The Arizona city of Scottsdale spans 185 square miles and is home to more than 225,000 people. Like many fast-growing cities in the western United States, Scottsdale has a traffic problem – one that is exacerbated by the fact that it borders several of Arizona's other large population centres, including Phoenix, Tempe, Glendale and Mesa. Meanwhile, its moderate winter weather makes it an ideal destination for numerous popular events, including the Barrett-Jackson Collector Car Auction, the Phoenix Open golf tournament and the Scottsdale Arabian Horse Show – all of which bring thousands of additional vehicles onto the city's streets.

In 2008, city administrators implemented the initial phases of an advanced traffic management system aimed at alleviating the mounting gridlock. Digital cameras were installed at key downtown intersections and connected to a state-of-the-art traffic management centre (TMC). Where possible, the camera pods were hooked up to existing fibre communication lines. For other locations, leased T1 circuits were installed. While extremely effective and reliable, the recurring costs for the T1 lines were considerable: approximately US$250,000 per year.

As plans to expand the coverage of downtown intersections were explored, Bruce Dressel, manager of the Scottsdale TMC, evaluated other options: "As the expansion took shape, we decided to eliminate the leased lines because they restricted our ability to expand the network. Further, building out a network infrastructure that we could own made a lot of sense, particularly since it would enable the city to connect other departments to the network."

The last-mile connection from existing fibre infrastructure
To replace the T1 lines, the city evaluated the feasibility of a broadband wireless network to interconnect the 100 planned nodes,

The social network

How a wireless mesh network is enabling an Arizona city to run an advanced traffic management system that reduces taxpayers' frustration and costs as well as benefiting citizens and those just passing through

Words | **Pramod Akkarachittor, Firetide, USA**

each with several pole-mounted digital cameras. During the course of the evaluation, city technicians concluded that they needed a wireless network that would provide sustained throughput over multiple hops (up to 10) between the existing fibre feed connection points and the numerous camera pole locations. ''We already have a lot of fibre in the ground, so the biggest challenge was to establish reliable, last-mile communications,'' explains Dressel. ''The question we needed to answer was 'could wireless provide that?' And could it do so within the constraints of typical downtown obstacles such as foliage and buildings, and during all kinds of weather, including dust storms and rain?''

To prove the concept, Firetide, a specialist in private wireless broadband networks, implemented an eight-hop test network that performed well over the course of one year of testing. The key advantage of a wireless mesh network is its ability to provide Ethernet connectivity anywhere, without wires. This makes mesh networks ideal for locations where network cabling is too expensive to install, such as busy urban settings, historic buildings, outdoor locations and temporary venues.

To all connected systems and equipment, the entire Firetide HotPort mesh network functions as an Ethernet switch. Therefore, any Ethernet device can operate over the mesh without any additional set-up, drivers or special software. Any device – IP camera, DVS, server, PC, etc – simply connects to one of the Ethernet ports on a HotPort node exactly as it would to a physical switch. A Firetide solution is a layer-2 mesh; it is independent of IP, the layer-3 protocol. Thus it is fully compatible with existing network systems and does not require any special IP configurations, unlike some wireless products.

Automatic transmission

Firetide's AutoMesh technology ensures network performance and stability. It automatically prioritises, load-balances and synchronises the multiple video streams that are being transmitted concurrently throughout the mesh network. By encapsulating each packet and using MAC ACL filtering, AutoMesh enables the intelligent transportation system (ITS) to pass the required multicast video traffic seamlessly through the wireless network, while simultaneously blocking egress onto the mesh network of any unwanted multicast/broadcast Ethernet traffic emanating from the city's LAN network. Where possible, the mesh topology was deployed with the use of a ring topology, with AutoMesh automatically re-routeing video traffic to bypass any link or node that the network detects is experiencing an outage in that mesh segment.

An additional benefit is that each Firetide 7020 node offered an integrated three-port Ethernet switch, which negated the need (and a per-pole cost of US$1,500) to install a separate ruggedised Ethernet switch at each camera location.

Scottsdale's ITS delivers substantial, tangible benefits

Scottsdale is a forward-looking 'smart city' that is focused on implementing technology to improve its critical infrastructure while saving taxpayer money. Migrating from its existing leased-line communications network to the wireless infrastructure mesh network is saving the city approximately US$250,000 a year in lease fees alone, and will deliver full ROI in only four years.

The ITS also delivers a whole host of additional benefits to the Scottsdale locals and visitors.

Firstly, dynamic signal control means that when collisions, spills or stalled vehicles occur, operators can immediately adjust signal timing to minimise traffic congestion.

Enhanced roadway safety is another benefit. The system enables the immediate detection and reporting of incidents to police, emergency services, media agencies and the public (via roadside signage).

The next advantage relates to media alerts. The ability to quickly identify traffic congestion as it occurs and – just as importantly – as it clears, and then notify local radio and TV stations, cannot be underestimated.

Effective event traffic management is another result of the new system. Costs are dramatically reduced through centralised traffic management and by eliminating the need to deploy police officers to direct traffic.

Proactive traffic management also improves safety through work zones.

Meanwhile, the ITS enables Scottsdale to keep travel time on city streets steady and, where possible, try to reduce travel times as traffic volume increases due to population growth.

Lower environmental impact is a noteworthy side effect of the new ITS due to improved downtown traffic conditions and reduced fuel consumption.

Looking to the future: expanded coverage and access

Cost-effective and relatively easy scaleability is a key benefit of a wireless mesh network. The Firetide mesh network enables Scottsdale to expand the geographic coverage area and the camera density to encompass hundreds of additional cameras, or any other IP-based equipment such as traffic signal controllers or other sensors by simply deploying additional nodes as needed throughout the network topology. Additionally, since the mesh network can handle

Wireless broadband network characteristics
• **Coverage:** The wireless mesh network covers more than 25 square miles and consists of more than 100 traffic camera nodes located throughout the city of Scottsdale;
• **Hardware:** Each traffic camera and signal controller cluster connects to a Firetide Hotport 7020 dual-radio mesh node, with the nodes segmented into multiple mesh networks. Each mesh originates at a traffic signal control box that terminates on the city's fibre network;
• **Software:** All of the meshes are hierarchically managed via the Firetide Hotview PRO network management system, which enables city technicians to push configurations to any or all Firetide nodes, troubleshoot problems and manage encryption settings;
• **Cameras:** Vicon and Axis digital cameras with pan-tilt-zoom.

(Top) **The city of Scottsdale is embracing the power of ITS to manage its roads infrastructure** (Above) **More than 100 cameras feed into the TMC, enabling operators to get a bird's-eye view of traffic conditions**

❝We're confident our wireless mesh network will give us the headroom we need to expand and address new possibilities❞

high-bandwidth mobility applications, Scottsdale can deploy in-vehicle nodes in police, fire and emergency response vehicles, and give them seamless mobile connectivity to the city's high-capacity network. Where might it all lead to? Bruce Dressel is already planning for a future that might be closer than one would imagine: ''There are applications on the horizon that we must begin to plan for today, such as vehicle-to-vehicle communications and roadside-to-vehicle communications. We're watching the emerging dedicated short-range communications (DSRC) standards so we can ensure we can offer downtown drivers the latest traffic and safety information. We're confident our wireless mesh network will give us the headroom we need to expand and address these opportunities.'' ◾