

Mobile WiMAX Acceleration Group

Customer Experience Report

22nd July 2009



M-WAG Membership

The current M-WAG membership is as below;

- Alvarion
- Bluenowhere
- EADS
- MLL
- Mobile Sense
- Mott MacDonald
- Urban WiMAX

In addition M-WAG received valuable contributions from the following organisations who were previously members

- Analysys Mason
- National Grid Wireless (Arqiva)
- Nortel
- Quiconnect
- Red-M

M-WAG vision & strategic intent

To create a powerful cross market industry voice which will communicate clear and consistent messages of the relative purpose of WiMAX and its value to consumers, business and government organisations.

The Mobile WiMAX Acceleration Group has been formed to prove the business case, user experience and technology for mobile WiMAX by road testing an end-to-end value chain through a series of showcases covering local government, emergency services and a university & college.

M-WAG Objectives

Promote a national deployment of WiMAX in UK and Ireland by establishing proof points on key elements of the business case;

- Qualify what WiMAX can actually do through trial 'proof points' from an objective and neutral position;
 - Demonstrate broadband wireless connectivity and usage diversity across a range of applications and market segments;
 - Prove a supply chain exists that is inclusive of all end-to-end components, is open and multi-vendor;
 - Establish identity with link to capabilities that can be re-used – at least across Europe;
 - Create a legally independent alliance that promotes and incubates 4G in Western European (mature market) deployments.
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1 Executive Summary

This report outlines the WiMAX business applications trials carried out by M-WAG during Sept 2008 through to May 2009. The trials consisted of:

- A Public Safety trial was performed by EADS Defence & Security to test the effectiveness of WiMAX as a technology for improved situation awareness and decision making in the emergency services, M-WAG was supported in the trial by Kent Fire & Rescue Service.
- Two CCTV trials and an enterprise mobility trial carried out with the support of Maidstone Council.

We present the business needs driving the adoption of a wireless/mobile data service. We have recorded user perceptions as they relate to the user's everyday experience of integrating the technology with the jobs which need doing, rather than with reference to any technical standards. Where applicable we have identified areas of potential cost savings, in some cases it has been possible to quantify these, where additional benefits have been noted by users have been recorded.

In addition M-WAG presents

- analysis of potential market revenues and roll-out costs,
- likely WiMAX technology roadmap

Where additional applications, device and infrastructure have been determined to be required this is also given

2 Fire & Rescue service WiMAX trials

2.1 Outline of fire and rescue service requirements

The emergency services use a Tetra based network for its voice communications, it is narrowband and therefore unsuitable for broadband applications such as video in any volumes.

Video is currently not an option for the management and control of incidents and disasters within the emergency services. Satellite services are currently expensive and may range into £100s per month per appliance for relatively narrowband services, and hence are not universally deployed.

For very serious events eg like the Buncfield fire, it is anticipated that information can be relayed not just to the local emergency services but to the most senior levels of decision making; to enable decisions such as deploying the army to support. It may also be possible to inform local authorities to support such things as decision making on re-housing etc.

The purpose of this trial is to explore how video might be used in situational analysis to help those in command of emergency situations such as fire, flood or major road traffic accidents to improve the speed and quality of decision making around an incident.

Mobile WiMAX is currently viewed by EADS as one of a number of technologies which will be used to provide broadband wireless data for the emergency services.

The FRSs (Fire and Rescue Services) operate a three tier command level structure;

- Bronze – tactical, at incident
- Silver – overall incident command
- Gold – strategic HQ

There are four types of urban search and rescue fleet:

- Heavy rescue for incidents involving lorries and trains
- Building collapse, containing equipment for shoring, breaching and breaking
- Technical rescue with cameras, listening devices and dogs
- Winches for access via drop-in where other entry is too dangerous

These are all deployed to complex incidents which may need some sort of strategic management in addition to the incident crews deployed to the scene.

2.1.1 Aerial views to support strategic incident management

Aerial shots of the area immediately surrounding a disaster zone taken by for example a helicopter might reveal roads which can be used, and more importantly those which can not due for example, to congestion and whether there might be additional hazards not listed on GISs (Geographical Information Systems). This information will support local decision making at the FRS control room on the strategy for handling the incident.

If people at fire control can “see” everything a fire officer can see on entering the area of an incident, they can provide strategic management without the inherent delay and lack of clarity of voice communications.

2.1.2 A video service can save time and effort at the incident

This is particularly useful for large incidents eg a train crash where crew allocated to rescue in one carriage can receive video brief directly from that carriage, whilst travelling to the scene in a fire appliance. This could save valuable minutes which could potentially reduce loss of life and damage to property.

2.1.3 A camera on a mobile appliance to reduce vandalism

One problem that 999 vehicles can suffer from, is anti-social behaviours such as youths throwing stones at them whilst en-route to incidents. Many fire appliances are fitted with anti-vandal cameras. These store video data on a hard drive fitted within the appliance. In some instances the data on these recorders must be recovered manually within 48 hours of an incident. A WiMAX device on these appliances removes this operational cost as the data can be streamed (during non-busy hours) and the data stored directly on the fire & rescue services' servers. If the appropriate measures are taken as regards audit trail then the data may be used for evidential purposes in any ensuing prosecution.

2.1.4 Aerial view of the incident provides benefits

This provides a bird's eye view of the incident. For this small incident the ground camera provided an excellent view of the incident. However for incidents where the fire appliances are used to create a cordon around the incident this may not be the case and the aerial view would be the only way to give the control centre a good view of the incident.

For warehouse (or other large structure) fires an aerial thermo graphic view will identify which part of the building is hottest and therefore the seat of the fire. This can influence the way the fire is attacked.

2.2 Network and systems configuration

2.2.1 At scene set-up

At the scene of the incident two cameras were deployed:

A tripod mounted ground camera was deployed which is a “one-man” lift device and comes equipped with an easy set-up tripod, which can be quickly deployed at scene. It would be possible to deploy several of these in a complex incident to get views from different angles. This was connected to a CSU (Command Support Unit), a transit sized vehicle equipped with screens and relays. The ground camera was not moved during the incident.

A “Sealview” aerial camera, which was able to show a bird’s eye view of the incident and also its surrounds. This was mounted on the FRS’s ladders.

The “Sealview” and tripod mounted camera form a mesh network on start-up, this takes 30 s to “boot-up” into an operational state.

The FRS’s use of visuals needs much less panning than perhaps a police requirement as incidents tend to be stationary in the short term.

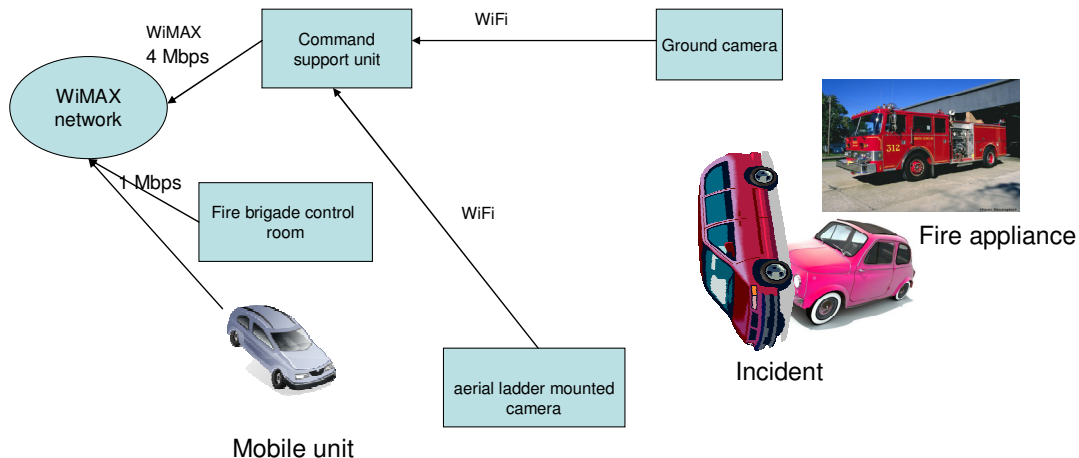


Figure 1 Showing logical flows of video information

The command support unit, an at-scene control facility acts as a relay sending video from the fire to the fire control centre. The command support unit itself hubs the CCTV for situation awareness.

2.3 Customer perceptions of service quality

The perception of picture quality by the fire control staff at C&C (Command and Control) was good; we were able to see clearly both the incident and the fire appliance approaching the incident.

Having the video of the incident was helpful; the FRS has a strong demand for visualisation of an incident and its surrounds. This is for strategic management of incidents.

2.3.1 Picture quality was deemed sufficient to allow the operator to control the aerial camera

At C&C we were able to see the approach of the bronze command and team, as well as the road traffic accident. This showed a clear picture, from the aerial view it was even possible to see the driver in the red car.

The video quality was good enough to track each stage of the rescue from stabilising the vehicles, to cutting away sections of the vehicles and removing the victims on spinal injuries boards. It was possible to see the soft protection applied to victims and the hard protection used whilst cutting the vehicle away.

It is possible to also pass sounds from the scene although this was turned off for the trial.

2.3.2 Ease of use of cameras over WiFi and WiMAX

The local WiFi signals have very low latency compared to the satellite alternative, the delay from moving the camera to seeing the new image is much shorter, so moving the camera for a better vantage point is easier.

