

## Cisco Outdoor Wireless Mesh Enables Alternative Broadband Access

Cisco® ServiceMesh defines a network design for service providers delivering value-added municipal wireless services over a mesh network. ServiceMesh is a validated, end-to-end solution that shortens time to market and enables multiple revenue streams for service providers. This paper examines the power of the Cisco solution when the advantages of Cisco ServiceMesh access technology—the Cisco Aironet® 1500 Series Wireless Mesh Access Points—are combined with other Cisco Unified Wireless Network products.

### Summary

A citywide Wi-Fi network can be an effective way to deliver broadband Internet access to a variety of customers. Entrepreneurial ISPs looking for a competitive edge can operate their own broadband infrastructure by creating a Wi-Fi cloud as a way to reach their customers. Wi-Fi is attractive infrastructure for this type of service because it is wireless, requires no spectrum licenses, and there are a variety of low-cost Wi-Fi client devices available. Cisco Aironet 1500 Series outdoor wireless mesh products make it practical to deploy and manage Wi-Fi on a citywide scale.

This application note describes how an Internet service provider (ISP) can provide residential broadband and other services using Cisco ServiceMesh along with other Cisco Unified Wireless Networking offerings.

### Creating Multiple Services

Cisco ServiceMesh, an end-to-end solution specifically designed for service providers deploying wireless municipal services for cities, has the flexibility and capacity required to deliver many different applications to millions of users across an entire city. ISPs can offer many different services on their network. The types of services offered depend on the competitive environment and the business needs of the service provider. A local cable company could use a municipal Wi-Fi network as a mobility enhancement for their residential broadband service. ISPs that provide dial-up service may move to Wi-Fi as a way to own a broadband connection to their customers. Rural telephone companies could operate Wi-Fi networks as their primary infrastructure for reaching their customers.

This application note examines GigaCom, a fictional ISP in a suburban community adjacent to a university, to see how they use a citywide wireless network to create new revenue opportunities. GigaCom is an established business with a good base of dial-up customers in the area. They already have a network operations center with a high bandwidth Internet connection. In addition, they have:

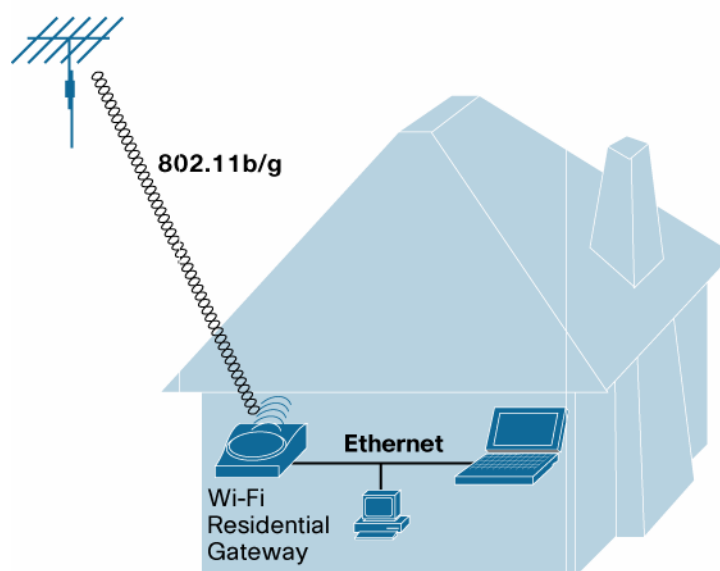
- Customer care, billing, and tech support functions in place.
- DSL and broadband-over-cable competition in most areas of their community.

A new citywide wireless network is a way for GigaCom to expand their business and deliver broadband services over their own infrastructure. Residential broadband is the primary driver for the new wireless network, but the wireless network will support other services and create new revenue opportunities for GigaCom.

