Communities and Local Government

Incident Ground Communications Study

Incident Communications Final Report

Fire Research Technical Report 21/2008

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Mott MacDonald

December 2008
Department for Communities and Local Government

The findings in this report are those of the authors and do not necessarily represent those of the Department for Communities and Local Government

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Contents

Chapter 1

Management Summary

1.1 Introduction

This project is one of a series undertaken as part of the work of the Building Disaster Assessment Group (BDAG) established to consider the issues, for fire and rescue services in the UK, that have been highlighted by the World Trade Centre incident of 11 September 2001 (9/11).

The project's aim is to provide advice and guidance on the possible types of communications infrastructure that may be needed in the built environment to support fire and rescue service intervention.

This scoping study forms the first part of that project its aim and the study's aim is 'to review the current level of knowledge and understanding of the forms of communications infrastructure available in the built environment and the requirements for effective communications on the incident ground within the UK' [Ref. 1-1].

Please note that the speed of technology development, in particular in the area of telecommunications, is rapid and therefore this report represents a snapshot of the situation at the time of writing.

1.2 Recommendations

This study produced twelve recommendations, as follows.

1.2.1 On the Fire and Rescue Service Requirement

RECOMMENDATION 1: That the existing fire and rescue service requirement for At-Incident communications (document 1 below) is reviewed and updated, taking into account: the requirement for bronze level interoperability with the other emergency services (document 2); the New Dimension Requirement; the decision to adopt TETRA as the technology for the wide-area requirements of the fire and rescue service in England and the technical possibilities that have become available since the earlier work.

1. 'Fire Service Radio Strategy Procurement Guidance – Standard Specification for Mobile Communications', Home Office Fire and Emergency Planning Department, April 1999

2. 'Statement of Interoperability and Resilience for Radio Communications Systems of the Emergency Services', Chief Fire Officers Association (CFOA) with Association of Chief Police Officers (ACPO) and Ambulance Services Association (ASA), Draft 3 23 September 2004.

1.2.2 On the Built Environment

RECOMMENDATION 2: Consideration should be given to whether it is desirable that developers or owners of new large buildings and/or those to which large numbers of the public resort should be compelled by law to:

1. Restrict the use of materials in buildings which are intended to limit the effectiveness of radio equipment in the building; and/or

2. Provide and subsequently maintain, in consultation with the fire and rescue authority for the area in which the building is situated, such on-site radio infrastructure as may be necessary in the view of the fire and rescue authority to ensure efficient and adequate radio-communications for the fire and rescue service in the event of an incident.

Ideally, any such provision should apply uniformly throughout the United Kingdom. It is recognised that any such compulsion may need to be subject to a regulatory impact assessment and that decisions on the circumstances in which it would apply would need to be measured and reasonable. A reference around which to begin this consideration would be those of the largest cubical extent, perhaps above a volume that would affect only the most problematic of new buildings.

RECOMMENDATION 3: Consideration should be given to standardising the arrangements relating to the provision, installation, testing and maintenance of radio installations to support fire and rescue service at-incident communications in the existing built environment, by means of a Code of Practice, or otherwise.

RECOMMENDATION 4: Consideration should be given to ensuring that the emergency services are adequately represented in the groups researching Frequency Selective Structures to ensure their needs are fully understood and taken into account.

RECOMMENDATION 5: That consideration of any proposal to change the way that fire and rescue service at-incident communications is provided (for example by the use of a different technology or the use of a different frequencies) ascertains any negative electro-magnetic compatibility impacts of that change on the electronic systems used within the built environment including the assurance that the control, detection, alarm and lift systems will continue to operate safely.

RECOMMENDATION 6: A watching brief should be maintained on developments in the built environment and this should be used to inform and update the recommendations of this study.

Details of how these recommendations were developed are contained in the following report, with supporting information included within the appendices.

1.2.3 On At-Incident Communications

RECOMMENDATION 7: That, pending the review of the fire and rescue service requirement, no decision is taken now on replacing existing At-Incident Technology. Although a solution based on TETRA appears to be best suited of the technical options to meeting current and future At-Incident requirements, a decision on the adoption now of this technology should not be made now unless the provision of direct bronze level interoperability is a paramount consideration. Even then the suitability of TETRA PMR is subject to the availability of all required Direct Mode Operation (DMO) functionality and should be confirmed by appropriate trials in the built and open environments. Any decision to replace the current analogue UHF technology must be informed by a rigorous cost-benefit analysis.

RECOMMENDATION 8: The existing UHF channel assignments should be examined to see whether it might be possible to modify the channel assignments to further minimise the potential technical limitations of the current channels and whether the number of available channels could be increased (perhaps by utilising channels vacated by the police service in its transition to the Airwave service).

RECOMMENDATION 9: That, for the longer term, a watching brief should be maintained over the development of Wireless Personal Area Networking (WPAN) technologies, products using them and opportunities for enhancing at-incident communications for the longer-term.

RECOMMENDATION 10: A watching brief should be kept on the development of Wireless Metropolitan Area Networking (WMAN) technology (included within this the Mesh radio products emerging onto the market) and the need for video at incident with a view to this being supplemental to the voice communication system if, as and when needed.

RECOMMENDATION 11: Close working relationships need to be maintained and developed between those considering At-Incident communications in the built environment and all the organisations (including CFOA, ODPM and PSSPG groups) that might have an impact on either the requirement for At-Incident communications. It is important to note that these groups themselves have ongoing work also which may identify changes that have an impact.

RECOMMENDATION 12: That the set of recommendations from this study be used to form a programme of further work, be they new projects or additions to the terms of reference of existing groups.

Chapter 2

Introduction

2.1 Background

This project is one of a series undertaken as part of the Building Disaster Assessment Group (BDAG) established to consider the issues, for fire and rescue services in the UK, that have been highlighted by the World Trade Centre incident of 11 September 2001 (9/11).

The project's aim is to provide advice and guidance on the possible types of communications infrastructure that may be needed in the built environment to support fire and rescue service intervention.

This scoping study forms the first part of that project and the study's aim is 'to review the current level of knowledge and understanding of the forms of communications infrastructure available in the built environment and the requirements for effective communications on the incident ground within the UK' [Ref. 1-1].

Mott MacDonald has been appointed to complete this study.

2.2 Purpose and scope

This report is the final deliverable of the study and is the output of the final stage, Stage 3. As such and so far as reasonably practicable at this time it provides information on the:

Current situation and future requirements found in reviewing existing arrangements for At-Incident communications in operational use (Stage 1)

- Built environment found in reviewing practices, regulations and trends in the construction industry (Stage 1)
- Communications technologies found in considering the current and emerging possibilities (Stage 1)
- Analysis of these findings in terms of the difference between future requirements and the current situation (Stage 2) and possible alternatives in developing At-Incident communications (Stage 2)
- Conclusions as to the most appropriate options to develop and a set of recommendations for the associated activities.

This report includes the summary and conclusions from previous interim deliverables issued in previous stages so that it forms a stand-alone document which may be read on its own. The full interim deliverables are a Current Situation Report and a Technology Review published as:

Fire Research Technical Reports numbers 19/2008 and 20/2008.

2.3 Key drivers

The key drivers are highlighted in the brief provided [Ref. 1-1] as follows:

'The radios presently used for incident ground communications in the UK operate in the Ultra-High Frequency (UHF) range. As such, signal transmission between handsets can be adversely affected by the interruption [degradation] of the signal by a number of factors, including the materials used in building construction. Signal problems [degradation] may be encountered in any environment but are a particular issue in the built environment (especially in large or complex buildings, and tunnels and other sub-surface structures) due to the nature of the construction methods used.

Problems in fire and rescue service communications may also occur where in-built systems, such as dedicated fire control centres within buildings, are adversely affected by extreme events such as terrorist activities.

The McKinsey report into the response of New York Fire Department (FDNY) to the World Trade Centre incident [Ref. 2-1] indicated that any interruptions to incident ground communications, particularly in large or complex buildings, can have a severe effect upon the effective command and control of incidents and thus the safety of firefighters and occupants. The U.S National Institute of Science and Technology (NIST) NCSTAR 1-8 report (Federal Building and Fire Safety Investigation of the World Trade Center Disaster) [Ref. 2-2] also identified radio communication problems.

In the UK building access and the provision of facilities for the fire and rescue service in buildings are facilitated through the Building Regulations. However, there are presently no general requirements in the Regulations for communications infrastructures to be provided where this might be necessary to overcome communications problems as part of such facilities.'

