



# RPMA 101 Module 4: Deploying the Network

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# Module 4 - Outline

- Network Deployment Roles
- Network Planning and Design
- Back Office Network Deployment
- Base Station Deployment
- Endpoint Deployment
- Network Verification and Testing Activities

# Network Deployment Roles Summary

- **Network Specialist**
  - Monitors Access Point commissioning progress and initial network health
  - Monitors Endpoint installation progress and health
- **Access Point Network Installer**
  - Physically installs Base Stations in the field
  - Could be customer internal resources or outside contractors
- **Network Operator**
  - Works with endpoint manufacturers to acquire and input endpoint keys into EMS
- **Back office IT Administrator**
  - Appliance installation
- **Applications Specialist**
  - Monitors initial application data and performance
  - Engages with application manufacturer on installation procedures
- **Applications Operator**
  - Works with installers to input meta data of newly installed endpoints

# Network Planning and Design

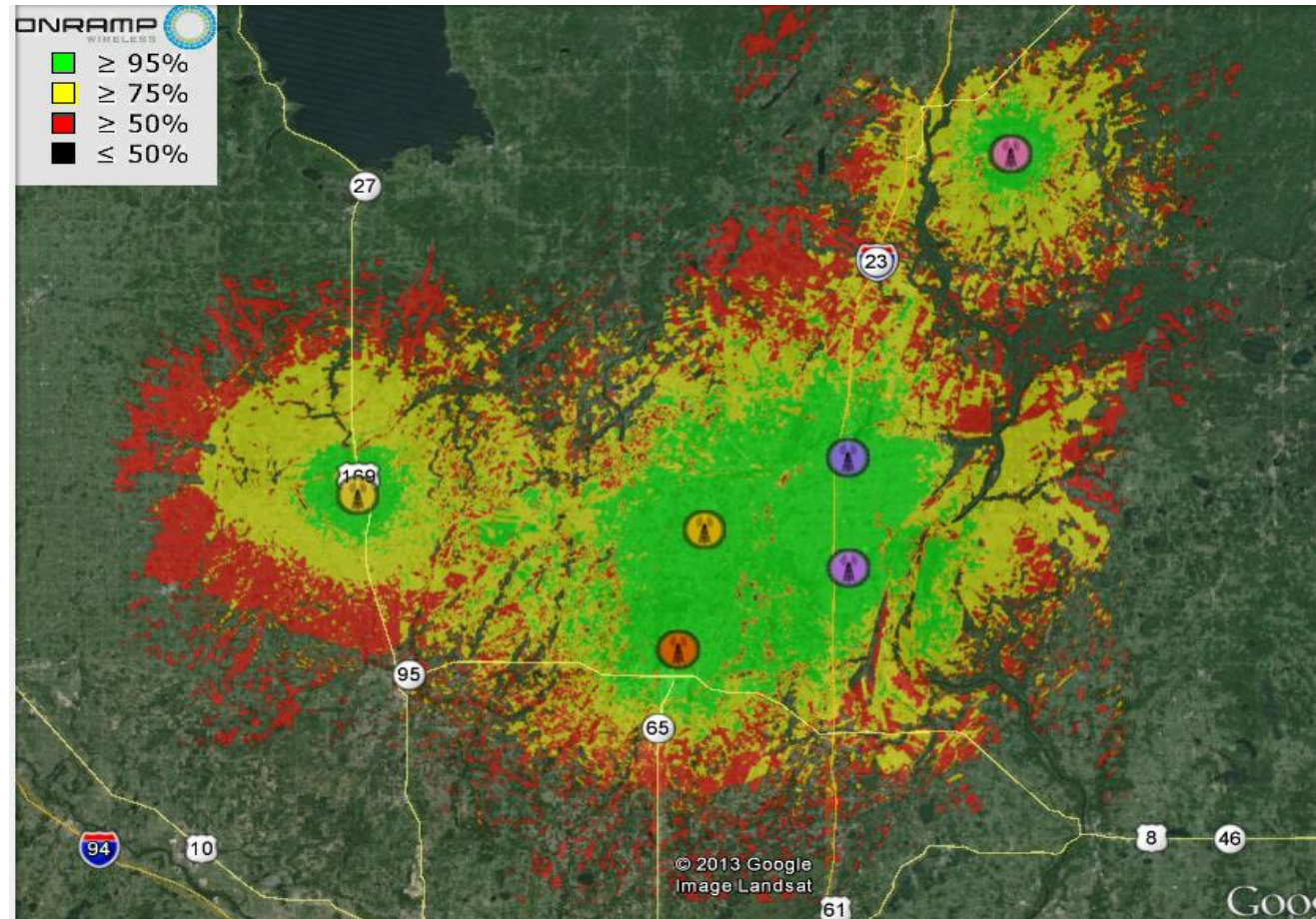
# RF Network Planning Process - Inputs

- Determine network coverage requirements
  - Area to be covered, map with polygon marked if available
  - Endpoint locations and priorities if available
  - Endpoint characteristics
    - Diversity or non-diversity
    - Endpoint height
    - Antenna loss versus ideal
- Identify potential Base Station locations in the desired coverage area
  - Company or partner sites with towers or significant elevation above the average terrain including rooftops, water tanks and distribution poles
  - Tower company sites, such as American Tower or Crown Castle
  - Other sites with towers or significant elevation above the average terrain
  - Longitude and latitude of candidate Base Station sites
  - Estimated antenna height above ground for each candidate
  - Identify any sites where the AP antenna will be below the clutter
  - Identify any sites where 2.4 GHz Wi-Fi is being used

# RF Network Planning Process - Activities

- Network Planning runs predictions for each site using the EDX propagation tool and On-Ramp prediction tools that consider:
  - Terrain
  - Clutter
  - Margin
  - Interference
  - Dynamic Link Conditions
  - Access Point Macro-Diversity
  - Node-side Antenna Diversity
- Rank candidate sites based on the predicted coverage