### Residential Broadband Service

GigaCom offers two levels of broadband service over the wireless network. GigaHome is the premium account that includes fixed service in the home at data rates comparable to DSL and cable. GigaHome also includes access to a portable broadband service that works throughout the community using the same account credentials. GigaHome is priced at \$35 a month, which is slightly less than DSL in the area. With a one year commitment, GigaCom includes a free residential gateway with the service. This configuration, illustrated in Figure 1, is exactly the same as residential broadband-over-cable or DSL in the home. There is a residential gateway that has a WAN connection to the citywide wireless network and a local Ethernet or Wi-Fi connection within the home. The residential gateway has firewall capabilities that isolate the local network from the Internet, and the gateway uses Dynamic Host Configuration Protocol (DHCP) to create and distribute IP addresses within the residence. The perception of customers is that they have a high-bandwidth, always-on Internet connection in the house that they can share with multiple computers. They may not even be aware that their connection to the Internet is wireless.

**Figure 1.** Home Configuration with Residential Gateway



There are several advantages of using a residential gateway with the GigaHome service:

- **Better Wi-Fi reception in home**—The residential gateway has a higher-powered radio and a better antenna than a typical Wi-Fi client adapter in a notebook PC. The residential gateway is able to receive the Wi-Fi signal from the GigaCom network in more locations in the house with better signal quality, which allows the Wi-Fi link to operate at the highest possible data rate.
- **Simpler configuration**—GigaCom supplies the residential gateway preconfigured to connect to the GigaCom citywide wireless network (assuming typical in-home security settings). This enables most users to self-install the system. A simple setup procedure helps them pick the best room in the house for the gateway installation.
- **More secure**—The GigaHome service uses an invisible Wi-Fi Service Set Identifier (SSID). The residential gateway is preconfigured by GigaCom with the appropriate SSID and security credentials. The gateway is authenticated before the GigaCom network is accessed, and the wireless link to the network is encrypted. All of this is transparent to users in the home. Home users do not need to log into the network through a Web page, since the residential gateway is authenticated before any access from the home is granted.
- **Uniform user experience**—If customers accessed the GigaCom network directly from PCs and handhelds around the house, results would vary. In some locations within the home, the user experience would be great. In others, where the Wi-Fi reception is impaired by interior walls, the performance might be poor, or the network might not be accessible at all. With the residential gateway, however, the user experience uniformly excellent all around the house because the signal is stronger. The residential gateway is configured and installed once in the best location within the house. Then it distributes the Internet connection throughout the house with Ethernet or Wi-Fi operating on a different channel.

### Portable Broadband Service

Since the GigaCom network is based on Wi-Fi, it can communicate directly with any Wi-Fi client. GigaCom leverages this capability to provide a portable broadband service, called GigaZone, that works anywhere in the city. The portable service has a lower data rate than the fixed residential service —up to one megabit per second throughout the town. GigaHome customers can access the GigaZone around town at no additional charge with their notebook PCs or with handheld devices that support Wi-Fi.

The GigaZone is a giant Wi-Fi hotspot with a few different pricing and log-in options. As with other hotspots, users can create long-term accounts or simply pay by credit card for a single session. GigaZone is available as a monthly service at \$18 a month or users can pay \$5 for a single 8-hour session. There is a secure version of GigaZone that uses an invisible SSID, encrypts the data on the wireless link, and uses 802.1x authentication to validate users. This requires a properly configured Wi-Fi client device that supports 802.1x authentication.

GigaZone also supports Wi-Fi roaming with the major Wi-Fi aggregators. Users of the supported roaming services can access the GigaZone using existing accounts and payment rates from their roaming provider.

### **Public Library Free Internet Access**

GigaCom also supports a free Internet access network at the city's two public libraries. Users with Wi-Fi-equipped computers can access the Internet within the library and in the immediate surrounding area. Even though there is no charge for the service, users must log in through a Web page or captive portal to authenticate. The librarian hands out login identifications or tokens that allow library visitors to gain access to the Internet on a temporary basis.

### **Hotel Internet Access**

GigaCom operates a wired and wireless network as a managed service for a local boutique hotel. GigaCom handles all of the hotel's data communications, including Internet connectivity to support back office applications and public Internet access available for hotel guests. The hotel includes high-speed Internet access in the room rate. Even though Internet access at the hotel is free, the hotel wants to provide a high-quality user experience for their guests. GigaCom provides 24-hour customer care service for guests in the hotel.

