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CANDIDATE INTEROPERABILITY NEEDS AMONGST RESPONSE & RECOVERY GROUPS

Paul Barnes
Queensland University of Technology

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Cover: Multiple agencies receiving a briefing before a multi-agency training exercise.

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Executive Summary

This report is a scoping study of the challenges of individual and inter-operational capability needs of first response, support and recovery agencies in a context of collaborative response to complex emergencies and disaster events.

Effective emergency and disaster management requires multiple agencies and organisations from all levels of government and the private sector to work together. Interoperability between these entities is essential for efficient and effective service delivery. This report examines a range of options for defining interoperability needs among first response groups and those whose role is at a secondary and tertiary level.

The report begins by detailing the way in which interoperability is currently defined and evidence of the variability in the way in which the term is interpreted. It follows with an examination of the various ways in which emergency and disaster management agencies have attempted to achieve interoperability. This includes a review of the Department of Homeland Security's Interoperability Continuum and the way in which it is used to identify capability needs and gaps in US disaster response, and the Joint Emergency Services Interoperability Principles Programme's Joint Decision Model which aims to assist the decision making process between UK fire, police and ambulance services to improve interoperability during the emergency response phase. It then considers two international case studies: one where interoperability' may have been more absent than present; the other a relative success. Finally, the report concludes with a discussion of suggested challenges for examining interoperability needs and presents conceptual frameworks and trigger questions to guide examination of solutions grounded in the needs of end-users.

Table of Contents

1 Introduction

Effective emergency and disaster management that can enhance response and recovery from the impacts of natural hazards requires multiple agencies and organisations from all levels of government and the private sector to work together. The heterogeneous nature of such entities creates a series of challenges to the goal of cohesive, efficient and effective service delivery.

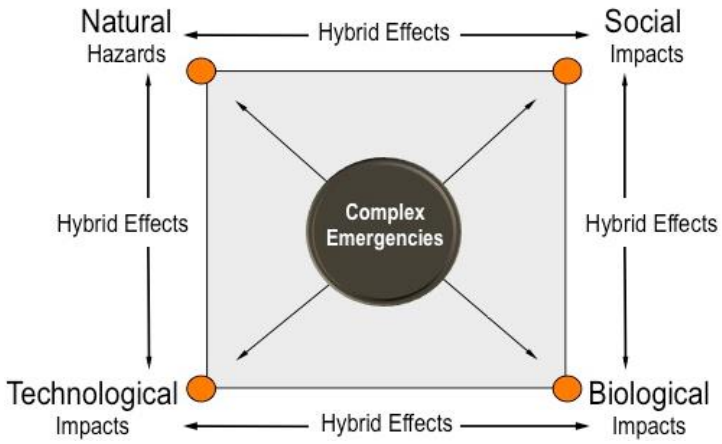
Interoperability, which in a disaster management context can be simply defined as "the extent to which organisations can work together coherently as a matter of routine", plays a pivotal role in enabling collaboration between emergency service agencies and organisations. In particular, the ability of first responders to effectively operate together can reduce the effects of disasters, the loss of property and human life, speed recovery of essential services and enhance the rebalancing of disrupted lives.

Despite numerous reviews and commissions of enquiries into past disasters frequently highlighting interoperability issues, lessons are not being learnt and the importance of interoperability is still not adequately integrated into emergency management planning and practice. Emphasis continues to be placed on technical aspects of interoperability, particularly use of common language and information and communication technologies, while organisational and cultural interoperability is largely overlooked. Joint training, promulgated policies and procedures, knowledge and understanding of the nature and depth of capability (and capacity factors) of other agencies (transparency) will enhance active steps towards establishing demonstrable interoperability more broadly.

A benefit of defining interoperability needs among groups active in emergency and disaster management is that the examination in and of itself can create an awareness of options for the effective and efficient, as well as flexible use of capabilities for preparing, responding to and recovering from significant protracted emergency incidents. Equally, consideration of such needs may assist in better understanding organisational constraints that limit the ability to deliver such effectiveness and efficiencies.

In terms of anticipating the potential scope of consequences from disasters, the often rapid spread of impacts across wide areas can render a comprehensive understanding of emergency and disaster response needs difficult to grasp. In fact commentators have suggested that enhanced understanding - as situational awareness - of rapidly escalating and spreading impacts from disasters will outpace the expectations and assumptions embedded in standard planning protocols; such rapidly evolving events have been described as 'too fast,' and 'too strange' (Lagadec 2004). Figure 1 below depicts the potential of natural hazards to propagate impacts into a range of different areas.

Figure 1: **Cascading Impacts from Emergencies** *(after Parker and Tapsell 1995)*



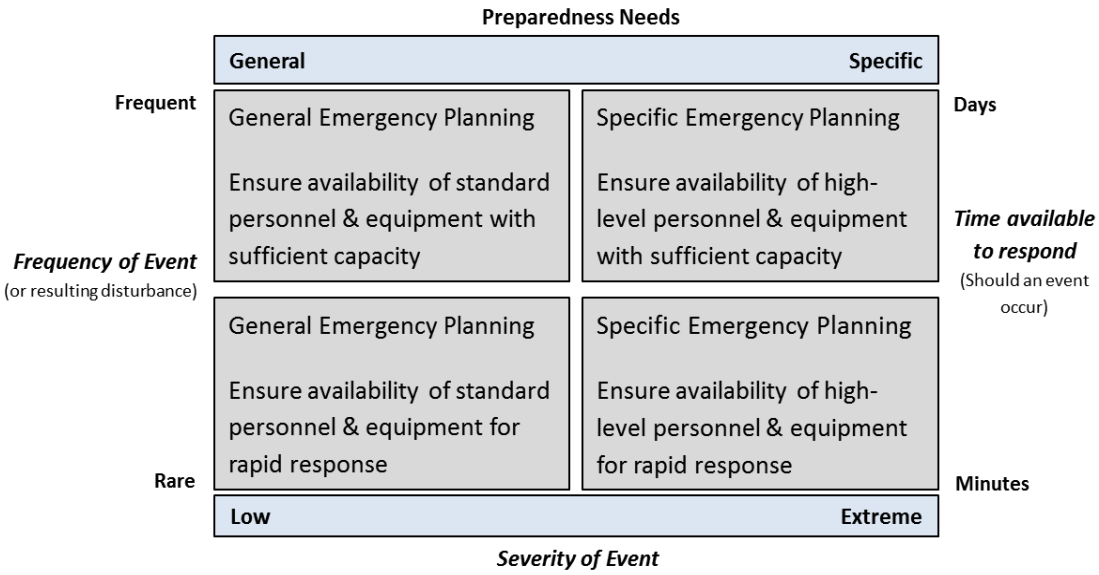
So while first response agencies most commonly deal with impacts from natural hazards, secondary and tertiary response and recovery agencies would be expected to engage with other cascading impacts manifesting in these other consequence categories, including technical (e.g. loss of electricity); biological (e.g. loss of potable water supplies); and social (e.g. displaced people and loss of the amenity of conventional communications and internet).

So assuming a range of predictable propagation pathways for cascading disruptions are generally available in large-scale disasters (Figure 1), a viable question to consider is that there may be an opportunity to pre-package 'units of capability' and the form in which they are defined and constructed across an all-agencies approach as part of joint response and preparedness planning. Figure 2 depicts a possible way to establish thinking about how to start building a planning schema for detailing capability within agencies ahead of actually having to activate a response. By including the notion of preparedness needs with standard risk analytics and suddenness of an event, the formation of a rubric for integrating the preparedness and planning needs of other agencies whose presence at a large-scale emergency is guaranteed by statute and or necessity can be examined with rigour and completeness.

What could follow the detailed exploration of planning, preparedness, and response needs is a means for defining integrated capabilities needed in complex emergency and disaster settings involving multiple groups. If 'Operational Interoperability'[1] is considered the ability [*of primary, secondary and tertiary response and recovery agencies*] to work together effectively and provide services and support to – and accept services and support from – other groups or disciplines, such examinations may benefit choices about all-agencies approaches to coordination of effort before, during, and after an emergency event.

1 Derived from: International Association of Fire Chiefs (IAFC)

Figure 2: **Planning Frame for Complex Emergencies**[2]



It has been noted[3] from examining US experiences of disasters over time that there is historical evidence of a lack of both integrated structures and policies for dealing consistently with a range of disaster types and critical understanding of Cooperation, Coordination, and Collaboration processes.

Further issues from a North American perspective[3] include:

- Working teams are sometimes not created until an emergency occurs
- Volunteer organisations or community groups are not adequately integrated into the command and control structure[4]
- Planning concepts need to be tested in context and the characteristics of the actual areas where disasters can occur.

An additional issue that may ultimately be central to considerations for interoperability planning is the suggestion that command structures [in emergencies] do not readily include integration across and between levels of government, organisations, and various man-made boundaries (Chen et al. 2008). A critical reality in most significant emergencies and disasters is that 'joined up approaches' to carryout protracted response and recovery activities requires exemplary collaboration - across all stages of the disaster and among all agencies with a lead role and those with emergent roles.

2 Derived from: Brauner, C. (2001) Preparedness: Basics of Business Continuity Planning, Swiss RE., Zurich, <http://www.lancsresilience.org.uk/Documents/Bcm/Preparedness.pdf>

3 Turoff, M., Van de Walle, B. & Hiltz, S.R. (2010) "Emergency Response Information Systems: Past, Present, and Future." Chapter 16 of Van de Walle, B., Turoff, M., & Hiltz, S. R. (Eds.) *Information Systems for Emergency Management*, Vol. 6 of the Advances in Management Information Systems monograph series (Editor-in-Chief: Vladimir Zwass). Armonk, NY. M.E. Sharpe Inc., pp. 384

4 Elements of this issue may be included in the BNH CRC Project – "Out of Uniform: building community resilience through non-traditional emergency volunteering," lead by Prof. John Handmer.

A further issue that has not been adequately factored into wider thinking about interoperability is the inclusion of all agencies with standing in emergency planning, response and recovery into a stratified view that enables the identification of dependencies and interdependencies among first response groups, and secondary and tertiary engagement agencies from across the private, public and non-government sectors.

This report goes some way towards addressing these issues and has been written to provide a focus for BNH CRC end-users to consider two related aspects of their professional practice: capability development and multi-agency needs for effective Interoperability. The work is not an exhaustive academic review of literature but seeks to generate dialogue among end-users on how they think about the concept of interoperability and organise to achieve it. Further, it is not meant to be a definitive piece on where Australia is lacking (or not) regarding interoperability. Central to a goal of generating dialogue on interoperability needs is the vertically integrated capabilities framework and the series of trigger questions (presented in Section 7) which are intended to stimulate discussion within and across emergency response and recovery agencies.

