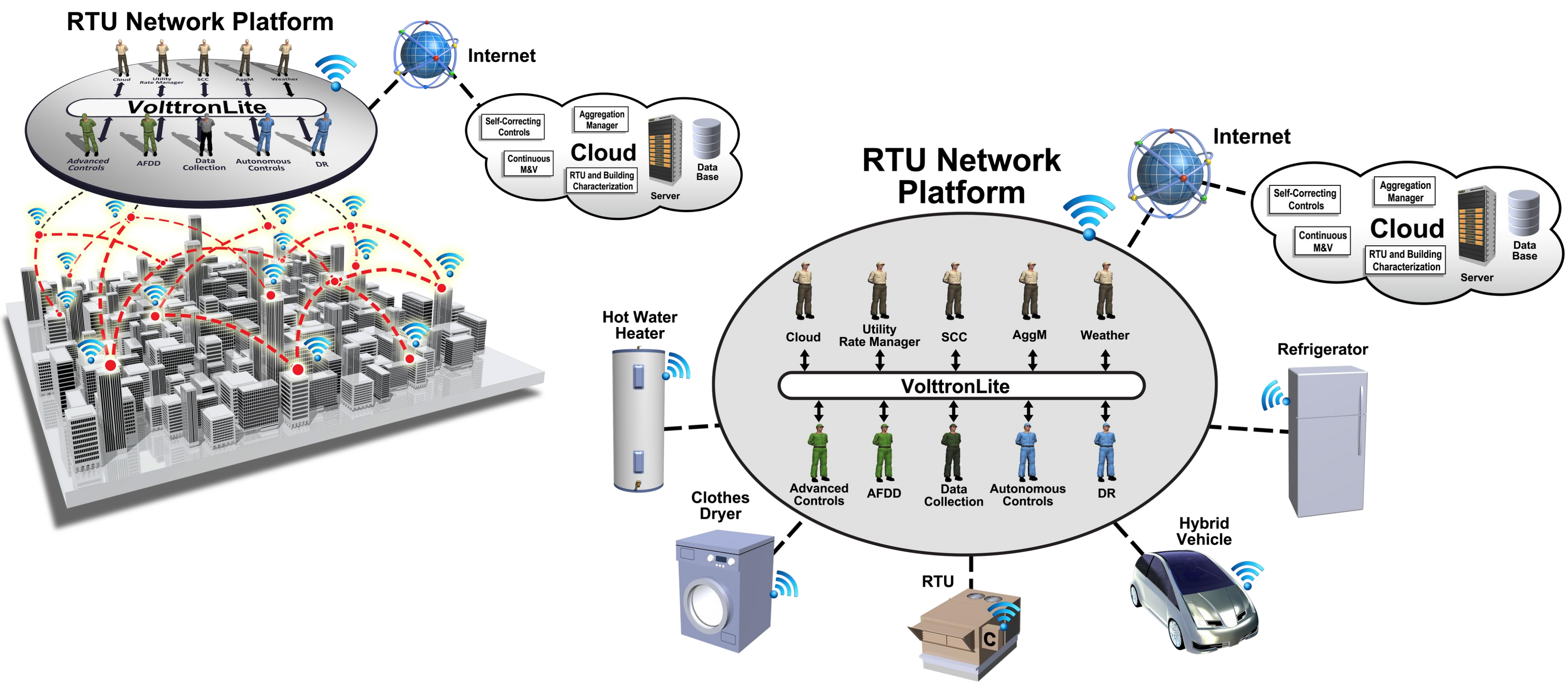

RTU Network Project

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Problem Statement

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- Packaged air conditioners and heat pumps (RTUs) are used in about 58% of all cooled commercial buildings, serving about 69% of the cooled commercial building floor space (EIA 2003)
  – Navigant estimates packaged A/C uses 0.9 quads of electricity for cooling annually and 0.4 quads of heating (source)*

- Operating efficiency is low due to lack of:
  – advanced controls to improve part load performance
  – equipment maintenance
- RTUs cannot easily interact with the grid to be more responsive to grid needs

