

# OTR 101: Module 2

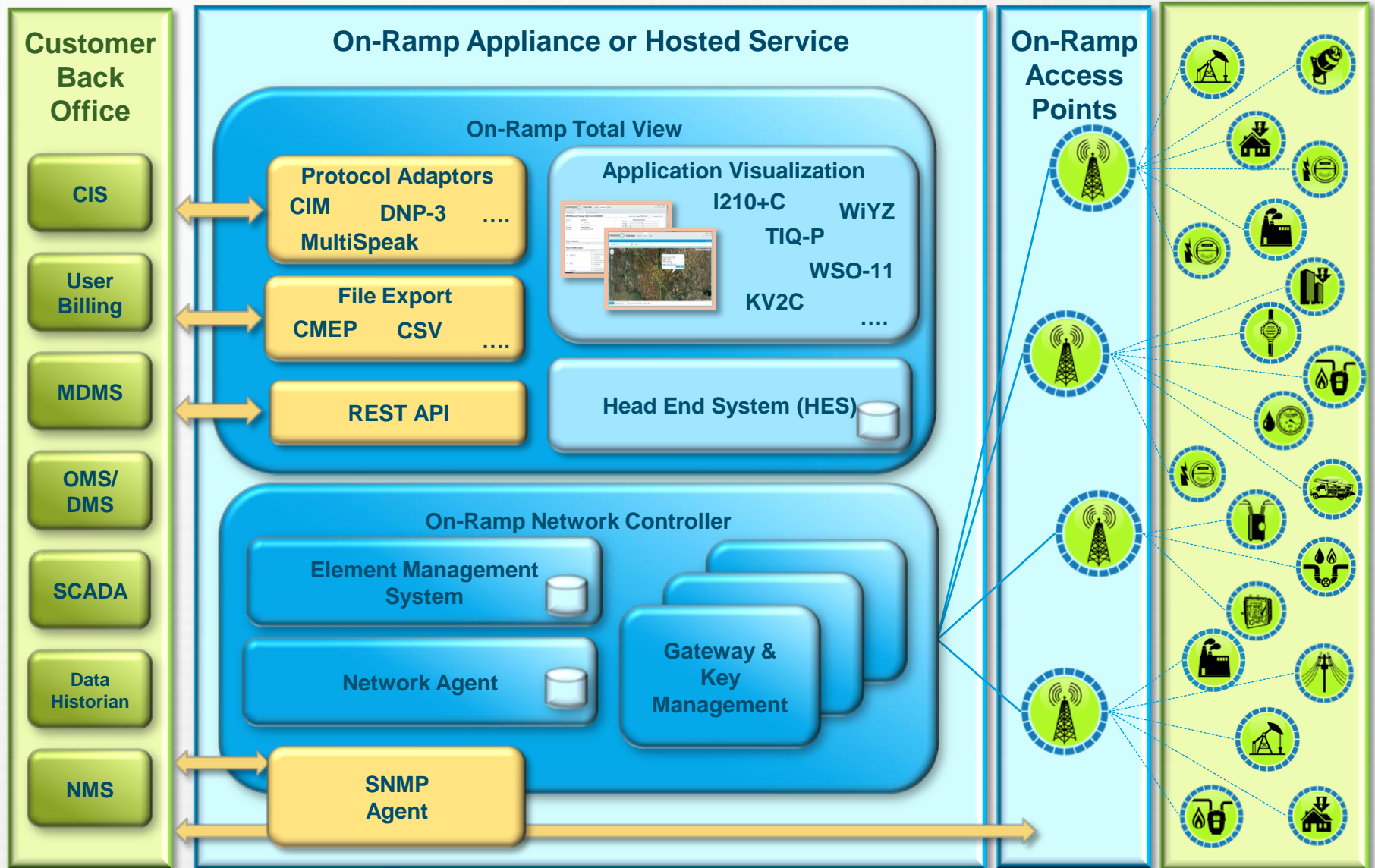
On-Ramp Solution Architecture

On-Ramp Communications System Features



# On-Ramp Solution Architecture

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# Enabling a Growing Ecosystem