2 Interoperability defined

Interoperability is defined by the United States Department of Homeland Security as: "the ability of public safety agencies to talk to one another via radio communication systems—to exchange voice and/or data with one another on demand, in real time, when needed" (National Taskforce on Interoperability 2005). Alternatively, the United Kingdom's Joint Emergency Services Interoperability Programme (JESIP) views interoperability more broadly and defines it as: "the extent to which organisations can work together coherently as a matter of routine" (JESIP 2013). By outlining two different definitions of the same term by leading interoperability-focused disaster management agencies/programmes, it is clear that varying interpretations exist about what the term completely constitutes. Furthermore, on top of understanding the differing viewpoints on the definition of this term, it is pertinent to highlight the difference between interoperability and operability. While interoperability broadly refers to *multiple* systems and organisations working together in an efficient and effective manner, operability relates to the functionality of a *single* system or organisation in line with pre-defined requirements.

In the context of disaster management, operability refers to the proficiency of a system or organisation to effectively carry out emergency response duties (Federal Communications Commission 2014). As an extension, interoperability has been comprehensively defined as "*the ability of disparate and diverse*

public safety agencies and their emergency response units to interact in emergency situations towards common goals, involving the sharing of information and knowledge between involved organizations and the public via defined or ad-hoc processes to achieve coordinated actions, by means of the exchange of data between their respective information and communication systems" (Kuehn et al. 2011).

Interoperability is essential in emergency and disaster management. The nature of disasters, whether they are simple or complex, natural or human-induced, requires the actions of multiple stakeholders not only for response and recovery efforts, but also for prevention and preparedness strategic planning too. A holistic response to an event demands interoperability between all agencies and organisations involved. When advanced interoperability is evident, the capabilities of all stakeholders can then be harnessed and utilised in the most effective way. Ultimately, this benefits the victims of disaster while also having the potential to save money, time and resources for response agencies and organisations.

3 Current approaches to interoperability

When examining interoperability in emergency and disaster management, it is possible to identify two clear schools of thought that align to the definitions mentioned above: interoperability as a narrow Information and Communications Technology (ICT)-specific ability versus the broader capability-driven activity. Although there is little doubt that communications-focused interoperability can be enhanced through the effective use of technologies, for example, compatible data and information exchange technologies (CSIRO 2014b), it is also acknowledged that agencies must review their broader range of capabilities as disaster management stakeholders to perfect interoperability with their fellow responders (Eyerman and Strom 2005; JESIP 2013). This varying interpretation is fundamental to the discussion throughout this report, particularly when examining how interoperability needs and gaps are defined and assessed.

Examples of broader usage of the term include:

- *Interoperability put simply, is a measure of the degree to which various organizations or individuals are able to operate together to achieve a common goal.*[5]
- *Operational interoperability is the ability to work together effectively. Specifically, it is the ability of different jurisdictions or disciplines to provide services to and accept services from other jurisdictions or disciplines, and to use those services to operate more effectively together at an emergency.*[6]

5 Hura, M. et al. (2000) Interoperability: A Continuing Challenge in Coalition Air Operations, Rand Monograph Report, <http://www.rand.org/content/dam/rand/pubs/monograph_reports/MR1235/MR1235.chap2.pdf>
6 Pessemier, W. (2005) *TOP PRIORITY: A Fire Service Guide to Interoperable Communications,* International Association of Fire Chiefs through a sponsorship from Nextel Communications <http://www.in.gov/ipsc/files/Fire_InteropHandbook.3.05.pdf>

- *The capability of organisations or discrete parts of the same organisation to exchange operational information and to use it to inform their decision making. Interoperability must be considered for incidents and events in the same service and across different services where working to a common purpose within a unified framework with a common command culture is critical to success. This can be at the local, regional or national level*.[7]

In the broader capability sense, a 'system of systems' approach has been a principal method of achieving interoperability in disaster management. Each system comprises people, organisations and technology (Department of Homeland Security 2008). Operating within such a systemic frame would involve a range of independent organisations (including people and their functions) each using their own operating principles that connect with other organisations, or systems, while maintaining their independence at all times (Department of Homeland Security 2008). Achieving such agility requires not only common approaches to technology (e.g. data acquisition, storage standards, information exchange), but also governance structures, standard operating procedures and training and exercises. In the context of disaster management, one system could be a local, state or federal government agency, and they form a part of a larger system targeting regional and national situational awareness that is dedicated to managing emergencies that impact across jurisdictions and various scales (CSIRO 2014a, b).

4 How Interoperability needs and gaps are defined and assessed

Interoperability needs and gaps are generally revealed during the response phase of disaster management (Strom and Eyerman 2008a, b; Fischer et al. 2006; Noran 2014b). Although disaster response agencies can carry out planning exercises and other preparatory activities to a meticulous level of organisation and detail, the specific nature of an event means that response can rarely be managed in a completely seamless manner (Waugh Jnr and Streib 2006). As a result, gaps and additional needs, particularly relating to interoperability between stakeholders, are apparent in this stage of disaster management and should be defined and assessed during and following an event. Interoperability needs and gaps, with particular emphasis on planning and targeted mitigation options, should then ideally be considered by agencies in order to increase their capability to respond effectively to future events (Fischer et al. 2006).

The events of September 11, 2001 in the United States and the bombings on London public transport systems in July, 2005 have served as a catalyst for first responder agencies from multiple nations to

7 Cole, J. (2010) Interoperability in a Crisis 2 (Human Factors and Organisational Processes), Occasional Paper, Royal United Services Institute: https://www.rusi.org/downloads/assets/Interoperability_2_web.pdf referencing National Policing Improvement Agency, 'Guidance on Multi-Agency Interoperability' (Wyboston: Specialist Operations Centre, 2009), <http://www.npia.police.uk/en/docs/Multi-agency_Interoperability_Secure_130609.pdf>

more closely define and assess interoperability gaps in order to improve multi-agency response to a major incident (Vander Veen 2010, JESIP 2013, Miller et al. 2005). This section aims to examine methods that currently exist to define and assess interoperability needs and gaps.

4.1 Interoperability Continuum

The United States Department of Homeland Security's SAFECOM program was established after the events of September 11, 2001 when reviews of the response to the attacks revealed that the lack of interoperable voice and data communication channels between response agencies prevented critical information sharing on demand and in real-time. In the immediate aftermath of the two commercial airliners flying in to the World Trade Centre buildings in New York, police and fire personnel entered the buildings to complete rescue operations. When it became apparent that a collapse of the burning skyscrapers was imminent, police officers received this communication and began their evacuation, whereas fire and rescue personnel were not provided the same information. Sixty police officers lost their lives, while more than 340 fire and rescue personnel died when the buildings collapsed (Mountjoy 2005).

The SAFECOM program brings together local, state and federal emergency responders to develop tools and initiatives to assist them in achieving dynamic and cohesive interoperability in communications. One such tool, the Interoperability Continuum (see figure 3) has been developed to define and assess interoperability needs and gaps in US disaster response (Department of Homeland Security 2015). It outlines a scale that local, state, federal and tribal agencies can place themselves on to indicate where they perceive their current capability in the interoperable communications challenge, and moreover, where they need to be to effectively respond to an emergency event. This gap analysis can therefore determine what practical activities an agency needs to prioritise and who they should engage with in order to develop a more sophisticated interoperable communications system.

The Continuum focuses on five key elements that are required in order to achieve coherent and dynamic interoperability:

- **Governance**

  Establishing a governance structure that consists of all agencies across the different levels of government working towards the same agreed objective of enhancing communications interoperability. Agencies should not be working independently on improving communications interoperability, but should be coordinated as a well-governed multi-disciplinary machine.

- **Standard Operating Procedures (SOPs)**

  SOPs are a set of formal written guidelines to refer to in response situations that should ideally be joint-developed by and for all agencies. The most effective SOPs must conform to the US National Incident Management System, as this can allow for the optimal communications interoperability between all response agencies (FEMA National Incident Management System 2014).

- **Technology**

  Advanced voice and data communications technologies are an essential component of perfecting interoperability amongst response agencies from different levels of government. All solutions must consider existing infrastructure in a region and conform to a positive cost-benefit analysis. The swapping of files and radios are identified as the most rudimentary technological processes to manage data and voice communications interoperability. A scalable standards-based shared system that can be adapted based on the magnitude of the respective event and promotes high levels of collaboration is the ultimate goal on the Continuum.

