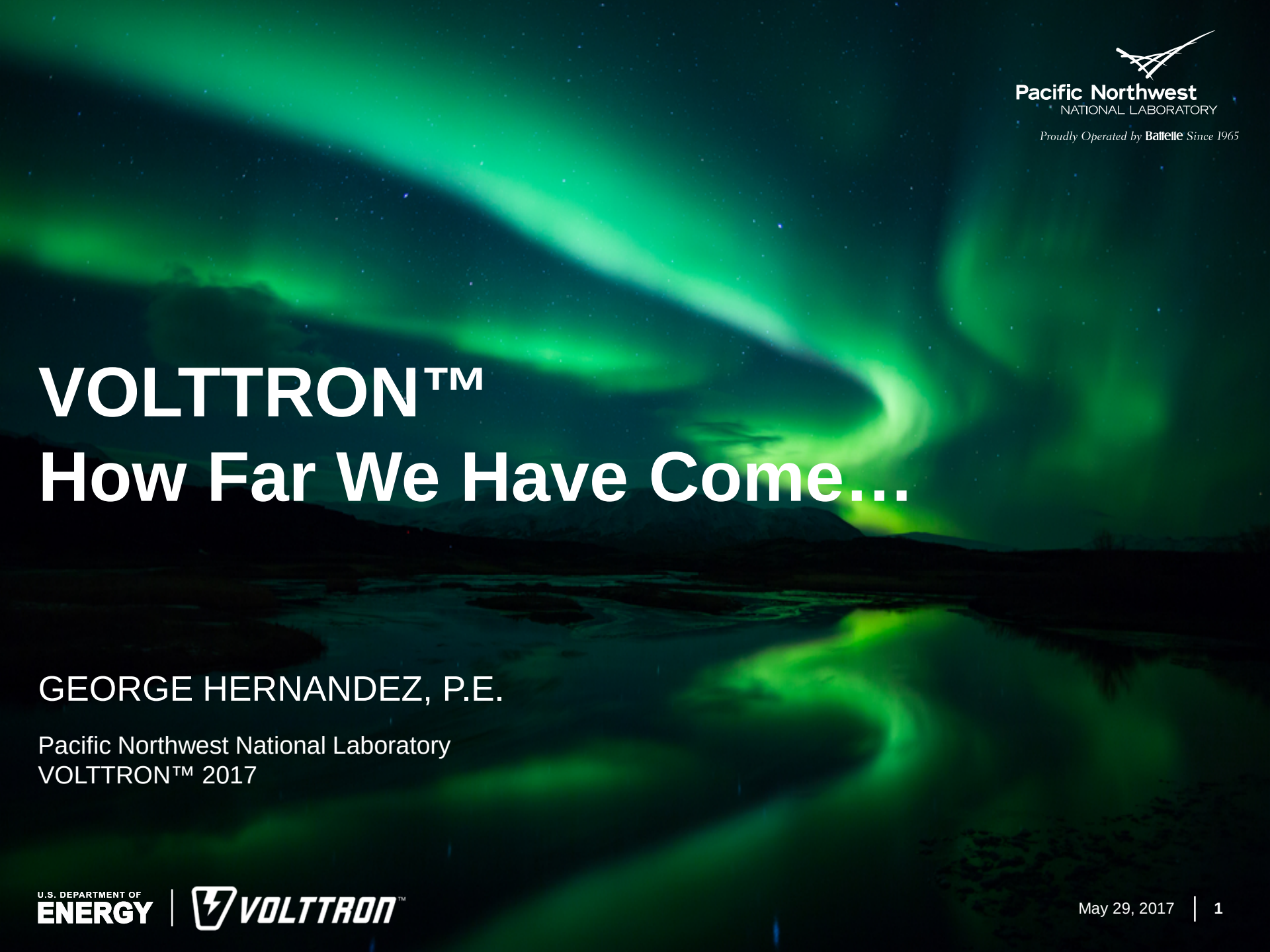

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VOLTTRON™
How Far We Have Come…

GEORGE HERNANDEZ, P.E.