**Energy Savings Potential and RD&D Opportunities for Commercial Building HVAC Systems*, NCI, Sept. 2011

Project Objectives and Team

- The main objective of the RTU network project is to enable energy saving retrofit solutions AND to enable the networked RTUs to transact with the grid to make it more reliable and enable buildings to optimally interact with the grid
- The RTU network can be extended in the future to accommodate other building systems and electric vehicles
- Work is being done at the three national laboratories
  - Pacific Northwest
  - Oak Ridge
  - Lawrence Berkeley

Link to BTO Strategic Goals

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- This project contribute to the BTO goal to reduce the energy required to operate existing commercial buildings by 40 percent, at less than the cost of the energy saved
- BTO strategic goal is to bring needed technologies and practices to market delivering:
  - 1,600 trillion BTUs in annual savings by 2020
  - 6,000 trillion BTUs in annual savings by 2030

Potential Project Impact

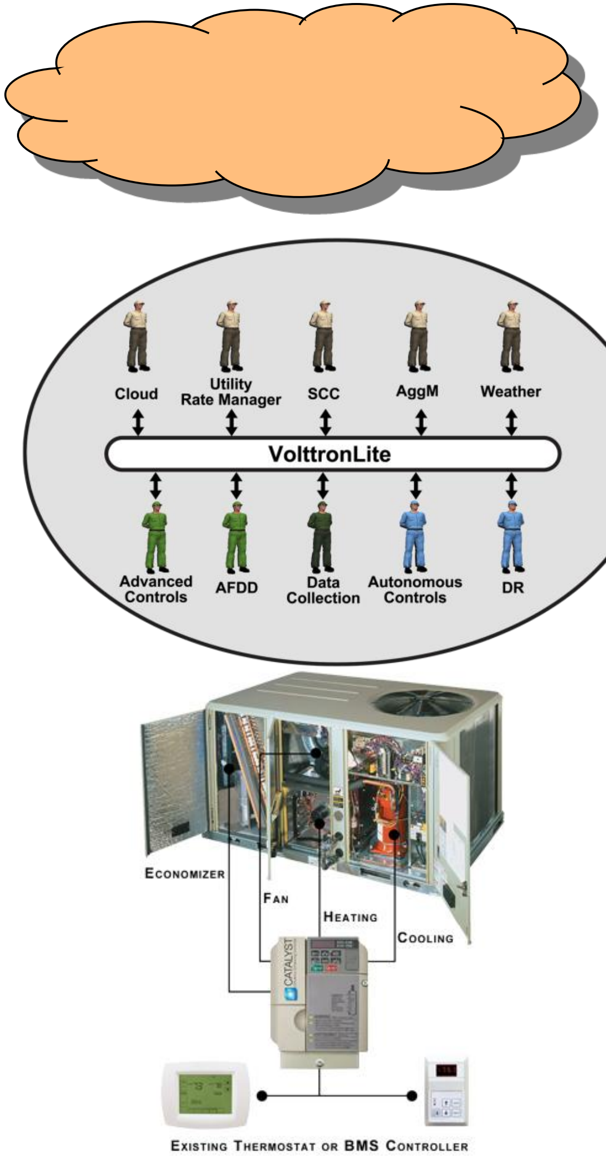
- The target market is all existing packaged air conditioners and heat pumps installed on commercial buildings with an annual consumption of over 1.3 Quads (source)
- Retrofitting these units with advanced controls and deploying smart monitoring and diagnostics systems can lead to significant reduction in consumption
  - Potentially an average of 30% to 40% of the energy consumption, cost and associated emissions
- Because the project will also make these RTU more grid responsive, significant cost savings are also possible through participation in the demand response programs and ancillary services market

What is the RTU Network?

- Transaction-based network that enables interactions among RTUs (other equipment in the future), the electric power grid, and software applications and data on the platform or in the Cloud
- Embedded automated diagnostics and advanced controls in the RTU platform and the controller
- Applications running in the Cloud in cases where RTU platform and controller resources (i.e. processing) are inadequate
- Applications that provide continuous monitoring and verification, automated energy management, etc.