2.4 Issues to be addressed

Issues to be addressed by this study are also highlighted in the brief provided [Ref. 1-1] as follows:

'The scoping study will take the form of an international literature review and survey of current practice, nationally and internationally, to identify and quantify where appropriate:

1. The forms of communications infrastructures currently used on the incident ground by the fire and rescue service in the built environment

2. The present advice and guidance provided on communications infrastructures designed to support fire and rescue service intervention in the built environment

3. The forms of communications infrastructures and systems which are, or in the foreseeable future will be, available for use in the built environment

4. The effect that the nature, configuration and construction of the built environment has upon fire and rescue service communications infrastructures

5. The use of telemetry equipment by fire and rescue services to monitor personnel and the incident environment and the interaction of this type of equipment with the built environment

6. The need for emergency service inter-service communication on the incident ground

7. The efforts of the communications industry, and others where identified, in devising means of suppressing or restricting radio communications within the built environment and the potential impact of these activities on fire and rescue service incident ground communication

8. The communication needs of the fire and rescue service currently and the likely needs in the next five years

9. A 'gap analysis' between the needs and the provisions currently, and in the next five years.

This report covers all of these issues and presents them as described in Section 2.6, Contents.

2.5 Approach taken

Given the limited time available to complete this report the approach taken was to divide the investigations and report production into discrete parts completed in parallel before then bringing them together as follows:

1. Current situation and future requirements – to consult a number of UK and international fire and rescue services, as well as others, by telephone and/or email using interview scripts and questionnaires prepared for this purpose

2. Built environment and communications technologies – to consult individuals within Mott MacDonald construction division (Buildings & Infrastructure) and telecommunications division (Information, Communications and Media) to investigate and seek expert views

3. Analysis – to bring a team together with operational fire and rescue service knowledge and technical expertise in the built environment and communications technologies to collectively consider the situation and options available and to make recommendations

4. Conclusions and recommendations – to produce this report using the above and to subject it to internal review and Communities and Local Government scrutiny before release.

This approach is not intended to be exhaustive or rigorous but is considered to be representative and sufficient for the purpose of this study at this time.

2.6 Contents

The contents of each of the following sections of this report are as follows:

- Section 1 – Management Summary, providing an overview of the key findings of this study plus a list of the recommendations
- Section 2 – This section
- Section 3 – Reference Documents, lists the key material referred to in subsequent sections
- Section 4 – Glossary, providing an explanation of the terms and acronyms used within the report
- Section 5 – Current Situation, giving an overview of current fire and rescue service practices, drawing conclusions on the strengths and weaknesses of those arrangements

- Section 6 – Technology Review – giving an overview of current and emerging trends in construction of the built environment and communications technologies those technologies that merit further consideration
- Section 7 – Analysis, offering an initial assessment and discussion of the current situation and possible alternatives in developing incident ground communications
- Section 8 – Conclusions and Recommendations, which makes explicit the advised activities that we believe from the analysis should be pursued.

Chapter 3

Reference Documents

3.1 Fire Research and Statistics Division (RSD) and Mott MacDonald

Table 3.1: below, shows the FRSD documents that are referenced in this report:

Table 3.1: Reference Documents, Fire Statistics and Research Division (FSRD) and Mott MacDonald	
Reference	**Title**
[Ref. 1-1]	'Statement of Requirement for Contract for a Scoping Study on Fire and Rescue Service Incident Ground Communications Needs within the Built Environment', Office of the Deputy Prime Minister (ODPM) – Fire Statistics and Research Division (FSRD), February 2006.
[Ref. 1-2]	'Consultancy Proposal for the Incident Ground Communications Study', Revision A1, Mott MacDonald, February 2006

3.2 Other organisations

Table 3.2: below, shows the other documents that are referenced in this report:

Table 3.2 – Reference Documents, Other Organisations	
Reference	**Title**
[Ref. 2-1]	'Increasing FDNY's Preparedness [Part II Recommendations, Improve communications and technology capabilities]' McKinsey Report, 2002
[Ref. 2-2]	'Federal Building and Fire Safety Investigation of the World Trade Center Disaster – The Emergency Response Operations', National Institute of Standards and Technology (NIST) NCSTAR 1-8, September 2005
[Ref. 2-3]	'The Building Regulations 2000 – Fire Safety – Approved Document B – 2000 Edition consolidated with 2000 and 2002 amendments', Office of the Deputy Prime Minister (ODPM)

Table 3.2 – Reference Documents, Other Organisations *(continued)*	
Reference	**Title**
[Ref. 2-4]	'Fire Service Radio Strategy Procurement Guidance – Standard Specification for Mobile Communications', Home Office Fire and Emergency Planning Department, April 1999
[Ref. 2-5]	'Statement of Interoperability and Resilience for Radio Communications Systems of the Emergency Services', Chief Fire Officers Association (CFOA) with Association of Chief Police Officers (ACPO) and Ambulance Services Association (ASA), Draft 3 23 September 2004
[Ref. 2-6]	'Airwave MMO2 Approved User List ("Sharers List") – April 2002 Applications – Decision', DTI April 2002
[Ref. 2-7]	'Study to Assess the Future of Spectrum Requirements to Meet Emergency and Public Safety Services', Ofcom/PSSPG March 2006
[Ref. 2-8]	The Cave Report 'Independent Audit of Spectrum Holdings', Professor martin Cave for Her Majesty's Treasury December 2005
[Ref. 2-9]	'Government Response and Action Plan' Cabinet Official Committee on UK Spectrum Strategy's response to the Cave report, March 2006.

Chapter 4

Glossary

The following terms or acronyms are used within this report:

Table 4.1 – Glossary	
Term or Acronym	**Explanation**
AGA	Air-Ground-Air
BA	Breathing Apparatus.
CAA	Civil Aviation Authority.
CCTV	Closed Circuit Television.
Codec	Coder Decoder
COTS	Commercial Off-The-Shelf.
CTRL	Channel Tunnel Rail Link.
DMO	Direct Mode Operation (i.e. radio to radio without any intervening network infrastructure)
EMC	Electro-Magnetic Compatibility
ETSI	European Telecommunications Standards Institute
FM	Frequency Modulation
FSRD	Fire Services and Resilience Directorate.
MAN	Metropolitan Area Network
New Dimension	The New Dimension programme is working with the fire and rescue service to develop regional based vehicles to provide a mobile capacity for command and control. The New Dimension details may be found at the ODPM website address is www.odpm.gov.uk.
ODPM	Office of the Deputy Prime Minister.
Ofcom	The Office of Communications.
PMR	Professional/Private Mobile Radio
PSSPG	Public Safety Spectrum Policy Group
RF	Radio Frequency.
TETRA	TErrestiral Trunked Radio (formerly Trans-European Trunked Radio).

Table 4.1 – Glossary *(continued)*	
Term or Acronym	**Explanation**
TMO	Trunked Mode Operation
UHF	Ultra-High Frequency.
USA	United States of America.
WT	Wireless Telegraphy

Chapter 5

Current Situation

5.1 Introduction

This section is summarises our findings as to the current situation and is structured as follows:

1. Current fire and rescue service practices – across the UK
    a. Current situation
    b. For the future
2. Related Fire and/or Communications Developments
3. Summary from this part of the study
4. Conclusions from this part of the study
    a. Initial views on strengths of the current arrangements
    b. Initial views on weaknesses of the current arrangements.

5.2 Current fire and rescue services practices – across the UK

5.2.1 Current Situation

There are few surprises from this brief review. The key findings relating to the current situation can be summarised as follows:

1. There is almost total reliance on UHF handheld communications to meet the voice wireless At-Incident communications requirement
2. Considerable ingenuity has been used to increase the effectiveness of UHF handheld equipment in the built environment

3. There is considerable investment in the current technology; a significant proportion of which is by third parties. If the sample is indicative of the whole fire and rescue service, a significant part of this is in London. A number of fire and rescue services in the sample were shortly planning substantial further investment, either in replacing existing equipment or to increase the scale of issue of handheld equipment

4. It would be worthwhile examining whether:

    a. There is any scope for looking at the existing UHF assignments to see whether it might be possible modify the channel assignments to further minimise the potential technical limitations of the current channels

    b. The number of UHF assignments currently available to fire and rescue services might be increased – perhaps by utilising channels vacated by the police service in its transition to the Airwave service.

5. There does not appear to be any common approach for assessing whether fixed communications infrastructure is necessary to support fire service At-Incident communications, no common standards for that provision and no means of compelling third parties to make or maintain it. With the exception of road and some rail tunnels and stations, this results in an ad hoc approach to the provision

6. The migration of the police service to Airwave and the resulting loss of police access to Channels 69 and 70 has caused some local difficulties, particularly in relation to police helicopters and New Dimension convoys. However, could these channels be retained for the exclusive use of fire and rescue services?

