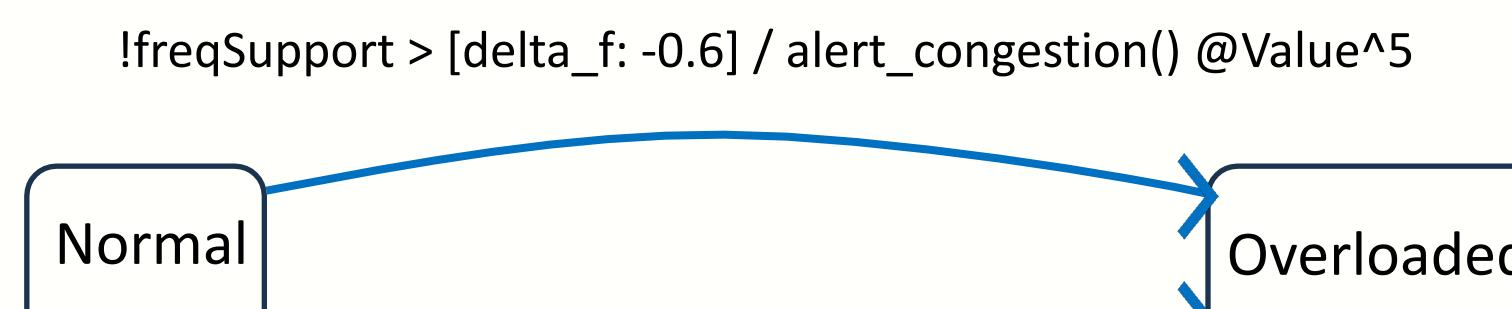
Transmission Station → monitors + manages flow

Visualize in the **PVM** tool using super ports & connectors

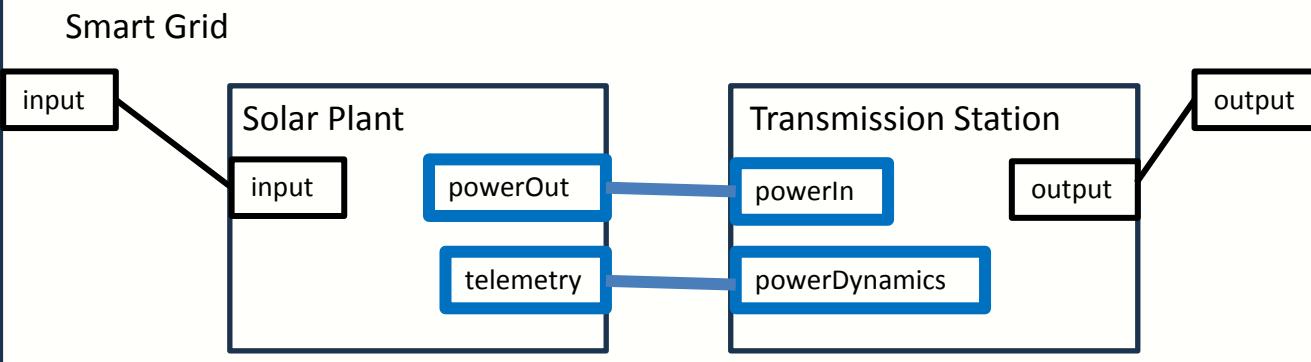
↑ Visual Scalability



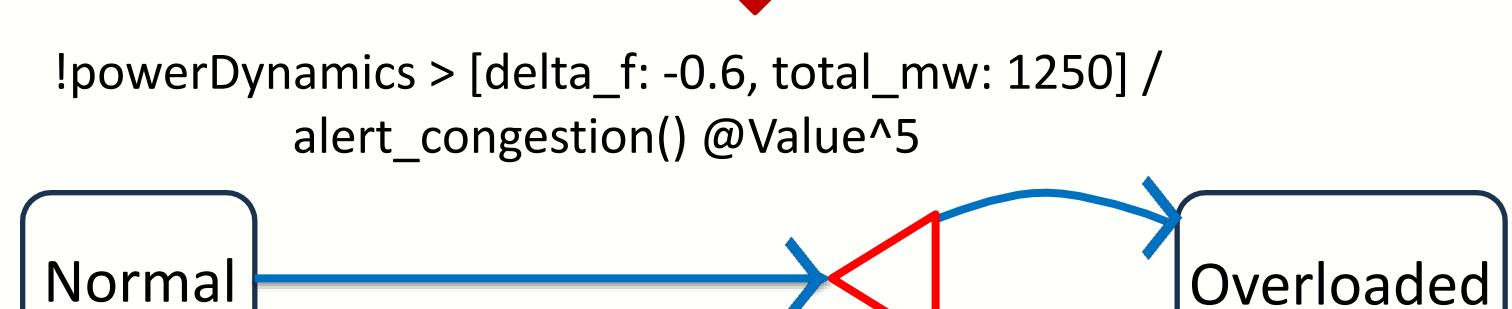
PDEVS coupled model of Smart Grid using PVM showing single ports and connectors



Hand-drawn PDEVS statechart of Transmission Station atomic model using single ports



Hand-drawn PDEVS coupled model of Smart Grid showing super-ports and connectors



Hand-drawn PDEVS statechart of Transmission Station atomic model using super ports

PDEVS Structure

Observation

Without Super-ports

V Single ports are connected directly
S Dense web of connectors
Hard to comprehend visually

B Single port → An event for transition

S New event adds a separate transition
More states → more transitions
Hard to comprehend and change

- VS – Visual Structure
- BS – Behavioral Statecharts

With Super-ports

Single ports aggregated to logical groups
E.g., powerOut, telemetry, powerIn, etc.
Easy to comprehend, scalable layout

Superport aggregates multiple events
Use of superports → fewer no. of events
More states → fewer transitions
Easy to comprehend, scalable layout

Results

Structural abstraction → Few connectors

Behavioral abstraction → Few transitions

hierarchical visualization
→

Fewer connectors
Simplified structure + behavior
Hiding/revealing details through disciplined visual abstractions

Modelers can develop large-scale and complex systems' visual structural and behavioral models

Future Work

- Visual super-port and super-connectors modeling
- Automatic code generation: Transform statecharts into executable code for the DEVS-Suite simulator

- H.S. Sarjoughian, S. Mohite, 2024, Constructing Hierarchical Modular Models in Alternative and Interchangeable Representations, Winter Simulation Conference, p. 2289-2300.
- A. C. H. Chow and B. P. Zeigler, "Parallel DEVS: A parallel, hierarchical, modular modeling formalism," in Proceedings of the 26th Winter Simulation Conference (WSC '94), pp. 716-722, IEEE, 1994