Pacific Northwest National Laboratory
VOLTTRON™ 2017

Future Power Grid Initiative

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Challenge

Accommodate Millions of Electric Vehicles

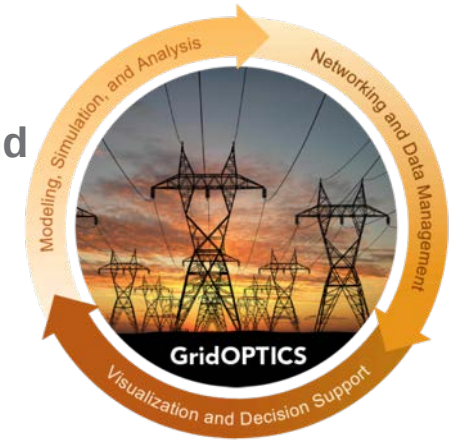
Manage Smart Loads

Integrate Renewables

Maintain Reliability

Approach

Modeling and Simulation



Networking and Data Management

Visualization and Decision Support

Impact

- Bridging operation and planning to enable seamless grid management and control
- Integrating transmission and distribution in end-to-end grid modeling and simulation
- Managing large-scale data in real time with high reliability and security

What's In A Name??

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VOLTRON – Defender of the Universe

Survey Says……*VOLTTRON™*

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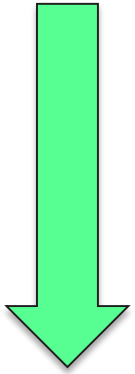
Intelligent Networked Sensors Capable of Autonomous, Adaptive Operations in the Electric Power System



VOLTTRON™

Devices | Data | Decisions

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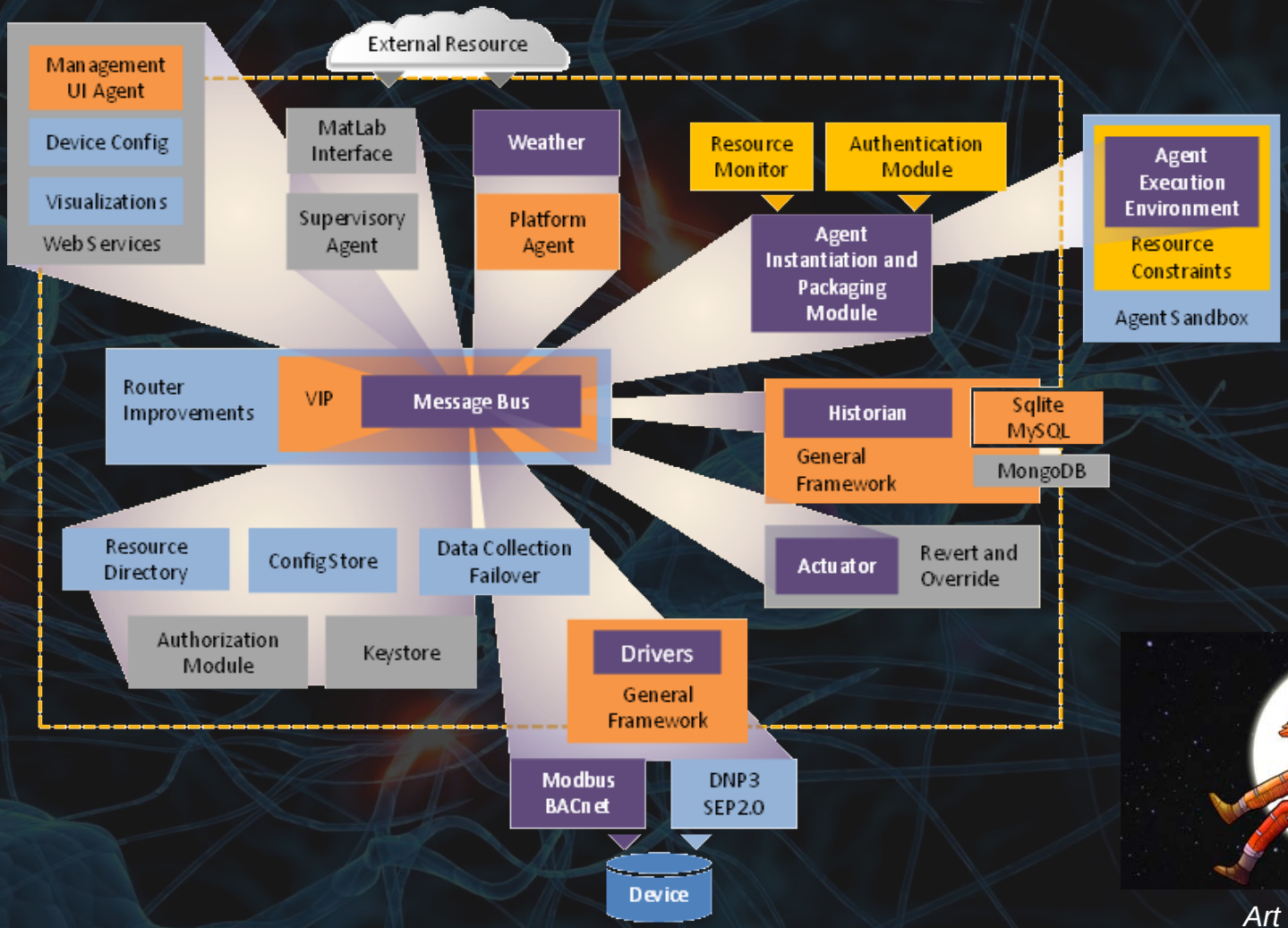

