



Metro-Scale Mesh Networking Defined™

Metro-Scale Wi-Fi for Public Safety San Mateo Police Department

A Tropos Networks Case Study
March, 2004

Scenario

The California Highway Patrol is engaged in a high-speed pursuit along Highway 101, a major north/south corridor in the San Francisco Bay Area. The pursued vehicle, attempting to evade capture, exits the highway in San Mateo, California. In the congested traffic of this Silicon Valley city with a population of over 90,000, the perpetrator quickly realizes he will not be able to outrun or outmaneuver the law enforcement presence behind him. He hastily abandons his vehicle and flees on foot, hoping to quickly disappear among the many pedestrian visitors of the downtown shopping district.

In most cities and suburbs, this is where the story would have ended. The perpetrator would have eluded his pursuers and moved on anonymously, working on his alibi, possibly reporting the car stolen and absolving himself of any responsibility for the pursuit. Unfortunately for this runner, he didn't exit the highway in just any city. He tried to make his break in San Mateo. The police in this city have in-vehicle laptop computers equipped with broadband Wi-Fi data access, allowing the patrol officers unprecedented access to high-bandwidth, headquarters-quality applications.

Directly after the vehicular pursuit ended, a San Mateo Police Department (SMPD) vehicle arrived on scene to assist the CHP. An immediate inquiry to the state's DMV records using the Wi-Fi-enabled in-vehicle computer provided the officers with information on the vehicle's registered owner, including a high-resolution driver's license photo and fingerprints. Previously, this information would have been unavailable to field officers limited by low-bandwidth mobile data radio and cellular data technologies. With Wi-Fi, the pursuing CHP officer instantly provided a positive identification that the driver of the pursued vehicle was in fact the registered owner. The SMPD officer then quickly broadcast this photo information to all other SMPD vehicles in the Wi-Fi coverage area. As a result of an identification made from the DMV photo, the perpetrator was apprehended less than 10 minutes after the pursuit ended.



History

The San Mateo Police Department, like most law enforcement agencies its size across the country, has used mobile data radio systems for years. Their Data Radio Corporation system, while useful for computer-aided dispatch (CAD) and text-only incident information, is painfully slow (9.6 kbps), much slower than dial-up. The lack of true broadband connectivity essentially turned their in-car laptop computers into dumb terminals.

Without in-field access to critical, bandwidth-intensive applications, the SMPD officers were forced to travel to headquarters several times per shift to perform vital tasks such as report filing, database access, photo-lineup generation, and other investigative activities. A typical patrol officer can spend as much as 60% of his or her shift performing these office constrained duties. When officers are at headquarters, they are not effectively policing the community. When the police presence in the community is compromised, the safety of the community suffers.

The SMPD, a leader in law enforcement technology adoption, set a goal to make these important applications available to their officers in the field with a system that was cost-effective to deploy and maintain. Frequently used tools such as LawNet, the San Mateo County multi-jurisdictional criminal justice intranet, and the California Gang Database are important tools for the community's officers as are the California Sex Offender Database and the Amber Alert system. Additionally, access to the Department of Motor Vehicles database and streaming video for traffic monitoring are vital to the efficient operation of the department. To get these HQ-quality applications out to the officers in the field, they would need to install big pipe broadband systems, previously a cost-prohibitive proposition.



All San Mateo Police cars are equipped with 802.11 enabled laptop computers.

Enter Tropos Networks, and the metro-scale Wi-Fi network.

Deployment

The metro-scale Wi-Fi solution from Tropos Networks delivered to the SMPD officers a true carrier-class broadband solution quickly and economically. Data rates of 1-5 Mbps are consistently delivered to the SMPD vehicles throughout the Wi-Fi coverage area. The Tropos 5110 MetroMesh router is an outdoor optimized, high powered 802.11 wireless mesh networking device designed specifically for building citywide outdoor broadband networks.

