



**Pacific Northwest**  
**SMART GRID**  
DEMONSTRATION PROJECT



# **VOLTRON™ Transactive Control Node**

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Panel: Industry Success Stories

## Transactive Control (TC)

- A unique distributed control and communication system demonstrated by the Pacific Northwest Smart Grid Demonstration Project (PNW-SGDP)
  - 5 year ARRA funded; ended in 2015
  - Largest demonstration project in the nation (\$179M)
  - [www.pnwsmartgrid.org](http://www.pnwsmartgrid.org)
- Localized power generation/load decisions enabled by
  - Distribution of predicted cost and load schedules
  - Incorporating local information and requirements
- Addresses the following areas:
  - Integration of renewable energy
  - Grid reliability
  - Cost reduction
  - Empoweriing consumers

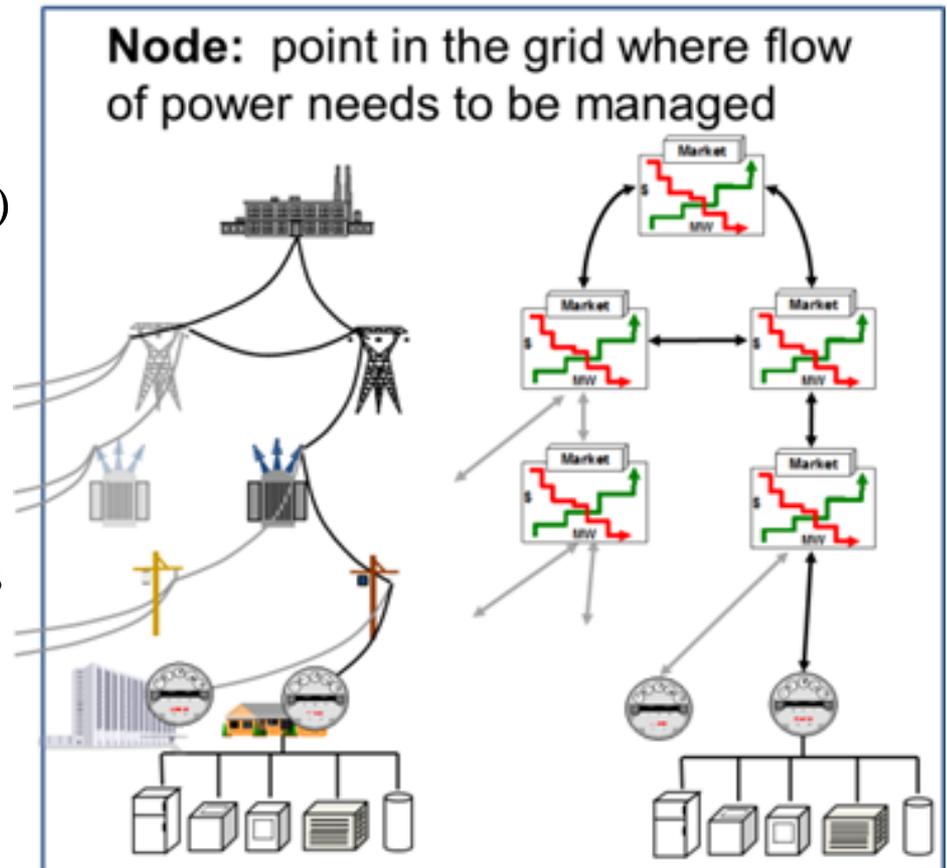
# Transactive Control Ingredients

## Transactive Control Signals

- Communication signals for predicted cost and load
- TIS (Incentive), TFS (feedback)

## • Transactive Control Node

- Uses neighbor signals and local information to generate predicted costs and load
- Manages local assets (resources and loads)
- Flexible and efficient design allowing deployment at all levels of the energy hierarchy
- IBM developed a proprietary node based on IEC 18012 (iCS)



# PNW-SGDP: TC Node Framework Specification

TIS/TFS (incentive and feedback signal) calculation and interaction with node neighbors defined by the demonstration project