Art by Ten Hundred

The Genesis of a GREAT Idea!

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DISTRIBUTION WORKSHOP

GTT DISTRIBUTION WORKSHOP – SEPTEMBER 24-26, 2012

On September 24-26, 2012, the GTT presented a workshop on grid integration on the distribution system at the Sheraton Crystal City near Washington, DC.

This technical workshop was the first in a series addressing the challenges and opportunities presented by the integration of 21st century energy technologies onto the electrical grid.

What Can Building Technologies Office Do?

The Solution……

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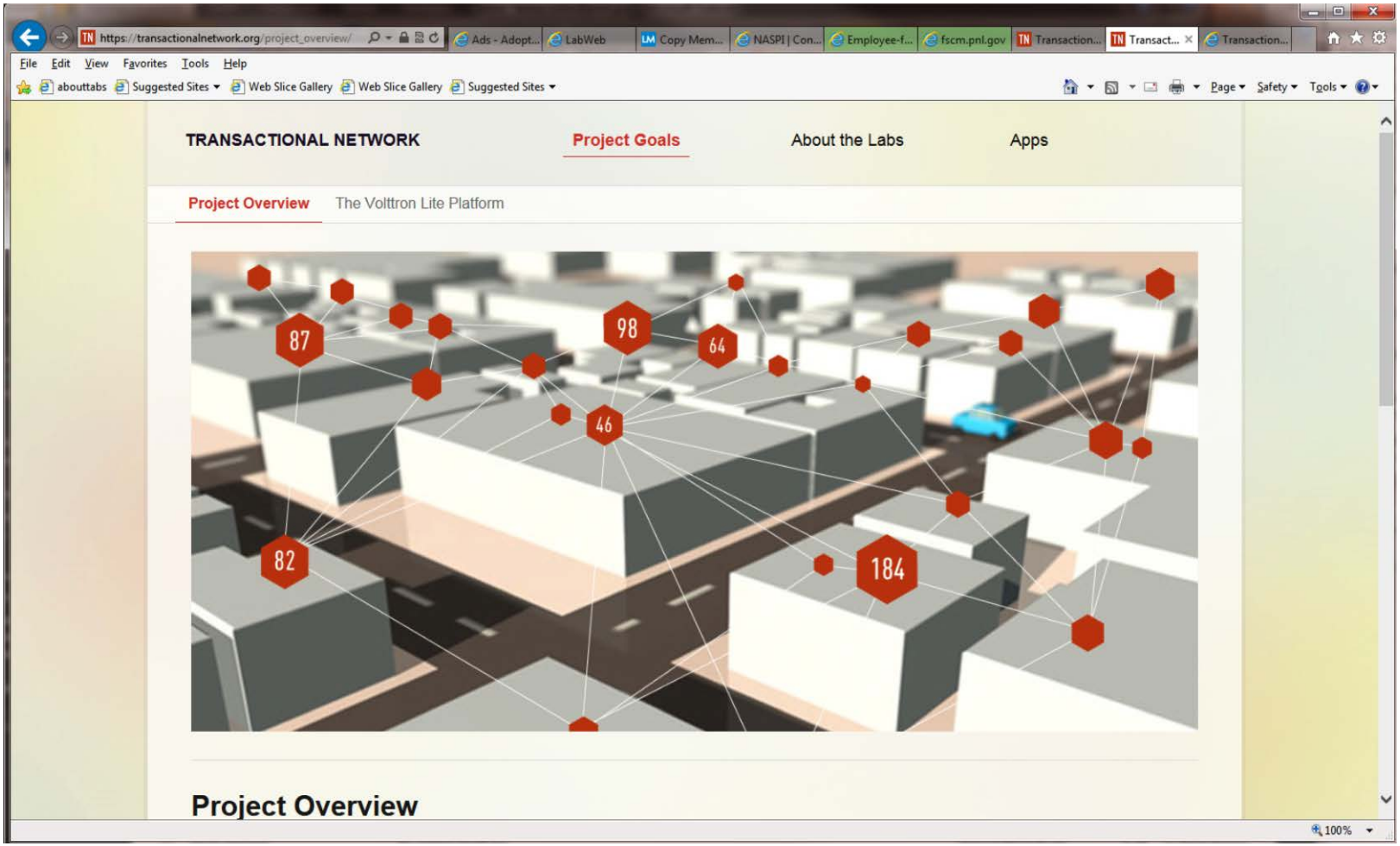
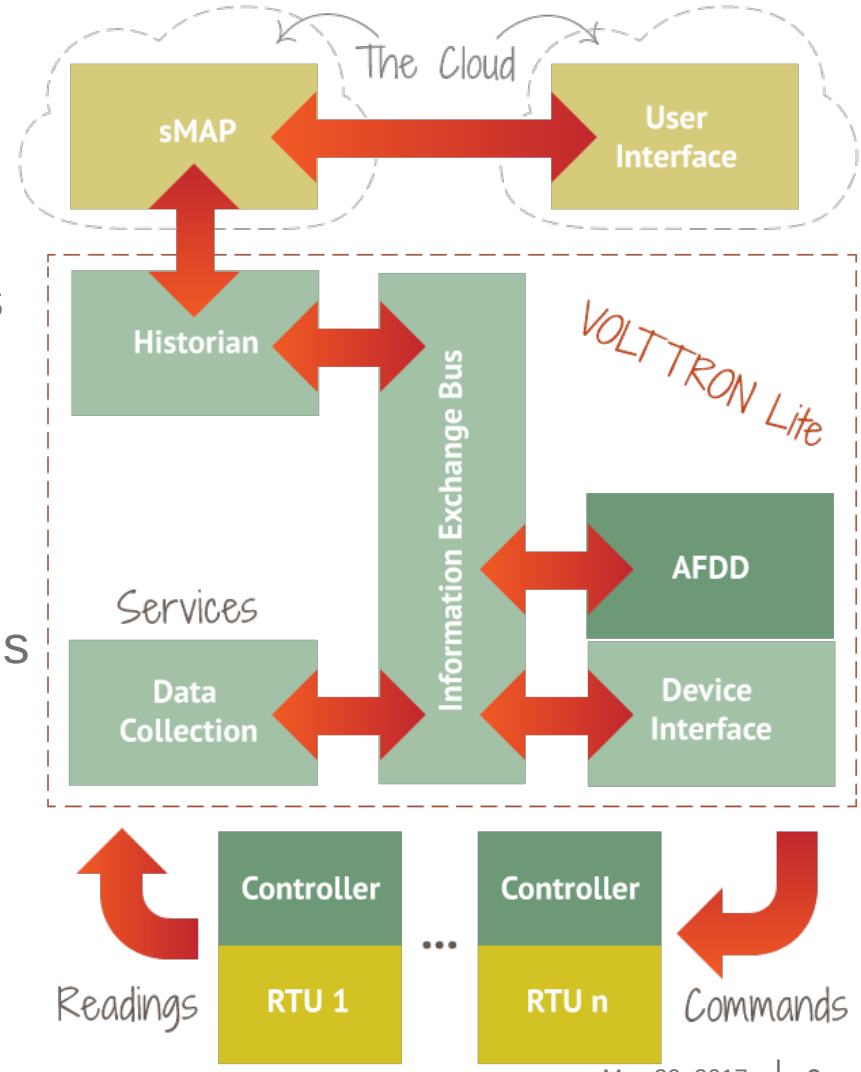
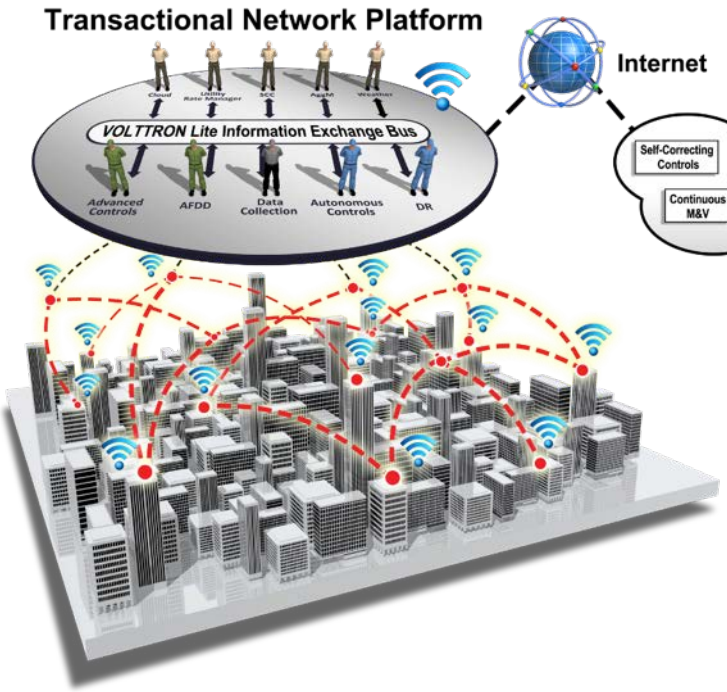
The Transactional Network

