UK 9/11: Will Our Emergency Radio Networks Withstand a Major Disaster?

11 September 2002

Summary

Poor radio communications may have led to the loss of 120 firefighters in the World Trade Center. One year on, BWCS has conducted a survey of senior communications managers in the UK's emergency services to determine how well our own networks could withstand a similar attack. The results show our existing analogue networks to be seriously inadequate. New digital technology could also be fatally flawed if all emergency services rely exclusively on one network, which could be destroyed in the event of an attack. Our research indicates that the emergency services believe there is misunderstanding on the part of the government about how the emergency services actually work together in a crisis, and highlights the fact that Airwave, the £1.4bn digital network procured by the police, has such poor data communications capability that many police forces are already planning to bypass it, using cellular networks for datacomms instead. We recommend that the UK's Fire and/or Ambulance services should investigate the cost implications of using an alternative digital network to Airwave to decrease the risk of a total loss of emergency services communications.

Lessons from the World Trade Center, 2001

One of the most tragic stories to emerge after the September 11th attack on the Twin Towers was that the lives of 120 firefighters were probably lost due to the inadequacies of the emergency radio communications network infrastructure. At a press conference in August 2002 leaders from unions representing New York firefighters claimed that 120 fire personnel had ascended one of the towers but were unable to hear a commander on the ground order them out of the building half an hour before it collapsed. The unions blamed poor in-building radio coverage and outdated radios for the communications failure.

These views were echoed by the key findings of an independent report[1] commissioned by the New York City Fire Department from US consultants McKinsey & Company. The McKinsey report into the service's handling of September 11th stated that:

"Firefighters and emergency services personnel were hindered in their response on September 11th by multiple failures of communications systems, processes and technology limitations."

The report was critical of the limited functionality of the radio handsets used by the fire service and the poor design of its radio infrastructure, which led to lack of resilience and network congestion. It also highlighted the lack of communications coordination and information sharing between the three emergency services on the ground.

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[1] *Increasing FDNY's Preparedness, McKinsey & Company August 2002*

The Current Situation in the UK

The UK's emergency services are in the process of moving from analogue to digital radio technology. The Police Service has adopted a single system, called "Airwave", which is being provided by O2 under an agreement signed by the Police Information Technology Organisation (PITO) in February 2000. Airwave is based on digital technology called TETRA. The total cost of Airwave is expected to be £1,470 million over 19 years. Currently, five forces have reached "Ready for Service" status, with the remaining forces of England, Scotland and Wales due to by ready by 2005 at the latest.

At the time of procurement it was envisaged that other "blue light" services would join Airwave. In 2001, a review of the requirements of the Fire Service concluded that a regional, rather than a national approach to procurement would be the best way forward. In March 2001 a group of south-western fire brigades (the South West Fire Consortium) issued an invitation to tender for a digital radio system. Unlike PITO, which had specified the use of TETRA, the South West Fire Consortium's scope of procurement did not specify any particular digital technology. The consortium ruled out Airwave at an early stage, entering preferred bidder negotiations with a consortium offering TETRAPOL technology, the principal alternative to TETRA.

However, on 7 May 2002 the former Fire Service Minister, Alan Whitehead, announced the government's intention to procure a national radio communications system for the Fire Service in England and Wales, thereby ending the earlier regional procurement process. According to the current timetable for national procurement, a contract will be awarded for England and Wales in April 2004.

The Department of Health favours a national approach to procurement for the UK's Ambulance Trusts. A national contract is due to be awarded in September 2003.

The BWCS Survey

BWCS interviewed senior IT and communications managers from 20 fire, police and ambulance services between 16 August and 8 September 2002. These 20 services together have responsibility for regions that cover more than 70% of the United Kingdom. Three of the respondents came from major metropolitan regions, four from predominantly rural regions, while the remainder served mixed regions encompassing at least three major towns or cities as well as number of rural communities.