- Provide a Google Earth KMZ map showing the predicted coverage probability for region in three colors:
  - Green = at least 95%
  - Yellow = at least 75%
  - Red = at least 50%
- Color coded percentage represents the probability of an installed endpoint has at least 95% reliability (QoS)

# Example: 6 AP ECE Pilot



# RF Network Planning Process - Design

- Best candidates visited during a “Site Walk” to gather site specifics:
  - Antenna height and location on the tower
  - Anticipated antenna cable length
  - Observed clutter (foliage, buildings)
  - Availability of suitable backhaul
    - Corporate WAN connection
    - 3G cellular modem
    - Dedicated radio or microwave link
    - Satellite link
  - Site Survey spreadsheet completed with photos
  - Confirm availability of the site
- Network plans are updated and reviewed with customer; some iterations to address site issues and optimize customer needs if required
- Once optimum site candidates have been selected and the plan is approved, next steps:
  - Complete a preliminary design for each site, including Base Station type and location
  - Order Base Station equipment
  - Initiate Base Station installation process
    - Develop scope of work document
    - Contractor selection and bidding



# RF Network Planning – Site Selection Summary

- Site coverage objectives
- Antenna height above surrounding terrain - Higher is better!
- Availability of power
- Site access considerations
- Available backhaul solutions
- Equipment location, indoor or outdoor
- Site security
- Site installation and recurring costs

# Back Office Overview

# Back Office Network Options

- Ingenu Network Cloud
  - Back office hosted and managed at the San Diego Data Center
  - Authenticated customer access to On-Ramp Total View (OTV) Data visualization tool
- Ingenu Network Appliance
  - Appliance installed in Customer Network (redundant hardware option available)
  - Load Balancing for additional redundancy
  - VPN support required for hands-on On-Ramp Network Operations management

# Network Cloud Features

- Redundant 2N power from two power grids
- Redundant internet connectivity from multiple Tier 1 service providers
- Physical and data security
- Virtualized back office services
- Managed hardware and software
- Real-Time hardware, network, and software monitoring
- Reduced network build time
- Local data recovery RAID 10
- Optional off-site data backup