RTU Network Components

- RTU network consists of three major components:
  - The Cloud, which hosts data and applications that cannot be hosted on the RTU network platform or the RTU controller
  - RTU Network Platform – VolttronLite and other software pieces
  - A controller integrated with RTU



Project Approach

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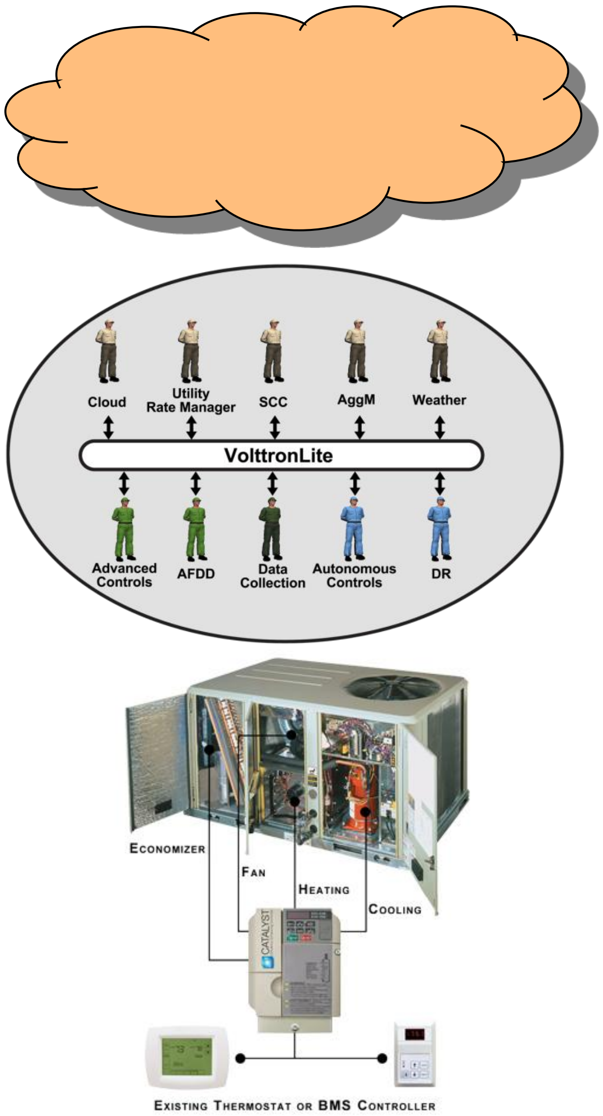
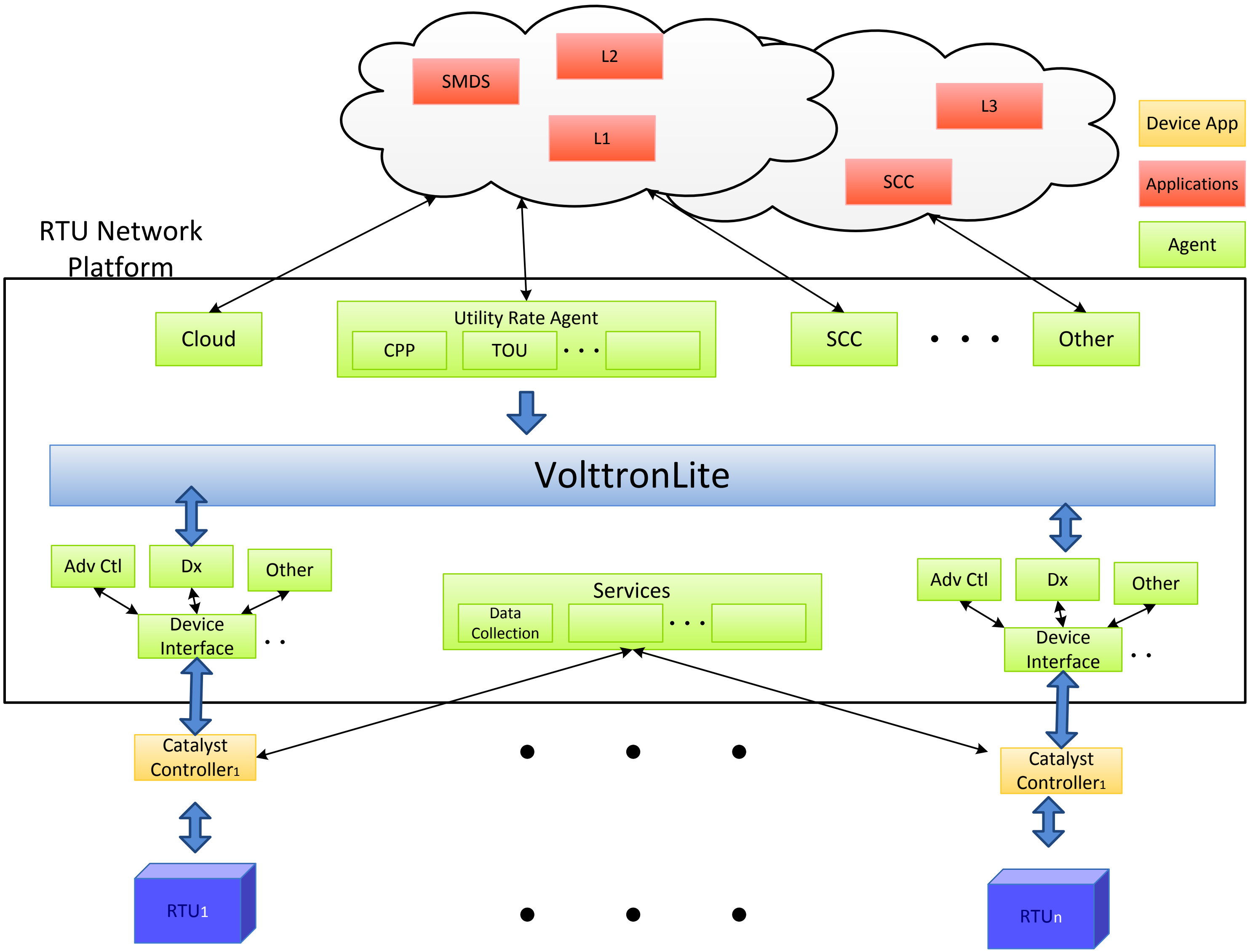
- **Approach**: PNNL will develop the RTU network platform that will host application and service agents, provide access to external data sources and coordinate applications hosted in the Cloud
  - PNNL will also develop and deploy three agent-based control applications on the RTU network platform and develop an application to be hosted in the Cloud
  - ORNL will develop and deploy three agent-based control applications on the RTU network platform
  - LBNL will develop and deploy seven Cloud-based applications
- **Key Issues**: The platform will allow multiple applications/strategies to be hosted at a lower transaction cost and is the first step in achieving the vision of integrating the buildings with the grid while ensuring that buildings are operated efficiently
  - Because buildings consume over 70% of the electricity generated, integrating buildings with the grid will fulfill many of the Smart Grid goals as well, including increasing distributed renewable generation reliably and enabling participation in the ancillary services market
- **Distinctive Characteristics**: The network platform and the associated agents will be released as open source
  - So others can enhance the platform, develop additional agents to control other equipment and appliances and develop commercial products and services

