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Telecommunications: The Opportunities & Challenges Linking Field Assets to the Operations Center

Introduction

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- Home: Mercerville, NJ (between Trenton and Princeton)
- Hobbies: Tech Geek; Boating and trying to catch fish; Telling "dumb jokes"

- Prior experiences include:
  - Distinguished Solution Architect: *Verizon Wireless*
  - Principal: *Schneider Electric Consulting Group*
  - Vice President: *DNV GL (KEMA)*
  - Managing Consultant: *PA Consulting Group*
  - Director Marketing: *Comverge*
  - Utility Consultant: *AT&T Solutions*
  - Vice President Engineering: *Base Ten Systems*

Overview:

- How is telecommunications changing the way we connect things
- Review the “connected things” that are used for Grid Operations (GoT)
- Examine the multitude of “things” that are being internet connected (IoT)

Objective:

- Explore how the inter-connectedness of things can be optimized to provide value to all parties.
- What is the impact of connectedness on the electric control center

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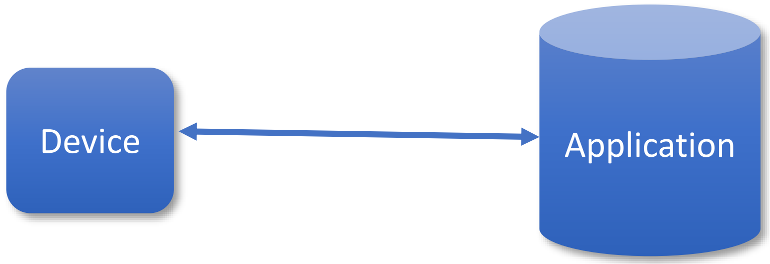
What is the difference between M2M and IoT?

Machine to Machine (M2M)

M2M represents communication between a machine or device and a remote computer. M2M is about connecting and communicating with a “thing” where a thing can be a machine, device or sensor across various type of Network connectivity (Cellular, Wired, Wifi, LPWA etc.).



Internet of Things (IoT)

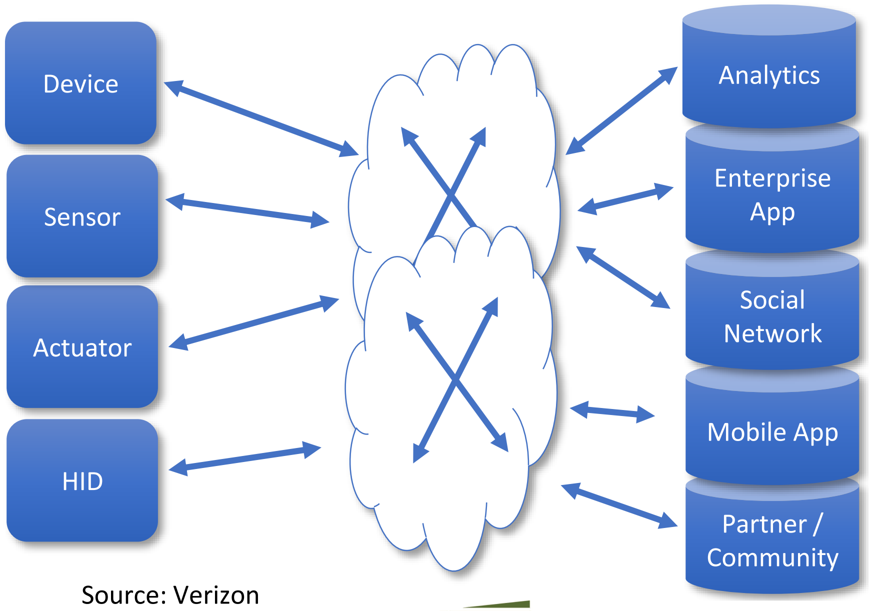
IoT represents things connecting with systems, people and other things with various platform, professional services and applications.

Connectivity and Things – Includes machines, devices, sensors, products, vehicles, etc.

Platform – Use IoT Platform, including management control systems, reporting, Alerts as well as other platforms such as Cloud, Security, Storage, etc.

Application – Functionality and performance tailored to the needs of the customer target

Professional Services – Elements of Consultancy, system Integration, deployment, training, governance, methods and procedures, stress testing and managed services, Big Data analytics and data warehouses



Source: Verizon

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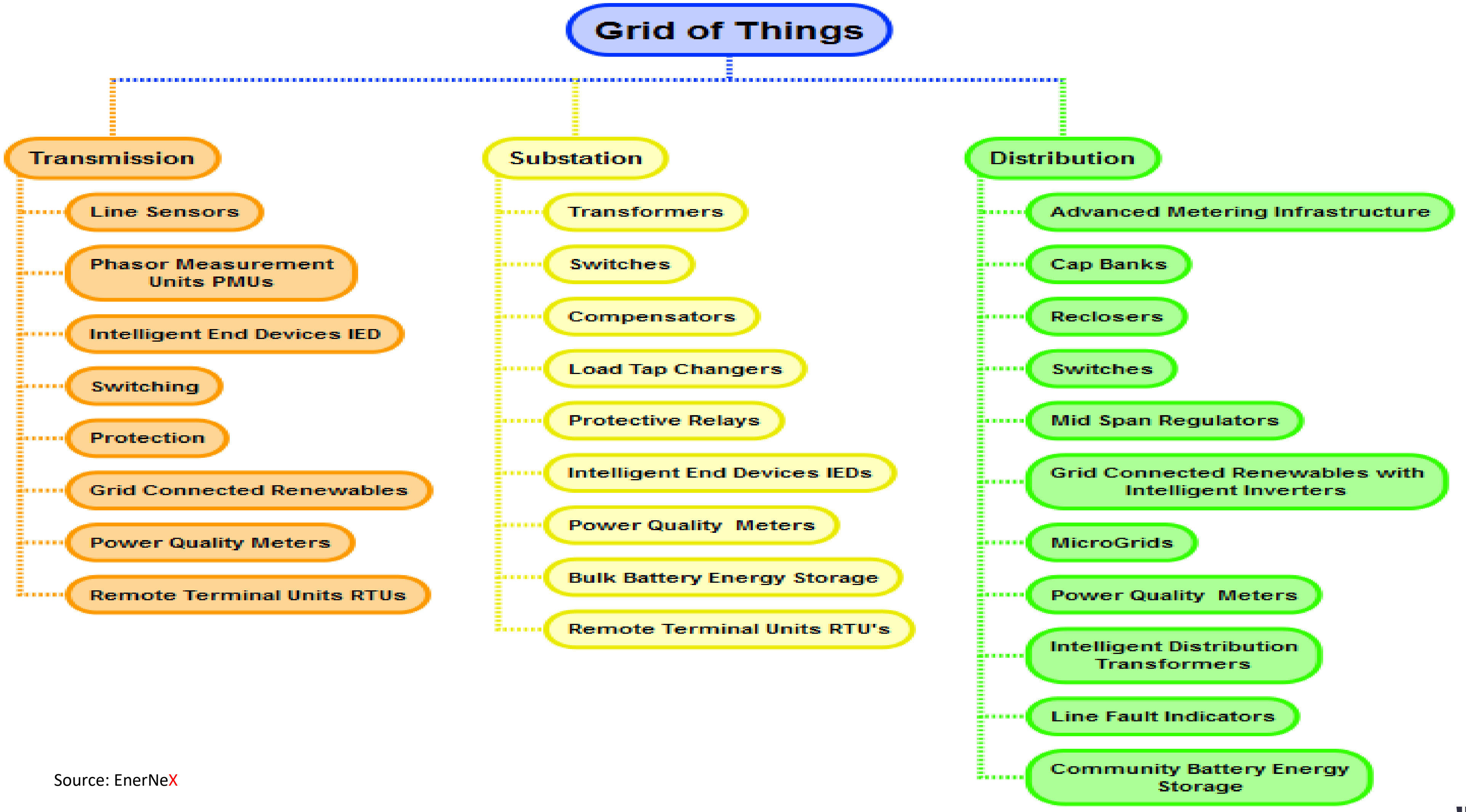
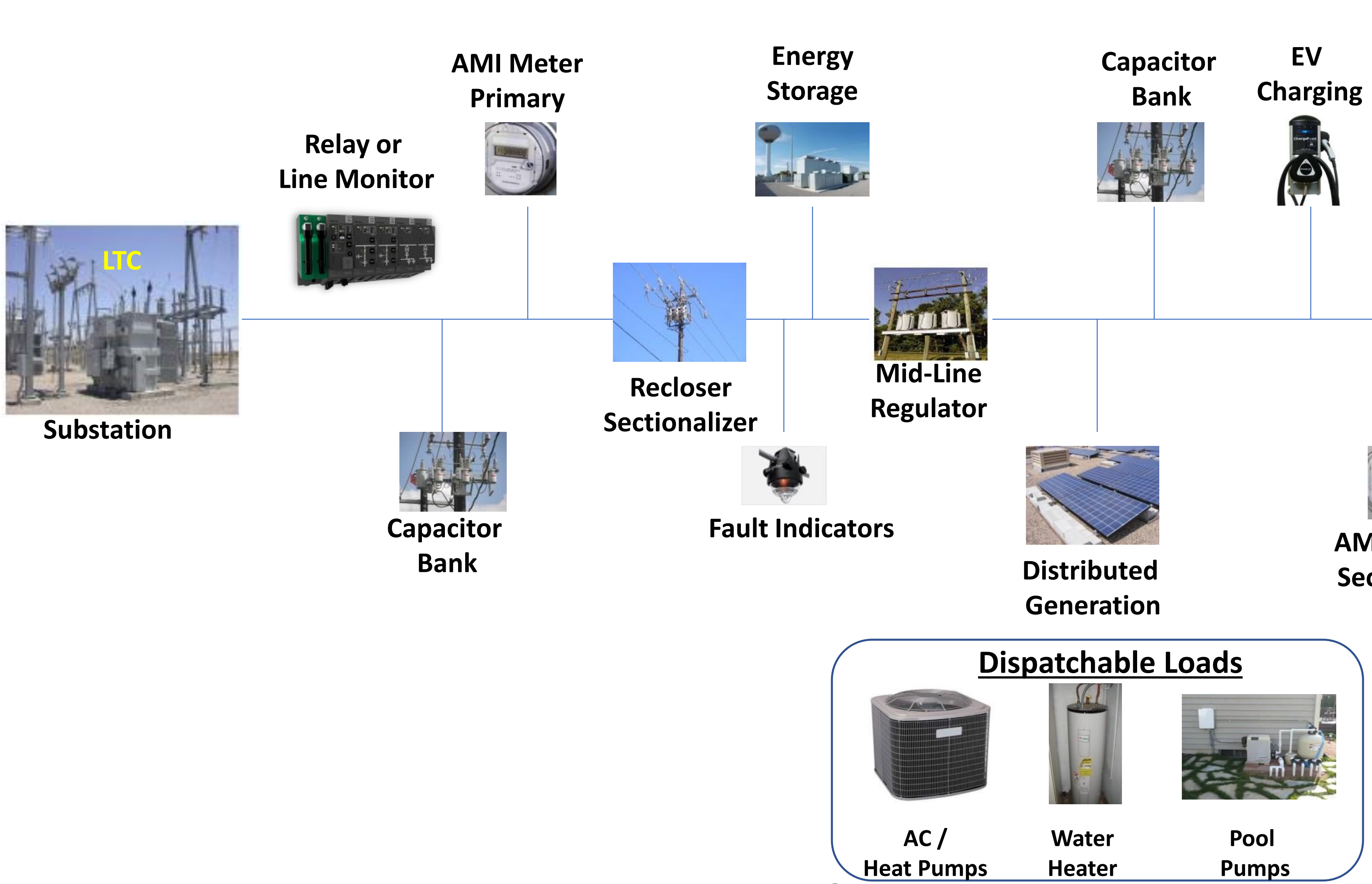
Today there are a lot of devices that are connected to the electric grid