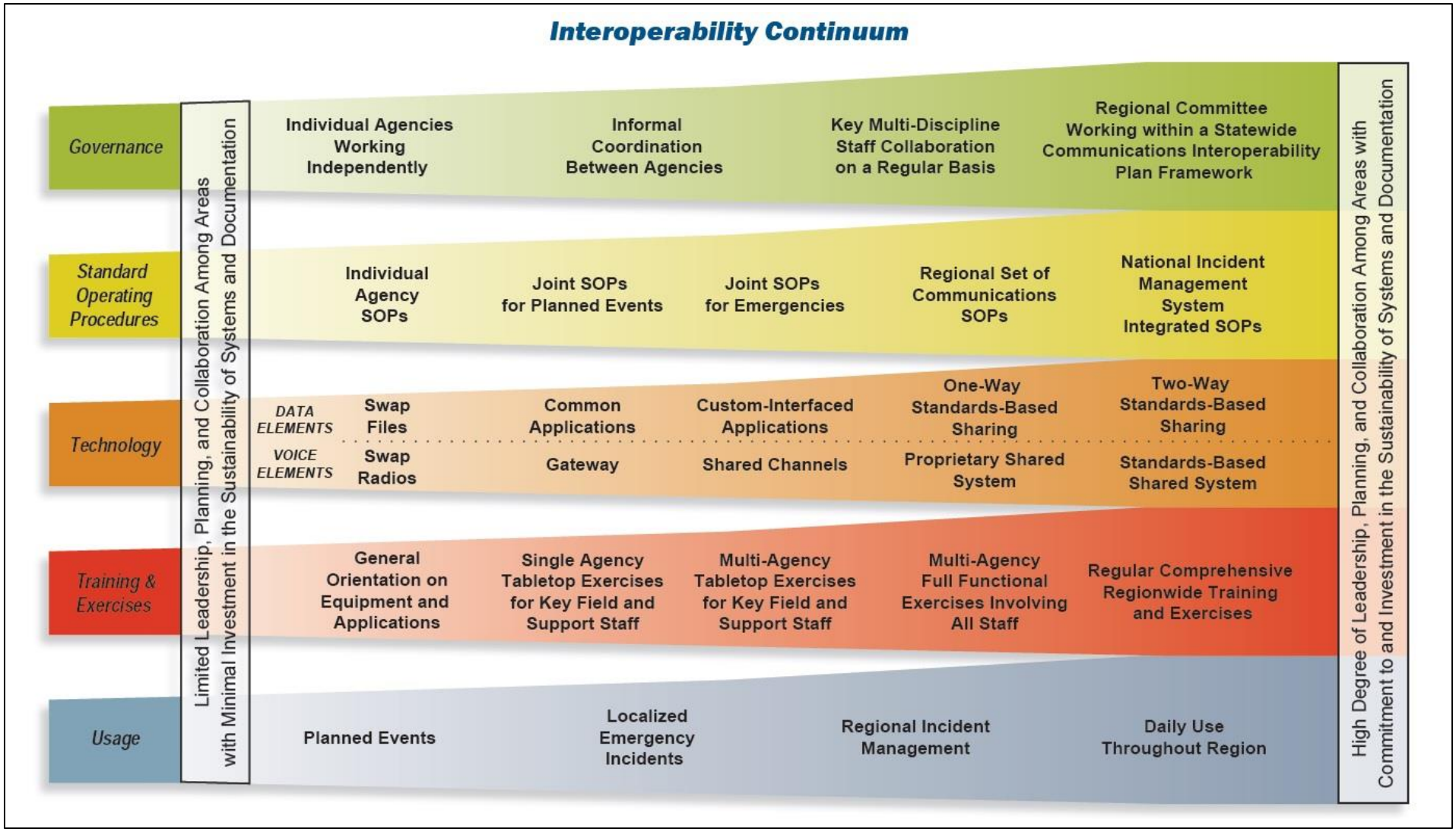
- **Training and Exercises**

  Training and exercises refer to practicing communications interoperability in preparation for a range of incidents that can affect the region. Training and exercises that are regular, comprehensive and realistic will have the greatest impact and make all personnel cognisant of the communications interoperability required between different levels of government to maximise the effectiveness of the response. Training needs to go well beyond a simple orientation of the technologies that will be used for incident response if proper communications interoperability is to be achieved.

- **Usage**

  The frequency that voice and data communications technologies are used has a direct impact on the success of disaster response. This component of the Continuum, which brings together

Figure 3: **Interoperability Continuum** (Department of Homeland Security 2015)



> the other four elements to demonstrate a daily usage of interoperable communications technologies based on clear governance structures and SOPs, will ensure greater interoperability in incident response across all agencies. Using communications technologies in coordination with all agencies on a routine basis can ensure preparedness for the heightened emergency response phase (Department of Homeland Security 2015).

The Canadian government's approach to achieving communication and information interoperability, as well as aligned capabilities among emergency management and public safety communities, has mirrored the US Department of Homeland Security's Interoperability Continuum in their Emergency Management System Interoperability (EMSI) Framework (Public Safety Canada 2010). Renamed the Communications Interoperability Continuum, but covering the same five elements as the US Continuum, the intent of the Canadian Continuum is to provide response agencies with a tool for self-assessment of their current capabilities against the intended targets for emergency communications interoperability on the Continuum.

The community of agencies involved are able to coordinate their self-assessments through utilities such as a web portal to gain an understanding of the common issues that exist with enhancing communications interoperability. Public Safety Canada then facilitates the development of interoperability initiatives with participating agencies that will better integrate them with the broader emergency and public security communities (Public Safety Canada 2010). The goal of enhancing emergency communications systems, capabilities and even intra-agency information sharing according to already prescribed legislative mandates is the driver for the use of the Communications Interoperability Continuum.

In addition to the Communications Interoperability Continuum, Public Safety Canada has adapted this to include two additional components, *Information Management and Architecture*, as well as a modified *Technology* component (focusing more on information security and sharing) to create an Information Interoperability Continuum (Public Safety Canada 2010). In the same vein as the Communications Continuum, the Information Interoperability Continuum enables agencies to self-assess against information interoperability goals. Consequently, the gaps that are displayed between current capabilities and ideal capabilities which align with these goals are the determinant by which interoperability needs are defined and assessed. The Information Interoperability Continuum maintains a predominant focus on interoperability being an ICT-specific issue, but requests Canadian response

agencies to consider additional elements that are critical to shared understanding of ontologies and processes at different levels of government and how that is communicated.

The Continuum and its five components – Governance, Standard Operating Procedures, Technology, Training and Exercises, and Usage – are also integral to the strategic objectives of the Communications Interoperability Strategy for Canada (CISC) (Public Safety Canada 2011) and associated Action Plan. Together, the CISC and Action Plan aim to provide a strategic framework (with goals and priorities for enhanced governance, planning, technology, training and exercises), and a roadmap (with specific tasks and milestones) to improve voice and data communications interoperability among emergency responders across the nation.

By focussing on communications technologies when exploring the issue of interoperability, the practical researcher gains an insight in to one important component of strengthening a multi-agency response to an event. Possessing effective means of communicating important information in real time and to all agencies involved in disaster response is the cornerstone of achieving interoperability. However, in order to understand the spectrum of interoperability needs and gaps, the practical researcher must look beyond an ICT-specific point-of-view to a broader understanding of disaster management capabilities and their relationship to achieving holistic interoperability.

4.2 Interoperability: a broader capability-orientated point-of-view

For effective emergency and disaster response, the necessity for interoperability in ICT capability cannot be denied, and indeed constitutes a vast majority of literature in this field (Department of Homeland Security 2008; Noran 2014a, b; Eslami Andargoli, Bernus and Kandjani 2013; Kuehn et al. 2011). It is suggested however that inclusive approaches are likely to deliver more complete solutions to need. Increasingly, government agencies are demonstrating an understanding of the achievement of interoperability being more dependent on a broader range of disaster management capabilities. Although communications is one of these capabilities, a broader capability viewpoint encompasses the idea that agencies must draw the connection of a *capability range* to the strategic outcome of enhanced interoperability with other response agencies, as well as within the agency. The identification of the enablers of these capabilities can allow for performance to be measured against the outcome of improved interoperability, which therefore informs how interoperability needs and gaps are defined and assessed.

The United Kingdom's disaster response agencies at a local and federal level provide examples of large-scale attempts to develop and rationalise a more holistic view of what constitutes interoperability.

4.2.1 Capability Development Processes (a UK example)

The London Resilience Partnership is a coalition of over 170 organisations that have a role in planning for, responding to, and recovering from all large-scale hazards that impact upon the capital city of the United Kingdom (UK). The Partnership aims to encourage more effective multi-agency collaboration and capability development (London Resilience Partnership 2013). Events ranging from terrorist threats to weather phenomena are identified to have significant negative consequences should they occur in the city of London; the Partnership has tailored its resilience strategies to deal with this range of disruptions. One of the results of this tailored approach is the creation of a Capability Development Process (see figure 4).

The Capability Development Process aims to address four functional capability areas that need to be developed or strengthened across the Partnership in a logical and staged approach to address the impacts of identified risks. These functional capability areas include:

- Risk assessment
- Training and exercising
- Coordination and information sharing
- Communicating with the public.

Within these high-level functional capability areas are more specific competencies related to resilience building along with response and recovery initiatives that are improved through the Capability Development Process. The process basically commences with a risk assessment that aims to highlight the specific capability that needs to be addressed. Following this, the Partnership develops a plan to manage the creation and implementation of the capability-building initiative that is consulted on by all necessary stakeholders, and subsequently updated to reflect their needs. Finally, the appropriate training, regular testing and conducting of scenarios takes place to ensure organisations involved in the London Resilience Partnership are proficient and *capable* to manage the respective risk.

The Capability Development Process has a practical application in defining and assessing interoperability gaps for organisations involved in the London Resilience Partnership. The very nature of the Partnership is that of multi-agency engagement and co-development of strategies to manage all hazards that have been identified as posing a risk. By undertaking this process flow, the key interoperability gaps related to the aforementioned functional capability areas are defined and plans are then subsequently created to address them. This initiative is managed by the Partnership which can therefore play a significant role in ensuring consistency and overall effective interoperability amongst the many organisations involved in disaster management in London. Other organisations such as the Australian Defence Force utilise a capability development process in relation to disaster management; this approach is employed

internally, on an interoperable level nationally between the tri-services, and also internationally, by harmonising concepts and capability requirements, primarily with the United States, the United Kingdom and New Zealand (Commonwealth of Australia 2014).

4.2.2 Joint Emergency Services Interoperability Principles Programme (JESIP)

A further example of industry-led innovation, again from the UK, is JESIP, a two year program established by the UK Home Office in 2012 which aimed to improve interoperability between the three critical first-response agencies (police, fire and ambulance) during the emergency response phase. The key objectives[8] of the Programme were to:

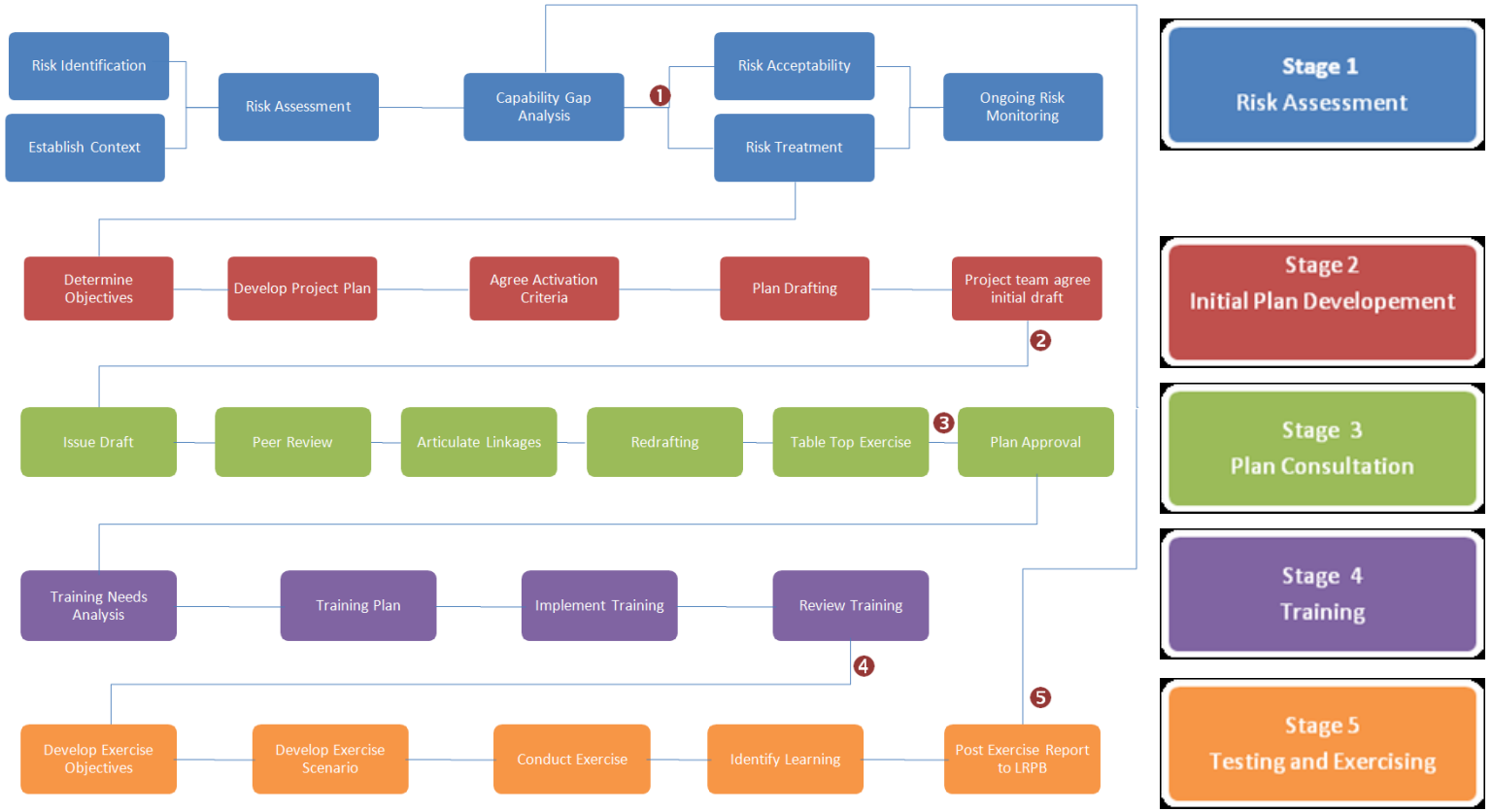
- Establish joint interoperability principles and ways of working (Joint Doctrine: The Interoperability Framework)
- Develop greater understanding of roles, responsibilities and capabilities amongst tri-service responders
- Improve communication, information sharing and mobilisation procedures between services including their control rooms
- Implement a training strategy for all levels of command
- Implement a joint testing and exercising strategy for all levels of command to ensure lessons identified progress into learning and procedural change.

Central to any national expectation about effective emergency and disaster management is access to succinct and well-practiced joint decision making capabilities.

A wide range of decision making models exist that have applications across many subject matter areas such as health, justice and commerce (Xia and Chen 2011). Within emergency and disaster management it is clear that decision making models can also be readily applicable, due to the high-stakes need for informed decisions to be made quickly and accurately (Taniguchi, Ferreira and Nicholson 2012). Although multiple decision making models are present in the emergency management space, few of them consider interoperability between the decision makers.

8 http://www.jesip.org.uk/what-will-jesip-do/what-will-jesip-do/

Figure 4: **Capability Development Process** (London Resilience Partnership 2013)



The Joint Decision Model (see figure 5) is a fundamental component of JESIP's Joint Doctrine. An adaptation of a decision model initially created by the police service in the UK, the Joint Decision Model is a suggested framework to manage multi-agency decision making in the response phase of major or complex emergencies. The UK police version of this model, the National Decision Model, was created with the goal of making the decision making or risk assessment process more consistent amongst its network of officers. The National Decision Model was not developed with the notion of collaborating with other organisations when officers were making decisions or assessing risks, however they were asked to continually ensure that the mission and values of the UK police service were at the core of how they dealt with each stage of the process. This would ensure overall alignment across the police force to a central vision, which would typically result in the officers making more effective decisions for all situations faced on the job (Association of Chief Police Officers 2012).

Similarly, JESIP's Joint Decision Model asks the emergency personnel using it to keep a clear mission of saving lives and reducing harm as the foundation for when they work through the decision making process. However, it is the inclusion of the term "working together" that is central to promoting interoperability between the agencies when they are deciding how to best manage the respective hazards they encounter.

At its core, the Joint Decision Model aims to facilitate:

- shared situational awareness, in which information is shared and understood between the organisations involved; and
- joint assessment of risk, in which a common understanding of threats and hazards and their likelihood of occurrence and harm is used to inform decision making and develop integrated multi-agency operational response plans. As part of these plans, legal standing and policies and procedures must be considered. The Joint Decision Model can contribute to identifying interoperability needs and gaps through bringing together the necessary parties involved in emergency response and ensuring they stay focused on assessing risk in a logical and inclusive manner.

Having built situational awareness and assessed risk, action to resolve the emergency can be taken based on the agreed response plans. The final stage of the cyclical Joint Decision Model also requires the response agencies to review what happened after action was taken as a result of the previous steps. By incorporating this exercise in the process, agencies should then be able to analyse what went right (and wrong) in the response phase and then develop strategies to respectively maintain or mitigate their future occurrence.

Figure 5: **Joint Decision Model** (JESIP 2013)

This 'lessons learned' component of the Joint Decision Model is particularly important for identifying interoperability gaps. Ultimately, this model can be extremely beneficial to the interoperability and enablement of shared situational awareness between police, fire and ambulance services in response to a range of hazards.

JESIP believe that "a detailed and well-practised understanding of the JDM will facilitate clear and ordered thinking under stress". Further, adhering to the core mission and values of JESIP will ensure that police, fire and ambulance services are working through the emergency response decision making process in a flexible and coordinated manner.

4.2.3 Shared Situational Awareness

Central to the decision making focus of JESIP is availability of a shared situational awareness. In the context of decision support in disaster situations, situational awareness has been defined as... "the perception of environmental elements with respect to time and/ or space, the comprehension of their meaning, and the projection of their status after some variable has changed, such as time, or some other variable … critical to decision-makers in complex, dynamic areas" CSIRO (2014a). While situational awareness might be presumed to be a relatively simple concept, there are some aspects that bear detailing. Harrald and Jefferson (2007)[9] suggest that situational awareness can be seen as a phenomena active on multiple levels:

9 Harrald, J. and Jefferson, T. (2007) Shared Situational Awareness in Emergency Management Mitigation and Response, in the *Proceedings of the 40th Hawaii International Conference on System Sciences*, Waikoloa, Big Island, Hawaii, January. IEEE Computer Society - Quoting M. R. Endsley, "Design and evaluation for situation awareness enhancement" in *Proceedings of the Human Factors Society 32nd Annual Meeting*, Human Factors Society, 1988, pp. 97-101.

- **Level 1:** Detection of critical factors in an individual's environment, often including visual cues; such as seeing smoke, hearing an explosion, tactile awareness (feeling seismic activity), as well as verbal and nonverbal communications with other individuals.
- **Level 2:** Incorporation of Level 1 factors into decision making contexts and needs; in particular in relation to prioritised lists derived from interpretation of significance of aggregated information and its meaning with respect to the objectives of the decision maker. This level requires an established knowledge base and/or level of experience to synthesise disparate pieces of knowledge.
- **Level 3:** Allows a degree of anticipation of near-term progression of an event and follows from awareness of information (level 1) and deriving meaning from interpretation. This level of understanding is likely to be dependent on a high level of domain expertise.

Important data specific aspects of situational awareness include[10]:

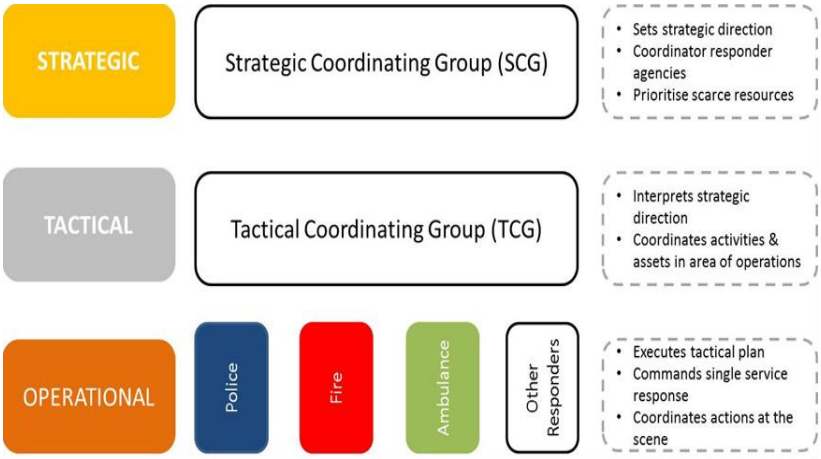
- Collection and processing of dynamic data (including validation, geo-location) from disparate sources - phone calls, social media, observations and monitoring activities - and relating these collations to established information on communities, assets, natural features across local government and regional areas;
- Visual representation of resultant information in support emergency management decisions. In short, answering the simple question: "what's happening?"
- Provision of accurate, near real time information for dissemination to other services and communities; and
- Using forecast data and real-time simulation to create probable scenarios, generating and visualising quantitative assessments of consequences to further support planning and mitigation decisions.

Central to JESIP is the importance of clear command and control structures that are common to all emergency response contexts. This also includes common approaches to mobilisation and data sharing. An additional critical factor resulting from combined situational awareness is that a more dynamic and agile approach to assessing risk and consequence management during rapid response and subsequent recovery phases is more likely.

Figure 6 depicts a conceptual model from JESIP Doctrine that purports to contribute to shared situational awareness by defining the response structure based on the semi-regularised strategic, tactical and operational levels of response activity (or gold, silver and bronze respectively).

10 CSIRO. (2014a) Building a System of Systems for Disaster Management Workshop: Joint Issue Statement. Accessed April 7, 2015 <https://publications.csiro.au/rpr/download?pid=csiro:EP142991&dsid=DS2>

Figure 6: **Overarching response structure** (JESIP 2013)



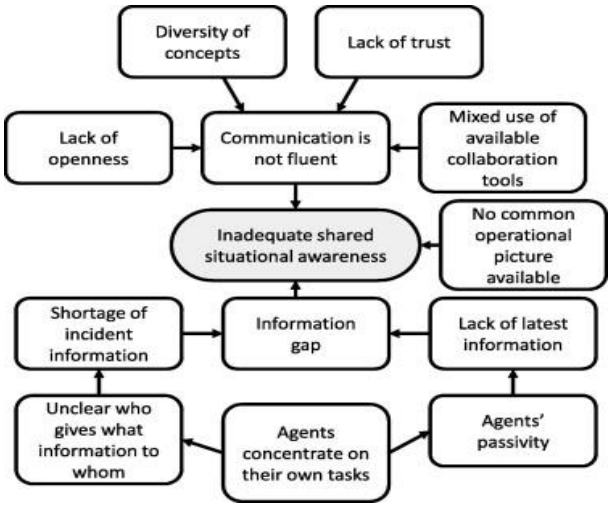
This approach typically allows coordinated planning and control of actions across the three levels of command, amongst all agencies involved, thus providing a structure within which optimal operational effectiveness can be sought. It should be noted however that the JESIP Doctrine currently does not fully include coverage of activities undertaken by agencies outside of the 'disciplined (blue light) services who may be activated in support roles during significant events. However, the principles described are also applicable to the wider range of Category 1 and 2 response organisations and can be applied to smaller scale incidents, wide-area emergencies, and pre-planned operations.