2.3.3 Setting QoS and Bandwidths to achieve usability of fire control application

To be fit for purpose emergency services video must have sufficient picture quality to carry out diagnosis of the incident.

The test WiMAX network was not optimised for coverage across Maidstone, test network base-station sites were selected for ease of implementation, which would not be the case in a commercial network, which would benefit from carefully planned sites. In addition both the Kent FRS control room and training centre were on hills, with the control room additionally disadvantaged by being surrounded by tall trees, both of which make radio reception more difficult. Despite this reception was sufficiently good to produce fit for purpose video signals.

The channel sizes used were 4 Mbps at the training centre (incident) and 1 Mbps at the control room the QoS model used was oversubscription of service.

The WiMAX was used as a backhaul service from the incident, the visual information being relayed to the CSU (Command Support Unit) via WiFi from the cameras.

Frame rates used were 25 frames/second. This was sufficient for the needs of the FRS. For most fire service incidents there is little need for fast camera panning.

2.3.4 Perceived benefits to other emergency services and how these were demonstrated by the trial

For fatal incidents the police will be in attendance and they have additional data requirements.

All three emergency services need video; the police may have a greater requirement in terms of bandwidth. The police need both evidential quality and public order quality.

2.3.5 A video service can support cross services co-ordination

The WiMAX service allows the video to be uploaded to a server, access to the video on the server may be granted to all emergency services, providing all of them with the same concurrent data. It is essentially a server which receives inputs from many cameras and can be accessed by many parts of the emergency services. This removes any delays inherent in voice-voice communications when fire control needs to relay to its command for greater support, the need can be seen and can be seen concurrently.

Similarly hospital staff can see the same data, as could the police and other services that need to keep the area clear and safe.

2.3.6 Additional perceived upsides

Information from mobile sensors, instant real time reporting and CCTV can be sent from incident or control units to be used by agencies that may be first or second line responders. This allows for better decision making, better co-ordination and responsiveness of first and second line responders.

2.3.7 Video support can be used to determine whether or not the incident needed to be escalated

This incident was a small managed incident and clearly did not need to be escalated, however for larger incidents it may be that additional appliances would be needed, the video would inform command and control of this without the delay and distraction of voice communications from the incident.

2.3.8 Types of incidents perceived to benefit most from video services?

Video services are required at the following incidents:

- Anything large, where the whole incident cannot be seen;
- Train crashes
- Collapsed structures
- Trenches
- Earthquakes

These are incidents where a number of teams will need to be deployed and hence co-ordination between the teams and management of additional resources is required.

In the view of fire control video support at incident is something which should be standard for fighting fires

In the view of Kent FRS incidents that would need strategic management are:

- Road traffic accidents of four or more vehicles: in a case where additional fire appliances (or ambulances) were needed.

Video of the surrounding road conditions would enable command and control to be able to route any of these additional appliances via un-congested roads and hence get the appliances to the incident more rapidly.

2.4 Benefits of a live video feed in emergency situations

2.4.1 Easier to brief remote decision makers

Normally the incident team are entirely responsible for decisions made at scene.

The ability of the officer in charge of the incident to brief remote decision-makers is significantly improved by having live video streaming from the incident scene, particularly compared with current practice where broadcast news may be the only source of visual data from a scene.

For example, redeployment of fire fighters can be difficult when only voice communications is provided (the difficulty of visualising the incident and how many fire-fighters are needed at point A and B, when everything must be described by someone at the incident to someone at the control centre). Currently the fire service manages locally whereas the police manage remotely at such incidents.

When there is also a need to share incident information, amongst first responders, for purposes of co-ordination; video data means that delays introduced by “voice-only” communications can be reduced.

2.4.2 WiMAX can support integration of information resulting in superior strategic control

During the trial GPS information transmitted from the land rover, communicated the position of the mobile appliance and this was plotted on a 3-d image of the incident so that Land Rover’s approach to the incident could be seen.

The video information provided over the WiMAX backhaul was integrated with GPS positioning data using the EADS application. The application was developed as part of Project DYVINE a collaboration of EU funded and EADS development. A wireless network would not only support video but could integrate information gathered by various sensors thus allowing the integration of:

- Fire alarms
- GPS sensors
- Video alarms
- Smoke alarms
- Other sensor feeds.

The tool carries out analysis of all of these inputs to provide consolidated information to the operative, reducing the amount of inputs the operator must process. For instance a video camera can be set to send an alarm if it detects motion or smoke alarm signal can be overlaid with geographical information so that the operative gets this information.

2.4.3 Strategic decision making is eased

The ability of the officer in charge to receive advice and guidance is enhanced with the use of quality video feeds. Something that today would require “on site attendance” could in future be handled by expertise at regional or national level.

For incidents which are still ongoing as light fades co-ordination of lighting to the scene would be carried out by C&C. With a video recording the events then C&C can more easily determine when lights need to be sent to an incident.

The aerial camera is also capable of using thermal images which can be used to identify the hottest part of the building, so whereas it may not be possible to see through the roof, the hottest part of a blaze can be detected. This visual information can be relayed both to the mobile CSU and C&C simultaneously, meaning that fire-fighters on the scene and the C&C centre both know where best to deploy the fire fighting team.

2.4.4 Live video saves time at the incident

An appliance fitted with a WiMAX receiver could receive video of the incident as they are driving to the scene. This allows the bronze commander to determine the tactics for tackling the incident when they arrive. For instance, who in the team will be responsible for each task:

- glass management
- cutting vehicle away from victims
- first aid to victims

This can save valuable seconds so that loss of life and injury can be minimised.

2.4.5 The combination of live ground and aerial feeds help diagnose the severity of the fire

Video input could help determine whether the incident is severe and requires additional resources.

2.4.6 Post incident debriefing is easier

After incidents there are a number of debriefings these are essential for learning purposes:

- Hot-wash debrief, -this is used to determine any learning outcomes, it is anticipated that the quality of these will be much enhanced with the availability of video, rather than depending on the memories of fire fighters themselves. This is one way that fire fighters learn and become more effective at their jobs.
- Critical incident debriefs occur wherever there is a fatality or injury,
- Structural debriefs are carried out whenever there are four or more “pumps” (and hence crews) at an incident. For larger incidents the response times slow down, due to the added co-ordination effort required. With concurrent access to a video of the incident some of these co-ordination delays could be reduced or even eliminated.

John West of Kent Fire & Rescue service thought that the trial went well, he stated:

“The trial went very well and it demonstrated just how useful the technology is for enhancing the delivery of risk information. It also highlighted to us just how valuable a role it can play in post incident de-briefing and also for training purposes.”

2.4.7 An ability to lock-on to existing CCTV cameras by the mobile control centre provides additional information

Highways cameras could in the future be networked to the emergency services, providing additional information concerning the surrounding areas. This allows local government to leverage more value from the cameras it already has.

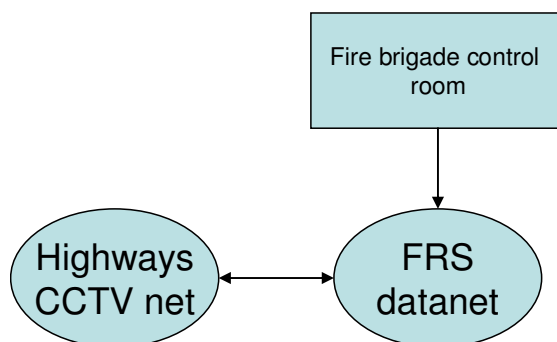


Figure 2 FRS control could temporarily take control of Highway CCTV cameras at incidents to improve strategic control

2.5 Estimated cost saving for end user

The FRSs do not currently have a wireless data service. Savings are likely to be made due to more effective fighting of fires and deployment of resources.

WiMAX needs to be cost effective to be useful to the emergency services. A cost to the fire service of greater than £100 pcm per appliance is deemed to high.

The sporadic nature of the demand for such a service may offer the potential to align service charges with demand, for example through the use of time based billing, which could eliminate the ‘dead money’ problem arising from high fixed monthly charges.

The emergency services may not be given their own spectrum, and so may have to procure a fully managed service on a public or virtual private network.

3 Maidstone Council CCTV trial

3.1 Outline of CCTV service requirements for Department of Anti-Social Behaviour and Violent Crime Reduction

The role of the team is to reduce anti-social behaviour, violent crime through developing a partnership working

- within the council
- with external parties

The cross functional partnership works together to solve problems, - to reduce environmental and other crimes, eg,

- dog fouling
- repeat victims of crime

and generally those things not covered by the police

As part of this remit the team are responsible for the deployment of both covert and overt CCTV cameras.

Meetings are held to facilitate solutions within the community. Complaints are followed up by a visit from Council employees. On average the department handles 2-8 visits per day. The more visits that are necessary the more report writing is involved.

3.1.1 Funnelling of criminal activity

Where CCTV cameras are deployed criminal activity stops, a series of cameras can be used to funnel criminal activity into predefined areas that may be better patrolled by police. Having mobile CCTV cameras makes this an easier task and also allows the Council to move surveillance to crime hotspots.