Computation flow diagram from Transactive Node Toolkit Framework, v 1.0

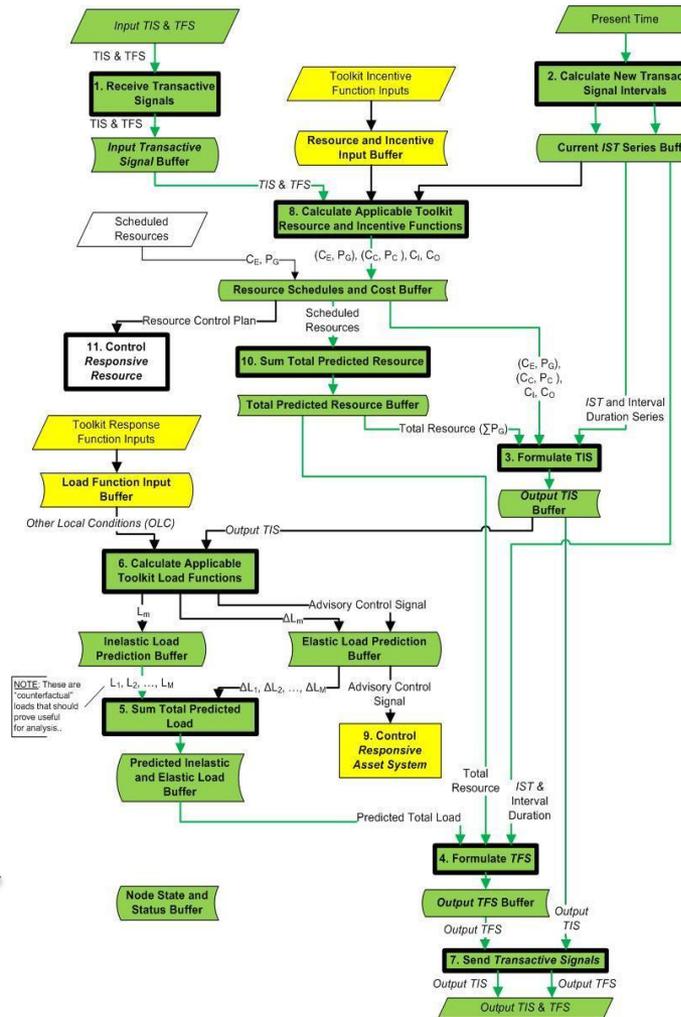
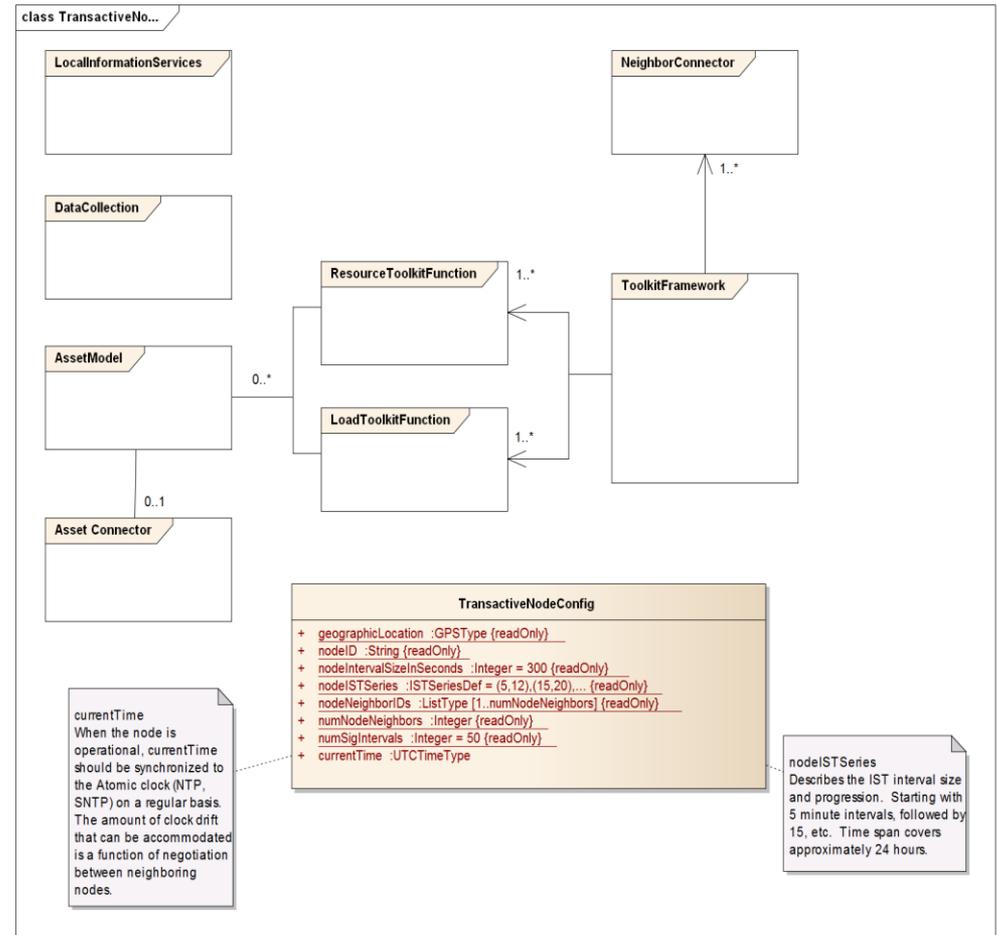