Source: EnerNeX

There is a rapid growth of connected assets on the distribution network



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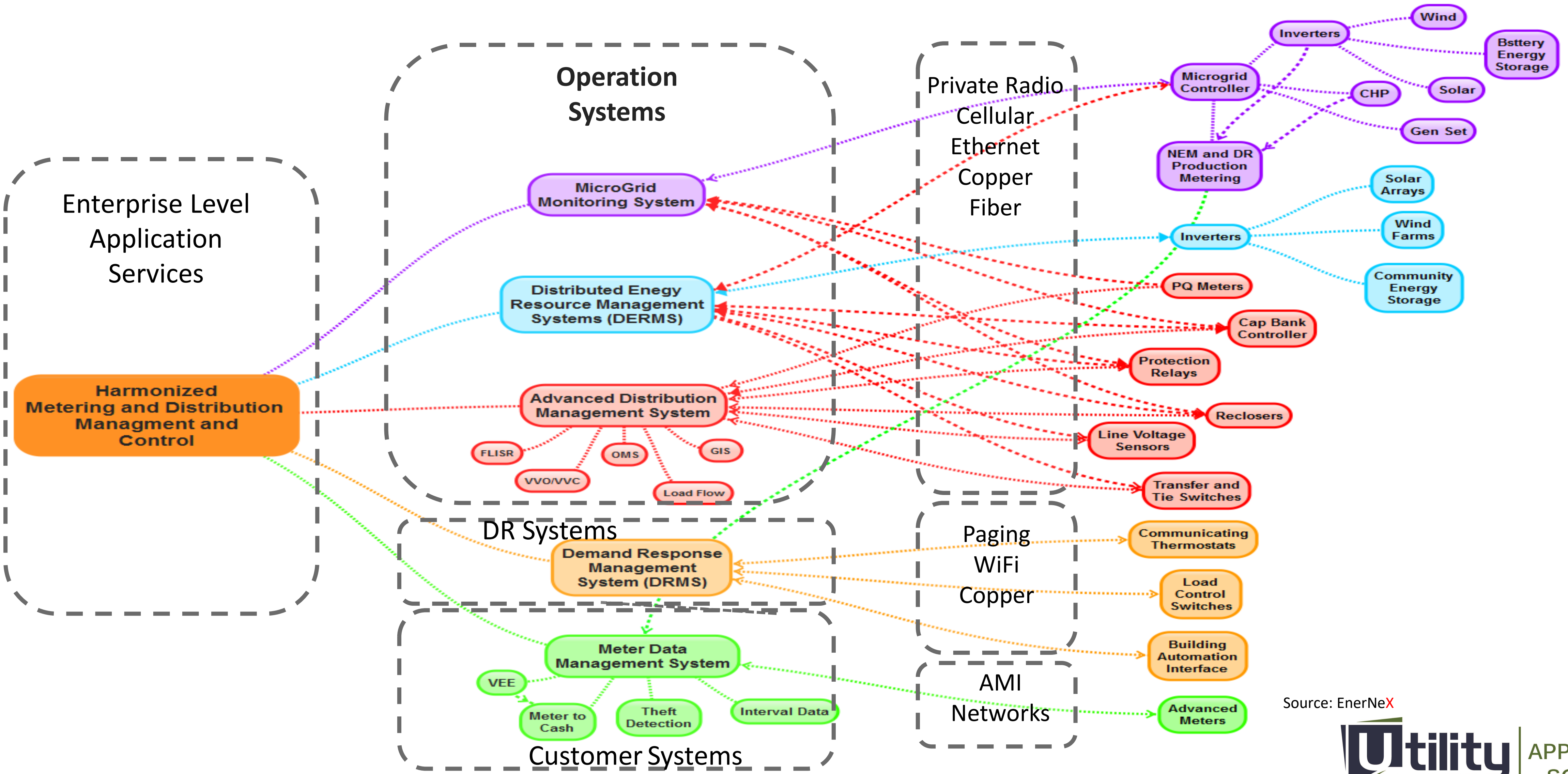
Frequently, these asset are connected to specific applications; often over disparate networks.



Source: EnerNeX

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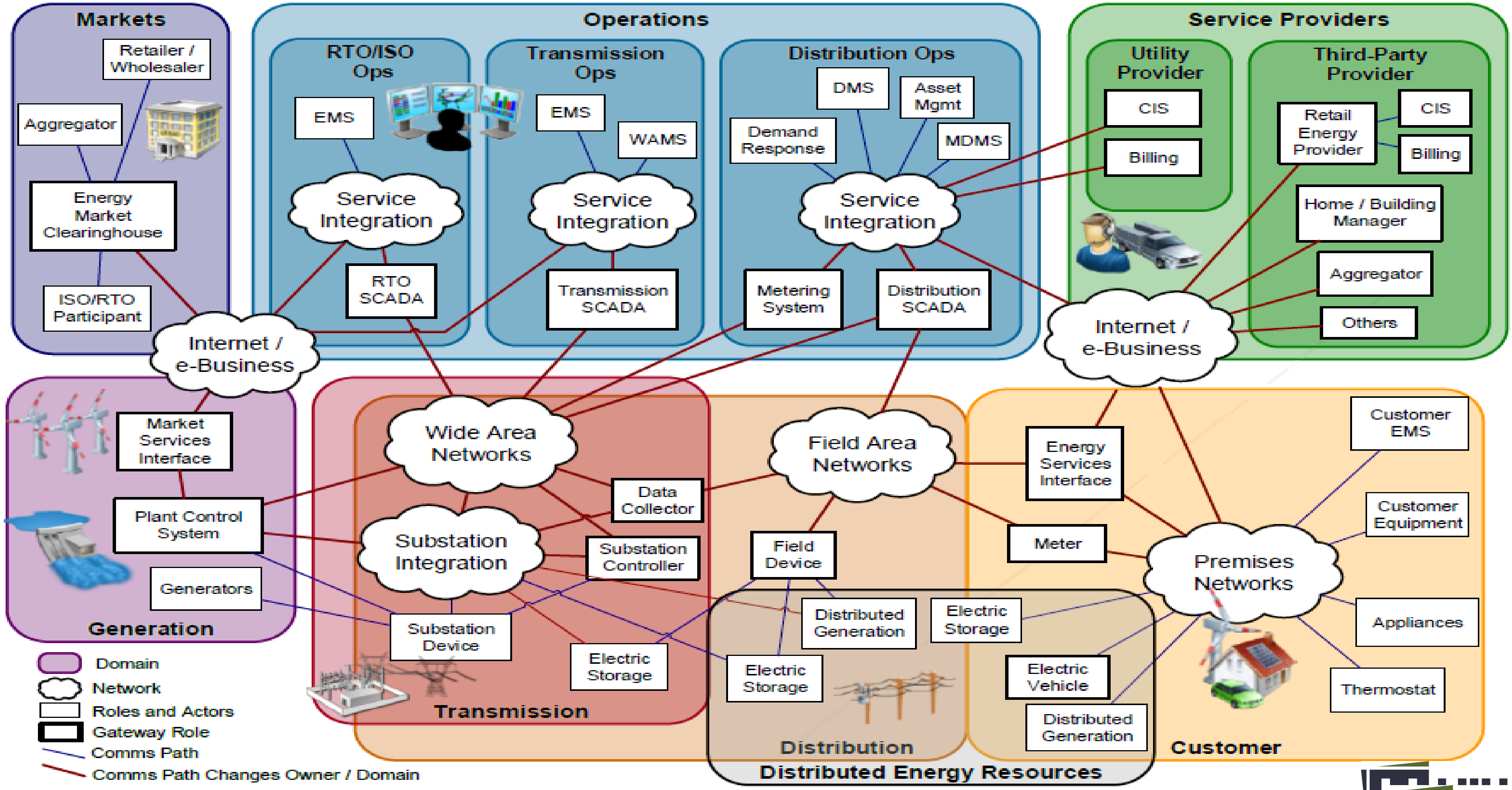
Communications plays major role in Grid Modernization



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Alignment of Business Need and Technology Solutions is essential

Grid Modernization Components

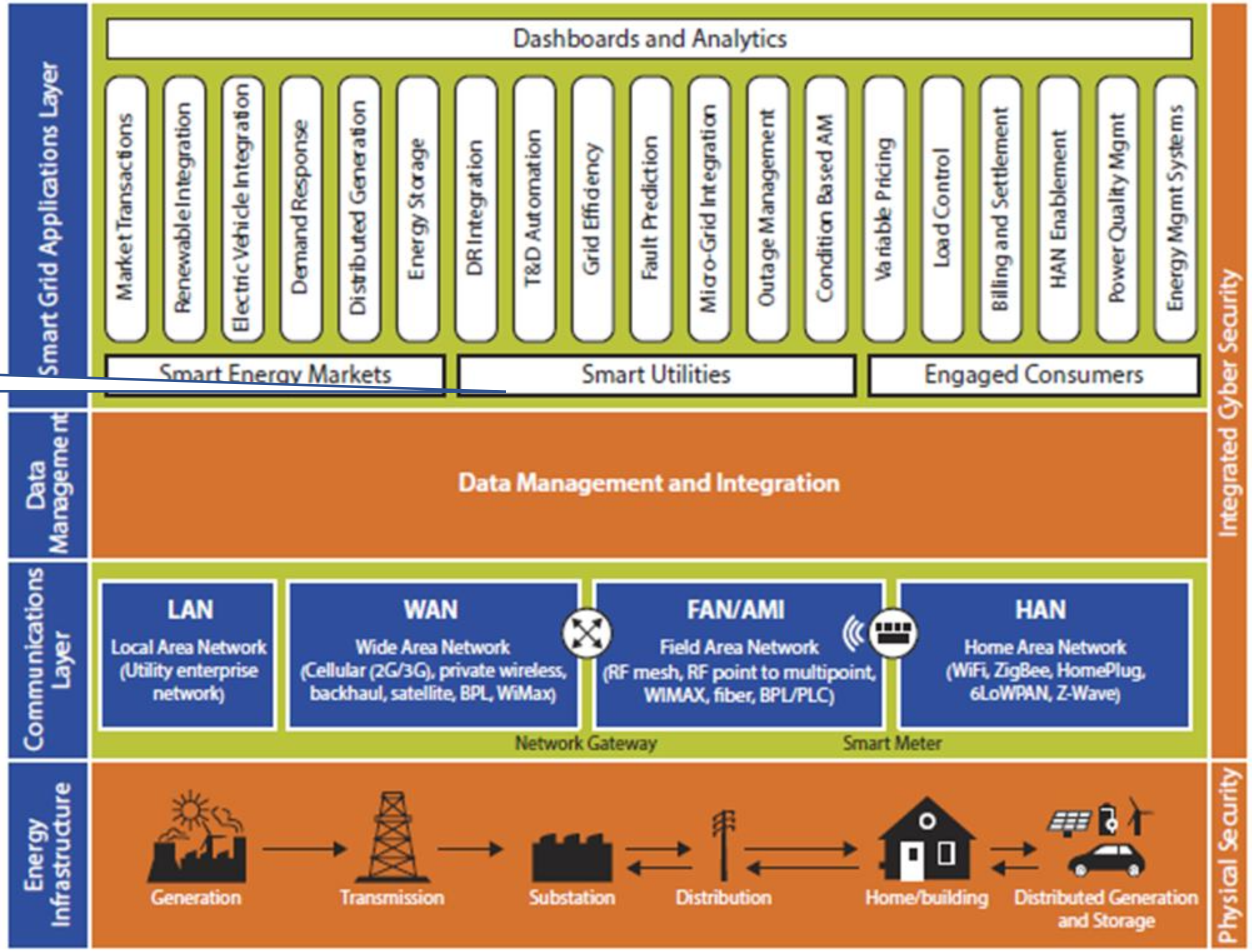
Directional Alignment

(Comprehensive Grid Modernization Focus)