In all but one case, our respondents had overall responsibility for the operation of radio communications for their respective service. The exception was a police respondent who was seconded to PITO. Interviews were held by telephone and were conducted on a confidential basis. The breakdown of respondents by Emergency Service was:

Fire: 6
Police: 6
Ambulance: 8

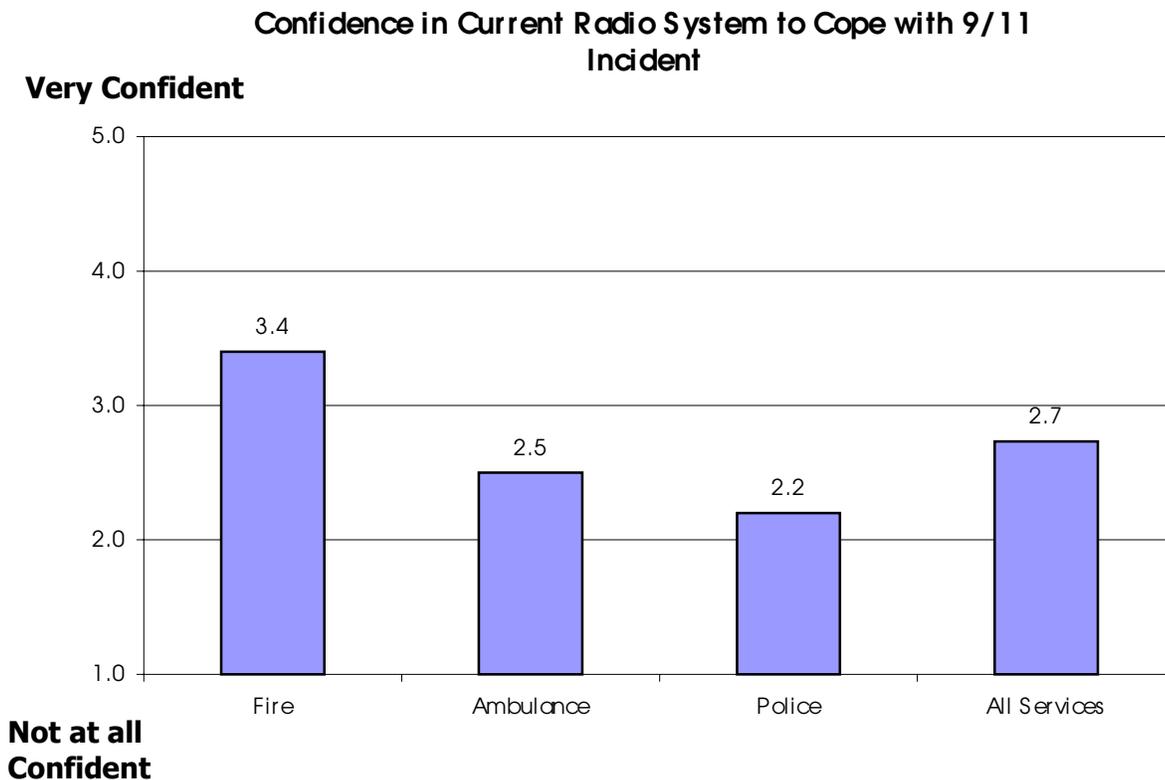The breakdown of respondents by region was:

England: 15
Scotland: 2
Wales: 2
N Ireland: 1

One police respondent was from a force already using Airwave. All other respondents were using analogue communications systems at the time of the interviews.

Today's Radio Networks Could Not Cope With a 9/11 Disaster

BWCS asked the respondents how confident they felt that their current radio communications system would perform adequately in the event of a disaster on the scale of 9/11. Respondents were asked to rate their confidence in their current system on a scale of 1 to 5, where 5 is Very Confident, and 1 is Not At All Confident.

The mean scores are shown below:

Confidence in Current Radio System to Cope with 9/11 Incident

Very Confident

	Fire	Ambulance	Police	All Services
Score	3.4	2.5	2.2	2.7

Not at all Confident

The majority of respondents had major misgivings about the ability of their current systems to cope with such a scenario. Respondents from the police were the least confident of all.

Comments included:

- "Not confident. None [of the services] will cope, to be honest." *Ambulance Service Respondent.*

- "I doubt it would be able to cope." *Ambulance Service Respondent*

- "Not at all confident." *Police Respondent*

The Main Problems with Existing Systems are Coverage, Capacity & Redundancy

The three most frequently cited problems with current systems in the context of a major catastrophe were poor coverage, redundancy and lack of network capacity. Interoperability – frequently cited as a major issue by policy makers – came fourth. Our survey revealed contradictory positions on interoperability when this issue was explored in more depth.