The SMPD, already equipped with Panasonic Toughbooks in their patrol cars and PDAs for motorcycle and bicycle patrols, needed no client device modification or equipment addition to provide all officers access to the network. The Tropos solution is based on the 802.11b standard, allowing client access via any standard 802.11b/g client card. This fact alone saved the department \$300-\$400 per client device as they were not forced to perform hardware upgrades on these devices in any of their 35 patrol cars or the additional client devices used by the more than 110 police officers.

The Tropos 5110 MetroMesh router is built for outdoor use, with extreme temperature, high wind, and lightning strike survivability. Additionally, the Tropos 5110 is specially designed for mounting on municipally owned street lamps, utilizing the many power options available on these lamp structures. The unit can be installed by a city worker in a bucket or lift truck in under 15 minutes without any specific technology training. The Tropos 5110 MetroMesh routers, once connected to power (usually taken from the photocell socket), 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, replaced with the world's first truly wireless metro-scale Wi-Fi mesh network. PWRP also ensures maximum bandwidth to each user and dynamically routes around interference and failures. The result is a true broadband (>1Mbps) network with superb coverage outdoors. [Reference EMS here, too.] PWRP means fast deployment, too: In general, a city-wide network can be deployed in under 30 days, and is easy to maintain thereafter.



The Tropos 5110 outdoor MetroMesh router.

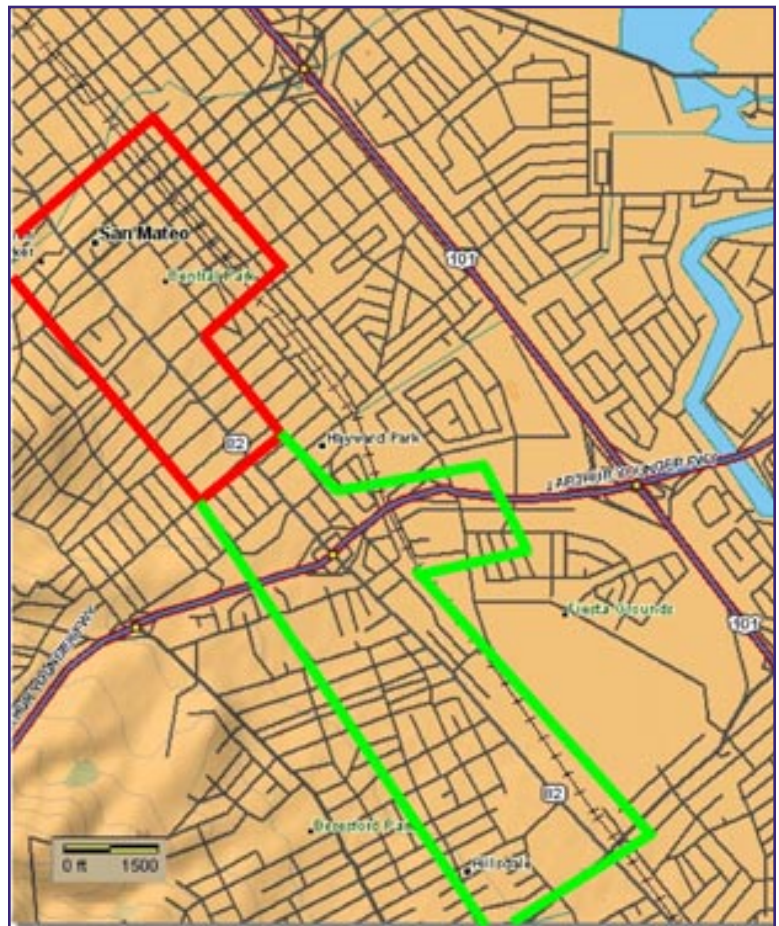
SMPD chose to take advantage of the modularity of the Tropos system and deploy the network in phases. With modularity, as few as 3 cells can be deployed at a time to provide full coverage to targeted areas. Initially, the SMPD opted to test the metro-scale Wi-Fi network in the downtown core of San Mateo. This approximately 1 square mile area of town is peppered with quaint shops and restaurants, and is frequented by thousands of visitors per day. The recent construction of a multi-screen movie complex in the downtown area added significantly to the already high volume of daily visitors. Clearly, this area of town would make for the most logical and challenging network test possible.