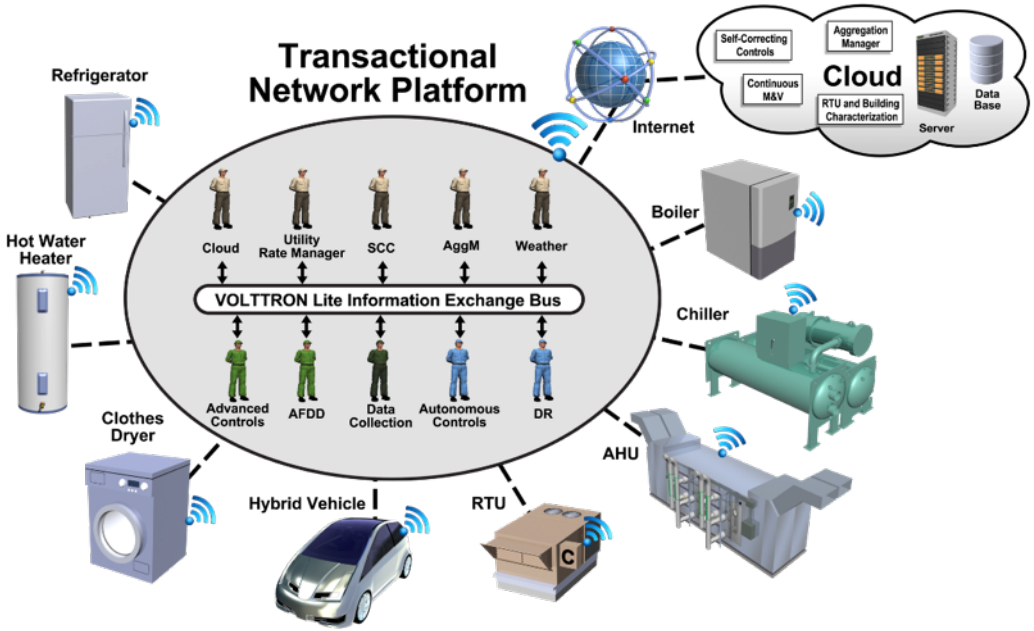


- The transactional network enables energy saving retrofit solutions AND the networked systems to **transact** with the grid to mitigate variable distributed renewable energy sources
- Initially, the transactional concept is demonstrated using networked RTUs
- In the future, the concept can be extended to network other building systems, interaction between buildings and electric vehicles