5.2.2 For the Future

Key conclusions on future needs include:

1. A need to review and update the current User Requirement for At-Incident communications to take account of the developing requirement, including any New Dimension requirement, and of technical possibilities that have become available since the earlier work. Any new technology must meet the requirement and be otherwise suitable for At-Incident use by the fire and rescue service

2. Consideration of the need for the development of national guidelines setting out the minimum performance requirement for At-Incident communications in the built environment. These guidelines could be used to assess individual buildings and structures, and steps taken to improve coverage

3. Consideration of the need for national guidelines which clarify responsibility for facilitating effective At-Incident communications in the built environment, and maintaining it

4. Basing any decision on future At-Incident communications on a rigorous cost-benefit analysis, taking into account the overall costs of any change; not just the cost to fire and rescue authorities.

5.3 Related fire and/or communications developments

Fire service At-Incident communications do not exist in isolation either nationally or internationally.

At the extremes, decisions affecting the operational requirement will be affected by the influences of a number of organisations and groups. Consultation will be necessary to ensure that vital elements of requirements and issues are not missed.

Similarly, the development of solutions in the future will need to take into account technical developments and technical possibilities not least those potentially available as a result of the decision to adopt Airwave as the technical solution for the Firelink wide-area requirement in England.

Additionally, consideration of solutions will need to take account of the:

1. Built environment, and in particular the extent to which any fixed installations are required and the extent to which they might, realistically, be achievable; and

2. Timely availability of appropriate and sufficient radio frequency spectrum.

It will also need to meet the needs of users and other stakeholders and satisfy any relevant regulatory requirements.

Accordingly, any work on reviewing and updating the At-Incident user requirement, determining an appropriate technical solution and facilitating the satisfactory operation of that technology in the built environment will need to involve the relevant stakeholders. It will also need to take account of known developments in providing communications for the other emergency services.

5.4 Summary from this part of the study

The key issues for the UK from this part of the study are:

1. The lack of an up-to-date definition of requirements for At-Incident communications

2. Near full reliance on the UK mainland on UHF handheld radio equipment to meet the At-Incident voice requirement and the extent to which users appear to be content with the current arrangements

3. The heavy investment in UHF technology by fire and rescue services and by other third-party stakeholders – including London Underground Limited and the CTRL

4. The apparently ad hoc nature in which fixed facilities to support At-Incident communications are provided in buildings and the lack of central guidance

5. The limitations of the radio regulatory environment, including the potential shortage of channels – particularly at large-scale incidents involving multiple fire and rescue service attendances and the apparent lack of central guidance on how this should be managed on a national basis

6. The new difficulties of delivering the agreed level of interoperability with current technology (and the new difficulties, particularly intercommunication with police helicopters) consequent on the police migration to Airwave

7. The extent to which the selection of a technology for Firelink might influence the requirement for At-Incident communications and possible solutions

8. The extent to which the New Dimension and to a limited extent, FiReControl projects might influence the requirement for At-Incident communications

9. The influence of technical development, innovative product design and standards development in the UK and internationally might affect user expectations, the user requirement and the candidate solutions for At-Incident requirements

10. The need to apply a rigorous cost-benefit analysis to any consideration of changing the current arrangements.

5.5 Conclusions from this part of the study

5.5.1 Initial View on Strengths of the Current Arrangements

The strengths of the current arrangements for At-Incident communications appear to be:

1. The existing UHF technology goes a long way to meeting At-Incident requirements in the built and open environment

2. The UHF analogue technology is robust

3. The technology and the user interface of the UHF equipment is simple and for the most part understood by users

4. The equipment is in place and in service now with new/replacement Commercial Off The Shelf (COTS) equipment available if required

5. There are temporary and permanent techniques for improving the coverage of UHF communications and telemetry in the built environment and these arrangements appear to be in place at sites where this is required

6. There is a separate solution to meet the BA telemetry element of the At-Incident data requirement thus providing resilience

7. Deliberate RF shielding and the use of "jamming" equipment in the built environment is not considered to be a significant problem.

5.5.2 Initial View on Weaknesses of the Current Arrangements

The weaknesses of the current arrangements appear to be:

1. The UHF channel assignments are not ideal, leading to potential blocking problems – particularly where the scale of the incident requires the use of all available channels

2. The provision of fixed installations on site to provide enhanced radio coverage is generally subject to the goodwill of the site owner/occupier. Save where other authorities are involved (Transport for London, the Highways Agency, HM Railway Inspectorate and similar) there appears to be no mechanism by which a site owner or occupier can be compelled to make provision for fire and rescue service tactical communications

3. Fixed facilities to support communications in the built environment may be damaged or rendered inoperative by the incident that the fire and rescue service is attending

4. Enhanced communications requiring fixed provision at a site is subject to the effectiveness of the management/maintenance regime of the site owner/occupier

5. Enhanced communications is usually only provided for a single UHF channel; (there is, in any case, a maximum of two channels that can theoretically be supported at a single incident under current arrangements)

6. There is currently no way of meeting the requirement to provide direct bronze level interoperability with the other emergency response organisations. The 25KHz bandwidth of current channels also creates problems inter-operating with other UHF users, such as at aerodromes licensed by the CAA

7. There appears to be a lack of central direction and guidance on At-Incident communications, particularly in relation to major and New Dimension incidents

8. A separate solution has to be sourced and maintained to provide breathing apparatus telemetry (but see Strengths above)

Chapter 6

Technology Review

6.1 Introduction

This section summarises our findings from the technology review and is structured as follows:

1. Built Environment – UK and Internationally
   a. Current situation
   b. For the future
2. Communications Technologies
3. Risk Review.

6.2 Built environment – UK and internationally

6.2.1 Current Situation

Key conclusions on the current situation are as follows:

1. Consideration of Emergency Services radio communications is not mandated in UK building regulations, but consultation between developers and local fire and rescue services are common place for large and complex buildings
2. Where consultation concludes that buildings require enhanced radio transmission properties it is normally achieved by the installation of repeaters the location of which is established by survey on completion of the building structure
3. Frequency selective surfaces and structures are emerging but as yet are not common. Research is ongoing at present into their effects and best use, with Ofcom aware of the emergency service issue
4. Support for emergency services radio communications within building infrastructure is mandated in some parts of the USA

6.2.2 For the Future

Key conclusions on the future needs are as follows:

1. There is a need to monitor developments in the built environment including:

   a. The extent that materials such as K-glass are used in the built environment

   b. The Ofcom research into frequency selective surfaces and structures.

2. There is a need to monitor the Ofcom research and represent the fire and rescue service needs within that programme of work

3. There should be consideration of the need for national guidance on practical measures to assist in-building coverage with reference to the various approaches internationally.

6.3 Communications technologies

Key conclusions on communications technologies are as follows:

1. Professional Mobile Radio (PMR) – Should be INCLUDED in the analysis

2. Wireless Personal Area Networking (WPAN) – Should be EXCLUDED from the analysis but monitored

3. Wireless Local Area Networking (WLAN) – Should be EXCLUDED from the analysis but monitored

4. Wireless Metropolitan Area Networking (WMAN) – Should be INCLUDED in the analysis AS A POSSIBLE FUTURE TECHNOLOGY FOR VIDEO

5. Wireless Wide Area Networking (WWAN) – Should be EXCLUDED from the analysis WITH THE EXCEPTION OF AIRWAVE.

6.4 Risk review

The initial risks considered, albeit a limited number of examples only at this time, suggest that their quantification may be difficult. However, it also suggests that many of these risks are likely to be relatively low level and that they can be mitigated by existing arrangements and are unlikely to justify radical changes in the near term.

Chapter 7

Analysis

7.1 Introduction

This section explains our considerations in analysing At-Incident communications and is structured as follows:

1. Analysis
    a. Working Assumptions
    b. Analysis of the Options
    c. Commentary on the Analysis
    d. BA Telemetry
    e. Video Solution Options
2. Discussion
    a. User Requirement
    b. Working Assumptions
    c. Technology Options Considered
    d. Initial Conclusions
    e. Towards a Decision on Technology
    f. Conclusions on Technology
    g. Discussions on the Built Environment
    h. Conclusions on Timing.

These considerations include elements of 'gap analysis' and 'options assessment' but are not limited to those techniques since:

1. At this time there are no formal future requirements against which to complete a formal gap analysis, and the current situation is based on representative sampling only

2. There are, potentially, many options in both the built environment domain and the communications domain, not of all of which are necessarily mutually exclusive and so there has needed to be some pragmatic 'filtering' of options for consideration based on working assumptions.

7.2 Analysis

7.2.1 Working Assumptions

We have made the following working assumptions for this part of the study:

7.2.1.1 Assumptions Related to the Requirement

That the last known operational requirement for At-Incident communications published in the year 1999 [Ref. 2-4] will be reviewed and updated to reflect:

1. Changes in the requirement since it was produced including the/any requirements of the *New Dimension* programme

2. The technical opportunities that have emerged since it was produced including those related to the decision to select a supplier offering a TETRA-based solution in the wide-area requirement (Firelink) and implementation of the FiReControl project.