**Main Problems with Current Systems**
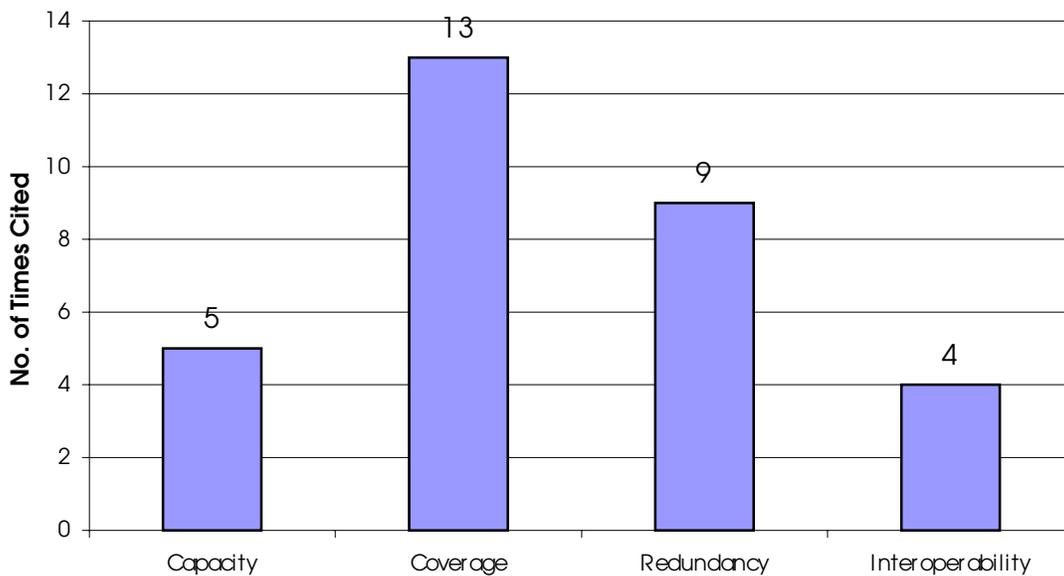
On the issue of coverage, respondents were concerned with both in-building coverage and coverage at remote locations. Redundancy worries centred on the failure of an entire communications network, which would leave at least one of the emergency services with no means of communication whatsoever. Capacity issues centred around large numbers of emergency personnel being concentrated into a small area, and not being able to get channels for radio communication.

Future Digital Systems Will Cope Better….

BWCS asked respondents about their confidence that a future digital radio system would be able to cope with a 9/11-type incident. The results are shown below:

Confidence in Future Digital Radio System to Cope with a 9/11 Incident

Very Confident
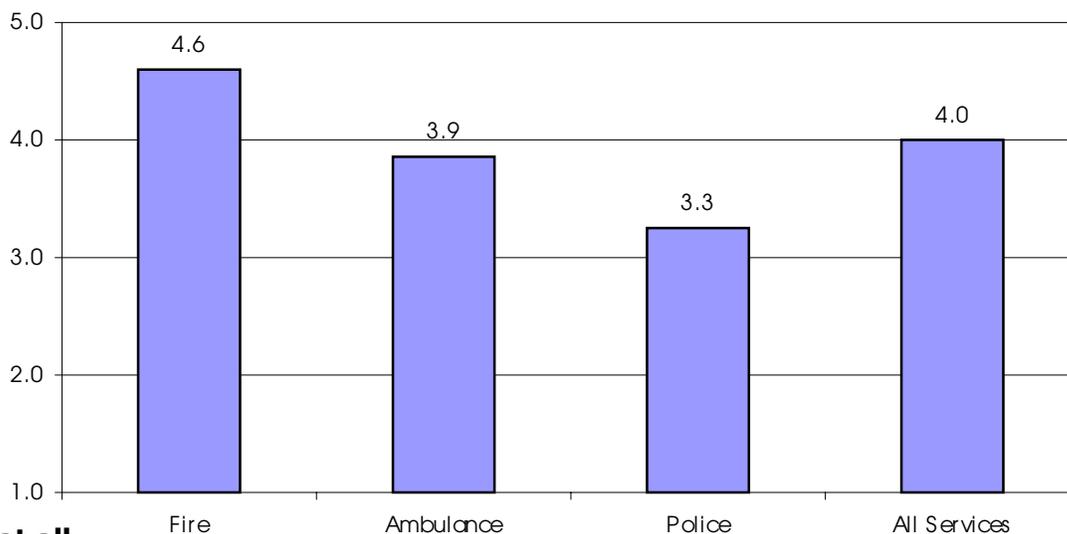
Not at all Confident

Respondents are more confident in the ability of a digital radio system to cope in the event of a major catastrophe. However, ambulance and fire service respondents, who have not yet selected their nationwide digital radio technology, were more confident than police respondents, who have.

