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Communications Inter-Operability in a Crisis

Sandra Bell and Rebecca Cox

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Contents

List of Figures

List of Tables

Abbreviations/Acronyms

ACPO	Association of Chief Police Officers
Airwave	A secure digital managed radio service for voice and data
APA	Association of Police Authorities
ASA	Ambulance Services Association
BCS	British Crime Survey
BT	British Telecommunications plc
BTP	British Transport Police
C2	Command and Control
CACFOA	Chief and Assistant Chief Fire Officers Association
CBRN	Chemical, Biological, Radiological and Nuclear
CCRP	'Command and Control Research Programme' within the Office of the Assistant Secretary of Defense
CCTV	Closed Circuit Television
CoLP	City of London Police
DoH	Department of Health
GLO	Government Liaison Officer
GLT	Government Liaison Team
HMIC	Her Majesty's Inspectorate of Constabulary
ISB	Invest to Save Budget
IT	Information Technology
LA	Local Authority
LAS	London Ambulance Service
LFB	London Fire Brigade
LRT	London Resilience Team
LU	London Underground
MDP	Ministry of Defence Police
MPS	Metropolitan Police Service
NAO	National Audit Office
NHS	National Health Service
ODPM	Office of the Deputy Prime Minister
OODA	Observe, Orient, Decide, Act
PITO	Police Information Technical Organization
PLA	Port of London Authority
PPAF	Police Performance Assessment Framework
PSNI	Police Service of Northern Ireland
SCG	Strategic Co-ordinating Group
TENYAS	Tees, East and North Yorkshire Ambulance Service
TETRA	Terrestrial Trunked Radio
TfL	Transport for London

Executive Summary

The London Assembly report into the bombings of the London mass transport system on 7 July 2005 stated that multiple communications failures hampered the response.

This seemed to come as a surprise. Yet, the inquiries into most large scale emergencies and disasters highlight communication difficulties between emergency services. For example, the inquiries into the 11 September 2001 terrorist attacks on the World Trade Center, the 1989 Hillsborough Football Disaster, the 1988 Clapham Junction Railway Disaster and the 1987 King's Cross Underground Fire all recommended that emergency services should review and improve communications between themselves.

All large scale emergencies and disasters require the emergency services to work together in non-standard ways. We should therefore be accustomed to the idea that emergency responders need to communicate with one another, wherever the emergency or disaster has happened – including underground.

It is hard to believe that modern communications and information technology are insufficient to solve this problem. Therefore, there must be other obstacles. Much has been written on the subject of the barriers to communication within, and between, individual responder organizations including technological, cultural, political and economic barriers. Likewise, many have postulated ways and means to overcome those barriers. However, there has been little written on the positive forces (or drivers) for communication between the services.

This *Whitehall Report* seeks to redress this balance. It is suggested that perhaps it is not the barriers that are too great, but rather that the drivers are insufficiently strong or focused.

An analysis of the response to past disasters highlights three main issues:

- Information remaining in organizational silos.
- A reliance on brittle information flows, which is suited for day-to-day circumstances but not for crisis situations.
- A lack of timely information about the environment where the emergency or disaster has happened.

Each of these issues relates to the 'joint response'. Therefore the ownership of the joint response is important.

The Report investigates this by looking at the structure of the UK emergency and disaster response capability and by investigating the joint command and control organization. A conceptual model, developed by the US based 'Command and Control Research Programme', is used to describe the current organization and the type of organization that could be achieved with the use of modern information and communications technology. The aim being to see if better communication, within the current organizational constraints, could have prevented the sorts of response failures highlighted in the real life disaster inquiries.

The Report demonstrates that significant advantages could accrue. However, the Report also demonstrates that such advantages are dependent on the different organizations, with very different cultures, being held together by an external influence. Such an external influence or 'glue' can, in part, be developed before the incident in the shape of prior knowledge: common education and training, doctrine, tactics, techniques, and procedures. But, the event-specific element of this guidance needs to be reflected in a joint 'Command Intent' or common purpose

as individuals need to be united in their efforts.

However, the Report identifies that, within the current UK emergency and disaster context, there is no single body with ownership of the joint response. This has resulted in the sorts of communications failures cited by the disaster inquiries within a crisis situation and incoherent strategy when attempting to implement the recommendations of the failures post disaster. The Report identifies that, in fact, the latter has resulted in a timeline extending well beyond eighteen years.

However, on a positive note, the Report identifies that as many emergency responder communities are voluntarily adopting compatible technology for their own internal information and communications use, there now exists the potential to transform UK emergency and disaster response.

The opportunities are identified as falling into three main areas:

- Joint Working
- Unified Multi-agency Command and Control
- Joint Information Systems

The Report makes three recommendations:

1. That there should be a unified communications policy encompassing all responder communities that ensures inter-operability.

2. That each response management tier – bronze, silver and gold – should have an 'Incident Commander' to take ownership of the Command Intent.

3. That multi-agency information flow requirements should be defined so that the platform on which the information systems are to operate are designed for purpose, rather than the systems being designed to fit the platform on which they have to operate.

Chapter 1: Introduction

The threat of international terrorism and the vulnerability of an interconnected society highlighted by the fuel price protests of 2000 has prompted the UK government to establish and exercise legislation and principles governing the arrangements for the response to emergencies requiring co-ordinated UK central government action.[1] Contained within this framework is the requirement for specific responders to share information with each other; but the physical mechanisms and extent of this sharing is left to the discretion of the designated responders themselves.

The ability to share information is directly related to the ability to communicate information and therefore communications inter-operability is often cited as essential. However, rather than defining the context in which communications inter-operability should take place, most of the documentation looks at the concept of inter-operability, with much being written on the subject of the barriers to inter-operability including technological, cultural, political and economic barriers. Likewise, many have postulated ways and means to overcome those barriers. However, communication is an enabler, and, in the case of emergency or crisis situations, it is the enabler that allows those charged with the resolution of the incident to receive and process the data and information necessary for them to make timely and effective decisions. This Report seeks to examine the decisions that need to be made, the players involved in making those decisions and then makes recommendations regarding the type and extent of communications that are best suited to support the information flows required for those decisions.

[1] Civil Contingencies Act 2004, The Stationery Office Limited, ISBN 0 10 543604 6; Central Government Arrangements for Responding to an Emergency. CONCEPT OF OPERATIONS, 31 March 2005. Available at: http://www.ukresilience.info/publications/conops.pdf.

Chapter 2: Communications Failures

The London Assembly Report into the bombings of the London transport system on 7 July 2005[2] reveals that multiple communications failures hampered the responses. Individual emergency service personnel at the affected sites could not communicate effectively in some cases either between themselves or with their control rooms. Such communications failures made it difficult to establish what had happened and therefore how first responders could best react collectively. Examples of failures included passengers being unable to communicate with drivers to alert them of their situation, transport and emergency service workers having to run from trains to platforms to communicate with colleagues and supervisors, London Ambulance service personnel being unable to communicate with their control rooms leading to requests for further ambulances, supplies and equipment failing to get through, and an over-reliance on mobile phone systems that predictably became congested and overloaded, hampering vital communications between senior commanders.

Likewise, the failure to get information to where it was most needed was an issue in the response to the terrorist attacks on the World Trade Center on 11 September 2001. At a press conference in August 2002, leaders from Unions representing New York firefighters claimed that 120 fire personnel may have lost their lives due to poor radio communications,[3] the claim being that 120 fire personnel had climbed one of the towers but were unable to hear a commander on the ground order them out of the building half-an-hour before it collapsed because of poor in-building radio coverage and outdated radios. An independent report commissioned by the New York City Fire Department[4] stated, 'Firefighters and emergency services personnel were hindered in their response on 11 September by multiple failures of communications systems, processes and technology limitations.'

However, such findings are not new and the inquiries into a number of UK disasters have cited communications and information flow as issues.[5] The 1987 King's Cross underground fire, the 1988 Clapham Junction railway accident, and the 1989 Hillsborough football stadium disaster all cite communication failures.

King's Cross Underground Fire – November 1987

In November 1987, thirty-one people died in a blaze, started shortly after evening rush hour, at the King's Cross underground station in central London. The fire is thought to have been caused by a match, dropped whilst it was still burning, igniting a build up of grease and dust under a wooden escalator.

The main recommendations concerning communications and information flowing from an inquiry into that incident were:

- Emergency services and London Underground should review the exchange of information between

[2] Report of the 7 July Review Committee, Greater London Authority, June 2006, ISBN 1 85261 878 7.
[3] http://www.bwcs.com/whitepapers/UK_9-11.pdf.
[4] Increasing FDNY's Preparedness, McKinsey & Company, August 2002.
[5] Presented at the Emergency Telecommunications Workshop held at ESTI Sophia Antipolis, France 26-27 February 2002.

themselves and London Underground during an incident both at their controls and at site.
- The London Fire Brigade and British Transport Police radio equipment should be compatible.
- London Fire Brigade should improve the means of radio communications below ground.

Clapham Junction Railway Accident – December 1988

In December 1988, a train collided with the rear of another train on the same track at Clapham Junction in South London due to a signal failure. Both trains were packed with commuters. The front carriages of the stationary train veered into the path of a third train travelling in the opposite direction on an adjacent track. As a result of the accident, thirty-five people died and nearly 500 were injured – sixty-nine of them seriously.

The main recommendations concerning communications and information flow from an inquiry into that incident were:
- Emergency Services should improve the communications between themselves to ensure, in particular, that the declaration of a Major Incident by any service is immediately passed by a dedicated phone line to all other services, who then act.
- Ambulance Services should review procedures to ensure that the designated and supporting hospitals are given a major incident warning as early as possible.
- Emergency Services should provide local radio communication at the accident site to facilitate liaison between the control units and experts on site.

Hillsborough Football Disaster – April 1989

On 15 April 1989, ninety-five people were crushed to death and over 400 received hospital treatment at a semi-final FA Cup match at Hillsborough Stadium in South Yorkshire. Many spectators came to watch the game, large numbers of fans trying to get through the turnstiles into the ground just before kick-off. Several gates were opened to relieve the congestion and pushing outside the ground, but this resulted in parts of the terraces becoming severely overcrowded. Surges in the crowd caused the fans at the front of the terraces to be crushed against the fences, which had been erected to stop the fans invading the pitch. There were gates in these fences that would have allowed fans onto the pitch, but there were delays in opening these due to those in control not fully appreciating the problem and failures in the communications system.

The reports published following the disaster made the following recommendations regarding information flows and communications:
- There should be sufficient operators in the police control room to enable all radio transmissions to be received, evaluated and answered.
- The radio system should be such as to give operators in the control room priority over, and the capacity to override, others using the same channel.
- Additional channels should be used, where necessary, to prevent overcrowding of the airwaves.
- There should always be a command channel reserved solely for the Police Commander to communicate with his senior officers around the ground.

The failures surrounding communication and information flow in each of the above incidents are different in detail; however, there are three common vulnerabilities:
- Information remaining in silos leading to commanders from different emergency services, echelons and geographic locations led to different understandings of the incident.
- There was an over-reliance on brittle communications systems or informa-

tion flows, whose failure then leads to disproportionate effects.

- There was a lack of timely information about the operating environment leading to delayed responses.

Information Silos: Each emergency service monitors the incident and collects the information to satisfy its role or responsibility. Generally, each emergency service has its own bespoke and separate information and communications systems to allow their commanders to reach an awareness and understanding of the incident within the context of their service's role or responsibility. This means that each emergency service is likely to have a different awareness and understanding of the incident based on the information received through their information and communication systems and their prior knowledge and training.

Dialogue with other commanders, both within and between emergency services, is the sole means of reaching a common understanding. An absence of meaningful dialogue where alternative actions are weighed-up and discarded means that there is the potential for different commanders to react according to completely different perceptions of the incident. The incident at Hillsborough amply demonstrates this where those in control did not have the same understanding of the incident as those at the scene.

Brittle Information Flows: Each emergency service generally has its own communications networks and protocols developed to support the flow of information needed to maintain the day-to-day command and control process. Many of these organizations are hierarchical, with the distribution of information directly linked with the distribution of authority, and the linkages are direct. This results in systems where commanders can receive information and direct action, as appropriate. Resilience and redundancy are generally built into such systems appropriate to the day-to-day risks. However, in a crisis situation or major disaster, innovation and creativity is not only required at the most senior levels of command but also at much lower levels and information needs to be available throughout the chain of command not just concentrated at the top. Likewise, having direct linkages makes the system brittle and, although resilient for day-to-day use, failures can occur under crisis situations and, if there is no alternative route for information to flow, then the consequences of such breakages can be disproportionate.

