



**Pacific Northwest**  
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

# Motivation for a Transaction Based Platform

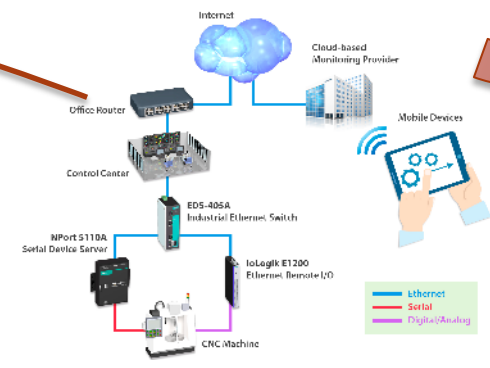
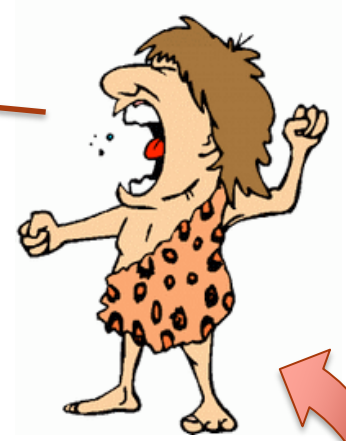
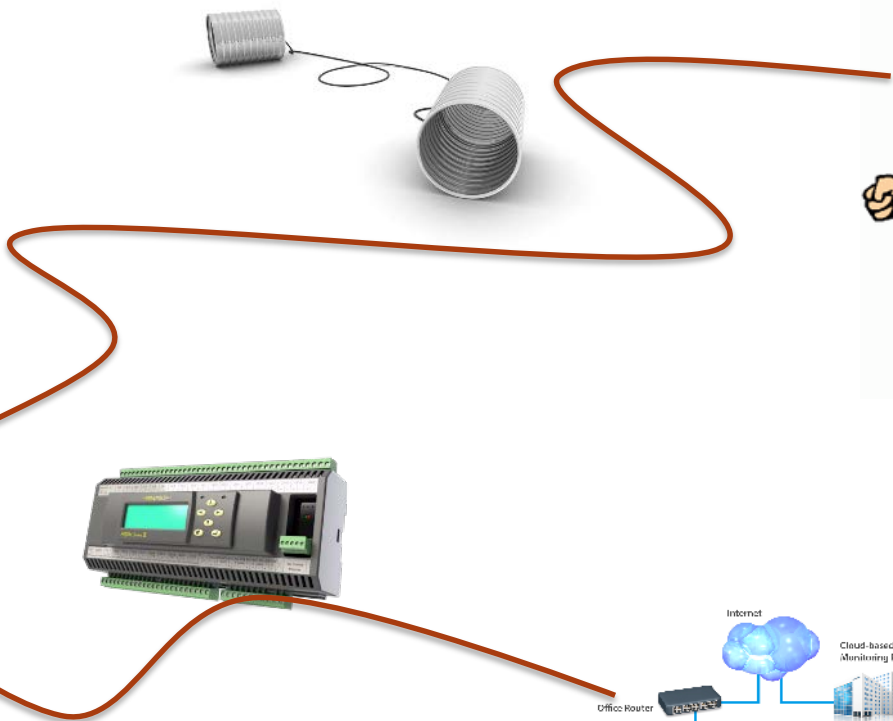
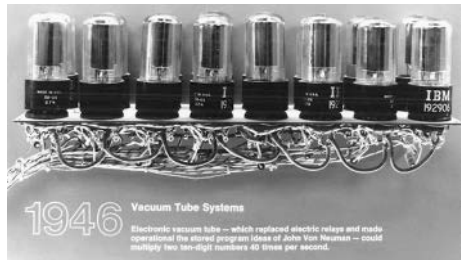
GEORGE HERNANDEZ, P.E.

Pacific Northwest National Laboratory

VOLTRON™ 2016



# How Far We Have Come...





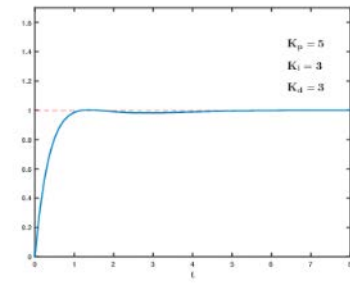
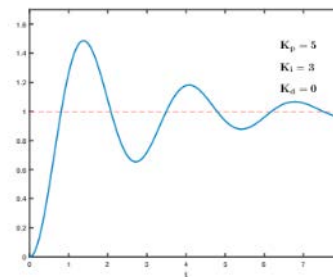
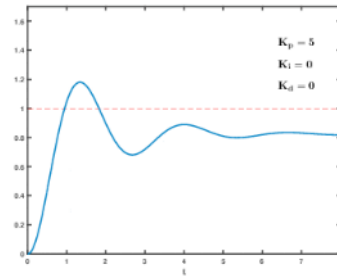
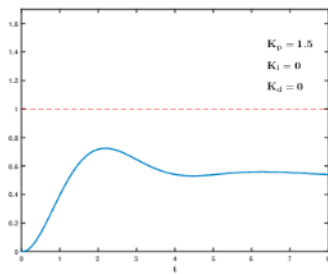
# Linear Verses 'Blobular'

Control systems tend to be linear

$$P_{\text{out}} = K_p e(t)$$

Or maybe even KINDA non-linear

$$u(t) = K_p e(t) + K_i \int_0^t e(\tau) d\tau + K_d \frac{de(t)}{dt}$$



But the problem *is* systems that include physical components tend not to be linear

# The Epiphany!

STOP trying make systems ever more complicated...