However, for the meantime, that the requirement continues to include requirements for speech, data and video and that Bronze Command speech interoperability [Ref. 2-5], is part of the requirement.

There is no operational reason for using a common technology to facilitate the three types of traffic, albeit that this may ultimately be a solution.

7.2.1.2 Assumptions Related to the Solution

The following assumptions are considered reasonable for the purpose of this analysis:

1. That for most incidents in the built environment, the At-Incident communications requirement will be met solely by equipment which fire-fighters bring with them to the incident

2. That whatever technology is selected to meet the At-Incident requirement, there will be structures in the built environment where effective wireless communications will not be achievable without supporting infrastructure for many risks, this supporting infrastructure will need to be pre-installed and permanent

3. That the same equipment will be used to provide At-Incident communications in the built environment as elsewhere, even where permanent or temporary infrastructure has been provided to support At-Incident communications

4. That the transition from a stand-alone solution to one that is supported by infrastructure will be both simple and transparent to users

5. That dedicated public safety RF spectrum should be used to facilitate the requirement

6. That equipment should ideally be manufactured to open/international standards and should be available from more than one manufacturer.

7.2.1.3 Assumptions Related to Resilience

That where effective and efficient At-Incident communications in the built environment is facilitated by a resilient supporting infrastructure, the possibility that it might be rendered wholly or partially inoperative as a direct or indirect consequence of the incident with which the fire and rescue service is dealing, cannot be excluded.

7.2.2 Airwave/Firelink

Airwave is available as a national commercially operated TETRA public safety TMO network, providing radio coverage (within defined parameters) throughout Great Britain to serve police and other public safety users. Terminals have to be registered on the system to access TMO services and subscription charges are payable by the users for each terminal. Usage charges also apply certain limits and usage in this context depends on a number of variables including the configuration and geographical spread of TMO talk-groups.

A similar TETRA based network, known as Barracuda, is to be available in Northern Ireland for use by the police, fire and ambulance services.

It is planned that the fire and rescue services wide-area radio requirements use the Airwave network through the Firelink project and that migration to this in England will be completed by 2009. Firelink is not specified to cover at-incident communications.

7.2.3 Analysis of the Options

Table 7.1 analyses and compares the communications technology options identified in the Technology Review as technologies that should be included in the analysis against a range of relevant criteria.

Because the characteristics of a TETRA solution are likely to be different from those of the other PMR technologies it has been analysed separately. The other PMR candidate technologies are considered to have generally similar propagation characteristics in the built environment.

Table 7.1 – Analysis of Communications Technology Options			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Option availability	Available and in use nationally to provide At-Incident communications.	TETRA DMO terminals are available now. TETRA TMO (the Airwave network) is technically available now – but coverage is mostly designed to meet the requirements of vehicle mounted terminals. Coverage to handheld terminals and in-building coverage is incidental unless specified by the user.	There is little possibility of the development of a national trunked network based on these technologies. There is little evidence of these technology options being in widespread use in the UK public safety environment.
Propagation in the built environment	Un-assisted performance in open air and in the built environment is considered to be broadly similar (given similar frequency assignments and handheld transmitter powers)		

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
How well is the solution suited to providing handheld communications in the built environment	Basic communications for the majority of incidents in the built environment can be, and are, provided by direct handheld to handheld communications. Where this is insufficient, coverage can be enhanced by the temporary deployment of a base station/repeater and antenna or by the permanent installation of a base station/repeater and antenna system. Permanent supporting infrastructure is already provided in a number of built environments.	Basic communications for the majority of incidents in the built environment can be provided by DMO handheld to handheld communications. Where this is insufficient, coverage can be enhanced by the temporary deployment of a DMO base station/repeater and antenna or by the permanent installation of a base station/repeater and antenna system. Incidental TMO coverage may be available in some parts of the built environment. A few buildings and structures may already be provided with TMO coverage to handheld terminals to meet the needs of other public safety user communities. TMO handheld coverage is also planned for other structures, such as the sub-surface parts of the London Underground system to meet the needs of other public safety user communities.	Basic communications for the majority of incidents in the built environment may be achievable using handheld to handheld communications. Where this is not possible or where this is insufficient coverage will need to be facilitated by a base station/repeater and antenna or by the permanent installation of a base station/repeater and antenna system.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Functionality	Capable of providing basic speech or data functionality using either single-frequency simplex or two-frequency half duplex channels.	Potentially highly functional and capable of supporting speech and data. However, a large part of this functionality requires TMO network connection of handheld terminals. DMO functionality is broadly similar to that of UHF analogue functionality.	Potentially highly functional and capable of speech and data. However, a large part of this functionality requires trunked connection to one or more base stations. Some technologies may support handheld to handheld communications, but functionality in these circumstances would be broadly similar to UHF analogue technology.
Availability of ATEX certified handheld terminals	ATEX certified handheld terminals are available.	ATEX handheld certified terminals are available.	ATEX certified handheld terminals will be available using these technologies.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Basic costs	Basic handheld terminals are inexpensive, c£200. IS variant handheld terminals are considerably more expensive to purchase and maintain.	TETRA DMO and TMO handheld terminals are likely to be more expensive than the analogue equivalents. Any element of the At-Incident requirement which is met by TMO services will incur network subscription and potentially use charges.	Costs are unknown – but speculatively are likely to be equivalent to those of TETRA equipment.
Standards compliance	An entirely open standard. Equipment available from a wide variety of manufacturers and sources.	An ETSI standard. Equipment available from a wide variety of manufacturers and sources.	Tend to rely on proprietary standards. Equipment supply may be limited to a single supplier.
Satisfying the fire and rescue service user requirement – including Bronze Command interoperability	Does not provide Bronze Command Interoperability with the other emergency services. A separate and discrete technology is used to meet the BA telemetry requirement. Otherwise appears to meet user requirements (data is not currently allowed for regulatory reasons)	Capable of satisfying the User Requirement for speech or data, including Bronze Command interoperability using DMO operation when in range (or TMO operation assuming coverage, network subscription and talk-group configuration).	Does not provide Bronze Command Interoperability with the other emergency services. Otherwise should be capable of satisfying the User Requirement for speech or data.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Providing direct interoperability with Firelink terminals	Not available.	Available using DMO operation when in range (or TMO operation assuming coverage, network subscription and talk-group configuration).	Not available.
Providing direct access to the Firelink network	Not available.	Available using TMO operation assuming coverage, network subscription and talk-group configuration.	Not available.
Providing AGA interoperability with police helicopters	Not available.	Available using DMO operation when in range (or TMO operation assuming coverage, network subscription and talk-group configuration).	Not available.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Simplicity and transparency	Technology simple and easily understood by fire-fighters. Handheld equipment relatively simple to operate and use. Training requirement not unduly onerous. Easily replaced during an incident as no reprogramming is required.	Technology more complex than UHF analogue technology, particularly if provided with DMO and TMO functionality. Handheld terminal equipment tends to be more complex than analogue equipment – particularly where TMO functionality is available. Training requirement is likely to be greater than for UHF analogue equipment. Speech codec delay may be problematic in some uses.	Technology more complex than UHF analogue technology, particularly if trunked and non-trunked functionality. Handheld terminal equipment tends to be more complex than analogue equipment – particularly where trunked functionality is available. Training requirement is likely to be greater than for UHF analogue equipment. Speech codec delay in digital options may be problematic in some uses.
Speech quality	Satisfactory.	Should be better than analogue in DMO and TMO modes.	Not known.
Spectrum availability	Exclusive spectrum available for fire and rescue service and currently in use.	Spectrum available to support Public Safety TETRA TMO (Airwave/Firelink) and DMO.	No spectrum currently identified for these technology options.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Fleet management overhead	Limited to programming handheld terminals with channels.	Limited to programming handheld terminals with channels for DMO operation. Substantial if TMO operation is relied on to provide any part of the At-Incident requirement.	Likely to be substantial for any solution that requires trunked operation.
Security implications	None.	The provision of TETRA handheld terminals capable of communicating in DMO mode with Airwave capable terminals and of TMO operation on the Airwave network may raise security issues and may involve a security management overhead which may be substantial.	None.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Resilience	Resilience of stand-alone handheld networks is subject only to failure of individual handheld terminals. Resilience of At-Incident networks involving base station/repeaters is reliant upon the failure of individual handheld terminals, the base station and the antenna system.	Resilience of stand-alone DMO networks is subject only to failure of individual handheld terminals. Resilience of DMO At-Incident networks involving base station/repeaters is reliant upon the failure of individual handheld terminals, the base station and the antenna system. Resilience of At-Incident communications involving TMO access is reliant upon the resilience of the network and its coverage and the failure of individual handheld terminals.	Resilience likely to be similar to that of analogue systems reliant upon on-site base station/repeaters.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Implementation costs	None.	Costs of terminals. Costs of DMO base stations/ repeaters to replace UHF analogue equipment. Costs of subscriptions (and potentially for usage charges) for handheld terminals for any in-building coverage that relies on TMO operation.	Costs of terminals. Costs of base stations/ repeaters to replace UHF analogue equipment and otherwise to facilitate At-Incident communications.
Migration overheads	None.	Potentially substantial. Will require national roaming and interoperability and existing in-building coverage to be maintained throughout roll-out period.	Potentially substantial. Will require national roaming and interoperability and existing in-building coverage to be maintained throughout roll-out period.
Other strengths of this option	Generally: 1. The UHF analogue technology is robust 2. The equipment is in place and in service now – new/replacement COTS equipment is available if required 3. There is a separate solution to meet the BA telemetry element of the At-Incident data requirement thus providing resilience.	Generally the technology can be regarded as robust	None.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Particular weaknesses of this option	Generally: 1. There is limited development potential – at the present there seems to be little scope for additional channels to meet the command/management needs of large/ complex incidents 2. The UHF channel assignments are not ideal, leading to potential blocking problems – particularly where the scale of the incident requires the use of all available channels 3. The 25 KHz bandwidth of current channels also creates problems inter-operating with other UHF users, such as at aerodromes licensed by the CAA 4. There appears to be a lack of central direction and guidance on At-Incident communications, particularly in relation to Major Incidents and New Dimension incidents 5. A separate solution has to be sourced and maintained to provide breathing apparatus telemetry (but see strengths regarding resilience)	Generally COTS terminal equipment may not be suitable for At-Incident use. In the built environment: 1. TMO talk-group configuration and capacity at built environment sites may not be appropriate to fire and rescue service At-Incident needs 2. The provision of fixed installations on site to provide enhanced radio coverage is generally subject to the goodwill of the site owner/ occupier. Save where other authorities are involved (Transport for London, the Highways Agency, HM Railway Inspectorate etc.) there appears to be no mechanism by which a site owner or occupier can be compelled to make provision for fire and rescue service tactical communications	Generally COTS terminal equipment may not be suitable for At-Incident use. In the built environment: 1. The provision of fixed installations on site to provide enhanced radio coverage is generally subject to the goodwill of the site owner/ occupier 2. Fixed facilities to support communications in the built environment may be damaged or rendered inoperative by the incident that the fire and rescue service is attending 3. Enhanced communications requiring fixed provision at a site is subject to the effectiveness of the management/maintenance regime of the site owner/ occupier.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Particular weaknesses of this option *(continued)*	6. There does not currently appear to be a technical solution for any other At-Incident data requirement or At-Incident wireless CCTV. In the built environment: 1. The provision of fixed installations on site to provide enhanced radio coverage is generally subject to the goodwill of the site owner/occupier. Save where other authorities are involved (Transport for London, the Highways Agency, HM Railway Inspectorate etc.) there appears to be no mechanism by which a site owner or occupier can be compelled to make provision for fire and rescue service tactical communications 2. Fixed facilities to support communications in the built environment may be damaged or rendered inoperative by the incident that the fire and rescue service is attending 3. Enhanced communications requiring fixed provision at a site is subject to the effectiveness of the management/maintenance regime of the site owner/occupier	3. Fixed facilities to support communications in the built environment may be damaged or rendered inoperative by the incident that the fire and rescue service is attending 4. Enhanced communications requiring fixed provision at a site is subject to the effectiveness of the management/maintenance regime of the site owner/occupier.	