Figure 1. Toolkit Framework of Functions and Processes at a Transactive node

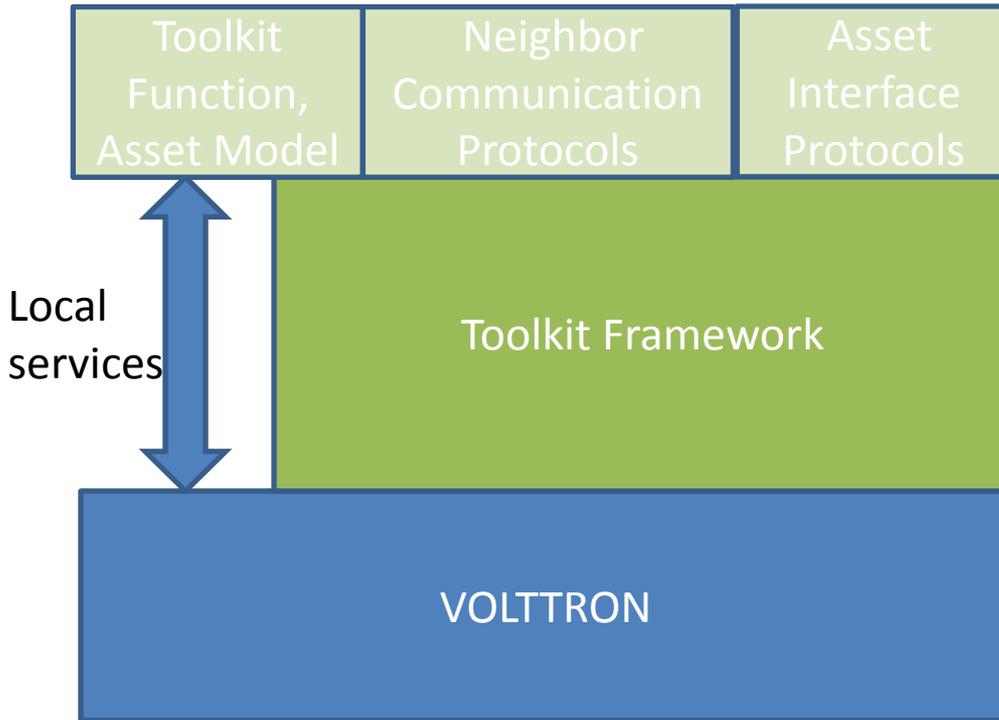
# PNW-SGDP: TC Software Specification

- TC Node objects, configuration and intra-node interactions defined and documented using UML
- Implementation agnostic

Node object diagram from  
Transactive Control Node:  
Interactions, Interfaces & Class  
Structures, v0.90



# VOLTTRON™ Reference TC Node



Resource/Load functions defined for node requirements, communication protocols (i.e. SEP, OpenADR, etc)

TC TIS/TFS computation flow and event management, APIs (toolkit, neighbor, visualization, asset, management)

Services (weather, data collection, management, messaging), agent execution and management, device drivers, security infrastructure

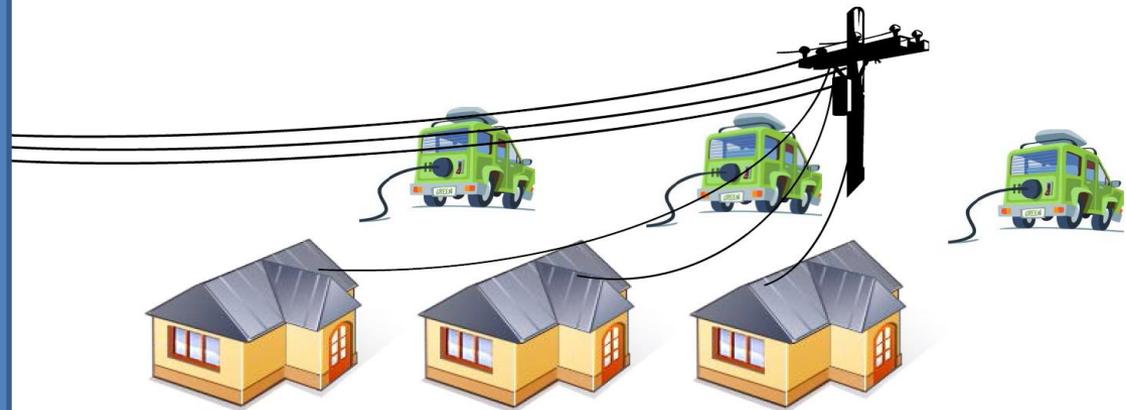
- Designed for research
- Based on the specifications:
  - PNW-SGDP Transactive Node Toolkit Framework, v1.0
  - PNW-SGDP Transactive Control Node: Interactions, Interfaces and Class Structures v 0.90

