Brightlayer: How Eaton is bringing the digital future to light

Brightlayer is the foundation for Eaton's transformation to an intelligent power management company by providing new insights from connected and intelligent assets.

EAS (Energy Automation Solutions) is focused on Utilities Analytics

- Significant hiring in EAS Business
- Concentrated effort on predictive analytics
- Working with Center for Intelligent Power team of International data scientists focused on data analytics and machine learning

Why the Brightlayer Utility suite?

Grid reliability

- Precise protection coordination
- Forecast risk
- Optimize assets
- Modernization strategies
- Renewable/DER integration

Operational efficiency

- Real-time data
- Network visualization:
  - Automation and validation processes

Regulations compliance

- Enable required reporting
- Develop systematic approach
- Cybersecurity
- Meet governmental requirements

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A digital solution for every trend

Operational efficiency & load reduction

Grid resiliency & reliability

Cybersecurity & regulatory standards

Network optimization & power engineering

DEMAND RESPONSE

YFA SOFTWARE

IMS SOFTWARE

CYME SOFTWARE

Intelligent product portfolio to manage controllable DR and DER resources

Server-based application with centralized communication architecture that improves reliability by enabling self-healing grid functions

Utility automations software provides complete reliability, security and compliance for all Intelligent Electronic Devices (IEDs)

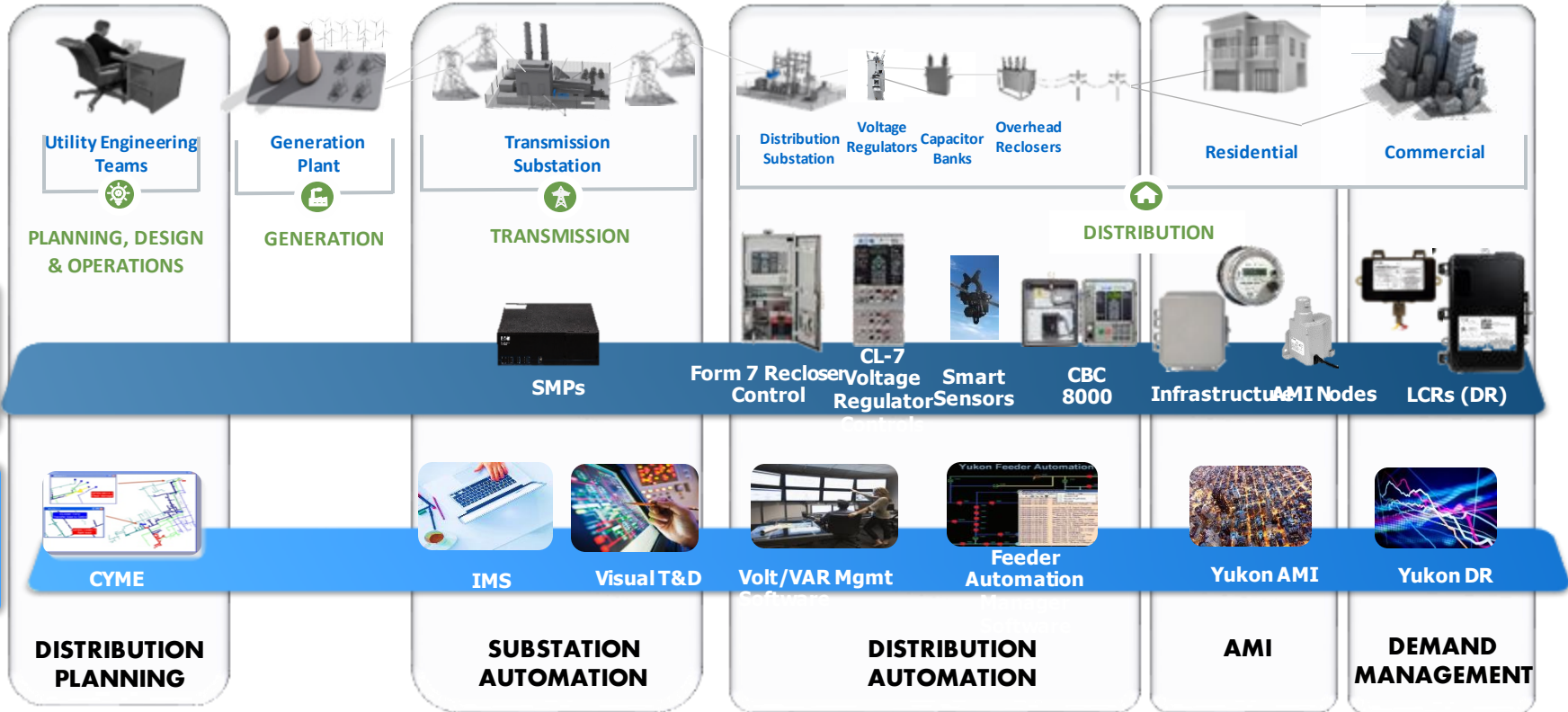Power system modelling and analysis software optimizes all utilities design, planning and operational activities

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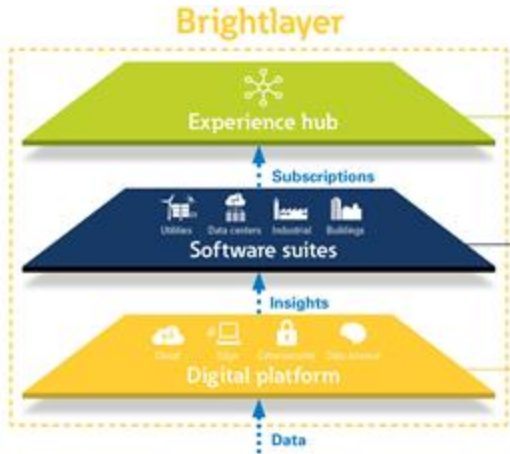# Brightlayer Utilities suite – End-to-End utility focus

Utility Engineering Teams — PLANNING, DESIGN & OPERATIONS

Generation Plant — GENERATION

Transmission Substation — TRANSMISSION

Distribution Substation | **Voltage Regulators** | **Capacitor Banks** | **Overhead Reclosers** — DISTRIBUTION

Residential | **Commercial**

HARDWARE LAYER

SMPs | Form 7 Recloser Control | CL-7 Voltage Regulator Controls | Smart Sensors | CBC 8000 | Infrastructure | AMI Nodes | LCRs (DR)

SOFTWARE LAYER

CYME | IMS | Visual T&D | Volt/VAR Mgmt Software | Feeder Automation Management Software | Yukon AMI | Yukon DR

DISTRIBUTION PLANNING | **SUBSTATION AUTOMATION** | **DISTRIBUTION AUTOMATION** | **AMI** | **DEMAND MANAGEMENT**

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Eaton's Brightlayer Utilities Analytics

Brightlayer

- Experience hub
  - Subscriptions
- Software suites
  - Insights
- Digital platform
  - Data

Brightlayer Applications & Services

Brightlayer Analytics for Utilities

Analytics Reports

Yukon

Analytics Libraries

1. Network Model Correction
2. Over/Under Voltage Analytics
3. Load Analytics & Detection
4. Solar Energy Forecasting
5. High Impedance Fault Detection
6. Power Quality

Connected and Intelligent Assets

Distrb Transformer | Recloser | AMI Meter | Storage | Load Control | EV Charging | PV Inverter

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Brightlayer Utilities Analytics
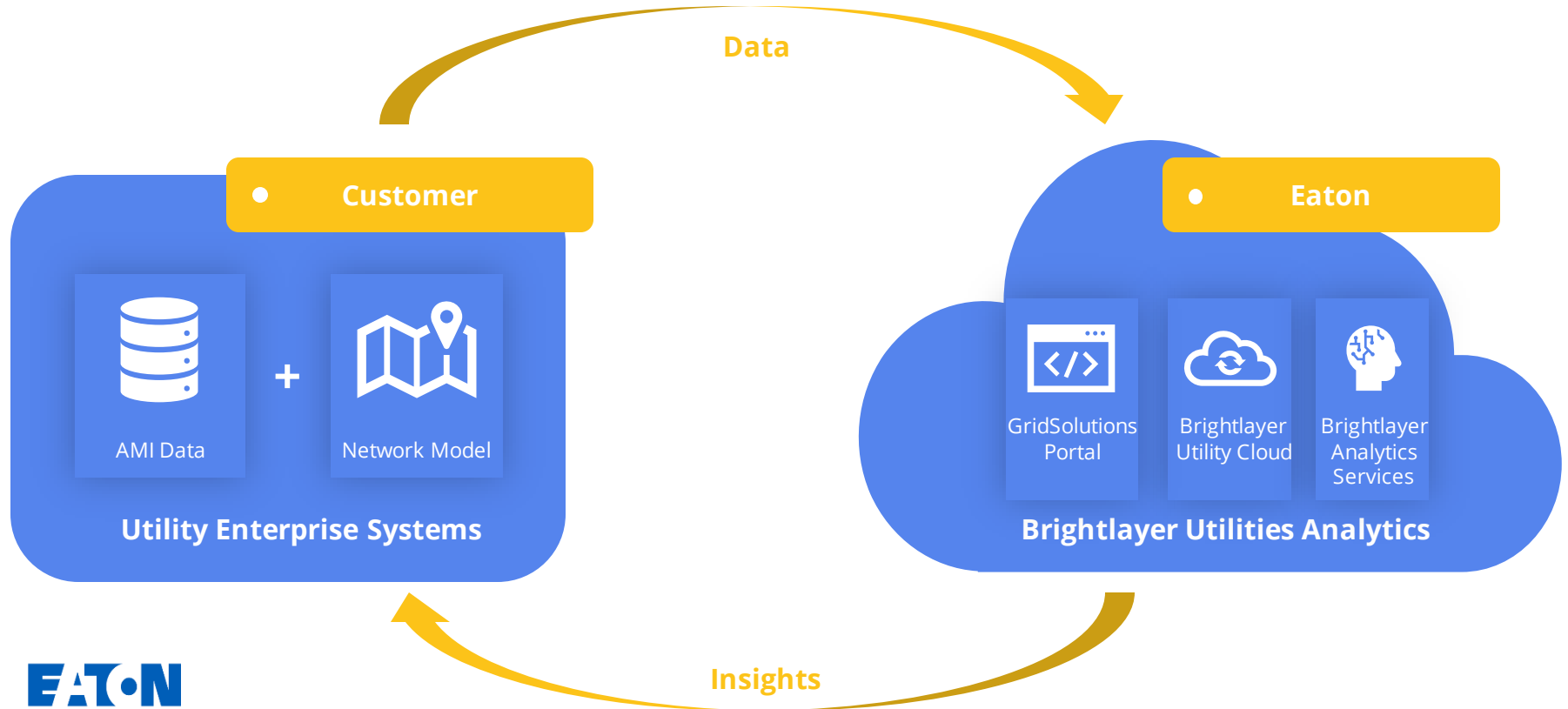
Eaton's Minnesota Connection