Distribution Automaton and DER integration general topics

Topical Alignment

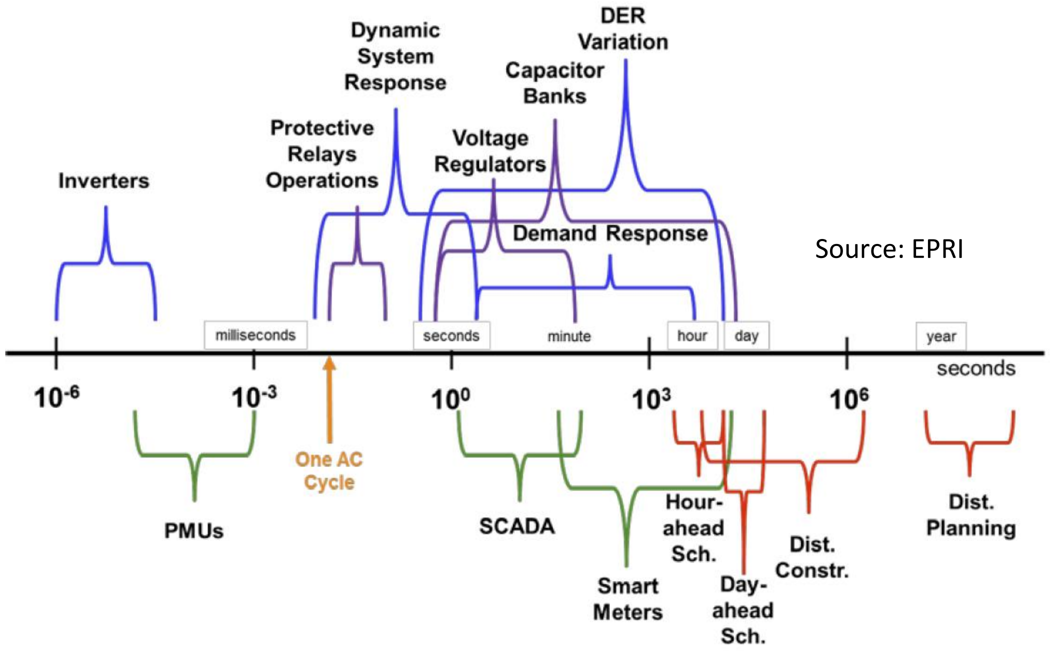
(Grid Modernization Component Focus)



Source: Adapted from Pacific Gas & Electric

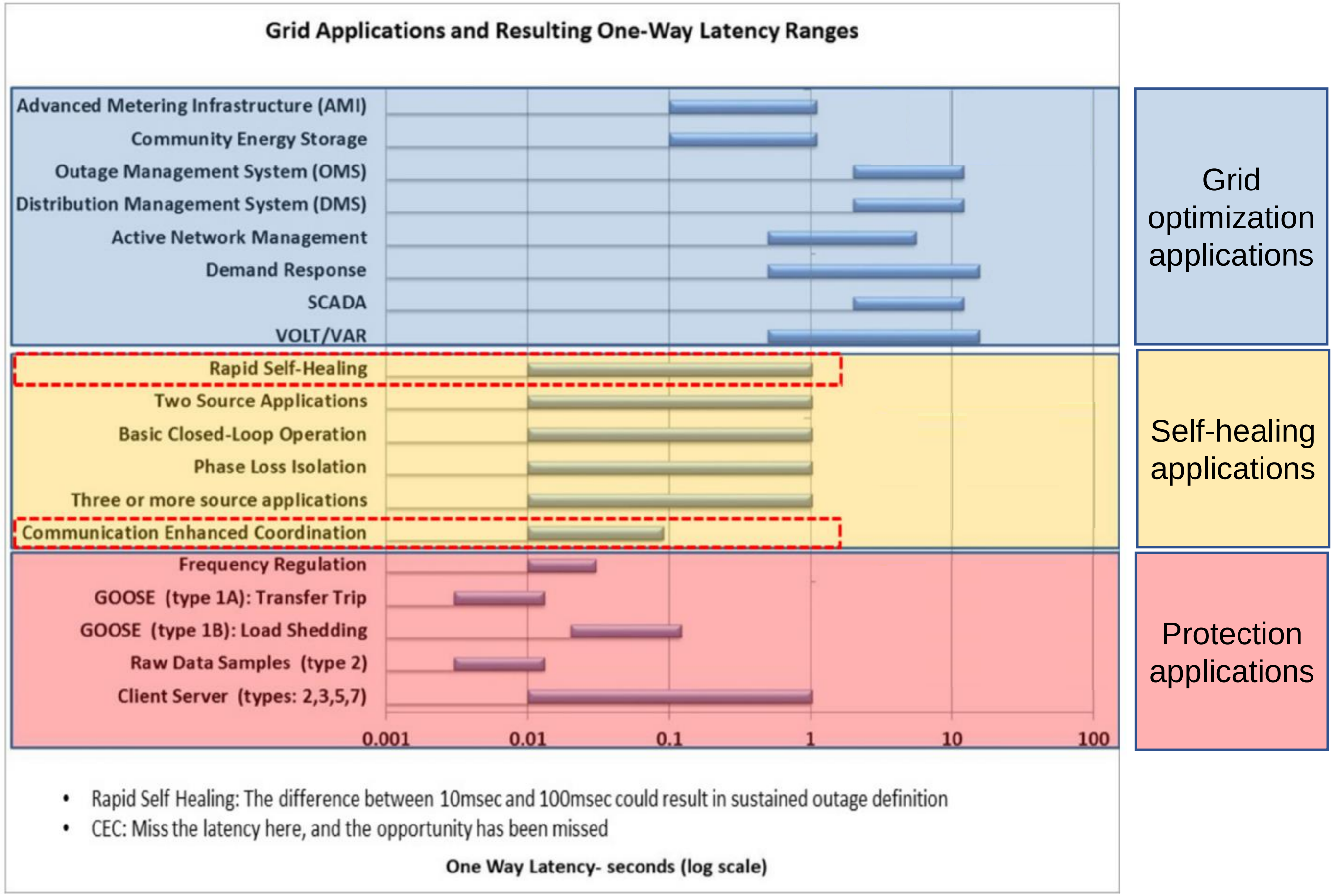
Applications & Devices – Latency

All grid devices are not the same and require different communications parameters - one of the key considerations is latency (i.e., data transmission speed/timing)



Source: EPRI

Purple = Traditional Devices
Green = Traditional Distribution Measurement Devices
Blue = DER & DR Devices
Red = Planning



Source: Adapted from S&C Electric CIGRE paper

Applications & Devices – Other Key Factors

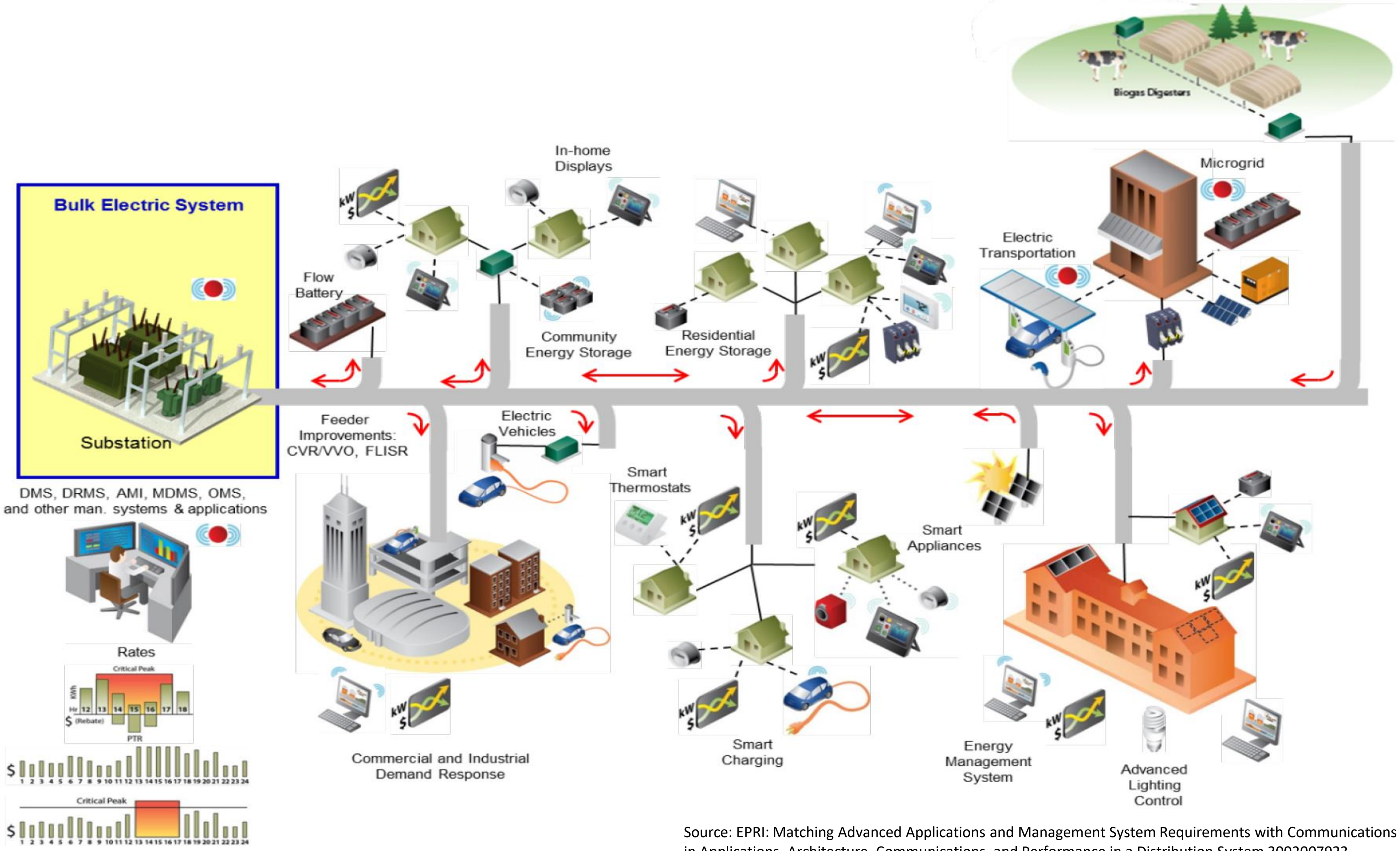
Some other primary factors for communications devices are throughput (data rate) and availability (reliability of communications)

GOOSE (Generic Object Oriented System Event) is fast peer-to-peer communication mechanism specified as part of the IEC 61850 utility communications standard

Application	Throughput (kbps)	Latency (msec)	Availability
• AMI & Demand Response • Legacy Distribution Automation (SCADA, Volt/Var, DMS, OMS)	<100	500 to 1000	2 to 3 NINES
Grid Automation & Control: Rapid Self-Healing	>100	<100	4 to 5 NINES
Grid Network Control: Communication Enhanced Coordination	>300	<80	5 NINES
• Frequency Regulation • IEC61850/GOOSE Type 1B • (Load Shedding)	>500	10 to 50	5 to 6 NINES
IEC61850/GOOSE Type 1A (Transfer Trip)	>1000	3 to 10	6 NINES

Source: Source: S&C Electric CIGRE paper

EPRI view of the feeder of the future



Source: EPRI: Matching Advanced Applications and Management System Requirements with Communications Performance Issues in Applications, Architecture, Communications, and Performance in a Distribution System 3002007923

Figure 3-2
Simplified Depiction of a Future Integrated Grid (Feeder View)

