Building Technologies Program

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Transactional Network Overview

Meeting on the Software Framework for Transactive Energy

July 23rd, 2014

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Challenges

- Application Challenges
  - Integrating variable distributed generation
    - Solar
    - Wind
  - Integrating storage at multiple layers
  - Integrating electric vehicles (EV)
  - Managing end-use loads
    - Residential
    - Commercial
    - Industrial
  - Enabling energy coordination and trading between buildings and trading between buildings and grid
- Technology Challenges
  - Rapid deployment of networked (grid, buildings, etc.) sensors and controllers
  - Scalable control and diagnostics
  - Secure and reliable communication

Distributed Systems Call for Distributed Solutions

- Are there solutions that we can leverage that will improve efficiency (reduce energy and emissions) while supporting grid reliability and integration of distributed variable renewable generation?
- What happens in a neighborhood where everyone has solar panels on the roof and there is intermittent unexpected cloud cover?
  - If a cloud cover is anticipated, what changes can you make locally to mitigate that in advance?
- What happens in a neighborhood where everyone owns an EV and everyone comes home at the same time on a hot day and start to charge?
- What if appliances in your house could communicate with each other to coordinate energy usage and shift load to off-peak times?
  - Customer sees lower bills
  - Utilities get more predictable and even load
  - Quicker response to mitigate variable distributed power generation
- If we are going to invest in infrastructure to mitigate the above challenges, can we leverage the same distributed solution to support condition-based maintenance of equipment and improve operational efficiency of building systems?

Need

Accommodate Millions of Electric Vehicles

Manage End-Use Loads

Integrate Renewables

Maintain Reliability

- Large amount of data generated by sensors goes unutilized due to high volume. Off-line analysis helps but is insufficient
- Appliances/devices unable to coordinate energy usage due to proprietary solutions and lack of underlying distributed control algorithms and platforms
- Growing ownership of electric vehicles will increase effect of load peaks
  - Increase in energy market purchases
  - Increase in maintenance due to equipment stress (e.g., transformers)
- Require techniques to better integrate renewables at all scales: rooftop photovoltaic (PV), wind farms, energy storage
- Agent-based approach is a natural fit for this area, but
  - Agent-based energy efficiency solutions often do not progress beyond simulation

Technology Solution Attributes

- Open, flexible and modular software platform
- Ease of application development
- Interoperable across vendors and applications
- Hides power and control system complexities from developers
- Object oriented, modern software development environment
- Language agnostic. Does not tie the applications to a specific language such as Java
- Broad device and control systems protocols support built-in
  - ModBUS, BACNet, DNP3, and others
- Multiple types of controllers and sensors
- Low CPU, memory and storage footprint requirements
- Supports non-Intel CPUs
- Secure
- Security libraries and cryptography built-in
- Manage applications to prevent resource exhaustion (CPU, memory, storage)
- Robust against denial-of-service (e.g., does not crash when scanned via network mapper)
- Supports modern application development environments

Transaction Based Controls are a “no regrets” solution for EERE

- Next generation building sensors/controls can be low cost and offer significant energy savings for buildings and other technology sectors
  - BTO-AMO Alcoa project

- The BTO prioritization tool indicates that various building controls measures have the potential to offer significant energy savings (> ~500 TBTUs in 2030) and are cost effective. These savings are derived from…
  - Commercial building automation particularly in small and medium buildings
  - Advanced controllers in new refrigeration systems
  - Demand control ventilation in commercial buildings
  - Predictive thermostats in homes and commercial buildings
  - Residential building automation (a sector of high market activity)