Doubts were expressed by both police and other respondents about the capability of Airwave. Comments included:

- "If we are forced to go into Airwave my confidence will certainly go down. My reason for this is to do with the all the eggs in one basket [single network] scenario. It is also based on my knowledge of Airwave, in that I know there are several single points of failure in the infrastructure." *Fire Service Respondent*

- "It's very difficult to tell [how confident we can be] as we don't know that much about the actual infrastructure of the new system. I would have to say I am not as confident as I am about the current one." *Police Respondent.*

- "In its present form Airwave wouldn't be much better [than analogue]. There is the problem of coverage in buildings and in rural areas. We are looking to use as much text as possible – voice communications are slow, subject to error and lack of coverage. At least with a text message it is stored until the mobile comes back into an area with coverage." *Police Respondent*

Respondents' doubts about Airwave centred less on the capability of TETRA technology and more on the risks of relying exclusively on a single network for emergency communications (see next section).

One respondent was also concerned at the level of geographic coverage offered by Airwave:

- "Due to the area/population core coverage criteria used by Airwave, only 7% of our geographical region was covered because we are a rural force. We have now paid for an additional 7% to increase handheld coverage to 14%[2]. The majority of our business takes place in that 14%, but it would be too expensive to have coverage everywhere." *Police Respondent*

…But Reliance on a Single Digital Network Will Leave Them Crucially Vulnerable

BWCS asked respondents how important they felt it was that their service should have access to more than one communications network in the event that their main network went down.

Many of the respondents referred to the failure in April 2002 of the BT exchange in Southampton, which left the Hampshire Constabulary without landline, email, cellular or UHF communications, and residents unable to make emergency calls on BT lines and three out of four cellular networks. Service was restored to the police some five hours later and to the public four hours after that.[3] Those respondents who referred to this incident cited it as an argument against relying on a single network for radio communications.

The results, shown below, showthat an overwhelming majority thought this was either very important or critical to their operations.

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[2] Under the deal negotiated with O2 by PITO, O2 provides certain Core Services to each police force. Core coverage is full coverage for vehicle-mounted radios across the force's entire geographic area. This does not equate to full handheld radio coverage, however. In this case, O2 provides only some of the force's requirement under the Core Service. Additional handheld coverage mustbe purchased by each force depending on its needs and budget.

[3] According to a letter from Deputy Chief Constable Ian Redhead, Hampshire Constabulary, to the Select Committee on Defence, the Hampshire police were unaware that back-up leased lines that they rented from BT were, along with all their primary links, routed through the Southampton exchange, despite having different logical routings. Thus, when the Southampton exchange failed, the entire police network also failed. Even mobile phones used as back-up did not work, since only one mobile operator, Orange, did not use BT lines, and the police did not use Orange. BT engineers were initially unaware of the problems at the exchange because system alarms that would normally alert them had also failed.