- Work is being done at the three national laboratories
  - Pacific Northwest
  - Oak Ridge
  - Lawrence Berkeley



Transactional Network





Moving to the New Paradigm

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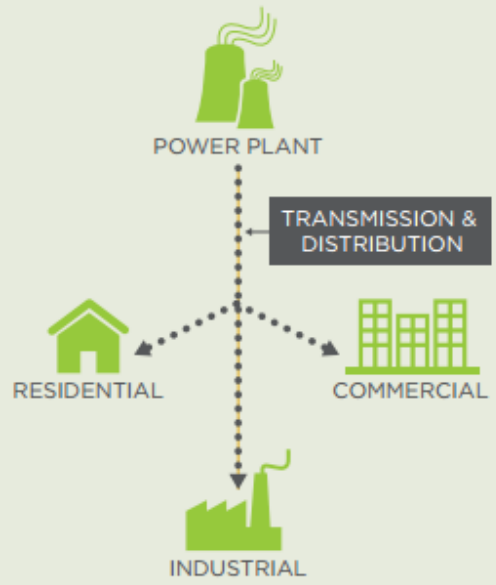
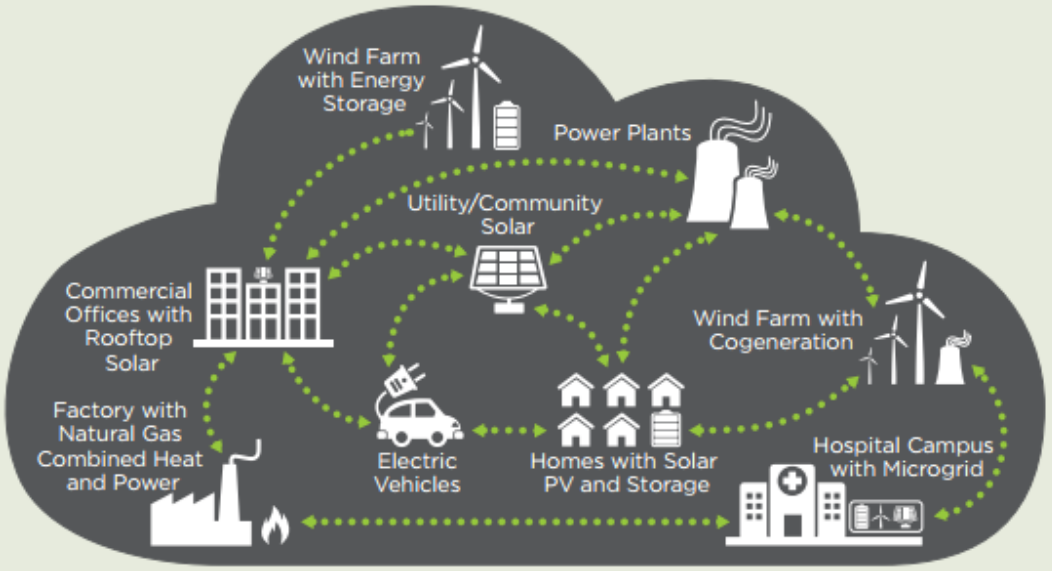
One-Way Power Flows