## On-Ramp Meter Communications Modules

- ANSI and IEC integration-ready MCMs
- Software configurable for meter capabilities, operator requirements



## On-Ramp Reference Platform

- Fully functional sensor communication module
- Integrated microNode
- Integrated K20 Processor
- Kit includes hardware design and manufacturing plans, reference software, and development guidelines
- Endpoint certification process



## microNode

- Lower cost and improved power consumption
- Antenna diversity support
- Global availability
- ULP 90nm SoC

# Connected by On-Ramp Support Package

Item	Item Description
<b>On-Ramp Development System</b>	Development System VM including the following : <ul style="list-style-type: none"><li>• Gateway Controller &amp; Security Services</li><li>• Element Management System</li><li>• Network Agent</li><li>• Total View Application</li><li>• Interface Support</li><li>• Related documentation and development license</li></ul>
<b>On-Ramp Access Point</b>	<ul style="list-style-type: none"><li>• Standard FCC/IC or ETSI Access Point</li><li>• AP Installation &amp; Commissioning Guide</li></ul>
<b>AP Lab Mounting Kit</b>	<ul style="list-style-type: none"><li>• Indoor mounting kit w/ POE</li><li>• Indoor GPS antenna</li></ul>
<b>Reference Platform</b>	Platform Kit includes: <ul style="list-style-type: none"><li>• Hardware design collateral (schematics, gerbers, etc.)</li><li>• Software source code (host API code, host reference application)</li><li>• Development documentation:<ul style="list-style-type: none"><li>• rACM Quick Start Guide and Developer Guide</li><li>• Interface Guides</li><li>• microNode and dNode Integration Specifications</li></ul></li></ul>
<b>Development Licenses</b>	Development licenses for Development System VM and Reference Platform
<b>Engineering Support</b>	Support packages available per developer requirements



# On-Ramp Total Reach Access Point

## On-Ramp Access Point

- Provides wide area wireless coverage to sensors with On-Ramp Nodes
- Transports data from field to back office on secure IP backhaul (e.g. cellular, DSL, fiber,...)
- Each AP can support up to 64K endpoints
- Rapid and low cost deployment (50-300 sq. miles of coverage a day)
- Supports various indoor and outdoor mounting options and powered or un-powered installations
- EMC certified by FCC, IC, ETSI, and numerous regional entities
- Environmentally certified for utility and industrial applications