Lack of Timely Information About The Operating Environment: All of the aforementioned incidents occurred at sites where the information flows linked to the operating environment normally occur in slow time. The primary emergency services day-to-day activities are emergencies, and therefore have communications systems that allow the rapid flow of information. However, running a business, such as an underground station or a sports stadium, often requires different types of information flows, such as financial management data or building maintenance information. The command and control systems in such organizations are also likely to be less tight than those in the primary emergency services. Hence, there is both a temporal and philosophical mis-match between the information flows in the physical domain about the operating environment and the information flows in the emergency services about the event. An inability to get timely information about the operating environment can

severely hamper any emergency response effort.

All this suggests that improving communications channels and allowing information to flow in a resilient and timely manner would be highly desirable and could be vital. However, information is only of use if it is relevant, timely, accurate and actionable. Therefore, an understanding of what information is needed, where and by whom is an important pre-requisite to any recommendations to improve communication or information systems.

Chapter 3: Information to Support Decisions – Communications to Allow the Flow of Information

Decisions and action upon those decisions are at the heart of managing any emergency or disaster situation. Both making and acting on decisions requires information to be communicated. Decisions need information to support them and action requires information to be communicated from the decision-maker to the actor. This process is often called the Command and Control (C2) of a situation, where 'command' is an order issued to achieve an objective or accomplish a goal and 'control' is the management of the issued command.

Modern information and communications technology coupled with the need for multi-agency working are leading to a paradigm shift in the understanding and practice of command and control within many areas, including military operations and disaster response. Within the military domain, where the thinking on C2 is highly developed, operations are now requiring complex coalitions of civil and military forces. Likewise, disasters and emergencies are increasingly requiring many diverse agencies to work together in changing combinations. At the same time, modern information and communications technology are offering the opportunities to do things that could never be done before.

The US-based 'Command and Control Research Program' (CCRP), within the Office of the Assistant Secretary of Defense, is at the forefront of thinking in this area. This programme looks at improving both the state of the art and the state of the practice of command and control together with increasing understanding of the security implications of the Information Age.

At the heart of the CCRP's work is the understanding that traditional approaches to command and control lack the agility required for twenty-first century operations.[6] This is not only because today's military missions are more complex and more dynamic but also because they require the collective capabilities and efforts of many organizations in order to succeed. Additionally, this requirement for bringing together diverse capabilities and organizations into effective coalitions is accompanied by an increase in operational tempo.

The CCRP has developed a number of new concepts for C2 in joint, combined, and coalition operations in the context of both traditional and non-traditional missions such as disaster response. The following chapters explore one such concept within a UK emergency or disaster response context. The original concept was published by Dr David Alberts, Director of Research for Office of the Assistant Secretary of Defense, in the CCRP book, 'Understanding Information Age Warfare'.[7]

Information Age Command and Control

The decision-action cycle within a C2 context is often described by the Observe, Orient, Decide and Act (OODA) loop.[8] Decisions begin by the **observation** of something. This information is then placed in the context of other information and prior knowledge such

[6] David S Alberts and Richard E Hayes, *Power to the Edge* (Washington, DC: CCRP Publication Series, 2003).
[7] David S Alberts et.al. *Understanding Information Age Warfare* (Washington, DC: CCRP Publication Series, 2001).
[8] Col. John R Boyd, USAF, *Patterns of Conflict* (Unpublished Lecture, 1977). John R Boyd, USAF, *'A Discourse on Winning and Loosing.'* A collection of unpublished briefings and essays (Maxwell AFB, AL: Air University Library, 1976-1992).

that the decision-maker can **orient** themselves, **decide** on the best course of action and then **act** accordingly. This process is illustrated in Figure 1.

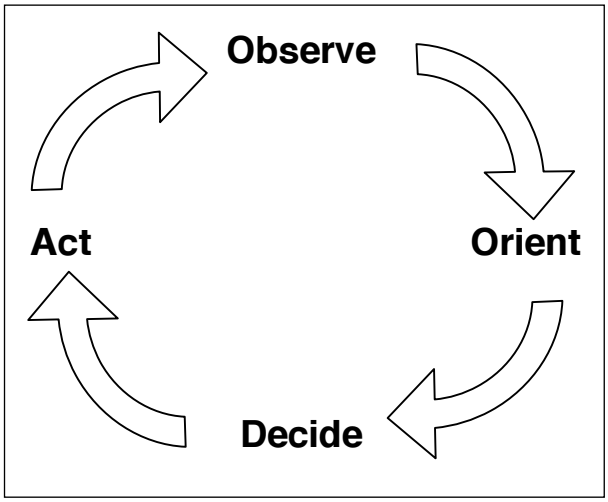

Figure 1: Observe, Orient, Decide, Act (OODA) Loop.

This process is often described as being acted out in three domains: physical, information and cognitive.[9] The physical domain is where the incident is occurring. That is, its physical reality – the place where all action is concentrated. The information domain is where information lives. That is, the area where information is created manipulated and shared. The cognitive domain is in the minds of the participants, which contains perceptions, awareness, understandings, beliefs and values and represents the place where decisions are made.

The decision-action cycle and how it relates to the three domains within the Alberts C2 concept is illustrated in Figure 2.

Within the UK emergency or disaster response context, each emergency response community has a different role and function. Their information and communication requirements are different as are the frequencies of operation of their decision-action cycles. To overcome the temporal and functional differences, they generally operate in isolation of one another only communicating when an incident requires a combined

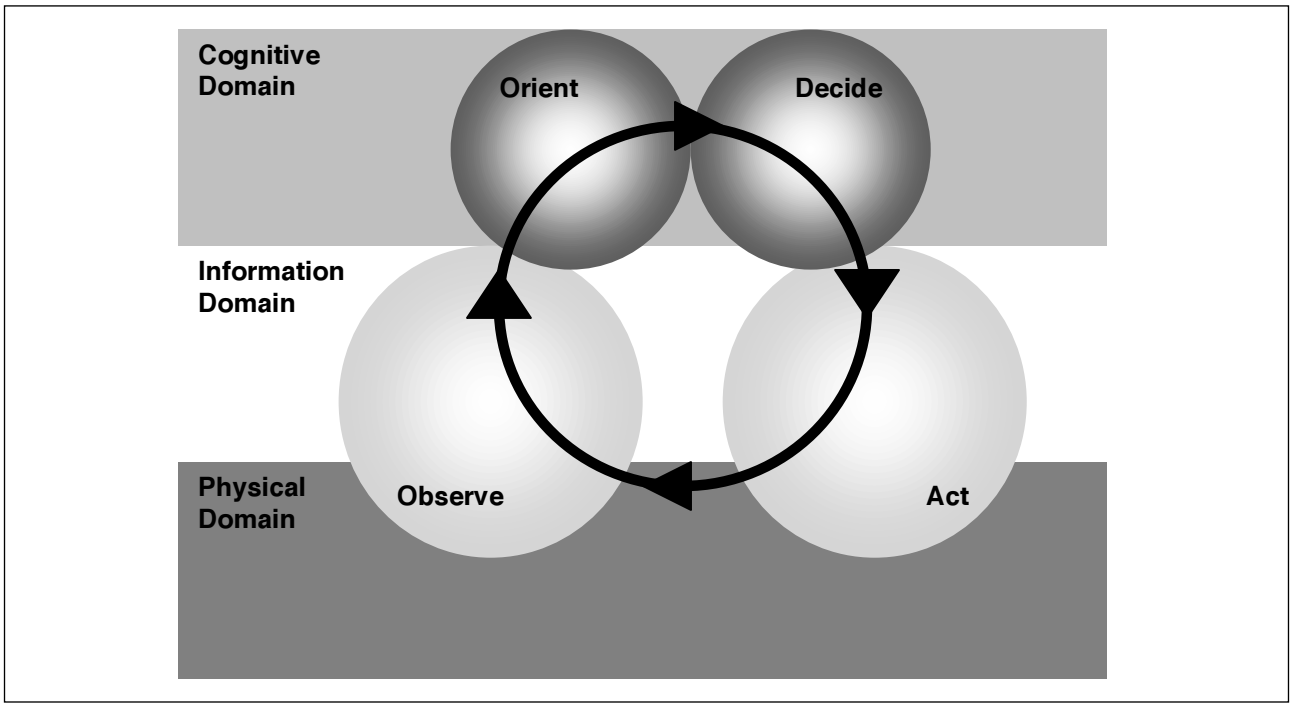

Figure 2: OODA Loop related to the three domains within the Alberts C2 concept.

[9] John J Garstka, 'Network Centric Warfare: An Overview of Emerging Theory', *PHALANX* (December 2000).

response. However, as evidenced by the shortfalls in response highlighted in Chapter 2, it is clear that there is a need for more co-ordinated activity both within and between agencies.

A system or process is therefore sought that facilitates co-ordination, whilst also allowing for the differing information needs and diverse response timescales for events that happen in complex and inter-connected environments. Many thousands of decisions need to be supported, facilitated and co-ordinated somehow across time, geographic location, organization, echelon and function. And, for every decision made, in addition to the information communications between the primary observer and actor, there are many other information exchanges required between the decision-maker and other actors to place the information into context.

The Alberts C2 concept postulates that modern information and communications technology, as recommended by the reports into the response to past disasters detailed in the previous chapter, can facilitate such a system or process. The rationale being that improved information sharing improves the quality of that information and allows shared situational awareness and enables collaboration; which in turn enhances the speed of command; and finally increases response effectiveness.

The result is an adaptive control system where the information and communication systems provide the linkages between the physical and cognitive domains to support actions. Real-time information regarding the incident and the operating environment, together with information to augment and support the pre-existing knowledge of the various decision-makers and commanders within the system, resides on these systems and provides the means to communicate that information freely. This concept is shown schematically in Figure 3.

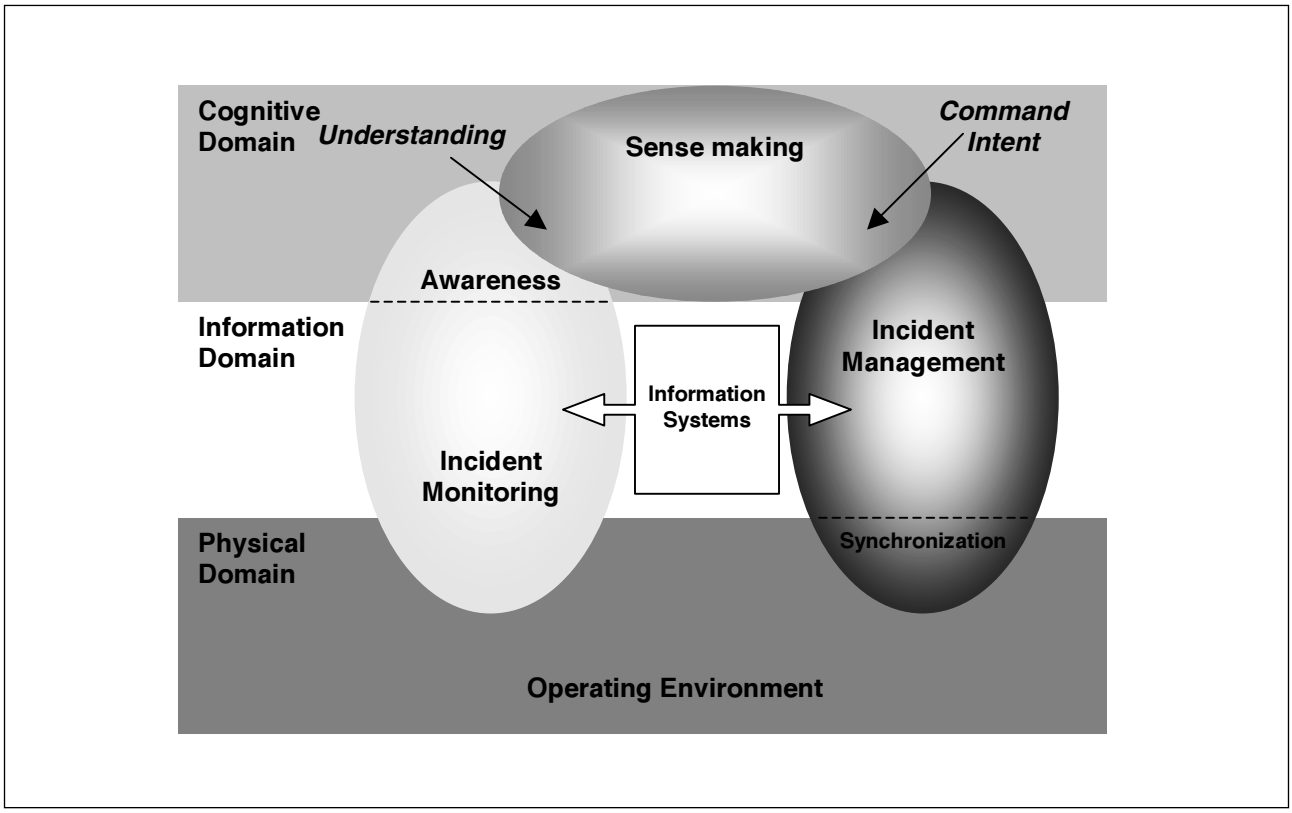

Figure 3: Adaptive Control System Using Information and Communication Systems.