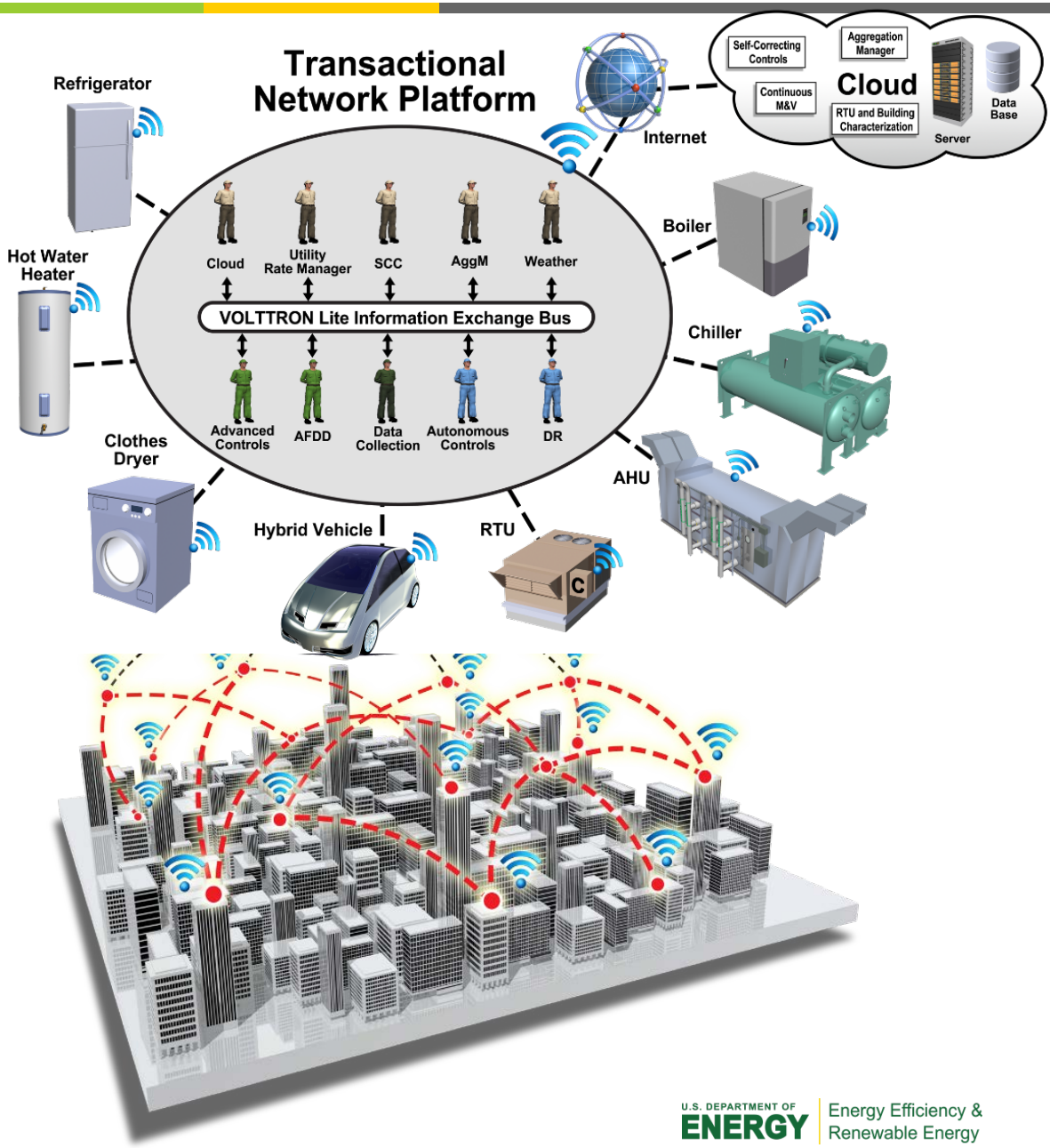
- ***Development and deployment of various cost effective transaction based control measures will contribute to 30% energy savings by 2030.***

Transactional Network Controls

- Buildings need to be smarter to participate in transactions within the building, with other buildings, and with grid entities.
- Sensors and controls at the whole building level and at the component level are fundamental to optimize DER and the grid.
- **The transactional network enables energy saving retrofit solutions**

  AND

  the networked systems to transact with all grid connected devices (e.g. EV, storage) and with the grid to help mitigate DER related disturbances.

