Maricopa County Regional Wireless Systems

An AZTech™ White Paper on
Wireless Systems Being Used in ITS

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Until recently, if an agency wanted communication to its traffic signals, the best method was installing fiber optic cable. Although very reliable, fiber came with high construction costs and was not even practical for some installations. Within a very short time, wireless technology has dramatically changed the possibilities of Intelligent Transportation Systems (ITS). With modern wireless technology, high bandwidth can be achieved over vast distances that were never a possibility before. Agencies in the AZTech™ region are now designing and building ITS networks with wireless technology, or use wireless with existing fiber to make network connections that were never possible before. This white paper reviews the status of wireless technology implementation in the region. The paper does not recommend a specific technology or product, but serves as a reference document for any agency interested in wireless technology.

1. Background

- There are approximately 2,500 signalized intersections in the region.
- There are ten jurisdictions with 50 or more signalized intersections (ADOT, Chandler, Gilbert, Glendale, MCDOT, Mesa, Phoenix, Peoria, Scottsdale, and Tempe).
- Nine jurisdictions currently have traffic management centers (TMC) that maintain constant communications to their traffic signals.
- Many jurisdictions are using a hybrid communication system, utilizing fiber and wireless technology to integrate traffic signals with TMC systems.

2. Vision

The agencies in the region have a vision to expand communications between the Traffic Management Centers and the traffic signals through fiber and wireless communications technologies to achieve better signal operations and coordination. To achieve this vision the agencies would like to:

- Deploy a variety of wireless solutions in areas where direct fiber is not available.
- Leverage wireless solutions in a cost-effective manner, to deliver ITS solutions.

Current Status

Wireless technologies are being implemented by several agencies in the region. Each has implemented a unique approach for their communication needs. The sections that follow describe each wireless communication approach for seven of the AZTech™ agencies (Maricopa County Department of Transportation, Arizona Department of Transportation, City of Surprise, City of Peoria, Town of Gilbert, City of Scottsdale, City of Chandler).

Maricopa County Department of Transportation (MCDOT)

- Uses HP Procurve Point to Point 5Ghz, Power over Ethernet radios to create traffic signal wireless corridors.
- Connects multiple wireless corridors to leased T1 demarcation points or fiber backbone.
- Consolidates as many wireless corridors to the minimum amount of leased lines needed.
- Leased lines have been replaced with wireless solution to achieve cost savings.

Arizona Department of Transportation (ADOT)

- Uses a variety of wireless solutions, including:
  - Licensed 450MHz to communicate with Dynamic Message Signs (DMSs) on the Department of Public Safety (DPS) microwave radio towers located throughout the state
  - Unlicensed 900MHz for DMS where communications is temporarily displaced
  - CCTV via licensed 4.9GHz (< 3 miles)
  - Detection and Ramp Meters via unlicensed 900MHz
  - Has one ITS facility (Traffic Signal & Lighting) connected to another ITS facility (PMD ITS) via a licensed 4.9GHz connection, providing a 24MB connection. PMD ITS is connected to existing ADOT FMS backbone.
  - New Dust Monitoring system utilizes unlicensed 900MHz
  - Truck Escape Ramp (w/ CCTV and Detection) uses 900MHz on a contact closure system; also utilizes a 3G network to send streaming CCTV images.

City of Surprise

- Uses Point-to-Point and Point-to-Multipoint wireless communication to connect signalized intersections to the ITS network that are not accessible by fiber optics.
- Utilizes state of the art wireless technologies that will provide adequate bandwidth and data throughput. This allows for high quality CCTV video streams, video detection video and controller communication to be brought back to the TMC simultaneously.
- Explores the various hardware options that will provide low cost and high quality solutions.