- 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

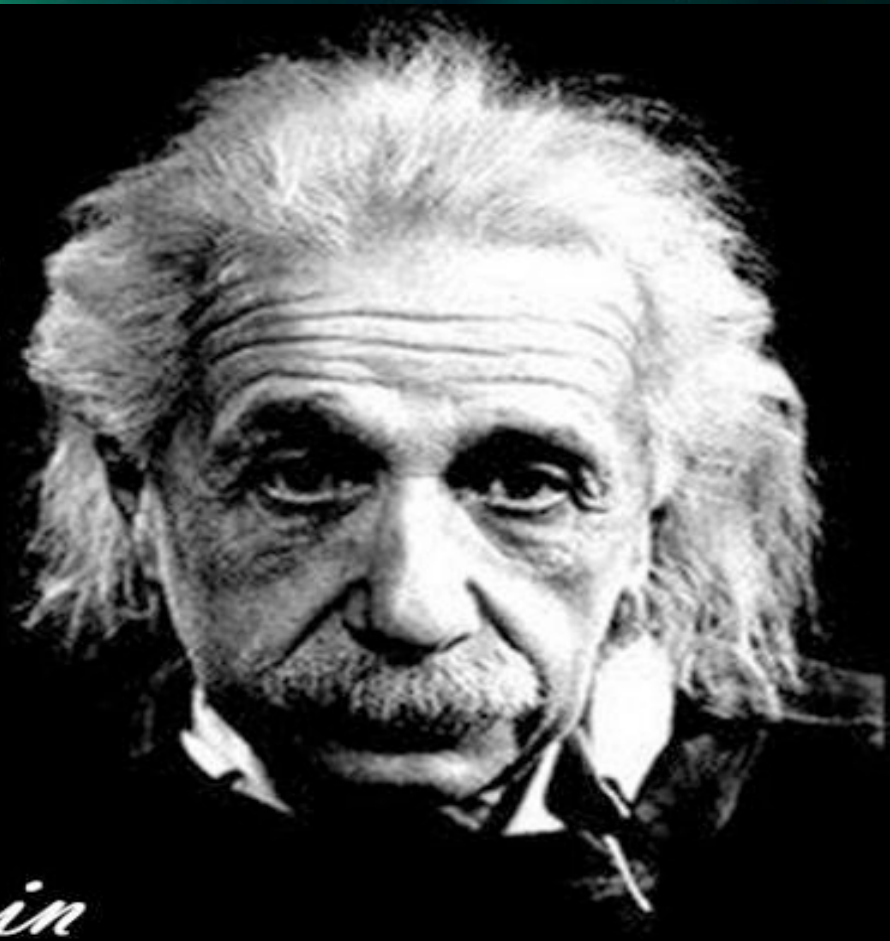
Two-Way Power and Information Exchange



(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.

we cannot solve
our problems with
the same thinking
we used when
we created them



~ Albert Einstein