3.1.2 Support for an increased number of CCTV cameras

There are 116 fixed cameras, connected by fibre, the telecoms bill is approximately £40-50k pa.

In addition there are currently twenty-one mobile or rapid deployment cameras.

The mobile cameras either use wireless; 3G, COFDM, and WiFi to communicate or store images locally for later collection. For 3G usage charges are very high and so use is minimised, for COFDM there are no usage charges, it is a point to point wireless system, however the transmit/receive units are typically £1000s rather than the £100s associated with a WiMAX unit.

3.1.3 The process of selecting sites for rapid deployment CCTV location.

There is an analytical process informed by police (and others), these emerging trends are used to define action that may be taken. CCTV is only one of a number of actions that the council may take. This trend information is presented at meetings (held every two weeks). The problems tend to be very dynamic, for example, three burglaries may happen in one street in a week, so in addition to the two week process it is required to be able to schedule camera moves based on urgent direct calls to the council.

All parties bid for the movement of cameras to particular sites. A prioritisation process is applied as there are usually more bids than cameras. For instance the housing association may have littering as its top priority but this requirement may be judged of lower priority than others by the group.

The cameras may be used in scenarios involving burglary, noise nuisance and to protect council staff who may be issuing tickets to litter louts and fly tippers. Direct monitoring of litter louts and dog foulers is not done by CCTV.

Once defined the locations and actions are minuted for future reporting and measurement purposes.

This process has been in operation for about eighteen months.

3.1.4 Camera moves and camera hotspots

There are 250 camera “hotspots”, these are all currently deployed on lamp-posts (because of the need to connect to mains electricity).

To set-up a new hotspot requires a qualified electrician, once set-up there is a camera set-up process operating on a 15 minute response, using internal resources. The allocated cost of a move to the council is £250. It is expected that over a period of time the hotspots will gradually increase in number.

Anecdotal evidence suggests that problems stop when cameras are deployed. It has been suggested that dummy cameras would have the same effect but Maidstone Council never do this.

Success is jointly measured by the partnership and centres on the reduction of anti-social behaviour and crime.

On average the mobile cameras are moved once per month.

3.1.5 Required network quality

It is anticipated that WiMAX will support by sending pictures back in real time. All cameras used must be capable of providing evidential quality video.

The service needs to be of sufficient quality to deliver 25 frames per second with little observable latency. It must also be a robust service. If it meets these criteria it can be potentially contribute to costs savings.

If it is to be used for covert police operation support eg such as tackling drug gangs then it must support confidentiality (strong encryption).

3.2 Network and systems configuration

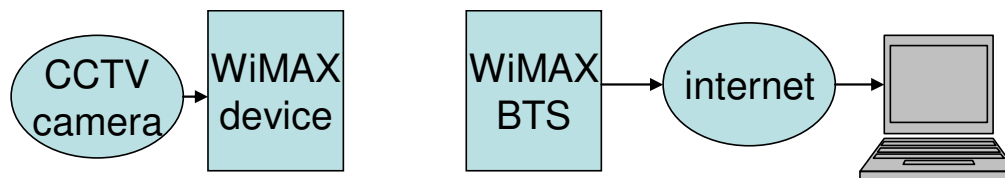


Figure 3 CCTV camera was fitted with WiMAX card to communicate with the WiMAX trial network

There were two mobile CCTV cameras fitted in Maidstone for the four week trial.

3.3 Customer perceptions of service quality

Formats and requirements for different business applications eg traffic monitoring, crime prevention vary and WiMAX is suitable for these formats. For this trial Motion JPEG was used as the format, this provides evidential quality video recording.

The WiMAX service was able to offer 25 frames/sec, this compared favourably with 3G which can achieve 25 frames/sec at its maximum but more typically achieves 10 frames/sec and occasionally drops to 3 frames/sec. At 25 frames/sec the picture quality was perceived by the users as acceptable and panning of cameras was easily achieved. If recording images from the CCTV camera at the control centre 25 frames/sec is required, otherwise local recording at the camera is a possibility.

The video quality was the same as Maidstone get with 3G CCTV cameras however with WiMAX the refresh rate was faster and hence better.

For good quality CCTV streams 2 to 5 Mbps is required per camera, CCTV control software can switch cameras into idle and in use mode as well as varying the resolution levels to optimise use of bandwidth amongst a group of CCTV cameras within a cell.

"I'd expect WiMAX enabled CCTV to be popular" Sam Fallon, Stryker.

3.4 Benefits of WiMAX enabled CCTV

3.4.1 Potential cost saving over more traditional connectivity services

Anecdotal evidence suggests that if price were lower the demand for wireless CCTV services would increase dramatically.

COFDM based CCTV cameras have transmit/receive units which cost £1000s per unit, whereas usage charges are low, 3G transmit receive units are very cheap but the usage charges make it difficult to allow the cameras to transmit in continuous mode, usage bills in the order of £500 per annum are not unusual and this is for sporadic use only.

WiMAX transmit/ receive units at £100 are much more favourable and a better pricing regime would make the mobile CCTV services much more attractive.

The CCTV cameras themselves are expensive, units £12,000 per unit, so that being able to move cameras and use them for multiple tasks is an attractive option to councils.

WiMAX units can be retrofitted to existing cameras so that uptake need not be dictated by camera upgrade programmes.

“It’s easy to connect a WiMAX pod to a CCTV camera.” Sam Fallon, Stryker.

3.4.2 Flexibility - camera can be easily relocated

Wireless CCTV services are inherently more flexible than a fixed service.

With a fixed service the camera has to be physically connected to the circuit and hence cannot be moved, without physically being disconnected and reconnected elsewhere. This involves the service provider sending a technician to the camera location to carry out the changes, in synchronisation with the camera technician. With a wireless service, the changes may be carried out remotely by the service provider and so the close co-ordination with the camera technician is less important.

The changes carried out by the wireless provider to support a camera move are lower cost than those services required by a fixed service provider and hence there is a potential to pass some of the cost savings to the end user organisation.

Wireless connection to CCTV services therefore supports ad hoc video in a way which fixed services cannot .

A point to point system requires alignment to work properly so that well trained engineers are essential for fitting and moves, WiMAX enabled cameras are much easier to fit as it is a cell based technology.

Once fitted the CCTV camera can be panned using the control software so that a view of the environment can be obtained, or the camera can home in on an area of particular activity. The trial showed that operators preferred 25 fps update rate, in reality 12fps is adequate for real-time monitoring and panning, but for less than 6fps operation becomes extremely difficult. Currently 3G cameras send 5-8fps on average and can use as low as 384Kbps connections.

Coverage can be checked with a laptop before deploying camera; this saves time on potentially wasted journeys and is particularly useful when determining a new hotspot location.

The feed from the CCTV camera can be accessed from the camera location (via the WiMAX network) to check it is working before the installer leaves the site. This can save on a wasted return journey and also allows cameras to be moved more swiftly. This could be useful in all weekend events where it may be determined that a CCTV camera might better be used by relocating, perhaps to areas of trouble.

The video feed can theoretically be accessed anywhere on the network by the Department. This provides added flexibility and could even be used during meetings to demonstrate issues within certain areas.

Locally stored footage could be pulled off the camera without having to send a van/man to camera location.

Feedback from end users was very encouraging, “Very good. Connection remained constant for 24hrs. Worked as well as broadband. Very high quality pictures and smooth motion” This comment was made about the footage returned from a camera operating at 1.7 Mbps with a 25 frame per second update rate.

3.4.3 Wireless connectivity for CCTV allows better support for events

Another advantage of wireless connection for CCTV cameras is that it can be used to support one-off events or weekly events, eg. demonstrations, outdoor concerts, football matches, etc.

For these types of event a wireless connection makes the CCTV camera and other video equipment easily reusable per event, thus containing the “per event costs” to sensible levels whilst allowing the local council or organisers to increase the levels of surveillance to levels they deem acceptable to enable them to manage the risks, thus ensuring crowd safety.

3.4.4 Other potential benefits of WiMAX to councils

Maidstone Council runs a car park metering service.

Meters send back data, and parking data is reviewed every two weeks to determine if there are parking problems on the streets.

There are 52 pay and display machines in Maidstone. This currently costs Maidstone £5000-6000 pa to send the data back, this is a sub optimal service, due to usage costs associated with 3G. monitoring is done only every 2 hours, a machine could be out of order for 2 hours before Maidstone identify this, in the meantime revenue is lost, so a more preferable service would be to have the meters monitored in real time.

Ideally real time information would be more useful as Maidstone will lose at least 2 hours of parking revenue if machine is not working for two hours.

The council cannot currently support same day payments as notices can only be downloaded from traffic wardens’ PDAs once per day, this is another area where a better service would help the council’s cash flow.

There is a market here for an aggressive new entrant as all council’s have parking facilities to manage.

3.4.5 New areas of automation enabled by WiMAX with CCTV

The potential to use CCTV cameras with WiMAX promises a cost reduction, which will open up the technology to areas where it is currently too expensive to use. The nature of the WiMAX network will also permit “sharing” of CCTV cameras across council departments, ie joint traffic and anti nuisance cameras. The ability to vary the quality levels opens up other possibilities for time sharing of CCTV camera resources.