Within a UK emergency and disaster response context, the main elements of such a system would be as follows:

Operating Environment: The operating environment would represent the incident to be managed together with the environmental framework in which the incident occurs. This environment would include political, social and economic factors together with factors associated with the physical infrastructure and those affected by the incident.

Incident Monitoring: This would be the collection and fusion of data relating to the incident within the context of the operating environment and the conversion of that data into information to inform decisions. Data can, and frequently does, come in many forms from many sources such as CCTV, sensors, first-hand observers and subject matter experts. Currently each agency and organization monitors the incident independent of one another in line with their own information needs but, within the Alberts C2 concept, this data would be fused through the use of modern information and communications technology.

Awareness: Awareness is a result of the interaction between prior knowledge and current perceptions of reality. Every individual has unique awareness based on their past experiences and training, but within the Alberts C2 concept 'shared awareness' is deemed desirable for a successful co-ordinated incident response. Within the UK emergency and disaster response context, joint professional education and training such as that provided by the UK Emergency Planning College[10] would play an important part in ensuring that shared awareness could be achieved across the UK first responder community. However, even individuals with the same training and education will not reach the same level of awareness unless they are being communicated with, and understand, the same data and information at the same time during the incident.

Within the Alberts C2 concept the fusion of data prior to reaching awareness allows shared awareness to be reached.

Understanding: Within the Alberts C2 concept it is essential that there is a 'shared understanding' amongst those that need to make decisions and collaborate in terms of incident response. Shared understanding is often reached through an iterative process of conversations and opinion sharing and, within the UK emergency and disaster response context, this would be facilitated through inter-agency communications.

Sense Making: During this phase, decision-makers generate alternative actions intended to control selected aspects of the situation, identify the criteria by which those alternatives can be compared, and conduct the assessment of those alternatives. Research has shown that complex decisions are best made by small numbers of individuals who have different backgrounds and views of the situation, and that the more individuals involved, the longer the process takes.[11]

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[10] www.epcollege.gov.uk.

[11] Lawrence Frey (ed.), *Group communication in context: Studies of natural groups* (Hillsdale, NJ: Lawrence Earlbaum, 1994); Linda Putnam and Cynthia Stohl, 'Bona fide groups: A reconceptualization of groups in context', *Communication Studies* (Vol 41, No 3, 1990), pp. 248-265; Putnam and Stohl, 'Bona fide groups: An alternate perspective for communication and small group decision making', in R.Y. Hirokawa & M.S. Poole (eds.), *Communication and group decision-making*, 2nd ed. (Thousand Oaks, CA.: Sage, 1996), pp. 147-178.

Likewise, networks or multi-connected systems of communications are associated with better complex decisions but are slower than hierarchical structures.[12] Within the Alberts C2 concept, modern communications technology allows small multi-disciplinary groups to be convened easily and quickly and thus aids the sense-making process.

Command Intent: This is the output of the sense-making and specifies the objectives to be achieved, the major agencies or organizations involved, the general responsibilities of each, linkages within and between them and constraints upon them. Within the UK emergency and disaster response context, this would not be the intent of a single commander but the combined intention from several commanders.

Synchronization: This would be the process where the agencies, aware of what they need to achieve, work together so as best to meet the goals established by the Command Intent.

However, every emergency or crisis is different in nature and often requires different sets of responders. This means that the information flow, and the communications channels,

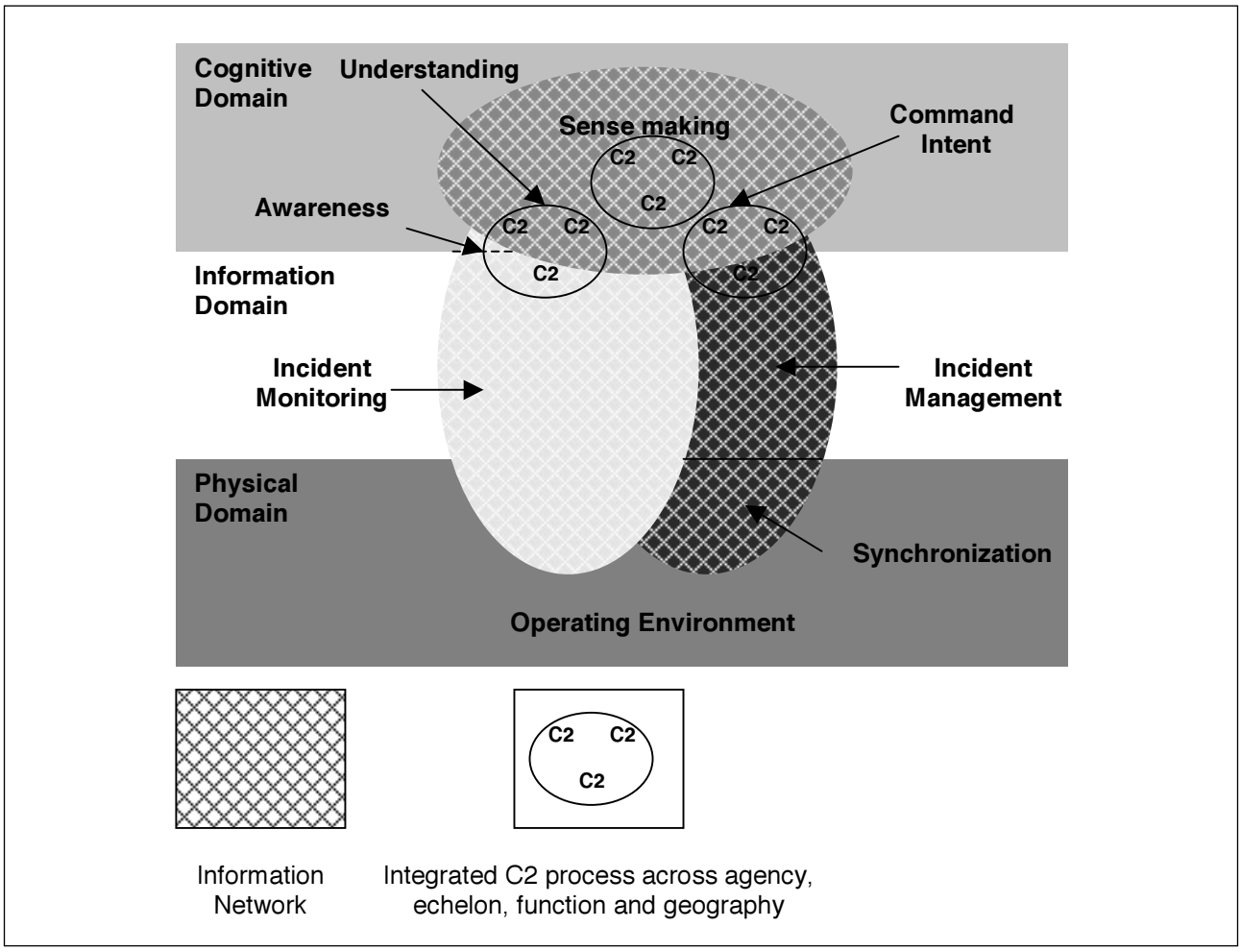

Figure 4: Information Network Integrated Decision Support.

[12] David S Alberts and Richard E Hayes, *Command Arrangements for Peace Operations* (Washington DC: National Defense University Press, May 1995).

required will be different for each incident. The Alberts C2 concept contends that modern communications technology may provide an answer to this. If it is possible to network every player within the command and control system, from the highest level commander to the individual PC or fire-fighter, embed the information systems within that communications network and configure the network to enable the right information to flow to the right people at the right time, then a fully networked system for UK emergency and disaster response can be generated as shown schematically in Figure 4.

The Alberts C2 concept asserts that the major advantages of such a system are:

- Increased agility – there can be a greater degree of delegation as decisions can be supported throughout the chain of command rather than support concentrated at the top.
- Feedback is almost instantaneous, meaning the response plan can be altered and adapted rapidly to respond effectively to rapidly changing or escalating incidents.
- Senior Commanders can be freed up to concentrate on creating the conditions necessary to allow their subordinates success rather than being involved with detailed planning.
- It is easy to convene a group of relevant people to allow optimum resolution of complex problems.
- Geographic integration means less boundary controls are required.

Given such a list of potential advantages, it is therefore not surprising that it is widely believed that emergency and crisis response communities should be able to communicate with one another freely at every level. However, the Alberts C2 concept is theoretical only. Having information communicated to you is not of any use unless it is relevant, timely, accurate and actionable.[13] In addition to this, within the UK emergency and disaster context, the information systems required to support multi-agency emergency and crisis response have to interface with many people from many organizations with diverse cultures and experiences. Failure to take account of the various needs and differences could have disastrous consequences, including the following:

- Changing information flow without altering concepts of operations, doctrine and organization within the responder communities could be highly dysfunctional.[14]
- There is evidence to suggest that the existence of such networks may tempt commanders, especially those not used to dealing with crises, to involve too many people in complex decisions. This could dramatically increase the time for decisions to be made and create what is commonly termed 'analysis paralysis'.
- Commanders could be tempted to use the information systems as a support for their own agenda rather than as a foil for their own leadership skills. As each and every disaster or emergency is different and the constitution of the response teams dependent on the type and location of disaster or emergency command teams will, by definition, be new, for every event. This means that, in a multi-agency context, the command teams are required to perform before they have fully formed. Each commander is therefore first and foremost an ambassador from his/her agency and may be reluctant to take risks or be creative. They could use the information communicated to them as

[13] Geographical Information Systems - Guide to GIS Applications in Integrated Emergency Management Version 1.0, Emergency Planning College, epcollege.go.uk, November 2005.

[14] David S Alberts, *The Unintended Consequences of Information Age Technologies: Avoiding the Pitfalls, Seizing the Initiative* (Washington DC: National Defense University Press, 1996).

a means to make the least errors as an individual in a complex system rather than as a support system to allow them to make the best decisions possible.

- Reliance on information systems could mean that system failure or compromise may result in disastrous and disproportionate consequences.

The Alberts C2 concept used within the UK emergency and disaster response context may offer the potential to reduce the response failures highlighted in Chapter 2. However, in reality the introduction of the information and communications systems necessary to support the concept may attract unintended and negative consequences. A closer look at the UK multi-agency command and control model is therefore necessary.

Chapter 4: UK Multi-Agency Command and Control

Within the Alberts C2 concept, the information systems and the communications networks that facilitate them are there to provide the linkages between the physical and cognitive domains and support decisions within the management of the incident. Therefore, the structure of command and control used will dictate what information needs to flow where, how and when. Likewise, within the UK emergency and disaster response context, the nature of the incident will dictate who needs to know what and when.

The Alberts C2 concept contends that networked information at every echelon, function and organization allows components to share knowledge and collaborate on key issues and plans, as well as synchronize their actions. Nevertheless, in order to work together, these organizations require guidance. Such guidance can be thought of as the 'glue' that holds the different organizations together.

However, within the UK emergency and disaster context, many of the responder organizations have distinct organizational cultures that can affect the 'stickiness' of the glue.

Organizational culture is commonly viewed as the shared values[15] dispersed throughout an organization. However, when cultures and strategies clash, invariably it is culture that wins the day. Therefore if the responder organizations' cultures are not engaged and fail to embrace the guidance, then the overall strategy to deliver in partnership will be predestined to failure.

According to the works of Pettigrew,[16] organizational culture consists of the behaviour, actions, and values that people in an enterprise are expected to follow. Conversely, Moorhead and Griffin[17] observe that organizational culture is a set of values often taken for granted that help people in an organization understand which actions are considered acceptable and which are considered unacceptable. More often than not, these values are communicated through stories and other symbolic means.

