



Metro-Scale Broadband City Network In Cerritos, California

A Case Study

Introduction

While broadband access has been available to residents and visitors of large cities throughout the country for years, countless communities are still without high-speed data services. Those communities fortunate enough to have meaningful broadband penetration are still left without free mobility, continually tethered to their wired connection. Cerritos, California, was one of those unfortunate communities until early 2004, when Aiirmesh, using back-office Operations Support Systems (OSS) from Pronto Networks and equipment from Tropos Networks, effectively unwired this city with the largest commercial metro-scale Wi-Fi network in the world.

History

Cerritos, California, is located in the heart of the Los Angeles/Orange County metro center, midway between Downtown Los Angeles and the business centers of Irvine, Santa Ana and Anaheim. Because Cerritos is virtually the geographic center of the Los Angeles Basin, it has become one of Southern California's premier commercial crossroads.

With a population of more than 51,000 residents, the city is also home to amenities that Southern California suburban dwellers have come to expect. First-rate shopping and restaurants, beautiful parks and public art centers, a quality education system, dedicated city services, and a thriving business and service community are all readily available to the residents and visitors of this sun-drenched Southland suburb.

Unfortunately, this thriving community has historically lacked a common service that is increasingly important in this digital age - broadband data access. A substantial percentage of the population lives in an area with no access to DSL services, and cable data is not offered anywhere in the city. Business users, who rely heavily on broadband data to remain competitive in today's markets, have had no economically viable options to obtain high-speed connections to their businesses. The city government, although equipped with fiber connec-

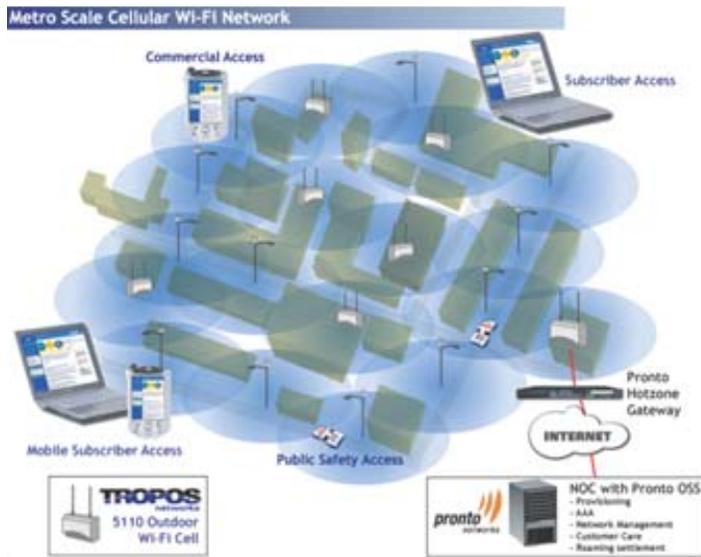
tions to central locations, has had no way to provide broadband mobility to its many field workers.

The City of Cerritos has always recognized the importance of broadband. In the early 1990s, the city was an early test bed for fiber-to-home trials. Although fiber broadband has long been touted as the answer to ubiquitous access to residential and business customers, the early Cerritos trials never got off the ground; the fiber provider quickly realized that the cost of network installation would far outweigh any reasonable revenue possibilities from the potential subscriber base. The costs and time associated with providing a fiber infrastructure throughout a community make this solution only selectively viable for traditional service providers. Cerritos, and countless other communities throughout the country, has been neglected by these providers for these simple economic reasons.

Enter Aiirmesh Communications, using back office services from Pronto Networks and equipment from Tropos Networks, and the metro-scale Wi-Fi network.

Deployment

The metro-scale Wi-Fi network in Cerritos is made possible by a collaborative partnership between Aiirmesh Communications, Pronto Networks and Tropos Networks, with the full support and cooperation of the City of Cerritos. The network is owned and operated by Aiirmesh, an integrator that designs, deploys, operates, and maintains Wireless Community Broadband infrastructure for Municipalities, Cellular Phone Companies, ISPs, and others. Wireless Community Broadband is like a new utility service, implemented for use by every segment of the community, everywhere in the community, much like other traditional utility services such as electricity or water. It is a broadband connection the customer can take with them and use anywhere in the community, like having "wireless DSL." The network was built using back-office billing, customer care and management systems from Pronto Networks and metro-scale Wi-Fi equipment from Tropos Networks. The City of Cerritos provided use of mounting assets and made a com-



Pronto's OSS and Hotzone Gateway, combined with Wi-Fi mesh technology from Tropos and fixed wireless equipment, are key infrastructure elements in the city-wide Wi-Fi deployment

mitment to be the "anchor tenant" of the Aiirmesh network. This partnership has enabled the incredibly rapid deployment of a broadband network that is cost effective to install and operate, and is truly scalable to metro-levels. Network deployment from conception to completion, including site surveys, node installation, network configuration, and testing, occurred in just a short few months. Traditional wireline broadband networks and incumbent wireless (3G) networks can take years, and substantial capital outlay, to provide coverage to a community such as Cerritos.