# Access Point with Deployment Option =Basestation

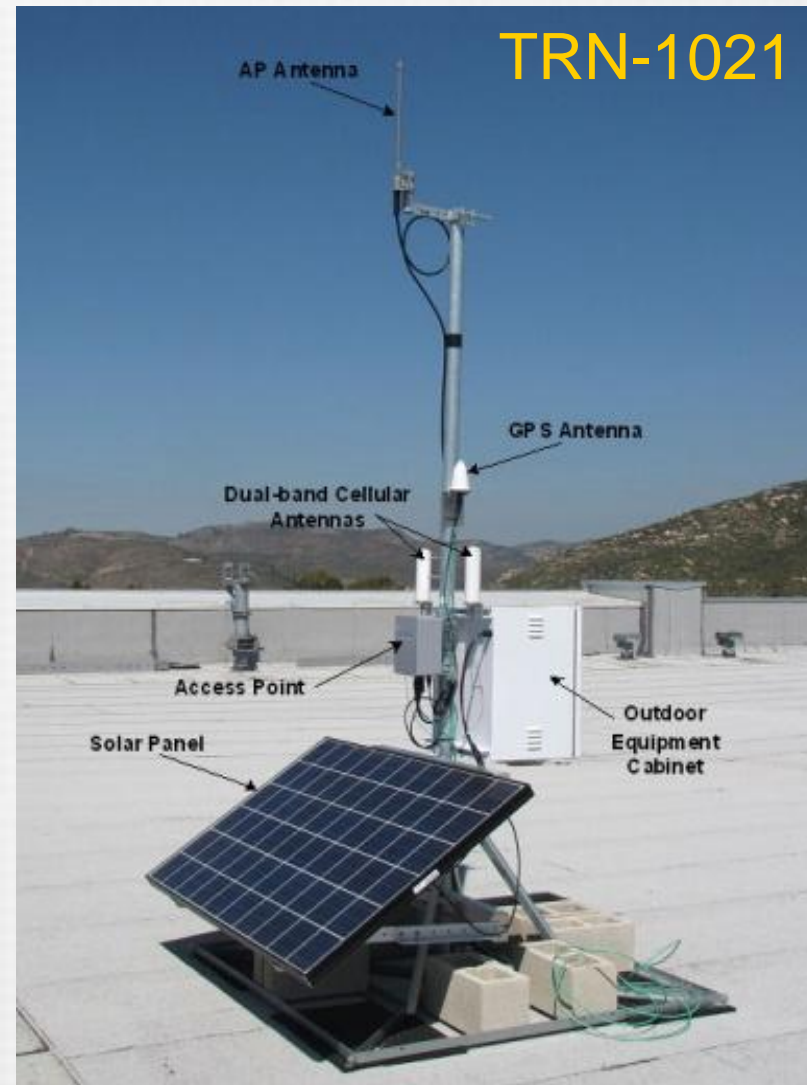
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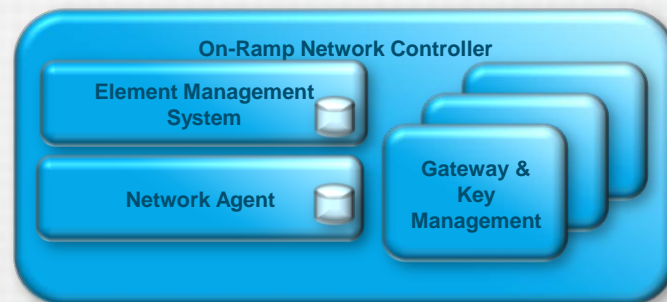


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# On-Ramp Network Control & Management

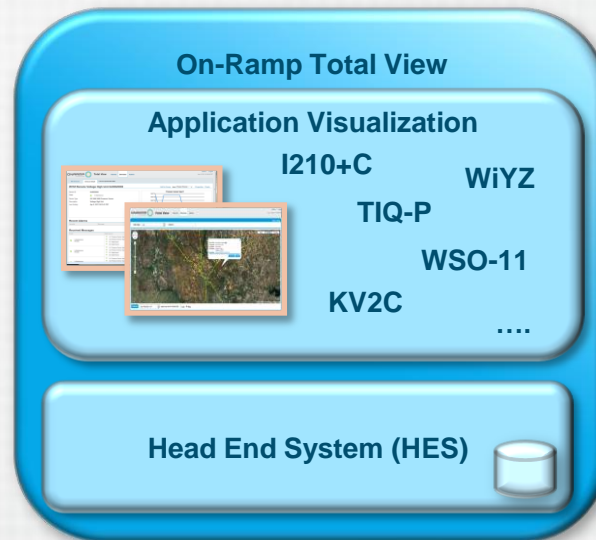
- The high capacity, high availability **Gateway (GW)** manages network security and AP connections with back office management applications.
- The **Element Management System (EMS)** manages network elements with intuitive interfaces for monitoring network performance, managing device configuration and firmware updates.
- The **Network Agent** provides network diagnostic and database services





# On-Ramp Wireless Device Management

- The **On-Ramp Total View (OTV)** application provides:
  - An intuitive interface for visualization of sensor performance, alarms, active commands, etc.; supported devices include meters, distribution automation devices, and remote I/O devices.
  - Head End Services which parses/manages sensor data and manages sensor interaction commands (e.g., device triggers, system alarms).
  - Database services responsible for managing storage of the end point application data



# On-Ramp Supported Interfaces

## ❖ Sensor Information:

### Protocol Adaptors

- Support specific protocol data interaction with SCADA, MDMS, etc., systems
- Connected by On-Ramp ecosystem partners have added protocol support

### File Export

- Export CMEP files for use in billing, meter management, or analytics applications
- Locally save an export in CSV format