According to Reiner,[18] the organizational cultures within the UK emergency responder community are particularly strong because discretion within these organizations is inversely proportional to hierarchical position, with the greatest discretion frequently existing at street level. Culture within these organizations is used to providing a structured set of understandings and access to an accumulated body of knowledge, which helps the personnel operate in this discretionary area.[19] Any centralized guidance

[15] Terrence Deal and Allan Kennedy, *Corporate Cultures: The Rites and Rituals of Corporate Life* (Boston: Addison-Wesley Publishing Co., 1982); Harrison Trice and Janice Beyer, 'Studying Organizational Cultures Through Rites and Ceremonials', *Administrative Science Quarterly* (No 9, 1984), pp. 653-669.

[16] An internationally acclaimed researcher, Professor Pettigrew is author of over ten books on management and organization issues, including *The Awakening Giant* (1985), and *Shaping Strategic Change* (co-authored with Ewan Ferlie and Lorna McGee, Sage 1991). He has also published a large number of highly-regarded articles on research methodology (longitudinal and processual change), strategic management, studies of boards and directors and transformation of organizational structures.

[17] Gregory Moorhead and Ricky Griffin, *Organizational Behaviour* (Boston: Houghton Mifflin, 1998).

[18] Robert Reiner, *The Politics of the Police*, 2nd Edition (Sussex, St Martins Press, 1992).

[19] http://www.leeds.ac.uk/law/staff/lawdw/cyberpolice/pol6.htm.

must therefore tap into the informal cultural networks as well as the formal command and control networks.

With respect to the fire and rescue service, the work of Baigent suggests that each watch on a fire station has an informal hierarchy through which older fire-fighters pass onto the next generations the skills required to be a fire-fighter.[20] New trainees are encouraged to recognize that work, talk and learning can become something to look forward to. Likewise, fire-fighting strengthens the bond to the watch as it provides an opportunity for fire-fighters to prove they can overcome fear and not let their 'mates' down. For the majority of fire-fighters, the watch is their primary reference group for understanding the world and also represents the place where they develop their identity.[21] However, the process of socialization of new fire-fighters by fitting them in hangs onto the past. Any multi-agency guidance that threatens the way peer group leaders believe their fire and rescue service should be organized is likely to be met with resistance.

Likewise, the police force has an equally strong but different culture, where policing is perceived by many police as a mission, a way of life rather than just a job. It is seen as a positive world of action, characterized by the chase – an exciting game of wits and skill. However, the police are nevertheless humans, who have to deal with some very inhuman aspects of life. This can result in an 'us and them' world outlook and a cynical interpretation of their immediate surroundings. Collectively, these qualities result in a culture that often has an over expectation of the police role and a narrow view of the world.[22] This view of the world is often the inverse of how the majority of society sees it.[23] Outside guidance is not always welcomed by such an isolated culture.

Notwithstanding the problems associated with culture, such guidance is necessary for collaboration and, within the UK emergency and disaster response context, part of that guidance can be developed prior to the incident in the shape of prior knowledge: common education and training, doctrine, tactics, techniques, and procedures. However, within the Alberts C2 concept, the event-specific element of that guidance is reflected in the Command Intent – the *purpose* essential for individuals to unite efforts. This means that the multi-agency command and control structure adopted for UK emergency and disaster response must allow for a Command Intent to be formed and communicated quickly across the whole multi-agency system.

There are an infinite range of organizational options available when you have a completely networked system and Figure 5 shows the basic range. Each example shows the relationships between an overall commander and his/her subordinates. 'Direct' coupling relates to when a command is accompanied by detailed instruction and command and control becomes a strongly hierarchical process. 'Loose' coupling relates to the situation where subordinates have greater autonomy. Here, command, the order to achieve something, and control, the management of the action to achieve the command, reside in different, loosely coupled entities.

Each organizational option, apart from the 'no organization' option, allows for a Command Intent to be formed and communicated and each option has advantages and disadvantages. Table 1 shows the summary of findings from an analysis of these organizational types within the military domain.

[20] Dave Baigent, *One More Last Working Class Hero: a cultural audit of the UK fire service* (Cambridge: Fitting-in, 2001). Available at www.fitting-in.com/baigent.pdf.
[21] http://www.publications.parliament.uk/pa/cm200506/cmselect/cmodpm/872/872we47.htm.
[22] Reiner, op cit.
[23] Clifford Shearing and Richard Ericson, 'Culture as Figurative Action,' *British Journal of Sociology* (Vol. 42, 1991).

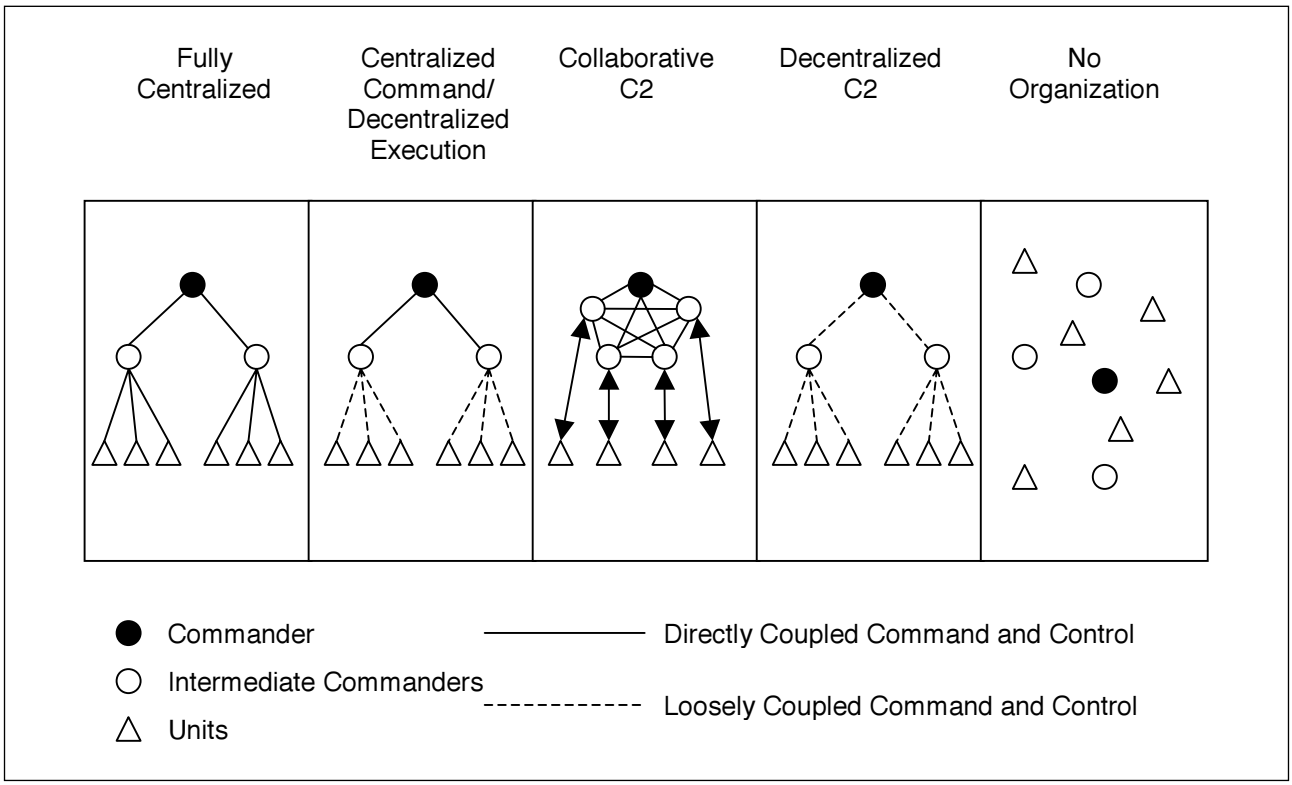

Figure 5: Spectrum of C2 Organization Options.

Type	Military Example	Advantages	Disadvantages
Fully Centralized	72-hour Air Tasking Order	Optimum use of assets	Large overhead Brittle structure
Centralized Command/ Decentralized Execution	Desert Storm	• Near optimum resource allocation • Encourages initiative	Potential for mutual interference or missed opportunities
Collaborative C2	• Bosnia • Kosovo	• Higher quality decision making • Units tightly coupled • Robust	• Can be slow to respond • Requires collaborative tools and co-operability
Decentralized C2	• Guerrilla Operations • Submarine Operations	• Low overhead • Responsive to local situational changes	Needs highly professional quasi-autonomous units
No Organization	Chaotic	Unpredictable to adversary	• Synergy accidental • Mutual interference likely

Table 1: Multi-Agency Command and Control Organizations.

Although the 'Fully Centralized' and 'Centralized Command/Decentralized Execution' options allow for optimum resource allocation, they both require a large command overhead structure. Emergencies and disasters can be initiated by a whole spectrum of causes – ranging from man-made such as terrorism and crime, man-assisted

such as serious industrial accidents, and natural events such as severe weather. And they can affect any infrastructure element anywhere. Therefore, within the UK emergency and disaster response context, an overhead structure capable of dealing with every eventuality could be vast. Likewise, attempting to respond to complex emergencies and disasters with no formal collaborative organization could quite easily result in mutual interference that exacerbates the situation.

The three primary emergency services in the UK typically employ fully centralized command at a local level and migrate to a form of collaborative C2 for larger incidents that require several police forces, fire brigades or ambulance services to co-ordinate their efforts. Co-ordination within agencies for the larger incidents is generally facilitated by one force, brigade or service having primacy and taking the lead in the agency response. There is not a complete shift to collaborative C2 as each force, brigade and service still retain centralized C2 at lower echelons. This structure is shown diagrammatically for four force/brigade/service units in Figure 6.

Day-to-day multi-agency responses, where a small number of responders such as a local police force, the local fire brigade and ambulance services co-ordinate to deal with a significant local emergency, are carried out largely on an informal, ad-hoc basis. However, recent large scale emergencies and disasters such as the fuel crisis of 2000 and the foot and mouth epidemic of 2001 have shown that although this option deals well with small local disturbances, a more structured approach is required for larger, more complex emergencies and/or disasters.

The events where a departure from normal practice is required are defined in the Civil Contingencies Act as 'situations or series of events that threaten or cause serious damage to human welfare, the environment or security in the United Kingdom'. The level

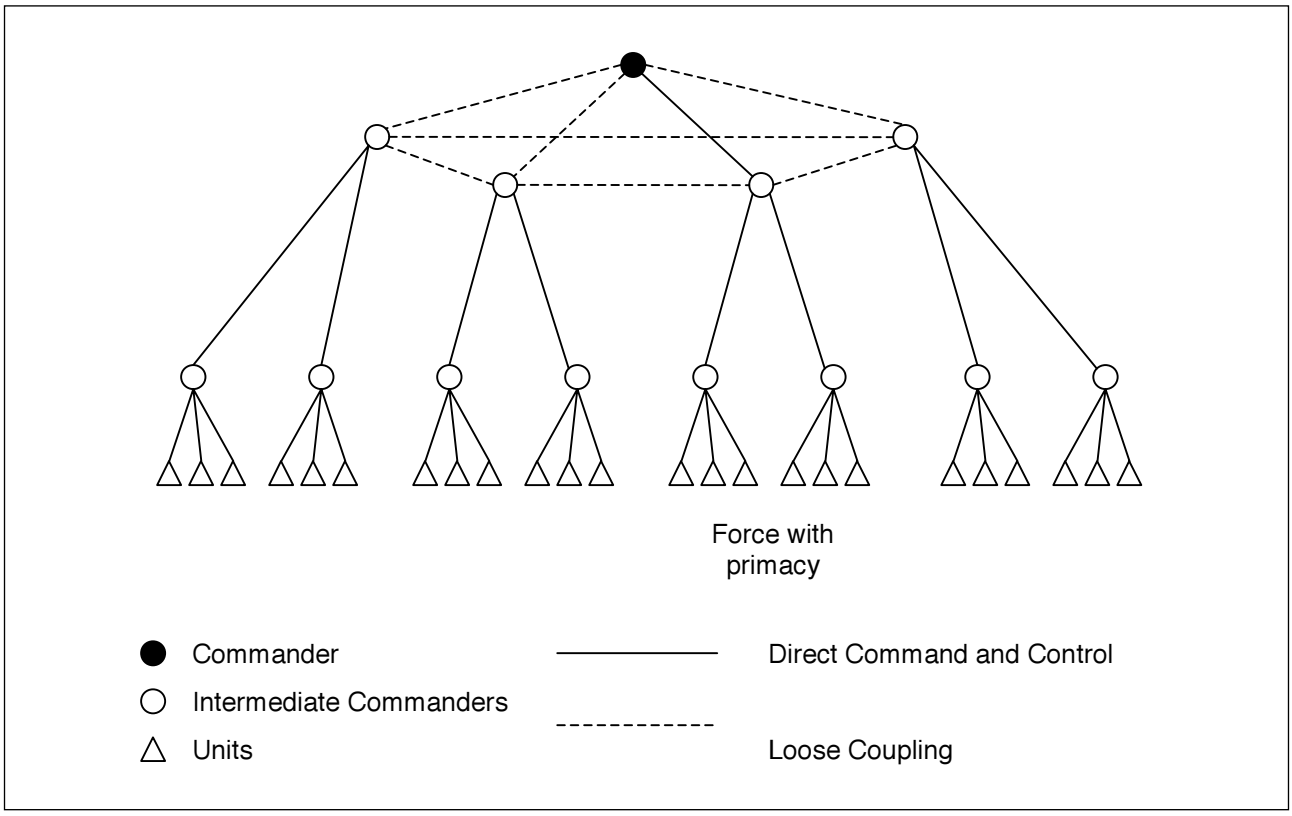

Figure 6: Intra-Agency C2.

and extent of multi-agency involvement required to respond to such events varies from case to case but, for the most severe emergencies, a co-ordinated, combined government response is essential.