Plymouth, MN

CHANHASSEN   DULUTH   JORDAN   MINNETONKA   PLYMOUTH   WHITE BEAR LAKE
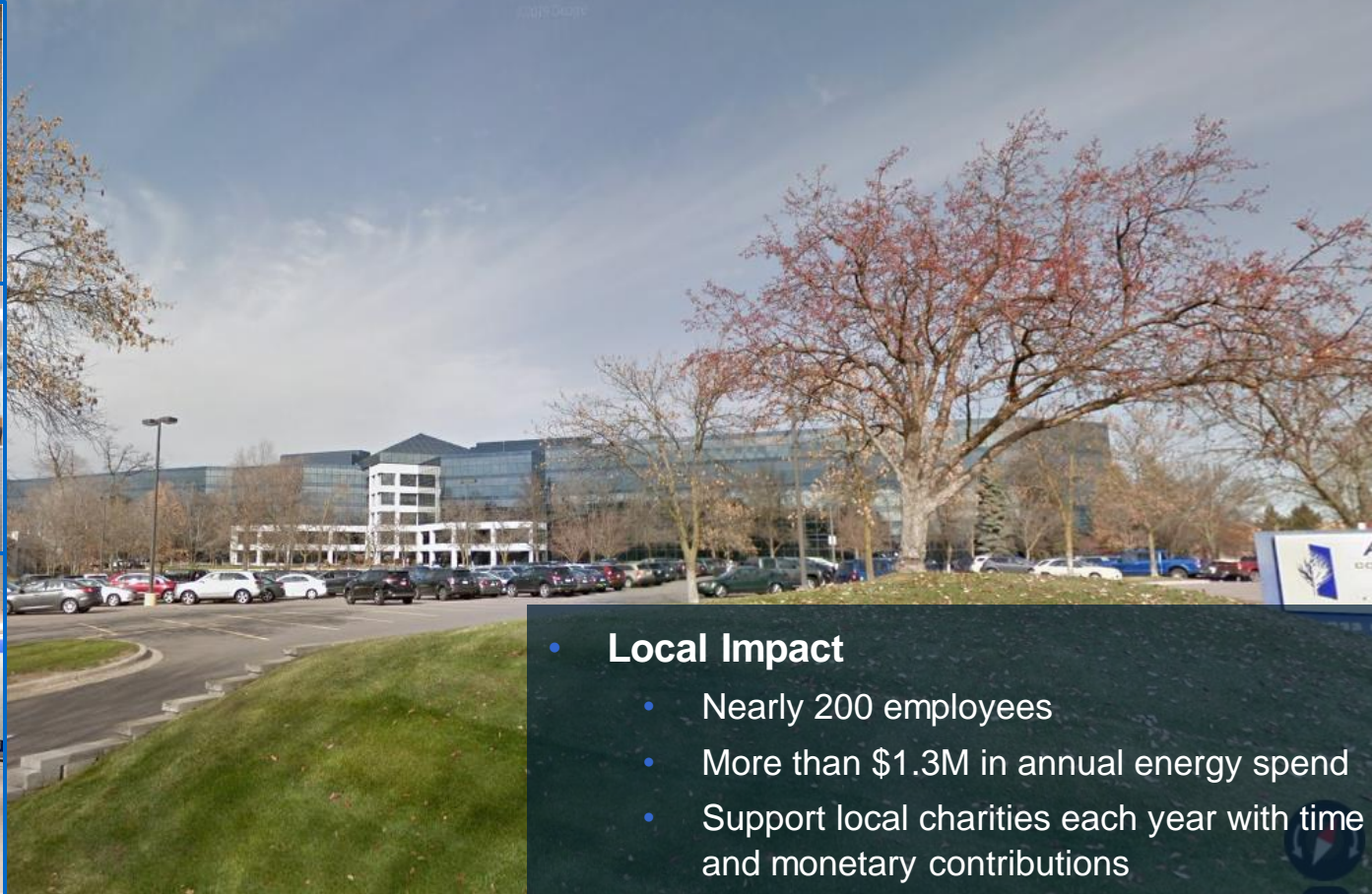
- **Local Impact**
  - Nearly 200 employees
  - More than $1.3M in annual energy spend
  - Support local charities each year with time and monetary contributions

RF MESH INFRASTRUCTURE COMPONENTS

Gateway

- Computer
- Radio w/ Future Expansion Slot
- Ethernet Port
- Antenna Bulkhead
- Quick connector for easy pre-wired cabinet installation:
  - DC power supply
  - Open door sensor
  - AC power outage alarm
  - Battery low alarm
- Alternative AC Power Supply (DC recommended for UPS battery backup)

Gateway Cabinet & UPS

- Gateway has a 5-minute super capacitor for backup power

- Eaton typically proposes Cabinets and UPS units for every Gateway. These can be eliminated for Gateways placed at existing utility assets (substations, buildings, service centers) that have existing backhaul and backup power.

- Simplify installation with plug-and-play equipment mounting and wiring

- Mounting and power provided for backhaul communication devices

- **8+ hour UPS** battery backup provided to power gateway and WAN communications hardware
  - Batteries designed for a minimum 5-year life

- AC surge suppressor and antenna lightning suppressor built in

- Two Analog/Digital Inputs (Door, Temperature and Voltage/Battery monitors)
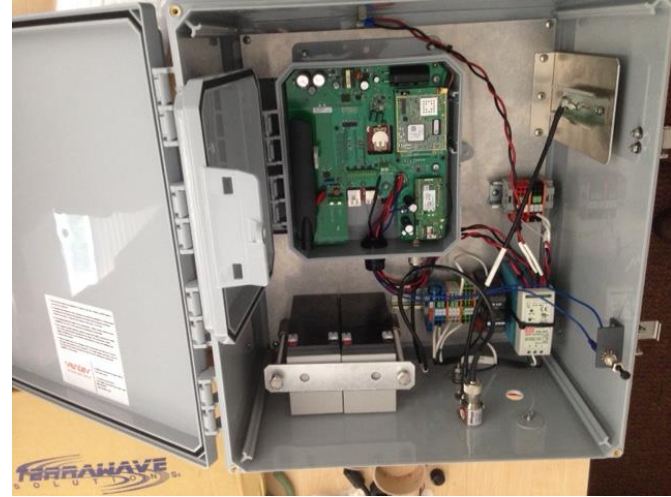
Power Usage

- Gateway – 3.0 W average or 26.28 kWh per year
- Gateway with Cellular – 5.1 W average or 44.68 kWh per year
- Cabinet – 16 W maximum w/heater, 142 kWh per year
- Relay 1.5 W average or 13.14 kWh per year
- Meter Modules – 0.6 W average or 5.26 kWh per year

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RF Relays & Cellular IPLink Relay

- **RF Relay Specifications**

  - **45-minute Super Capacitor** for Backup Power

    - **No batteries to replace or maintain**

  - 120-277V and 120-480V AC, and 12V DC options
    - Optional Photocell Adaptor Cable to power at Streetlights

  - Multiple Mounting Options
    - Band Bracket for Pole Mount
    - Band Bracket for Street Light Arm Mount
    - Lag Bolt Mount
    - Pad mount Transformer/Switch Cabinet

  - External Antenna Options (attached and remote)

- Additional **Cellular IPLink Relay** Specifications

  - IPv6 CAT-M1 cellular connection to Eaton's Virtual Gateway for use as 'mini-Gateways'

  - Cellular service either direct or through Eaton

Zero Maintenance, cost-effective relays ensure coverage throughout your service

Flexible Extended Coverage Options

Passive Coupled Meter Antenna

External Meter Antenna

Solar Power Supply
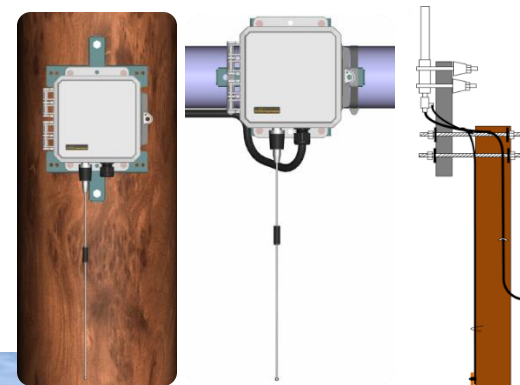
External Relay Antenna

Network Runner Field Tool

- Trimble hardware options
  - 7" sunlight readable touchscreens
  - Built-in Eaton RF Mesh radio, powered directly by the handheld
  - Optional cell modem (Yuma 7 only)
- Windows 10 operating system
  - Standardized, modern user interface
  - Allows screen sharing with Eaton technical services team for easy support
- Features:
  - Network troubleshooting and range testing
  - GPS coordinate collection and programming (not required for network operation)
  - "Fast Join" a node to the existing RF Mesh
  - Critical on-demand activities for emergencies such as meter reconnect or load control opt-out

Ranger 7   Yuma 7

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EATON NETWORK ARCHITECTURE

Eaton Smart Grid Architecture

Public Power's End-to-End Solution
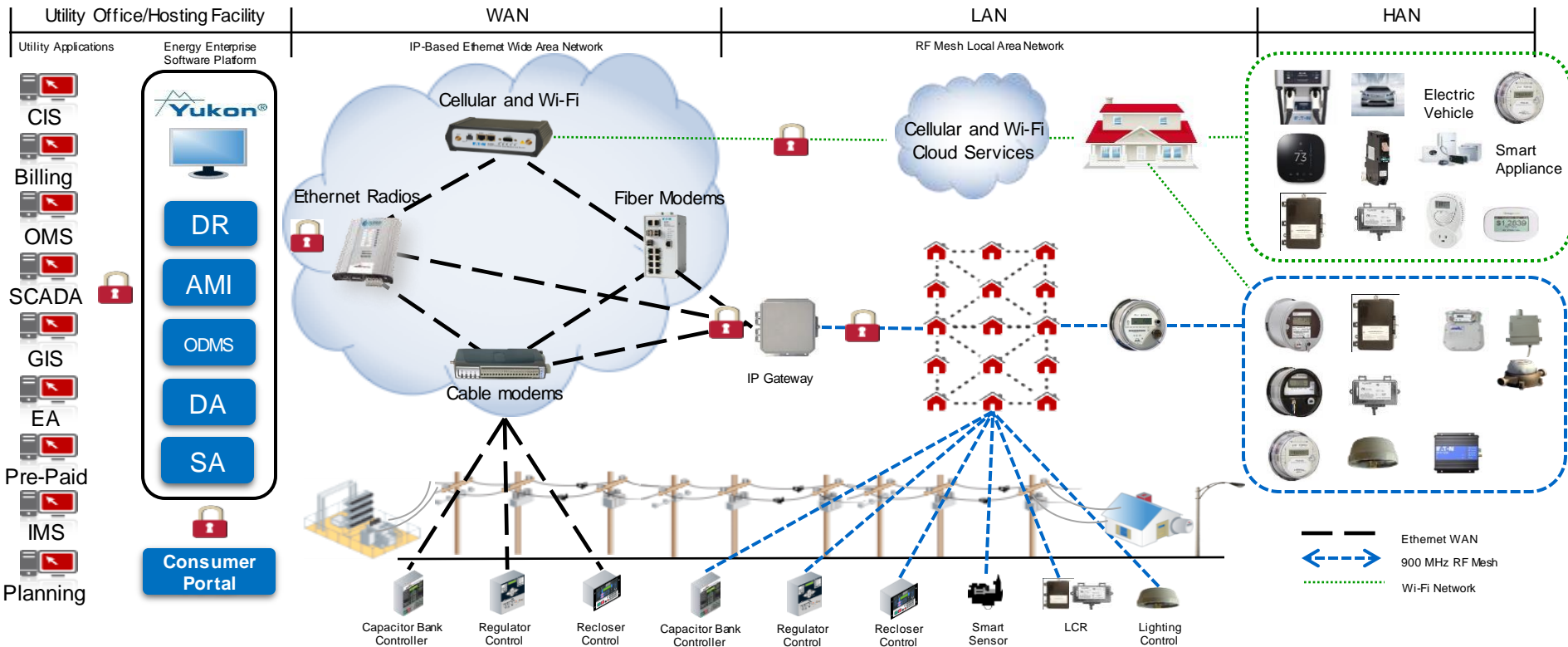
Eaton's RF Mesh Network Specifications

