THREE-TIER WIRELESS COMMUNICATION NETWORK IN SUGAR LAND, TEXAS

Rick J. Staigle
Principal, Traffic Engineers, Inc.
8323 Southwest Freeway, Suite 200
Houston, TX 77074
+1-713-270-8145, rick@trafficengineers.com

ABSTRACT

The City of Sugar Land, Texas is constructing a wireless communication network to provide access to the City's traffic signals and other traffic related devices. This network will allow City employees to monitor and adjust traffic signal timing, view images from closed circuit television (CCTV) cameras, and provide access to other City employees working remotely in the field such as police officers, building inspectors and public works employees. This project utilizes eight high sites to develop a wireless backbone. The high sites communicate with the traffic signal through point-to-multipoint radios to transmit signal information, CCTV video and provide Wireless Access Points. Fiber Optic interfaces are provided to bring the information back to the Traffic Management Center at two locations.

KEY WORDS

Wireless Communication, CCTV, Traffic Management Center (TMC), Traffic Signals, Wireless Access Points

INTRODUCTION

The City of Sugar Land, Texas is constructing a wireless communication network to provide access to the City's traffic signals and other traffic related devices. This network will allow City employees to monitor and adjust traffic signal timing, view images from closed circuit television (CCTV) cameras, and provide access for other City employees working remotely in the field such as police officers, building inspectors and public works employees. During the evaluation process, this project was merged with a project being developed by the IT department to provide additional bandwidth and user capabilities for other City departments such as Public Utilities and Parks & Recreation.

EXISTING CONDITIONS

The City of Sugar Land, located in eastern Fort Bend County, is approximately 20 miles southwest of downtown Houston. Sugar Land is one of the fastest growing cities in Texas, with Census 2000 figures ranking Sugar Land #1 in growth in the Houston metro area and #1 among

the state's 45 largest cities. The City's estimated January 2010 population was 84,511. Sugar Land's city limits encompass approximately 34 square miles, with approximately 21 square miles in its extra-territorial jurisdiction (ETJ).

The City of Sugar Land currently operates and maintains 72 traffic signals divided into eleven different signal subsystems. There are approximately 20 more traffic signals that are currently operated by other agencies in the ETJ which will become the responsibility of Sugar Land when the areas are annexed over the next ten years.

Sugar Land has a Traffic Management Center (TMC), shown in **Figure 1**, which is located at the Public Works building on Gillingham Lane. The TMC monitors the eleven signal subsystems with ten broadband Integrated Services Digital Network (ISDN) lines. The subsystems communicate with the individual traffic signals through spread spectrum radios, twisted pair copper communications cable or fiber optic cable. The ISDN lines are leased from the telephone company for $100 per month for each connection. The TMC utilizes software named ATMS.now (ATMS is an acronym for Advanced Traffic Management Systems) to monitor and control the traffic signals. The software and the traffic signal controllers in Sugar Land are produced by Naztec, Incorporated. The traffic signal control units are currently configured to communicate at baud rates of 19.2 Kbs. Sugar Land intends to upgrade the communications system and field hardware to provide communications in the 10 to 1,000 Mbs range.

Figure 1. Sugar Land TMC

The wireless network will replace or enhance communication systems that currently exist. Traffic signals that are not currently on the network would be brought into the system. Additional CCTV cameras will also be deployed to allow the staff at the TMC to observe traffic flow or incidents. The staff will modify traffic signal timing plans to address the observed congestion or traffic patterns, as well as provide incident management capabilities. The instantaneous observation and adjustments will reduce congestion and fuel consumption and

improve air quality in Sugar Land. This will increase the capacity of the roadway network to accommodate the expected traffic volume increases as the area population expands. This will reduce the need for as many roadway widening projects and allow infrastructure investment in other high priority areas.

COMMUNICATION AND FIELD EQUIPMENT OPTIONS

This project evaluated communication networks and current technology capable of providing a comprehensive, citywide system solution with sufficient bandwidth and sustainability to provide communication to all existing and proposed traffic signals in the City of Sugar Land as well as other departments. The primary communication mediums available are fiber optic cable, Wi-Fi and Wi-MAX systems, spread spectrum systems and communication cable like hardwire ethernet or twisted copper pair cable.