The UK response framework for such events comprises three management tiers – gold, silver and bronze.

Bronze – Operational Level:[24] This is the management of the immediate 'hands-on' work at the event. This management tier contains operational Commanders from each agency involved who concentrate on specific tasks within their areas of responsibility. Each agency takes their lead from their own Commander relying on informal communications between Commanders to reduce the chances of mutual interference.

Silver – Tactical Level: The purpose of this management tier is to ensure that actions taken at the operational level are co-ordinated and coherent in order to achieve maximum effectiveness and efficiency. This management tier usually comprises the most senior officer of each agency committed and assumes tactical command of the situation This management tier usually operates from an incident control point located nearby or directly adjacent to the scene.

Like the bronze management tier, each agency takes their lead from their own Commander relying on informal communications between Commanders to reduce the chances of mutual interference.

Gold – Strategic Level: The Strategic level is formally called the 'Strategic Co-ordinating Group' (SCG) and is commonly referred to as 'gold command' or simply 'gold'. Its aim is to establish the policy and strategic framework within which silver will work. Within the UK, there is no formal overall Gold Commander but the group of Gold Commanders from all agencies involved is commonly chaired by the Police. Dependent on the size of the incident, Gold may have local, regional or central government involvement.

As disasters and emergencies come in all shapes and forms and can occur anywhere, the types of organizations that need to be involved in the three tiers of management is great and varied. Figure 7 shows a typical Gold Co-ordinating Group for the London area. Each organization within the group has evolved separately to deal with certain types of, or locally occurring, emergencies and disasters and have their own ways of working, internal command and control organization and information flows.

The command and control within some of these organizations is hierarchical, with the distribution of authority identical to the distribution of information. Others have flatter organizational structures.

The multi-agency model calls for each commander within each management tier to formulate a statement of Command Intent from which their subordinates can take their lead. As each agency has a different command and control philosophy each Command Intent will be different and the directives they assign will also be different.

In order to avoid ambiguity caused by subordinates receiving directives alien to their command and control philosophy, restrictions on information flow are imposed. Information systems are generally discrete and agency-specific and multi-agency command and control is organized in information silos to avoid the danger of creating a dysfunctional system by changing information flow without altering concepts of operations, doctrine and organization within the responder communities.

The UK emergency and disaster

[24] Within the military context 'tactical' refers to the hands-on level. The use of the same terminology within the same context but with different meaning can cause confusion when both civil and military agencies are required to respond together.

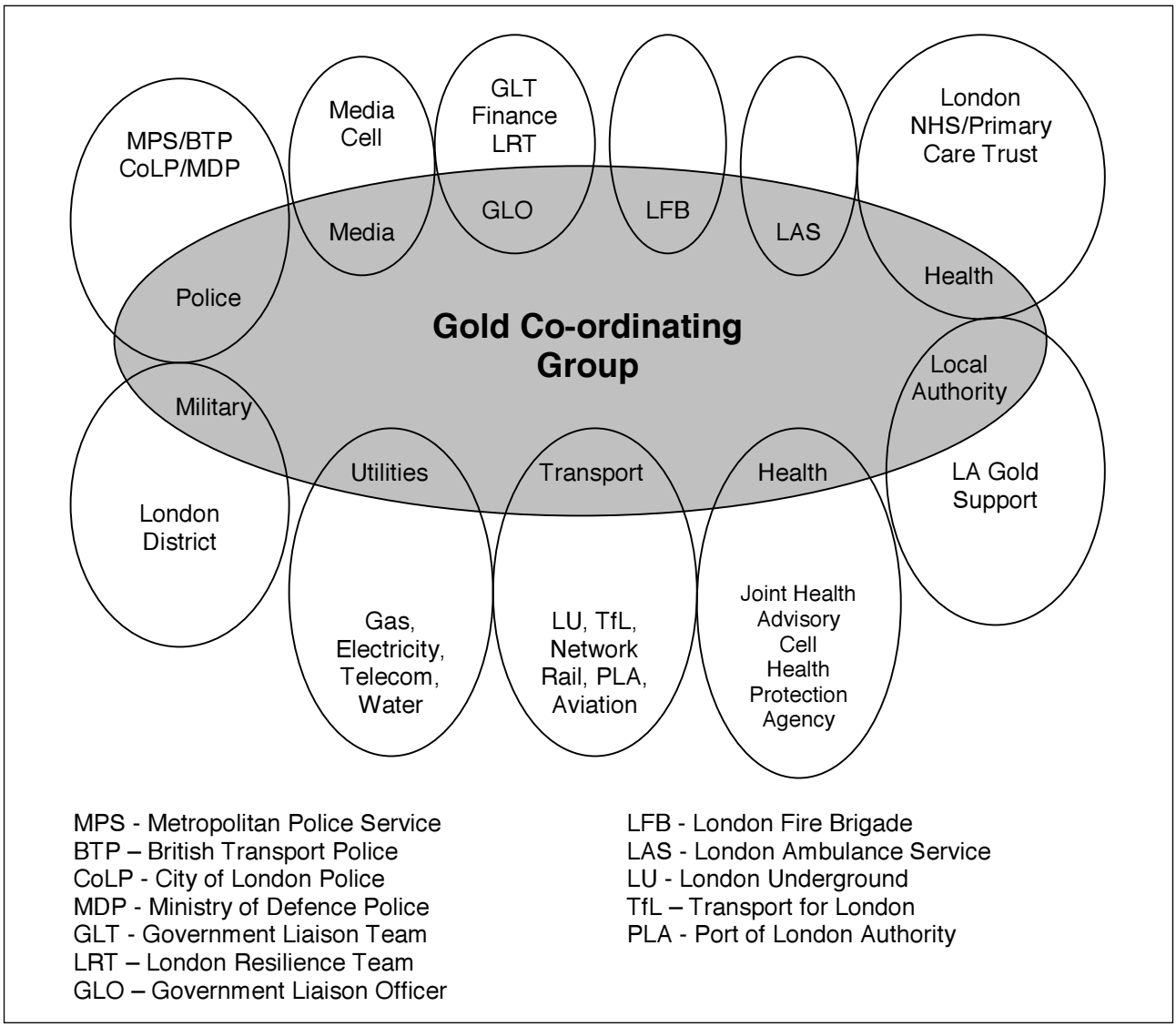

Figure 7: Typical Gold Co-ordinating Group for the London Area.[25]

response system therefore does not fully embrace the Alberts C2 concept because the introduction of the information and communications systems necessary to support the concept within agencies with differing cultures and work practices could attract many of the unintended and negative consequences highlighted in the previous chapter. Instead, multi-agency working relies entirely on communication between agencies at the three management tiers: bronze silver and gold. Therefore the response of the entire system is directly dependent on the speed and quality of these communications.

Each individual organization and agency collects data from the physical domain and passes that data through their own information systems to their own commanders for the sense-making process to take place. As there are no formal joint information systems, individual commanders within each agency base their decisions solely on information received from their own information systems. The co-location of the

[25] London Resilience Strategic Emergency Plan - Version 2.1 – April 2005.

Figure 8 represents current multi-agency command and control organization.

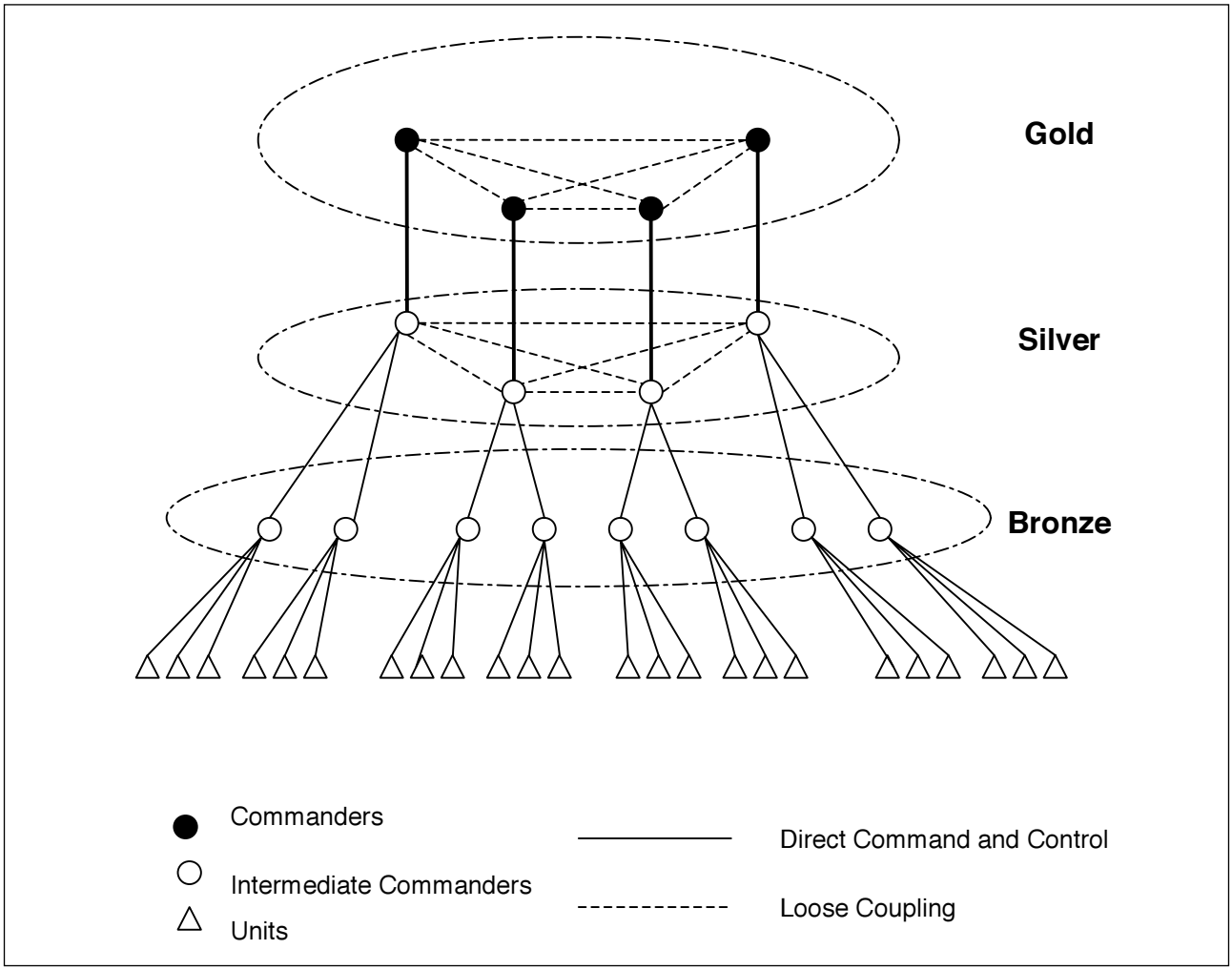

Figure 8: Multi-Agency C2 Organization.

three management tiers – bronze, silver and gold – allows commanders to share their thoughts on their understanding of the event and the operating environment's physical domain. However, the information shared at this level has already passed through the perceptual filters of each individual commander and is therefore incomplete and biased toward the past training and knowledge of the individual in question.

