

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

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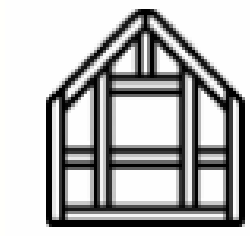
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Research Question

Difficult to visualize



Structure



Behavior

> 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

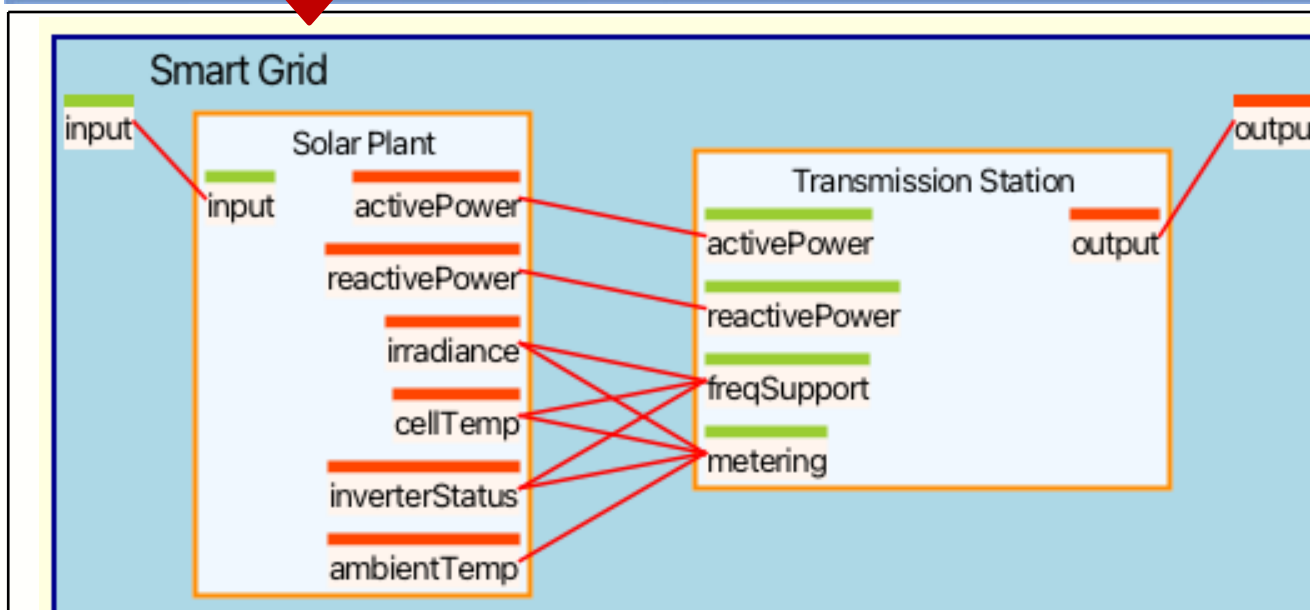
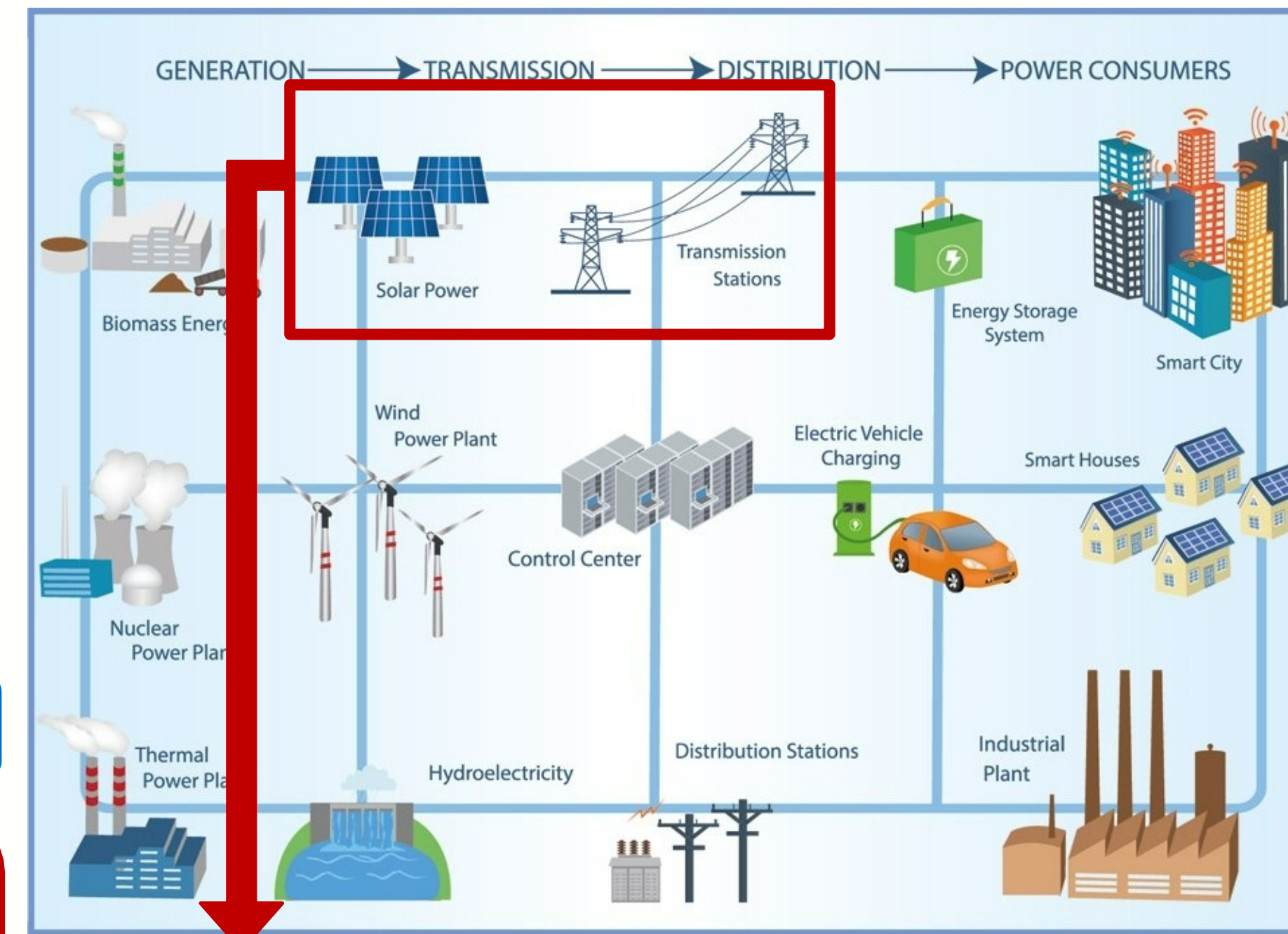
Selected Subsystem from Smart Grid:

Solar Plant → generates power + telemetry

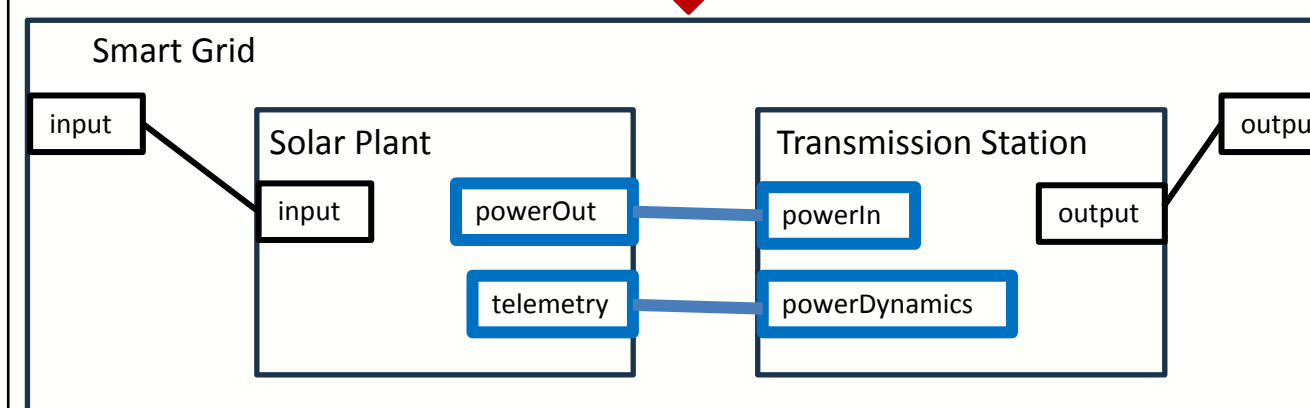
Transmission Station → monitors + manages flow