- **License-Free Spectrum**
  - ISM band - Frequency Hopping Spread Spectrum 902-928 MHz
  - 25 MHz of available spectrum (50 channels)
    - **Not Impacted by Interference**

- **Data Throughput**
  - Up to 300 kbps data rate with Auto-Optimization
    - **Provides long range solution while maximizing throughput as well**

- **Variable Power Optimization**
  - 0.125W to 1W
    - **Ensures adequate coverage while minimizing operating cost**

- **Industry-leading data transport**
  - 80 daily values, 15 interval channels, 50+ alarms & events
    - **Granular actionable information and insights**

- **Optional Data Streaming**
  - Connectionless data transfer facilitates streaming *data as fast as 1 minute* from key endpoints
  - CVR support, real-time TOU, real-time consumer portal

- **Security**
  - Industry-leading end-to-end security, with mutual authentication & derived encryption keys for each node data exchange
    - **Robust security architecture enabled throughout the system**
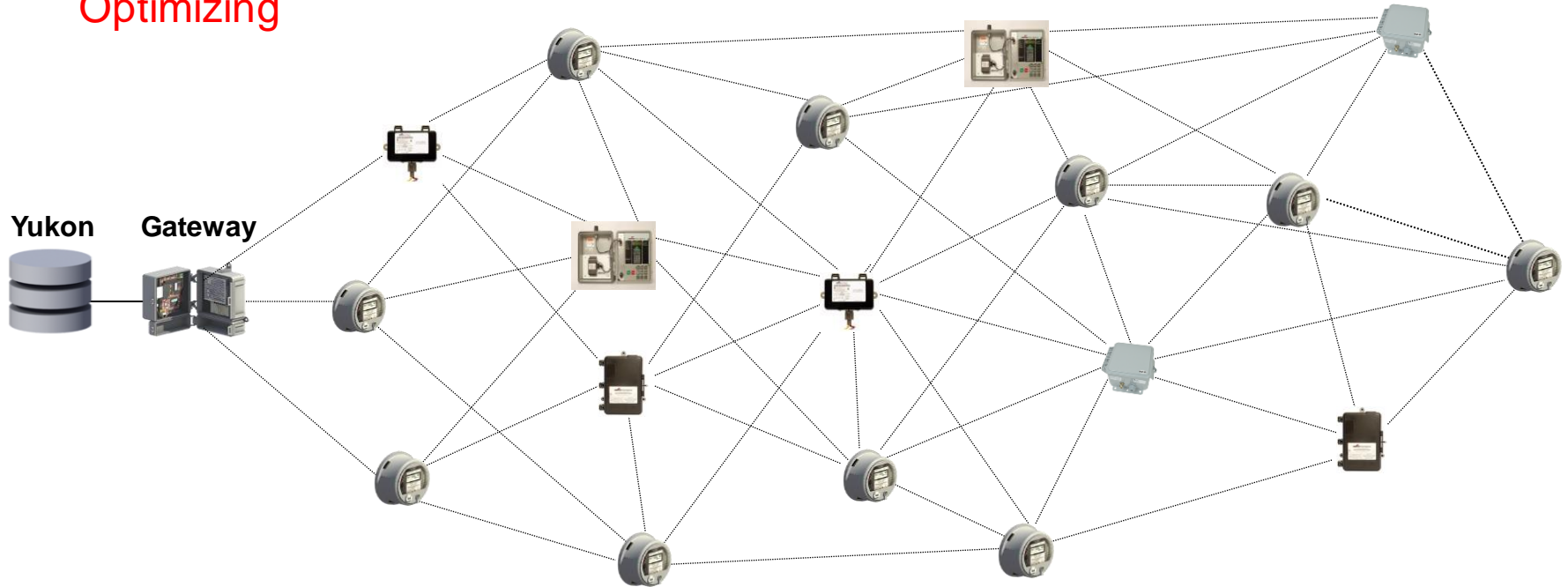
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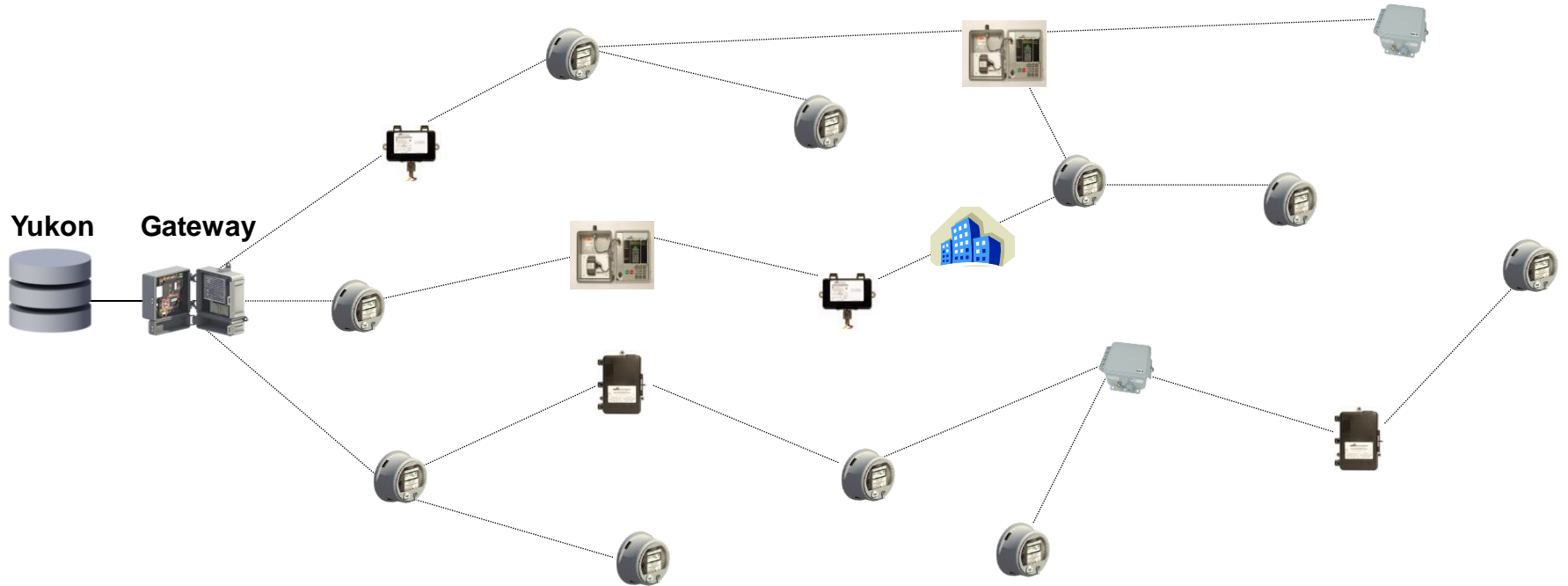
Self-Organizing Smart Grid Network

Operational Systems

Network Management

IP Backhaul

RF Mesh Network

CIS

Outage Management System

Yukon

Gateway

GIS

Engineering Analysis

SCADA

Mesh is the Most Reliable RF Network

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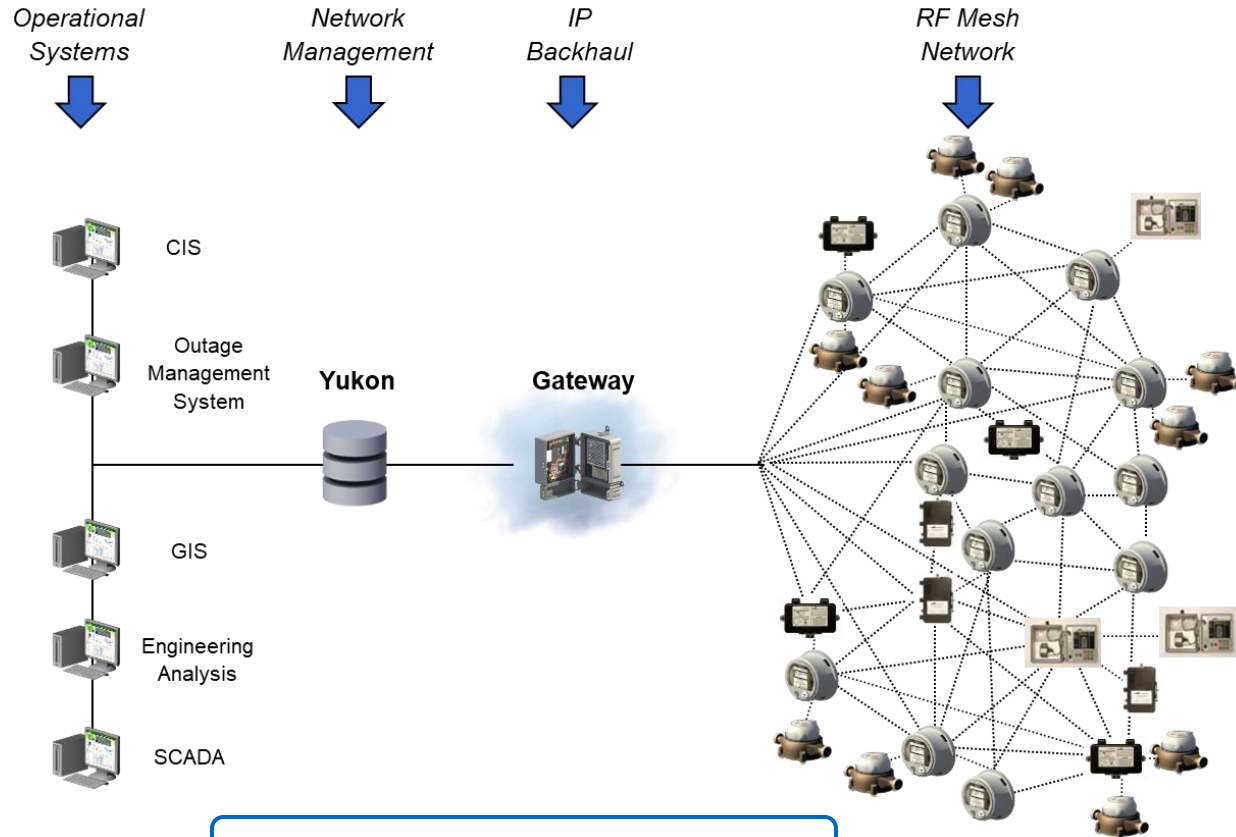
Self-Organizing Smart Grid Network