All of the response failures noted in Chapter 2 concern either failures of communication within agency command structures or between agencies at the three management tiers. It therefore makes sense to introduce robust and resilient communications channels at these critical points.

Much of the intra- and inter-agency information flows in the above model relies on face-to-face or non-standard communications. Therefore, perhaps the least contentious way of increasing speed and resilience of information flow at these interfaces is to facilitate the communication through mobile wireless communications channels.

Chapter 5: UK Wireless Communications Inter-Operability Timeline

Creating the technical environment to support information flow within and between the primary emergency services at the three management tiers as described in the last chapter has been a long-term aspiration. Figure 9 shows the timeline of some of the major events regarding wireless communications inter-operability within and between the primary emergency services in the UK.

In 1993, a major review of radio communications in the Police and Fire Services by the Home Office concluded that a new system was required and that it should be

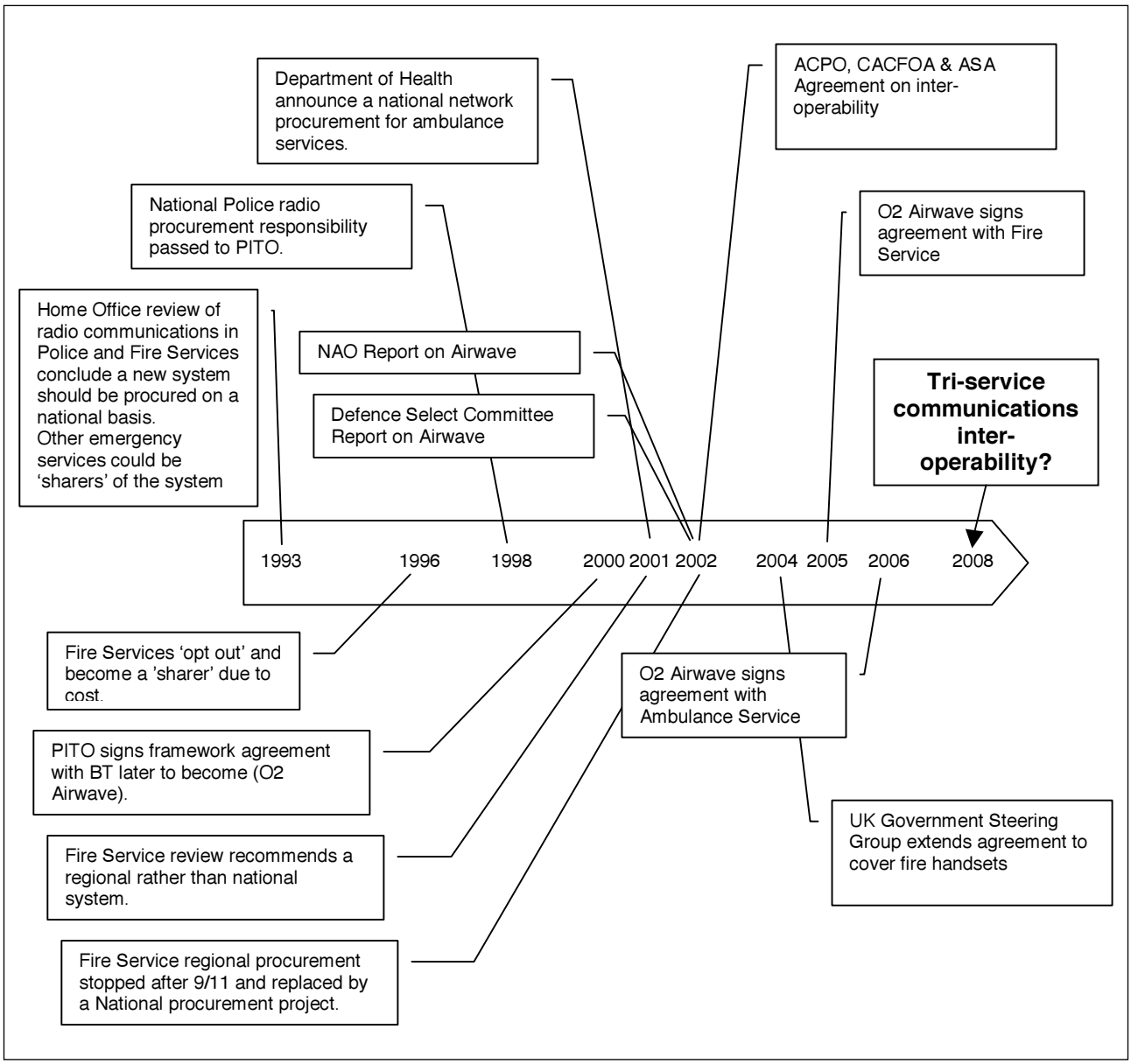

Figure 9: Communications Inter-Operability Timeline.

procured on a national basis. The review recommended that the new system should be shared by the Police and Fire Services, along with other emergency services, if their individual requirements were met and it was relatively cost effective to do so. An outline business case was produced and bids were sought from the private sector.

As the procurement process progressed, the Fire Services considered that features such as encryption and the ability to communicate from outside their service areas required by the Police were not needed to meet the operational requirements of Fire Brigades and were likely to add significantly to the cost. In 1996, the decision was taken, in consultation with the Home Office, that the Fire Service should not be part of the initial procurement but should be included, with other emergency services, as a potential sharer.

In 1998, the part of the Home Office responsible for the project was transferred to the Police Information Technology Organization (PITO), a non-departmental public body established to provide procurement, contract management and advice for communications and information technology used by police forces.

In February 2000, PITO signed a framework arrangement with a section of British Telecommunications plc (now referred to as O2) for a new radio service across Police forces in England, Wales and Scotland to be delivered by 2004-5. The radio system is known as 'Airwave' and is a secure digital managed radio service for voice and data, which uses an open standard, Terrestrial Trunked Radio (TETRA).

In 2001, a review of Fire Service needs concluded that a regional rather than a national approach to procurement would be pursued and ten regional collaborative groups were established to undertake these procurements.

In June 2001, the procurement of a national digital radio network for Ambulance services in England was announced and inter-operability with the local police forces and fire brigades was stated as a key requirement. The Department of Health rejected a local or regional approach to procurement because it did not ensure a common standard of communication across all Ambulance Trusts and would necessitate up to thirty-two separate competitions.

In April 2002, a National Audit Office (NAO) Report[26] voiced concern that the Fire and Rescue Service had started a consortium for a regional procurement of a new mobile communication system and was looking at alternative technology solutions to that chosen by the police. Further, the House of Commons Defence Select Committee reflected these concerns in the 6th Report on Defence and Security in the UK.[27] The Committee stated that they 'were particularly concerned at the prospect of the fire services procuring systems which might not be compatible either with other systems procured by other regional consortia, or with those of the police and ambulance services.'

Following these reports, and the tragic events of 11 September 2001, the presidents of the professional bodies representing the three primary emergency services (Chief & Assistant Chief Fire Officers Association, Association of Chief Police Officers and Ambulance Services Association) agreed a joint statement on same service and inter-service inter-operability.[28] It became apparent that the regional fire service procure-

[26] National Audit Office (NAO) 'Public Private Partnerships: Airwave' Report by the Comptroller and Auditor General HC 730, Session 2001-2001: April 2002, London, The Stationery Office.

[27] House of Commons, '6th Report from the Defence Select Committee, Airwave Section'. Available at: http://www.parliament.the-stationery-office.co.uk/pa/cm200102/cmselect/cmdefence/518/51802.htm.

[28] Personal correspondence from Head of Information & Communications Technology Unit, UK Home Office. 23 August 2004.

ment strategy would have been unlikely to meet this agreement in full. Therefore, the government announced in May 2002 that it was going to procure and fund a single radio solution for the Fire Service. Local Authority Fire Brigades were subsequently invited to join the new national strategy and the project, named 'Firelink', became a full national procurement project.

The agreement between the professional heads drew on two lessons from the events of 11 September 2001: Emergency services and their control rooms should be able to inter-communicate irrespective of organizational boundaries and location, and that those communications must be resilient. The agreement also stated that voice communications between the Incident or 'Silver' Commanders of the fire, police and ambulance services at a major incident is a long-established principle and represents the basic minimum requirement for inter-service inter-operability.

The agreement did not require the primary emergency services to use a common wide-area radio system. Rather it stated that where they do not do so, any interfaces, gateways and links between systems that facilitate multi-service inter-operability must be resilient to failures of power supplies, equipment and connecting links between systems.

In summary, the professional heads agreed that the requirements for multi-service inter-operability were as follows:

- That the incident command (or Silver) of each primary emergency service at an incident should be able to communicate directly by voice with the incident command (or Silver) of the other emergency services attending the incident.
- That every control room of each primary emergency services dealing with an incident should be able to communicate directly by voice with the control room of the other primary services dealing with that incident and Gold command. (Where the Gold commanders of each emergency service were not co-located, then there would be a requirement for them to communicate by voice directly with each other).
- That police and ambulance personnel should be able to communicate directly by voice with each other at the level of Bronze commanders and individuals below that level.
- Any locally agreed transmission of data between the primary emergency services would take place between the control rooms from where it would be cascaded through the command structures of each emergency service as required.

However, the agreement also stated that it was neither intended nor desired that multi-service inter-operability should apply to the handheld radio sets used to provide the fire service with incident communications. Any incident communication between the fire services and the other emergency services were to be restricted to the 'at incident' command (Silver-Fire).

Further, to the Heads of Profession Agreement, the UK Government Steering group, which manages inter-operability, agreed in January 2004 that in certain exceptional and specified circumstances there was a justified requirement for the direct inter-operability between the at-incident handsets used by the main services.[29] This capability was seen as separate from normal operational requirements and only two circumstances were foreseen where the capability might be used:

- At a catastrophic incident where normal communications were not possible, because of damage to the communication networks. The use of the capability for full inter-operability would be at the instigation and mutual agreement of

[29] Personal correspondence from Head of Information & Communications Technology Unit, UK Home Office. 14 January 2005.

the Silver commanders at the incident.

- At an incident where it is necessary for the emergency services to operate in joint teams and where normal communication would be difficult – for example when wearing CBRN personal protection equipment or at an incident underground.

There was also a recognition that use of this capability in these circumstances (and any others which might arise) would need to be strictly controlled, with clear and agreed protocols between the emergency services for bringing the capability into use and using it.[30]

In July 2005, the Department of Health (DoH) chose to adopt the same radio communication system (Airwave) as the Police for all NHS ambulance trusts in England. The Scottish Ambulance Service and the Welsh Ambulance Service Trust are scheduled to make a decision on the choice of their new communications solution in the near future.

Ambulance Trusts in England started taking delivery of the system in 2006, and roll-out is predicted to be complete by the end of 2008.

The Fire and Rescue service followed suit in March 2006 when Fire Minister Jim Fitzpatrick announced that the ODPM had let a contract for a new multi-million pound digital radio communications system for England. The ODPM also chose to adopt 'Airwave' to deliver both voice and data transmission and the new radio system replaces forty-six systems around the country and improves the current capability. It is expected that the system will be rolled out across Fire and Rescue Services in England from 2006/07. In July 2006, the National Assembly for Wales and Scottish Ministers signed up to the same contract. The new radio system is expected to be rolled out to fire and rescue services throughout Great Britain by 2009.

It is likely that the earliest practicable date for achieving inter-operability across all services, as agreed in the Heads of Profession Agreement, is 2008/9 for England. Inter-operability across the whole of the UK is likely to take much longer.

Due mainly to the temporal communications requirement differences, there has been limited attempt to provide communications linkages with the operating environment. However, the Highways Agency, HM Prison Service, the Ministry of Defence, British Energy, the Immigration Service and the Military have all invested in the same communications system as the primary emergency services – Airwave. This has been to satisfy their own internal communications requirements but also, in some cases, with the long-term aspiration for direct communication with the primary emergency services.

Providing for information to flow across wireless communications networks may increase the speed and resilience of the multi-agency response by increasing the speed and quality of selected communications inter- and intra-agency. However, the agility and flexibility of the fully networked system, described by the Alberts C2 concept, will not accrue.