Self generation and islandable microgrids are the new grid assets

Montgomery Co.,MD Correctional Institute

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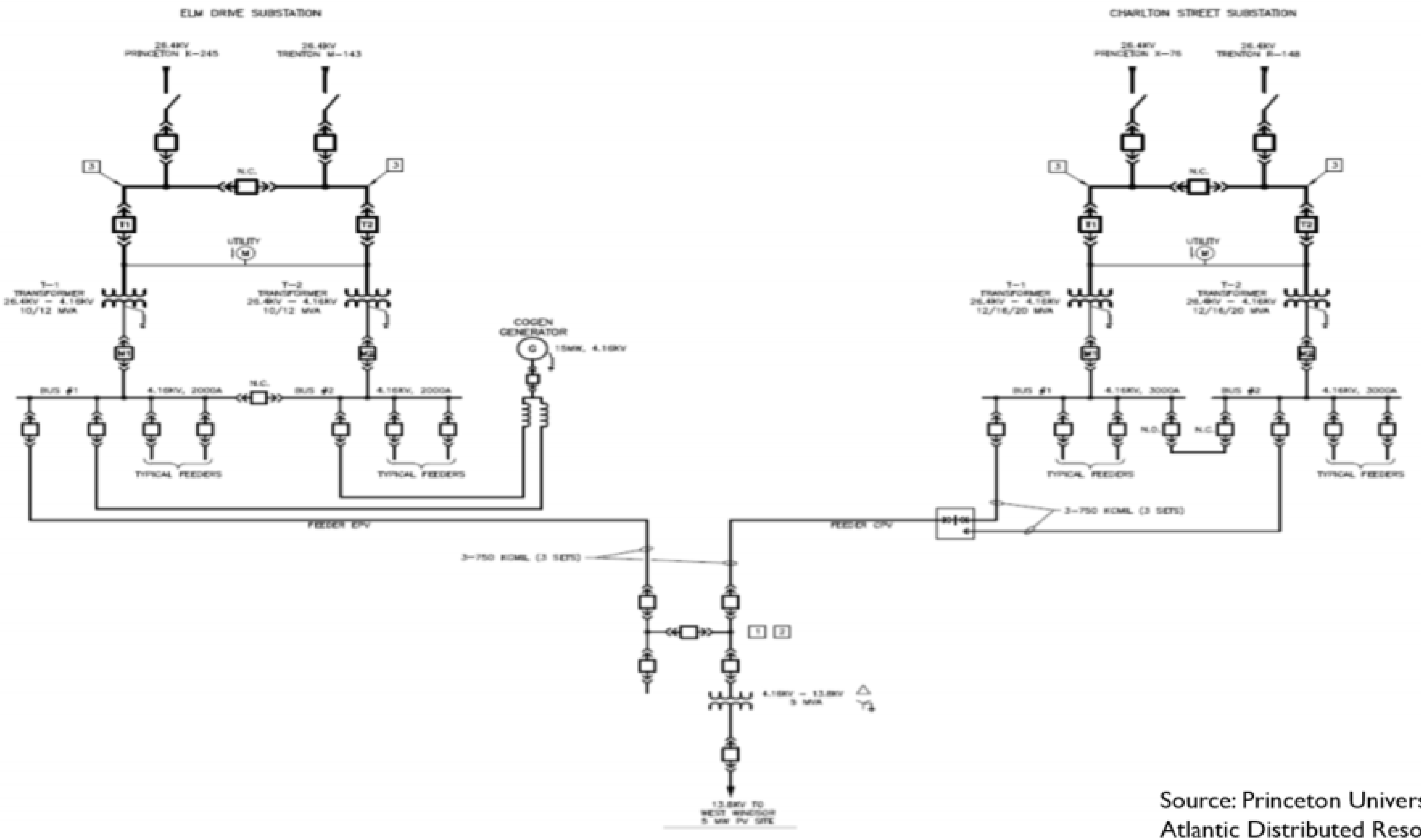
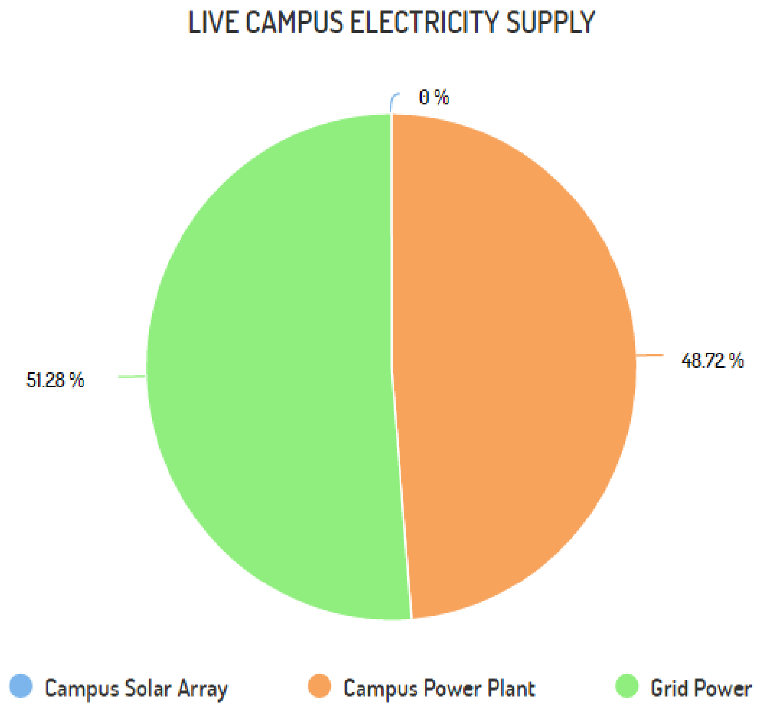
Example: Princeton University Microgrid

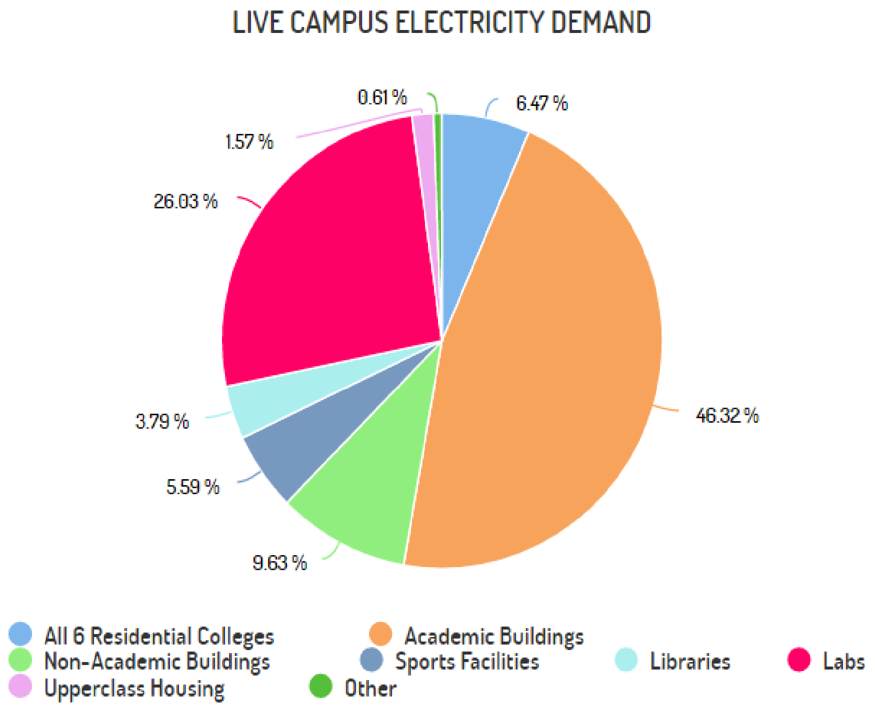


Source: Princeton University Presentation to Mid-Atlantic Distributed Resource Initiative Fall 2015

Princeton University has a diverse energy profile

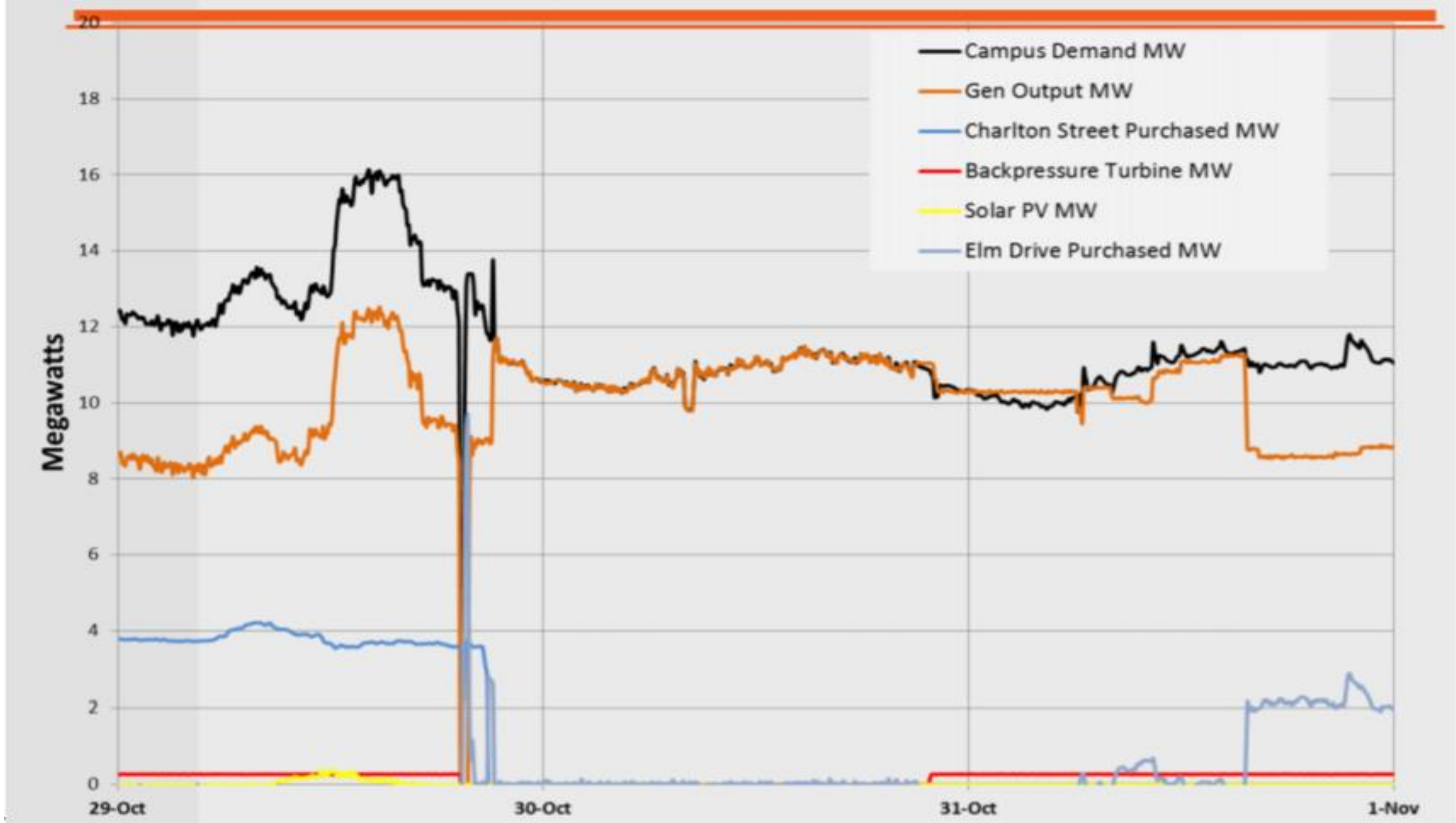
Princeton uses energy in the forms of electricity, chilled water, and steam.