Self Organizing
Optimizing

Yukon   Gateway

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Self-Organizing Smart Grid Network

Self Healing

Yukon **Gateway**

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Self-Organizing Smart Grid Network

Self Optimizing – With Wi-Fi or Cellular IPLink Takeout Points

Yukon   **Gateway**
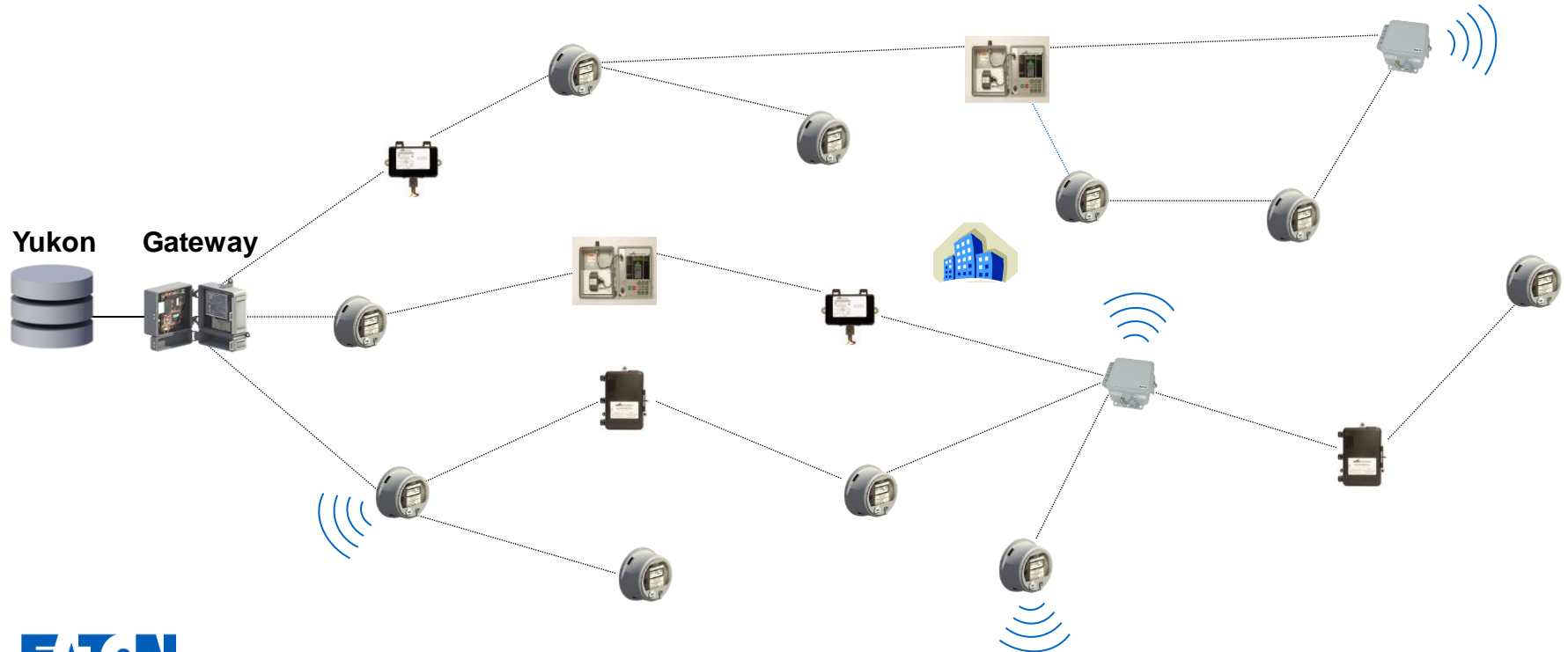
Self-Organizing Smart Grid Network

Easy Network Expandability

Yukon **Gateway**
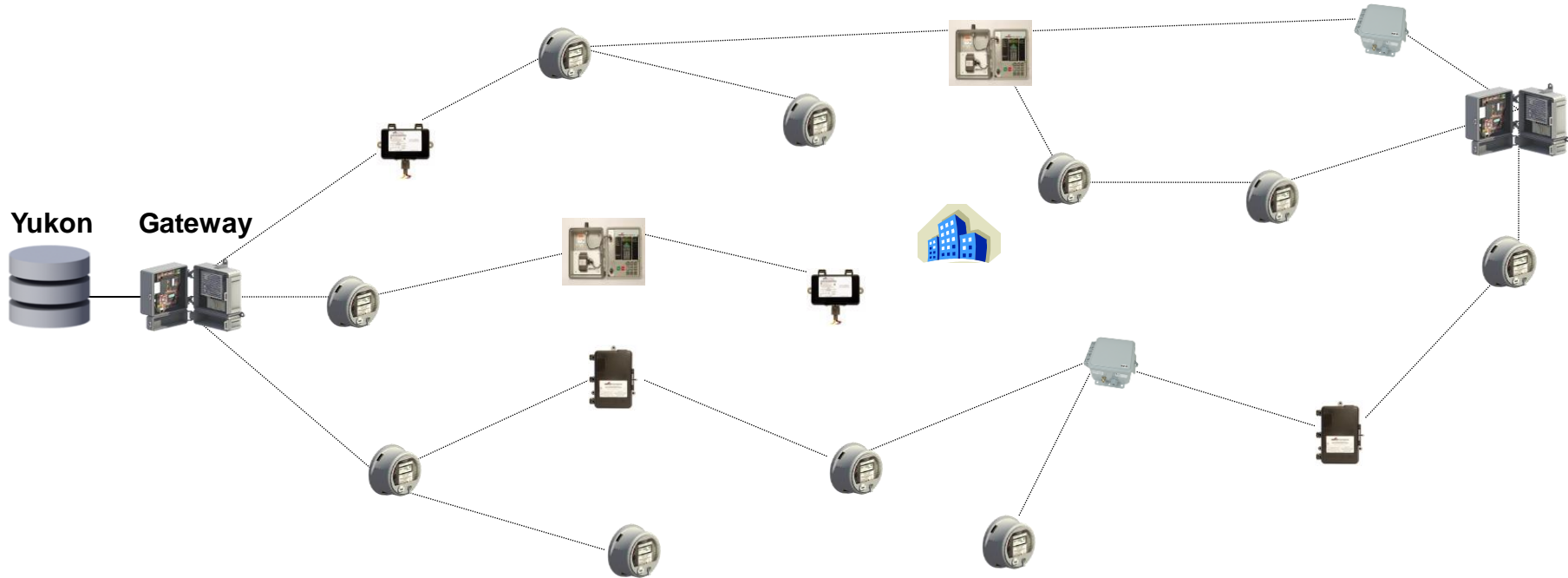
Self-Organizing Smart Grid Network

Water on the Same Network
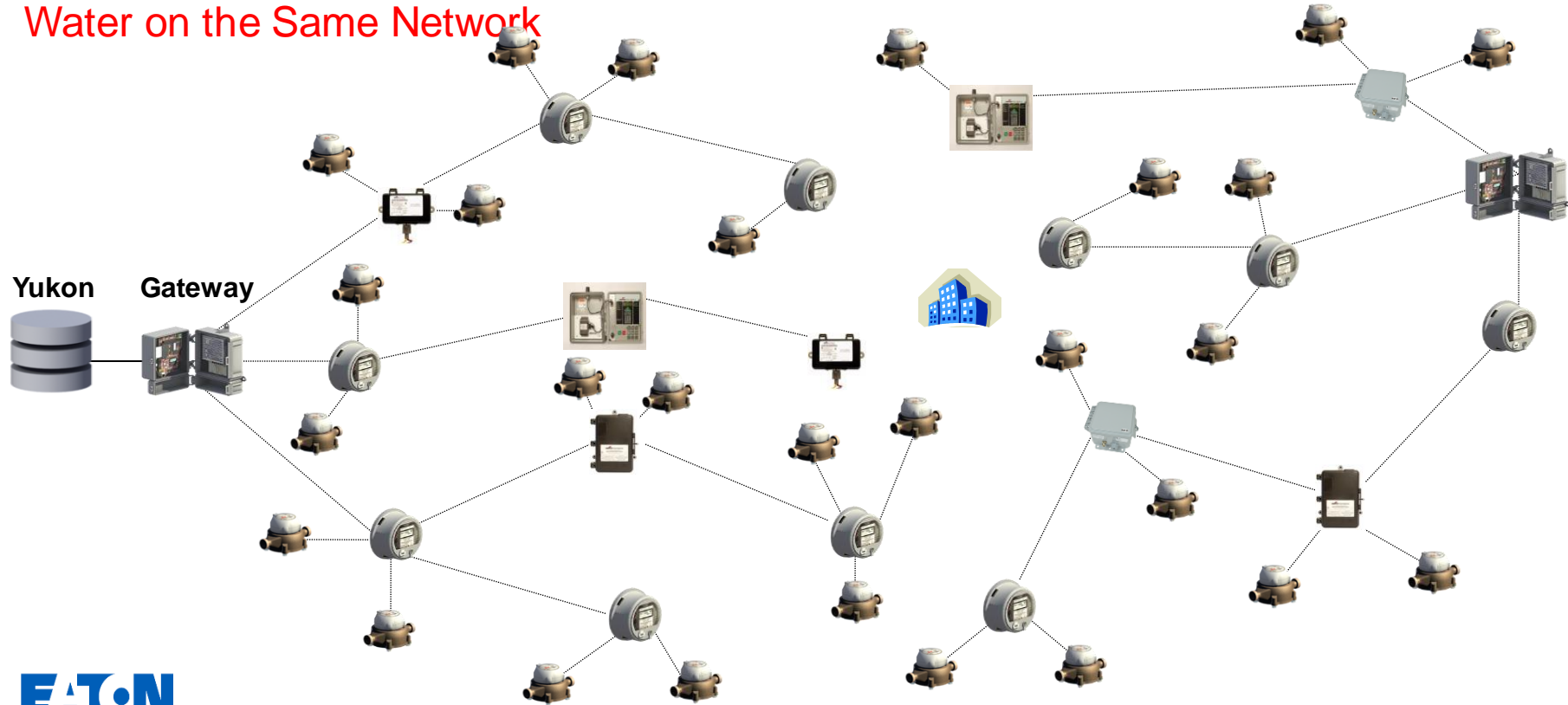
Yukon   Gateway

WI-FI IPLINK METER

IPLink Architecture

Virtual Gateway

Yukon

Network Manager

WAN Communication Backhaul

Wi-Fi

CAT-M1 Cellular

Direct Fiber (future)

Physical Gateway

IPLink Meters

IPLink Relays

Yukon DB

Network Manager DB

- Additional takeout points
  - Throughput and redundancy
- Less pole-top infrastructure
- Easy coverage extension