### REST API

- Access uplink raw or parsed device data
- Send commands or configuration updates to one or more devices

## ❖ Network Information:

### SNMP Agent

- Access network health information
- Diagnose network issues



# On-Ramp Communication System Features

# Communication System Features

- Optimized for Remote Sensor Applications
- Designed for Robust, Reliable Communications
- Secure End-to-End
- Flexible Deployment, Upgrade and Support

# Communication System Feature Overview

- **Optimized for Remote Sensor Applications**
- Designed for Robust, Reliable Communications
- Secure End-to-End
- Flexible Deployment, Upgrade and Support

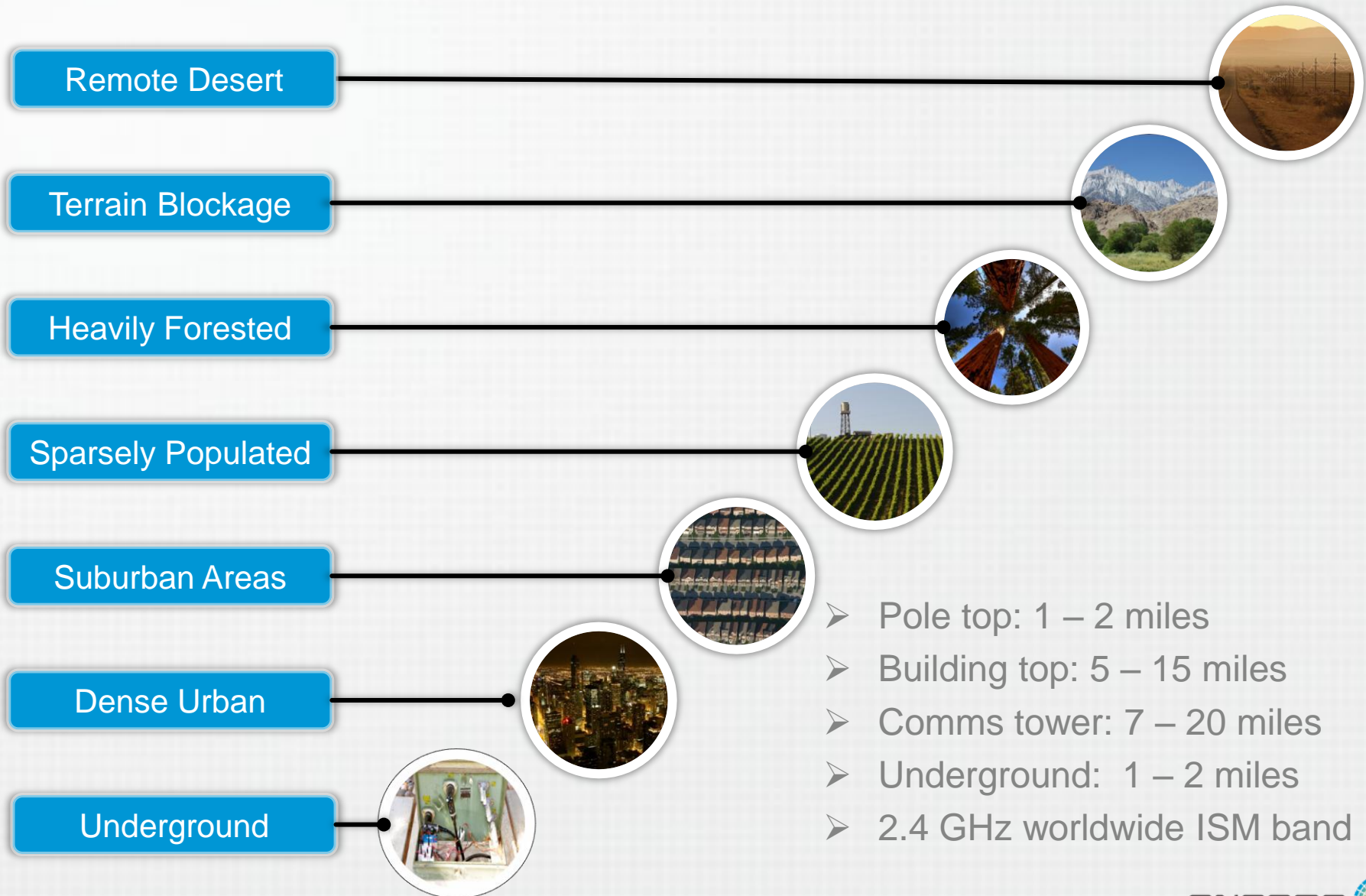


# One Network, Capacity for All Applications

## Grid IQ™ AMI P2MP Solution Applications



# Wide-Area Coverage Anywhere



# Efficient 2-Way Communications

## ○ Uplink Communications:

- Scheduled data - Node wakes up to send a message at each Update Interval (UI)
  - Continuous reporting:
    - An endpoint is configured to both transmit and receive (i.e. listen) each frame.
    - Provides the fastest response time or minimum latency for on-demand operation.
    - However, utilizes the most network capacity per end device; consequently, use should be carefully considered.
    - The 2.X release supports the concept of paging to address capacity; for lower latency on-demand operation paging should be considered.
  - Periodic reporting:
    - The endpoint Node can be in a low power “deep sleep” mode most of the time, and is awake for only short periods of time to receive and transmit data.
    - UI is set at 4.8 mins, 7.2 mins, ... 24 hrs. Note: This setting defines your listening interval and consequently your on-demand latency when using this configuration.
- Unscheduled data – Host wakes Node to send asynchronous events