The fact that all three primary emergency services, and a number of agencies with expert information about the likely operating environments, have chosen to adopt the same communications platform means that not only does each agency have the capability to communicate same-service at every level and geographic location, but they also have the potential, if they wish, to communicate inter-agency at every level and geographic location.

This, therefore, presents an opportunity to enhance further emergency responses by migrating further toward the Alberts' theoretical ideal.

[30] It is currently unclear how such procedures would be constructed and agreed.

Chapter 6: Vertical and Horizontal Inter-Operation Enabled by Communications Networks

The length of the timeline to create the technical environment necessary for basic inter-operation is contingent upon the cultural and political barriers that are faced. However, such barriers are not just between services. Each of the primary emergency services has historically operated on a local basis and integration and inter-operation 'within' each service has been an essential pre-requisite for the national-level inter-operation between the services as described by the Heads of Profession Agreement.

Each primary emergency service has different requirements for internal inter-operability, which directly reflect their differing command and control arrangements. The Police services require a system that allows police at all levels to communicate with one another. The Ambulance services requirement focuses on communication between the radio control room and the ambulance fleet and hospitals. The Fire and Rescue services require the officer in charge of a fire engine to be connected with the control room.

The following sections describe the different internal agency requirements and the cultural barriers that can be associated with information flow.

The Police Service

The aim of the Police forces is to keep the country peaceful by enforcing the country's laws. Modern policing involves many diverse activities that defy easy classification. However, the Police Performance Assessment Framework (PPAF) developed by the Home Office and Her Majesty's Inspectorate of Constabulary (HMIC), with support from the Association of Police Authorities (APA) and the Association of Chief Police Officers (ACPO), identifies seven key domains of policing.[31] Three of these domains are core functions that touch every aspect of policing and four relate to the actual service provided by the police. The four service related domains are:

- **Reducing Crime:** The main priority of the police – measured by the level of crime reported to the police directly and by the British Crime Survey (BCS).
- **Investigating Crime:** Bringing those responsible for crime to justice.
- **Promoting Public Safety:** Actions to reduce the fear of crime.
- **Providing Assistance:** Activities including: Dealing with calls from the public (999 and non-emergency), undertaking specialized operational duties (particularly where armed officers are deployed), and policing motorways and major trunk roads.

For many years, police forces were responsible for procuring and maintaining their own radio communications systems. In 1993, following a review, the Home Office concluded that many of the existing systems were obsolete and needed to be replaced. The Home Office also decided that there would be substantial benefits from procuring the new system on a national rather than a local or regional basis.

The service was finding that officers increasingly needed to communicate outside their own force area. For example, motorway patrol officers, restrained by a limited number of motorway exits are now regularly obliged to cross into each other's areas.

[31] http://police.homeoffice.gov.uk/248458/PolicePerformance.pdf?view=Binary.

Likewise, the rise in the number national forces such as the National Crime Squad and the British Transport Police means that there are an increasing number of officers who need to operate, and therefore communicate, across geographic boundaries.

Additionally, radio coverage and capacity were creating safety issues. There were significant gaps in radio reception across the country and police control rooms often had difficulty in locating and talking to officers in areas of poor or no radio reception. Congestion of radio channels also meant that police officers were sometimes unable to gain access when required. Not only did this mean that officers did not communicate on routine matters where extra information might have been helpful to them, but it also meant that occasionally police officers lost their ability to call for rapid response. Another operational problem regarding capacity and coverage was that vehicle mounted radios were operating on a different radio frequency to handheld radios. This meant that police officers in vehicles were frequently unable to communicate with police officers on foot, without the use of a second radio.

The service was also finding difficulty in responding to major incidents spanning different county boundaries and, as the complexity and reach of crime expanded, they were increasingly seeing the need to be able to bring together groups of people from across geographic boundaries and different specialities, both within the force and with other organizations such as the Highways Agency and CCTV operators, to respond to specific incidents.

In summary the issues that needed to be addressed were:

- **Congestion**: Radio channels were often very congested, with police officers unable to gain access when required and sometimes the ability to call for rapid response when required.
- **Flexibility:** Capacity could not be re-assigned quickly to overcome congestion, or, when necessary, provide command and working-level channels.
- **Security:** The majority of police radio systems were unencrypted and messages could be intercepted with simple scanning receivers available cheaply (less than £100) from high street stores. This sometimes resulted in police operations being called off, as suspects, monitoring police radio traffic, became aware of police surveillance.
- **Interference:** Interference from commercial continental radio users was causing severe problems to police radio systems in the South and East of England and some way inland.
- **Operational:** Vehicle mounted radios operated on a different radio frequency to handheld radios, and police officers in vehicles were frequently unable to communicate with police officers on foot, without the use of a second radio.
- **Roaming:** Lack of support for regional and national roaming prevented police officers maintaining radio contact with their control rooms when outside their force areas.
- **Management Information:** Lack of information on the status and location of police officers inhibited the ability of commanders to make operational decisions on, for example, deployment of police officers.

From this list of deficiencies the requirements can be summarized as:

- **High Quality Transmission:** Ease and speed of communication, reliable and understandable voice messages. Less need for messages to be repeated.
- **Encryption:** Greater security of information, criminals unable to use scanners in order to intercept police communications and greater privacy for personal information potentially transmitted over the radio.
- **Talk Groups:** Enables everyone on a particular operation to hear radio mes-

sages intended purely for them and no-one else. Relevance of information received is, therefore, higher, with less distracting background information.
- **Emergency Button:** Improved officer safety and improved officer morale.

Although voice communications facilitate a certain amount of information flow – the police service have also recognized that they have a requirement for access to data whilst mobile.

Officers on patrol frequently require detailed information from police intelligence and other information databases to enable them to make critical decisions. Current methods of access are extremely inefficient as they are normally restricted to an officer making a voice radio call to an operator, who then accesses databases on behalf of the officer and relays results back to the inquirer over a further voice radio call. Additionally, as much police intelligence and information is kept on local force database systems, officers often can only access information relating to 'their' force and routine checks do not automatically search across neighbouring force databases – thus allowing travelling criminals to operate across police boundaries and to reduce the likelihood of detection and arrest.

Individual tasks and objectives are normally allocated to officers on paper or verbally before they go on patrol. This means that they have to remain 'in station' to be briefed in detail which wastes time, reducing time on patrol, and hence effectiveness. Similarly, when officers are 'dispatched' to incidents using voice radio messages, they do not have the benefit of the paper or verbal briefing, which creates the potential for inaccuracies and ambiguities and officers frequently enter critical situations with 'sketchy' information.

Officers on patrol still gather most information and reports on 'paper' forms or in pocket notebooks and have to 'enter' this information on 'back office' IT systems for it to be accessed by other users. This means that officers have either to return to police stations to access technology, or engage in lengthy telephone calls to call centre operators who take dictation from the officer.

Reliable and secure mobile data solutions that can provide patrolling officers with remote access to local and national force systems and allow information and intelligence checks to search automatically across several neighbouring or regional forces have been identified as potentially beneficial.

The Fire and Rescue Service

The Fire and Rescue Services Act 2004[32] states that the core functions of the Fire and Rescue Service are:
- **Fire safety:** Promotion of fire safety.
- **Fire-fighting:** Extinguishing fires and protecting life and property in the event of fires.
- **Road traffic accidents:** Rescuing people in the event of road traffic accidents and protecting people from serious harm, to the extent that it considers it reasonable to do so.
- **Emergencies:** Appropriate assistance as directed by the Secretary of State.

Additionally, the service is trained to deal with released chemicals in order to render an incident site safe or to recommend exclusion zones.

Their main requirements for a communications system stem from a study carried out by the formally entitled Chief and Assistant Chief Fire Officers Association (CACFOA), changed recently to the Chief Fire Officers Association (CFOA).[33] The study investigated the future importance to

[32] Fire and Rescue Services Act 2004. The Stationery Office Limited, ISBN 0 10 542104 9.
[33] Chief and Assistant Chief Fire Officers Association, Fire Service Mobile Data Task Group, 'CACFOA Mobile Data Study: Study Report', 2001, Staffordshire, United Kingdom.

fire brigades of voice and data transmission capabilities through the use of questionnaires and the following four key data requirements were identified:

- risk information;
- operational and other brigade procedures;
- chemical hazard information; and
- maps.

Almost without exception, brigades aspired to a mobile system that could, at a later stage, be fully integrated with all systems and allow remote mobilizing and the dynamic exchange of information between the central functions and mobile vehicles. Currently, Fire and Rescue services have data stored on board their vehicles. The systems are largely stand-alone and are not connected to Control Headquarters or other departments.

A need to operate across county borders was also identified by the study.

The Ambulance Service

The Ambulance service provides Accident & Emergency and Patient Transport Services.

The Ambulance service identified a need to provide an efficient, effective and fully supported integrated communications infrastructure for all those involved in the provision of Ambulance services and the facilitation of communication between all relevant partners involved in the provision of health services. In essence – an infrastructure to enable robust and secure radio voice and data communications between the ambulance service and other NHS and emergency service users as appropriate.

The main need was to improve communications generally through faster and higher quality transmission and greater coverage of service. The specific aims of the infrastructure identified were and improvement of:

- response times;
- patient care; and
- staff support and safety.

Tri-Service Communications Inter-Operability

Whilst the police, ambulance and fire service recognize the merits of inter-service working, they acknowledge the diverse operational requirements of each. In addition, all three emergency services are constrained by their political and statutory obligations, each with different employers, government sponsors and funding arrangements, making the management of effective inter-working difficult.[34] Initial emphasis has therefore been on 'collaboration', not 'integration'.

However, even collaboration has not been without trouble. This is perhaps best demonstrated by the problems encountered by the 'Invest to Save'[35] budget (ISB) funded national pilots for joint control rooms whose objective were to deliver substantial and measurable improvements in the provision of a response to the public in emergency situations through enhanced information flows among adjacent call takers.

Allowing information to flow through communication channels at the control centre level was expected to result in a number of benefits and a project was started in 1999 to bring together the emergency call handling services of Cleveland Fire Brigade, Tees, East and North Yorkshire Ambulance Service (TENYAS), and Cleveland Police. Cleveland was selected because of the enhanced risk of major incidents needing close co-operation between the three services due to the concentration of major

[34] 'Three Distinct Services – Shared Ambitions for a Healthier and Safer Community', CACFOA, ACPO & ASA (2001).

[35] The Invest to Save Budget (ISB) is a joint Treasury/Cabinet Office initiative with an aim to create sustainable improvements in the capacity to deliver public services in a more joined up manner. A key principle of the ISB programme is that investment is provided in return for reform.

chemical and industrial plants in the Middlesbrough area.

The project started to experience significant problems fairly soon after start-up as the highly unionized culture within the Fire Brigade did not sit easily with other cultures. This eventually resulted in a call for industrial action.

A similar project was embarked upon in Wiltshire, where the boundaries of the three services are co-incident, thereby making the amalgamation process seemingly fairly straightforward. Although each of the emergency services had different drivers for establishing a shared control room, all three shared a common desire to improve service delivery and the project was not seen solely as a means to save. It was felt that the amalgamation would greatly improve the information flows between the services during multi-service incidents and improve response times and quality.

Wiltshire appears to have always benefited from close co-operation between its three emergency services and the joint control room was meant to enhance this by allowing closer sharing of information and was ultimately seen as a step towards further initiatives whereby Emergency Services in Wiltshire shared resources and expertise to the benefit of the local community. However, the three Emergency Services are still operating as separate organizations. No new procedures have been introduced and the ethos is very much of three separate agencies in a single room with common systems.

Other Responding Agencies

In addition to information flowing between the primary emergency services, information about the operating environment is also needed. Communication channels are the responsibility of the individual agencies and therefore, full national communications inter-operability relies on best practice being adopted bottom-up across the whole civil contingency and resilience framework.

Many organizations have seen the advantage of direct communication with the primary emergency services and currently, the Airwave communications framework extends to Local Authorities, the Highways Agency, HM Prison Service, the Ministry of Defence, British Energy, the Immigration Service and the Military amongst others.

However, it could be argued that the network should encompass all the core responders and those responsible for restoring public services after an incident as described by the Civil Contingencies Act 2004. Yet many of the organizations and agencies who qualify as either Category 1 or Category 2 Responders are not on the Ofcom sharers list and therefore cannot adopt the same communications platform as the primary emergency services.

Chapter 7: Inter-Operability – Where Next?

