Cisco Outdoor Wireless Network Serves Up Automatic Meter Reading

Summary

Cisco® outdoor wireless solutions make it practical to deploy and manage Wi-Fi on a citywide scale. This application note describes how a systems integrator utilizes the Cisco Aironet® 1500 Series to build a fixed data network that enables automated meter reading and other network applications for the local electric utility. The network supports standard Wi-Fi client access, which enables the systems integrator to deliver services to the city government as well.

Business Model

To illustrate this application, we will describe MeterPro, a fictional systems integrator that sells products and services to water, gas, and electric utilities. MeterPro specializes in automated meter reading (AMR). They develop intelligent gas, water, and power meters that can communicate with the utility company over wired or wireless networks. Early versions of the MeterPro system used proprietary wireless technology. Now that Wi-Fi networks can cost-effectively operate on a citywide scale, MeterPro is switching to standard Wi-Fi infrastructure for their fixed data networks. The applications and network architecture remain the same, but MeterPro now uses Cisco Aironet 1500 Series outdoor wireless mesh products as the core wireless network infrastructure. Switching to a standards-based wireless network reduces the cost of the communications module in each meter and opens up the possibility of supporting additional applications on the citywide wireless network.

MeterPro runs the wireless network as an application service provider for the utility company. MeterPro owns and operates the wireless network. The electric company owns the endpoints. MetroPro sells communications modules that can be used to upgrade existing electric meters and complete intelligent electric meters with an embedded Wi-Fi communications module. MeterPro delivers the meter data for each meter across the entire city directly to the data center in the utility company.

Automated meter reading brings many benefits that justify the expense of upgrading the meters at each customer location, as well as the ongoing cost of operating the wireless network.

The benefits of AMR include:

- **Lower cost to read the meters**—Using the MeterPro wireless system, the power company can read all of the meters in a community every day, or more frequently as appropriate. It is not necessary to send a service person to visit every customer location once a month.
- **More accurate and complete reads**—The power company will no longer need to estimate usage when meters are not physically accessible to their service people. They can get real-time usage data from any of the meters in the system instantly. Meters are always accessible.
- **Possibility of two-way communication with each meter**—With intelligent power meters and two way communications, the power company can manage their peak loads better and offer incentives for customers to shift their power usage to off-peak times.

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- **Theft of service detection and prevention**—Meter tampering is detected instantly through the wireless network, making it much more difficult for someone to steal the service.

These benefits alone justify the cost of the power company upgrading all the meters, building the network, and paying MeterPro to operate and maintain the network on an ongoing basis. MeterPro creates additional value through the network by extending the power company's corporate network throughout the city over the wireless network. MeterPro delivers a separate virtual private network (VPN) that the power company uses to support their business operations from anywhere in the town.

Each service technician from the power company is equipped with a tablet computer that has built-in Wi-Fi. They can connect to the MeterPro wireless network from anywhere in the town. They use a VPN to establish a secure connection to the utility company network and access the resources available there. The utility company uses this capability to run their service and repair dispatch application, which allows them to provide better customer service. Through the wireless network, repair technicians in the field have real-time access to the entire map system and building database while they are responding to power-related emergencies.

Wireless Infrastructure

The MeterPro wireless network is a Cisco Unified Wireless Network. It is a private, enterprise network that includes a Cisco 4400 Series Wireless LAN Controller, outdoor access points, and outdoor wireless bridges.

The wireless coverage throughout town is provided by Cisco Aironet 1500 Series Outdoor Mesh Access Points. The Cisco Aironet 1500 Series combines a large-coverage Wi-Fi access point in a rugged outdoor enclosure with a wireless mesh capability. Cisco Aironet 1500 Series Access Points typically include two radio modules: a 2.4-GHz radio providing wireless access for standard Wi-Fi clients, and a 5- GHz radio that is used for the wireless backhaul function. It is also possible to configure a Cisco Aironet 1500 Series Access Point with a single 2.4-GHz radio that supports both client access and backhaul. Single-radio MAPs are used at the edge of a network, where the bandwidth requirements are low.

Two-Level Wireless Infrastructure

MeterPro deployed dual-band Cisco Aironet 1500 Series Mesh Access Points throughout the network. They can be configured as either root access points (RAPs) or mesh access points (MAPs). Root access points are usually connected directly to the wired network and act as a gateway for clusters of up to 32 MAPs. Each MAP provides a large coverage area in the 2.4-GHz band for IEEE 802.11b/g Wi-Fi clients and connects to its neighboring MAPs or RAPs primarily through wireless links in the 5-GHz band. The Cisco Aironet 1500 Series supports Cisco's Adaptive Wireless Path Protocol (AWPP), a wireless mesh protocol that automatically creates a secure and reliable wireless mesh that interconnects all of the MAPs and RAPs, and connects them to the Cisco WLAN controller on the MeterPro's wired network. As Figure 1 shows, RAPs are typically mounted higher than MAPs, creating two levels of wireless infrastructure, with MAPs mounted on power poles or streetlights and RAPs mounted higher on buildings or towers.. The benefits of the wireless mesh apply through both levels of the infrastructure.