RTU Network Components

- VolttronLite, is the core of the RTU network platform that provides the framework to transact with both the RTUs on the roof and applications and data hosted in the Cloud:
  - Provides access to information from external sources to the applications hosted on the RTU network platform, RTU controller and the Cloud-based applications
  - Coordinates all interactions between applications and manages their execution
- RTU controller, which is connected to each RTU and provides low-level control actions
  - Some control actions are initiated on the controller, while most are initiated either in the Cloud or on the RTU network platform



RTU Network Architecture



RTU Network Single Building

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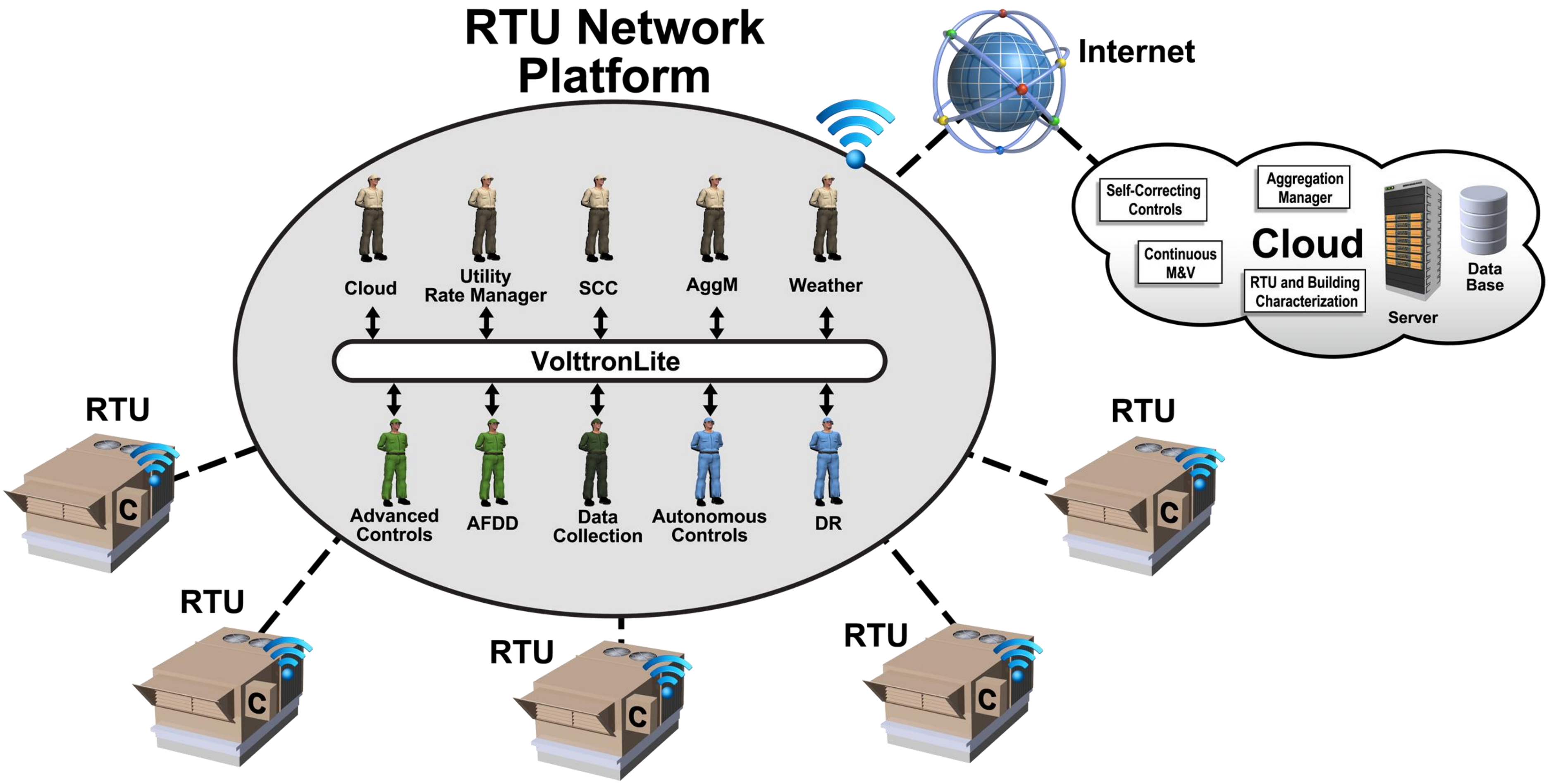