3.4.6 Network Capability

For applications such as CCTV the uplink capacity of the network is critical. The latest WiMAX release from Alvarion offers 35Mbps gross sector throughput in a 10MHz channel operating in MIMO Matrix B.

Assuming a typical asymmetric traffic ratio of 29:18, this should provide a peak capacity of approximately 21Mbps in the downlink and 13Mbps in the uplink.

Whilst serving mobile devices will substantially reduce this performance due to the challenges of penetrating indoor environments and achieving good uplink connectivity, the use of appropriately positioned outdoor CPE should ensure uplink capacity on the sector can be maximised.

In addition, the ability to achieve higher order modulation, such as 64QAM in the uplink, as well as the potential to exploit collaborative uplink MIMO techniques, especially in a 4Rx environment, should drive gains in aggregate sector throughput and further improve the business case for carrying high quality video feeds such as CCTV.

3.5 Estimated cost savings

The cost of CCTV camera connection is not insignificant, below are publicly available prices for BT CCTV service components.

There is a potential for reduction of fees for fixed CCTV camera connections, see below a table detailing costs from BT Openreach headline prices. The service is available as compressed (digital) or uncompressed, analogue.

For small scale users, say using 20 CCTV cameras the following prices would apply, bulk discounts may be obtained for higher scale users but for smaller scale users discounts are not so easy to obtain. We have assumed that the CCTV cameras are located no more than 1 km from the control room.

compressed service	connection	rental	mainlink charge	connection	annual fees
	£	£	£	£	£
connected as singles	110000	24000	8000	110000	32000
connected as duals	120000	28000	4000	120000	32000
connected as quads	130000	32000	2000	130000	34000
connected as eights	140000	36000	1000	140000	37000

uncompressed service	connection	rental	mainlink charge	connection	annual fees
	£	£	£	£	£
connected as singles	160000	22000	10800	160000	24700
connected as quads	206000	26000	2700	206000	28700
connected as eights	240000	28000	1350	240000	29350

Table 1 Illustrating prices for fixed CCTV connectivity

In addition to the above costs, if the camera is sited in a location where no service provider currently has a fibre there will be an additional one time cost of digging a trench and providing ducting. The end user will be charged this amount and so more remote locations are more difficult to monitor.

Notice that the connection charge is significant and that this must also be paid if a camera is moved within the contract period, thus adding to the costs.

A wireless operation on the other hand could afford to forego the cost of the install, opting for a lower fee for re-arrangements. Thus using WiMAX for CCTV will save money whilst providing the council with added flexibility without further additional connection charges.

4 Maidstone Council Building Surveying video trial

4.1 Outline of building service's video requirements

During the trial a number of interviews were conducted with staff of Maidstone Borough Council's Building Surveying Department. M-WAG developed an understanding of the business application and in particular the areas, which were taking much resource and where staff thought that technology may offer some benefit.

Maidstone Council's Building Surveying Department is seeking new ways of improving efficiency and effectiveness of the services which they provide, in particular to use Senior Surveyors' time more efficiently and to minimise unnecessary travelling time and expenses wherever practically possible.

The Building Surveying Department carry out a number of inspections on new build and extensions. Among these are the statutory inspections, these are required by law as a minimum:

1. Commencement
2. Foundation
3. Foundation concrete
4. Over site preparation
5. Damp-proofing course
6. Drains before cover
7. Drains after cover
8. Occupation
9. Completion

Of these inspections 2 and 3 are likely to cause problems. In addition there may be intermediate inspections, where the "bones" of the building are inspected.

For example foundations may suffer from tree problems, an examination of the ground will yield valuable information to a Senior Surveyor about whether the foundations need to be modified to suit ground conditions. High resolution images of the trench are required for this.

In addition to the above intermediate inspections may be carried out. For intermediate inspections a good knowledge of structural engineering is required. This is an area where a Junior Surveyor may need the advice of a Senior Surveyor with more experience.

Examples of the kinds of problems where junior may need help;

- a new steel beam may have been designed as a support, but a brick pier may be missing. To detect this, the Junior Surveyor needs to relay, what is there, and what was planned to be there. If cracks have formed images of these also need to be relayed
- where unorthodox techniques have been used for example a ply beam, where normally a full solid beam would be used (A sheet of ply is reinforced by a number of smaller beams).

This requires not just stills but an ability to pan the local environment.

Dormer windows are another area where there is a lot of design flexibility, “a Senior Surveyor can tell from viewing the structure whether or not it is sound, whereas a junior would need advice”, Vic Datlen, Senior Surveyor Maidstone Council.

Being able to view the number of supports and bolts can determine the structural safety of the building and this is all possible using the video.

4.1.1 On site access to on-line documentation

As a result of the trial the Building Surveying Department developed its ideas on other benefits of having network access whilst out on site.

The council has rigorous standards and on-line access to these can support on the spot decision making, as to whether a building passes or fails its inspection.

Access to the Technical Index of Construction Information Services provides access to all British standards, and being able to download these and print for the benefit of builders would enable them to do a better job.

There are occasions when the council’s representatives are challenged and being able to quote and/or handover copies of the relevant standards would cut short some of these arguments.

Access to LABC (Local Authority Building Controls) information is also beneficial as this allows the look up of materials and their substitutes, - on the spot.

Access to the CLG (Community & Local Government) website allows access to changes of rules which are in progress.

The Planning Portal, which contains planning and building regulations and may also be used to back-up local decision making at sites.

BBA certificates: Building research establishment, supports the determination of alternate materials and their certification for use in certain situations.

“About 50% of builders will dispute decisions by the council and this tends to be higher when the surveyor is a junior. Having senior back-up via the video services and also through access to regulations etc. will help to reduce the time wasted by such disputes.” Vic Datlen, Senior Surveyor Maidstone Council.

4.1.2 Recording unauthorised works for evidence

From time to time some builders carry out unauthorised works in which cases evidential quality video/stills may be required.

4.1.3 Video support to reduce emergency call-outs

The council has an obligation to identify and act where dangerous structures are discovered. This results in occasional weekend and other out of hours working.

An example may be that a gutter is falling from one building and is a danger to the public, who may be passing by beneath. In these cases it is necessary for the council to determine whether the structure is dangerous or not dangerous. If a structure is dangerous then immediate action is required.

In many cases a Senior Surveyor can determine by looking whether or not the structure is dangerous. Having remote access to video of these structures could enable the surveyor to avoid unnecessary journeys out of hours saving both money and carbon producing journeys.

This is an area where the council could multi-task its existing CCTV cameras around the town.

4.2 Network and systems configuration

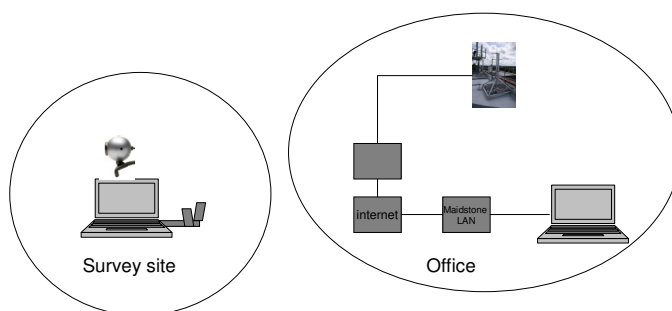


Figure 4 Showing configuration for building surveying trial

The video stream was relayed from the WiMAX enabled laptop to the receiver on Maidstone house. The M-WAG network connected to the public internet and from there through to the Maidstone corporate LAN.

4.3 Customer perceptions of service quality

4.3.1 Picture Quality

The picture quality through the webcam and over the WiMAX network, was judged to be good enough for assessing structural members. The latency was deemed irritating and it would be good to improve on this, but it should be noted that the latency issues encountered are not inherent to WiMAX, but rather the limitations encountered in this particular trial, and would not be present in a commercial network architected appropriately.

“The picture quality is good enough for what we need despite the delays when the camera is moved,” Vic Datlen, Senior Surveyor, Maidstone Council.

4.3.2 Video vs. Stills

Stills have been used by the council in the past, although surveyors had to use their own personal mobiles to achieve this. Stills have limited use and the ability to pan the camera to view the immediate environment is useful as this contains a lot of information on the general topography of a site that is useful to a surveyor.

Tree pulling is a common problem, if trees are pulled just prior to building this makes the site damper and may result in a need to review the foundation design. Builders may seek to avoid any re-design in order to minimise up front costs but at the expense of design efficacy. “Video can detect if trees have been recently pulled, the sawdust, and excess roots in the soil is a giveaway.”, Vic Datlen, Senior Surveyor, Maidstone Council.

Also brown field sites, landfill and certain rocks eg limestone and ragstone are porous and may result in the leakage of gas. These sites can be detected by video and appropriate modifications to the foundation design suggested.

4.3.3 Latency issue using internet as backhaul

With the trial set-up which used the council's existing internet access, the video suffered from noticeable latency, whilst this was annoying it did not detract from the surveyor's ability to process the visual information required.

The resolution provided by a standard webcam was sufficient for the majority of the department's needs, however for certain survey work, eg inspection of trenches a greater resolution would be required. Hence a Building Surveying application needs to have the flexibility to support both low and high resolution to minimise costs whilst maximising usefulness.