Self-Organizing Smart Grid Network

Self Optimizing – With Wi-Fi or Cellular IPLink Takeout Points

Yukon **Gateway**
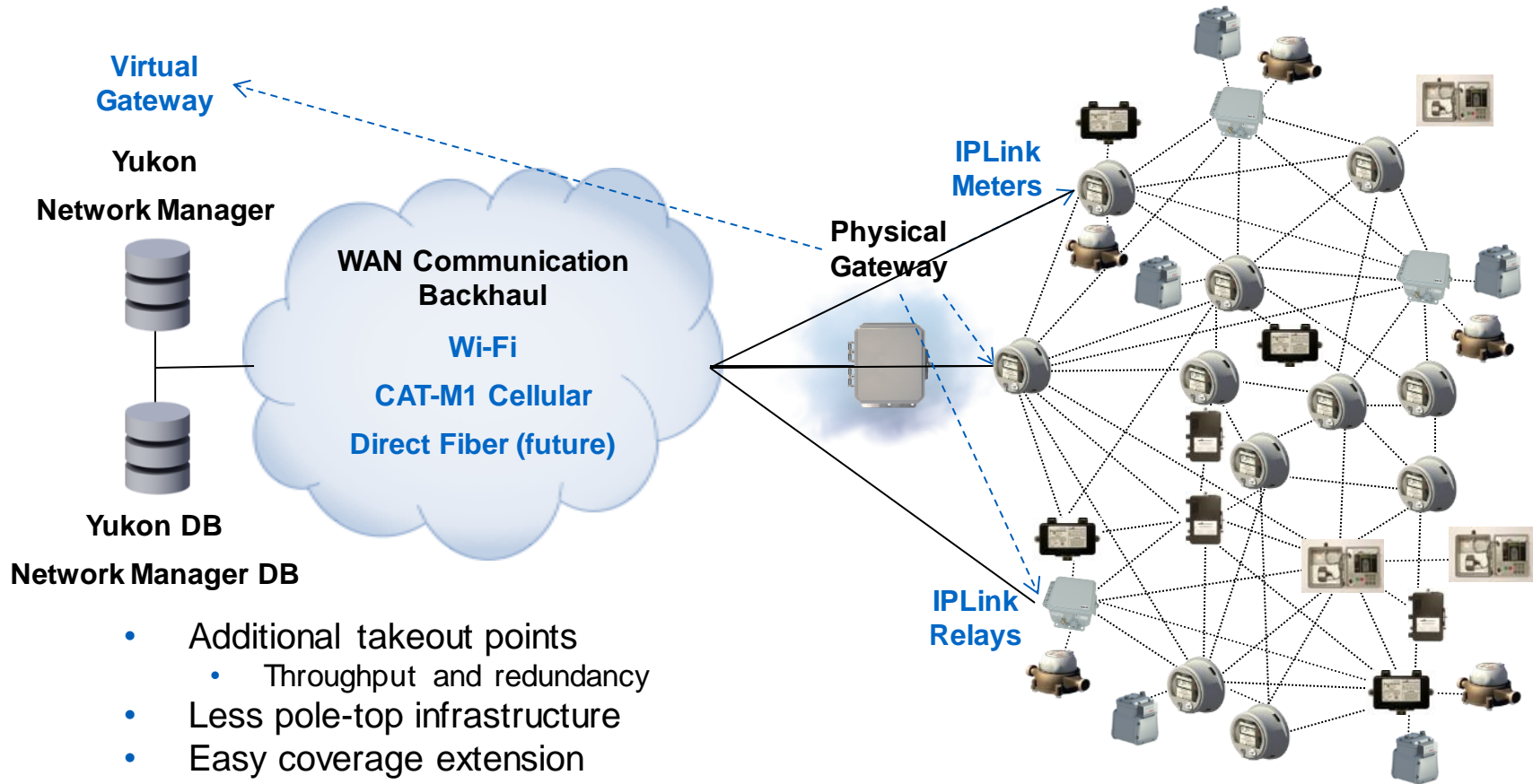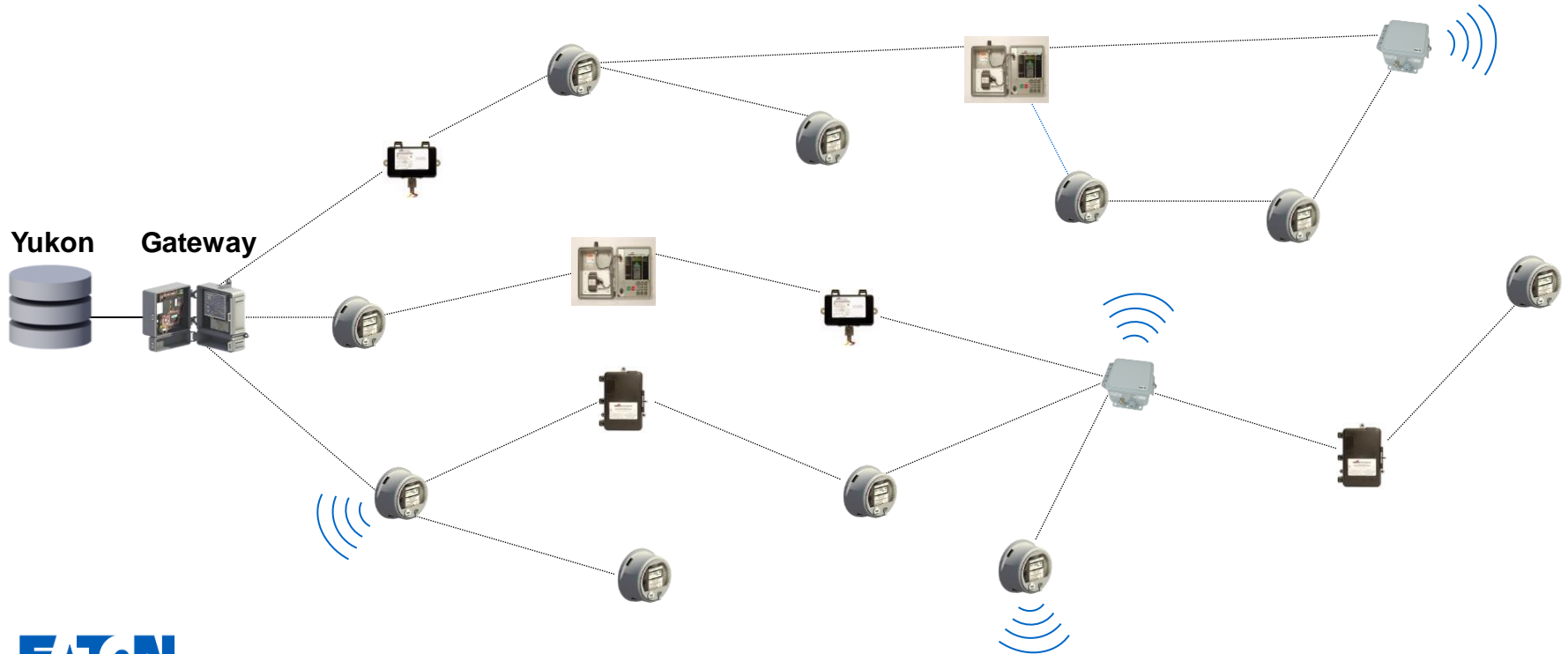
Wi-Fi in the Meter

Utility Side

- What % of meters might have Wi-Fi access?
  - 30% take-rate
  - ½ own their own router or are out of range of the meter
  - **15% or at least 1 in 10 meters?**

RF Mesh Connections

Possible Wi-Fi Connections from the Meter

6 SSIDs Reserved for Utility

ONT/Router

Inside the Home

6 SSIDs Provided to Homeowner

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Key Benefits of Wi-Fi IPLink Meters

- Utilize investment in fiber deployments for more applications and reduce the need for pole-top RF infrastructure
- Work with the utility's FTTH communications network and Wi-Fi technology, which is already familiar to utility personnel and the general population
- Use a standards-based (Wi-Fi) high-speed communication that is known to support tomorrow's data requirements in the trend towards real-time data
  - Support for real-time pricing rates
  - Granular data for additional analytics and insights into the grid
- Provides an IoT strategy for your smart grid
- Allows some utilities access to additional RUS or similar loans to help fund AMI deployments
- Helps some municipalities justify FTTH projects through electric department funds
- Reduce overall costs, setup, and maintenance of the AMI network
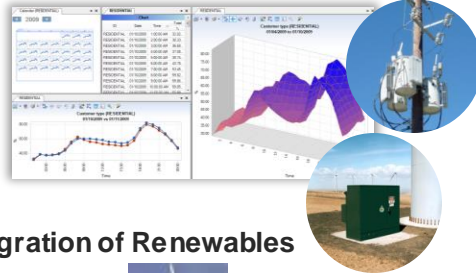
ADVANCED METERING

Smart Metering Solution

Integration of Voltage Monitoring into CVR/IVVC
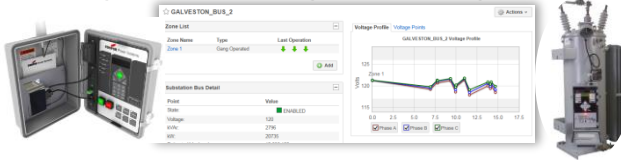
Alarm & Event Visualization
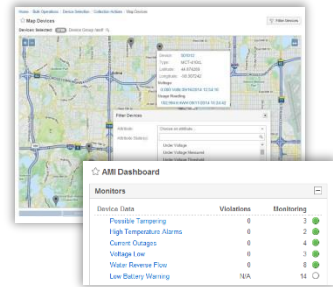
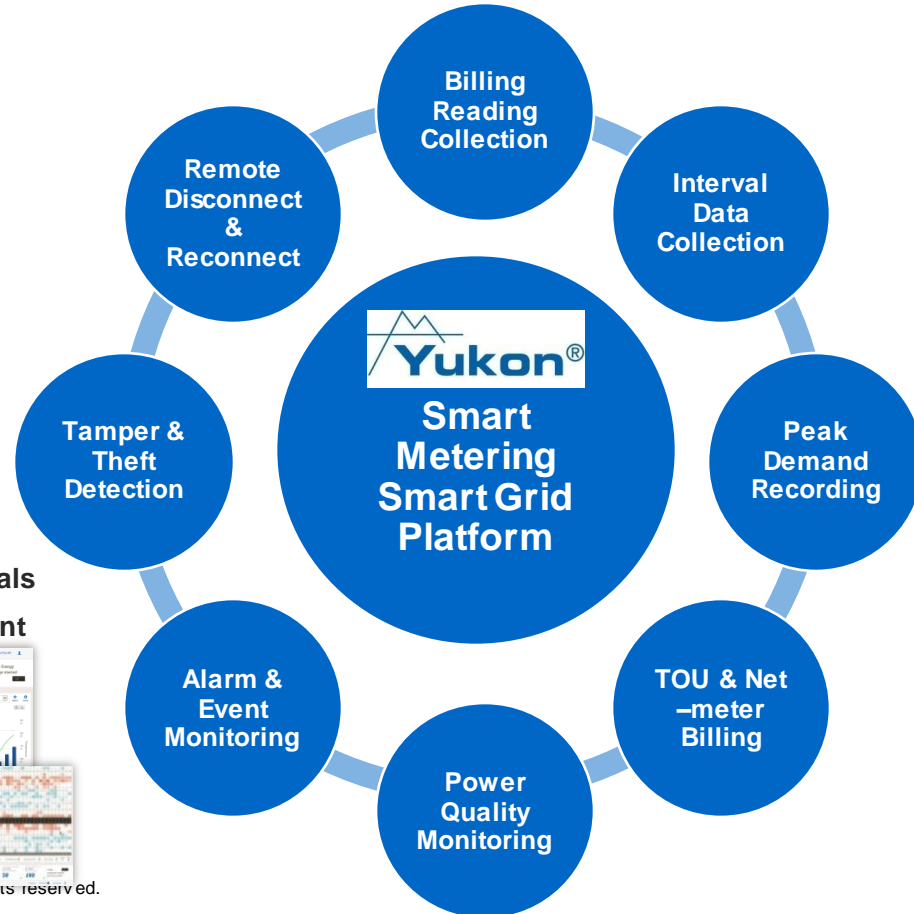**Transformer Loading Analysis**