Wi-Fi and Wi-MAX networks can be set up to operate at different frequencies. Each frequency has its own advantages and disadvantages. The primary frequencies for Wi-Fi networks are 900 megahertz (MHz), 2.4 gigahertz (GHz), 4.9 GHz (reserved for public safety), and 5.8 GHz. Wi-MAX operates at 2.5 GHz in the United States. The City determined that the 4.9 GHz frequency would be the most advantageous. The City plans to establish a fiber optic system in the future.

CCTV cameras with pan, tilt, and zoom (PTZ) capabilities will be installed at strategic locations to supplement existing camera locations. The cameras will be located on key traffic signals along the major arterials and will allow City staff to monitor areas of frequent traffic congestion. The CCTV cameras will be used to observe the arterial street system to allow staff to adjust signal timing as needed or to verify a crash and deploy needed personnel to clear a crash quickly. The system will also assist the observation of traffic conditions during evacuation events.

SYSTEM DESIGN

A wireless backbone was designed using eight high sites. These high sites consisted of water towers, existing buildings and one new self-supporting tower. The wireless backbone will use 11 GHz microwave point-to-point radios. The wireless backbone will tie to the existing city network at City Hall and Fire Station #2 (via fiber optic connections). **Figure 2** shows an overview of the microwave backbone. **Figure 3** shows an overview of the system design. In the event that additional bandwidth is needed prior to the completion of the fiber optic system, additional point-to-point and point-to-multipoint radios can be added to the system.

The high sites will communicate with the individual traffic signals using 4.9 GHz point-to-multipoint radios. All traffic signals within the City will be included in the network. Approximately half of the traffic signals will include CCTV cameras and Wireless Access Points (WAP). The WAP, operating at 2.4 GHz, will allow staff to log into the city network from the field and reduce the number of employees requiring aircards and the associated expense. The remaining intersections will have some combination of signal controller communication and possibly CCTV cameras.