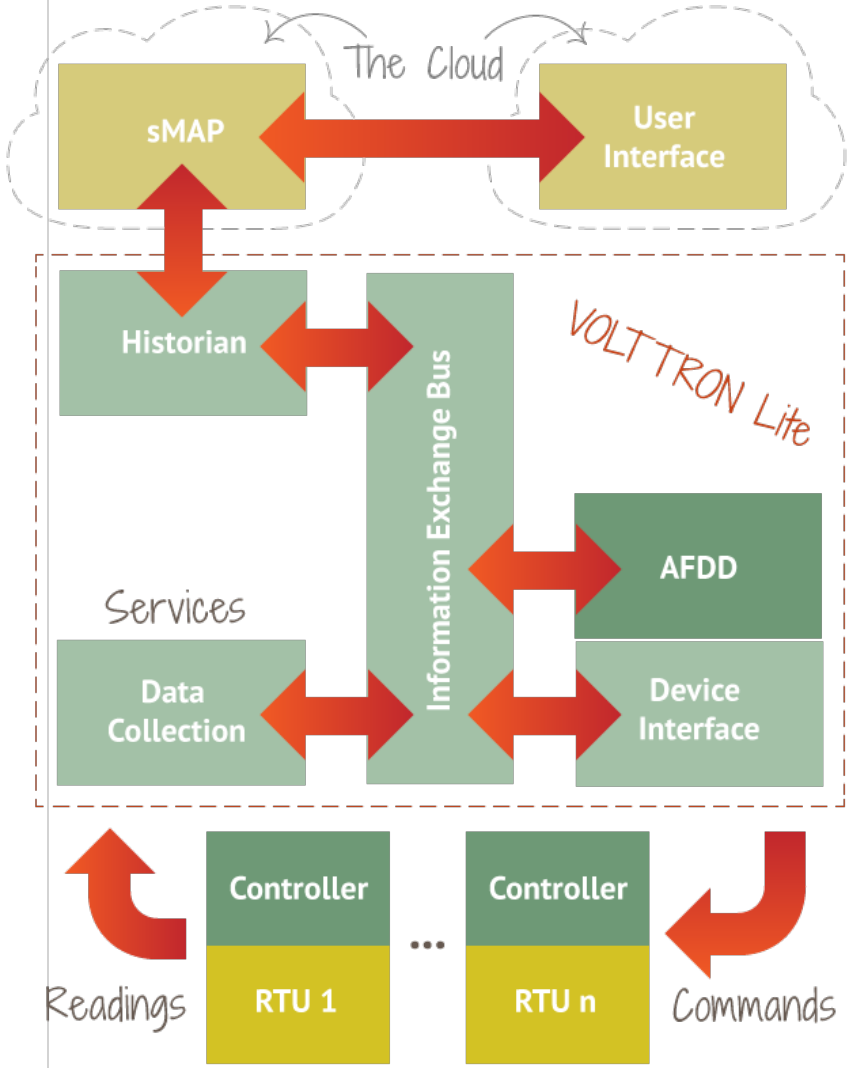


What is a Transactional Network

- **Transactional network** enables:
  - Interactions among networked systems (e.g., RTUs and other building systems) and the electric power grid
  - Software applications on the platform or in the Cloud
- Embedded automated diagnostics and advanced controls on the transactional platform and the RTU controller
- Applications running in the Cloud in cases where the transactional platform and controller resources (i.e., processing) are inadequate
- Applications that provide continuous monitoring and verification, automated energy management, etc.

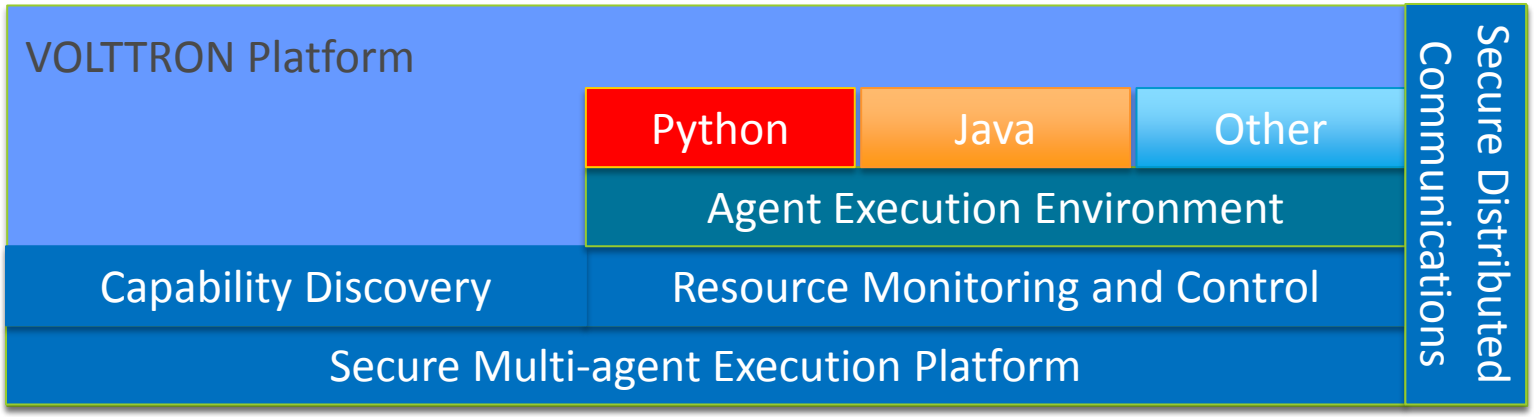
Transactional Network

- The transactional network enables energy saving retrofit solutions AND the networked systems to **transact** with the grid to mitigate variable distributed renewable energy sources
- Proof of concept has been demonstrated using networked RTUs, Supermarket refrigeration systems and Photovoltaic arrays
- In the future, the concept can be extended to network other building systems, interaction between buildings, electric vehicles, storage, microgrids, CHP, etc.