Source: Princeton University Facility Web site

Princeton campus during Super Storm Sandy



When Super Storm Sandy hit NJ, the Campus went into island mode

Source: Princeton University Presentation to Mid-Atlantic Distributed Resource Initiative Fall 2015

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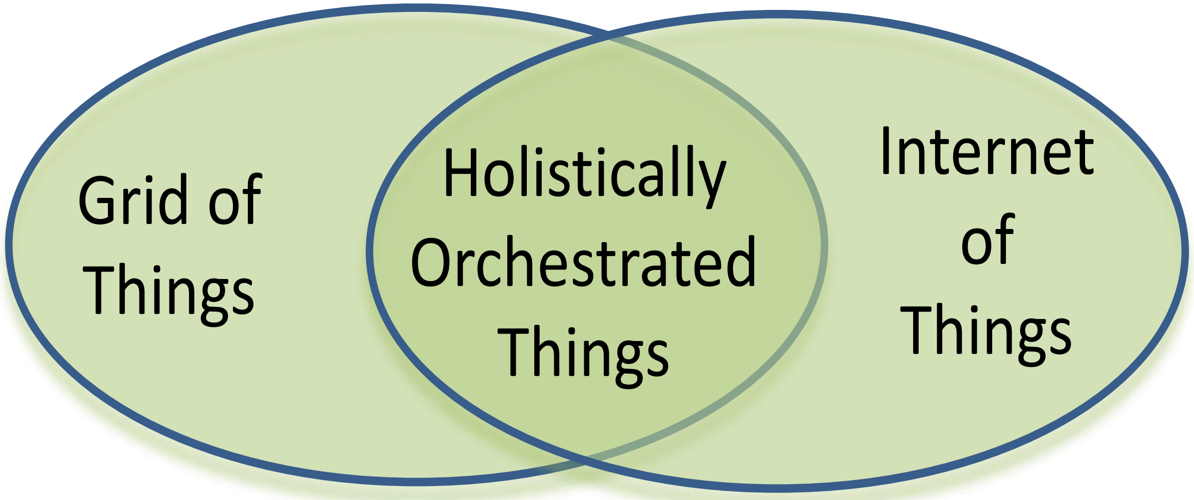
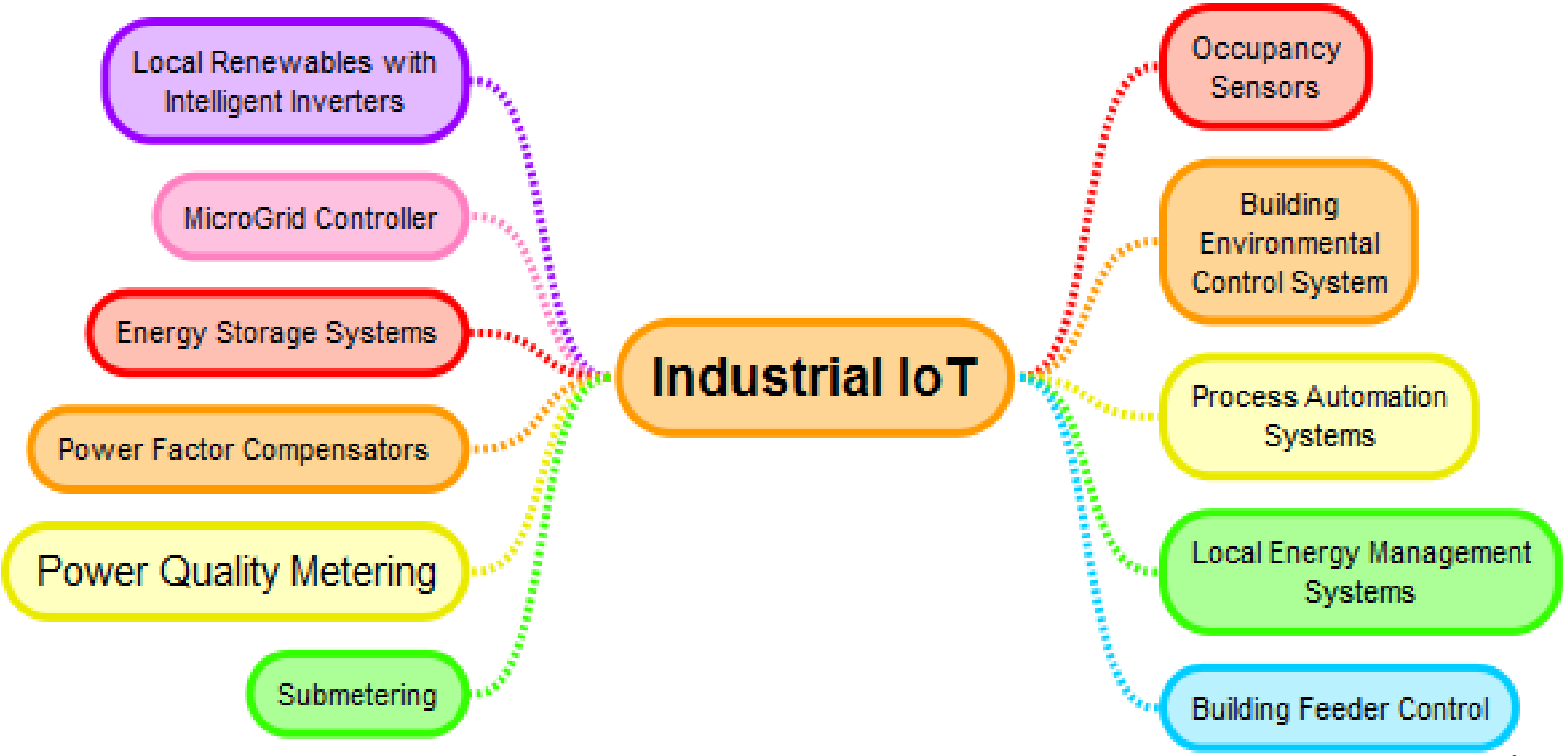
The intersection of the Grid and IoT is an area of growing interest



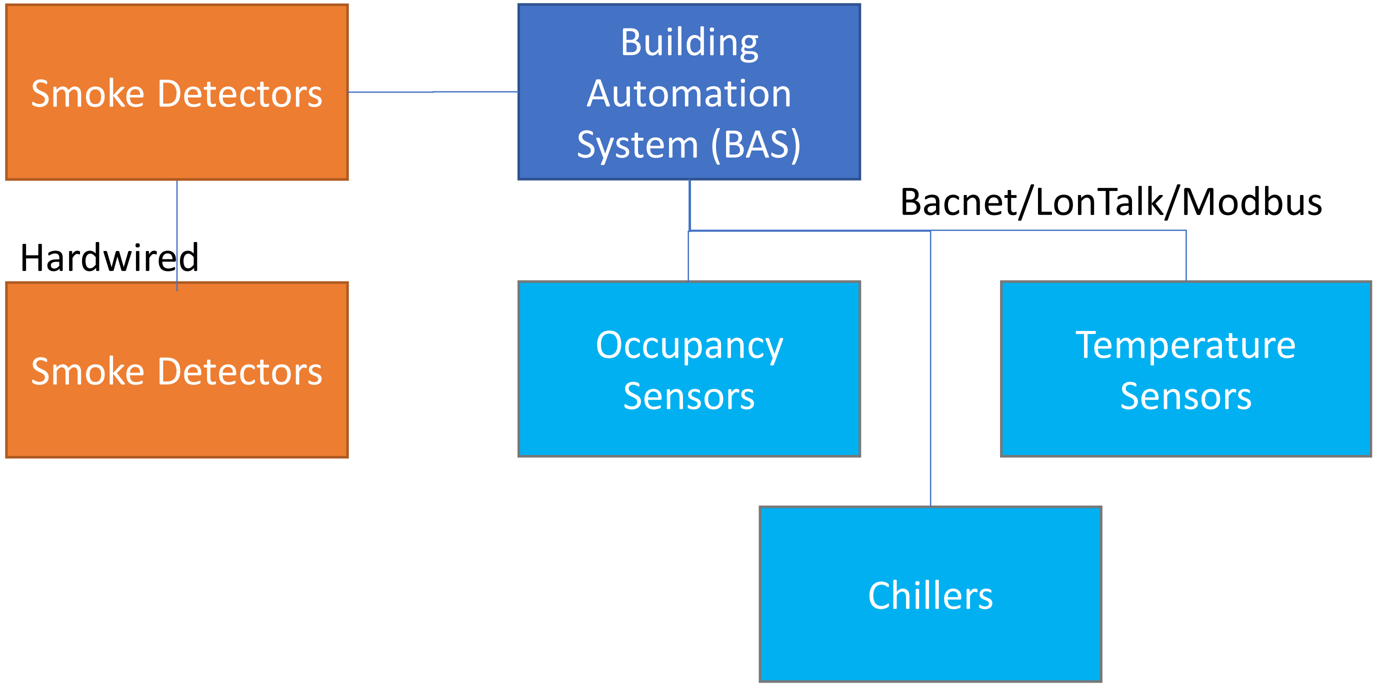
Source: EnerNeX

Similar to the grid, many industrial facilities, have key assets that are interconnected



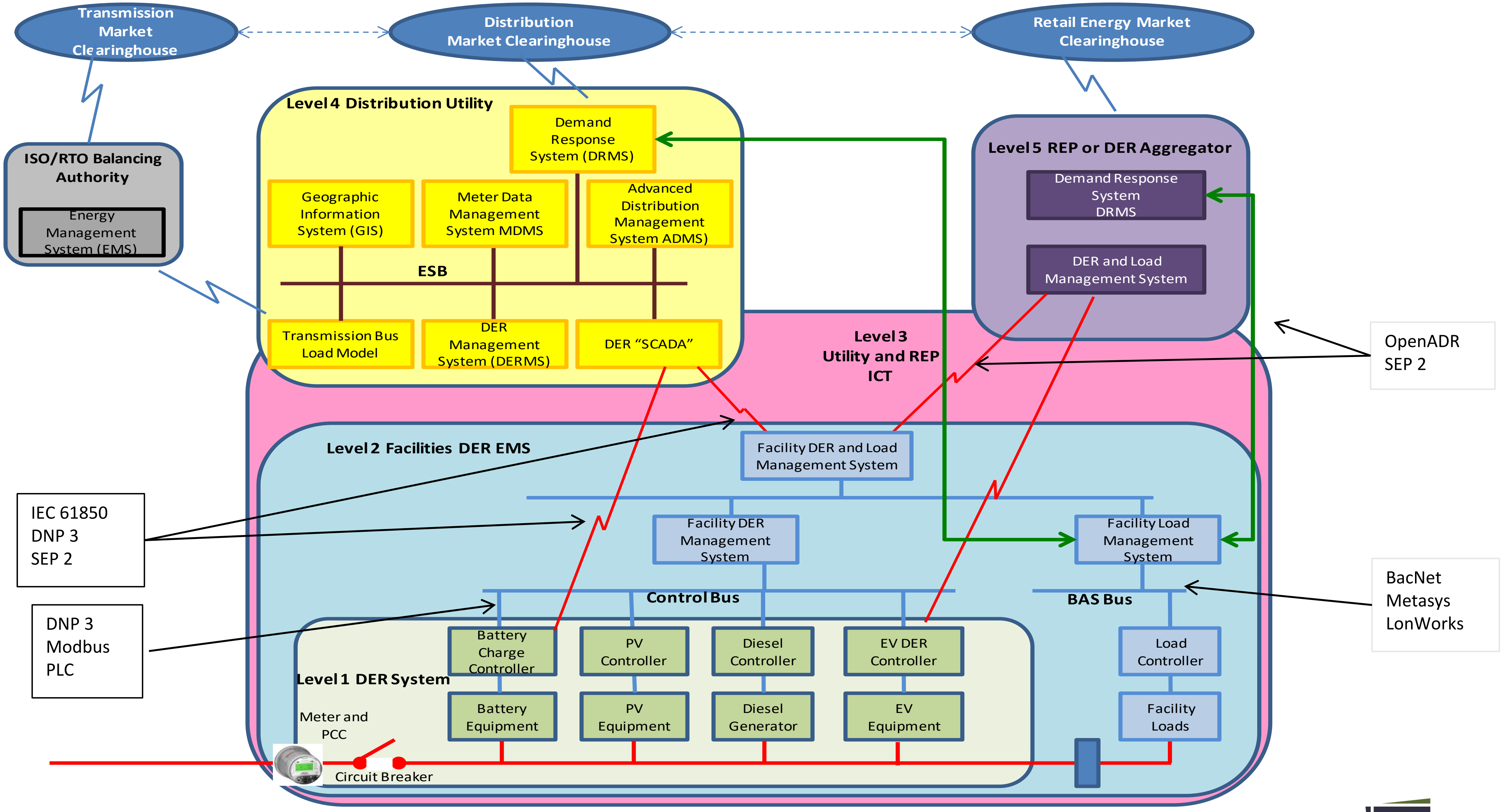
Source: EnerNeX

Generally, these assets communicate over hardwired systems such as Modbus, Bacnet or PLC



Source: EnerNeX

Integration is A Hierarchical "Systems of Systems"



Source: Adapted from CPUC Smart Inverter Working Group (SWIG)