Importance of Access to More than One Communications Network
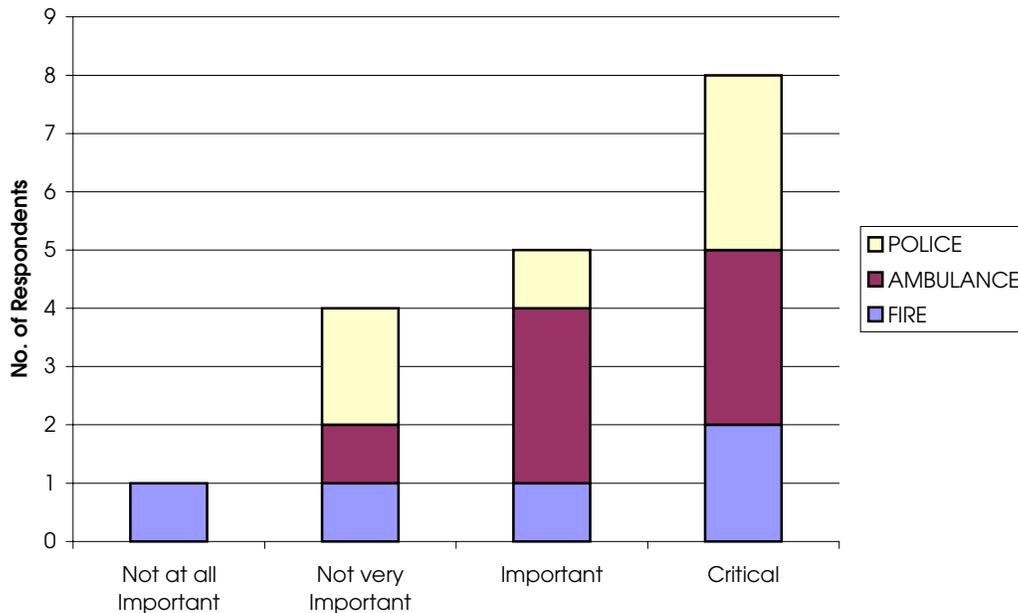
At present, some back-up systems are available. However, some services have been forced to rely on the cellular networks either as a stand-by or, occasionally, as the central means of communications in areas where coverage is poor.
Arguments in favour of access to a secondary network included:

- "It is very important for major emergencies. In general the fire brigade triplicates everything anyway so there is a fall back for a fall back. This is done independently so there are three separate ways of doing everything. When BT's Hampshire network went down for example the fire service network was the only one operating because it didn't rely on BT. To have a single network and put all of your eggs in one basket is very dangerous in my view." *Fire Service Respondent*

- "This certainly needs careful consideration. At the moment we do offer separate networks and if we were all brought onto Airwave then one would need to question that. There is an example of this: on 25th of April there was a major infrastructure failure in Southampton and BT's systems failed." *Police Respondent*

- "We're not really happy with a single system and the implications of failure. We are working on contingencies for this." *Police Respondent*

- "A second back-up arrangement with a secondary route is vital. We don't want all our eggs in one basket." *Police Respondent*

- "This is a key consideration, all our ambulances are equipped with cellular phones as a second line of defence, though we are aware that in a major disaster they might not be able to access the network." *Ambulance Service Respondent*

The Government Message on Interoperability Is Unclear

A key consideration in all government literature to date has been the need for 'interoperability', both between regional divisions of the same service and between services themselves. However, there is virtually no clear official explanation from the government or any other body about what interoperability means in practice for emergency services radio communications. This has led to confusion and concern within the emergency services as to the government's intentions.

At its most basic level, interoperability could be taken to mean that individuals from one emergency service could communicate with those of another via command centres. At the other extreme, it could mean that a policeman could directly call a fireman at the same incident and speak to them (any-to-any communication). A possible intermediate level would be for 'Silver Controls' (Commanding Officers at the Scene) to be able to call each other.

BWCS asked our respondents specifically about interoperability. While many respondents acknowledged that any-to-any interoperability within their own service might be desirable in some situations, very few believed this level of communication was necessary or helpful with other blue light services. As the following graph shows, the overwhelming majority of respondents believed the ideal level of interoperability between different emergency services is at a command centre to command centre level. Two respondents from the fire brigade preferred communication between Silver Controls. Police respondents were split 50/50 between the command centre level and any-to-any communication.

Comments in favour of any-to-any communication included:

- "I listened to a talk from [former New York] Mayor Giuliani recently and was pleased to hear him say that absolutely of greatest importance post-9/11 was interoperability between the emergency services. We have the same issues that they do in New York, but today police, fire and ambulance can't talk to each other. Interoperability is very important and this is very much the government line." *Police Respondent*

