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*Policy Backgrounder*

# Wireless Public Safety Data Networks Operating on Unlicensed Airwaves: Overview and Profiles

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From the firefighters who died on 9/11 to the rescue workers struggling to help victims of Hurricane Katrina, recent crises have demonstrated that the absence of reliable and interoperable voice and data communications among public safety agencies is an urgent national dilemma. While the need for *voice interoperability* among first responders is a fundamental and long-standing public safety issue that must be resolved in a timely manner, many communities across the nation have already begun to supplement their voice communication networks with wireless broadband *data networks* operating over unlicensed spectrum—most notably the 2.4 GHz "Wi-Fi" band.

These cutting-edge mobile high-speed data networks complement voice systems and serve as a cost-effective means to deliver applications such as streaming video for surveillance and disaster response, fast downloads of suspect mug shots or building blueprints, and access to public safety databases. By providing first responders with more resources in the field—and reducing the time they need spend in the office – these wireless data networks act as a "force multiplier," improving overall public safety.

**From TV to Public Safety**

America's upcoming transition to digital television (DTV) offers the potential both to solve the voice interoperability problem once and for all, as well as to foster the development of high-quality, high-speed wireless data networks, by freeing up valuable and desperately needed airwaves in the prime 700 MHz TV band spectrum. These airwaves travel farther using less power and better penetrate through obstacles such as walls and trees—which would significantly boost the quality and reduce the cost of deploying community, municipal, and regional wireless broadband networks which could be utilized for public safety. Today, such networks primarily utilize the crowded 2.4 GHz Wi-Fi band, which has less favorable propagation characteristics than the lower-frequency 700 MHz TV bands.

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The DTV transition involves the future use of two different sets of frequencies (channels) that are currently underutilized by TV broadcasting: channels 2-to-51 and channels 52-to-69. After the DTV transition is complete, channels 2-to-51 will remain allocated to DTV. However, because an average of only seven full-power local TV broadcast stations operate in each of the nation's 210 local TV markets, the TV band will continue to have many vacant, unassigned channels (known as **TV "white spaces"**) even after the DTV transition. Congress has recognized that opening vacant, unassigned channels between channels 2 and 51 for unlicensed access would foster the development of commercial and community wireless broadband networks as well as data networks for public safety agencies. **See below for profiles of jurisdictions that are currently utilizing wireless broadband data networks operating on unlicensed spectrum for public safety applications**. Bipartisan bills directing the FCC to complete its long-standing proceeding to open the TV white spaces for unlicensed use (Docket 04-186) have been introduced in both houses of Congress. Senators John Kerry (D-MA) and Gordon Smith (R-OR) have introduced a Senate bill, and Representatives Jay Inslee (D-WA) and Nathan Deal (R-GA) have introduced a House bill, both entitled "The Wireless Innovation Act of 2007." These bills resume last year's bipartisan Congressional push to open up the white spaces (last year's Senate bill was approved by the Commerce Committee, but failed to reach a full floor vote).

At the completion of the DTV transition, channels 52-to-69 are set to be cleared of broadcasting entirely and reallocated for public safety agencies and for auction to commercial wireless services. Congressional budget legislation focusing on the DTV transition, passed in both houses in 2006, imposes a hard deadline of February 17, 2009 for the clearance of channels 52-to-69. According to the FCC's current plan, 24 MHz, or four TV channels (63, 64, 68 and 69), will be allocated to public safety agencies in harmonized, nationally-contiguous bands that will be used primarily for interoperable voice communication between first responders of different jurisdictions. The rest of the channels are currently set to be auctioned to commercial wireless service providers.

Several private enterprises, most notably Frontline Wireless, LLC, and Cyren Call, Inc., have proposed plans to utilize portions of this returned TV band spectrum to deploy nationwide wireless broadband networks for shared use by public safety and commercial services. These proposals operate from the principle that although public safety systems must be designed for peak demand, actual demand is, at most times, far below that. Regardless of the strengths and weaknesses of the individual proposals, they show that public safety and commercial users can efficiently share physical networks, with public safety users getting priority, thereby ensuring adequate communications capacity in an emergency. This is not only an efficient use of wireless broadband spectrum, but it would also allow public safety to share infrastructure financed by commercial entities. Several jurisdictions profiled below have already demonstrated this efficiency using municipal and regional wireless data networks operating on *unlicensed* spectrum.