Intstead of endless nested loops or layers...



Sophisticated Simplicity is the right answer... Biological in concept... Like a **BRAIN**

*BUT...*

“The idea that the brain has a center is just wrong. Not only that, it is radically wrong,”  
Daniel Dennett – Tufts University professor of philosophy

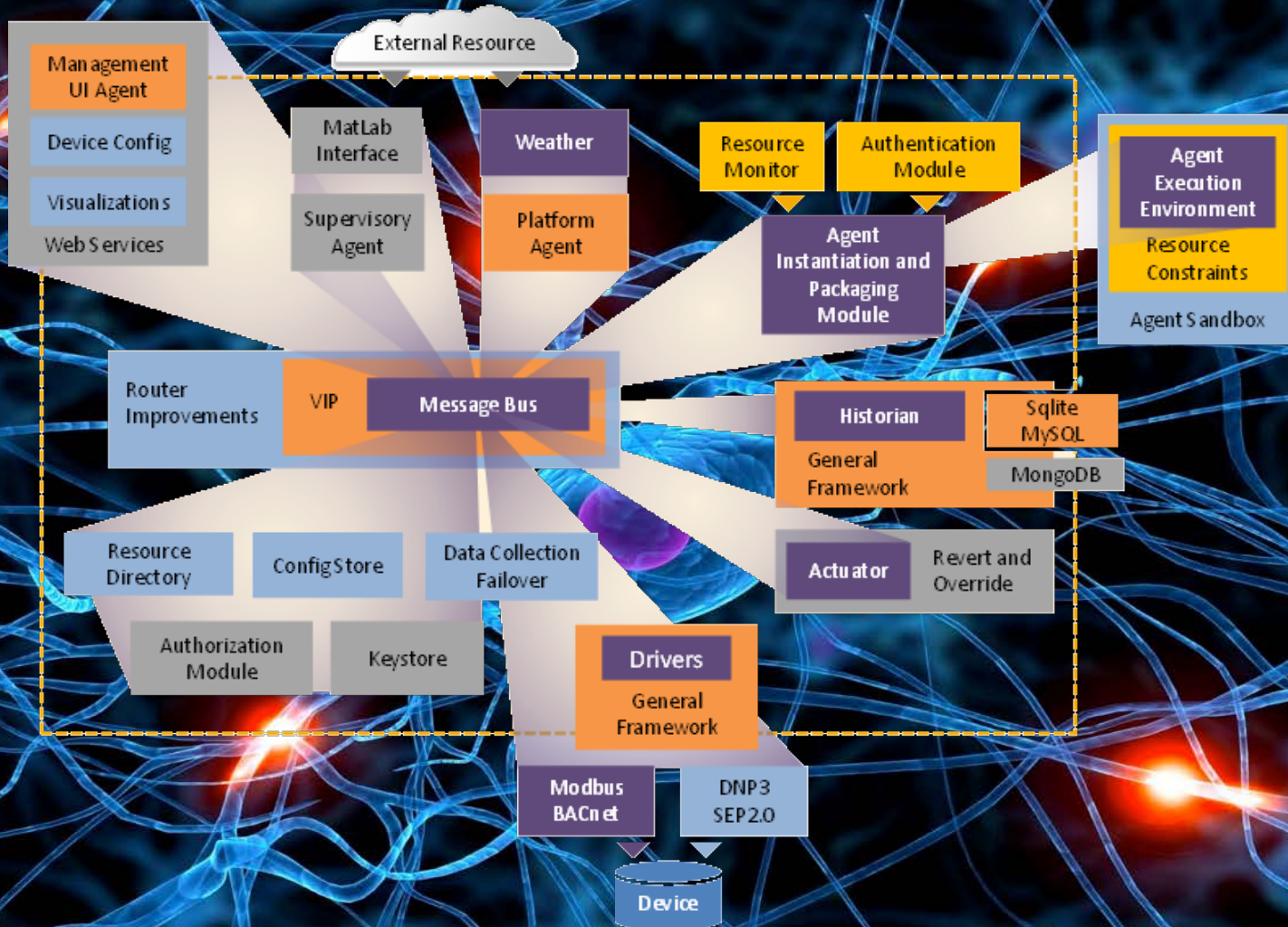


# Autonomous Self Configuring Agent Based Data and Control Systems



Pacific Northwest  
NATIONAL LABORATORY

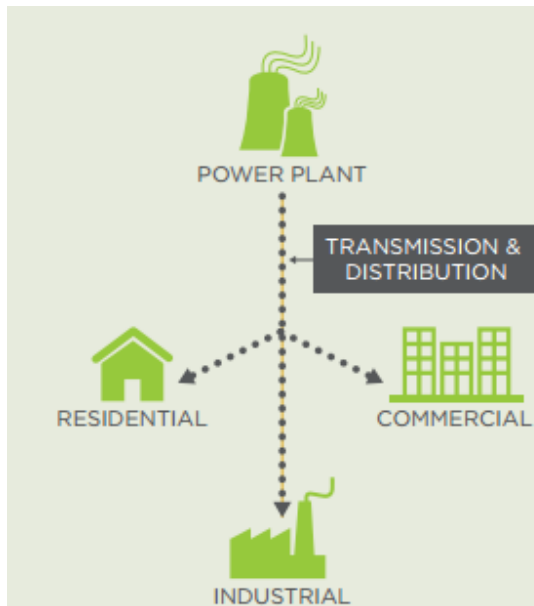
Proudly Operated by **Battelle** Since 1965





# Moving to the New Paradigm

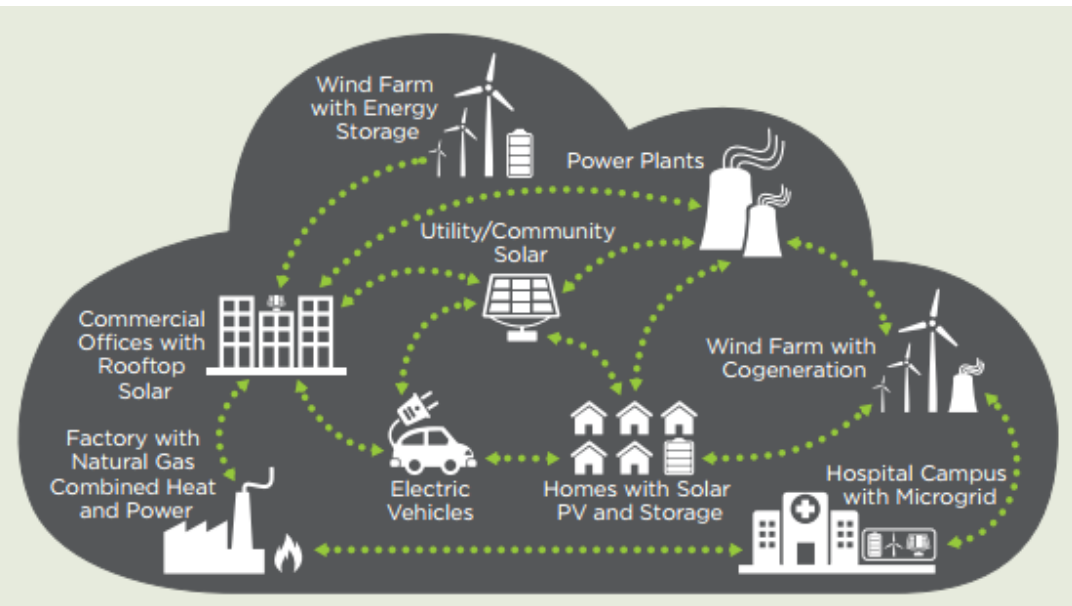
## One-Way Power Flows



©2016 Navigant Consulting, Inc. All rights reserved.

- Large, centrally located generation facilities
- Designed for one-way energy flow
- Utility controlled
- Technologically inflexible
- Simple market structures and transactions
- Highly regulated (rate base) and pass through

## Two-Way Power and Information Exchange



(Source: Navigant Consulting)

- Distributed energy resources
- Multiple inputs and users, supporting two-way energy flows
- Digitalization of the electric-mechanical infrastructure: smart grid and behind the meter energy management systems
- Flexible, dynamic, and resilient
- Complex market structures and transactions
- Regulation changing rapidly around renewables, distributed generation (solar, micro-grid, storage), net metering etc.



# Transactive is the Answer!

**Transactive Buildings** – buildings that can dynamically respond to signals or messages from entities outside the building.

Can provide a measurable response to entities outside the building through the utilization of building located loads.  
Self-aware (continuously aware of building state such that availability can be quantified) and continuously interacting with the larger systems they are a part (e.g. campuses, grid, etc.)  
through ICT, negotiations, etc.

Transactive Equipment and Transactive Buildings are assets to the grid but will scale at different rates and through different drivers thereby presenting a range of solutions:

- ✓ Existing building transactions include Demand Response (DR) triggered through Automated-DR messaging;
- ✓ “Clunky,” limited transactions could be in the form of existing Building Automation Systems (BAS) control (until transaction based controls proliferate into whole buildings);
- ✓ Portfolio-based control of transactive equipment located throughout distribution feeder (distributed devices across time and spatial boundaries);

**Transactive Campuses** are the physical locations of fully integrated collections of transactive equipment, buildings, and other EERE.

Transactive locations can deliver energy market and grid services through the management/ interactions of installed assets, devices, and loads.





**Pacific Northwest**  
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

# Undergoing Evolution

If you show people the problems and you show them the solutions they will be moved to act.

Bill Gates