
Wireless Traffic Systems

UK Councils have the unique opportunity to create wireless communication systems that cover whole cities.

Fixed line costs can be reduced significantly by utilising the existing infrastructure.

Enhanced service levels are provided to both the general public and council employees.

802.11 b/g systems fail due to blocking and security concerns but a Mesh Network based on military communication works.



Summary

Experience with Portsmouth City Council's network, operational since December 2003, has allowed Now Wireless to implement traffic light communication systems in partnership with Peek and Siemens. These are currently being trialled in Portsmouth and Glasgow.

Capital costs are lower than those for civil engineering work of typical UTMC systems, and with no revenue costs.

Technology employed is a military Mesh Network technology called **Mesh4G**.

Wi-Fi (802.11b/g) failed to provide the service because of the blocking problem.

RTI can be done with **Mesh4G** as it operates on moving vehicles. Bus Priority and Clear-Down issues are solved.

Scope of the Mesh Network can encompass RTI, Car Park Counters, Variable Message Signs, Information Kiosks, Bus Stops, Ticket Machines, Council Workers, Buses and CCTV.

Introduction — Why Wireless for Councils?

In the present wireless digital world, it is now possible to provide integrated communications for councils with no revenue component. With their physical infrastructure, Councils are in a very commanding position to install digital systems with a wireless infrastructure.

Traffic lights are not the only application to benefit from wireless; other areas are real-time passenger information, CCTV, parking ticket machines, variable traffic signs, Council workers, emergency services and schools.

With the advent of Urban Traffic Management and Control systems (UTMC), there is a need to provide information from the traffic light controller back to the Central Server. Either this is an existing system, based on serial communications which requires replacement, or a new communications connection. In most cases the use of a wireless system has an equal or lower capital cost than an equivalent cabled solution (taking into account the required civil engineering). In addition, the wireless solution does not incur a revenue cost.

For UTMC-connected traffic lights, a communications path must exist back to the control centre. This can be accomplished by the use of Mesh Network clusters. Traffic lights are connected via Mesh Nodes to each other, and then via an Access Point back to the Network Control Centre.

Each Mesh Node provides an opportunity for other devices to route through it, either by direct connection or by a wireless connection from a nearby node. CCTV cameras for traffic monitoring can be easily and cheaply connected this way. In fact, connections for multiple cameras can be put in place at one junction.

What Can It Do?

Mesh4G, a street-level wireless Mesh Network, provides a low cost connection between traffic lights, buses, Council employees, bus stops, CCTV, ticket machines, variable message signs and the Council offices. Traffic lights are converted from standalone operation by the installation of a wireless point in the control cabinet with a cable running to the nearest traffic pole. Just a small box with an aerial is installed, connecting to existing mountings on the pole, and installation is complete.

No major engineering is required and the traffic light can now communicate with devices such as other traffic lights or central servers.

The wireless device can communicate through up to five or more devices before reaching an Access Point, which then connects via a higher-level network to the Control Centre. The higher-level network can consist of ADSL, EPS9 circuits, 5.8GHz wireless or any other existing communications medium.