As broadband data applications become an even more critical part of public safety communications, access to more and better spectrum and networks becomes critical. This can potentially come through proposals for nationwide networks on licensed spectrum such as those discussed above – or by allowing unlicensed access to the vacant TV channels between 2 and 51 on a market-by-market basis for the development of community, municipal, and regional wireless broadband networks. The latter option holds the promise of opening up considerable amounts of prime spectrum, particularly in rural and small town markets, for both public access and for public safety, while not reducing the availability of returned 700 MHz spectrum for auction to commercial wireless providers.

The following snapshots convey just a few examples of the multitude of ways in which communities around the country are already utilizing today's extremely limited amount of unlicensed public airwaves below 3 GHz for public safety broadband data networks:

# Examples of Public Safety Wireless Broadband Data Networks on Unlicensed Airwaves

## Corpus Christi, Texas

Type of Implementation: 2.4 GHz Wireless Mesh Network
Service Area: 147 Square Miles
Application(s): see below

Corpus Christi, a city of 293,000 located on the Gulf of Mexico, recently completed a multipurpose wireless broadband network. Public safety officers are among the primary users of the network. Indeed, the new network enables a multitude of applications to enhance public safety, including:

- **Aerial Video Surveillance**: The city's Aerial Video Surveillance is designed to enable officials to see a live aerial view of a situation—such as a major fire or sporting event—or for routine surveillance. In such a system, an "eye in the sky" (a video camera mounted on a five-foot-long unmanned helicopter) transmits video images back to the ground via the city's wireless mesh network.
- **Automated Vehicle Location**: The city's Automated Vehicle Location is deployed in 140 of its police vehicles and 50 of its Fire and EMS vehicles. AVL uses global positioning system (GPS) technology to pin-point location, elevation, and velocity of these vehicles. Public safety officials can track the position of public safety vehicles on a map located at each dispatching station.
- **Emergency Disaster Response**: Trailer-mounted communications towers that run on solar power are designed to be set up at the scene of a major accident or fire, or other disaster area that is located outside the reach of the city's wireless network. These "towers on wheels" can link with the city's network and provide public safety officials a way to use devices—such as handheld PDAs, emergency VoIP phones, and video surveillance cameras—in areas where communications infrastructure has been damaged.
- **Mobile Data Computers**: More than 100 of the city's public safety vehicles are equipped with mobile data computers. These computers use the city's wireless network to run high-end applications such as in-car streaming video and car-to-car messaging. They also allow officials access to sex offender databases, mug shots, and satellite imagery.
- **Electronic Field Study**: The city's wireless network can allow police and fire officials to view images of a location—such as maps and building floor plans—in their vehicles, allowing them to make logistical decisions before they arrive at the scene.

## Washington, DC

Type of Implementation: 700 MHz Wireless Broadband System on Experimental License
Application: Mobile broadband access for law enforcement

The District of Columbia has been piloting the Wireless Accelerated Responder Network (WARN) since January 2005. Operating on the 700 MHz band utilizing an experimental license granted by the FCC, the system shows the potential benefits of deploying a network in the beachfront TV band spectrum. No more than 120 access points are required to cover the entire District of Columbia with access to WARN, as compared to the approximately 37,000 sites that would be needed to cover the same area on the 4.9 GHz public safety licensed band. WARN was implemented to test a host of broadband data applications for public safety. These include creating ad hoc video surveillance networks in areas that need monitoring, broadband data access for squad cars and other mobile units, even remote analysis of suspicious packages using specially equipped HAZMAT suits. The network boasted 99.7% availability in 2005, and offers average connection speeds of 3 Mbps downstream, and 300 kbps upstream.

## San Mateo and Milpitas, California

Type of Implementation: 2.4 GHz Wireless Mesh from Tropos Networks
Application: Mobile broadband access for law enforcement

San Mateo was the nation's first municipality to use a citywide Wi-Fi network for public safety purposes. The mesh network provides police vehicles mobile access to critical law enforcement applications. Using laptops in their vehicles, officers have wireless broadband access to LAWNET, a county-wide Intranet for law enforcement that connects officers to the Amber Alert System, the Sex Offender Database and other databases. From anywhere in the hot zone, officers can now download DMV records, including high resolution photos, conduct in-field photo lineups, and perform other tasks that previously required them to return to headquarters. In the future, officers will have access to live video feeds of security cameras and access to the city's Geographic Information System (GIS). The network, operating entirely on unlicensed spectrum, has provided a significant return on investment by keeping police officers in the field 1.5 hours longer per shift.

Meanwhile, neighboring Milpitas has built a wireless network that is able to bring video feeds from traffic cameras on freeways to police headquarters. This allows police officers to more quickly dispatch officers from Milpitas or neighboring cities to accident scenes.