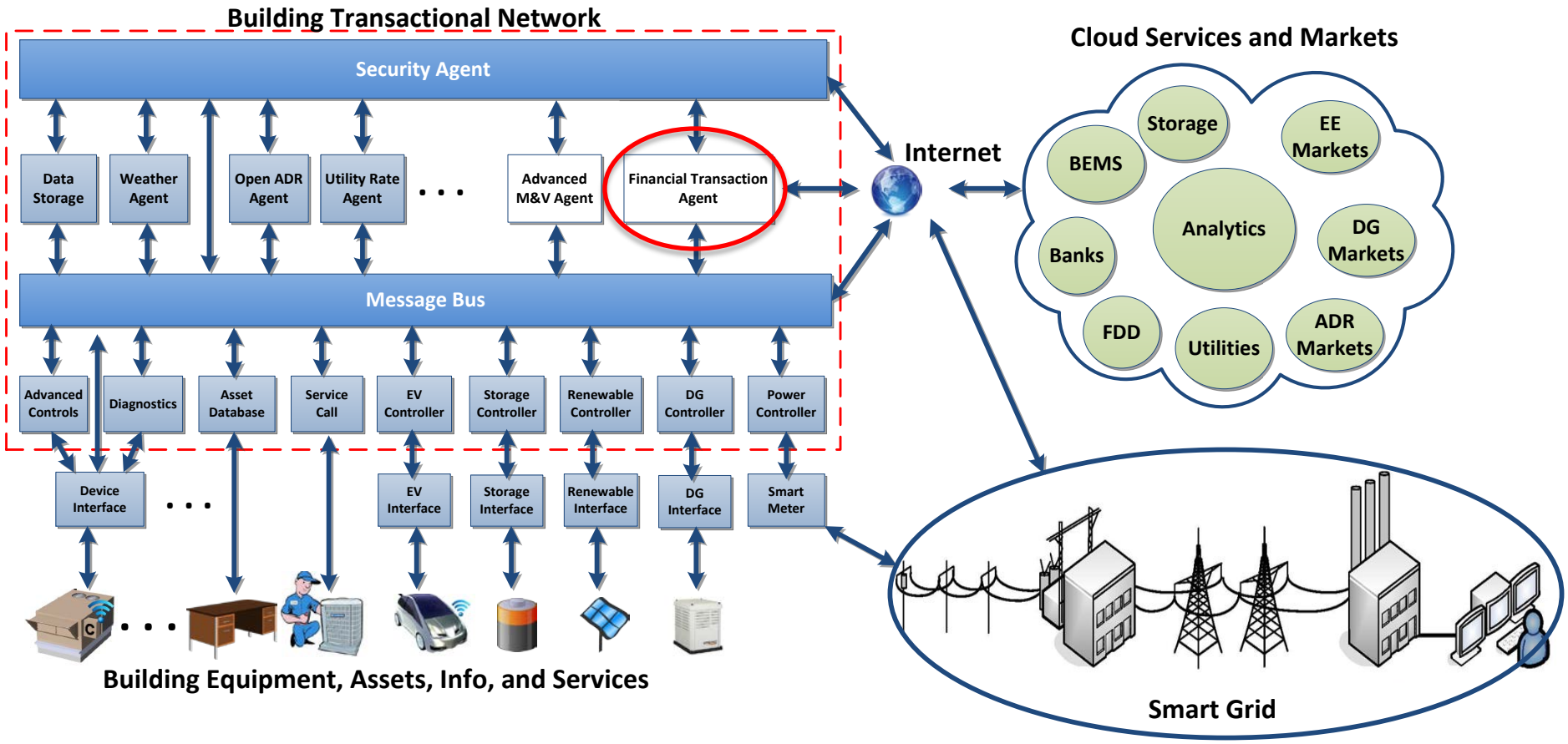


VOLTTRON™ Platform

- VOLTTRON is a software platform for next generation distributed control applications for integrating buildings and power grid
- Proven through simulation, prototypes and field deployments
- Flexible, modular and language-agnostic
- Open-source, easy to extend, already being used by external collaborators
- Maintain security and manage platform resources
- Services for applications to find each other



Transactional Network from VOLTRON Perspective



A key component of the Transactional Network is a 'Financial Transaction Module'. This will provide the automated mechanism to 'track and settle' transactions executed by the 'buyers and sellers' of energy and energy related services