The three levels of shared situational awareness defined by Harrald and Jefferson (2007) allows for consistent understanding and cohesion in response initiatives in the entire command structure. This is particularly relevant from an interoperability perspective where it is imperative to be familiar with the available capabilities and most appropriate allocation of resources for all bodies responding to the incident. Shared situational awareness can contribute to the identification of interoperability needs and gaps as it assumes all organisations involved in the disaster response are able to coordinate logistics, leadership and communication capabilities. The utilisation of the Joint Decision Model (Figure 5), along with following a clear overarching command and control structure (Figure 6), are influential in achieving degrees of shared situational awareness, often supported by a common operating picture.

It is important to note however that the best-made plans are often significantly challenged by the reality of large-scale disasters or severe disruption and in particular where coordination is required between government organisations and non-government organisations and in situations where multi-national cooperation is required.

Seppänen et al. (2013) examined factors that can impede the acquisition of cooperation and subsequent adequate levels of situational awareness. Depicted in Figure 7 below, factors such as accuracy and timeliness of information on extent of damage, a lack of fluency (and accuracy) in communication, and the disruption of the absence of a common operational picture and familiar command and control structures are symptomatic of ineffective situational awareness.

Figure 7: **Impediments to effective Joint Situational Awareness** (in major Search and Rescue contexts)[11]



In the presence of inadequacy or failure in doctrinal factors, as shown in Figure 7, the type of integrated situational awareness referred to by Harrald and Jefferson (2007) might be unachievable.

4.2.4 Joint Organisational Learning

A critical adjunct to sustained interoperability is arguably learning from errors or surprises; both which might be more likely than less during the intense tempo of emergency and disaster response efforts. A 2011 comparative review of recent Australian disaster inquiries by the Monash University Injury Research Institute[12] identified common strategic issues and themes of significance that required addressing to enhance Australia's disaster management arrangements. These included:

- A re-focus on critical infrastructure resilience
- Enhanced appreciation of shared responsibilities between emergency management agencies
- The need to professionalise the emergency management workforce
- More targeted research
- Actual implementation of gaps and opportunities from (post-disaster evaluations).

11 Seppänen, H. et al. (2013) Developing shared situational awareness for emergency management, *Safety Science*, 55, pp. 1-9
12 Goode, N. et al. (2011) 'Review of Recent Australian Disaster Inquiries', *Monash University Accident Research Centre*, Accessed April 7, 2015
<http://www.em.gov.au/AboutAGD/Authorityandaccountability/Committeesandcouncils/Documents/Review%20of%20Recent%20Australian%20Disaster%20Inquiries%20-%20final%20report.PDF>

Similar findings arose in a review of deficiencies in large-scale operations in 32 major disasters in the United Kingdom.[13] Common factors included:

- Poor working practices and organisational planning
- Inadequate training
- Ineffective communication
- No system to ensure that lessons were learned and staff taught
- Failure to learn lessons
- No monitoring/audit mechanism
- Previous lessons/reports not acted upon.

Additional evidence of similar deficiencies in the United States suggested further familiar issues:[14]

- The need to radically improve the way we train and exercise
- The need for a comprehensive, nation-wide capability to gather and validate the information we learn from incidents, develop and vet corrective actions, and disseminate them to those who must inculcate the changes
- The need for incentives to institutionalise lessons-learning processes at all levels of government.

Following on from the Joint Decision Model, JESIP has also developed a Joint Organisational Learning approach that aims to define and address interoperability gaps (see figure 8). JESIP identifies this approach as being central to the legacy it wishes to leave behind as a program that has been focused on the issue of interoperability. A recurring theme from reviews and inquiries in to how disasters have been managed in the UK is that lessons are not being learned.[15] Further there has not been sufficient change at a practical and policy level to indicate that previously identified issues in disaster management have been rectified for future scenarios.

As a result, the Joint Organisational Learning approach has been developed to ensure that this does not happen by bringing together all relevant stakeholders to confirm what needs to be learned as a group, develop any necessary actions to address the learnings and subsequently implement and evaluate their performance.

The mechanism that the Joint Organisational Learning approach will operate through is a web-based tool that allows interoperability lessons to be uploaded by responders such as fire, police or ambulance, along with other governmental departments and local resilience forums.

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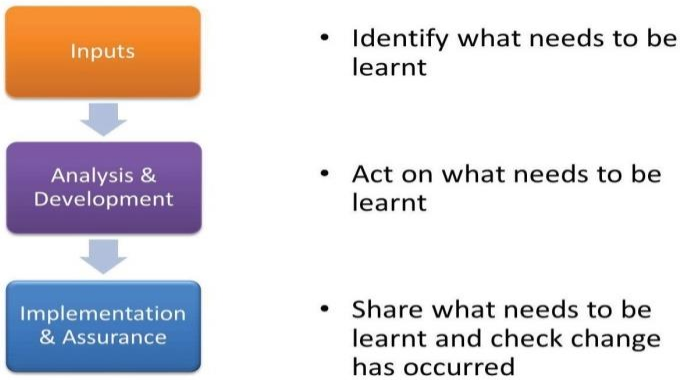
13 Pollock, K. (2013) 'Review of Persistent Lessons Identified Relating to Interoperability from Emergencies and Major Incidents since 1986', *Emergency Planning College Occasional Papers New Series Number 6: A report commissioned by the Cabinet Office Civil Contingencies Secretariat*, pp. 1-97

14 Donahue, A.K. & Tuohy, R.V. (2006) 'Lessons We Don't Learn: A Study of the Lessons of Disasters, Why We Repeat Them, and How We Can Learn Them', *Homeland Security Affairs*, II(2) (July 2006), pp. 1-28 <http://www.hsaj.org>

15 Pollock, K. (2013) 'Review of Persistent Lessons Identified Relating to Interoperability from Emergencies and Major Incidents since 1986', *Emergency Planning College Occasional Papers New Series Number 6: A report commissioned by the Cabinet Office Civil Contingencies Secretariat*

Figure 8: **Joint Organisational Learning** (JESIP 2013)



These lessons could be obtained from actual incidents or training exercises and span across a range of capabilities required in disaster response. The central JESIP team analyses and prioritises the uploaded lessons and a program of work is then commissioned to enact the necessary changes to address the interoperability gaps (JESIP 2013).

JESIP has proposed that in order to confirm if the Joint Organisational Learning approach is being utilised across the response agency base, review methods should be employed on a regular basis. This could include 'dip-sampling' amongst the agencies responsible for implementing change in their organisation or tri-service joint reviews (especially relevant for police, fire and ambulance). Ultimately, Joint Organisational Learning is seen as a core approach to defining and assessing interoperability needs and gaps. The fact that this can be done collaboratively with all response agencies on a modern technologically-driven platform gives the Joint Organisational Learning approach credibility in its capacity to identify how interoperability in disaster management across multiple capability areas can be enhanced across the UK.

4.2.5 Other Views: United States Analysis of Coordination in the United Kingdom

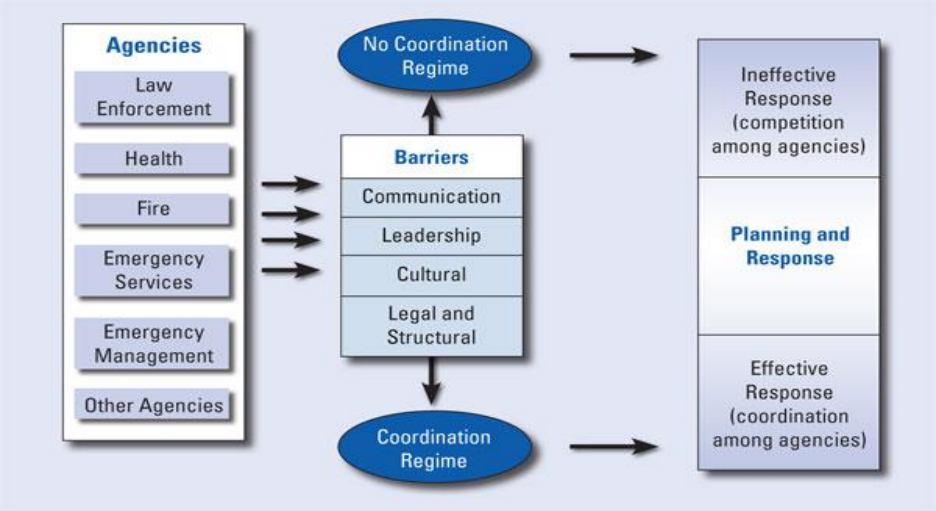
In 2008[16] the United States Department of Justice published research into response coordination during the 2005 London public transport bombings. This study led to the development of a General Coordination Model that identified [what are deemed as] critical barriers that can impact the overall effectiveness of multi-agency planning and response to an event depending on the level of coordination (see Figure 9). The model suggested that a key to effective planning and response among agencies was

16 Strom, K.J. and Eyerman, J. (2008a) Interagency Coordination: A Case Study of the 2005 London Train Bombings. *National Institute of Justice Journal*, 260, pp. 1-9

the presence of a robust coordination regime that aligns Communication, Leadership, Culture, and Legal and Structural elements.

The researchers argued that the long history of coordinated efforts of London-based emergency response agencies, dating back the aerial bomb attacks during World War II, to the Irish Republican Army bombings, and up to recent times, ensured that they were very experienced at joint activation and response to a range of disruptions. It could be argued that more recent efforts to ensure interoperability across the UK as a whole via the JESIP initiatives have made them even more efficient.

Figure 9: **The General Coordination Model** (Strom and Eyerman 2008b)



While the initial consideration[17] of these four elements was from a law enforcement and public health perspective, in which they were seen as *enablers* of interagency interoperability, the researchers[15] reapplied them to assessment of collaboration issues in the emergency response of the UK-based agencies as *barriers* to interoperability between agencies involved in disaster response, specifically:

- **Communication:** Agencies tend to develop their own jargon based on their areas of focus and internal workings. The subsequent lack of a common language often impedes cross-agency communication
- **Leadership:** Coordinated planning and response require an ongoing commitment from agency leaders. Response can fail when a leader of a critical partner agency is unwilling to commit qualified staff and resources because he or she is unconvinced of the benefits to the agency
- **Cultural differences:** Although public safety and health officials share the common goal of saving lives, each agency develops its own cultural standards of behaviour that reflect the educational and social backgrounds of its staff, organisational hierarchy, leadership style and core mission

17 Eyerman, J. and Strom, K.J. (2005) A Cross-national Comparison of Interagency Coordination Between Law Enforcement and Public Health, Final Report, *National Institute of Justice Office of Justice Programs US Department of Justice*. RTI Project Number 08914

- **Legal and structural differences:** Each agency has a unique internal hierarchy, different processes for working through the chain of command, legal limitations, and varying geographical and topical jurisdictions. These differences can discourage, delay or prohibit joint planning initiatives.