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

↓ Visual Complexity ↑ Visual Scalability

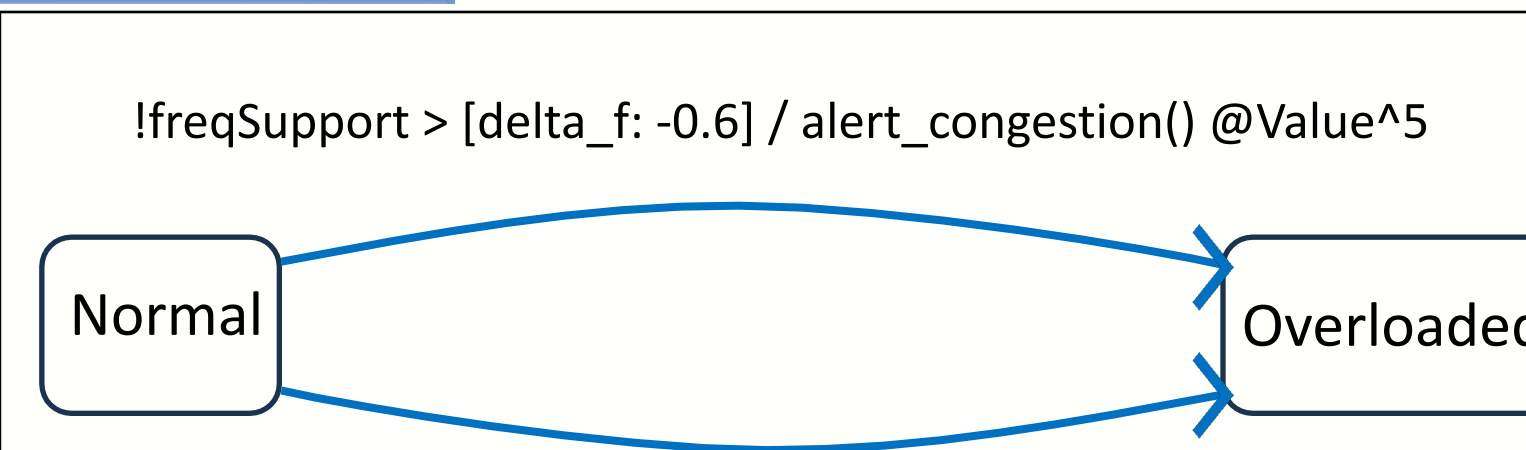


PDEVS coupled model of Smart Grid using PVM showing single ports and connectors



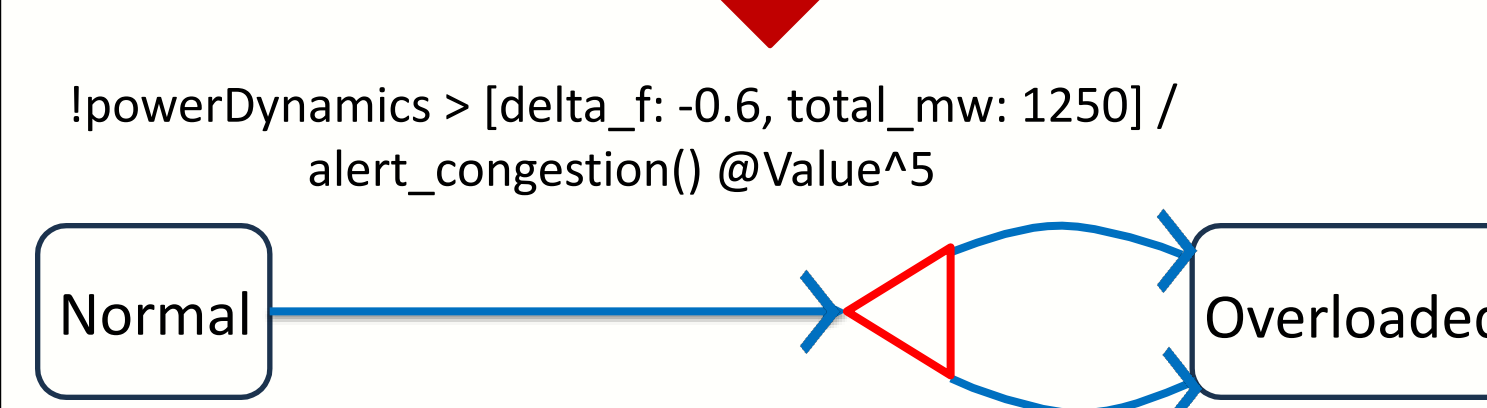
Hand-drawn PDEVS coupled model of Smart Grid showing super-ports and connectors

PDEVS Structure



$!freqSupport > [\delta_f: -0.6] / alert_congestion() @Value^5$

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



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

PDEVS Behavior

Observation

| | Without Super-ports | With Super-ports |
|----------|---|--|
| V | Single ports are connected directly Dense web of connectors Hard to comprehend visually | Single ports aggregated to logical groups E.g., powerOut, telemetry, powerIn, etc. Easy to comprehend, scalable layout |
| S | Single port → An event for transition New event adds a separate transition More states → more transitions Hard to comprehend and change | Superport aggregates multiple events Use of superports → fewer no. of events More states → fewer transitions Easy to comprehend, scalable layout |

- **VS** – Visual Structure
- **BS** – Behavioral Statecharts

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

References

1. H.S. Sarjoughian, S. Mohite, 2024, Constructing Hierarchical Modular Models in Alternative and Interchangeable Representations, Winter Simulation Conference, p. 2289-2300.
2. 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