### **Wireless Infrastructure**

GigaCom operates a Cisco Unified Wireless Network that includes indoor and outdoor access points, as well as outdoor wireless bridges. The Cisco ServiceMesh network, deployed to support wireless broadband, integrates seamlessly with their existing network and is managed from their headquarters using the same tools that GigaCom uses to manage their wired network. This drastically reduces operational expenses and the time to market for the municipal wireless services.

GigaCom built the citywide wireless network in stages, starting with the downtown area, then expanding to a few residential neighborhoods, and finally covering the whole town. GigaCom was able to offer new services and generate revenue as each stage was completed. The wireless coverage throughout town is provided by the Cisco ServiceMesh access infrastructure—[Cisco Aironet 1500 Series Outdoor Mesh Access Points](#). The Cisco Aironet 1500 Series combines a large-coverage Wi-Fi access point with a wireless mesh interconnection and backhaul, making it practical to deploy Wi-Fi infrastructure on a citywide scale. Cisco Aironet 1500 Series Mesh Access Points can be configured as either root access points (RAPs) or mesh access points (MAPs). Root access points are usually connected 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. RAPs are typically mounted higher than MAPs, creating two levels of wireless. Two-level wireless infrastructure is illustrated in Figure 2.

**Figure 2.** Two-Level Wireless Infrastructure, Rooftop and Streetlights



One deployment challenge for GigaCom was securing the locations to mount the wireless network infrastructure. GigaCom struck a deal with the city for access rights and power on the city light poles for their mesh access points. GigaCom agreed to provide free Internet access in the city's two public libraries in return for exclusive access to the light poles and a favorable monthly rate for power. GigaCom also needed roof rights on some buildings to mount the RAPs. GigaCom's headquarters and network operations center is in an office building downtown. Four RAPs on each side of the roof were enough to support the mesh of 45 MAPs for phase 1 of the network in the downtown area. The RAPs are connected to GigaCom's wired network, and there is a [Cisco 4400 Series WLAN Controller](#) at GigaCom that is used to manage all the access points in GigaCom's wireless network from their offices.

### Zero-Touch Configuration

Cisco Aironet 1500 Series Access Points and the Cisco 4400 Series WLAN Controller support zero-touch configuration, which simplified the installation of the network for GigaCom. The Cisco Aironet 1500 Series Outdoor Wireless Mesh Access Points have omnidirectional antennas. An RF engineer is not needed to mount each MAP on a streetlight. No antenna pointing is required, and the wireless mesh is formed automatically. Once a Cisco Aironet 1500 Series Mesh Access Point is mounted and powered on, it will discover its neighbor mesh nodes and find the best path back to a RAP and the WLAN controller. No further local configuration of the access point is required. After the mesh is formed, the Cisco WLAN controller communicates with all of the mesh access points using the Lightweight Access Point Protocol (LWAPP).

The entire wireless network is managed by a single, unified management system that seamlessly integrates with indoor wireless LANs and wired networks. GigaCom also uses the industry-leading [Cisco Wireless Control System](#) (WCS), which allows a GigaCom system administrator to view a map of the entire system and monitor the status of individual wireless mesh links between Cisco Aironet 1500 Series access points. Cisco WCS enables centralized network management from a single console at the GigaCom offices and includes features such as RF management, policy provisioning, network optimization, troubleshooting, user tracking, security monitoring, and wireless LAN intrusion detection and prevention.

### **Remote Sites and Indoor WLAN Coverage**

The main public library is downtown, and there is a remote branch library on the other side of town near a residential neighborhood. GigaCom installed two dedicated wireless links to connect the library to the GigaCom 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. Cisco Aironet 1400 Series Wireless Bridges provide a cost-effective alternative to leased lines for connecting remote buildings.

GigaCom built a wired and wireless network in both libraries. The WLAN controller in the main library also manages the four access points at the branch library. GigaCom can manage the entire network for both libraries from their offices.

GigaCom uses a similar arrangement to bring Internet access to the hotel. A point-to-point wireless link is established from the roof of the hotel to GigaCom's office using the Cisco Aironet 1400 Series Wireless Bridges. GigaCom also manages the network in the hotel. There is a wired and wireless network within the hotel, and GigaCom provides the Internet connection and operates the entire system including providing 24-hour customer service for hotel guests.