## ○ Downlink Communications

- Unicast interaction with a specific meter
- Multicast to multiple endpoints or group(s)
- Broadcast to entire network
- Firmware Update – to endpoints type or entire network

# Capacity to Cover Anything

Simultaneous  
Uplink and  
Downlink!

## ○ Uplink (Node → AP)

- AP can receive **100 MBytes/day** in steady-state using RPMA
- Can service >2000 nodes simultaneously, e.g. outage flood

Application	Update Interval	Data/Day
Electric AMI Meter	15 min interval data	2.4 KB
Gas Meter	2 per day	140bytes
Fault and line sensor	1 per day	16 bytes
Smart Transformer	24 per day	2.4 KB

## ○ Downlink (AP → Node)

- Up to **72 MBytes/day** of unicast user data
- Up to **144 kBytes/day** of multicast user data
- Up to **72 kBytes/day** of broadcast user data



# Power Efficiency and Responsiveness

- Ultra low power consumption delivered:
  - Used low power network acquisition
  - Efficient sleep modes, advanced deep sleep
  - Optimized communications timing
- Getting to a 20-year battery life:
  - Minimize update frequency
  - Minimize packet size
  - Ensure solid network coverage
- Achieving required responsiveness:
  - Battery-powered devices:
    - Trade off Update Interval and Read Interval - consider having sensor read or evaluate condition more frequently (Read Interval) but transmit scheduled updates less frequently (Update Interval)
    - Change transmit frequency only when in an alarm condition, return to less frequent transmissions once alarm is cleared
  - Line-powered devices:
    - Increase responsiveness by operating in continuous mode (Uplink/Downlink every frame)
    - Minimize the time between a command (e.g., meter disconnect, on-demand read) and its completion
    - Continuous mode reporting does impact uplink capacity