4.3.4 Devices for building surveying support

The trial system using a separate web cam and a standard office laptop was not ideal. This was clumsy to operate. Maidstone suggested that a bespoke device, a handheld with the webcam integrated might be more suitable.

4.4 Benefits of WiMAX enabled video for building surveying

4.4.1 Reduce travel time for Senior Surveyors

Maidstone could benefit by:

- reduced travelling time and greater time in the office for Senior Surveyors
- reduced disputes of decisions by Junior Surveyors
- reduced carbon footprint.

4.4.2 New areas of automation enabled by video over WiMAX?

To date the building surveying industry has not taken advantage of video, as a means for increasing automation. The technology has not been available at a sufficiently low price point to make this possible.

An enhancement to current business processes is possible if the price point can be lowered and an appropriate device developed. The existing process is as follows:

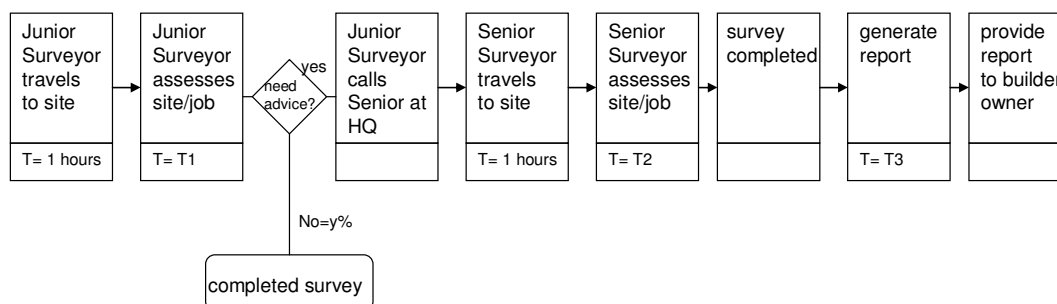


Figure 5 Showing existing process to back up Junior Surveyors

The new process will involve a Junior Surveyor taking a webcam to site whilst another Senior Surveyor reviews in real time the video footage. The objective is to ensure that the problems are spotted by the Senior Surveyor in HQ.

The time taken for a Senior Surveyor to travel to site is eliminated, leading to cost savings or better use of Senior Surveyor's time for higher value add activities.

If the technology is suitable Maidstone intend to use this technology in two scenarios:

- real time video relayed from site to HQ, where Senior Surveyor can be used more efficiently, basically none of his/her time is wasted on travelling.
- real time video is relayed from site to another site where the Senior Surveyor may be conducting another survey, offering flexibility. The Senior Surveyor can flexibly support the Junior Surveyor whilst working on his/her own caseload.

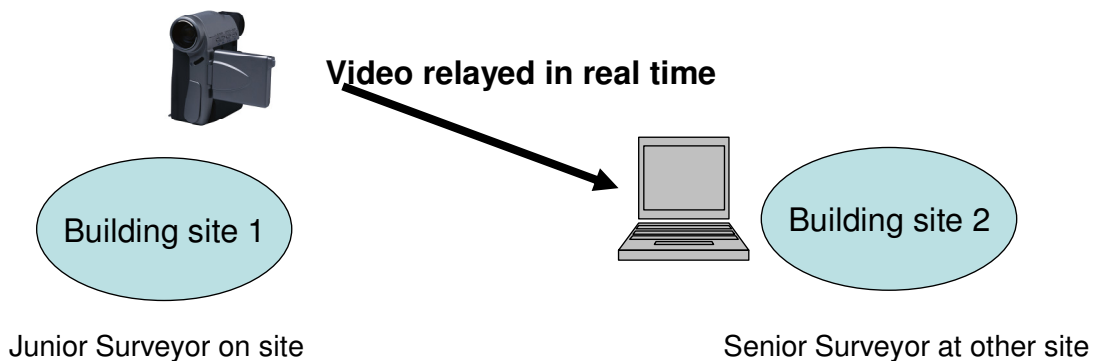


Figure 6 System is flexible enough to support Senior Surveyor on site as well as in HQ

4.5 Estimated cost savings

The Maidstone Council Building Surveying Department consists of:

- two team leaders
- three Senior Surveyors
- three Junior Surveyors.

The Building Surveying Department is called upon to survey:

- new build projects, these may be medium or large
- single storey extensions
- minor works & drainage

In an average year the department handles 160 – 170 projects.

Approximately 15% fall into medium or large new build projects, with single storey extension and minor works making up the remaining 85%.

Large and medium projects produce between 1-2 callouts per week, on average 20-30 callouts per project. Each call out consumes 1-2 hours travelling time for both an assistant and a Senior Surveyor.

Single storey extensions require an average of 8 callouts. The duration of these may vary depending on whether or not there is skilled labour on site (ie understands the building regulations.)

Surveyor time has an allocated cost of £40 per hour for a senior and £20 for a Junior Surveyor.

		Minimum	Maximum
average number of jobs	pa	160	170
big & medium callouts per project	pa projects per 3 year	24 6.7	26 10
single storey & minor callout per project	projects per 1 year	136 8	145 8
travelling time per project	hours	1	2
total travelling time big projects		160	510
total travelling time small projects		1088	2312
cost per hour	£	40	40
potential savings on large projects		6400	20400
potential savings on small projects		43520	92480
Total potential savings	pa	£49,920	£112,880

Table 2 Illustrating potential savings due to video use in building surveying

5 Maidstone Council employee mobility trial

5.1 Outline of customer requirements for employee mobility

It is hoped that a WiMAX service could also support office based communications for the Anti-Social Behaviour, Violent Crime Reduction team.

Members of the team regularly visit residents in the borough to take complaints in person. Currently these meetings are recorded using written notes and must be later transcribed into the centralised systems.

Staff spend about 50 % of time in the office and 50 % on visits. Travel times vary; for calls that are a long way from the town travel time can be significant, especially if a return journey is needed in order to enter data into systems.

Certain details are entered into a database and the complainant is issued with a reference number. This does not usually happen in real time as the staff must return to the office to access the system.

It is anticipated that the WiMAX service will enable system to be accessed in real time and a reference number to be issued on the spot, thus providing a better impression of the service, and a more rapid time to job completion.

Additionally a more full description of problem is typed up separately, also usually done at the office.

Photographs are sometimes required, these currently are also uploaded back in the office.

Sometimes staff are required to do more than one visit and so the information concerning the first visit is not entered into the systems until after the second or possibly third job is also completed.

After a certain number of jobs, staff want to come back to the office, to ensure that the information is all properly captured; they suffer information overload and fear forgetting/muddling details.

Having the system up to date would have the additional advantage of allowing staff who have had a few days off to get up to speed very quickly.

Some complainants withdraw their complaint at the thought of taking part in a court case, it is believed that when people realise that they are not the only complainant they are more likely to follow-through on a complaint. If an employee can access the system they would be able to provide the complainant with information as to whether there have been other similar complaints. This is thought to encourage complainants to pursue their complaints, thus making more effective use of the council's resources; complaints are resolved and offending behaviour stopped. Complaints which are not pursued fully still take up valuable resources of the council, and if the behaviour continues further complaints are likely to ensue.

No information can be stored on the "C" drive of laptops, this is a policy of Maidstone Council, and this means that the connection must be reliable and broadband. If the connection does not stay up for long enough or latency is too high the remote application will be unusable.

USB sticks are disabled so that presentations at Council offices can be difficult. If there was WiMAX coverage within the building which enabled presentations to be accessed directly off the servers holding data then this problem would disappear.

Currently audio conferencing is used so that the group can communicate when some of them are away from the office. Some staff would like to use video conferencing/messaging services for these calls.

The system needs to be simple to use and staff would like to be able to use the laptops with WiMAX with no need to log-off between sites.

5.2 Network and systems configuration

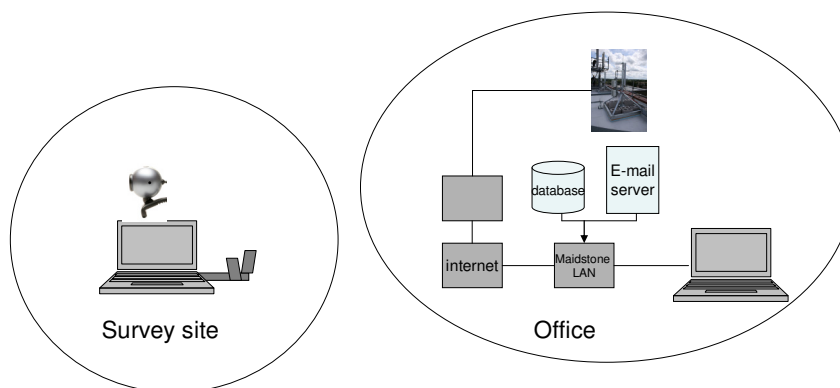


Figure 7 Set-up to enable access to Maidstone Council's database, email server

5.3 Customer perceptions of service quality

The WiMAX network provided a faster service than the office LAN, the speed of access to the internet and to Maidstone Council's centralised systems was faster. Only 3 people were using the service, sharing 25 Mbps between them.

Richard Wingett was pleased with the trial service and said, "The WiMAX network was faster than the office LAN."