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Particular weaknesses of this option *(continued)*	4. Enhanced communications is usually only provided for a single UHF channel; (there is, in any case, a maximum of two channels can theoretically be supported at single incident).		

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Opportunities of this option	1. Consideration can be given to whether it is desirable that developers or owners of new large buildings and/or those to which large numbers of the public resort should be compelled by law: to (i) restrict the use of materials in buildings which are intended to limit the effectiveness of radio equipment in the building and (ii) provide and subsequently maintain, in consultation with the fire and rescue authority for the area in which the building is situated, such on-site radio infrastructure as may be necessary in the view of the fire and rescue authority to ensure efficient and adequate radio communications for the fire and rescue service in the event of an incident 2. That fixed infrastructure in adjacent buildings can be used to provide resilient coverage in tall buildings 3. That different transmitter power settings for different channels can be used to improve coverage/range at incidents in the built environment, without compromising re-use of channels at nearby incidents	1. This option may be a better match to a future revised and updated user requirement 2. Consideration can be given to whether it is desirable that developers or owners of new large buildings and/or those to which large numbers of the public resort should be compelled by law: to (i) restrict the use of materials in buildings which are intended to limit the effectiveness of radio equipment in the building and (ii) provide and subsequently maintain, in consultation with the fire and rescue authority for the area in which the building is situated, such on-site radio infrastructure as may be necessary in the view of the fire and rescue authority to ensure efficient and adequate radio communications for the fire and rescue service in the event of an incident.	1. This option may be a better match to a future revised and updated user requirement 2. Consideration can be given to whether it is desirable that developers or owners of new large buildings and/or those to which large numbers of the public resort should be compelled by law: to (i) restrict the use of materials in buildings which are intended to limit the effectiveness of radio equipment in the building and (ii) provide and subsequently maintain, in consultation with the fire and rescue authority for the area in which the building is situated, such on-site radio infrastructure as may be necessary in the view of the fire and rescue authority to ensure efficient and adequate radio communications for the fire and rescue service in the event of an incident.

Table 7.1 – Analysis of Communications Technology Options *(continued)*			
Criterion	**UHF Analogue (Current)**	**TETRA PMR**	**Other PMR Options**
Opportunities of this option *(continued)*	4. The comparatively low cost of handheld equipment means that users can consider making it a personal issue – thus reducing maintenance costs and improving availability.		
Threats to this option	1. That the review of the At-Incident User Requirement recommended by this study identifies essential requirements that cannot be met by current technology 2. That site developers/occupiers refuse to co-operate in providing fixed infrastructure in the built environment 3. That increasingly materials used in the construction of the built environment impair the effectiveness of At-Incident communications 4. That the six channels available are insufficient for large/regional scale interventions and that there is no possibility of further expansion within the existing bands 5. That the two channels available for repeater/base station use become insufficient to support interventions inn the built environment. 6. That spot frequency assignment changes are required in the future.	1. That fire and rescue authorities do not wish to change the technology or refuse to fund the change 2. That site developers/occupiers refuse to co-operate in changing fixed infrastructure in the built environment.	1. That sufficient suitable RF spectrum cannot be found to facilitate the introduction of the solution 2. That fire and rescue authorities do not wish to change the technology or refuse to fund the change 3. That site developers/occupiers refuse to co-operate in changing fixed infrastructure in the built environment 4. That the selected technology becomes moribund.

7.2.4 Commentary on the Analysis

7.2.4.1 Current Technology

The strengths of the current arrangements are substantial, not least that it is in place, it works and the equipment has been updated over-time. These arrangements also permit a number of development opportunities.

Of its weaknesses, the most potentially significant at the moment is the inability of the current technology to deliver interoperability at Bronze Command level with the other emergency services since, although we recommend that the User Requirement be reviewed and updated, this is already known to be a requirement that has developed since 1999.

However, if direct interoperability is not a requirement, there are a number of technical and non-technical ways in which a measure of interoperability could be achieved. These include the use of FM/TETRA repeaters or the *ad hoc* use by fire and rescue service Bronze Commanders of TETRA DMO handheld terminals solely to provide the wanted interoperability. These terminals could be brought to an incident when required – perhaps as part of the Bronze/Silver/Gold initiation process – or could be provided in limited numbers (perhaps one per appliance) on appliances. We understand that the former approach has been adopted as an interim means of facilitating Bronze interoperability. We felt that in the fire and rescue service context there may well be procedural advantages in keeping the interoperability network entirely separate from command networks – and the use of separate equipment (however provided) was a means of achieving this.

A review of the User Requirement may result in the identification of new requirements that cannot be met with current technology. However, it may be that any new requirements are best met, as is the BA telemetry requirement currently, by additional equipment designed to meet that requirement. An obvious candidate for such an approach would be a requirement for At-Incident video.

The built-environment related weaknesses of the current technology are likely to be common to, and shared with, other PMR based solution to the At-Incident requirement. It is important to remember that the built-environment solutions for the current technology are already largely in place whereas those for any new technology would be need to be provided and resourced.

The apparent lack of central direction on the use of At-Incident capability ought to be easily resolvable and it would be worthwhile pursuing the capacity weaknesses and the resolution of the blocking problem through the PSSPG.

Save for the opportunities for improving the way in which enhanced in-building coverage is provided (an opportunity shared with all the candidate technologies), the development opportunities for current technology are relatively limited.