While the four elements of the General Coordination Model can act as barriers, they can be overcome by implementing practices that facilitate cooperation amongst agencies. These include up-front planning and ongoing collaboration and training, such as[15]:

- Creating and instituting standing procedures for rapidly recognising and declaring a major multiagency incident
- Having a standardised process for multiagency preparation and response that is rehearsed and used regularly for major events – thus becoming a new norm to all emergency response agencies
- Using a "liaison" model, in which personnel from one agency are assigned to work at other agencies for periods of time; sharing staff in this way facilitates communication and on-site consultation across agencies
- Developing relationships to facilitate cooperation among agencies by holding joint trainings, planning sessions and informal social events (such as off-site dinners)
- Encouraging participation of senior and junior staff of all relevant agencies in joint training and planning sessions to foster relationship building, communication, trust and appreciation for each other's roles
- Providing continued reinforcement from senior management through ongoing support for annual (and more frequent) training and interactions and dedicating resources to joint initiatives
- Implementing procedures to coordinate and send joint messages to the news media to forestall panic and exaggerated public perceptions.

Effective interoperability involves promoting positive aspects of communication, leadership, culture, and legislative considerations. If the four elements are viewed as *enablers* of interoperability and a coordinated approach between agencies is taken, an effective response is likely to occur (Eyerman and Strom 2005). The General Coordination Model has a very clear application to the definition and assessment of interoperability needs and gaps, and furthermore, is effective at categorising the key interoperability areas that agencies should focus on in order to enhance their response to an event.

Communication is essential for effective interoperability. From an operational perspective the importance for all agencies to be able to give and receive important voice and data information in real time is a clear example of an interoperability need related to communications.

Clear, inclusive and decisive leadership is critical for a coordinated disaster response regime. These leadership traits must also be espoused in the emergency planning and preparedness phase, as a principle interoperability need is for agency leaders to prescribe to a unified approach of allocating people, finance and resources in the best possible way that is separate of political influence. Due to the

fact that the very nature of interoperability is working cohesively with different agencies, it is obvious that clear leadership structure is a need that must be defined and assessed to coordinate multiple agencies from different levels and areas of government for a common goal.

Culture, which can vary widely between response groups, can have a substantial impact on achieving interoperability. A lack of understanding or appreciation of individual agency roles decreases the capability of a multi-agency response. By highlighting culture as a barrier to a coordinated multi-agency response, the General Coordination Model demonstrates its ability to define and assess a key interoperability need.

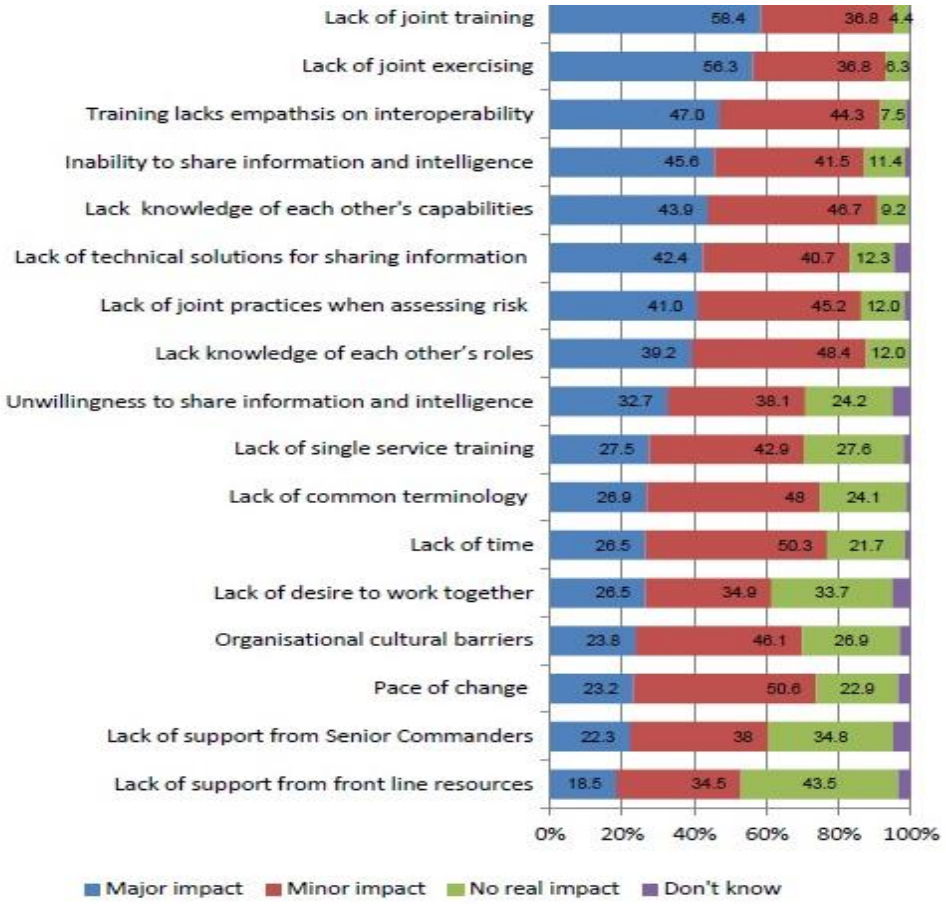
Legal and structural differences are significant interoperability gaps between agencies. A multi-agency response to an event often involves different levels of government, which may possess varying structures relating to command and decision-making authority, and are commonly governed by multiple pieces of legislation. This can lead to confusion and weakened interoperability in the immediate aftermath of a disaster. An understanding of the legal structures in each agency that interacts in a disaster response setting and the effects this legal component has on multi-agency response is fundamental to improving interoperability.

4.2.6 First Responder Surveys (JESIP)

An interesting factor within the JESIP approach was that the views of first responders were sought to detail insight into interoperability gaps and needs in the immediate aftermath of events. In 2013 JESIP undertook a survey of first responders that paid particular attention to the barriers to interoperability (see figure 10). The survey of first responders highlighted the key barriers to achieving dynamic interoperability. Specifically, it found that over 90% of respondents believed a lack of joint training and exercising were the principle barriers to a cohesive and effective multiagency response. The lack of information sharing programs and training packages that deal with the issue of interoperability in disaster response were also seen to be significant issues too.

It is clear that the actions proposed by JESIP have attempted to address the above-mentioned interoperability gaps. At the end of phase 1 of the JESIP (September 2014) “Joint Doctrine: the interoperability framework” has been accepted by 105 emergency services along with significant common training outputs nationally that have resulted in an excess of 10,000 Commander-level officers trained in formal session with an additional 20,000 staff engaged via e-learning or awareness sessions.

Figure 10: **Results of first responder survey** (JESIP 2013)



5 Case studies

Many examples of interoperability *in-action*, or *not-in-action*, can be found in relevant international disaster management literature (Mountjoy 2005; Department of Homeland Security 2006; Fischer et al. 2006; Eyerman and Strom 2008). In Australia also, there have been numerous post-disaster reviews and inquiries which have highlighted the need for collaborative emergency planning and interoperability during response activities (Australian Government 2005; Goode et al. 2011, Queensland Government 2012). In this report we review two case studies – covering joint agency response to historically significant events, one human-induced[18] and one of natural origin – to specifically examine and detail the effectiveness of agency interoperability in the aftermath of these events.

5.1 Public transportation terrorist bombings – *London, United Kingdom (2005)*

On a busy Thursday morning in central London, right in the middle of peak-hour, a systematic terrorist attack on the London transportation network occurred, killing 52 people and injuring more than 700 others. The bombings that took place on three London Underground trains and a double-decker bus

18 While the UK case study represents a man-made disaster, which sits outside of the CRC mandate, it has been chosen to highlight the need for interoperability in emergency response and the consequences when it is not adequate.

was the most fatal attack on British soil since World War II and tested the many agencies involved in disaster response like never before. Although some flaws in the immediate response were noted, the management of the event was fortunately regarded as largely effective, particularly due to the level of interoperability between the multiple agencies involved (Strom and Eyerman 2008a).

The creation of the London Resilience Team in 2002 had a beneficial impact on the response to the 2005 terrorist attack. This team, responsible for supporting the London Resilience Partnership of over 170 agencies from emergency services, local authorities, military, transport and many other areas, had allowed one key achievement: the prior establishment of relationships and an understanding of each other's capabilities in disaster management (London Resilience Partnership 2013). Agencies involved in the London Resilience Partnership routinely meet and practice response procedures for a range of scenarios, along with discussing and evaluating the risks faced by a city like London and how they can be managed cohesively. As a result, agencies knew what tasks they were responsible for and the level of interoperability required in achieving these goals (Eyerman and Strom 2008).

In addition to the London Resilience Partnership, the structure provided by UK legislation also assisted in enabling interoperability during the response to the London bombings. The *Crime and Disorder Act* (1998) and the *Civil Contingencies Act* (2004) predicate roles and responsibilities for agencies involved in disaster response and the requirement to work together. Following the terrorist attack in London, the *Civil Contingencies Act* (2004) has been updated with the inclusion of a legal framework around performance managing agencies that are not performing sufficiently through auditing and formal preparedness assessments (UNISDR 2014). Initiatives such as these in the legal space encourage and actively monitor multi-agency partnership in disaster response. This assists in ensuring the level of interoperability seen in the aftermath of the London bombings is only enhanced in the years to come.

However, it must be noted that other areas of UK legislation were seen to act as a barrier to interoperability after the bombings on the London transportation network. The privacy laws relating to sharing information about the identity and status of victims saw agencies and families lacking important knowledge. The *Data Protection Act* (1998) stipulates that without the consent of the concerned party their personal data cannot be shared. This inability to share information in a time of crisis prevented interoperability between response agencies that could have used this information to communicate to families of victims in a more efficient and effective manner (Eyerman and Strom 2008).