5.3.1 Meetings

The WiMAX service was used during meetings in and around Maidstone. Our users reported that the ability to cross check input at meetings saved time and reduced follow-up actions from the meeting, reducing resolution time from two weeks to immediate resolution. This was seen as a process improvement.

In another case access to a research document available on-line during the meeting enabled on the spot resolution of another problem.

Taking the laptop to meetings saved time both in meetings and through reduced follow up actions, agendas and minutes etc. did not need to be printed as these could be accessed over the WiMAX link from email servers and centralised systems.

"I didn't need to bother printing agendas and minutes for meetings.", Richard Wingett, Maidstone Council.

This has the potential to reduce the amount of waste paper.

5.3.2 Document sharing

Network quality levels were sufficient to allow document sharing during meetings, facilitated using the laptop and WiMAX access with a projector. This neatly avoided the problem that documents are not allowed to be stored on local “C” drives to avoid loss of confidentiality.

5.3.3 Presentations

The access was fast and robust enough to allow access to systems and therefore avoided the problems caused by not being able to store data on laptops and USB sticks.

5.3.4 Portability

Despite the small coverage area within Maidstone the portability benefits were deemed good enough by the users to support remote working within the town centre. WiMAX access around the town centre was described by one of the employees as “great”. A laptop was used on some customer visits, the laptop was used for form filling and to access centralised systems. Write-ups were done on the spot saving time through wasted journeys back to the office at the end of the day.

5.3.5 Drawbacks of the system

The current version of WiMAX is portable rather than mobile. The WiMAX works very well in the office, but as soon as the laptop is moved the link is broken and the user needs to log out and log-in again thus wasting time. One of the hoped for benefits was a reduction in wasted time brought about by the relatively long start-up time of today’s laptops.

Printing documents (Word, PowerPoint etc.) of over 2 pages in length caused a problem, the pages did not print and the operation locked the printers requiring print jobs to be deleted. (model HP LaserJet 4650dtn)

Despite the problems and the obvious geographic limitations of the trial the overall experience was very positive.

5.3.6 Devices needed to support employee mobility

To be effective the laptop used by employees will be in use for more than 1 hour a day so they anticipate needing long life batteries or laptop chargers that work “in-car”.

Some users would like to have a tablet rather than a PC so that data can be entered by a stylus rather than a keyboard, thus reducing the amount of time spent with the complainant.

5.4 Benefits of WiMAX services for employee mobility

5.4.1 New processes and procedures enabled by WiMAX

Currently staff return to the office before issuing the complainant with a reference number.

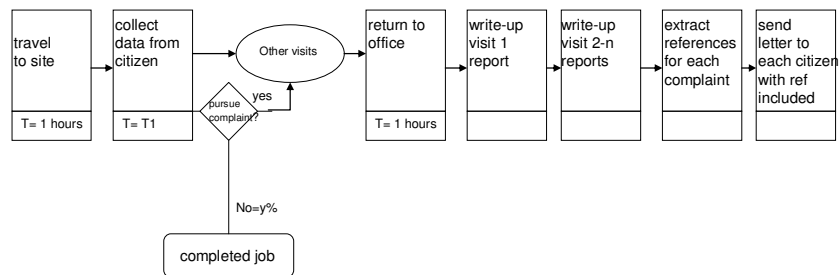


Figure 8 Showing existing process for collecting and reporting complaints, nuisance, anti-social behaviour etc

With WiMAX the reference number may be issued on-the-spot thus closing this part of the job. The new replacement enabled by on-line access to the centralised systems is as follows:

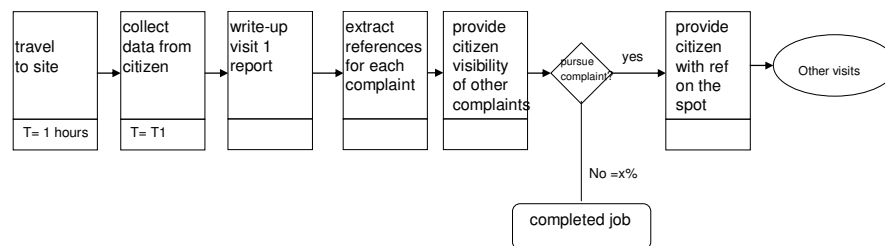


Figure 9 Showing more effective process taking advantage of online access to centralised systems

5.5 Cost savings demonstrated by the trial

Our estimates are that cost savings are attributable to reduced travelling times, field workers can avoid travelling back to HQ from other parts of Maidstone.

For a department of say three people and with a travel time saving of approximately 6 hours per week per person, this could result in savings to the council of some £30k.

6 Non completed trials

At the formation stages of M-WAG a number of trials had been planned, it was not possible to complete all of these trials. Below are M-WAG's thoughts and positions on these areas.

6.1 Outside broadcast trial

6.1.1 Outline of customer requirements for outside broadcast events

The customers needed to be able to take moving images at outside locations, at relatively short notice. In particular to be able to cover live/unfolding events at short notice. Satellite services are available for outside broadcast events but these services are expensive and require the slots to be pre booked.

The images needed to be uploaded to a broadcast studio over the public internet for work behind the scenes for onward broadcasting or for use on the broadcasters' websites.

6.1.2 Network and systems configuration

There were two problems which occurred and which we were unable to do anything about with the limited resources available:

- link to broadcasters' studios used the internet service from Maidstone Council offices. At certain times of day the service was overloaded and unsuitable for transmitting broadcast quality.
- the IP enabled broadcast camera was new on the market and the configuration settings were being tested as part of the trial.

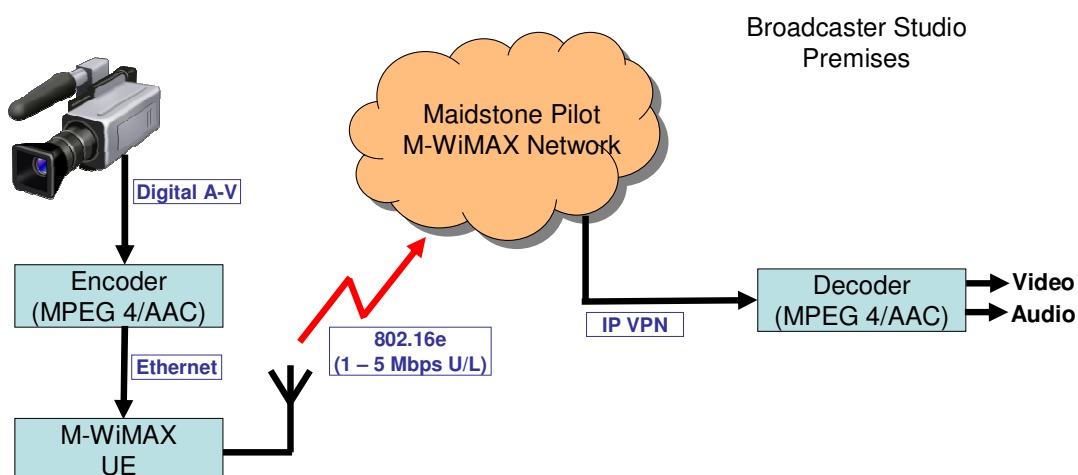


Fig 10 below shows the configuration of the network for the broadcast event.

6.1.3 Benefits of WiMAX for outside broadcast events

Currently broadcasters use a satellite service for outside broadcast, this suffers from inflexibility, and the equipment needs to be reserved in advance.

6.1.4 Customer perceptions of quality

The objectives of the broadcaster were:

- to establish whether a WiMAX network could provide the bandwidth and QoS settings necessary for broadcast quality video
- to establish minimum QoS settings necessary if the internet was to be used as a transit mechanism for broadcast quality video
- to validate the trial system configuration settings required at all levels.

Across the WiMAX network from the mobile CPE to Maidstone the QoS and bandwidth levels were appropriate for broadcast quality transmission. At certain times of day, broadcast quality over the internet connection was possible, however during busy hours spurious problems were noted which reduced the quality from time to time during the transmission.

We were able to demonstrate the technical capability in principle, both in early testing and later as part of a live broadcast, but the problems we encountered were due to camera encoders and internet latency.

6.1.5 Potential cost savings demonstrated by the trial

Satellite services are expensive and specialised equipment is needed. Avoiding the use of satellite services offers broadcasters significant cost savings.

It should be noted that many broadcasters have been scaling back their regional news services due to the high costs associated with news gathering. The possibility of reducing costs of live or near-live reports could have a positive impact on these services.

6.2 Consumer Trial

The original scope of the consumer trial was to offer a mobile internet access service to fifty students, the objective of the trial was to allow seamless WiMAX access to the target audience and to allow them to obtain services such as Video on Demand, IP TV, VOIP, and games. These services would have been supported on both WiMAX and standard WiFi, depending on where the user was. This would have allowed us to obtain feedback with regards to the user experience across the two technologies.

Unfortunately the dongles that were available at the time were not user friendly, late to market and lacked the appropriate drivers for use and would have required a fair amount of technological knowledge on the part of the end users to set up.

It was therefore decided that there would be no value in attempting to run a consumer trial that would fail at the first hurdle with regards to consumer ease of use. M-WAG however still firmly believe that once handheld devices start to become readily available consumers will be able to enjoy a vast array of services across a number of wireless technologies.