The preceding chapters have shown that although it is desirable, and technically possible, to employ modern information and communication systems to aid response to emergencies and disasters, such a path is fraught with difficulty. However, as many emergency responder communities are voluntarily adopting compatible technology for their own internal information and communications use, there now exists the potential to transform UK emergency and disaster response.

The opportunities fall into three main areas:

- Joint Working;
- Unified Multi-Agency Command and Control; and
- Joint Information Systems.

Joint Working

The report 'Three Distinct Services—Shared Ambitions for a Healthier and Safer Community' referenced earlier was commissioned by the Home Secretary to explore collaboration, co-operation and partnership between the primary emergency services. It was prepared by the presidents of the three emergency services associations (ACPO, CACFOA, ASA) and made sixteen recommendations to improve joint working. However, many of the recommendations remain outstanding today. For example, none of the three ISB tri-service projects have yet been able to implement common mobilization systems.[36]

The report stated that the operational requirements of the three services were very different and should not be compromised. It also cited different cultures, financial regimes, organizational structures and statutory responsibilities as barriers to joint working.

An extract from the report states: 'The context for emergency service collaboration must be community focussed. Whilst each service has, and should remain distinct to carry out functions that are unique to them, many areas can provide a greater impact when done collaboratively or in partnership. The measure of success of such partnerships must not just be financial but should also extend to encompass the impact on the quality of life in local communities.'

The local focus has indeed provided a basis to start to break down the barriers cited in the report and there are a number of local pockets of joint emergency service working. The extent of joint working within and between the different services is currently ad hoc and largely uncoordinated, but the very fact that some joint working exists demonstrates potential.

Joint working can only be facilitated through the sharing of information. There needs to be a common goal and an agreement on the legitimacy and importance of that goal. Likewise, participants need to have a knowledge and understanding of one another.

Previous chapters have shown that it is now technically possible for the necessary communications to take place. But communication takes time and effort; consequently each agency must see a legitimate advantage in order to invest the time and effort required for effective joint working.

The main investment for joint working is in the human, rather than technical, aspects of communication. Information

[36] House of Commons Hansard Written Answers for 21 Feb 2005 (pt 92).

needs to be exchanged before agendas and priorities can be set and, rather than being able to make decisions alone, negotiations need to be made. Only once common ground has been established, can agreements be reached on positive or negative approaches and joint action taken.

The current UK emergency response model is based on each agency carrying out their specific role with communications limited to those necessary to avoid mutual interference. Therefore, individual agencies have little or no incentive to enter into the sorts of communication necessary for joint working as it is only the joint response which is currently not 'owned' by any singular entity that accrues advantage from joint working.

Joint working means that agencies with different functional and geographic areas of responsibility focus their attention on achieving assigned missions. Their unified goal being to create a common (shared) understanding of the situation, take advantage of their differing knowledge, expertise, information, and capabilities, and organize the activities they control in time and space so that they not only avoid mutual interference but also have synergistic effect. In the absence of an entity that has ownership of the joint response and can require its subordinates to work together, joint working will only take place if the environment is created whereby each agency gains advantage from enhanced communication with each other.

As stated previously, joint working is enabled by the communication of information but information is only of use if it is relevant, timely, accurate and actionable. In many cases information from one agency to another will not satisfy these conditions; not just because it is irrelevant to the particular role of another agency but it may be that it would have been useful but was delivered at the wrong time to be actionable.

Current inter-agency communications are generally synchronous, either through face-to-face or mobile voice communications, yet each agency has different tempos of operation. Advantages could, therefore, potentially accrue from greater use of asynchronous forms of communication such as email or database sharing. Data could then be accessed as appropriate – information pull as opposed to information push – ensuring relevance through timeliness.

Accuracy can also be enhanced through information exchange as pooled data means better quality and more up-to-date data. A little bad data can go a long way and the ability to cross-reference from many sources can only be helpful in improving accuracy.

Consequently, slightly extending the way the currently available information and communication systems are used could not only improve single agency responses but also create the environment for joint working and improve multi-agency response.

Unified Multi-Agency Command and Control

Theoretically, it is possible for a Joint Multi-agency Command Intent to be formed from the synthesis of the various sense-making processes taking place within each agency. However, there is no single person who has overall responsibility for the joint response to the incident. Such a process has no owner and is unlikely to happen in a crisis situation, where time is of the essence. However, the Command Intent is fundamental to successful co-ordinated action and the lack of one will compound the deficiencies already being suffered by the system due to the information silos.

As stated previously, each senior agency commander communicates their interpretation of any joint intent, together with agency specific guidance, to their own agency. This means that any downstream decisions and plans formulated by subordinates to manage the incident may be made in ignorance of the full picture. As a result, there is a significant chance of mutual interference.

In practice, during a crisis situation, a 'leader' often emerges within the manage-

ment tiers and assumes ownership of the joint response to the incident. However, this role of 'Incident Commander' is not legitimate and in the case of the 7 July bombings, the City of London Police acted outside of the consensus of the management tiers resulting in unintended communications problems for other agencies.

Using the current communication and information systems to their full could provide sufficient decision support to an Incident Commander, and therefore: allow the legitimization of this role; provide ownership to the Command Intent; and provide accountability for joint action.

Joint Information Systems

It is commonly accepted that Commanders in crisis situations need two different pictures of an incident. The first is a close-up of the situation from which they can gain a sense of what subordinates are experiencing. This view allows them to get an idea of the subordinate's physical and moral state, which will determine what they can and cannot demand them to do. Such a picture can only come from someone at the scene and, speaking about the 1967 Arab-Israeli war, General Yshayahor Gavish said about this picture, 'There is no alternative to looking into a subordinate's eyes, listening to his tone of voice.'[37]

The second picture is an overall view of the situation from which they can gauge the difference between the actual situation and the desired end state. This view is generally called 'topsight' – where 'insight is the illumination to be achieved by penetrating inner depths, topsight is what comes from a far-overhead vantage point, from a bird's eye view that reveals the whole – the big picture; how the parts fit together.'[38]

The first picture is the most detailed but usually offers a very narrow field of vision and Commanders who focus only on this image risk losing sight of the big picture. The second picture provides an overall image but lacks critical detail; Commanders who focus only on this image risk being out of touch with reality.

It is therefore important that commanders form a composite view. With the current multi-agency arrangements, the individual agency close-up pictures are obscured from the commanders and from other agencies. They risk misunderstanding the implications of their suggestions for the subordinates in other agencies, thus reinforcing the agency silos.

However, if all the pictures were to be shared then not only would teamwork and collaboration be possible but joint response times could be made more rapid. Being able to have the same pictures seen simultaneously from many perspectives would mean that the implications of them would be recognized sooner and action taken quicker.

All the above sounds like common sense; however, there are significant risks if introduced without training and proper thought to human factors. Within the military environment, collaboration has been shown to affect decision-making under stress, and without training and exercising forceful collaboration may severely affect response. Likewise, automated decision-support tools have been shown to distract people from their primary task which means that any joint system will need to take account of human factors.

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[37] Gavish: 'There is no alternative . . .': quoted in Martin van Creveld, *Command in War* (Cambridge, Mass: Harvard Univ Press, 1985), p. 199.

[38] 'Topsight': David Hillel Gelernter, *Mirror Worlds, or, The Day Software Puts the Universe in a Shoebox–How It Will Happen and What It Will Mean* (New York: Oxford University Press, 1991), pp. 51–53. Gelernter argues that topsight is 'the most precious intellectual commodity known to man. . . . It is the quality that distinguishes genius in any field.'

Chapter 8: Conclusions & Recommendations

Emergencies and crises are often characterized by uncertainty. Frequently, speed of response is decisive. However, responding in a fast and effective manner when there are many stakeholders involved is difficult. Many thousands of decisions need to be made and actions coordinated. In theory, a fully networked, multi-agency response system working to the same command and control doctrine, fully supported by robust, resilient and accurate multi-agency information systems is ideal. However, political, technical, cultural and financial constraints mean that such an ideal will take time to achieve, even perhaps forever.

The current UK multi-agency response model allows for a gradual migration from discrete agencies responding to an emergency or crisis in isolation from one another to an integrated response system through co-operation facilitated by communications inter-operability. However, migration has been slow. This Report has, however, highlighted that there is potentially a further step to make – that of collaboration supported by the full use of the modern information and communication systems currently being adopted widely by the emergency response community.

Although this step will no doubt take time to achieve, it is recommended that thought is given to how to facilitate it now. It is recommended that effort is concentrated on the following three areas:

The Extent of the Communications Network

Analysis of past emergencies and disasters has shown that the communications linkages that are most likely to have most beneficial effect are those that allow information to flow within and between every echelon of the primary emergency services (police, fire and ambulance) and those that allow expertise about the operating environment to feed into the joint information network (see Chapter 2). In terms of the type of communication channel required to allow such information flows, it is crucial to recognize that emergencies and disasters can happen anywhere, and therefore, such information flows need to be carried by wireless communications channels that are resilient and can be deployed anywhere and work in hostile environments such as inside buildings and tunnels.

The major review of radio communications in the Police and Fire Services carried out by the Home Office in 1993 found that the public mobile network services cannot fulfil all of the unique and critical requirements of the emergency and crisis response as access, availability, extensive coverage and high level security cannot be afforded (see chapter 5). This means that bespoke resilient systems need to be procured and be inter-operable with each other.

However, as emergencies and crises can be initiated by a whole spectrum of causes ranging from man-made (such as terrorism and crime), man-assisted (such as serious industrial accidents), and natural events (such as severe weather), and can affect any infrastructure element in any part of the country, nearly every part of society may become part of a response system. The sheer number of stakeholders means that networking between agencies is generally carried out on a bottom-up basis which can be problematic and time-consuming.

For example, it is likely that the earliest practicable date for achieving inter-operability between police, fire and ambulance services

in England alone is 2008-9 (see chapter 5) – some twenty years after it was first called for by the inquiry into the Clapham Junction Railway accident. Financial and political, rather than technical, constraints dominated and resulted in the long timescale. Although the three primary emergency services had different day-to-day information flows, and therefore communications requirements, they are used to working with one another and their tempo of operations is broadly similar. Likewise, they are all public sector organizations. Agencies and organizations which are perhaps best placed to provide information on the operating environment are abundant and often operate within a competitive private market, where information is proprietary. They also have very different information flow, and therefore, communication needs. Consensus between these stakeholders to have inter-operable communications is therefore likely to be very hard indeed.

It is therefore recommended that there should be a unified communications policy encompassing all responder communities that ensures inter-operability.

Command Intent

A Command Intent is fundamental to successful co-ordinated action (see chapter 4). This statement encompasses the mission-specific guidance necessary for subordinates to plan and execute their response without fear of mutual interference and must be communicated to all responders at all levels. However, as information regarding the operating environment is gathered and processed in agency-specific silos (see chapter 2) and generally exchanged by word of mouth alone at senior commander level (see chapter 4), the Command Intent becomes supported, in part, by subjective rather than objective analysis.

Additionally, under the pressure of a crisis situation, it is by no means certain that such a statement will be constructed as there is no 'Incident Commander' to take ownership of the formation of this statement (see figure 8).

There is also a further barrier to the formation of such a vital statement. The different responding agencies have different command and control philosophies and will expect the statement of intent to be consistent with their usual level of intervention from senior commanders. To overcome the problems of ambiguity arising from inconsistent commander intervention, each senior agency commander is currently meant to communicate their interpretation of any joint intent, together with agency specific guidance, to their own agency. This means that any downstream decisions and plans formulated by subordinates to manage the incident are made in ignorance of the full picture. There is therefore an increased chance of mutual interference, or gaps in coverage.

It is therefore recommended that each management tier – bronze, silver and gold – has an 'Incident Commander' to take ownership of the Command Intent.

Information Flow Requirements

At present, it is unknown what the multi-agency information flow requirements will be. In line with the formation of a Command Intent, all multi-agency decisions are unsupported by formal multi-agency information systems and are therefore partly based on subjective, rather than objective analysis (see chapter 4). There is an acknowledgement that information should flow, but the exact form that the information flow should take remains undefined.

This means that, as the communications network to support the information flow is being established bottom-up, the lack of any formal specification and individual financial pressures will result in acquisitions largely based on current single-agency requirements and minimal inter- and multi-agency requirements.

Such a strategy will result in a system that has only limited improvements over the present system and will fail to accrue the full advantages of a common communications platform.

It is therefore recommended that multi-agency information flow requirements are defined so that the platform on which the information systems are to operate is designed for purpose – rather than the systems being designed to fit the platform on which they have to operate.