This phase one deployment utilized 20 MetroMesh routers installed strategically throughout downtown to provide ubiquitous broadband coverage to the zone. There are two installed wired backhaul points for redundancy; the wired gateway mesh routers tap into the city's fiber ring at the baseball field at San Mateo Central Park and near the new multiplex.

After successfully completing the phase one test, the phase two rollout of the system began to take shape. An area in the southern portion of town along the El Camino Real corridor was chosen for this latest phase of network expansion. The area, starting at the Hillsdale Mall at the southern end and ending at Highway 92 at the northern boundary, and encompassing several blocks on either side of El Camino Real, covers approximately 1 1/2 square miles of the city. The corridor was chosen because of its high volume of vehicular and pedestrian traffic, as well as the dense mix of business and residential structures. Additionally, the Police Department and City Hall are located within the network boundaries of phase two.

For the phase two deployment 13 Tropos 5110 MetroMesh routers were strategically installed in order to provide ubiquitous broadband access throughout the zone. The network takes advantage of city fiber in only three locations, the city hall, SMPD headquarters, and a San Mateo fire station.

These areas provide a substantial improvement in policing capabilities to the SMPD. They are able to monitor these high-traffic areas more effectively while in the field, keeping the streets safer for the residents of and visitors to this beautiful bay area city.



The phase one (red) and phase two (green) San Mateo Wi-Fi areas.

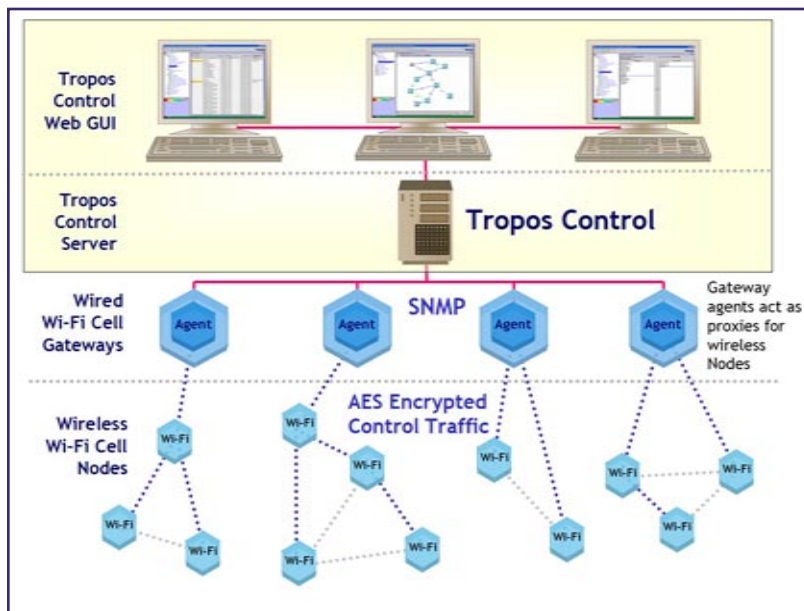
Eventually, the SMPD plans expansion of the Wi-Fi coverage area to encompass the entire 16 square miles within the city borders. The expansion will continue to take shape as funding becomes available. This eventual expansion will allow true broadband wireless access to patrol vehicles anywhere in the city of San Mateo.