## Morrow and Umatilla Counties, Oregon

Type of Implementation: 2.4 GHz Proxim Tsunami Broadband Wireless Access System
Service Area: 600 Square Miles in Morrow and Umatilla Counties
Application: Public Safety First-Responders System

In a county without a single traffic light, the Morrow County Emergency Management Department has built a 600-square-mile wireless broadband network to monitor the region surrounding the Umatilla Chemical Depot, a U.S. Army-built storehouse for the destruction of chemical weapons, in case of a disaster. The primary intent of the network is to coordinate evacuation and emergency responses in case of a major incident. Police will be able to view live video footage on laptops, divert traffic and organize evacuations. Emergency medical workers can send medical data to hospitals while en route and know ahead of time which hospitals can accommodate more patients. Though a hazmat emergency has not yet occurred, routine use of the network has caused an estimated 65 percent reduction in paperwork, as police use it to monitor traffic flow, communicate on the go with dispatchers, download data and file reports from the road, saving an estimated half of the 4,000 or so hours each officer spends on such bureaucratic tasks each year. The ubiquitous network is also open free to the public – and for a moderate fee to businesses, providing a valuable service in sparsely populated northeastern Oregon.

## New Orleans, Louisiana

Type of Implementation: 2.4 GHz Wireless Mesh from Tropos Networks
Application: Unlicensed wireless surveillance camera network

Prior to the tragedy of Hurricane Katrina, New Orleans decided to set up a real-time video surveillance network to monitor strategic points around the city as part of Mayor C. Ray Nagin's ambitious crime-fighting agenda. The city researched both wired and wireless solutions, and ultimately decided that a wireless system operating on unlicensed spectrum would be both versatile, reliable and more cost-effective than other alternatives.

The city selected to anchor its police surveillance system on a Wi-Fi mesh network by Tropos. Wi-Fi nodes are mounted on the city's power poles, drawing power from them as part of an agreement with the city power utility. Indeed, during Hurricane Katrina, some of the most dramatic videos of the disaster were recorded by the city's wireless surveillance system—at least until the power grid went down.

Using detailed crime maps of the city, the New Orleans Police Department worked with the mayor's Office of Technology to place cameras in the areas most plagued by murders, robberies, vehicle thefts and drug trafficking. The IP-based cameras, controlled remotely from police headquarters, provide high-quality digital images that can be made available to any wireless device on the city's IP network. The reconfigurable mesh architecture of the city's Wi-Fi network allows city officials to easily move Wi-Fi nodes and cameras to needed areas. This is helpful to ensure safety at special events, such as the annual Mardi Gras parade. During the pilot phase of the project, conducted from January through August of 2004, the area covered by the surveillance network recorded 57% fewer murders and 30% fewer car thefts than in the same months the previous year.

## Pratt, Kansas

Type of Implementation: 2.4 GHz Alvarion BreezeACCESS system
Application: Mobile broadband access for law enforcement

The rural Kansas town of Pratt has a mobile broadband wireless network that allows police officers to access critical law enforcement related applications from their patrol cars. Officers can obtain critical arrest and other criminal information, access department databases and submit reports from the field, without having to report to the office. The private city network, which allows both fixed and mobile data access, is built on Alvarion Inc.'s BreezeACCESS system, which utilizes the 2.4 GHz unlicensed band. The city chose an unlicensed wireless solution to avoid the user fees and higher equipment costs associated with a licensed frequency. Network nodes are installed on water, airport and other civic towers. The network covers the entire city, and provides T-1 comparable (1.544 Mbps) connectivity. For added security, the network employs Frequency-Hopping Spread Spectrum (FHSS) technology and a firewall to ensure data privacy.

## Las Vegas, Nevada

Type of Implementation: 2.4 GHz Tropos MetroMesh
Application: City police and fire network and downtown hotspot

Began as a search for a better way to control traffic lights, the city of Las Vegas realized that Wi-Fi could do that and more. The city decided to build a mesh network to support traffic monitoring and communication for public safety personnel. Mesh networks such as that of Las Vegas are self-healing in the event of a node failure, making them robust enough to survive a potential Homeland Security crisis. The first 5 square kilometers cost $175,000, and coverage of the entire city is estimated to cost just $6 million. Using the access granted them by the city, Cheetah Wireless is also able to use the similar equipment to offer public access "hot zones" to subscribers all over the city. This business model helps keeps cost to the city low, and brings the benefits of high-speed wireless access to the general population.