# Constrained Feeder 4-Node Demo

Constrained Feeder Node  
Modifies forecasted price based on  
expected load forecasts from home nodes

## Home Nodes

- Produces home base load forecast
- Load forecast modified when EV requests charging
- Uses price forecast from feeder and home owner information to manage EV charging



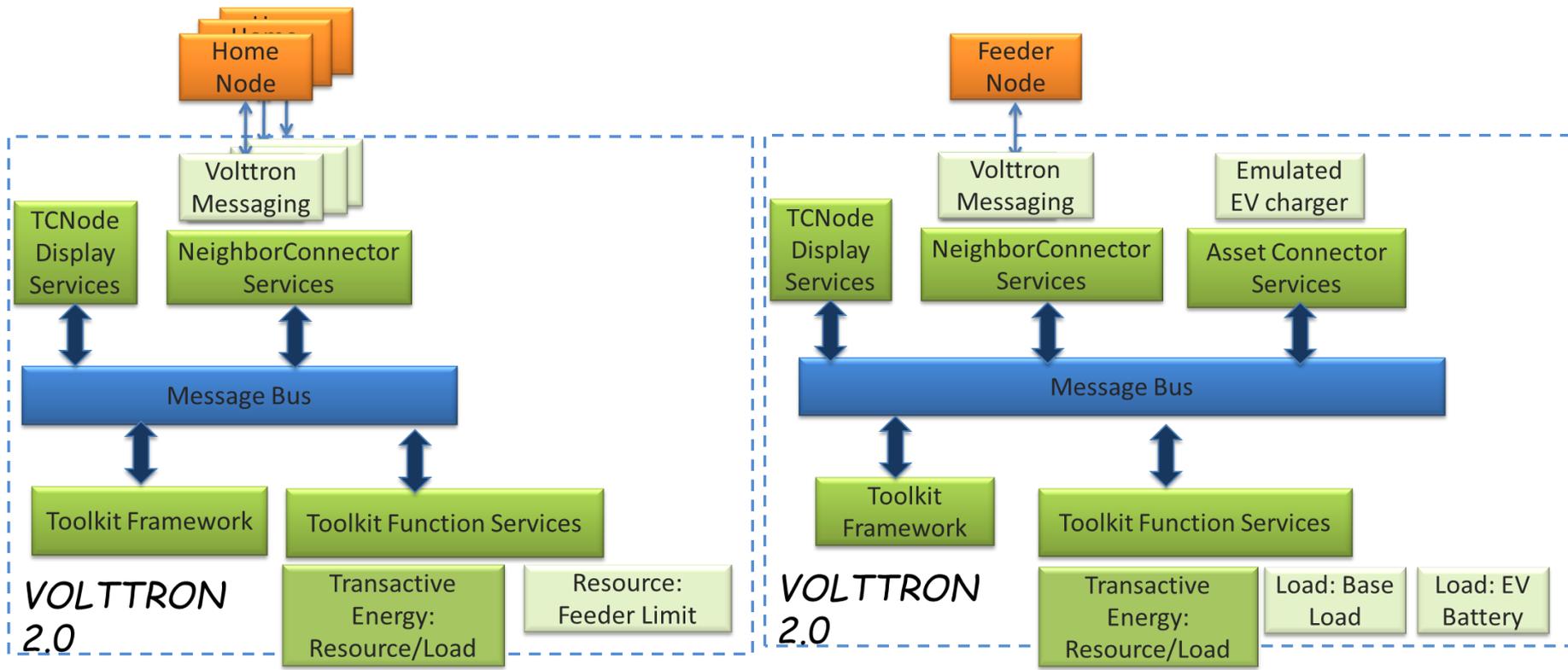
House 1:  
I'm flexible

House 2:  
I want it now!

House 3:  
I'm a bargain hunter

Demonstrates how TIS/TFS and home owner requirements are used to modify EV charging when feeder limits are exceeded.