Network Design

The Cerritos deployment was made possible by combining technologies from several leading vendors. Back-office Wi-Fi OSS technology was provided by Pronto Networks. Pronto's OSS is a carrier-grade software solution for deploying, provisioning and managing large scale, public WLAN networks. Pronto's OSS handles access control, authentication, pre- and post-paid billing, security, customer care, network management for the Cerritos citywide hotzone. Pronto's OSS is hosted at a remote Network Operations Center in San Jose, CA (see Fig 1).

Pronto Networks also provides the WLAN gateway used in the deployment. The Pronto Hotzone

Gateway is deployed at a data center in Cerritos, CA and supports up to 2000 concurrent users. Pronto's gateway provides AAA (Authentication, Authorization and Accounting), IP routing and VPN functionality, as well as the ability to customize the captive portal and walled garden sites. Pronto's gateway communicates with the Pronto's OSS via SOAP/XML in sending accounting and network information.

Fiber backhaul is brought to the Pronto Hotzone Gateway through a router/switch. The Pronto Hotzone Gateway is connected to an Ethernet switch which is connected to fixed wireless and the Tropos Wi-Fi mesh network. In short, fixed wireless is used to connect the Tropos mesh network to the data center where the Pronto gateway is installed.

In Cerritos, 130 Tropos 5110 Wi-Fi cells were installed to allow ubiquitous broadband coverage throughout the entire 8.6 square miles of the city. (see Fig 2). The city offered use of its mounting assets for the installation, including municipal buildings and intersection signal light structures. Aiirmesh worked closely with the City Manager of Cerritos to ensure the availability of these appropriate mounting locations. The initial installation allows the density required to offer service throughout the city, as well as the flexibility to increase capacity as subscriber numbers grow. By adding additional

Figure 2: Tropos 5110 Wi-Fi Cell



nodes or backhaul, Airmesh can increase aggregate capacity of the network without the necessity of a long and costly redesign process. The Tropos nodes automatically reorganize to assimilate the added network elements.

The Tropos 5110 Wi-Fi cells, once connected to power, are self-discovering and self-configuring, instantly extending the network range upon power-up. And, because of the Tropos Networks patent-pending Predictive Wireless Routing Protocol (PWRP), over 80% of traditional wired backhaul is eliminated.

Based on the 802.11 standard (Wi-Fi) for backhaul and client access, the network requires no proprietary radio frequency (RF) equipment for access devices. The Wi-Fi network delivers true broadband speeds (>1Mbps) to users accessing the network with a standard 802.11b client device. Additionally, mobile users have the ability to freely roam throughout the coverage area while the Tropos 5110 Wi-Fi cells seamlessly and transparently perform node-to-node handoffs, ensuring the client continually has the most optimal path available back to the wired gateway. Additionally, in the unlikely event of a node failure or loss of wired backhaul, the Tropos PWRP will re-organize the nodes and route traffic back along the most optimal

path to the gateway. The result is a network that is always on, always available to the end user, and RF interference is completely transparent to the client.

Within the Wi-Fi coverage zones, the client is allowed free roaming without the requirement of manual re-association. The Tropos 5110 Wi-Fi cells perform the client handoffs transparently, ensuring continual and uninterrupted service to mobile users.

Customizable Captive Portal

To use the Wi-Fi service, citizens of Cerritos simply launch their browsers anywhere within the hotzone. The Pronto Hotzone Gateway redirects the request to a customized splash screen for the City of Cerritos (see Fig 3). This initial splash page contains walled garden links to specific websites which provide more information on Airmesh, the City of Cerritos, and the local school district. The splash page also enables new users to securely register for both prepaid and subscription plans. Returning users are able to securely logon from the initial page.

The initial splash page, as well as the self-care portal, are remotely managed by Pronto's OSS, giving Airmesh the ability to periodically update the captive portal through a web-based interface.

Figure 3: Airmesh Service Plans

Plan	Connection Speed Downlink/Uplink	Price/ Month
Aiirmesh Home		
Monthly	512 Kbps/256 Kbps	\$29.99*
Aiirmesh In-Town		
Hourly	512 Kbps/256 Kbps	\$4.99
Daily	512 Kbps/256 Kbps	\$8.99
Weekly	512 Kbps/256 Kbps	\$17.99
Monthly	512 Kbps/256 Kbps	\$29.99*
Aiirmesh BusinessPro		
Monthly	1 Mbps/1 Mbps	\$249.99*

*Annual contract agreement required.

Figure 4: Aiirmesh Splash Page



Pronto's OSS enables the customization of the splash page for both Aiirmesh and the City of Cerritos. Customizable walled garden links enable users to get more information on Aiirmesh's Wi-Fi service and the City of Cerritos without logging on.

Subscription Services

Aiirmesh offers a number of service plans within the Cerritos hotzone (see Fig. 4). For their At Home™ service, Aiirmesh uses integrated third party customer premise equipment (CPE) devices to bring the broadband signal to the home. Aiirmesh can provide home users connection speeds comparable to cable or DSL, without the costly and time consuming installation associated with those technologies. For BusinessPro subscribers, Aiirmesh offers a high-speed managed account suitable for supporting up to 25 users in a single location, replacing expensive access technologies such as T1 connectivity. The Aiirmesh In Town™ service, for notebook and PDA users, offers high-speed Wi-Fi access with full roaming throughout the city's coverage area. All service plans are electronically billed to the users' credit card via Pronto's OSS.