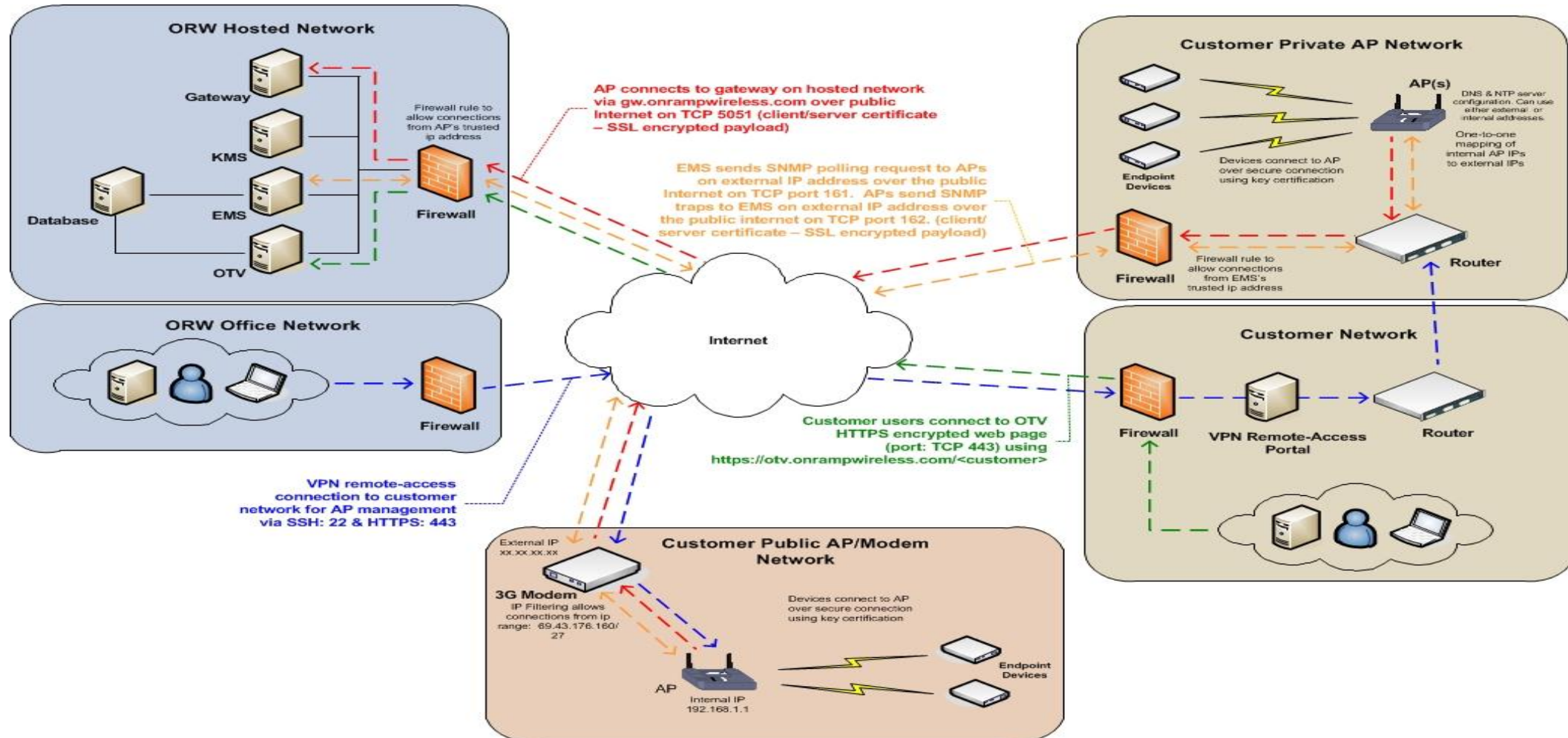
# Network Appliance Features

- Appliance Features
  - All On-Ramp Wireless back office software on a single server
  - Local data recovery via RAID 10
  - Redundant power supplies
  - Redundant SSD drives
  - Redundant Hypervisor SD cards
  - Real-Time hardware, network, and software monitoring
  - Dual server option for High Availability (HA)
  - Using Load Balancing for redundancy
  - VPN option for On-Ramp management
- Appliance Planning
  - 1-2 OTV servers need to be ordered and built (6 week lead time)
  - IP Range provided by Customer
  - VPN setup by Customer