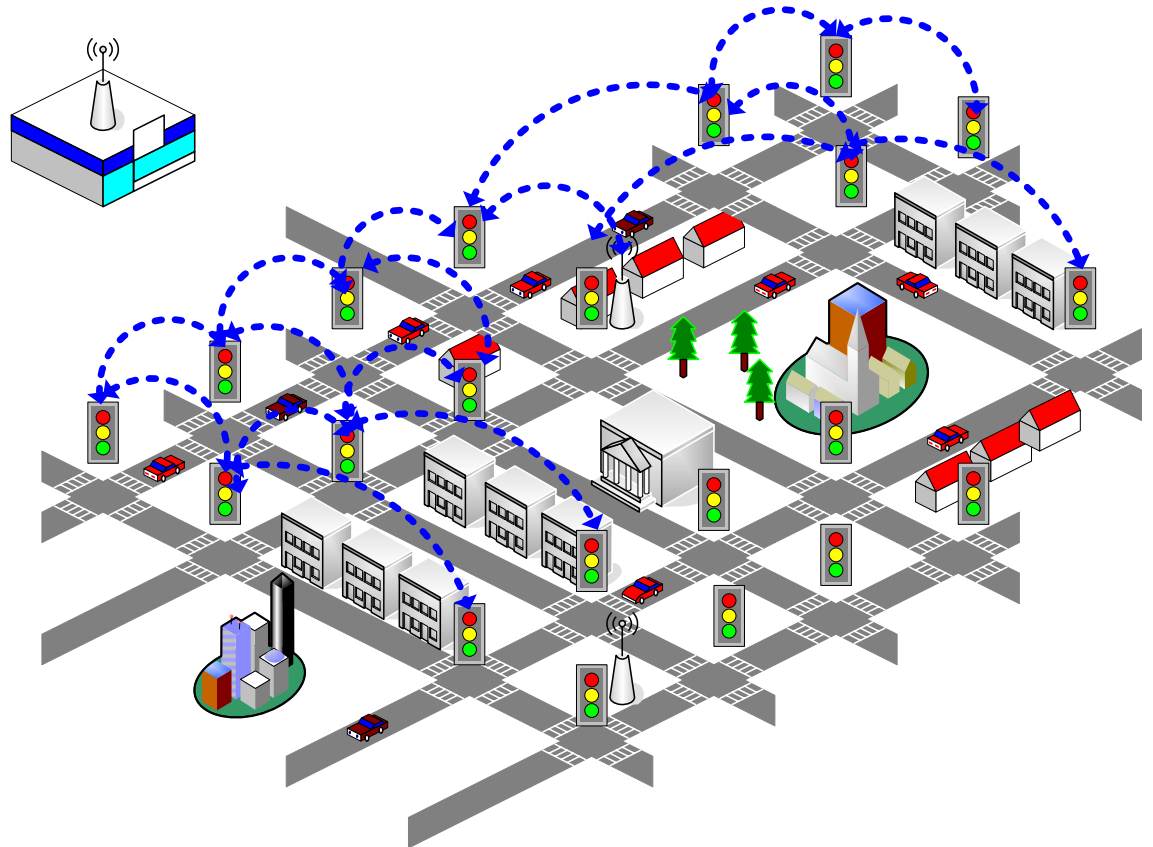
If a gap in reception is found then a Wireless Repeater can be used.

Devices are then installed within range of any of these wireless points to provide services including access terminals for variable message signs, bus stops, etc.

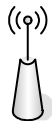
Buses with a **Mesh4G** device installed can communicate with the city network, providing location information to a central server or communicating directly to bus stops and traffic lights. They in turn act as extra dynamic repeaters in the network, providing additional resilience. The more nodes that are deployed, the more traffic and resilience the system can deliver. Traffic does not all need to go to the centre; it may go from point to point as needed.

In out-of-town locations where a street-level Mesh Network is not required, connections using 5.8GHz can be made at a cost similar to or lower than the Mesh Nodes. If more equipment is needed at a later time then a **Mesh4G** Access Point can be installed and a local cluster of devices managed.

CCTV traffic cameras can be installed on the network anywhere within range of a traffic light. There is no requirement to install special circuits. If detectors are required, these can also be connected back to the traffic lights via wireless.



2.4 Ghz Mesh



5.8 Ghz Mesh

Why Wireless for Traffic Lights?

The disruption and cost of civil engineering work, together with the delays involved waiting for communications cable installation, have resulted in

headaches for traffic managers. Great hopes were generated by the introduction of wireless technology; however, to date it has not resulted in effective systems. In short, the wireless technologies were not sophisticated enough to provide the resilience needed.

In the wireless world there are two levels of sophistication: on the one hand, the world of GSM and 3G, which have billions invested in their respective technologies. On the other, the 802.11 world uses \$15 components and does not have the resilience needed for street-level deployments.

Now Wireless has an extensive range of wireless products ranging from £60 value 802.11b/g access points to sophisticated 5.8GHz systems giving 20 mile coverage.