The events of the London attacks had spread across three different police jurisdictions: the Metropolitan Police Service, British Transport Police and City of London Police. Although a clear command and control structure was initiated in the aftermath of the bombings to ensure coordination

amongst responders, there were a few issues noted that are indicative of a lack of interoperability. The Metropolitan Police Service failed to have communications that worked underground, even though the British Transport Police had this capability. The nature of this disaster meant that communicating underground was essential to interoperate with other responders. Consequently, instead of communicating with each other in a seamless manner, runners often had to be sent to transmit information to the relevant personnel in the ticket halls (Casciani 2011). An absence of adequate foresight and planning for this kind of scenario could be seen as hampering the response phase.

Additionally, the City of London Police restricted mobile phone network access within their jurisdictional boundary in order to assist first responders having the unimpeded ability to make and receive calls through the reduction in network traffic. A by-product of this decision was that other responding agencies, such as the London Ambulance Service, did not have sufficient network access to fulfil their role after the bombings (Eyerman and Strom 2008). Although the London Ambulance Service was still able to communicate through other means, their preferred method was significantly impacted. This example highlights an interoperability weakness that could have easily been prevented by enhanced inter-agency communication pre-event.

Overall, the response by London and UK authorities to the terrorist attacks in 2005 is generally lauded as an example of decisive disaster management. While some flaws relating to comprehensive interoperability were still evident, the UK Government has committed to addressing these issues and others through specific initiatives; most notably, is the creation of JESIP. Along with the continued work of the London Resilience Partnership and refinement of UK legislation, it is obvious that the UK sees the necessity for interoperability in all hazards disaster management. Moreover, the achievement of interoperability is seen as more dependent on a broader capability range as opposed to a singular focus on the implementation of more advanced information and communications technologies.

5.2 Hurricane Katrina – *New Orleans, United States (2005)*

One of the most well-known disasters in modern times is Hurricane Katrina, a Category 5 hurricane that devastated the southern-US city of New Orleans, along with other communities along the southern US Gulf of Mexico coastline in 2005. Emergency management officials at all levels of US government were criticised for their lack of preparation and delayed response to the catastrophic hurricane. Although countless reasons have been documented as to why the management of Hurricane Katrina was such a widely perceived failure, this case analysis specifically focuses only on interoperability issues.

It is generally agreed that cohesive interoperability between all responding agencies was lacking in the response to Hurricane Katrina, and this had a significant contribution to the magnitude of the disaster

(Waugh Jnr and Streib 2006). A 2006 US House Select Bipartisan Committee report identified significant coordination problems between the Federal Emergency Management Agency (FEMA), the Department of Defence (US) and the state of Louisiana. A poorly implemented command and control system that lacked flexibility to respond to the dynamic conditions was evident in the aftermath of the hurricane. The information flow from the bottom, or the first-responders, to the Emergency Operations Centres (EOCs) was sparse and ineffectual. For example, the city of New Orleans operated their EOC out of a hotel ballroom, without adequate plans in place to account for telecommunications failures. As such, once phone services failed it became substantially difficult to communicate their requests to federal and state based agencies (Delisi 2006). FEMA were identified as being out-of-touch with the needs and issues at the ground-level. Victims of Hurricane Katrina were counting on the federal government coming in to assist them straight away, but a clear lack of understanding of agency roles was noticeable as FEMA were not capable of being present in the immediate aftermath (Fischer et al. 2006). Turf wars between the various responding agencies were apparent mainly due to a lack of capability to combine resources and personnel and allocate them in the most effective manner possible (US House Select Bipartisan Committee 2006).

Other agencies such as the National Guard, the US Coast Guard and the Northern Command (military) also had a significant role in rescue operations immediately following Hurricane Katrina, but the organisation of their combined efforts were documented as being problematic (US House Select Bipartisan Committee 2006). The reason for this lack of coordination between these entities and the many more involved in the response cannot purely be attributed to the failures of information sharing communication systems, as is often identified in the available literature (Fischer et al. 2006; Waugh Jnr and Streib 2006; Department of Homeland Security 2008). The Northern Command has documented that a lack of situational awareness stemming from the absence of unity of effort and logistical command were critical to the flawed multi-agency response to Katrina (Wood 2006).

As a result of the in-depth reviews and inquiries into the Hurricane Katrina disaster, multiple agencies have recommended and implemented strategies to enhance interoperability with their fellow responders across all levels of government to ensure the problems witnessed in the aftermath of Katrina are not seen again. Disaster managers from all levels of government and all states are encouraged to attend FEMA's Integrated Emergency Management courses held at the National Emergency Training Centre in Maryland; collaboration and cooperation are identified as central themes to these training programs. The idea behind the courses offered by FEMA is to establish some consistency nationally in terms of how disaster management should be carried out from an all hazards perspective (FEMA Emergency Management Institute 2014). Furthermore, these courses allow disaster

managers to engage and collaborate with their counterparts from different agencies through in-course activities, and to additionally forge working relationships that are critical to the achievement of effective interoperability in an actual disaster response scenario (Waugh Jnr and Streib 2006).

The Northern Command has also ramped up efforts to address the issue of interoperability post-Katrina. A closer and more visible relationship with state governments across the country has been developed through attendance at National Governors Association meetings. The Northern Command also participates in weekly FEMA-led teleconferences that deal with the issue of supply chain and logistical management. A commitment to acting on lessons learned is apparent by working with the Department of Defence to develop a website that documents and vets the lessons that need to be addressed. Implementation and review programs are carried out to ensure that actions have been completed or are in the process of completion to satisfy the necessary requirements (Wood 2006).

6 Challenges and Options to Consider

6.1 Challenges

Based on experience from the United Kingdom, Pollock (2013)[12] suggests three core thematic issues that must be addressed as a basis for examining interoperability needs:

1. **Failure to assume responsibility - at all levels**

   The drive for multiagency teamwork may lead to lack of clarity regarding individual and organisations with specific roles and responsibilities that should not be subject to consensus.

2. **Complexity of response structures**

   There is a lack of understanding about where individuals and organisations (outside blue lights) actually fit into the response structure. However, complex boundaries are a fact of life - what is required is those who are sufficiently competent and flexible to work within such complexity and still achieve safety objectives. It's not just structures that are the problem, but the skills of the staff who work in them. What is critical is the effectiveness of the management and leadership.

3. **Inadequate Communication between stakeholders**

   Both within organisations and between organisations - from the very top to the bottom of the organisation people need clarity about what they should be doing and why. They also need the appropriate means of communicating, so that during 'response' the system is capable of dealing with the surge of related activity.

These issues emphasise the importance of effective delivery of services in complex and often trying settings and thus act as a backdrop for detailed consideration of challenges faced by most agencies.

Table 1 lists a number of vignettes, set as challenges relevant to all agencies with standing in emergency response and recovery and with particular relevance to achieving suitable levels of interoperability. While there will be a range of additional challenges that might be added to the list related to circumstance and community vulnerability, the critical starting point for agencies is to question their status regarding enabling systems/practices specific to the challenge vignettes. Any examination of how to structure cross-agency dialogue, with consensus building as an endpoint, needs to consider issues such as those detailed in the vignettes and the considerations internally, and then in collaboration with others agencies.

Table 1: **Challenge(s) of Emergency Response Coordination** [19]

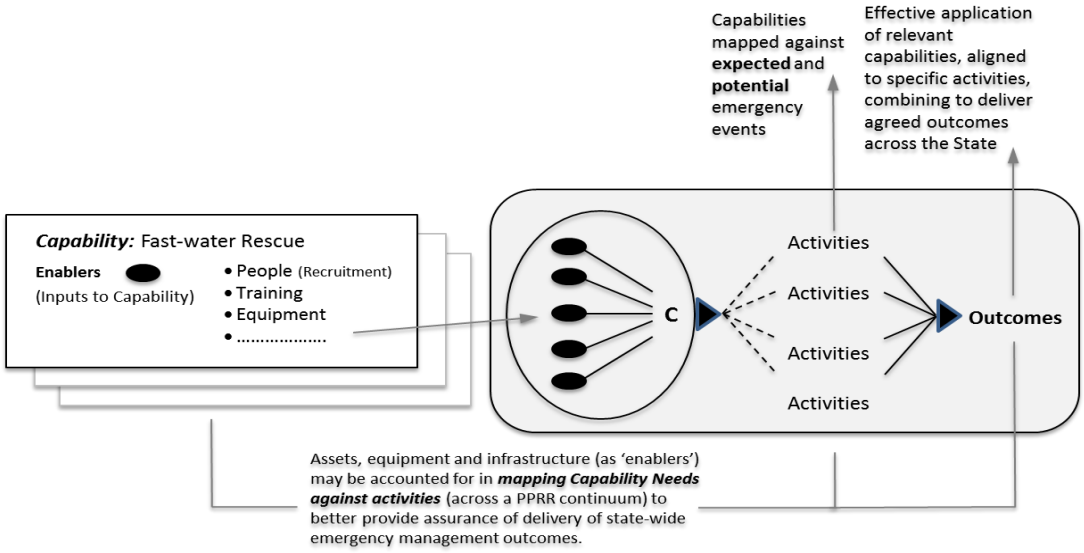
Challenge Vignettes	Enabling Considerations *(for each vignette ask, "what is the status [readiness] of our organisation regarding …?")*
High uncertainty regarding sudden and unexpected effects	° Real-time monitoring and timely alert notification for situation awareness ° Improvisation and rapid adaptation of predefined plans to real-time events ° Periodic evaluation and update on existing coordination practices
Incomplete consideration of disaster risk-reduction needs	° Threat, vulnerability, and risk assessment and countermeasures ° Risk-sharing policies among other response agencies ° Operational sustainability management
Increased time pressure and urgency on decision support	° Accessible repositories of relevant plans, procedures, policies ° Knowledge-bases and networks of internal and external experts ° Capabilities for data and knowledge mining, and intelligence fusion ° Effective decision support technologies
Severe resource shortages	° Logistic management and resource-sharing network across local, national, and international levels ° Self-equipped response teams
Uncertainty about scale of impacts and damage	° Coordination agreements: governmental, public, and private sectors across local, national, and international boundaries ° Efficiency of information, intelligence, and resource-sharing networks ° Efficiency and effectiveness of integrated communication networks to inform, guide, and reassure the general public
Disruption of infrastructure	° Monitoring damage to infrastructure during and post-emergency ° Planning for interdependencies within critical infrastructure systems in essential service settings
Complexity of multi-authority incidents	° Unified response command protocols for coordination ° Real-time management of authority and regulatory conflict ° Communication operability and interoperability
High demand for timely & relevant information	° Means and processes for information gathering and provisioning ° Capabilities to enhance information fusion and validation

19 Derived from Chen, R., Sharman, R., Raghav Rao, H. and Shambhu J. Upadhyaya, S.J. (2008) Coordination in Emergency Response Management (Developing a framework to analyze coordination patterns occurring in the emergency response life cycle). *Communications Of The ACM*, 51(5), pp. 66-73

An additional factor underpinning results of an examination of the challenges detailed in Table 1 is an assumption that agencies have determined functional capability needs as part of strategic planning for service delivery. For example how *capability* is aligned to *outcomes*: particularly in relation to joint outcomes which is an important corollary to interoperability. Figure 11 describes an alignment between capability enablers, capability, activities and outcomes.