Integration of Renewables

Prepaid Services

Consumer Portals & Empowerment

Smart Metering Smart Grid Platform

- Billing Reading Collection
- Interval Data Collection
- Peak Demand Recording
- TOU & Net–meter Billing
- Power Quality Monitoring
- Alarm & Event Monitoring
- Tamper & Theft Detection
- Remote Disconnect & Reconnect

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Multiple Meter Options – "Meter Independent"

Landis+Gyr Focus AL	Landis+Gyr Focus AX/AXe	Itron Centron C1SX	Itron Centron C2SX	Honeywell Elster A3 ALPHA	Landis+Gyr S4e/S4x	Landis+Gyr AX Poly	Itron Sentinel

- Eaton has the capability to support **ALL** of [Utility]'s existing and future single phase and polyphase meter forms and applications, for example:

    - Eaton has recently integrated with the Landis+Gyr CL320 Service Disconnect

    - Eaton provides the capability to enable TOU over the air, without a meter changeout

- **Expected Polyphase Meter battery life = 20 years**

- [Utility] will never be limited to a single meter vendor, thereby eliminating the potential of a stranded asset or end-of-life scenario.

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Grid-Edge Intelligence – Single-phase Meters

- **Industry-leading data transport**
  - **80 daily values, 50+ alarms & events, and 15 interval channels supported by default**
- **Voltage**
  - Daily Min/Max with Timestamp
  - Over Voltage & Under Voltage Alarms
  - 5 days of 5-minute profile always available
  - Temporary 2-week collection of 5-minute data
- **Demand (kW)**
  - Last Interval
  - **Peak with Date and Timestamp**
  - Daily Peak kW
  - Interval Load Profile Data
    - 1-, 5-, 15-, 30-, 60-min intervals supported
- **Temperature Information**
  - Interval and Midnight Data
  - **High Temperature Alarm**

- **Tamper Indications**
  - Zero Usage, Meter Inversion (Unexpected Reverse Usage), Meter Flags
  - Major Decrease or Increase after Outage
- **Outage Information**
  - **Outage/Restoration Notification**
  - **Blink & Outage Count**
  - Daily Outage Count
  - Outage Duration Logs
- **Time of Use (TOU) Information**
  - kWh Usage and Peak kW
  - Remotely configurable
- **Bi-directional (Net) Metering**
  - Delivered (Forward)
  - Received (Reverse)
  - Net (Forward – Reverse)
  - Added/Security (Forward + Reverse)
- **Display Control**
  - TOU, Net Metering, Demand, etc.

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Remote Disconnect Features

Features
- Load side voltage sensing
  - Personnel safety
  - Identify possible meter bypass tampering
- **Load limiting and load cycling**
- Yukon Demand Response integration
- Local and remote status information
- **CL320 units available / supported**
  - **Landis+Gyr AXe-SD**
- Reactive metering measurements
  - Itron: kVAh/kVA included
  - Landis+Gyr: kVARh/kVAR optional adder

Benefits
- Great for move in / move outs
- Supports cold/warm weather rules and accounts with medical considerations
- Supports prepaid metering programs

Itron CENTRON II C2SXD

Landis+Gyr FOCUS AXe-SD
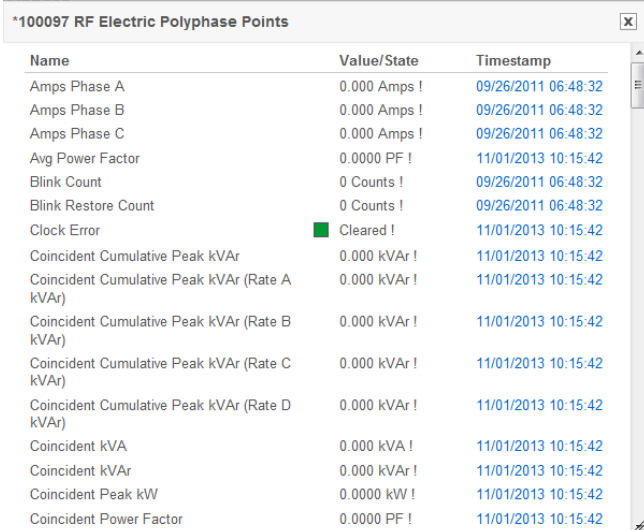
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Polyphase AMI Capabilities

- All polyphase AMI modules interface via ANSI C12.19 tables w/ consistent data availability
  - Allows meter choice for utility
  - Available Information:
    - Consumption & Peak Demand
    - 4 TOU rates w/ kWh and Peak kW
    - Load Profile (5-, 15-, 30-, or 60-minute intervals)
    - Outage Count
    - Meter Event flags
    - Per Phase Voltage & Current
    - kVAR/kVARh – optional
    - kVA/kVAh – optional
    - Power factor – optional
  - *Unmatched Data Collection over AMI:*
    - *80 daily midnight values*
    - *15 metrics providing interval data*
    - *Over 50 different alarms and events*

- Convenient
  - FULL Auto-ranging 120-480V
    - Same meter type for all Forms, Classes, and Voltage Ranges
    - Less hassle / Less reliance on accurate field data
    - Fewer failures/Eliminates safety concerns
    - Uses full-featured meters, with the most extensive data capabilities for your largest services

Remote C&I Meter Programming

- Further reduce the need to visit meters in the field!
- Configure polyphase AMI meters over the AMI communication network (in addition to AMI parameters)
- Useful for:
  - Time of Use (TOU) rate times and sche[...] and holidays
  - The method of calculation for a metric,
  - Meter display behavior, including timing display
  - DST/Time Zone
  - (varies some by meter manufacturer)
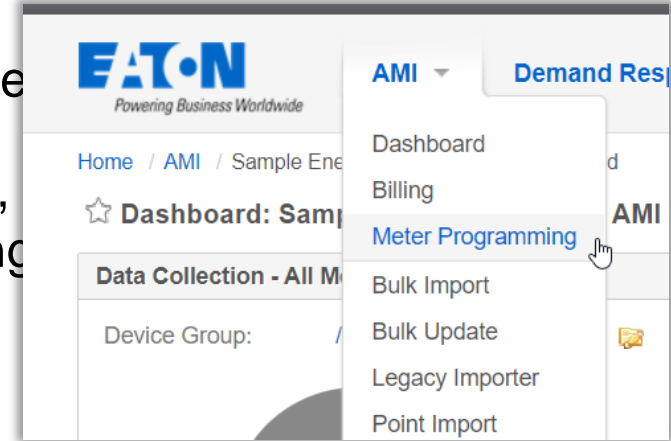
Retrofit Kits for All Supported Meters

- Itron CENTRON C1S
  - RFN-410cL
- Elster A3 ALPHA
  - RFN-430A3
- Itron SENTINEL
  - RFN-430SL
- Landis+Gyr FOCUS and S4e
  - RFN-510fL and 520fX/fD
  - RFN-530S4e
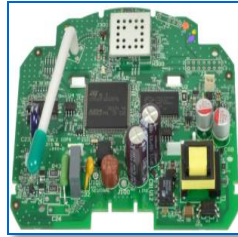
Mitigates Stranded Asset Costs and Reduces Costs

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WATER METERING

Water Metering – Supported Meters

Eaton works with ALL major meter vendors
Consistent functionality across ALL meter brands

	Badger Meter	Elster AMCO	Itron Actaris	Master Meter	Metron Farnier	Mueller Hersey	Neptune	Sensus	Zenner	Kamstrup
Pulse	✔									
Encoder	✔	✔	✔	✔	✔	✔	✔	✔	✔	
Electronic	✔	✔	✔	✔		✔	✔	✔	✔	✔

True "free agent" allowing you to select your preferred vendor

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RFW-201 Water Node

- **All supported on the exact same RF Network with the same Yukon Software**

- **Full two-way nodes**

- **Same device used with all supported water meters**

- Benefits
  - Billing Reads
  - Interval Information/Consumer Presentment
  - Leak Detection
  - Loss Identification/Reduction
  - Tamper/Theft Identification
  - Water Conservation/Watering Restrictions
 - Identification of Maintenance Issues
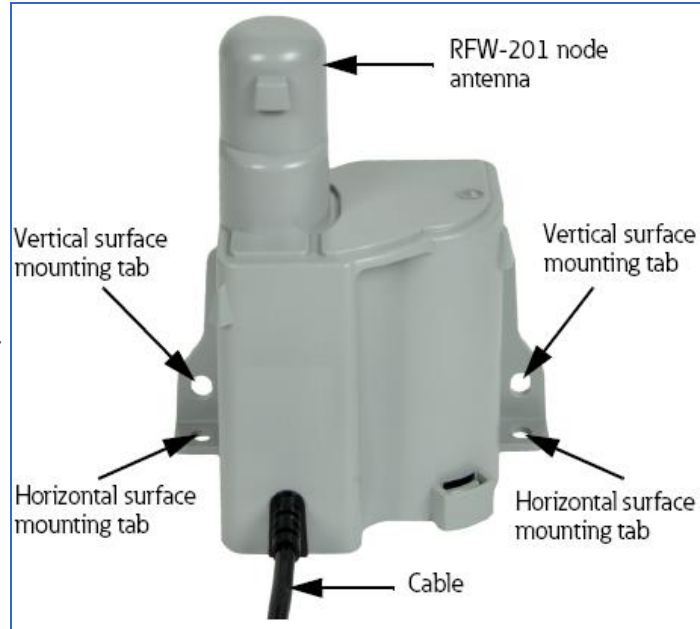
- Features
  - Usage Data
  - Interval Data
    - Configurable Interval (Default: Hourly)
    - Storage of 90+ days of data
  - Status Indication
    - Encoder Communication Status
    - Between Node and Water Meter Encoder
  - Software-based Leak Detection
  - **Field Replaceable Battery**
  - Multiple Connection Options
  - Flexible Installation
    - Supports pit or wall mount installation
   - Doesn't have to be placed right at water meter