Three years ago, Now Wireless was brought in by Portsmouth City Council to deploy a street-level network. As the 2.4GHz band was licence free and capable of penetrating buildings, it provided the best solution. However, EC regulations limit the power of these networks to 100mW, whereas in the US and Far East power levels of 1 or 2W are commonplace. GSM handsets use 500mW–1W. Wi-Fi (802.11b/g) was investigated but it was found that, with only three non-overlapping channels and a very primitive radio, it was very easy to block. A person with a notebook computer could easily stop a Wi-Fi transmission. This solution ignored the security issues of Wi-Fi, which can be solved, but no solution was found for the blocking.

In our review of available technology, we found a military system which had had some \$350 million invested in it. This technology was a Mesh Network which employed military-grade encryption and was designed to be resistant to all attempts to block it. This was one of the most complex wireless technologies we had seen, with four individual radios with multi-tapped receivers for dealing with reflections, as well as full Doppler correction to allow operation aboard moving vehicles (tested to 250mph). Each radio acted within the network to provide transmission of a signal from one point to another, selecting frequency and route according to available resources. Currently used by the US Military, a commercial

lower cost version with a PCMCIA card in the sub-£500 category made this an obvious option.

Portsmouth has had this Mesh Network installed for over a year. Excellent service has been provided without disruption at the street level.

Brief Overview of Other Wireless Technologies

Mesh4G is a system utilizing three pieces of technology to provide a network with multiple redundant paths. It is designed to utilise the 2.4GHz and 5.8GHz unlicensed wireless bands. The 2.4GHz network provides the street-level communications while the 5.8GHz provides longer distance communications.

Technology History

2G is a GSM network with dial up data with up to 14.4kbits/sec

2.5G is a GPRS network with up to 44kbits/sec

3G is a UTRAN network with speeds up to 384kbits/sec

Mesh4G is a mixture of 2.4GHz and 5.8GHz networks using hopping technology to make connections, with speeds of up to 54Mbps/sec

Mesh4G networks also include a mixture of fixed-line communications to fill in areas where wireless communications are not practical, especially on the links returning to the Network Control Centre.

2.4GHz wireless uses only 100mW but can penetrate two brick walls on average, with a free-air transmit distance of approximately 500m. 5.8GHz has a transmit power of 1W and has a transmit distance of some 18 miles, but cannot penetrate anything. GSM in contrast has a transmit power of 1W in a phone handset.

The Now Mesh4G Solution — How Does It Work?

Infrastructure

To provide a city-wide communications network, two networks are required. The first is a street-level network which allows individual nodes to communicate with each other and with the Network Control Centre. The second is a backbone network that allows for secure and resilient high-capacity data transfers.

In the street-level network, individual nodes connect to each other before jumping to the high-level network to access the central system. These points where the two networks join are called Access Points.

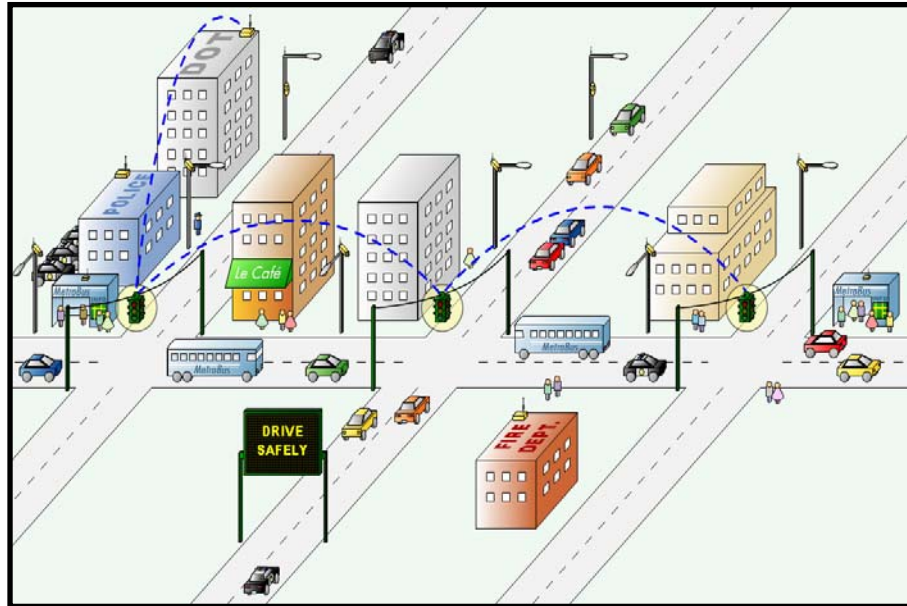
The backbone network consists of a number of different technologies to allow for maximum utilisation of the existing infrastructure; fixed links such as ADSL, fibre, etc., in addition to wireless.