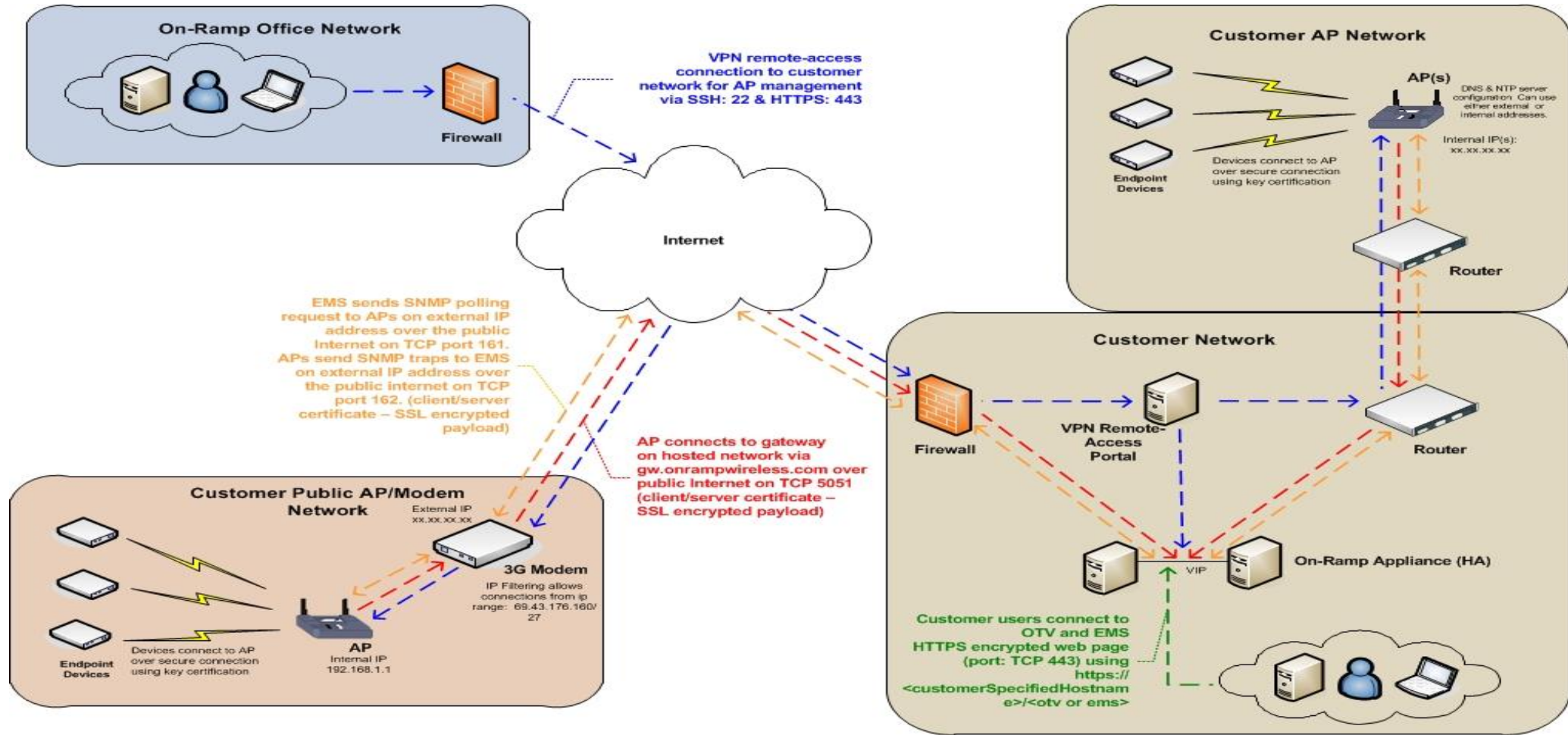
# IT Network – Appliance Applications

- Preinstalled Applications
  - On-Ramp Gateway
  - On-Ramp Key Management System
  - On-Ramp Total View
  - On-Ramp Element Management System
  - HA Proxy load balancer
  - VMware ESXi
  - MySQL database
  - Nagios infrastructure monitoring tool
  - Cacti network monitoring and graphing tool