Field Replaceable Battery

- Lithium Battery

  - Should not be air-shipped in cargo holds

- Field Replaceable

  - Simple to replace

- Disposal

  - Law requires disposal via Authorized Battery Recycling Centers

  - Documentation provides recycling center info
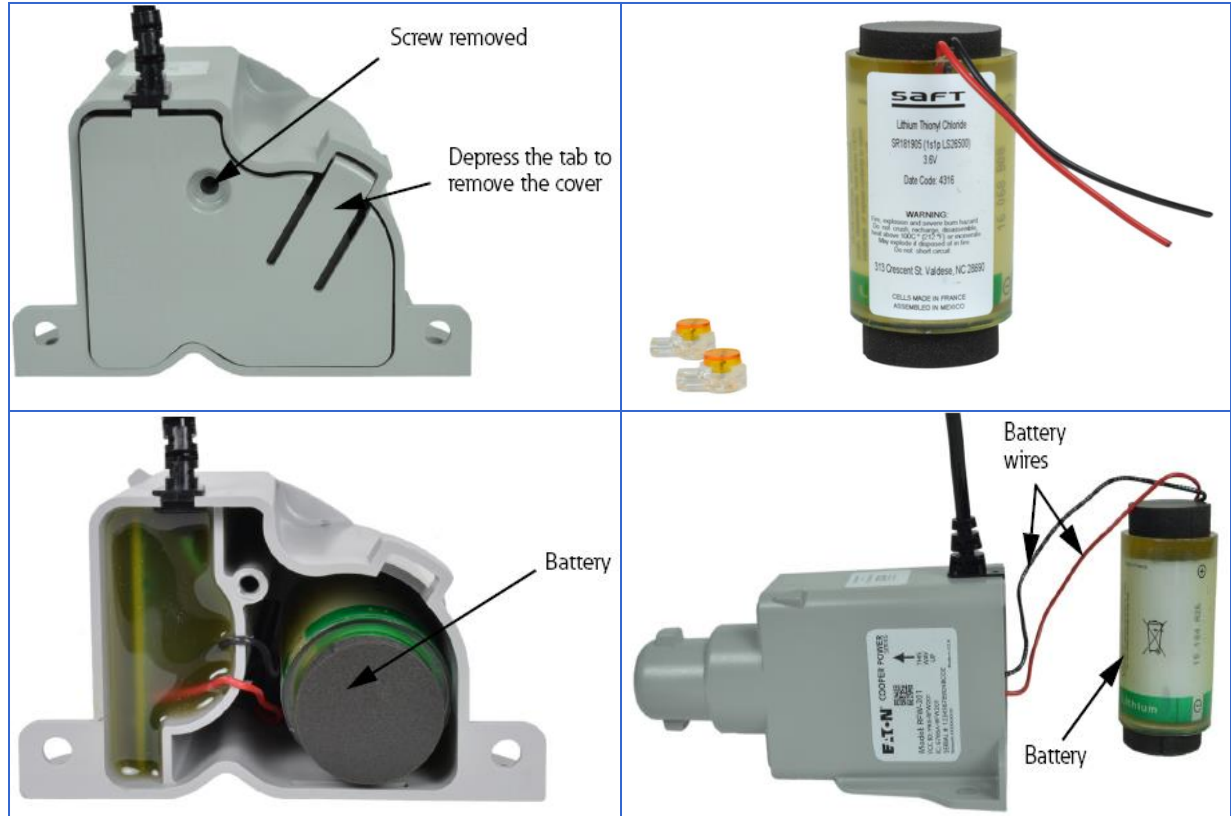
Mounting Options

- ## Wall-mount
  - Recommend as high as possible in basements, typically near floor joists
- ## Surface-mount
  - Mount on top of a surface
- ## Pipe-mount
  - Wire tie it on to pipe in basement as high as possible
- ## Pit-mount
  - Stake-mount
  - Lid Lock Kit
    - Through lid
    - In lid
      - Both support optional spacer
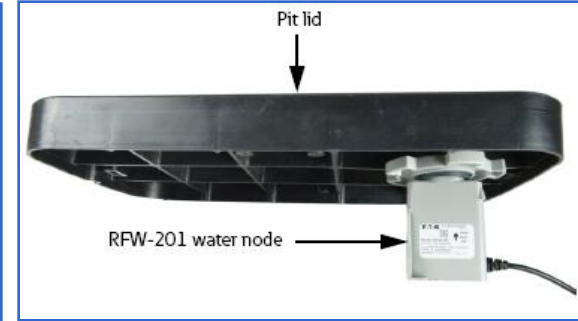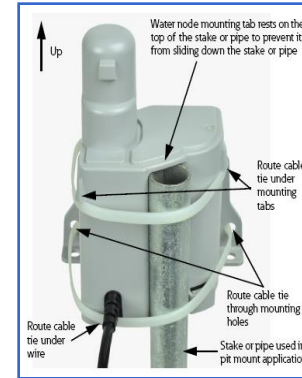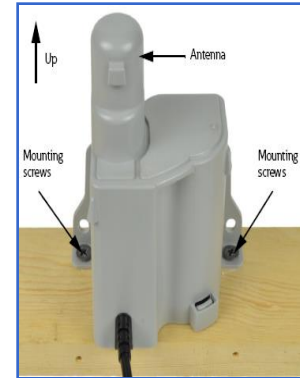
GAS METERING

Gas Meter Preference Flexibility

Development Supports ALL major meter vendors
Consistent functionality across ALL meter brands

Honeywell Elster American AC & AL/Rotary	**Sensus** Invensys Rockwell Equimeter	**Itron** Actaris Sprague Schlumberger Metris	**GE Dresser** Roots Rotary Pulse
✔	✔	✔	✔

Flexibility to enable retrofit existing meter assets and to select your preferred manufacturer(s)

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Eaton Gas/Metered Propane Nodes

- All supported on the same RF Network with the same Yukon Software
- Full two-way node
- Uses same proven radio and node technology as water node

- Features
  - Usage Data
  - Interval Data
    - Configurable Interval (Default: Hourly)
    - Storage of 90+ days of data
  - Status Indication
    - Communication Status/Tamper Detection

- Benefits
  - Billing Reads
  - Interval Information/Consumer Presentment
  - Tamper/Theft Identification

- Broad support of residential & commercial meters
  - RFG-201 Pulse-based Interfaces
    - **Currently Available**
  - RFG-301 Integrated Registers
    - **Currently Available**

RFG-301A
American/Honeywell

RFG-301R
Rockwell/Sensus

RFG-201
Pulse
Interface

Leveraging Proven Technology to Meet Our Customers' Needs

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RFG-201 Gas Node Installation Process

- Remove Index cover and the index from the gas meter
- Install the RIO Tronics Index and Pulse Kit
- Route the cable through the gromet of the new Index Cover and attach to the gas meter
- Insert the tamper caps into the holes on the index cover
- Mount the RFG-201 gas node and connect to the cable of the pulser kit with waterproof gel caps
- "Wake up" the RFG-201 gas node with a magnet
- Commission the RFG-201 with the Network Runner field tool

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RFG-301 Gas Node Installation

- Remove Index cover and the index from the gas meter
- Place the existing index inside the RFG-301 node
- Use the screws provided to secure the index to the RFG-301 node
    - If the index dials turn all the way, it is installed correctly
- Place two ¼ - 20 5-inch bolts with no heads in the two holes of the gas meter
- Take the MIU with the index attached and slide it onto the bolts on the gas meter
- Slide the index cover onto the meter and secure the bolts
- Insert the tamper caps into the holes on the index cover
- "Wake up" the RFG-301 gas node with a magnet

Figure 13: Gas Meter with MIU installed

Network Runner Field Tool

The following configuration parameters are sent to the gas node during the commissioning process:

- Meter Serial Number
- Base Reading
- Rotation to Pulse Ratio
- Pressure Compensation (Red?)
- Ship Mode
- GPS Location

Other Network Runner Features:

- Configure Recording/Reporting Interval
  - Default (60 minutes every 24 hours)
- GPS Coordinates
- Meter Read Command (read, voltage, temp)
- Firmware upgrade
- Retrieval and display of RF signal strength to target device

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Yukon Account Dashboard – Gas
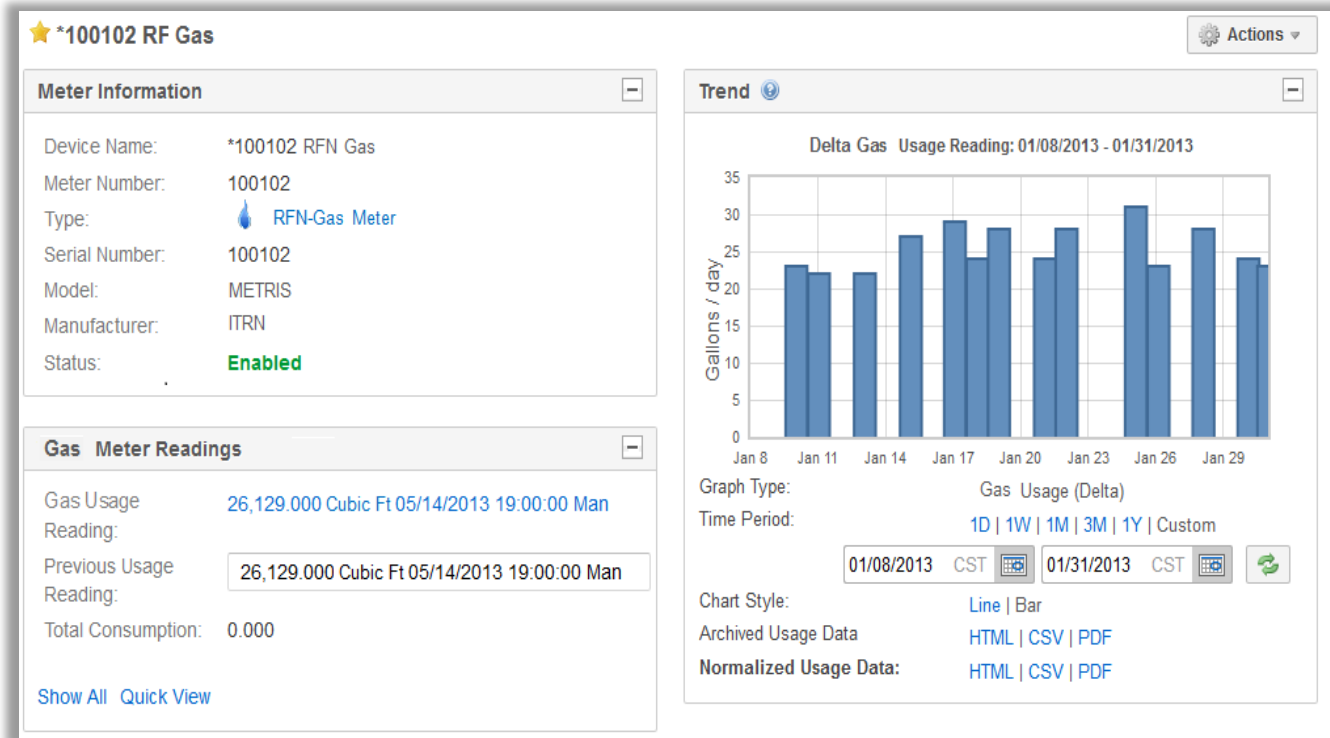
DEMAND RESPONSE