RTU Network Applications

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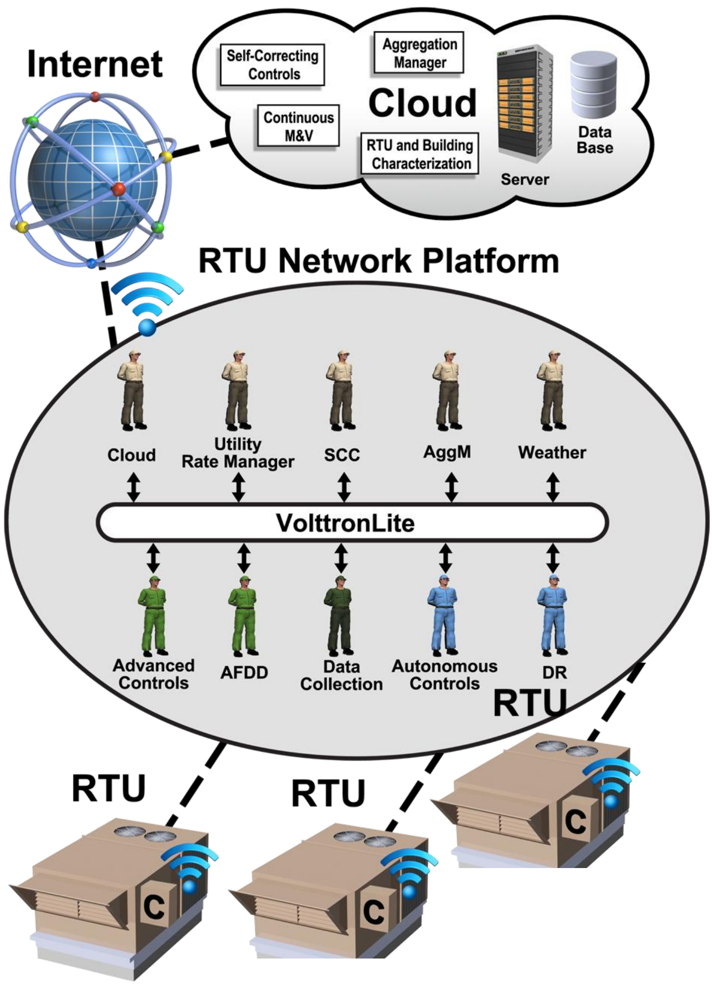
- Advanced Controls – RTU Network Platform
- Grid Responsive Controls – RTU Network Platform
- Fault Detection and Diagnostics – RTU Network Platform
- Smart Monitoring and Diagnostics – Cloud

- Autonomous Controls - RTU Network Platform
- Load as a Resource – RTU Network Platform
- Interoperability Considerations for Wireless Sensors – RTU Network Platform

- Baseline Model Development – Cloud
- Energy Savings, Load Shift or Shed Analysis – Cloud
- Continuous M&V – Cloud
- Economic Analysis – Cloud
- Integrate OpenADR – Cloud
- sMAP Historian – Cloud
- OpenADR Client/Server – RTU Network Platform/Cloud



Project Plans and Schedules

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Summary	Legend
ET-SENCON-PNNL-FY13-02	Work completed
CPS Agreement # 25574	Active Task
	Milestones & Deliverables (Original Plan)
	Milestones & Deliverables (Actual)

Task / Event	FY2013 Q1 (Oct-Dec)	FY2013 Q2 (Jan-Mar)	FY2013 Q3 (Apr-Jun)	FY2013 Q4 (Jul-Sep)	FY2014 Q1 (Oct-Dec)	FY2014 Q2 (Jan-Mar)	FY2014 Q3 (Apr-Jun)	FY2014 Q4 (Jul-Sep)
Project Name: PNNL Rooftop Unit (RTU) Network								
Current work and future research								
D.1.1: Slide presentation of RTU network concept								
D.1.2: Slide presentation on RTU network design								
M.1.1: Complete implementation of the prototype RTU network								
M.1.2: Complete testing of the prototype RTU network								
D.1.3: Design and implement the main page of the RTU Network Dashboard on the Cloud								
D.1.4: Report documenting design, implementation and initial test results for the RTU Network								
D.2.1: Document grid responsive control strategies for RTU (letter report)								
D2.2: Document sequence of operations for control strategies identified in Task 2.1								
M.3.1: Selection of project partner complete								
D.3.1: Document embedded airside Dx algorithms to be tested on a RTU (report)								
D.3.2: Document embedded grid responsive controls to be tested on a RTU (report)								
M.3.2: Implementation of embedded Dx and grid responsive controls in an advanced controller complete								
D.3.3: Design and implement the application specific pages								
M.3.3: Testing and validation of embedded Dx and grid responsive controls in the field on RTUs complete								
M.4.1: Selection of control manufacturer partner								
M.4.2: Complete development/implementation of the Cloud SMDS with multi-speed fan capability								
M4.3: Complete testing of the Cloud SMDS for RTUs outside the RTU Network								
D.4.1: SMDS module of the RTU Network Dashboard								
D.4.2: Documentation on the SMDS methodology, the design of the Cloud SMDS and the results of testing								