Ideal Level of Interoperability
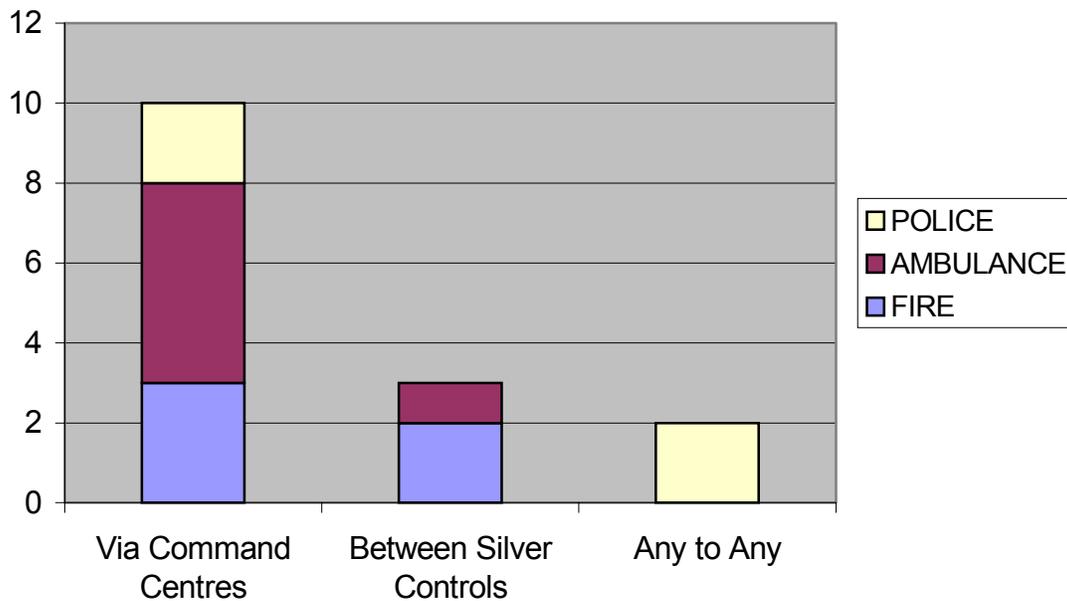
However, such comments were outnumbered by respondents who believed exactly the opposite. Their comments on this question uncovered a belief that the government has misunderstood the communications requirements of the emergency services and the reality of what happens 'on the ground' at a serious incident:

- "I'm not sure why the government is so hung up on interoperability. In my opinion we don't need it. At a major incident we simply swap radios between the silver commanders from different services. We already communicate with each other via landlines. Inter-working is crucial and we do that already. Interoperability won't work and will just lead to confusion." *Ambulance Service Respondent*

- "Its not important. It's a fallacy. It's ridiculous to expect a bobby to be able to or want to talk to a fireman or ambulance driver. I can tell you now, you are not going to achieve much with this at all. The example always given is that of the Marchioness disaster, where you had ambulances queuing up on the wrong side of the river. Now if the policemen on the ground could have told the front ambulance to move position, that might have helped, but of course how does the PC on the ground know how to get through to the ambulance at the front? He or she would have had to go through the control room anyway." *Police Respondent*

- "Most fire-fighters I have talked to about this are steaming under the collar as they believe interoperability with the police is extremely dangerous. It will lead to a breakdown in the chain of command and result in policemen and firemen trying to tell each other what to do. It is a dangerous myth that interoperability

is desirable, but inter-working at command centre level certainly is." *Fire Service Respondent*

- "I think this is very important for communications with other brigades and also very important for communicating with other services, certainly at command level. Probably down to Silver level – command on the ground." *Fire Service Respondent*

- "The ability to talk to other police forces at all levels will be a huge benefit; at present when a vehicle being followed moves from one force area to another there is no efficient way for the officers to talk to each other. It would also be useful to talk to the other emergency services, but text would probably do for this." *Police Respondent*

- "Since September 11th this has been very high on the agenda. However, I don't think we would need much interoperability on the ground. Ambulance men do not need to talk to Bobbies." *Ambulance Service Respondent*

Airwave Cannot Cope With Future Data Communications Needs

Traditionally, the emergency services have relied almost exclusively on voice communications between control centres and their officers on the ground. Few of the respondents used sophisticated data communications.[4]

However, much work is underway in the emergency services to examine how data communications could be used more effectively. Police services could interrogate databases of stolen vehicles and criminal records, and transmit and receive photographs of individuals. Ambulance services could more accurately track the location of vehicles to guide them to the scene and provide realistic estimated times of arrival. Upon reaching the patient they could transmit photographs to an expert at the hospital, thus allowing the hospital to prepare to receive the patient and allowing the ambulance team to be given specialist advice. Fire crews could interrogate data on dangerous substances and building blueprints.