DEMAND RESPONSE SOLUTIONS

Open architecture, Multiple Two-Way communication solutions

Advanced Control algorithms deliver 20%+ more load reduction

Legacy Demand Response program migration options

Robust two way dataset
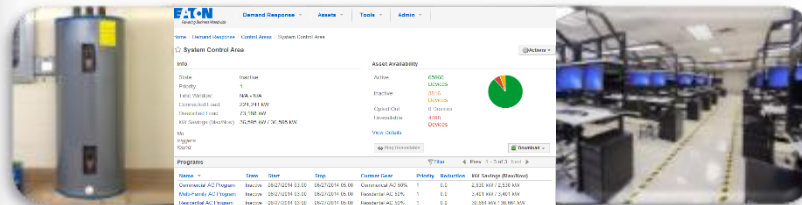
HARDWARE:

Residential and C&I Control Equipment

- Controls Residential Loads
  - AC
  - Water Heaters
  - Electric Heat Strips
  - Pool Pumps
  - Electric Vehicle Chargers

- Controls Commercial Loads
  - Irrigation
  - Transfer Switch for Backup Generation
  - Interruptible Commercial
  - Electric Vehicle Chargers

SOFTWARE:

Yukon Residential Demand Response and C&I Curtailment

- Multi-Tier Control Structure
- Hardware Controlled
  - LCRs
  - Wi-Fi Thermostats
  - Communications Gateways
  - RTUs

- Notification to C&I Facility
- Event Lifecycle management
- Complete Customer Information Data Model
- Premise and Connected Data Model

Maximize control options, comfort, and customer participation

Eaton Load Control Switch (large version)

- Up to 4 Relays (Combination of 5 Amp and 30 Amp)
- Intelligent Control Algorithms for AC control
- Grid Stability Features: Cold Load Pickup, U\ TrueStability
  - TrueStability OV/OF Response Solution for high   eas
- Two-Way Benefits
  - Improves Maintenance Scheduling
  - Improves Measurement and Verification
  - Improves Remote Troubleshooting
- Support for:
  - 120-240V and 24V
 - 277/480V for Irrigation Control

LCR-6701 RFN

Legacy 3rd Party Switch Vendor Retrofit

<u>Key Features:</u>

- RF Mesh retrofit w/LCR-6700 characteristics

- Retrofit for Comverge & Scientific Atlanta devices

- Appears to support Hunt/L+G and Entek devices

- Conversion Kit

  - CTs for Load Sensing on 30Amp Loads

  - Drive Existing Ice Cube Relays

  - Connect Existing 5 Amp Harness to PCB

  - Power Harness Extender

- Appliance Usage Monitoring

- Short Cycle Protection for Appliances

E·A·T·N
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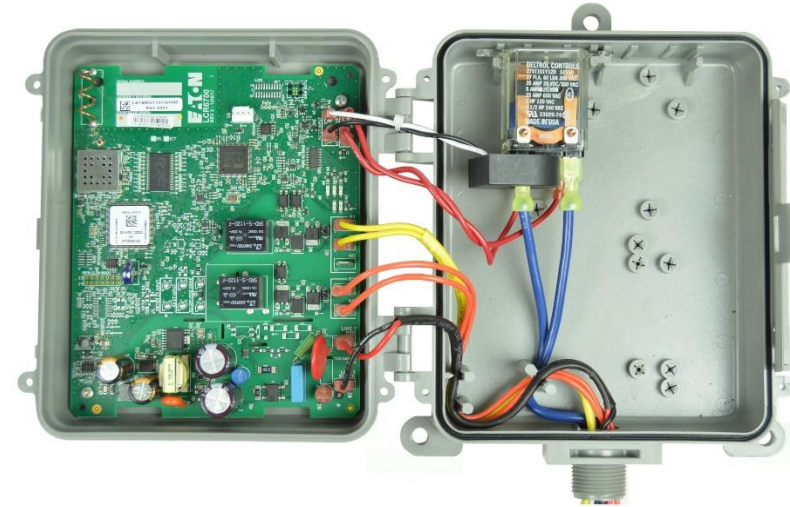
CAT-M1 Cellular LCR

Eaton Advanced Solutions: from the Cloud and at the Grid Edge

LTE CAT-M1: High Speed Dispatch and Reporting

- Fast Delivery Control Execution
- Real-time Control Acknowledgement
- Notification of Event Status Change
- Data for Analysis
  - Device Control Behavior
  - Appliance Runtime Profile
  - Power Status
  - Connectivity Performance
- Over-the-air Firmware & Configuration

Grid Edge Solutions for local autonomous control

- Flexible Control Strategies
  - Immediate 100% Shed and Restore
  - Cycling with Randomized Ramping
- Intelligent Control Based on Appliance Profile
  - TrueCycle Intelligent AC Control
  - Hot Water Assurance
- Appliance and Grid Protection Strategies
- Customer Participation Strategies

Verizon Service Reseller

- Bundled Pricing for all Devices Connected through the Cellular Service
- Flexibility with How we Offer the Service

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Wi-Fi Thermostat Offering

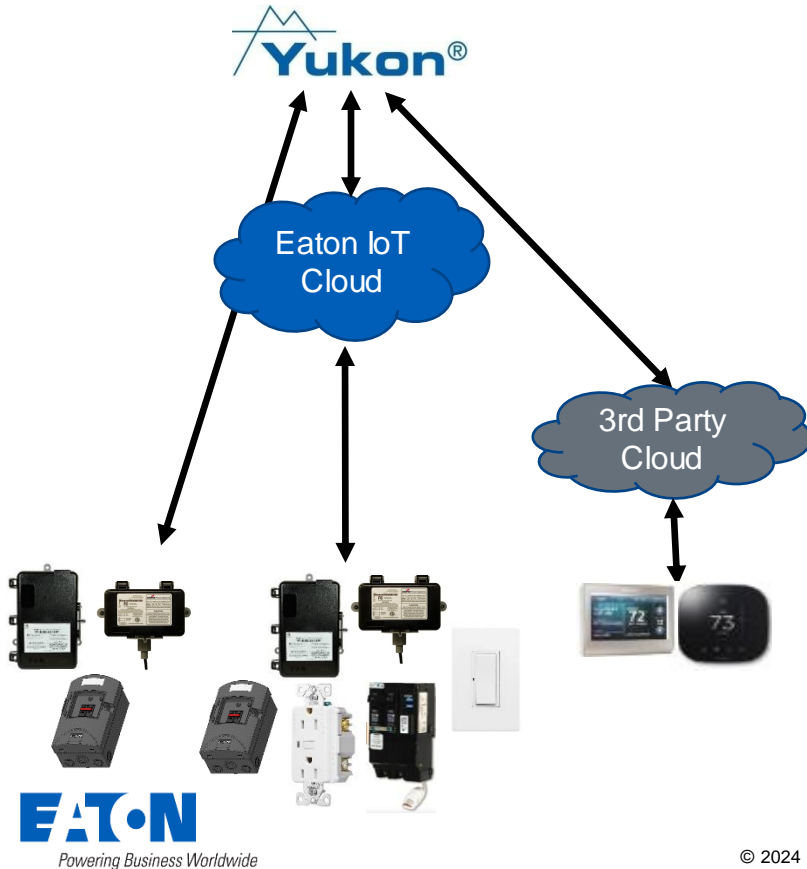**ecobee Product Family**

Residio (formerly Honeywell) Product Family

Nest Learning Thermostat

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Wi-Fi Connected Devices

Yukon®

Eaton IoT Cloud

3rd Party Cloud

- **Features**
  - DR using Customer's Wi-Fi
  - Plug and switched loads economically controllable
  - Customer accessible with home automation system
- **Functions**
  - Control of Eaton Wi-Fi devices
    - Smart Receptacles, Smart Switches, DLCR, EMCB
  - Control of 3rd-party Wi-Fi thermostats
- **Benefits**
  - DR control of plug and switch loads
  - TOU rates enabling technology
  - Energy audit / energy conservation tool
  - Utility store front products

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Eaton Wi-Fi Connected Receptacle and Switch

- **Utility Driver**
  - Retiring Coal Generation Plants
  - High Penetration of Window AC Units
  - Need to Create Low Income Programs (TOU)
- **Solution**
  - Eaton Smart Receptacles and Switches
    - Established Player in Industry (Z-Wave)
    - Launched Wi-Fi Version with Alexa Support
    - Building System to Integrate with Additional Platforms
  - Yukon
    - Integration Leverages Common Eaton IoT Platform
- **Benefits**
  - Leverage Consumer Product w- Smart App
  - Economically Access and Control Lower kW Loads
  - TOU rates enabling technology
  - Offering as Part of Energy audit
    - Energy Conservation Tool
  - Utility Store Front Product

Energy Management EV Breaker

EV Charging hardware – Multiple form factors for installation

Yukon®

Wallbox

EV Breaker

Single & Dual head pedestals

Breakers installed in LC & panelboards

- **Utility Driver**
  - Electric Vehicle Enablement
  - Metering of Electric Vehicle Consumption
  - Monitoring and Control EVCI
- **Solution**
  - Energy Management EV Breaker or EMCB
    - Wi-Fi Enabled
    - Remote Controllable
    - Revenue Grade Metering
    - Level 2 Charging (SAE J1772)
    - OCPP 1.6J Compliance
  - Yukon
    - Integration Leverages Common Eaton IoT Platform
- **Benefits**
  - Eliminates Need for Additional Equipment
  - Easy Installation to add Metering
  - Control Change Level during Economic or Emergency Event
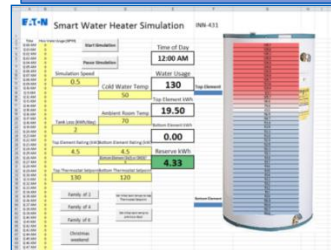
Smart Water Heater Control

Drivers
- Standard DR with Comfort Assurance
- Peak/OffPeak – Price Avoidance (TOU/CPP)
  - Greater Customer Flexibility
- Renewable energy storage
  - Locally controlled sensing over voltage
  - Dispatchable renewable energy storage
- Market Participation
- Energy conservation

Traditional water heater
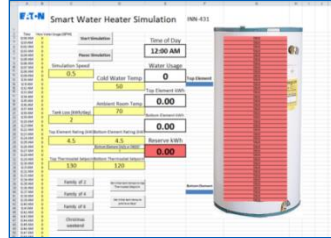
Smart water heater

Solution
- Wall Mounted Switch Configuration
  - Continue to control the main power
  - Remains in place when water heater replaced
- Mount thermal probe near bottom element
  - Develop a load profile to know when hot water will be needed
- Sense when top element is trying to run
  - Allow the tank to charge when top element is calling for power

Optimize Volume of Hot Water

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