# Communication System Feature Overview

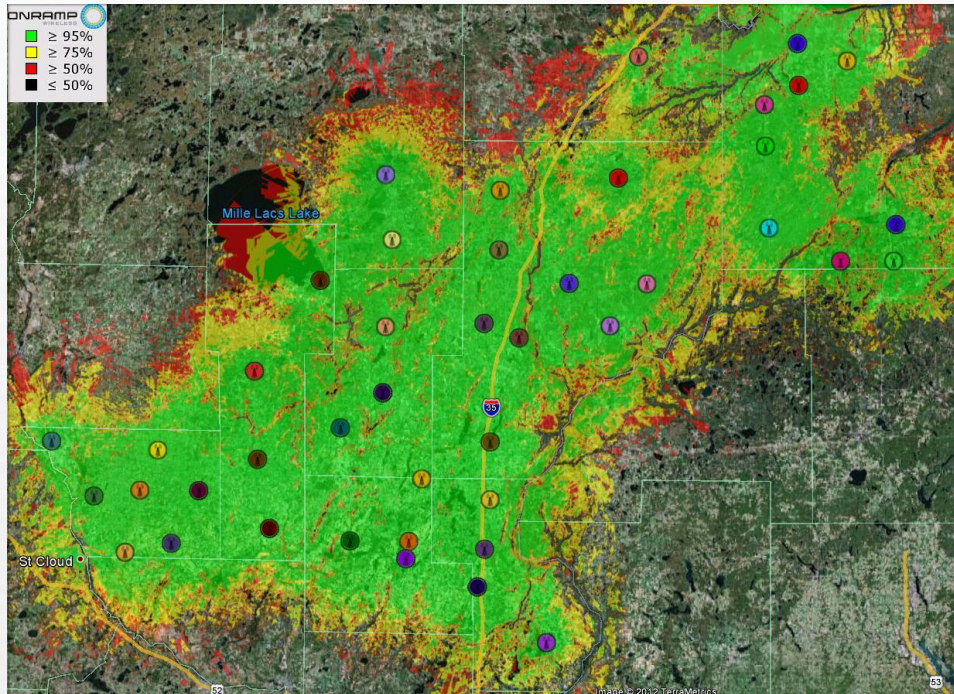
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# Reliable Data Delivery

- Delivery Acknowledgment: Uplink and downlink confirmation of receipt and re-request of missing packets
- Time Stamp Accuracy: Precise GPS time stamping of events enhances data reporting and analysis.
- Traffic Prioritization:
  - Endpoint host can specify uplink traffic prioritization:
    - An “urgent” packet will be handled as an asynchronous message
    - “Non-urgent” packet will be queued or scheduled for transmission at the next update interval
- Rapid detection of issues in critical network components and applications through redundant monitoring systems

# Accurate Propagation Planning

Maps are created that gives a very high degree of confidence of coverage



Accurate techniques model the effects of:

- Terrain
- Clutter
- Margin (for high probability of coverage)
- Interference
- Dynamic Link
- Access Point Macro-Diversity
- Endpoint Antenna Diversity

# Reliable Network Coverage & Availability

- AP Diversity:
  - Depending on data delivery requirements, APs can be deployed to provide redundant coverage
  - Even if not fully overlapping in coverage, partial redundancy can improve overall coverage for endpoints throughout the coverage area
- Antenna Diversity:
  - Two available antennas on a single endpoint, separated by a few inches significantly improves the reliability of wireless communications of a static endpoint
- Endpoint/AP Failover:
  - Endpoint devices deployed on a network dynamically adjust to network conditions
  - Endpoints continually search for optimal network connectivity and automatically reestablish connection if communications with an AP were interrupted
- Interruption Recovery:
  - In the event of lost backhaul connectivity, AP user data caching (default 1 hour) allows network entities to remain operational
  - Upon regaining connectivity, the affected network entities synchronize communications and return to normal operations
- Appliance Availability:
  - Appliance designed with redundant power supplies, SSD drives and hypervisor SD cards
  - Can be deployed in a dual server option for High Availability (HA)