7.2.4.2 TETRA PMR (O2 Airwave)

The significant strength of the TETRA PMR technology option, is that in addition to meeting the 1999 user requirement [Ref. 2-4], it could also provide bronze level interoperability with the other emergency services. It can also potentially provide interoperability with Firelink terminals and with the Firelink network. This is the only PMR technology option that will deliver this functionality.

Against this, a change to TETRA, will incur costs and cause challenging migration difficulties.

For the built environment, the costs of implementing any alternative PMR solution may be substantial. However, this may not be the case for a TETRA based PMR solution at those sites where in-building TMO network coverage is already provided by the Airwave/ Firelink network, or such coverage is already planned (and where talkgroup configuration and TMO capacity meets fire and rescue service At-Incident needs and where handheld terminals are subscribers on the network).

Where new infrastructure is required, site owners may be reluctant to replace existing base station/repeater equipment with new PMR technology – particularly as they will secure no obvious benefit from the change. Even where site owners are prepared to co-operate, migration to a new technology in the built environment, maintaining national and local interoperability will be a particular challenge.

Lastly, fire and rescue authorities themselves may themselves baulk at the cost administrative overheads to a change in technology and central direction and funding may be necessary to achieve this. Central direction may be problematic since the national administrations would need to agree that change was necessary, on the selected solution and agree to implement the measures necessary to achieve this.

Nonetheless, we recognise that any future significant change in the 1999 User Requirement [Ref 2-4], resulting from the recommended review may tip the scales more towards one of the PMR technology options, and given this analysis, particularly to a TETRA based PMR solution.

Note: In discussing 'TETRA PMR (02 Airwave)' for at-incident communications it is important to recognise that the requirement is actually for 'interoperability with the Airwave/Firelink service and so other technologies could interoperate by means of a gateway. In this context a gateway is where a mobile with connection to the network can act as a relay for other nearby mobiles that are not on the network. It is envisaged that any future procurement for at-incident communications would be subject to normal practices of procuring against a technology-neutral specification.

7.2.4.3 Other PMR Candidate Technologies

Other candidate PMR technologies suffer in comparison with the TETRA PMR technology option, in that whilst they might satisfy the 1999 user requirement, there may be more involved in provide bronze level interoperability with the other emergency services. Neither can they cannot provide interoperability with Firelink terminals and with the Firelink network without the use of a gateway. None of these solutions currently has spectrum available to support it. Lastly, none of the technologies appear to have any other significant compensatory advantage over the TETRA option.

Any change to one of the PMR candidate technologies will incur costs and cause challenging migration difficulties with the same issues as the TETRA PMR option.

7.2.5 BA Telemetry

It may be sensible that, for the time being at least, BA telemetry continues to be provided by means of a stand-alone dedicated technology as this is already established practice and provides some degree of resilience in the event of radio communications failure.

7.2.6 Video Solution Options

The Technology Review has identified WMAN technology as a potential solution to the At-Incident video requirement. The selection otherwise of WMAN technology for this application is unlikely to have any impact on the analysis of the current equipment or of the technology options for delivering speech and data communications.

We assume that a decision of whether or not to adopt this technology will be made once the requirement is finalised and the technology matures. WMAN technology for fire and rescue service At-Incident video requirements has therefore not been subjected to a detailed analysis.

7.3 Discussion

7.3.1 User Requirement

The Current Situation element of this study recognised a need to review and update the current (1999) User Requirement for At-Incident communications [Ref 2-4] to take account of the developing requirement, including any New Dimension requirement and of technical possibilities that have become available since the earlier work.

7.3.2 Working Assumptions

We continue to use the working assumptions identified in Section 7.2.

7.3.3 Technology Options Considered

The Technology Review identified a range of PMR options that could potentially meet the At-Incident requirement. These included:

1. Proprietary equipment (Conventional PMR, MPT1327 TETRAPOL, iDEN, EDACS, ASTRO, APCO25)

2. Equipment complying with European Standards (Conventional PMR and TETRA)

3. Equipment developed to meet planned or future European Standard (DMR).

The Technology Review concluded that Private Mobile Radio (PMR) technologies, including TETRA, should be considered as a potential alternative to the existing UHF analogue technology for meeting the At-Incident requirement.

It also concluded that Wireless Metropolitan Area Network (MAN) technology should be considered only as a potential solution for the At-Incident video requirement.

7.3.4 Initial Conclusions

7.3.4.1 The Choice of Technology Options

All the PMR technology options are likely to have similar performance in the open air and in the built environment (given similar frequency assignments and handheld transmitter powers).

The analysis of the technologies concluded that there were issues common to many of the options but that:

1. Only a solution based on the use of gateways would satisfy the requirement to provide Bronze Command interoperability with the other emergency services

2. Only a solution based specifically on TETRA would potentially provide interoperability with Firelink terminals

3. Only a solution based specifically on TETRA would potentially provide access to the Airwave/Firelink network.

Of the potential replacement technologies, the TETRA PMR (02 Airwave) option also had RF spectrum allocated to TMO and DMO operation and was the only candidate technology for which some in-building infrastructure was either already provided or contemplated.

Adoption now of a PMR technology for At-Incident communications that did not provide Bronze Command interoperability would be justified only if the chosen technology offered functionality or performance which was exceptional when compared with the technology that did allow this provision. In our judgement, the non-TETRA PMR (02 Airwave) technologies identified in the Technology Review do not offer either exceptional functionality or performance.

We therefore conclude that the non-TETRA PMR (02 Airwave) technologies should be excluded from further analysis.

7.3.4.2 The TETRA PMR (O2 Airwave) Option Understood

An At-Incident solution based on TETRA technology is likely to have the following characteristics:

1. **RF Spectrum:** The TMO elements of the solution will use the spectrum reserved for public safety and emergency service use to support the Airwave/Firelink network. However, it remains unclear whether this would be sufficient to support any additional capacity required to support any TMO element of the fire and rescue service At-Incident requirement. The DMO element of the requirement will use the additional channels that it is understood have also been identified to support additional TETRA DMO use beyond those provided for the police in the 380-400MHz band.

2. **DMO Availability:** Currently Firelink are not providing DMO facilities as it is outside of the scope set for the project. However, the radio terminals that are being procured will nonetheless support DMO, so they are buying the functionality by default.

3. **DMO Channel Blocking:** Dependent on how TETRA DMO channels are assigned for At-Incident communications, they may potentially be subject to similar blocking problems to those experienced with UHF analogue channels.

4. **Terminal Costs:** Handheld terminal procurement costs are likely to be more expensive than the costs of UHF analogue terminals, now and for the foreseeable future.

5. **Usage Charges:** TETRA DMO use should, like the use of UHF analogue equipment, be free of use-related charges. There are currently no WT licence charges for access to TETRA DMO assignments. Any handheld TMO network use/access as a result of the At-Incident requirement may attract network usage charges, above a specified use threshold in addition to any network subscription charges.

6. **Equipment Availability:** Equipment, and particularly terminal equipment and accessories should be available from a number of manufacturers/suppliers.

7. **ATEX Certified Terminals:** The availability of ATEX certified handheld terminals is likely to be limited – but probably no worse than that of ATEX certified analogue terminals.

8. **Human Interface:** Handheld terminal equipment is likely to have a more complex user interface than an analogue terminal, especially if DMO and TMO functions are contemplated. Communications, particularly in the built-environment are likely to be less transparent to users than the current UHF analogue solutions and this may have impact on the training requirement.

9. **Communications in the Built Environment:** Where enhancement of TETRA DMO handheld terminal to handheld terminal is required, this can potentially be achieved through the use of DMO base station/repeaters connected to a fixed antenna infrastructure in a manner analogous to current At-Incident communications or through Airwave/Firelink TMO network access.

   However, the TMO option would be optimal where handheld network coverage has already been provided (for other emergency service users), but:

   a. Coverage would need to meet fire and rescue service requirements

   b. Network access in these circumstances is likely to require the payment of network subscription and any use charges for every handheld terminal that would need to access the system – this may, of necessity, include all At-Incident terminals

   c. TMO talk-groups would need to be configured in a way that met fire and rescue service needs

   d. TMO network capacity would need to be sufficient to support the fire and rescue service in building requirement and that of other uses of the network.

10. **Security:** The use of TETRA terminals capable of interoperating with Airwave/Firelink capable terminals and/or accessing the Airwave/Firelink network is likely to raise issues of security management and incur a security management overhead.

11. **Fleet Management:** Any TMO provision supporting fire and rescue service At-Incident communications is likely to involve a substantial fleet management overhead.

12. **Bronze Command Interoperability:** Bronze Commend level interoperability will be available using TETRA DMO and also, subject to Airwave/Firelink handheld coverage, suitable talk-group configuration and network subscription charges, using TMO.

13. **AGA interoperability:** At-Incident interoperability with police helicopters will be available using TETRA DMO, when required.