As both Airwave/TETRA and the alternative TETRAPOL systems have the capability to carry data communications, BWCS asked respondents what they key criteria for data communications would be. The results are shown in the following table.

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[4] None of the police respondents currently use any form of data communications. Among fire respondents, only one operated a separate data network, one a paging network and two used a service that sends simple mobilisation messages over a channel of its existing voice radio network. Of the eight ambulance services surveyed, three used no data communications at all. One used a simple text delivery system to carry status messages. Four others used this together with automatic vehicle location (AVL). One used AVL only. Of the three services that currently use no data communications at all, three are about to introduce AVL.

Three Most Important Issues for Data Communications	First	Second	Third
Fire	Coverage	Capacity	Resilience
Ambulance	Capacity	Coverage	Data Speed
Police	Coverage	Security	Data Speed
All Services	**Capacity**	**Coverage**	**Data Speed**

In summary, future data communications solutions must meet respondents' expectations in terms of capacity (the number of simultaneous users), coverage (the geographic area in which communications is available) and data speed (how much information can be transmitted per second).

Police Respondents' Confidence in the Data Comms Capability of Airwave
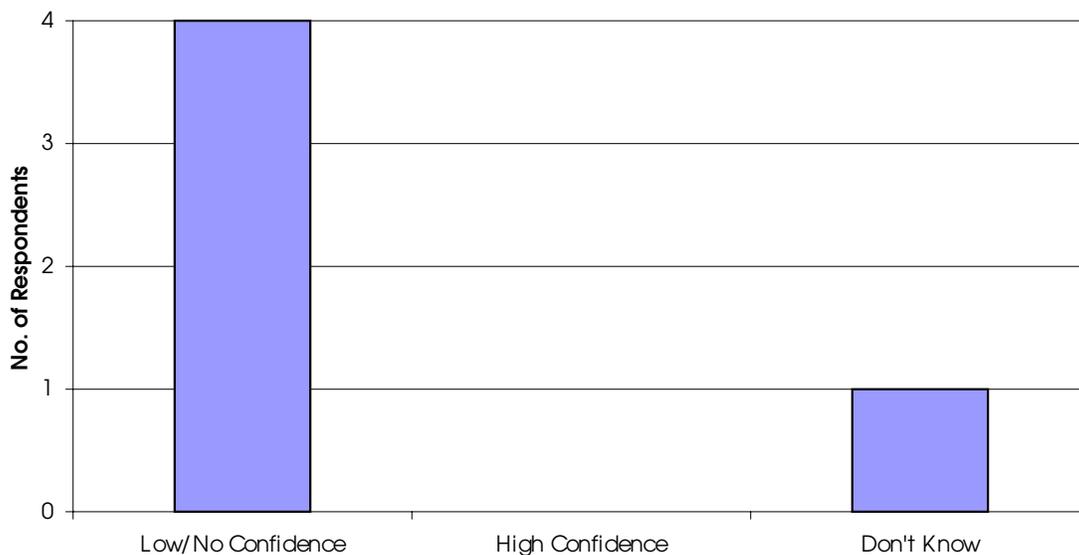
We asked respondents from the Police Service how confident they were that Airwave would deliver their data communications requirements. Their overall confidence was low.

In all four cases where respondents indicated no/low confidence, the root of their concern was the data transmission speed of Airwave. All four respondents with no/low confidence indicated that they were already planning to use GPRS[5] on cellular networks to transmit data, and would not be relying on Airwave for this capability.

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[5] GPRS (General Packet Radio Service) is a data communications technology offered by all four of the UK's cellular operators. It can be accessed by cellular phones and other specialised devices such as PDAs (Personal Digital Assistants, such as a Palm Organizer, for example). GPRS transmits at a maximum 56kbit/s, and averages around 22kbit/s, compared with respondents' expectations of 4.6kbit/s from Airwave. In other words, GPRS is between five and ten times faster than Airwave.