# Ingenu Hosted Network Architecture



# Appliance Network Architecture





# IT Back Office Network References

- Reference Documents
  - 010-0039-00 On-Ramp Wireless Appliance Data Sheet
  - 010-0109-00 On-Ramp Wireless Appliance Installation Guide (2.1)
  - 010-0107-00 EMS Operator Guide (2.1)



# Base Station Deployment Overview

# Core Infrastructure – Access Point

- Fundamental RPMA component for infrastructure sites
- Typically deployed either indoor (comm shack) or outdoor cabinet (“base station” config)
- Connections:
  - RJ-45 POE
    - 48V power
    - Ethernet connection to backhaul
  - Type N RF: 2.4GHz Antenna
  - Type N RF: GPS Antenna (3.3V supply for LNA)
- Size: 9”x8”x4”
- Power Consumption: 15W



# Base Station Overview

- Physical deployment configuration of RPMA infrastructure consisting of multiple indoor and outdoor versions.
- Consists of following components and subsystems:
  - Core RPMA Access Point
    - GPS Antenna
  - Power Subsystem
    - AC
    - Solar
    - Optional battery backup
    - POE
    - Grounding, surge, and lightning protection
  - Back-haul Subsystem
    - Provisions for back-haul modem
    - Antenna options
    - Ethernet switch
  - Monitoring and Security Subsystem
    - Internal watchdog
    - Intrusion detection



# Base Station Installation Considerations

- Base station location
  - Indoor or Outdoor?
  - Does a suitable equipment room exist?
  - How long are the AP and GPS antenna cable runs?
  - Where is power available?
  - Physical security
  - Customer specific requirements (e.g. grounding)
- Base station power considerations
  - Does customer require battery back-up?
  - 120/240 VAC
    - Without UPS
    - With UPS, size dependent on the number of hours required
    - 120 VAC outdoor base station with 8 hours of battery backup is available
  - 48 VDC
    - 48 VDC systems typically include battery backup
    - May be available in customer's equipment room
    - Frequently used with indoor rack mount base stations
  - Outdoor solar powered base station is available

# RPMA Access Point Deployment Types

- Communications/Cell Tower
  - Indoor rack-mount AP with remote RF antenna and GPS.
  - Outdoor cabinet as base of tower. Cabinet integrates power subsystem including optional battery backup, backhaul solution (typically cellular), optional watchdog.
  - RF antenna configurations include single omni or sectorized.
  - Multiple AP configurations in shared outdoor cabinet are also available for high-capacity sites.
- Utility Pole/Structure
  - Outdoor cabinet as described above; solar powered configuration available. RF Antenna remotely elevated;.
  - Outdoor “Compact Base Station”; RPMA AP, Cellular Backhaul, and antennas integrated into compact chassis.
  - Outdoor “RPMA Extender”; RPMA back-hauled single-hop network extender
- Building Rooftop, Water Tower, or Other Similar Structure
  - Typically similar to utility pole; antennas either integrated into cabinet or remotely pole mounted.

# Base Stations

- On-Ramp offers four base station kits:
  - TRN-1011 Outdoor Base Station – 120/240 VAC powered
  - TRN-1021 Outdoor Base Station – solar powered
  - TRN-1031 Rack Mount Base Station – 19” shelf with indoor AP
  - TRN-1032 Rack Mount Base Station – 19” shelf with outdoor AP
  - RPMA Compact Basestation
  - RPMA Extender
- All On-Ramp base stations utilize the TRN-1000 Access Point (AP)
- Base Station kits include GPS and AP antennas
- The outdoor base stations support customer provided 3G cellular modems (Digi DC-WAN-U805)