## Spokane, Washington

Type of Implementation: 802.11 Wireless
Application: Downtown hotzone and public safety

Spokane's network covers 100 city blocks and is used primarily for public safety applications. The city claims it is largest municipal Wi-Fi network in the US. The network has two domains: (1) the city's private domain which it uses for public safety, mobile workforce, and automated parking enforcement and (2) the public domain, SpokaneHotzone, which is devoted to public access offered through OneEighty Networks, a local ISP. Time Magazine profiled Spokane's network, citing many examples of current and planned public safety uses, such as allowing fire fighters to download floor plans before entering a burning building.

## Odessa, Washington

Application: Wi-Fi Internet, public safety (police vehicle data access)

Odessa Office Equipment is a WISP serving the towns of Odessa, Wilbur, Creston and Ephrata with its 11Mbps wireless system running on unlicensed spectrum. Odessa set up a wireless data access network for the local police departments. According to Marlon Schafer, the company's owner, police in the region report that roughly 50% of their stops are of people who lie about their identity and don't present proper identification. Law enforcement officers will soon be able to run bandwidth-intensive applications such as fingerprint identification from in the field in cases like this, to help immediately identify individuals with outstanding arrest warrants, suspended licenses, etc. The availability of unlicensed low-frequency spectrum to carry such data at high speeds is essential to making that a reality.

## Tacoma, Washington

Application: Homeland security, monitoring inventory at Port of Tacoma using RFID

Unlicensed wireless has important homeland security applications as well. Odessa Office Equipment (profiled above) also installed a system that uses unlicensed wireless to read Radiofrequency Identification (RFID) tags on shipping containers at the Port of Tacoma. Using RF ID readers on moving cranes, the system automatically identified what was coming off each ship before the containers even left the port.

## Charlotte County, Florida

Type of Implementation: 5 GHz unlicensed Motorola Canopy
Application: Wi-Fi Internet for businesses and emergency services

DayStar Communications provides high-speed wired and wireless data and voice services for the business communities of Port Charlotte, Punta Gorda and Venice. DayStar has a Wi-Fi network operating on unlicensed spectrum covering parts of Punta Gorda, Port Charlotte, Englewood and Venice. The company offers an affordable wireless Internet package for businesses in the region. After Hurricane Charley devastated the Gulf Coast in the summer of 2004, DayStar opened its arms to the community and began offering free domestic Voice Over Internet Protocol (VOIP) phone calls and Wi-Fi Internet access to county residents at two different locations. Sixteen VOIP telephones were made available in Punta Gorda and Port Charlotte. A DayStar Communications representative was made available at each location to help residents use the service. DayStar President Al Sanders was especially concerned about the region's elderly, who were forced to wait in long lines to call relatives and register for assistance from the Federal Emergency Management Agency following the disaster. Sanders decided to offer the service to assist in hurricane-related situations. The availability of a high-bandwidth unlicensed wireless network proved critical in getting assistance to the elderly community during a time of crisis, when wired communications had gone down.

## Daytona Beach Shores, Florida

Type of Implementation: 5.3 GHz Unlicensed Wireless
Application: Residential/business Internet, municipal and public safety

For the past four years, local WISP Qmega Technologies, Inc. has provided high-speed wireless Internet access to the businesses and residents of the entire town of Daytona Beach Shores, FL. Qmega has an agreement with the city to provide wireless Internet services for the city hall & public safety as well. The five buildings of the city complex are connected wirelessly to each other, with voice and data, which in turn allows police officers & staff in City Hall to be able to access public safety applications over an encrypted link. All of this is done with Mikrotik routers using unlicensed spectrum in the 5.3 Ghz band. The entire city core is covered for mobile in-car service. The city's high-speed network has also proved its importance not just in police work, but in emergency response as well. During the devastating 2004 Florida hurricanes, the city's wireless network was online during the storms, enabling city officials to look up weather & hurricane reports online to better plan evacuation and response efforts. Unfortunately, because Qmega's coverage area will not include a new public safety complex being built 20 miles away, the city is now forced to switch to a more expensive cellular service.