Figure 1. Two-level Wireless Infrastructure: Rooftop, Power Poles, and Street Lights

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The wireless network had to cover all the populated areas of the city in order to support the meter reading application for the power company and reach every customer. MeterPro designed a network that required hundreds of mesh access points to be mounted throughout the city. MeterPro used a mix of power poles (controlled by the power company) and city streetlights as mounting locations for the MAPs. They needed 12 RAPs for the network design and were able to mount them on the roofs of larger buildings, including the power company office building, city hall, and the city library. Wired network connections were not available at all of the buildings where the RAPs are mounted. For those RAPs, MeterPro installed dedicated wireless links to the MeterPro network using Cisco Aironet 1400 Series Wireless Bridges. Cisco Aironet 1400 Series Outdoor Wireless Bridges deliver unlicensed point-to-point or point-to-multipoint wireless backhaul links in the 5.8-GHz band, with data rates up to 54 Mbps. The Cisco Aironet 1400 Series Wireless Bridge creates a transparent bridge between the remote RAP and the MeterPro wired network.

Simplified Installation

MeterPro quickly deployed the system by using teams from the utility company to help install the wireless network. The utility company owns bucket trucks. Their service and repair technicians are qualified to mount equipment on the power poles and streetlights, but they have no networking or RF expertise. Cisco's zero-touch configuration for lightweight access points using Cisco WLAN controllers and the AWPP mesh protocol make it possible for utility company crews to mount most of the Cisco Aironet 1500 Series Access Points throughout the city, dramatically reducing deployment costs for MeterPro.

MeterPro network engineers and RF engineers designed the wireless network layout and determined the best placement of mesh access points after doing an extensive survey. Utility company crews mount the Cisco Aironet1500 Series Access Points at the designated locations and apply power. No other local configuration is required. RF engineers are not needed to mount each MAP. The Cisco Aironet 1500 Series Outdoor Wireless Mesh Access Points have omnidirectional antennas, eliminating the need for antenna pointing at installation time. Once a Cisco Aironet 1500 Series Mesh Access Point is mounted and powered on, the wireless mesh is automatically formed. Each node will discover its neighbor mesh nodes, authenticate itself to the network, find the best path back to a RAP, and ultimately connect to the WLAN controller.

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Once the mesh is formed, the Cisco WLAN Controller communicates with all of the mesh access points using the Lightweight Access Point Protocol (LWAPP). Complete configuration including Service Set Identifiers (SSIDs), channel assignment, power levels, virtual LANs (VLANs), and security policies, is pushed out to each mesh access point from the central WLAN controller.

The entire wireless network is managed by a single unified management system that seamlessly integrates with wired networks. MeterPro uses Cisco's industry leading Cisco Wireless Control System (WCS), which allows a MeterPro system administrator to view a map of the entire system or monitor the status of individual wireless mesh links between Cisco Aironet1500 Series Access Points from their headquarters. Cisco WCS enables centralized network management from a single console at MeterPro offices and includes features such as RF management, policy provisioning, network optimization, troubleshooting, user tracking, security monitoring, and wireless LAN intrusion detection and prevention.

Each SSID is the name of a wireless LAN. Systems that support multiple SSIDs have the capability of supporting multiple logical wireless LANs, with different security profiles on the same physical infrastructure. Traffic can be further partitioned into separate virtual LANS (VLANs) within each SSID. All of the Cisco access points support multiple SSIDs, and the entire Cisco infrastructure supports VLANs and VLAN routing. MeterPro utilizes these capabilities to deliver two very different applications to the utility company. The automated meter reading application appears to the utility company to be running on a custom private network. The service and repair network is a transparent extension of the MeterPro corporate network. They are completely distinct applications with different security and performance requirements, yet they share a common physical infrastructure.

Conclusion

MeterPro created a secure, citywide private wireless network that supports multiple applications for their customers. The MeterPro network is a unique citywide wireless network in many respects. It does not broadcast any SSIDs and is therefore invisible to the casual observer with a Wi-Fi client. The network does not support public Internet access. It is a private and secure network that is operated as an enterprise network. Every node in the wireless mesh network infrastructure is authenticated to the network before it is allowed to participate in the mesh. All wireless traffic is encrypted on each wireless hop through the system. The network supports Wi-Fi Protected Access 2 (WPA2), and all devices accessing the system are authenticated using 802.1X.

The MeterPro wireless network covers the entire city and delivers enough capacity to support multiple service offerings on the same infrastructure. The initial driver for the network was the utility company's automated meter reading application. Once the AMR application was running smoothly, MeterPro added other revenue-generating applications. Each of these applications runs on a separate VLAN that delivers different levels of performance and quality of service and different security policies.

The Cisco Aironet 1500 Series Access Points and Cisco 4400 Series Wireless LAN Controller make it practical to deploy and manage a Wi-Fi infrastructure on a citywide scale. Cisco's zero-touch configuration simplified installation of the system and reduced the cost of deployment dramatically.

MeterPro uses the following Cisco products as part of their network:

- Cisco 4400 Series Wireless LAN Controller

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- Cisco Aironet 1500 Series Wireless Mesh Access Points
- Cisco Aironet 1400 Series Outdoor Wireless Bridges
- Cisco WCS
- Cisco 3200 Series Mobile Router

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Printed in USA

C27-378715-00 11/06

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