# TRN-1011 Outdoor Base Station (120/240 VAC)

- Applications
  - 3<sup>rd</sup> party communication sites
  - Customer sites without equipment shelters
  - Electric utility distribution poles with available 120 VAC power
- Secure, outdoor, NEMA 4, single cabinet solution
- 34"Hx24"Wx10"D cabinet mounts to H frame or wall
- Provides integral cellular and GPS antennas
- Provides a minimum of 8 hours of battery backup
- Ready for installation of customer provided 3G cellular modem for backhaul
- Provides remote monitoring and alarming of power system and environmental conditions over the backhaul
- Preassemble and tested system for easy installation by contractor
- Required connections: AC power, AP antenna line and ground wire
- Additional Documentation:
  - 010-0036-00 TRN-1011 Base Station Installation Guide
  - 010-0021-00 AP Deployment Guide 2.1





# TRN-1021 Outdoor Base Station (Solar Powered)

- Applications
  - Remote sites without commercial power
  - Electric utility transmission towers and poles
- Designed to support southwest solar zones 1 and 2
- Capable of providing seven days of normal AP operation without any sunlight
- Includes outdoor, NEMA 3, equipment cabinet 23.5"H x 19"W x 18"D
- Provides integral cellular modem antennas for backhaul
- Mounts on a 3-1/2" pipe (4" OD), other sizes may be accommodated
- Due to weight and wind considerations not suitable for most rooftop applications
- Ready for installation of customer provided 3G cellular modem for backhaul
- Remote power system diagnostics capability
- Additional Documentation:
  - 010-0034-00 TRN-1021 Base Station Installation Guide
  - 010-0021-00 AP Deployment Guide 2.1



# TRN-1031 and TRN-1032 Rack Mount Base Station Kits

- Applications
  - Customer owned communications sites with an equipment room or shelter
  - 3<sup>rd</sup> party communications sites with an equipment room or shelter
- Comprised of the following items:
  - TRN-1000 Access Point
  - 3RU, 5-1/2" high, 19" aluminum shelf with;
    - PoE injector
    - 120/240 VAC 48VDC power supply, or
    - 48 VDC power terminal strip
    - 12" Cat 5E Ethernet cable
  - RF surge suppressor
  - 40 dBi gain GPS antenna
  - 9 dBi omni directional antenna
- Additional Documentation:
  - 010-0040-00 TRN-1031 and TRN-1032 Base Station Installation Guide
  - 010-0021-00 AP Deployment Guide 2.1



# RPMA Compact Base Station

- AP
- 3G modem and Antennas
- Backup Battery Subsystem
- GPS Antenna
- External connections to:
  - 2.4GHz Antenna
  - 120VAC



# Base Station Deployment Planning Activities

1. Determine Base Station model required at each site based on the information collected during the Site Walks
2. Plan the physical Base Station deployment at each site with detailed scope of work documents and drawings if required
3. Network Planning will provide Channel and Reuse Code assignments for each site
4. Plan the backhaul configuration for each site
5. Configure the AP network parameters and setup backhaul solution
6. Add the AP to the EMS system on the network back office

Planning worksheets and templates are provided to aid in the data gathering and planning

# Base Station Physical Installation Activities

1. Install the antenna system with industry accepted practices
2. Install the GPS antenna
3. Mount the base station
4. Connect the antenna to the base station
5. Connect the GPS antenna to the base station
6. Connect a suitable ground wire to the base station
7. Connect power to the base station
8. Verify that the green Status LED on the AP is solid or flashing
9. Verify remote connectivity to the base station
  - If using an outdoor base station with a 3G modem, remotely ping the 3G modem's public IP address
  - If the AP has been assigned an AP address on an IP network, verify that address is reachable

# Base Station Go Live Activities

- Contact Network Operations\* and request the new base station be commissioned
- Network Operations will:
  - Verify the backhaul is operational and the AP is reachable
  - Commission the new base station by configuring the AP in the Gateway and setting the AP's parameters
  - Verify the AP's GPS receiver is seeing the satellites
  - Put the base station "on-line", this could take 15 minutes or more for a new base station
  - Advise when the AP's state has changed to "on-line"
  - Run the "AP Site Survey" utility, this utility will measure average and peak noise on all 38 TRN channels
  - Work with the field team to verify that a nearby node (endpoint) can successfully "join" the new base station