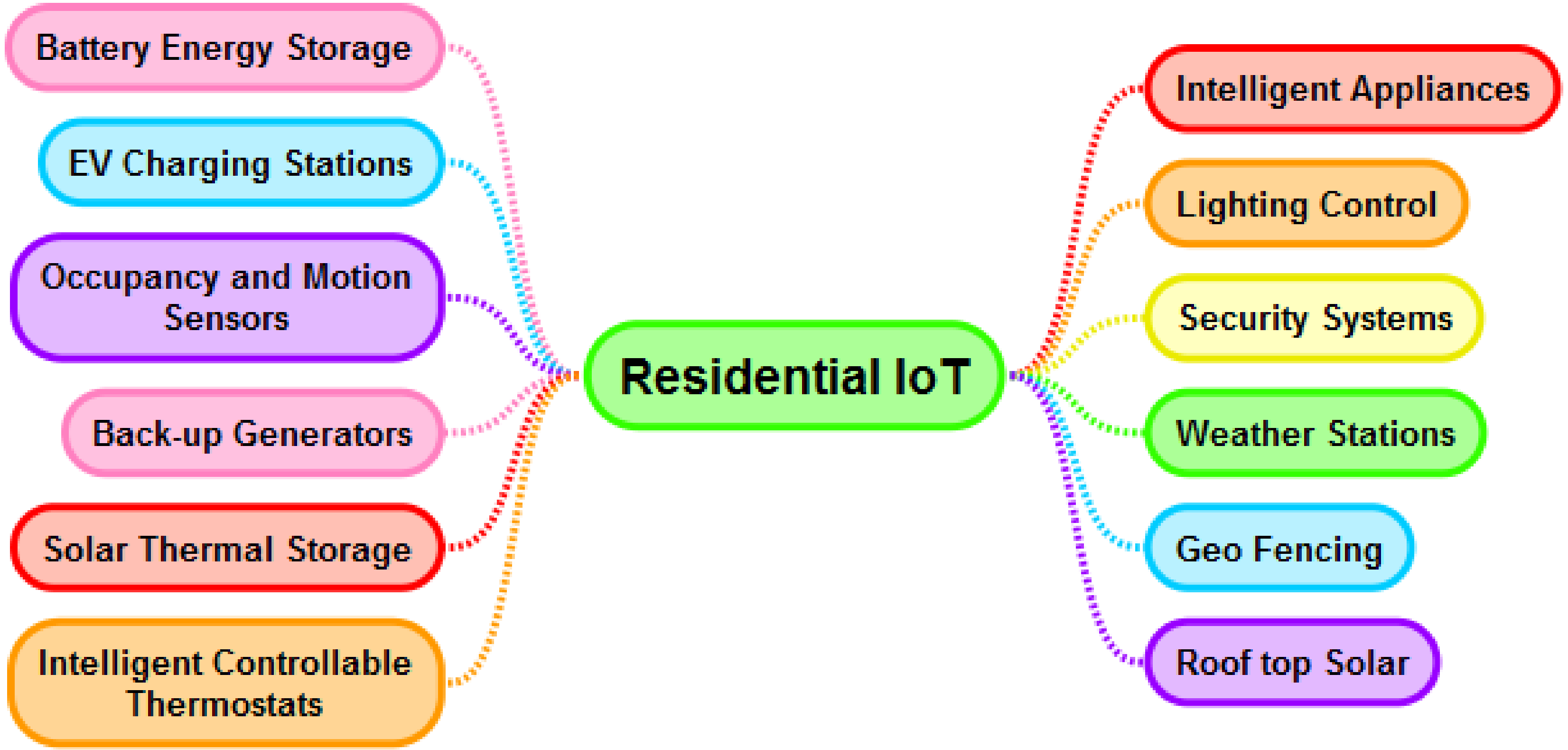
Grid and Industry HoT Areas:

- **Short-term grid support during anomalies (e.g. Voltage/Frequency Ride through)** – With the direction of IEEE 1547-2018 , grid support functionality will need to be supported. The control of this is an augmentation of a Distributed Energy Resource Management System (DERMS).
- **Improving grid stability by using customer-owned compensation elements –** Since some facilities have capacitor compensation to overcome local VAr conditions, these assets may be called upon by the utility to augment utility-owned assets.
- **Intelligent building control response to demand response requirements** – Leveraging the intelligence within a building management system may offer new tiers of potential demand reduction based on occupancy sensors, build envelop characteristics, etc.
- **Coincident Demand Peak Avoidance** – With grid-wide knowledge of demand characteristics, intelligent load control and sequencing may be used to minimize co-incident peak situations.

Grid and Industry HoT Areas:

- **Customer based thermal/energy storage to as a Non-Wires Alternative (NWA)** – As utilities seek short term options to new construction or re-enforcement, customer owned assets or potentially co-owned assets may be leveraged to overcome seasonal peak demands.
- **Microgrid optimization** – Utilities are in a position to help customers better understand their options for supply, load management and load profile characteristics.
- **Outsourced MicroGrid operations and maintenance** – With increasing intelligence provisioned within the facility microgrid controller, utilities may be in unique position to provide services to support internal staff for operations and maintenance (O&M) as a service (when permitted).
- **Vehicle to Grid (V2G)** – With intelligent charging stations combined with knowledge-rich electric vehicles, the use of this customer asset may now effectively leverage grid conditions to react accordingly while still ensuring customer needs for convenience and cost.

With connected devices, residential IoT is rapidly seeing greater adoption and use:



Source: EnerNeX

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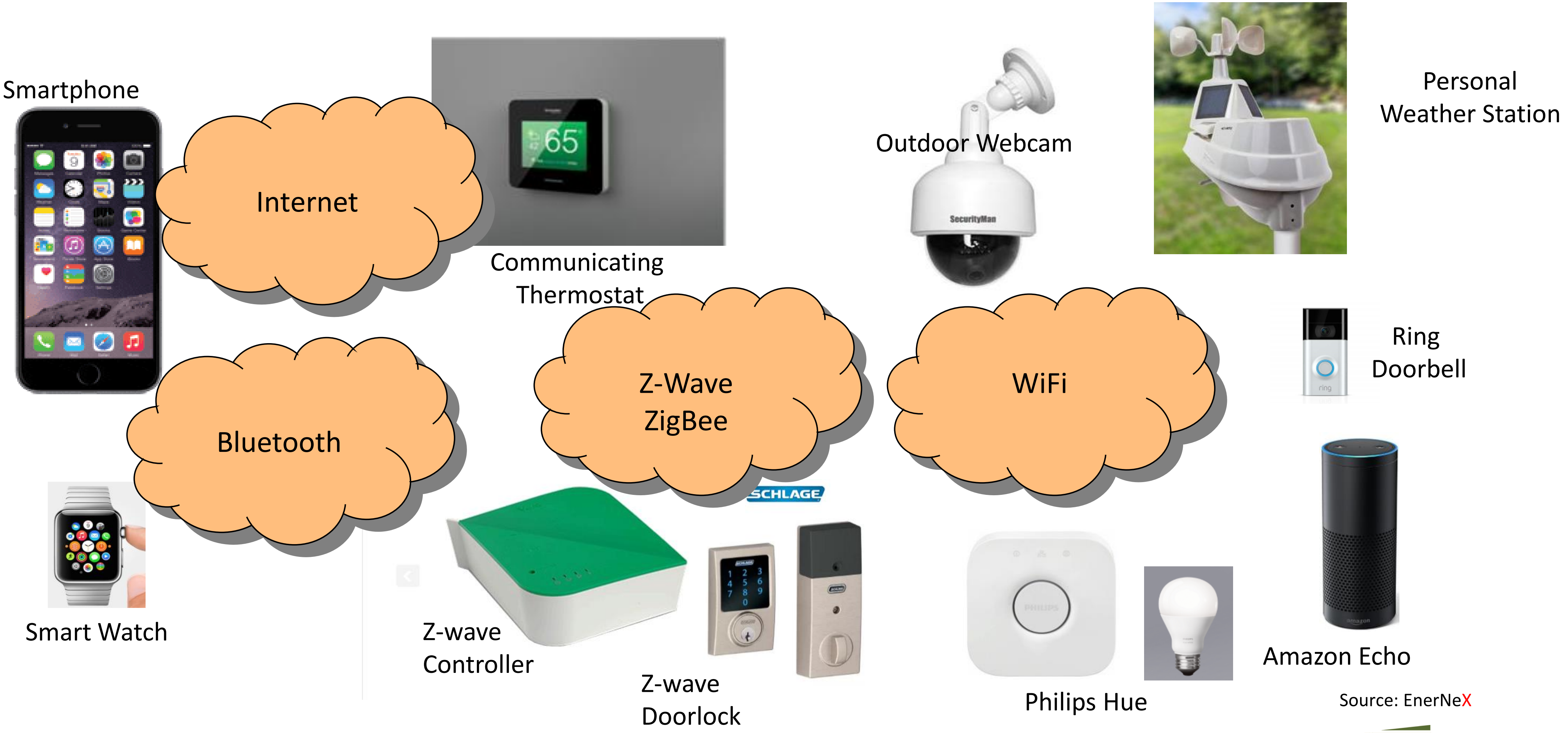
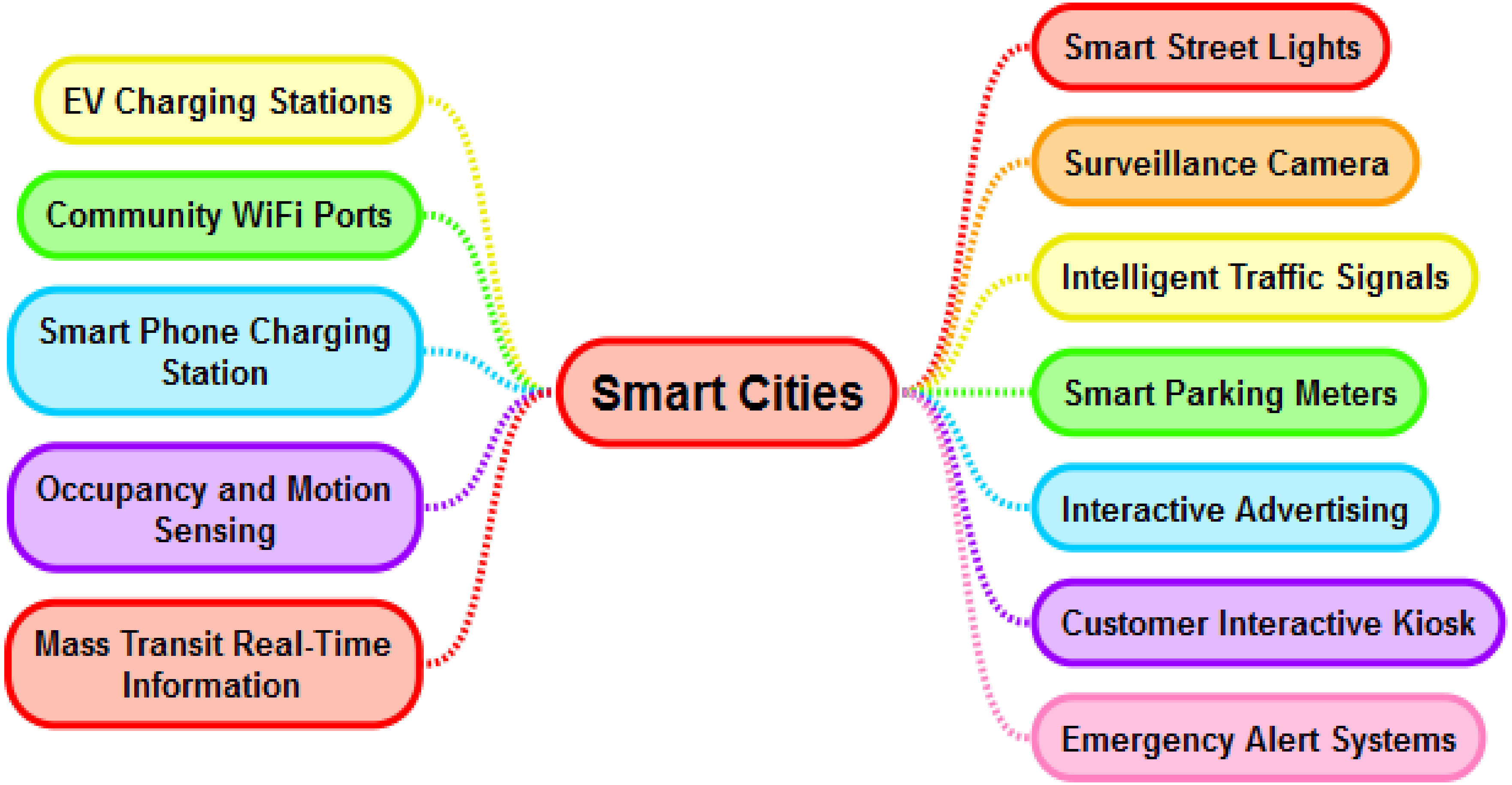
The connectedness of “things” is happening, Here are some of the IoT devices. I personally access…