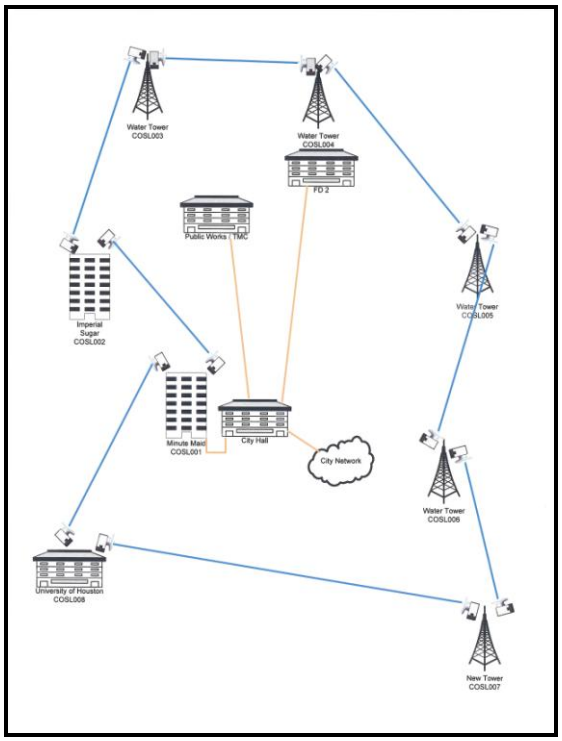

Figure 2. Overview of the Microwave Backbone

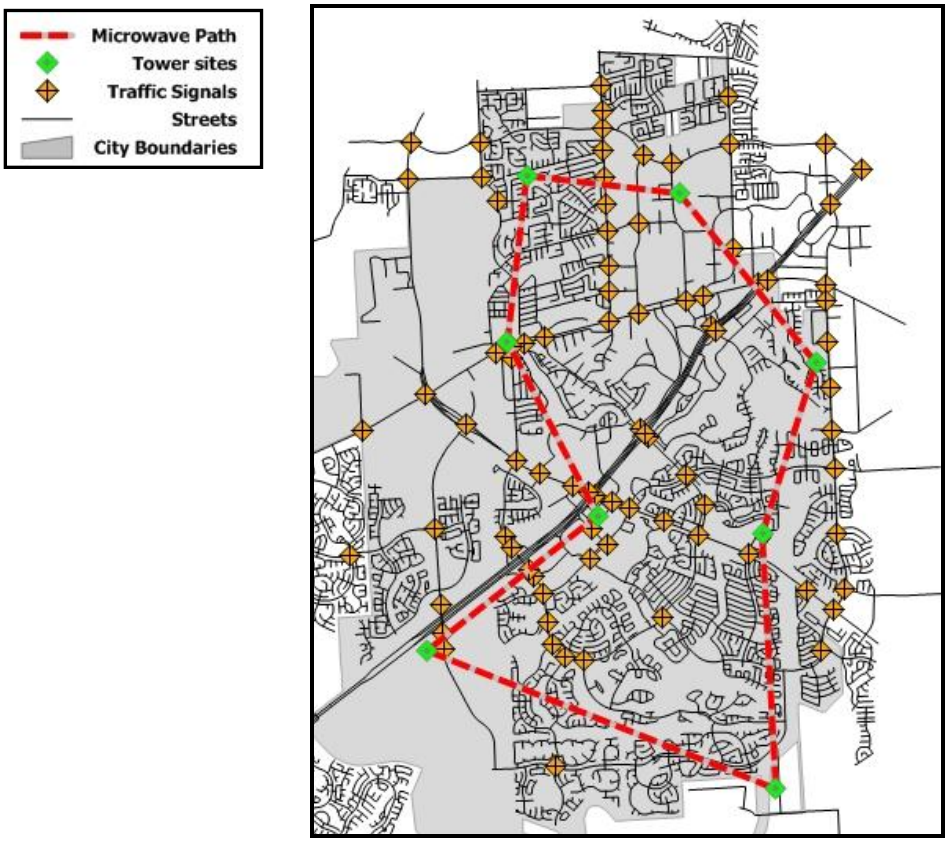

Figure 3. Overview of the System Design

Nine older signal controllers and cabinets are being replaced with TS2 Ethernet controllers. In addition, 35 TS2 signal controllers are having the faceplates replaced to make them Ethernet controllers. This will allow the signal controllers to interface with the switch and ultimately the 4.9 GHz radio better. Approximately half the cabinets had existing Ethernet switches and the rest will have switches installed as part of this project. One intersection exceeded the distance limitations for the Ethernet cable and will utilize multimode fiber for communication between the CCTV cameras and the switch and from the switch to the 4.9 GHz radio. Two locations that had cameras located away from an intersection will connect the cameras directly to the 4.9 GHz radio to communicate directly to the high site, bypassing the signal controller cabinet.

FUNDING AND IMPLEMENTATION

The project was funded through an Advance Funding Agreement (AFA) between the City of Sugar Land and the Texas Department of Transportation (TxDOT) through Congestion Mitigation Air Quality (CMAQ) funds. The AFA provided $1.9 million for construction with 80% coming from the federal government and a 20% local match. The cost estimate for the project was approximately $1.9 million. Four bids were received on the project, ranging from $1,596,099 to $2,748,650. The project is currently under construction and is expected to be completed in fall 2010.

CONCLUSION

The City of Sugar Land has a history of installing forward looking ITS projects and has recently completed a triple-left turn on the US 59 southbound frontage road to eastbound SH 6 which utilizes in-pavement markers and a dynamic message sign. Quiet zones and wayside horns were installed for the rail line along the US 90A corridor in 2009. A 1.25 mile fiber optic connection on SH 6 between the City Hall and the Police and Courts building is under design and a traffic adaptive signal system is being developed on SH 6. The Three-Tier Wireless Communication Project, along with these other additional projects, improves the efficiency of City staff and the quality of life for area residents.