## Rio Rico, Arizona

Type of Implementation: 802.11 Wireless
Application: Public safety/first responder; eventually, access for schools and residents

Arizona has helped to construct a public safety network over a 30-mile stretch of U.S. I-19, part of the CANAMEX corridor that links Canada to Mexico. The pilot project was financed by a two-year, $500,000 grant from the Department of Homeland Security, secured through the state and the Arizona Telecommunications and Information Council. Soon after the network was completed in April 2006, there were 50 first responders connecting to it by way of Mobile Access Points in their vehicles. For example, various fire districts in the area use the network to send text and voice information to each other. A key advantage of the network is the ability for public safety officials to communicate while cruising at up to 70 miles per hour. The project leaders have said that they will begin selling part of the network's bandwidth to customers living near the highway to provide Internet access, revenues which will make the network self-supporting. Two thirds of Santa Cruz County's schools are within a half-mile of the highway, putting them within range of the network. Arizona has said it hopes to cover more of the CANAMEX route with a wireless cloud. (Sources: Government Information Technology Agency, Arizona Telecommunications & Information Council)

## Buffalo, Minnesota

Type of Implementation: Motorola MeshNetworks; 2.4 GHz Band QDMA
Applications: Public safety, city utilities

Buffalo, a town located 40 miles north of Minneapolis, has a public safety network that utilizes Motorola's mesh architecture on the 2.4 GHz unlicensed band, giving each node a one-mile range. The city's network, covering 12.4 square miles, went live in February 2005, and is used by police, fire, and other city services for a core suite of applications: filing reports and checking records from the road, accessing architectural information from the field (useful for both firefighters and civil engineers), and accessing other online resources. As of this year, 14 squad cars are equipped with rugged laptops that can access the wireless network. The city also maintains a parallel Wi-Fi ISP, Buffalo Wireless Internet Group, using standard Wi-Fi, which charges just $9.99 per month for 192kbps; and $33.99 for 576kbps. The builder of the network, WaveRider, claims that in 2006 more than 1,000 households and networks in the city with a population of 2,800 used the network. (Sources: City of Buffalo, Vecima Networks)

## South Sioux City, Nebraska

Type of Implementation: 802.11b Wi-Fi
Applications: Public safety, city utilities

South Sioux City first built its own Fiber Optic ring in the late 1990s to provide high-speed communications for the city government, and leased bandwidth to private ISPs to resell to residents and businesses. The city then experimented with wireless in 2002, and initial trials were so promising that they decided to build a dedicated network for public safety and municipal uses, for which they received a $457,000 grant from Homeland Security. At least 20 city fire, rescue and police vehicles are equipped with mobile data computers that have access to the city's entire Closed Circuit Television (CCTV) security system. The city's CCTV system covers locations including schools, bridges, and power substations. The wireless network provides 100 percent high-speed mobile data coverage anywhere within the city limits and reliable mobile data coverage over a roughly 30 square-mile area. (Source: South Sioux City)

## Ripon, California

Type of Implementation: Motorola MeshNetworks; 2.4 GHz Band QDMA
Applications: Public safety, city utilities; eventually open for public access

Ripon, a town of 13,000 people in California's Central Valley, is deploying a mesh network using Motorola's hardware and covering 8 square miles. The city researched both licensed and unlicensed wireless solutions, and overwhelmingly decided upon an unlicensed solution due to its high quality and cost advantages. The network will be used for public safety and other municipal uses such as real-time remote monitoring of city wells and pump station data and mapping of the city by Geographical Information Systems. City police officers will have mobile data systems in their cars, and soon the city will use the network to deploy more than 20 surveillance cameras to monitor and investigate suspected criminal activity. The cameras will be placed at three truck stops on a major freeway, in city parks and at locations in the downtown area, among other places. The network is expected initially to save the police department at least $2,000 per month. Overall, the network is expected to cost $500,000 (with no recurring fees), offset by a $75,000 homeland security grant. The 18-month preliminary study rejected cellular as being too expensive and limited in its data capacity, deciding instead on unlicensed IP based service. The network will be made publicly accessible eventually, which the city hopes to use to attract residents from Silicon Valley.

## Oklahoma City, OK

Type of Implementation: 2.4 GHz Tropos MetroMesh
Applications: Public safety

Oklahoma City has built a wireless network covering 640 square-miles for public safety use. In outlying areas, there are fewer towers per square mile—a feature that made build-out of the network more economical. To ensure police cars can access the networks at the periphery of the coverage zone, police cars are equipped with mobile routers that turn the cars into mini-hot zones. (Source: Tropos Networks)

## Tucson, AZ

Type of Implementation: 2.4 GHz Tropos MetroMesh
Applications: Video conferencing in ambulances

The city has used money from the federal government to build a "proof-of-concept" wireless network that allows ambulances to transmit video of a patient to doctors as they speed toward the hospital. This allows doctors to give instructions to paramedics in the ambulance, and also gives doctors a chance to size-up the patient's condition and prepare for treatment. (Source: Tropos Networks)