\* Network Operations refers to either On-Ramp Network Operations or Customer Network Operations for non-managed appliance environment

# AP Info Screen in 2.1 EMS

## Network Status Details [Edit Network Configuration](#)

Config State	Enabled
AP Reported State	
Broadcast Service Domain	EOTA
Network State	Registered
Backhaul State	Connected
RF Status	Online
GPS State	Online
Last Connection Time	Aug 14, 2013 16:54:11 +0000
Last Connection Gateway	079dc877-2947-4fcf-a556-725f24e40af8
Last Connection Result	
Last Connection Address	
Last Disconnection Time	
Last Disconnection Gateway	
Last Disconnection Reason	

# Base Station Deployment References

- Reference Documents
  - 010-0021-00 AP Deployment Guide (2.1)
  - 010-0032-00 Backhaul Selection and Configuration Manual
  - 010-0036-00 TRN-1011 Base Station Installation Guide
  - 010-0034-00 TRN-1021 Base Station Installation Guide
  - 010-0040-00 TRN-1031 and TRN-1032 Base Station Installation Guide





# Endpoint Deployment

# Endpoint Deployment Summary

- Each type of endpoint will have specific installation instructions provided by the device's manufacture
- “Connected by On-Ramp” endpoints are securely provisioned for each network
- Deploying an endpoint on an On-Ramp network involves the following steps:
  - Provisioning of security keys and network channel assignments on the endpoint by the manufacturer prior to shipping
  - Installing the endpoint within Access Point coverage
  - Monitoring the network join status of the endpoint via the On-Ramp Total View application or EMS
  - Many endpoints also provide visual network status feedback to endpoint installer