City of Peoria

- Installed 26-mile fiber optic backbone for Traffic IP addressable field hardened VLAN communication network (i.e. Ruggedcom switch, Traffic Signal equipment to Central Computer System, CCTV multicast streaming video, DMS control, video sharing, data information sharing, video conferencing)
- Installed HP Procurve wireless radio on corridors that do not have fiber connection for the Traffic IP addressable VLAN communication network
- Installed additional CCTV cameras in strategic locations (wireless / fiber communication to central)

Town of Gilbert

- Uses Point-to-Multipoint serial radios (Encom) and IP radios (Encom and Simrex) to communicate to signal controllers from the traffic management center (TMC)
- Connects serial and IP wireless zones to the Town's fiber network
- Uses Broadband IP radios to bring multiple video feeds (PTZ and detection camera feeds) back to Gilbert TMC
- Uses Broadband IP Radio Bridge to connect active fiber not connected to the Town's fiber loop on Power Road.

City of Scottsdale

- Installed a mesh network of high bandwidth radios for video and data transportation to the last mile traffic signals and cameras
- Maintain a radio connection at every existing Scottsdale fiber trunk line
- Has developed Ethernet communications to all field devices, using video compression codecs, media converters and managed/hardened field switches
- All but a few leased phone lines have been disconnected for cost savings. Only a few major arterial leased connections exist
- Maintain multicast video traffic which allows more demarcation points of the video without dedicated fiber paths throughout the City

City of Chandler

- Installed 58-mile fiber optic backbone for Traffic IP addressable field hardened VLAN communication network (i.e. managed and unmanaged Ethernet switch, Traffic Signal equipment to Central Computer System, CCTV multicast streaming video, DMS control, video sharing, data information sharing, travel time system)
- Installed Motorola, Cisco, and AvaLAN wireless radio on corridors that do not have fiber connection for the Traffic IP addressable VLAN communication network
- Travel Times on 3 DMS using Bluetooth and FMS data.
- IP addressable multicast streaming video from 612 detection cameras deployed, 9 PTZ analog cameras, and 10 PTZ HD cameras. (Videos can be seen using a web browsers)
- Will replace twisted pair wire, and wireless radio in the future with fiber optic cable.

City of Tempe

- Initial wireless installation uses Point-to-Point and Point-to-Multipoint 4.9GHz Proxim radios
- Connects 8 arterial intersections to ADOT fiber to bring controller data, video detection and CCTV video streams back to the TMC
- Planned 2013-14 deployment of additional wireless radios to connect 22 arterial intersections to ADOT fiber backbone

Deployment Analysis

There has not been one perfect solution that fills the roles of every agency's needs. With different goals in mind each agency has chosen a radio technology and strategy that specifically fits its own need. Here are a few examples:

MCDOT

MCDOT has a unique system as it is the only agency that is using leased T1 lines as the main source of communication to the field. So any desire to have the best picture quality cannot be achieved due to bandwidth limitations. Also, leased lines have costly month fees that can easily add up over time. With the nature of the network in mind, an inexpensive radio that can pass multicast video streams and can be easily deployed was what MCDOT needed. By using the HP Procurve 5GHz radio, MCDOT can quickly add radios to intersections with existing leased lines to connect multiple traffic signals, even connect multiple wireless corridors and eliminate the needs for several leased lines all together. As a result of this approach MCDOT has added 54 traffic signals without adding additional leased lines.

ADOT

ADOT is using GE industrial wireless MDS hardened equipment used in the oil and gas industry that has a proven track record. The GEMDS 450 Licensed equipment is digital narrowband encrypted and has a range of up to 60 miles and works well located on a high point such as a mountaintop. This is perfect for 9600 baud communications for DMS and signal control. It also has the capability for IP applications but ADOT has not implemented that since DPS has not provided IP connection. Phoenix White Tanks and Thompson Peak should be the first IP area in the future. IP to the rural mountaintops are not available yet. The Kingman Truck escape ramp will be using GE NetIO 900 MHz unlicensed for short range detection of a truck. GE MDS Entra Net 900 MHZ unlicensed spread spectrum radios have been tested for detection systems on the L202 for Phase 6C testing. Full motion live video bandwidth requirements have necessitated the use of microwave links and Proxium 4.9 GHz microwave point to point or point to multipoint systems have been deployed and tested. The Proxium system is in use as a 25 MB link between two buildings. The 4.9 GHz licensed spectrum works well and is available for Government agencies.