Their comments included:

- "The Airwave network can match current data services but there is currently a huge issue as to whether TETRA can keep pace with the development of the Force's data needs." *Police Respondent*

- "We aren't looking to use Airwave for data but will use GPRS. We are already trialling GPRS, in fact. GPRS will be available in 6-12 months but Airwave won't be able to meet our data requirements for at least 18-24 months and we can't wait for that." *Police Respondent*

- "I have to say our expectations of Airwave, with respect to data services, have diminished considerably. We are now looking at GPRS as there is no way you could ever send a photo, for example, via Airwave." *Police Respondent*

- "To say we are disappointed [with Airwave data rates] would be a huge understatement. Some of the mobile data gateways must wait for release of analogue TV spectrum, which will not be available until 2010, which is way too long." *Police Respondent*

During the 9/11 attack in New York, cellular networks quickly became congested as members of the public tried to dial the emergency services and their friends and family. It is highly likely, therefore, that a similar situation would arise in the UK, thereby completely disabling the data communications capability of the police, and any other emergency services that choose to rely on GPRS. This view was echoed by one of our respondents:

- "We have looked at GPRS and tested it but it's too expensive and too subject to overload at the time of a major incident, which is just when its needed." *Police Respondent*

Currently, this would not necessarily impede the ability of these services to respond effectively, as their existing use of data is limited. However, as the use of data communications becomes increasingly part of normal procedures, the loss of a data network would have much greater operational impact.

Looking at specific data applications, ten[6] of our respondents were either using or planning to use automatic vehicle location (AVL) over their existing or future data network. Being able to track emergency service vehicles accurately has obvious benefits in terms of improving response times and the safety of emergency personnel. However, one respondent from the Police service raised specific concerns about Airwave's ability to support AVL.

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[6] Five respondents from the ambulance service were already using AVL over proprietary data networks and one other was planning to implement it. One police respondent was using AVL over a cellular GPRS network and two others had definite plans to introduce it, as did one respondent from the fire service.

- "The Airwave AVL proposition is crap, it only samples every five minutes, and if you are chasing someone down the motorway at 100 miles an hour that is just silly." *Police Respondent*

Conclusions

While the government should be applauded for its swift action in reviewing the UK's existing emergency radiocommunications infrastructure following the September 11th terrorist attacks in New York, BWCS has uncovered some major concerns among the emergency services regarding its procurement strategy for replacement radio networks.

Our respondents believe that existing emergency service radio communications systems would be severely compromised in the event of a 9/11-type incident in the UK because of poor levels of coverage, capacity and redundancy.

Digital radio technology, such as the Airwave solution being implemented by the Police Service can address some of these issues. However, the view of the majority of our respondents is that reliance on a single network leaves the emergency services vulnerable in the event of that network being made inoperable, either as a result of damage sustained in an attack, or through catastrophic technical failure. They believe that access to an alternative network is critical in emergency situations.

The majority of our respondents believe that the government has misunderstood the issue of interoperability, and that there is no need for any-to-any communications between different emergency services at the scene of a disaster. Indeed, such communications may hinder the work of the emergency services by breaking clear command chains, leaving personnel on the ground with conflicting instructions. Most respondents believe that command centre-to-command centre communications is the optimum level of interoperability required. Although it is BWCS' understanding that this is also the government's view, this message is not being communicated clearly to the emergency services, and is at present causing a great deal of concern.

Respondents from the Police Service believed that Airwave could not cope with their data communications requirements and most plan to use GPRS on commercial cellular networks. BWCS believes reliance on these cellular networks would almost certainly be fatally compromised in the event of a major catastrophe.

Recommendations

Based on our research, BWCS recommends the following:

- The UK's Fire and/or Ambulance services should investigate the cost implications of using an alternative digital network to Airwave.

- The alternative network should be fully redundant from Airwave in both the radio and fixed components of the network to avoid common points of failure.

- The alternative network should offer command centre to command centre interoperability with Airwave.

- Procedures must be put in place to provide all Silver Command personnel with easy access to both networks at the scene of an incident.

- Emergency services data communications strategies should be reviewed as a matter of urgency.

- For the police forces using GPRS communications, well-rehearsed voice communications-based procedures should be in place at all times in the future as a back-up to the procedures based on GPRS, since it is highly likely that GPRS communications could be lost in a major disaster.

About BWCS

BWCS is a leading wireless telecommunications consultancy, based in the UK and operating worldwide. We work with wireless operators, equipment vendors, wireless software providers and major corporate users on wireless communications strategy. For more information, please visit our website at http://www.bwcs.com. This report was researched and written by Graham Wilde, Peter Kingsland, Ross Parsons and Bob Marshall. To contact the team, please email peter.kingsland@bwcs.com.