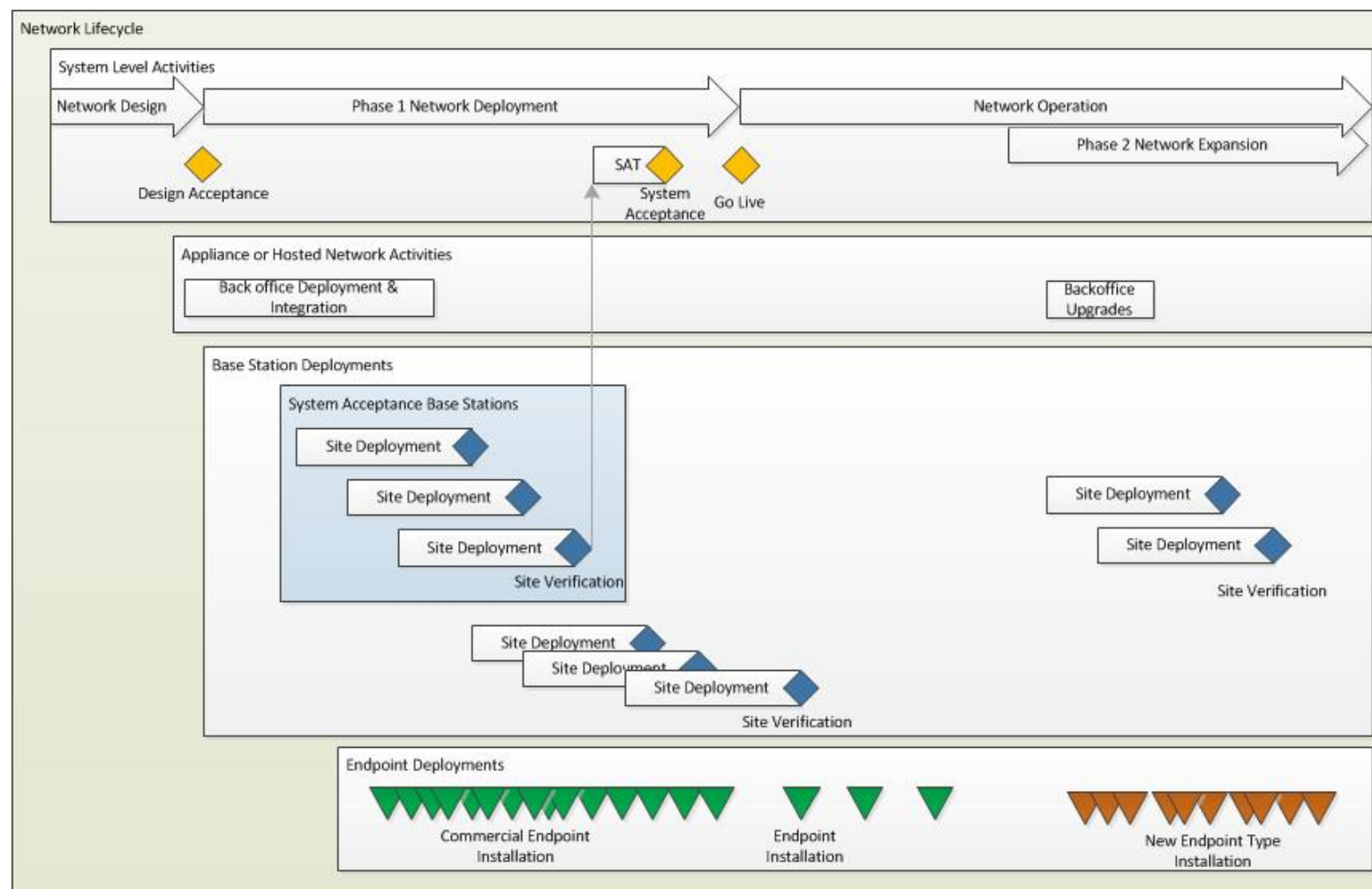
# Endpoint Status Indicator Examples

- SEL WSO-11
  - Mechanical red/white target flag indicating network join and device arm state
- GE WiYZ
  - Front panel LEDs indicating network scanning, tracking, join status
  - LED's turn off after 30 minutes
- Gridsense TIQ
  - Detachable LED dongle to indicate network join status
- GE Meters
  - Front Panel LCD screen indicating network status and signal strength



# Acceptance Testing and Network Verification

# Network Lifecycle Overview



# Field Testing and Network Verification

- Contractual activity with deliverable test plan and results
- Test plan scope proposed by On-Ramp and negotiated with customer
- Test plan timing and schedule to be planned with customer. Test plan execution may be used to signal end of program phases
- Testing typically conducted jointly between On-Ramp and Customer (and in some case endpoint partners). On-Ramp personnel on-site requirements to be negotiated
- Test results archived and officially signed-off by On-Ramp and customer
- References:  
014-0070-00 On-Ramp System Acceptance Test Specification

# Site Verification

- Conducted after each Base Station has been installed and brought online
- Performed before installation team leaves the Base Station site
- Test cases executed jointly with customer, results signed off and archived
- Test Cases may include
  - Verify Base Station Physical Site Installation
  - Verify AP RF Parameter Configuration
  - Verify AP Network Parameter Configuration
  - Verify AP Online Status through EMS
  - Verify Base Station Physical Site Security

# System Acceptance Testing

- Conducted after back office network has been setup
- Planned number of Base Stations and endpoints have been installed on the network
- Test cases executed jointly with customer, results signed off and archived with As-Built documentation
- Test cases
  - Verify Basic Tools and Login Capabilities
  - Verify End-to-End AP Network Management
  - Verify End-to-End Device Management
  - Verify End-to-End Back office Management



# Document Reference Summary

- Back office Network Documents
  - 010-0039-00 On-Ramp Wireless Appliance Data Sheet
  - 010-0109-00 On-Ramp Wireless Appliance Installation Guide (2.1)
  - 010-0107-00 EMS Operator Guide (2.1)
- Network Deployment Documents
  - 010-0021-00 AP Deployment Guide (2.1)
  - 010-0032-00 Backhaul Selection and Configuration Manual
  - 010-0034-00 TRN-1021 Base Station Installation Guide
  - 010-0040-00 TRN-1031 and TRN-1032 Base Station Installation Guide
  - 010-0036-00 TRN-1011 Base Station Installation Guide
- System Testing Documents
  - 014-0070-00 On-Ramp System Acceptance Test Specification