14. **Firelink terminal Interoperability:** At-Incident interoperability with Firelink terminals on appliances will be available using TETRA DMO and also, subject to Airwave/Firelink handheld coverage, suitable talkgroup configuration and network subscription charges, using TMO.

15. **Firelink Interoperability:** TMO interoperability of At-Incident handheld terminals with the Firelink network will, subject to fleetmapping authorities, Airwave/Firelink handheld coverage, suitable talk-group configuration and network subscription charges, facilitate at incident access to a full range of Firelink contracted services where this is required.

16. **National Roaming:** That a common At-Incident solution, based on TETRA PMR will obtain throughout Great Britain using DMO and TMO where necessary – the latter facilitated by the Airwave network

Note however that the assumption that TETRA PMR technology will satisfy the fire and rescue service requirement for At-Incident Communications and will otherwise be suitable for that purpose, in the built environment and otherwise, still remains to be tested.

7.3.5 Towards a Decision on Technology

UHF analogue equipment is already used by all fire and rescue services in the UK, to provide At-Incident communications both generally and within the more complex built environment. It has been (and still is) the subject of considerable investment, most of which would be wasted if it were to be replaced.

So the consideration now is probably not:

Which solution is optimal for the At-Incident requirement?

but,

Whether the additional attributes of a TETRA PMR solution, and particularly the ability to deliver Bronze Command interoperability and to interact with Firelink, are sufficient to justify it replacing UHF analogue technology, given particularly the cost and migration challenges that this is likely to involve?

7.3.6 Conclusions on Technology

There appear to be a number of ways of providing a measure of Bronze Command interoperability with the police and ambulance services (Ref 7.2.3.1).

Therefore, unless the provision of direct Bronze Command interoperability is a paramount consideration, we conclude that the adoption of TETRA PMR (O2 Airwave) as the means of providing At-Incident communications for the fire and rescue service is not justified at this stage.

We also conclude that TETRA PMR should only considered after appropriate practical operational trials to confirm that it can satisfy the At-Incident requirement and is otherwise suitable in built and un-built environments.

Finally, we conclude that any future decision to replace the existing At-Incident technology should be informed by a full and detailed cost-benefit analysis. This analysis should include migration costs and the wasted costs of existing provision, wherever they fall.

7.3.7 Discussion on the Built Environment

7.3.7.1 New Buildings

The Technology Review indicates that there appear to be varying approaches in local building control arrangements related to the provision of emergency service radio communications in the built environment. In the UK there are no mandates, in some countries there are best practice guidance and in some parts of the US there are local Ordinances requiring minimum standards.

There is scope for considering whether it is desirable that developers or owners of new large buildings and/or those to which large numbers of the public resort should be compelled by law:

1. To restrict the use of materials in buildings which are intended to limit the effectiveness of radio equipment in the building

2. To provide and subsequently maintain, in consultation with the fire and rescue authority for the area in which the building is situated, such on-site radio infrastructure as may be necessary in the view of the fire and rescue authority to ensure efficient and adequate radio communications for the fire and rescue service in the event of an incident.

Ideally, any such provision should apply uniformly throughout the United Kingdom.

It is recognised that any such compulsion may need to be subject to a regulatory impact assessment and that decisions on the circumstances in which it would apply would need to be measured and reasonable.

A reference around which to begin this consideration would be those of the largest cubical extent, perhaps above a volume that would affect only the most problematic of new buildings.

We conclude that emergency services communications needs, as well as those relating to fire safety and fire service access, are fully understood and taken into account in the design of new buildings.

7.3.7.2 Existing Buildings

For the existing built environment the current arrangements for repeater/base station installations for facilitating effective fire and rescue service at-incident radio communications should continue. These include:

1. Significant road tunnels
2. Railway tunnels and sub-surface stations
3. Airports and aerodromes
4. Other large building complexes

We note that there does not appear to be a uniform approach to determining whether such facilities are needed and how they should be procured, installed and maintained.

There is also scope for considering standardising the arrangements relating to the provision, installation, testing and maintenance of radio installations to support fire and rescue service at-incident communications in the existing built environment, by means of a Code of Practice, or otherwise.

Some materials used in the built environment, including certain types of glass, inhibit radio transmission. Extensive use of glass construction is often associated with metal frame structures which together can act as a Faraday cage.

Frequency Selective Structures (FSS) are also being developed. We understand that materials, particularly glass, are being developed with characteristics that include frequency blocking properties by design. Research into these materials and their application, by organisations including Ofcom, is ongoing. They appear generally aware of the emergency services issue but this is not their focus.

7.3.7.3 Other EMC Issues in the Built Environment

We noted that deliberate radio "jamming" of licensed radio traffic is illegal in the UK.

We conclude that:

1. Safety-critical building systems, such as lifts for use by firefighters, alarm systems and building ventilation systems, should be designed to ensure that they are not affected by and do not themselves interfere with fire and rescue service at-incident communications

2. At-Incident communications should be useable within the built environment without risk of interference to, or by, other in-building electronic and radio systems. The study noted that guidance to the fire and rescue service already existed in relation to the possibility of problems occurring in relation to some medical devices primarily in a hospital environment

3. The consideration of any proposal to change the way that fire and rescue service at-incident communications is provided (for example by the use of a different technology or the use of a different frequencies) account needs to be taken of the EMC impacts of that change in the built environment

4. Ofcom needs to be advised that its submission to the Treasury-funded research programme, the Spectrum Efficiency Scheme (SES) relating to a passband for emergency services spectrum, does not include the band currently used for fire and rescue service At-Incident communications.

7.3.8 Conclusions on Timing

The proposed recommendations targeted at securing facilities to support At-Incident communications in the built environment can be progressed in parallel with the proposed review of the User Requirement and a final decision on the technology to be used for this purpose.

However, it makes sense to delay any substantive change to the process by which At-Incident radio is supported in the built environment until a decision on the technology has been taken.

Chapter 8

Conclusions and Recommendations

8.1 Introduction

Based on the analysis, this section summarises our conclusions and recommendations and is structured as follows:

1. The Fire and Rescue Service Requirement
2. The Built Environment
3. Radio Communications
4. Next Steps.

8.2 The fire and rescue service requirement

The Current Situation element of this study recognised a need to review and update the current User Requirement for At-Incident communications to take account of the developing requirement, including any New Dimension requirement, and of technical possibilities that have become available since the earlier work.

RECOMMENDATION 1: That the existing fire and rescue service requirement for At-Incident communications (document 1 below) is reviewed and updated, taking into account the requirement for bronze level interoperability with the other emergency services (document 2); the New Dimension Requirement; the decision to adopt TETRA as the technology for the wide-area requirements of the fire and rescue service in England and the technical possibilities that have become available since the earlier work.

1. 'Fire Service Radio Strategy Procurement Guidance – Standard Specification for Mobile Communications', Home Office Fire and Emergency Planning Department, April 1999
2. 'Statement of Interoperability and Resilience for Radio Communications Systems of the Emergency Services', Chief Fire Officers Association (CFOA) with Association of Chief Police Officers (ACPO) and Ambulance Services Association (ASA), Draft 3 23 September 2004.

8.3 The built environment

There appears to be different approaches in local building control arrangements related to securing the mandating the provision of emergency service radio communications. In the UK there are no mandates, in some countries there are best practice guidance and in some parts of the US there are local Ordinances requiring minimum standards.

RECOMMENDATION 2: Consideration should be given to whether it is desirable that developers or owners of new large buildings and/or those to which large numbers of the public resort should be compelled by law to:

1. Restrict the use of materials in buildings which are intended to limit the effectiveness of radio equipment in the building; and/or

2. Provide and subsequently maintain, in consultation with the fire and rescue authority for the area in which the building is situated, such on-site radio infrastructure as may be necessary in the view of the fire and rescue authority to ensure efficient and adequate radio-communications for the fire and rescue service in the event of an incident.

Ideally, any such provision should apply uniformly throughout the United Kingdom. It is recognised that any such compulsion may need to be subject to a regulatory impact assessment and that decisions on the circumstances in which it would apply would need to be measured and reasonable. A reference around which to begin this consideration would be those of the largest cubical extent, perhaps above a volume that would affect only the most problematic of new buildings.

For the existing built environment, the current arrangements for repeater/base station installations for facilitating effective fire and rescue service at-incident radio communications should continue. However, we note that there does not appear to be a uniform approach to determining whether such facilities are needed and how they should be procured, installed and maintained.

RECOMMENDATION 3: Consideration should be given to standardising the arrangements relating to the provision, installation, testing and maintenance of radio installations to support fire and rescue service at-incident communications in the existing built environment, by means of a Code of Practice, or otherwise.