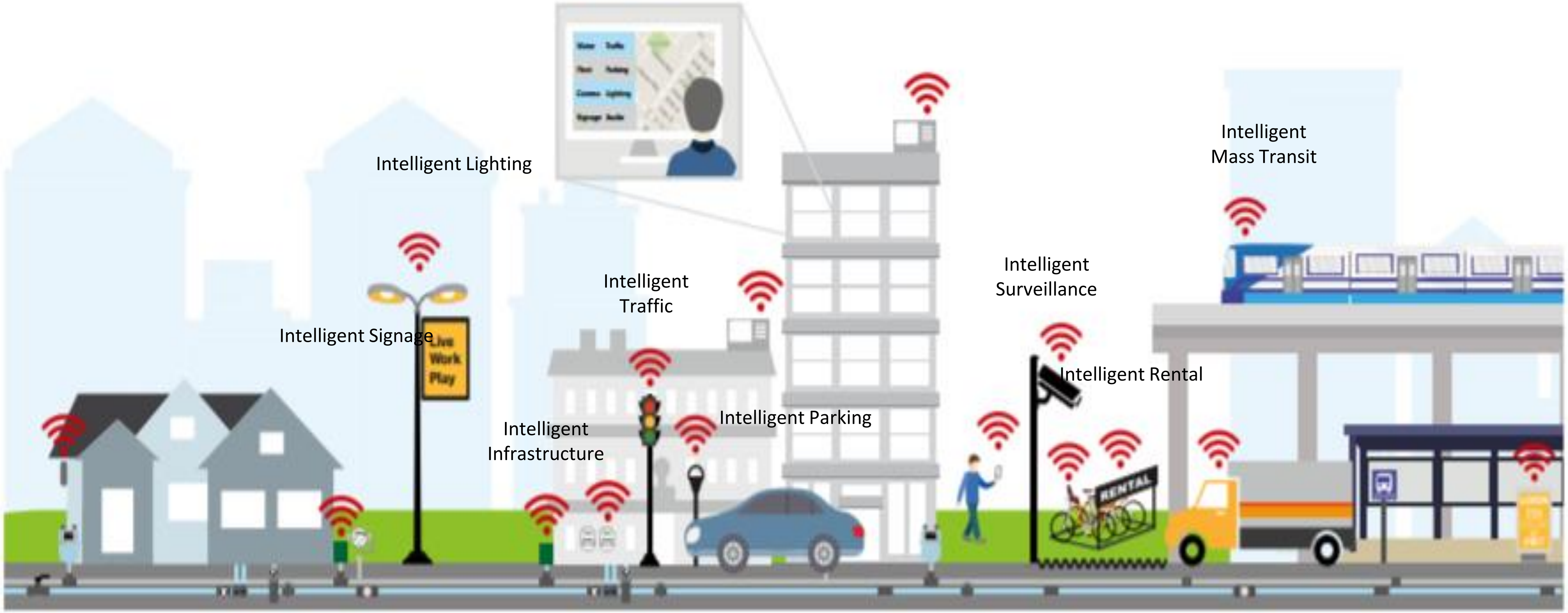
Source: EnerNeX

Smart City IoT is gaining momentum



Source: EnerNeX

Verizon's Smart Connected Cities Overview



Source: Verizon Website

HoT Areas: Smart City and the Grid

- **Common use for Communications Infrastructure** – Many AMI providers have already incorporated smart street light applications as part of their offering suite. Including streetlights as nodes on an AMI network has shown to improve performance, lower latency and deliver.
- **Gateway for fixed radio AMR**– The potential exists to leverage assets as a home for collection gateways for older automated meter reading (AMR) using drive-by methodology.
- **Intelligent EV Charging Stations** – Since many of these assets would be located near vehicle parking, intelligence using Near Field Communication (NFC) or other tagging could be used to provide smart charging programs.
- **Smart Lighting Control** – LED replacement for traditional overhead lights can result in substantial savings (30-50%) and when coupled with motion sensing can further reduce many of these unmetered services by another 10%.
- **Streetlight Outage Response** – Leveraging luminary intelligence, servicing of dark lights can be optimized.

Examples of IOT/GOT harmonization

Example : Volt/var Optimization/Conservation Voltage Optimization CVO/VVO Use Case

Summary Narrative:

Various sensors and elements can provide data at key points within the distribution network. Gathering these and presenting these to a unified or common decision support system is essential to determine the most appropriate set of actions to take to adjust assets in the field. The purpose for adjusting these assets could be for a number of conditions, such as VAR management, conservation or for overall distribution grid optimization. Assets that may be controlled include substation as well as remote edge devices. As the complexity of the network increases with growing use of intelligent devices, such as inverters and edge regulators, coordination of these will become more essential particularly in an underground network distribution environment that prevails in the service territory. This use case depicts the potential sources of this data, the data gathering elements, decision tools as well as the target devices that would be under control.

Dependencies and Timing Implications:

Near –Term limited predictive VVO leverages the following resources:

- Information provided by sensors in the grid
- Spot voltage monitoring in the network
- Command and control using dSCADA functions of SCADA
- Controllable utility assets such as LTC's

Mid-term migrating to more closed-loop VVO would use the following:

- AMI data for areas where this is deployed
- Additional sensor data communicated to the DMS
- Information form in a consolidated GIS Asset Management System

Long-term effective and comprehensive VVO, would use:

- Intelligent inverters with VAR absorption/injection
- Smart edge regulators
- ***Customer Asset Control***
- ADMS with a unified and robust connectivity model

Reference Use Cases:

There are a number of use cases for VVO/CVR and related actions that have been used in the development of this case

These include cited reference cases from: SCE;EPRI; AEP

Potential Gaps and Issues:

- Verification of system to perform VVO
- AMI meter information latency
- Information latency
- Verification of communication capability and applicability

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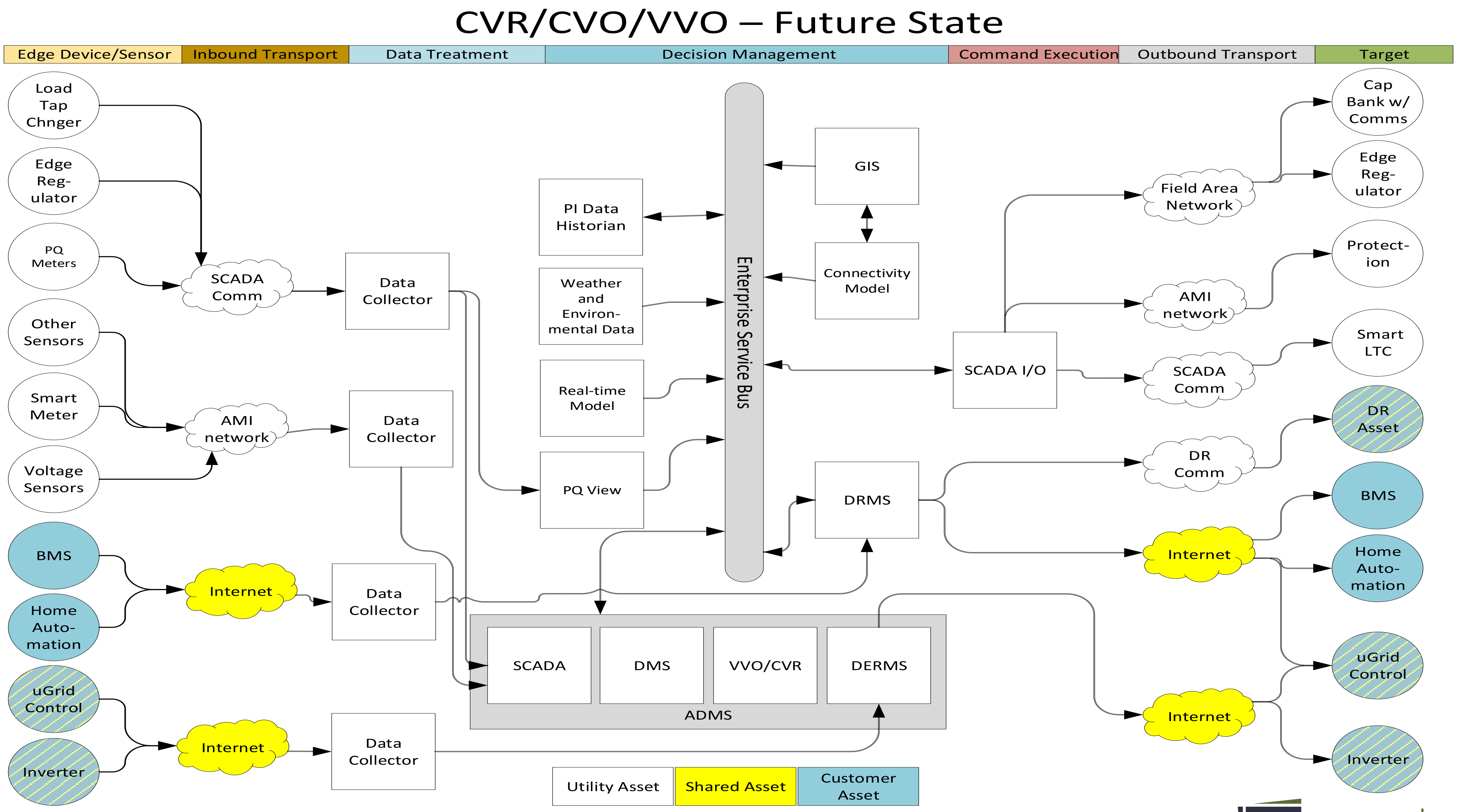
A “Linear View” (Inputs to Commands) to identify actor zones

Zone	**Description**	**Examples**
Edge Device/Sensor	Element of the solution that provides data / telemetry or content that informs or augments awareness	Voltage Sensor, trip indicator
Inbound Transport Communications	Means by which the edge device/sensor provides its information (this may be different than the outbound transport)	Digital cellular services
Data Treatment	Processing system that does data extraction aggregation or affiliation, e.g. meter to service delivery point	Meter Data Management System
Decision Management	System that takes sensor data from various sources, leverages inputs from other systems and apply algorithms and rules to establish actions to take	Advanced Distribution Management System (ADMS)
Command/Execution	System that is responsible for ensuring transmission of execution steps, e.g. turn on x; turn off y	SCADA
Outbound Transport Communications	Means by which the command actions are delivered to the element that will be executing the step	Substation fiber optic network
Target Device	Device or elements that are responsible for fulfilling the command	Load Tap Changer