The street-level network operates at 2.4GHz using a QDMA® (Quadrature Division Multiple Access) transmission over four independent 20MHz channels, with dynamic channel selection on a node-by-node and packet-by-packet basis. Each packet is routed by the optimal route at every transmission. This communication is designed to allow information to be carried over any available spectrum and route around congested areas.

Each node within the network acts as a Wireless Repeater, so the more nodes there are in the system, the more traffic it can handle. Each link is unique and capable of handling 6Mbit burst and 2Mbit sustained. All wireless traffic is encrypted and designed to be non-blocking. It would require a city-wide attempt to stop communications by using transmissions from other radio equipment.

Each Mesh Node finds a communications path to the Access Point which then uses a directional wireless system in the 5.8GHz band to transmit the signal to the nearest physical connection to the Council Building. This can be situated on the Council Building itself or to other points where high speed access is available, such as CCTV camera poles.

It is recommended that a traffic light be no more than five hops from an Access Point, though more hops are possible. Multiple paths back to the Council Building can be created by the use of more than five hops so that redundancy can be built in. This gives a 2.5Km radius on each access point dependent on geography of the city with the potential of 100+ nodes per access point.



System Components

Mesh4G Nodes

These allow different types of street and vehicle equipment to converse with each other over a wireless connection that hops through other Nodes as needed.

Mesh4G Access Points

All the Access Points are connected together at the Network Control Centre. Not only does this allow individual Mesh Nodes to send data to the Central Network, but it also allows Nodes which have no wireless connection between them to communicate as if they did.

Mesh4G Backhaul

These links allow the Access Points to connect to the Network Control Centre and communicate with each other. They also allow for higher-capacity fixed devices to communicate as well.

Devices

Street Level Devices

M4.4030 – Mesh4G Node PCMCIA – Traffic Light Vendors may integrate into their Controller

M4.4020 – Mesh4G Node Ethernet Connection

M4.4050 – Mesh4G Node Ethernet Connection External

M4.4010 – Mesh4G Wireless Repeater

M4.4000 – Mesh4G Access Point

Building Level Devices

M4.5000 – Mesh 4G 5.8GHz Access Point

M4.5010 – Mesh 4G 5.8GHz Access Point and Repeater

Prices

In a typical installation a Mesh Node ranges from £500–£1150. For design purposes we would normally recommend that no wireless node is more than five hops from an Access Point and that they are approximately 400 metres apart, depending on the environment.

Wireless Access Points cost £2500.

Wireless Repeaters cost £1950.

Wireless 5.8GHz nodes range from £700–£3000 per link depending on the distance and speed required. Distances of up to 18 miles are available, and even 30 miles with enhanced wireless devices.

A detailed presentation is available on the technology — please contact brian@nowwireless.com.

Consultancy

Now Wireless Ltd has been involved in many wireless projects over recent years. These include the wireless gateways for the police's new Tetra system, the implementation of the data element of the 3G network on the Isle of Man, and many other projects. Now Wireless has, in the past two years, worked with Portsmouth City Council to implement a wireless strategy for their RTI, traffic light and CCTV systems, as well as extensions for car park signs, variable message signs and ticket machines.