7 WiMAX roadmap

Figure 11 below represents a roadmap for the development of WiMAX technology. The implications of this roadmap on the serving of customer groups for particular applications is indicated in table 3.

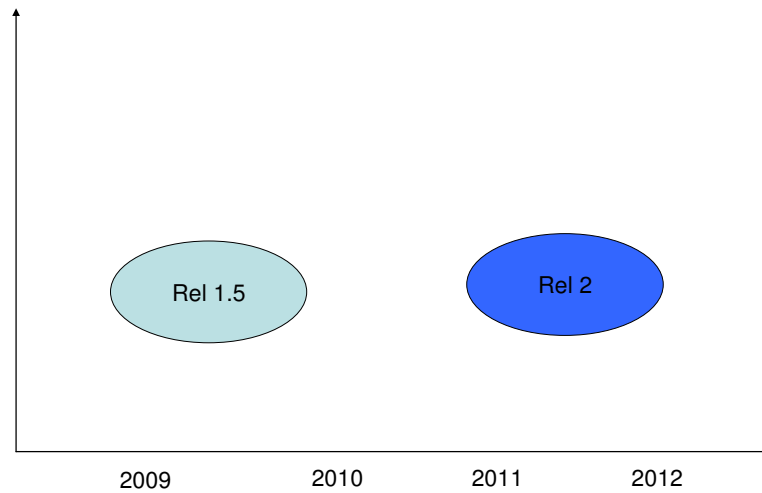


Figure 11 Key new WiMAX releases outline timetable

	Rel 1.5	Rel 2.0
New Features	<ul style="list-style-type: none"> Support for VLAN/ethernet Support for multicast/broadcast Support for FDD & channels of 20 MHz Support for mobility at 120 km/hr Support for 400-500 VoIP users per 20 Mz 	<ul style="list-style-type: none"> Support for mobility at 350 km/hr
Bandwidth implications	144 Mbps DL on 2x2 MIMO	350Mbps DL on 4x2 MIMO

Table 3 Showing planned features of releases

Release 1.5 has planned profiles at 700 MHz, 1.7 GHz, 2.1GHz, 2.3GHz, 2.5GHz, and 3.5 GHz, providing spectrum for all demographics from low density rural to high density urban environments.

8 Revenue and cost analysis

8.1 Market Background

To date business use of mobile data has been restricted by availability and price.

Where price has been reduced to a market acceptable point demand growth has been rapid, eg 3G dongles. The impact of nomadicity and mobility on the broadband market should be regarded as transformational, it should be expected that both consumer and business users will take a mobile/nomadic variant of broadband in preference to a fixed service should this be offered at a price deemed affordable.

Pressure is growing on all organisations both public and private sector to reduce costs to become more competitive in the market place. This will involve automating ever more processes and will include a certain amount of employee mobility not previously seen. The limited trials conducted bore out these views.

Certain government targets and policies will drive an increase in remote monitoring and control, for example monitoring of pollutants, carbon, water, clean energy, smart grids etc. This monitoring requires an increase in both bandwidth and broadband penetration requiring coverage of even more rural parts of the country.

First and second responders, having voice services are now looking to the deployment of data services, which will need to be used in the field and therefore be mobile, uniquely these responders require high penetration networks, ie must still have service in out of the way places, at least at roadside.

Amid this pent up demand, the environment is suffering a credit crisis, which is making it difficult for entrepreneurs to get the funding for new innovative ventures, add to this the delays in the 2.5 GHz auction and this adds to pent up demand with no obvious supply.

The UK is one of the most competitive telecoms environments. There are currently 5 mobile operators and in the broadband market space, there are 4 main players targeting consumers. The main fixed incumbent BT has no mobile network, although it has MVNO arrangements.

The mobile incumbents have decided to focus on the use of LTE for their 4G offering, availability of LTE indicates that the roll-out will not commence within the next year, but possibly start the 2010 or 2011.

There are signs of consolidation in the market place, eg Carphone Warehouse purchasing Tiscali and T-Mobile possibly being merged with another operator. Whilst incumbents are distracted, re-organising their cost bases there is a potential opportunity for a brave new entrant, willing to develop new flexible business model and to serve a more divers range of customer bases.

8.2 UK Market Revenue Analysis

As part of the trials M-WAG carried out a revenue analysis to ascertain the likelihood of a national WiMAX roll-out within the UK.

8.2.1 Methodology for derivation of revenue

To ascertain the value of the market, Mott MacDonald applied its forecasting techniques. We started with the known value of the whole UK telecoms revenues this was divided into fixed and mobile derived revenues. Within each of these we further split the revenues by service category, and we projected these forwards to 2019. As we are deriving ultimately a figure for a wholesale wireless data operator, we consider both residential and business revenues within the projections.

In order to arrive at a market share addressable by a broadband wireless operator, we exclude all services that are deemed not suitable to be supported by WiMAX, eg all very high bandwidth services. For the remaining revenue streams we assume a market share that is potentially achievable. It is in the market share factor that we apply the assumption relating to number of competitors.

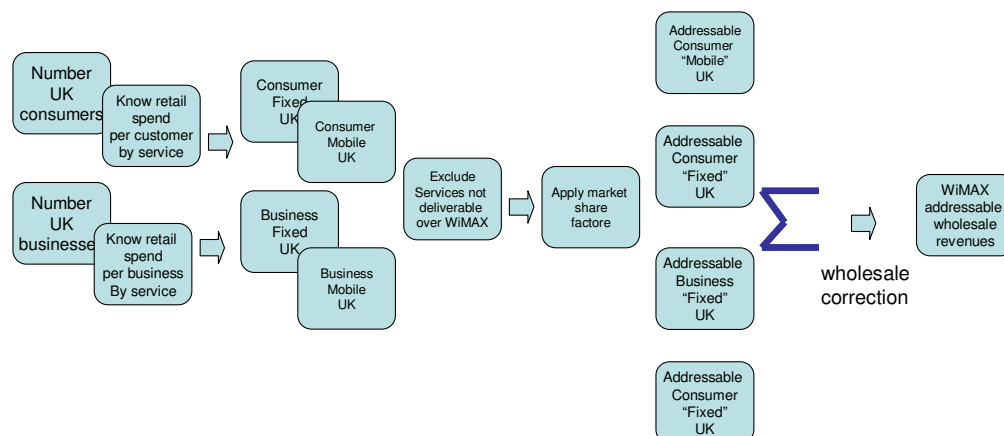


Figure 12 Methodology for revenue projection

Two scenarios were considered:

We consider that, where WiMAX technology enters the mainstream of telecommunications technologies substituting for both fixed, nomadic and mobile services in certain situations where WiMAX has an advantage. We considered a WiMAX network could provide a substitute network for the following services:

- Internet access (nomadic/fixed/mobile)
- Messaging/texting
- Voice (fixed/mobile)
- Leased line (sub 2 Mbps)

- Corporate networks (remote access & small sites)

It was postulated that a wholesale operator might reasonably have a chance of achieving this by selling services to both fixed and mobile incumbents as well as new entrant application providers. The revenues here are largely substitutional to existing products and services in the market today.

The results for this scenario are shown in Figure 13 below.

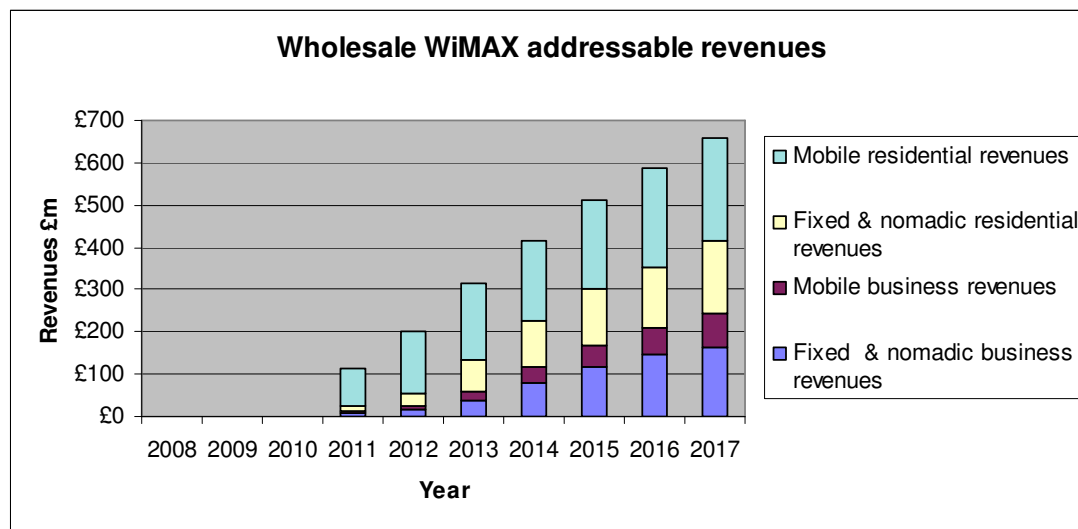


Figure 13 Potentially addressable revenues

In the current environment with a shortage of capital for investment and both fixed and mobile operators operating in increasingly competitive environments, it is less likely that a new wholesale operator will be tempted into this overcrowded space.