Project Budget

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Project Budget:	$1,375K for FY13
Variances:	Project was initiated in January, so we are slightly behind on spend rate; however, plans are in place to have the RTU Network ready for demonstration in September 2013
Cost to Date:	$230K through 3/1/2013

Next Steps and Future Plans: Extending the Network

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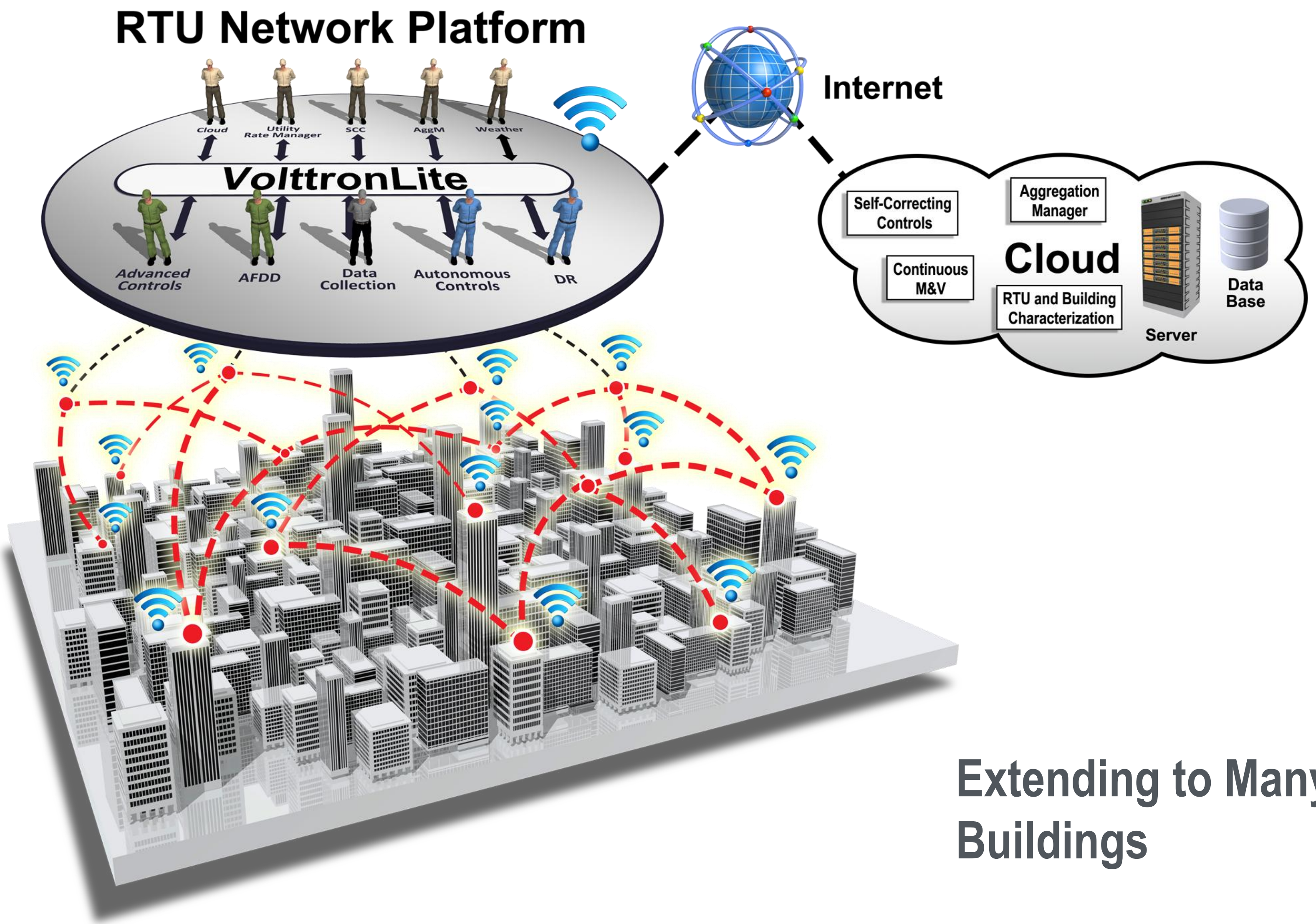

Extending to Many Buildings

Next Steps and Future Plans: Extending the Network

Extending to Many Devices