# Demo Node Configurations



**Feeder Node**

**Home Node**

Each home node configured for “customer requirements”

# VOLTTRON TC Node: Enabling TC User Community



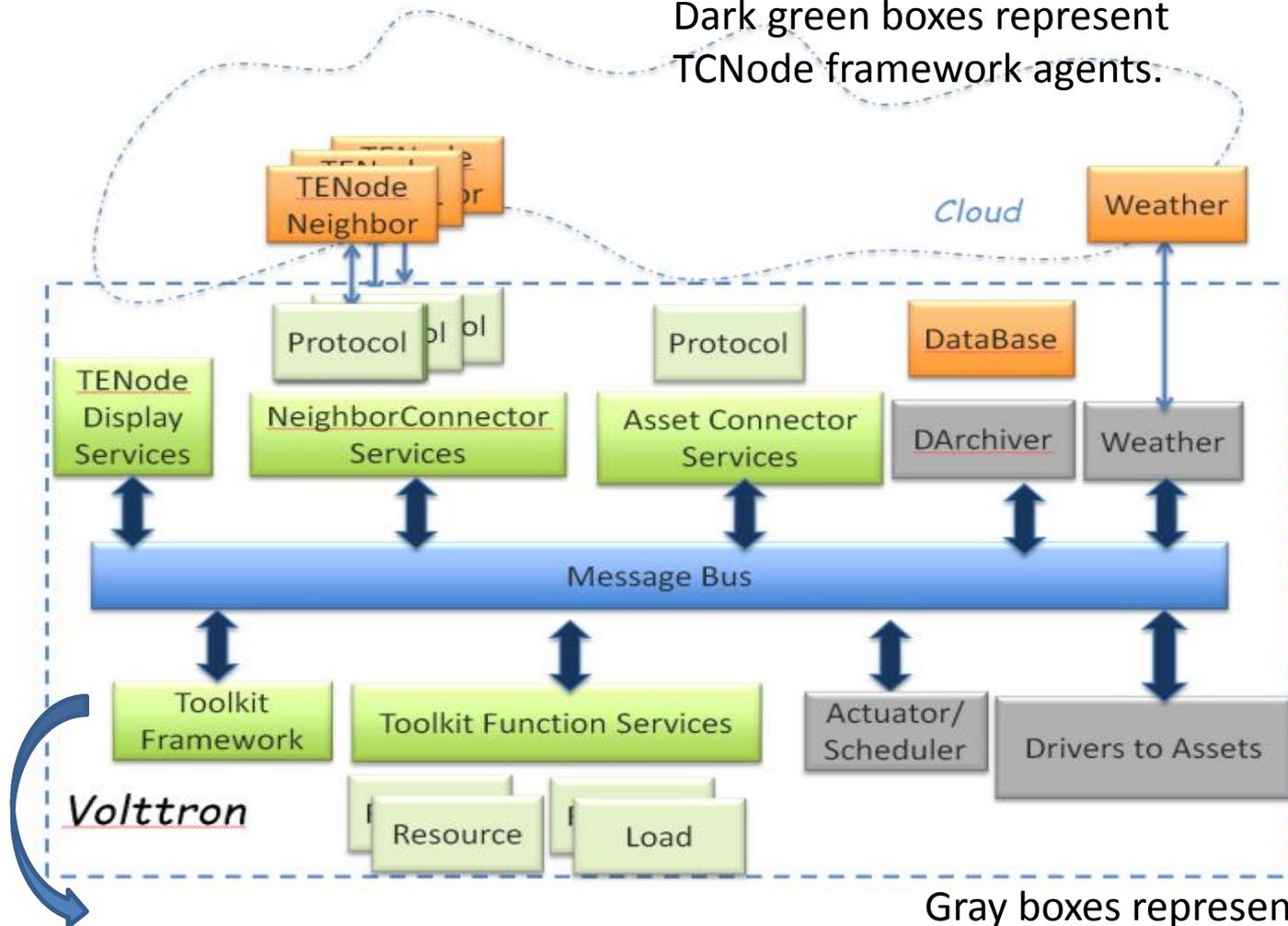
- Provide as open source
  - Enabling important research on Transactive Control
  - Allowing research/customization of load/resource/asset algorithms
  - Development of asset interfaces, emerging smart grid protocols
  - Data analysis/structures become “standardized”
- Technical needs
  - Refinement of TC application and specifications
  - Demonstration of multi-level hierarchy
  - Porting to VOLTTRON 3.0 (system management, data collection, VIP)
- Infrastructure needs
  - GitHub owner/administration and support
  - Test/compliance tools/methods

# Thank You and Demonstration



# VOLTTRON 2.0 TC Node

Dark green boxes represent TCNode framework agents.



Toolkit Framework Agent is the sequential point of control for Transactive Control functions.  
All other agents are event-based, asynchronous

Gray boxes represent existing VOLTRON 2.0 services.