Given the results of the trial we looked at specific niche segments and demand for emerging applications. During the course of the trials it was ascertained that there is a potential to serve niche markets within the public safety and utilities markets. Some of these markets traditionally prefer to operate their own networks on owned spectrum and so the opportunity may lie in displacing bespoke networks with a either a “shared” or a public but flexible network. Currently the safety services and utilities have limited use of wireless data services, and so this represents a new revenue stream which will be more easily addressable by a new entrant.

Changes are anticipated due to the need to be more carbon friendly and are expected to cause the need for the introduction of smart meters; some 25 million homes in the UK must have connectivity to support this. Likewise the need for more distributed electricity distribution leads to a far greater need for real time monitoring of the electricity distribution network.

Local councils’ growing needs for the use of CCTV for nuisance management and crime prevention similarly drives a need for more bandwidth. A drive for portability of CCTV cameras means that wireless may become the preferred connectivity option over fibre services, and in this case a revenue substitution is possible.

A number of market segments within the UK were identified and quantified for nomadic/mobile data, these were:

- Utilities (smart meters & smart grids)
- Fire and police services
- Local council CCTV use
- Local council employee mobility
- Building Surveying

Some additional markets were identified but at this time have not been quantified, so that there is a potential upside, examples are

- Water management
- Ambulance service
- Level 2 responders
- Outside Broadcast

The methodology for deriving the niche market revenues was different and here a bottom-up approach was taken.

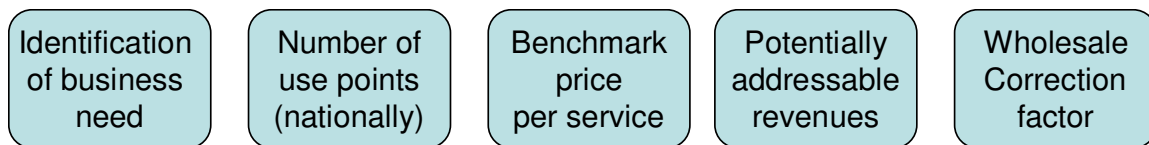


Figure 14 Methodology for deriving niche revenues: Bottom-up

As much of the demand was associated with points of monitoring and numbers of vehicles, in these cases we were able to determine a volume of demand. The prices applied were those current market prices that were deemed most close to the emerging service being demanded. In this model we have also been prudent, estimating prices low rather than high.

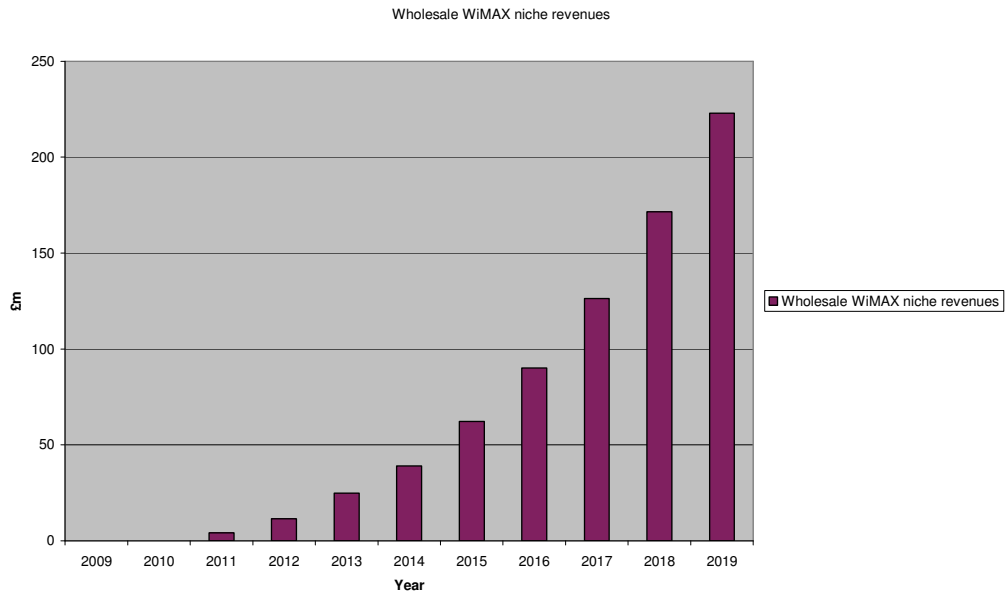


Figure 15 Potentially addressable revenues public safety, utility, emerging applications

8.3 Estimated costs of setting up and operating a commercial WiMAX network

As part of the work a simple model was put together to estimate the costs of a national roll-out for a wholesale network.

Aspects considered in the capital cost model were:

- Access network, including tower build
- Backhaul network
- Core systems
- Support systems

The assumptions made in the model include, that only 15% of towers are new build, ie use is made of existing tower infrastructure, building a new tower infrastructure would lead to unnecessary expense, we have used a blended price for UK tower rentals and have not price reduced this year on year. Backhaul is assumed to be 75% by leased Ethernet services, with the remaining 25% using wireless backhaul. This is a bold assumption in that currently most base stations are not connected with Ethernet services, but have a much smaller backhaul bandwidth suitable for today's lower bandwidth requirement. We have also not price reduced Ethernet backhaul prices even though it is likely that prices will fall year on year.

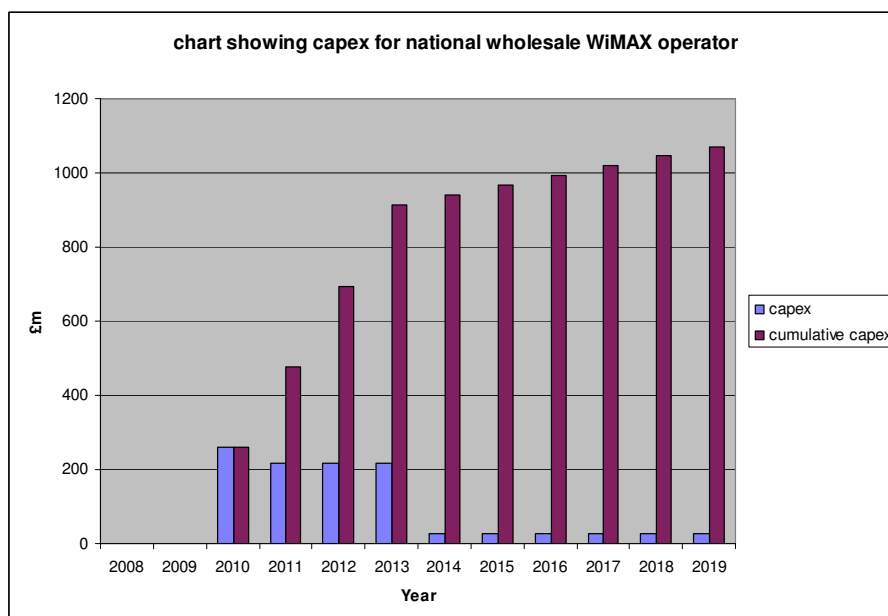


Figure 16 Graph showing capex and cumulative capex levels for a national WiMAX operation

All revenues and costs are prudent, prices are assumed to fall year on year whereas we have assumed no such reductions in the cost levels.

9 Conclusions

The trials showed an appetite and a willingness to embrace WiMAX technology.

The employee mobility trial demonstrated a pent-up demand for the flexibility provided by nomadic services. This trial also showed that expectations are set for near instantaneous access with low tolerance for delays caused by, for instance logging out and logging back into the network when moving between offices. We would expect employees in other organisations such as private sector to exhibit similar needs, in particular employees in the professional services sector with a high need for up to date information.

The WiMAX network demonstrated a demand for greater usability, ie faster access to data and a need to always have access to up to date information. This reflects the importance and value of “up to the minute” information in most organisations today. It demonstrated that current corporate networks were not keeping pace with the demand from users for greater and easier access to information. The demand for removing wasted time for employees requires the nomadic/mobile features that wireless can offer.

Video seemed to excite the most interest with employees and it was clear that organisations are just starting to think about the possibilities. CCTV is required for antisocial/crime prevention segments, but the trials demonstrated that there are other segments where CCTV services can support both cost reduction and process improvements. In spite of the Outside Broadcast trial being incomplete there was evidence of a clear demand from mainstream broadcasters. There is no doubt that the widespread uptake of video would not be supportable over most 3G networks, higher data rates per sector are required.

In all the trials once users had used the technology for a short time additional areas where efficiencies could be gained were identified. In some cases better processes are possible which will result in better outcomes for councils and FRSs, eg better clear-up rate for nuisance, lesser damage to property and loss of life, easier training, better containment of serious fires and incidents.

There is a demand for better applications to implement the process improvements hinted at during the trial; in addition there is also a demand for more integrated and robust handheld devices in some cases.

In terms of revenue quantification M-WAG believes that the appetite in the market for a new wholesaler addressing the well understood markets for consumer internet access using wireless is not apparent, although it is clear that WiMAX could complement, as well as substitute, both fixed, 3G and LTE networks.

The device market in the WiMAX area is relatively immature, and this will hold back the development of this market.

M-WAG does believe that there are several niche markets, for example public safety, and monitoring of various utilities that have a currently un-served demand and that this represents a new revenue stream. Many of these applications are currently non-existent and where similar exist they are carried over private networks.