### **Adding More Coverage**

With roof rights to these buildings and high-speed connections to the GigaCom offices already in place, GigaCom was ready to build out the next phases of the citywide wireless network. To create the new coverage areas, GigaCom placed additional Cisco Aironet 1500 Series Lightweight Access Points configured as RAPs on the roof of the hotel and branch library buildings. It placed MAPs on the streetlights below. These remote RAPs connect to the Cisco WLAN controller in GigaCom's office through the Cisco Aironet 1400 Series Bridges.

### **Adding More Capacity**

When usage increases as new subscribers are added to the network, GigaCom can add more capacity to the wireless network by adding more RAPs on the rooftop locations. The Cisco mesh network will automatically reconfigure when the new RAPs are added. The MAPs will redistribute themselves across the RAPs. Each RAP will support fewer MAPs and the capacity available to each MAP will increase.

More capacity can be added by provisioning more wired connections. Initially, the remote library branch and the entire mesh from the surrounding area is connected to GigaCom through a wireless link. GigaCom can add a wired network connection at the remote library, and the entire surrounding network can use that direct connection to the Internet.



## Enabling Different Services

There are two key capabilities common to all Cisco wireless products that enable the GigaCom network to support many different access services with different security, performance, and billing options.

First, all the Cisco access points support multiple SSIDs, and second, the entire Cisco infrastructure supports virtual LANs (VLANs) and VLAN routing. Each Service Set Identifier (SSID) is the name of a wireless LAN. Multiple SSIDs create the capability of supporting multiple logical wireless LANs with different security profiles on the same physical infrastructure. Within each SSID, there is the ability to partition the traffic further into separate VLANs.

Given these capabilities, GigaCom supports the different services that it offers as follows:

- GigaHome uses a private, invisible SSID and supports wireless encryption and device authentication for the residential gateway. GigaHome traffic is carried on a separate VLAN.
- GigaZone uses a public SSID that has no wireless encryption. Authentication is handled through a Web page. The Web page allows the user to log in with an existing account or create a new account.
- GigaZone Secure uses a private SSID with 802.1X authentication and wireless encryption. The client devices of subscribers must support Wi-Fi Protected Access 2 (WPA2) and be configured with the appropriate certificates in order to access this service.
- The free Internet access at the library uses the same profile as open GigaZone. However, library traffic is on a different VLAN, and the walled garden Web page for authentication is different.
- The hotel high-speed Internet access also has a profile similar to the open GigaZone, but the Web-based login is entirely different.

Each of these services runs on a separate VLAN that can deliver a different level of performance and quality of service. For more detailed management down to the individual subscriber level, GigaCom uses the BroadHop Service Management Engine (SME). BroadHop's SME is tightly integrated with the [Cisco Service Selection Gateway](#) that GigaCom runs on their Cisco 7600 Series Router. BroadHop's SME provides an intuitive graphical interface that allows GigaCom to easily support new subscribers and to create and manage new service offerings.

## Conclusion

GigaCom was able to create a competitive broadband service offering new revenue opportunities by building a citywide network using Cisco Aironet 1500 Series Outdoor Wireless Mesh Access Points. GigaCom was able to position its GigaHome service as high-end residential broadband service with extras such as around-town mobility. They also defined a low-end "value" broadband service called GigaZone that is attractively priced. GigaCom also leveraged their network to support other business—for example, by operating a hotel network as a managed service.

The GigaCom network, based on the Cisco Unified Wireless Network architecture, delivers enough capacity to support multiple service offerings on the same infrastructure. Cisco's sophisticated VLAN routing enables customized services that are secure from each other. GigaCom manages their entire network with an integrated set of Cisco tools.

The Cisco mesh network using the Cisco 4400 Series WLAN Controller enables an incremental rollout of services. GigaCom was able to generate revenue as soon as the downtown portion of the network was complete.

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

- Cisco Aironet 1500 Series Wireless Mesh Access Points
- Cisco Aironet 1400 Series Outdoor Wireless Bridges
- Cisco Aironet 1200 Series Indoor Access Points
- Cisco 4400 Series WLAN Controllers
- Cisco WCS
- Cisco Compatible Extension program clients



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