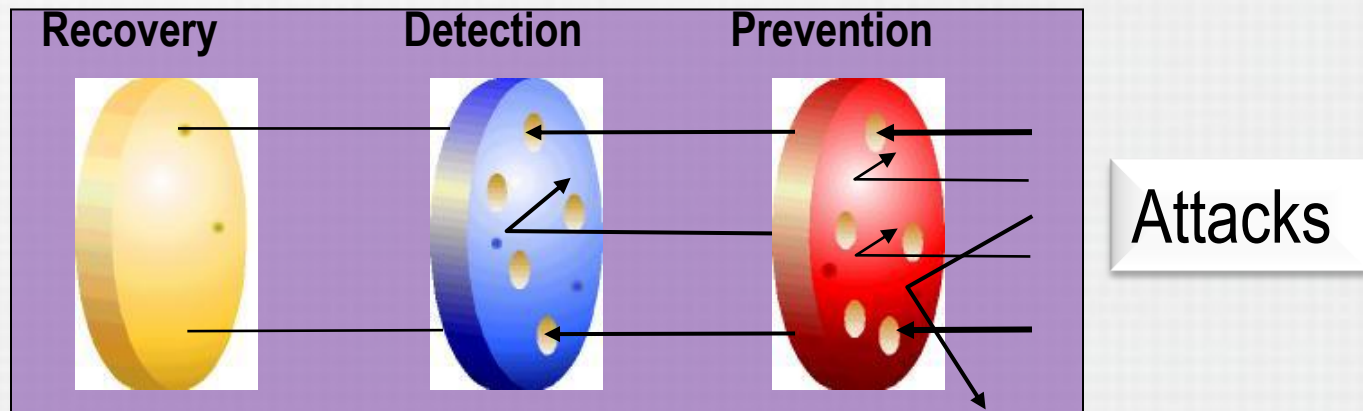
# Communication System Feature Overview

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- **Secure End-to-End**
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# ORW Security Approach

- Security by design - supports NERC CIP, NIST and FIPS guidelines for critical cyber assets
- Security mechanisms designed for a star topology network that requires bandwidth efficiency, power efficiency, and long life (10-15 years)
- Defense in depth strategy:
  - Prevention mechanisms - access control, mutual authentication, confidentiality, high availability, secure firmware updates
  - Detection mechanisms - identification and alert of attempts to break into the system
  - Recovery mechanisms - graceful degradation and/or successful operation even when under attack



# On-Ramp Security Attributes



## Mutual Entity Authentication

Meters and devices will join only a valid network and only valid meters or devices will join a network



## Message Authentication

Messages authenticated using AES-128 based CMAC  
Immune to replay attacks.



## Message Confidentiality

Messages encrypted using 3-key 3DES (192 bit key) at Communication layer and using AES-128 at the MCM layer.



## Limited Anonymity

Communication link does not disclose identity of meter.



## Secure Firmware Upgrade

Meter, MCM and Node firmware securely updated with no OTA key exchange

# Communication System Feature Overview

- Optimized for Remote Sensor Applications
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- Secure End-to-End
- **Flexible Deployment, Upgrade and Support**

# Flexible Deployment

- Flexible Deployment Options
  - Network Cloud
    - Operator owned field infrastructure
    - Fully hosted and managed network
    - Implementation services
  - Network Appliance
    - Operator owned field and back office infrastructure
    - Optional implementation, network operations, support and maintenance services
- Rapid Solution Deployment and Validation
  - Simple field infrastructure, deploy 50-300 sq. miles of coverage a day
  - With point-to-point architecture, deployment of the network is not dependent on the deployment of any given endpoint.
  - As soon as an endpoint is deployed within coverage, it is live – no need to wait on multiple endpoints to form the network.

# Flexible Upgrade & Support

- Most network upgrades supported with minimal to no service interruption
- The EMS operator console is used to
  - Manage additions, updates, and removals of APs
  - Addition, upgrade, and removal of and endpoint Nodes
  - Report and assist with diagnosis of alarm conditions
  - Perform ongoing network performance monitoring
- Over-the-air firmware updates efficiently delivered to sensor devices, MCMs, and On-Ramp Nodes:
  - 50 Kbytes per day
  - 5-10 days to upgrade 99% of 1 million end nodes in our network (could be 6 months to achieve the same with mesh networks)
- On-Ramp will support Appliance software and environment updates and upgrades



# Module 2 Quiz

- What types of Nodes are available for an endpoint integration?
- What are the required field infrastructure components of an On-Ramp network?
- What is the function of the On-Ramp Gateway?
- What is the difference between what you can manage/monitor with EMS vs. OTV?
- What is the best way to get the data out of the On-Ramp system and used by other systems?
- What is the on demand latency for a battery powered application with a UI of 1 hour?
- What components can be upgraded once deployed?