The City of Cerritos is one of the largest users of the Aiirmesh network. They have agreed to service subscriptions for many of their mobile employees, including city maintenance workers, code enforcement officers and building inspectors. In addition to being a user of the Aiirmesh service, the city is committed to the deployment of Community Broadband to all of the residents and businesses of Cerritos.

Authentication, Security

For security Aiirmesh has utilized a multi-layered approach, allowing them to operate a Wi-Fi network that is as secure as most wired networks. The features built into the 802.11 standard such as 64/128 bit WEP encryption act as early deterrents to hacking by casual users. Subscribers must sign in and be authenticated by Pronto's OSS in order to have

access to the Aiirmesh network. During the registration and login process, all HTTP traffic is secured over SSL. Pronto also supports public IP for home users and full VPN compatibility.

Based on the log in information, the Pronto OSS enforces the network policies established by the Aiirmesh, seamlessly providing the appropriate levels of service for which the subscriber has paid.

Customer Care

Pronto's OSS provides customer care for Aiirmesh subscribers. To minimize call center costs, users are provided a robust self-care portal which enables them to monitor access history, modify their account information, and update credit card information on their own. In the event a user calls the toll-free customer support number provided on the splash screen, customer service reps are provided with incident tracking tools as well as the means to troubleshoot any network issues real-time. Service reps are also able to make account adjustments and refunds.

Network Management

Both Pronto and Tropos provide robust management tools for monitoring and managing the network. From the OSS, the network operator is able to determine if the Hotzone Gateway is operational. Every minute, the Hotzone Gateway sends a heartbeat to the Pronto OSS signaling that the Pronto's Hotzone Gateway is operational. In the rare instance the Hotzone Gateway is not available, an email alert is automatically sent to the NOC and the Hotzone Gateway appears on a heartbeat monitor as not operational. In the Cerritos deployment, a



second Hotzone Gateway is available in case of failure.

Pronto's OSS also allows Aiirmesh to monitor the traffic levels and usage patterns within the hotzone. Aiirmesh also has the ability to remove any abusive user from the network.

Tropos provides the the Tropos Control element manager, enabling Aiirmesh to monitor and manage the Wi-Fi mesh network from a centralized location. Tropos 5110s configured as wired gateways communicate with Tropos Control via SNMP and act as management proxies for the wireless Tropos 5110 Wi-Fi cells.

Tropos Control provides multiple graphical views of the network, its Wi-Fi cell clusters, and the individual cells themselves to deliver at-a-glance network status and performance information. A single alarm manager interface monitors performance and identifies actual and potential problems, including backhaul or node failures and path failures due to obstruction or radio frequency (RF) interference. Tropos Control also eases on-going maintenance by enabling bulk configuration changes and over-the-air software upgrades, eliminating the need to log-in into every unit during these processes.

Reporting

Aiirmesh is able to access multiple standard reports, including revenue reports from subscription and pre-paid plans, refund and adjustment reports, and settlement reports. All reports are accessible through a web-based operator portal in Pronto's OSS.

Subscriber API for Email Integration

In addition to Wi-Fi access, Aiirmesh is offering email services to Cerritos subscribers. This is made possible by leveraging Pronto's subscriber APIs, which is being used to link Pronto's OSS to an external email application. When a user logs on and signs up for an email account, all customer information is fed to the external email application for account activation.

Summary

By utilizing the sophisticated back office functionality of the Pronto OSS and the broadband access made available by the Tropos metro-scale Wi-Fi network, Aiirmesh Wireless Community Broadband was able to provide ubiquitous broadband access throughout the City of Cerritos for the first time in its history. Residents and businesses in this Southern California city now have access to bandwidth that many of us have come to take for granted. In addition, residents and visitors to Cerritos have unrivaled broadband mobility at their disposal, a feature unavailable in a public network anywhere until now.

Because of the powerful subscriber and network management tools of Pronto's OSS and the self-discovering and self-healing nature of the Tropos metro-scale Wi-Fi network, scaling the network to meet the future demands of the community is both simple and cost effective. As the Aiirmesh subscriber base continues to grow, the network capacity can be increased significantly by simply adding backhaul or additional wireless nodes.

The flexibility, ease of deployment, and simplified client access of the metro-scale Wi-Fi network have allowed Aiirmesh to build a sophisticated, ubiquitous broadband coverage area available to the over 50,000 residents of this city. With this innovative technology, the network, from conception to reality, was completed in a fraction of the time it would have taken for a traditional cable/DSL service to be deployed. And, the elimination of over 80% of wired backhaul exponentially reduced the capital expenditure needed to make the network a reality.

The partnership of Aiirmesh Communications, Pronto Networks and Tropos Networks enabled Cerritos, California to become the first truly unwired city in America.



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