Integrated approach for CVR



Source: EnerNex Client Analysis

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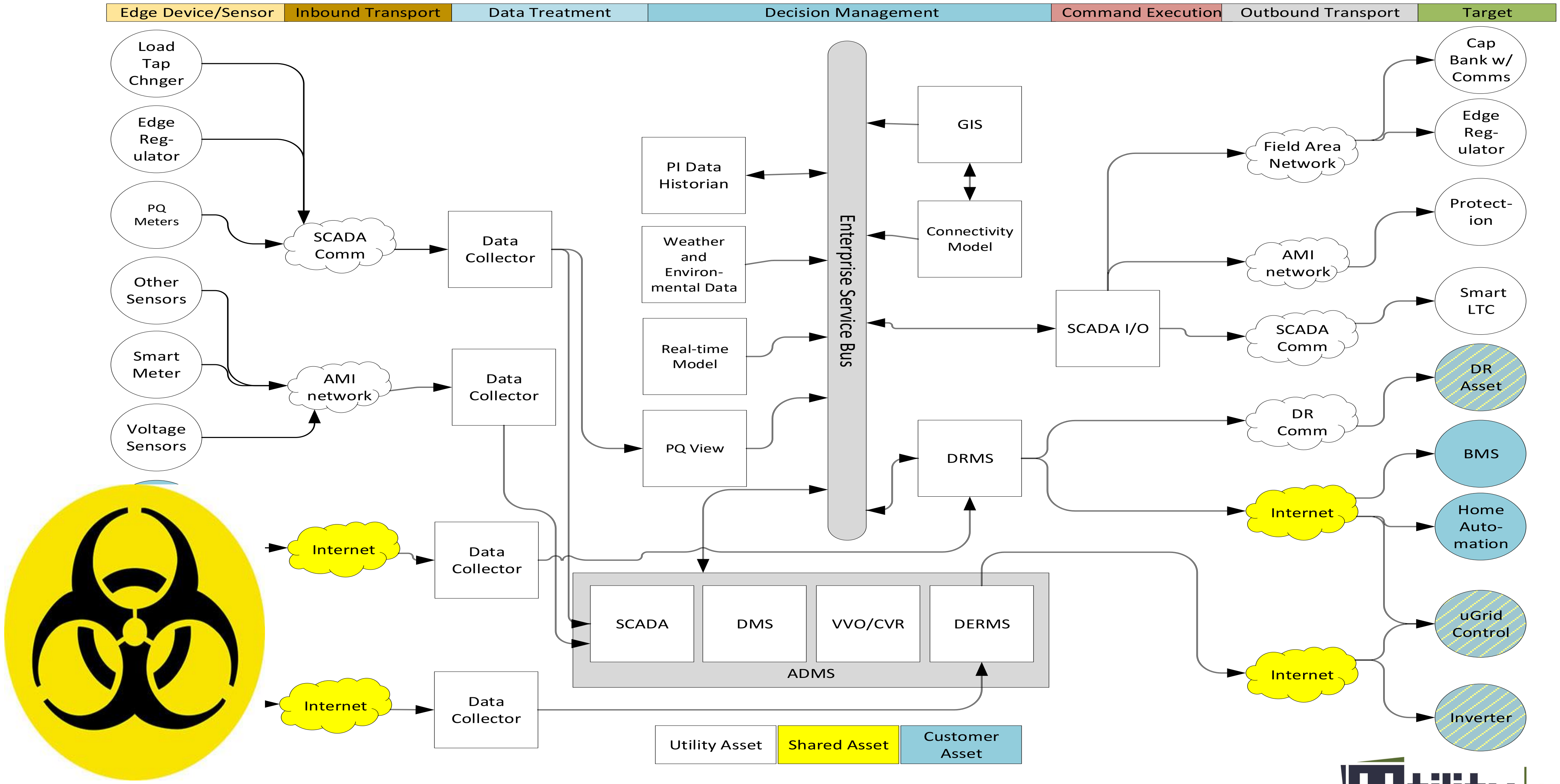
Integrated approach for CVR



Source: EnerNex Client Analysis

IoT: What are people saying?

Predictions:

Gartner

- By 2022, IoT will save consumers and businesses $ trillion a year in maintenance, services, and consumables

Cisco

- Within 20 years the Internet of Things (IoT) could add **$15T** to global GDP

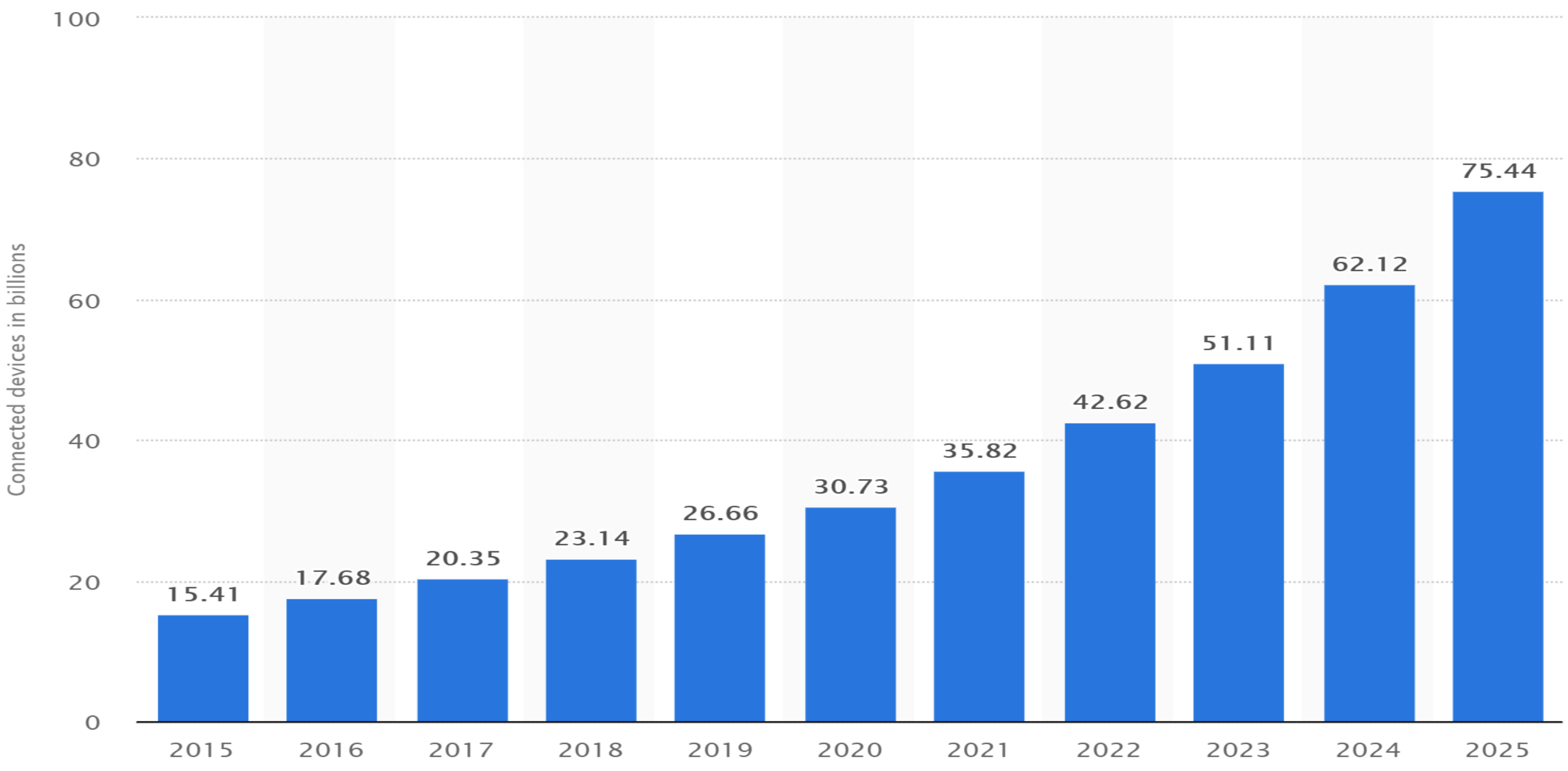
Intel

- By 2020 there will be **26** "smart objects" for every person on the planet

Ericsson

- The number of cellular IoT connections to reach 3.5 Billion by 2023

IoT Devices projected to amount to 75.44 Billion by 2025



Are you ready for the flood of new devices bringing a tsunami of data into your utility?

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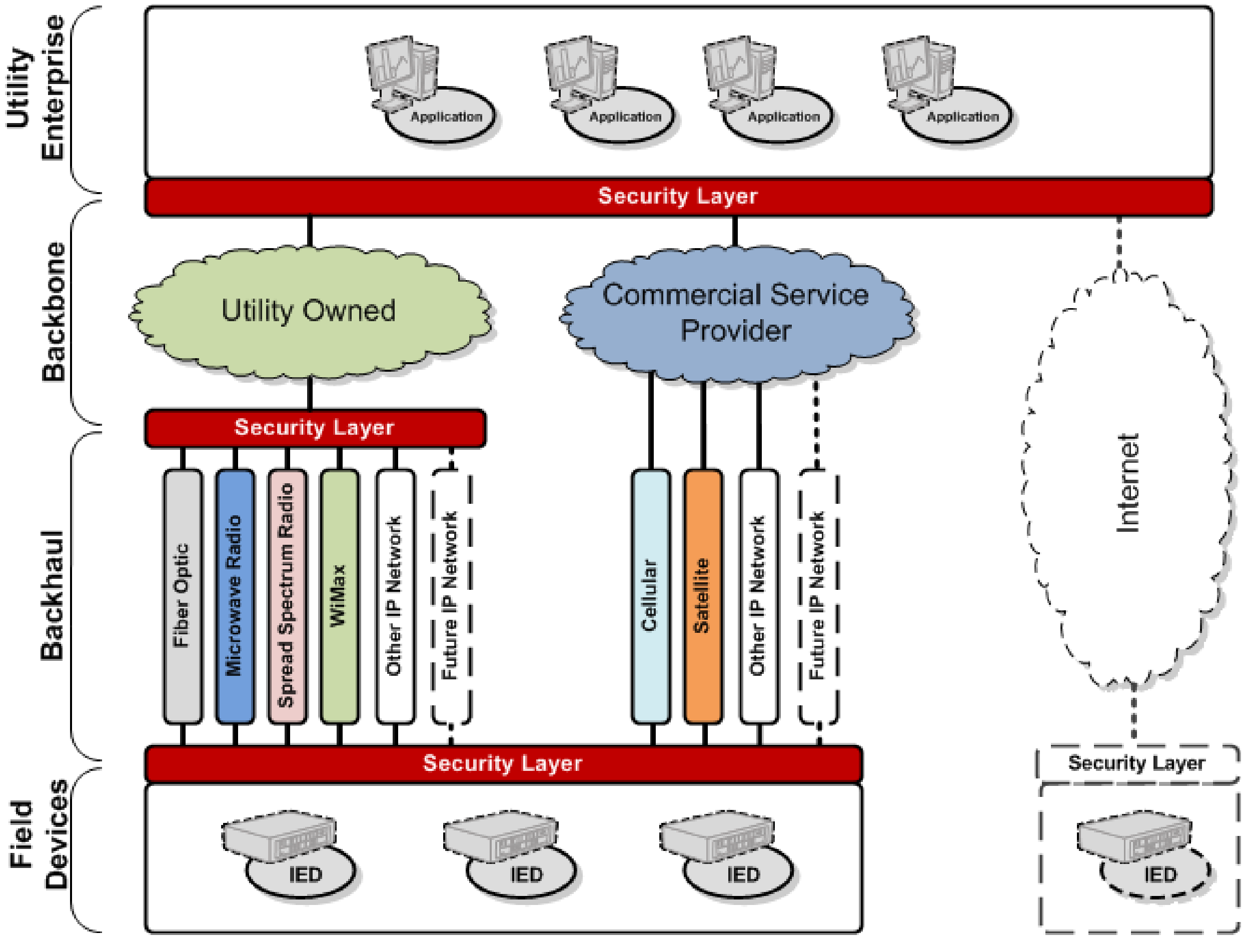
Communications Network - Recommendations



Current Comm. Network Assessment

1. Develop a detailed inventory of existing communications network characteristics (topology, communications pathways, communications devices) from end-to-end

Identify Future Communications Network Need

2. Identify communications network needs vs. wants, including desired performance criteria (future state) for various communications pathways, levels of communication, and geographic topologies

Communications Network Plan

3. Develop a communications network migration plan based on a gap analysis between future and existing states, including implications of transition.

THANK YOU

Checkout The Energy Exchange Podcast:

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