Whilst not an issue of at-incident communications, we note that in connection with the built environment consideration should also be given to providing guidance to occupiers of large buildings and those to which large numbers of the public have access relating to the

provision of on-site electronic systems storing building, risk and occupancy information for use when the fire and rescue service arrives at an incident. There are systems on the market currently that vendors suggest could be used to provide such information.

Some materials used in the built environment, such as Pilkington K-Glass, have a side-effect in that they inhibit radio transmission. Extensive use of glass construction is often associated with metal frame structures which together can act as a Faraday cage.

Frequency Selective Structures (FSS) are also being developed. We understand that materials particularly glass are being developed with characteristics that include frequency blocking properties by design. Research into these materials and their application, by organisations including Ofcom, is ongoing. They appear generally aware of the emergency services issue but this is not their focus.

RECOMMENDATION 4: Consideration should be given to ensuring that the emergency services are adequately represented in the groups researching Frequency Selective Structures to ensure their needs are fully understood and taken into account.

As regards electro-magnetic compatibility issues arsing from fire and rescue service at-incident communications, we note that:

1. Deliberate radio "jamming" of licensed radio traffic is illegal in the UK; and

2. Safety-critical building systems, such as lifts for use by fire-fighters, should be designed to ensure that they are not affected by and do not themselves interfere with fire and rescue service at-incident communications.

Fire and rescue service radio equipment should be useable within the built environment without risk of interference to, or by, other in building electronic and radio systems. The study noted that guidance to the fire and rescue service already existed in relation to the possibility of problems occurring in relation to some medical devices primarily in a hospital environment.

RECOMMENDATION 5: That consideration of any proposal to change the way that fire and rescue service at-incident communications is provided (for example by the use of a different technology or the use of a different frequencies) ascertains any negative electro-magnetic compatibility impacts of that change on the electronic systems used within the built environment including the assurance that the control, detection, alarm and lift systems will continue to operate safely.

These built environment observations should be noted BUT are not the focus of the analysis because:

1. Regulatory Impact Assessments and the Building Regulation process mean that associated actions are for the long-term, not the five year horizon of this study – they will in any event only affect new buildings

2. Similarly, the introduction of new building materials including FSS are likely to take a considerable time to become widespread in construction use

3. The cost-benefit case for any changes is also likely to be biased against changes to many buildings in favour of changes to a relatively few fire rescue services.

RECOMMENDATION 6: A watching brief should be maintained on developments in the built environment and this should be used to inform and update the recommendations of this study.

8.4 Radio communications

Of the technology reviewed, being Professional Mobile Radio (PMR) and wireless broadband technologies – Personal Area Network (PAN), Local Area Network (LAN), Metropolitan Area Network (MAN) and Wide Area Network (WAN) – only PMR and MAN will require detailed consideration since:

As regards the PMR options for at-incident communications for further consideration, we believe that the following criteria would need to apply to their use:

a. Only licensed spectrum should be used as interference may be encountered in unlicensed spectrum and without an ability to resolve it if it affects service quality.

b. Only private systems should be used, again providing sufficient control over service quality and security.

c. Only spectrum available to, or reserved for, the emergency services should be used (although at present this implies i. and ii. above, this could change following the Ofcom 'Study to Assess the Future of Spectrum Requirements to Meet Emergency and Public Safety Services' [Ref. 2-7] that builds upon the findings of the Cave report in December 2005 [Ref. 2-8] and the associated Government response [Ref. 2-9].

d. Proprietary technology and equipment capable of being sourced only from a single supplier should be avoided.

This study could recommend that the PMR technology options be subject to a detailed analysis and comparison against these criteria. However, the focus of this study is the built environment. Against this, given similar transmission powers, it is likely that for practical purposes the performance of each of the potential replacement technologies would be broadly similar.

With this in mind, an assessment of whether it would be sensible and realistic to adopt an alternative technology to the UHF analogue equipment (used at present to provide at-incident communications) leads to the following conclusions:

a. That the current UHF analogue technology appears to meet the at-incident voice requirement; and

b. That a number of the alternative PMR technologies might perform similarly well, however there is no particular or significant reason for change to these technologies

c. That TETRA technology (in DMO mode) would also potentially perform similarly and additionally it could potentially provide:

    i. The possibility of direct interoperability at Bronze Command level with police and ambulance (a capability supported by CFOA)

    ii. The ability to communicate directly with Firelink terminals on appliances

    iii. The technical ability, given an appropriate level of radio coverage (and subscription) to directly access the Firelink system in TMO mode or through an appliance DMO/TMO repeater

    iv. Infrastructure to support police use of the Airwave network is already installed in, or installation is planned for, some of the built environment. This infrastructure might also be used (subject to capacity and subscription) to support TETRA based fire and rescue service at-incident communications in these environments.

But any change from the current technology would be likely to involve real and substantial costs to fire and rescue services (in equipment, training and transitional costs) and also probably to those who already provide infrastructure to support existing at-incident communications.

So the consideration now is probably not '*which solution is optimal for the At-Incident requirement?*' but *'whether the additional attributes of a TETRA PMR solution, and particularly the ability to deliver Bronze Command interoperability and to interact with Firelink, are sufficient to justify it replacing UHF analogue technology, given particularly the cost and migration challenges that this is likely to involve?*'

RECOMMENDATION 7: That, pending the review of the fire and rescue service requirement, no decision is taken now on replacing existing At-Incident Technology. Although a solution based on TETRA appears to be best suited of the technical options to meeting current and future At-Incident requirements, a decision on the adoption now of this technology should not be made now unless the provision of direct bronze level interoperability is a paramount consideration. Even then the suitability of TETRA PMR is subject to the availability of all required Direct Mode Operation (DMO) functionality and should be confirmed by appropriate trials in the built and open environments. Any decision to replace the current analogue UHF technology must be informed by a rigorous cost-benefit analysis.

It should be noted that a TETRA at-incident solution for the fire and rescue service is viable only if there are sufficient and suitable TETRA DMO assignments to support this use and sufficient TMO capacity where on site Firelink/Airwave network services are to be used to facilitate TETRA communications in the built environment.

For this reason amongst others we would urge that TETRA PMR should only considered after appropriate practical operational trials to confirm that it can satisfy the At-Incident requirement and is otherwise suitable in built and un-built environments.

It would also seem sensible to explore the extent to which revised UHF analogue assignments could be used to improve the utility and flexibility of this solution.

RECOMMENDATION 8: The existing UHF channel assignments should be examined to see whether it might be possible to modify the channel assignments to further minimise the potential technical limitations of the current channels and whether the number of available channels could be increased (perhaps by utilising channels vacated by the police service in its transition to the Airwave service).

WPAN (Wireless Personal Area Networking) may be a useful component of an at-incident communications system for example by connecting personal data devices on the fire-fighter to the system, but could not provide an incident communications system itself. Therefore a WPAN interface with PMR and WMAN options should be considered but WPAN technologies should not be options themselves.

RECOMMENDATION 9: That, for the longer term, a watching brief should be maintained over the development of WPAN technologies, products using them and opportunities for enhancing at-incident communications for the longer-term.

For WMAN technologies we believe that these do not warrant further consideration in this study other than as potential solutions to the video transmission element of the requirement as:

a. There is not, as far as we are aware, any ATEX certified IS equipment handheld radios available on the market using this technology; and

b. The primary application for these technologies would be video transmission – this is included in the at-incident requirement but it is not a primary requirement and it is not currently in widespread use.

RECOMMENDATION 10: A watching brief should be kept on the development of WMAN technology (included within this the Mesh radio products emerging onto the market) and the need for video at incident with a view to this being supplemental to the voice communication system if, as and when needed.

WWAN (Wireless Wide Area Networking) cordless and cellular telephony are not suitable technologies for providing at-incident communications. The study noted that the fire and rescue service requirement for wide-area communications will be met through Firelink (recently confirmed as Airwave O2 Ltd using TETRA). Firelink will also facilitate interoperability with the other emergency services at Silver Command level and some of the current reported problems in communicating with police helicopters at incidents.

The study has identified a number of organisations [Ref. 2-6], the deliberations of which may have an impact on the requirement and potential solutions to the fire and rescue service requirement for at-incident communications.

RECOMMENDATION 11: Close working relationships need to be maintained and developed between those considering At-Incident communications in the built environment and all the organisations (including CFOA, ODPM and PSSPG groups) that might have an impact on either the requirement for At-Incident communications. It is important to note that these groups themselves have ongoing work also which may identify changes that have an impact.

8.5 Next steps

The proposed recommendations targeted at securing facilities to support At-Incident communications in the built environment can be progressed in parallel with the proposed review of the User Requirement and a final decision on the technology to be used for this purpose.

However, it makes sense to delay any substantive change to the process by which At-Incident radio is supported in the built environment until a decision on the technology has been taken.

RECOMMENDATION 12: That the set of recommendations from this study be used as the basis of a programme of further work, be they new projects or additions to the terms of reference of existing groups.

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