City of Surprise

The City of Surprise is currently using wireless technology to expand its ITS network to those intersections that are not on a fiber optic backbone. These are both permanent and temporary solutions as some intersections have future fiber optic infrastructure planned for the future, while others will rely solely on wireless technology for communications. The City's wireless connections provide the ability to access multicast video, remote signal controller monitoring and programming, and remote video detection monitoring and programming from the TMC as

well as remote locations via a VPN connection. The City of Surprise currently has HP Procurve 2.4/5.8GHz radios as well as Motorola 5.8GHZ point to point radios deployed.

City of Peoria

The City of Peoria has a fiber optic backbone north / south direction in the City of Peoria. The City uses the Ruggedcom RS900G network switches at all their traffic signal cabinets whether they are connected by fiber or wireless communication. The City uses the HP Procurve MAP 330R wireless radios for a point to point connection to traffic signals that are not connected directly to the fiber optic backbone. All of the Econolite ASC 2S traffic signal controllers are connected to the switch via a CAT 5 cable from the switch to the Econolite Ethernet interface card. The Econolite ASC 3 traffic signal controllers are connected with a CAT 5 cable from the switch to the controller Ethernet port. The field hardened IP addressable network transmits traffic signal controller data info, Multicast CCTV Streaming video, DMS sign control, Shared Detector info, Shared Traffic Signal Timing parameters, Shared Multicast CCTV Streaming Video, and Video Conferencing.

Town of Gilbert

The Town of Gilbert uses wireless radio devices to communicate to traffic signal controllers and bring back unicast video feed from intersections not located on the Town's fiber network. Master radio locations for the point to multi-point network are located on the fiber network and all feeds are brought back to the Gilbert TOC. Gilbert has Encom serial radios, Encom 900MHz Compak IP radios, Encom 5GHz Compak BB radios and Simrex 5GHz WB 5800 radios currently deployed in the field.

City of Scottsdale

The City of Scottsdale is using Firetide 7000 Series Dual Mesh radios with directional 4.9Ghz Mimo antennas. One radio is connected to the fiber network through an Ethernet connection at the intersection where Fiber is terminated. The radios were selected based on the future expansion plans to include mobile communications to Police and municipal vehicles.

City of Tempe

The City of Tempe is using wireless technology to expand its ITS network by connecting nearby intersections to its ADOT fiber backbone located along I-10, L101, L202 and US60. Eight intersections are currently online, using Proxim Tsunami MP.11 4.9GHz Point-to-Point and Point-to-Multipoint radios and an upcoming wireless deployment will connect an additional 22 arterial intersections. Some of these intersections will be temporary wireless placements, as a planned fiber installation will eliminate the need for wireless radios along that route, allowing them to be repurposed for use in other locations. A current fiber installation project underway around the ASU Tempe campus will also provide additional opportunities for using wireless to expand the reach of the City's fiber backbone by connecting adjacent intersections. As most of

the City's signalized intersections are on leased lines, using wireless technology in conjunction with its fiber backbone offers the benefits of much higher bandwidth and reliability, which achieving significant reduction in ongoing fixed costs. With the increased bandwidth available, in addition to signal controller data, video and data from video detection systems, as well as unicast video streams from PTZ cameras, are brought back to the TMC for improved monitoring of the City's network. Remote programming and maintenance of several field systems is also now possible as well as improved monitoring and operation of our emergency vehicle preemption system.

Benefits

The benefits of this vision include:

- Affordable means to communicate with traffic signals and CCTV cameras.
- Can be easily deployed without affecting daily traffic, and little to no construction needed.
- Little to no potential damage resulting in loss of communication due to construction near infrastructure.
- Network communication can be just as secure as a wired network using available encryption standards.