Management and Security

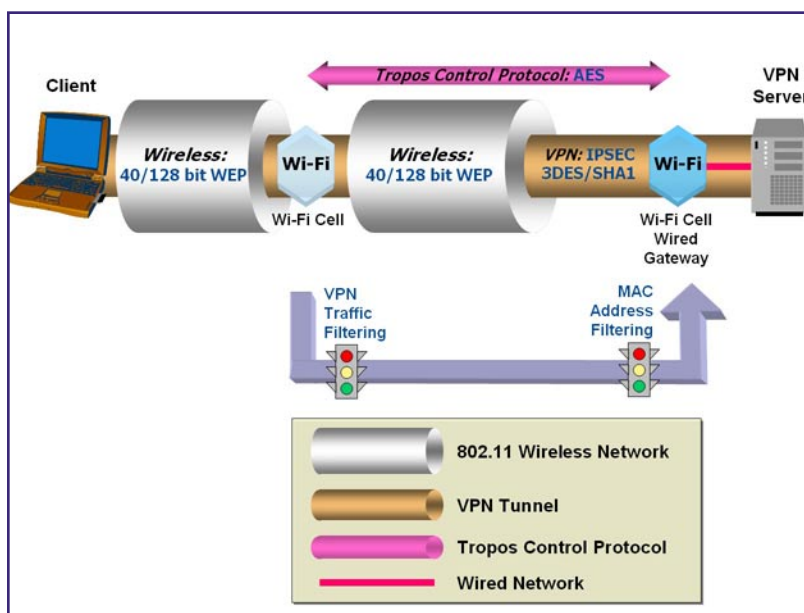
Utilizing the Tropos Control element manager, the SMPD's IT staff can monitor and manage the Wi-Fi network from a centralized location. Tropos Control is built on a client/server architecture; the server collects and stores management information from devices in the network, and the Web-based clients provide a graphical user interface to server data. Tropos 5110s configured as wired gateways communicate with Tropos Control via SNMP and act as management proxies for the wireless Tropos 5110 MetroMesh routers. This allows rapid and simple field deployment and over-the air upgrades, minimizing costs and time-to-network, and automatic discovery makes scaling the network simple.

Tropos Control provides multiple graphical views of the network, its MetroMesh router 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 mesh router failures and path failures due to obstruction or radio frequency (RF) interference.

For security the SMPD has utilized a multi-layered approach, allowing it to operate a Wi-Fi network that is as secure as their wired network. The features built into the 802.11 standard, such as 64/128 bit WEP encryption and ESSID suppression, act as early deterrents to hacking by casual users. Layered onto these features are more sophisticated tools such as VPN traffic filtering and MAC address filtering, further securing the Wi-Fi network from



The Tropos Control element manager.



A multi-layered approach to security.

unauthorized use. Finally, a NetMotion VPN and intrusion detection/prevention software were added to ensure a secure end-to-end computing environment.

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

When an SMPD vehicle leaves the Wi-Fi coverage area, the NetMotion VPN suspends any activities that were taking place over the Wi-Fi network. Downloads, etc., are resumed from the point they were suspended whenever the vehicle returns to the Wi-Fi coverage area. When outside of the Wi-Fi coverage zone, the in-vehicle system has access to the existing narrowband solution, enabling continued (although limited) data access for the officer.

Summary

By utilizing the broadband applications made available by the Tropos metro-scale Wi-Fi network, the SMPD has effectively improved the safety and security of their community and the productivity of their officers. Officers are able to spend much more time in the field where they are needed, policing the streets and performing vital services for the residents and visitors of San Mateo. Their ability to more quickly and efficiently solve crimes within their borders has already been proven and future network and application enhancements will continue to improve the investigative and preventative policing capabilities of the department. The end result is a much safer community without the need to increase the number of patrols on the street.

The Tropos system is the quickest and lowest cost truly broadband network that the city could deploy. Because of the self-discovering and self-healing nature of the Tropos metro-scale Wi-Fi network, and the powerful management and monitoring tools built into the Tropos Control, scaling the network to meet the future demands of the community is both simple and cost effective.

For the first time, a truly unwired police department is finally a reality.

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