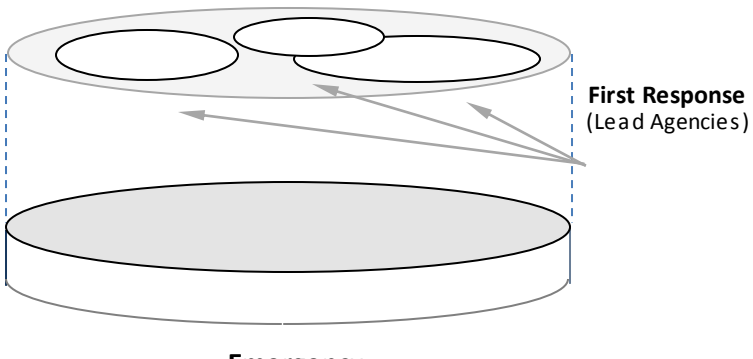
While the Continuum presupposes a particular approach to defining 'capability', being able to articulate a relationship between the *enablers* of a capability, the *activities* in which specific capabilities are used, and then aggregated to outcomes allows not only a means for costing service delivery but also generating a coherent pattern for emergency planning.

Figure 11: **A Capability – Outcomes Continuum**



As detailed earlier (Section 5.2), efforts across government agencies in the United Kingdom (Joint Emergency Services Interoperability Principles Programme: JESIP), demonstrate an understanding of the achievement of interoperability as being more dependent on a broader range of aligned and tested disaster management capabilities. Figure 12 depicts a conceptual notion central to the intent of JESIP; the importance of established capabilities, applied together, coordinated with jointly understood and practiced command and control structures.

Figure 12: **Aligned Interoperability** (A First Responder Focus)



Benefits from such arrangements, as intended in the JESIP approach in particular, require common approaches to mobilisation, information sharing and coordinated communication strategies – key components of situational awareness. A critical factor resulting from a more complete means to define situational awareness is enhanced support for decision-making and development of integrated multi-agency operational response plans.

While Figure 12 depicts an idealised representation of combined efforts amongst first response agencies, a reality faced by all developed and developing economies is that actual responses to significant disruptions from natural hazards – as a primary cause – and subsequent impacts, require the combined efforts of multiple agencies (both government and non-government) through time and across geographical space.

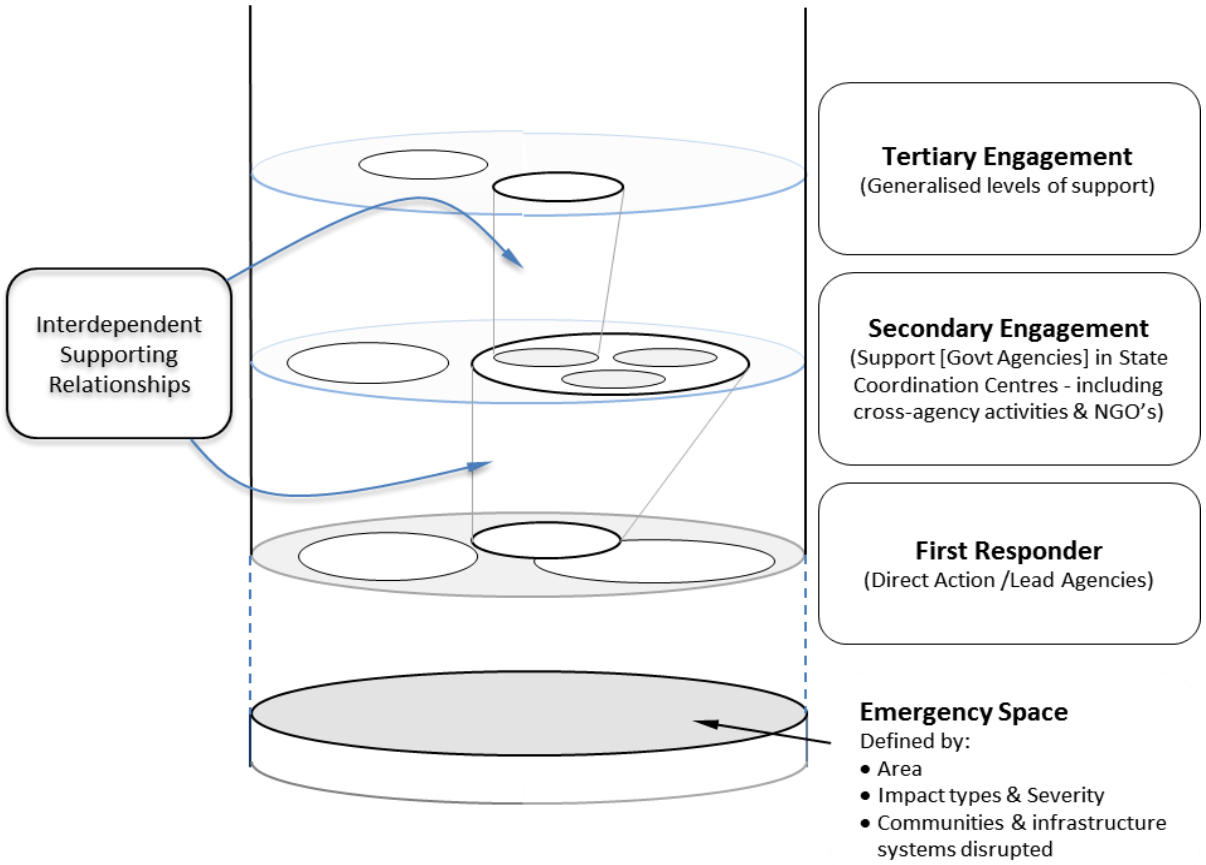
Given this reality, how 'interoperability' needs and efficiencies are approached from an all-agencies perspective, particularly for response and support agencies that may be called on to activate in a protracted disaster scenario, is important. In addition to an expectation that relevant agencies have well defined, understood and resourced capabilities, an additional and probably more complex set of requirements involve how first response and secondary response/recovery agencies will work together. While JESIP-related material suggests that the commonality of its principles relate to other non-blue light agencies, the testing of doctrine and training principles seem to have focused predominantly on first responder groups. A focus on this *within-group* category (see Figure 12) is critically important however examining interoperability across a more diverse set of agencies active in significant disaster response efforts warrants consideration.

While many first response groups will have experience of the 'nuts-and-bolts' of collaborative efforts and as a result, appreciate the dependencies and interdependencies between application of their specific capabilities to a joint response (*horizontal interoperability*), there are gaps in extant research and published material in civilian contexts examining the complexities, assumptions and impediments to efficiency in joint multi-agency campaign response over extended time periods.

Thus an examination of *vertical interoperability* relevant to a full appreciation of the 'emergency space' is needed. A visual base on which to consider these needs is depicted in Figure 13.

Central to the idea embodied in Figure 13 is that capabilities arrayed vertically between first response groups to secondary and tertiary engagement groups may be entangled via dependent and interdependent relationships that remain under or unexplored.

Figure 13: **Vertically Integrated Emergency Response Capabilities** (All Agencies Focus)



A critical extension of an examination of the challenge vignettes (Table 1) earlier, which can be examined by self or small group reflection, is that the vertical relationships inherent in Figure 13 suggest that the question central to the enabling focus … *"what is the status [readiness] of our organisation regarding…?"* requires a similar dialogue among all agencies that have a role across the PPRR continuum.

6.2 Where to from here: *Questions and Next Steps*

In summary a series of questions should be considered in thinking about mapping interoperability needs. These questions address the relationships shown in Figure 13 in particular but also the challenges outlined in Table 1. While it is assumed that other issues and questions will arise throughout the research effort, end-users are asked to consider the following initial questions, particularly in reference to the horizontal and vertical layers of Figure 13:

1. Are dependencies within levels of responder groups considered and understood - are they horizontally integrated?
2. Have Communication - Leadership - Cultural differences - Legal and Structural differences been examined and mapped? If not, what assumptions might be significant?

3. What interdependencies exist between different (vertical) agencies? Do any such relationships impact an all-agencies ability to deliver the required response and recovery effect over time?
4. Does emergency response planning assume that different scales of response with rapidly cascading impacts just require more units of capability?
5. Does emergency response and recovery planning assume that all required relationships among agencies are known - or that all agencies that might be involved in a protracted or unusual emergency response and recovery effort are known?
6. Are legislative structures aligned – within horizontal layers and vertically (Figure 13)? Have legal impediments been tested for different scales of coordination against different types and scales of events?
7. When faced with a complex crisis, how does your agency operate effectively (cooperate and collaborate) with others? Is engagement any different in an event thought to be less complex?

Considering these questions is by no means a simple endeavour. End-users are encouraged to commit to discussions because failing to begin the process of institutional review limits the benefits that will be gained by attempting it. Such benefits extend beyond single institutions.

By considering their current approaches to capability development and related frameworks in the context of these questions, end-users of the research can begin to develop a clearer picture of how well focused current thinking and practice is with respect to intra- and inter-organisational operations. Internal operational gaps as well as gaps in the ability to effectively cooperate and collaborate with other emergency service organisations and agencies, both horizontally and vertically, will likely be identified. To expand on this initial thinking, the planned series of state-specific workshops with end-users will re-examine these questions, specifically in the context of existing capabilities and capability needs for effective emergency and disaster management in the future.

The 'desktop' workshops will involve facilitated simulations for individual and combined agency operations applying future emergency scenarios as they relate to four natural hazard event categories: climatological, hydrological, meteorological, and geophysical in scenarios tailored to each state. From these constructed future 'hazard-scapes', capability gap analyses will be conducted in which actual and ideal capabilities are defined, and capability gaps subsequently identified. As far as we know, research like this in Australia hasn't been attempted before.

This research seeks to discover capability gaps within organisations themselves, and integrated capabilities needed in complex emergency and disaster settings involving multiple groups. Documenting the known (horizontal) and discovered (vertically integrated) capabilities needed by first and second responders, and allied agencies, as matched to current and future natural disaster contexts,

allow the formation of scaled descriptions of capability along a continuum of increasing effectiveness, adaptability and maturity.

It is important to appreciate that gains that may be returned from applying this work do require an investment by end users in wanting to understand their own interoperability needs. As innovative as the conceptual frameworks presented in this work are there is a need to appreciate that as far as we know, research like this in Australia hasn't been completed before and a commitment to different ways of thinking about how and what emergency agencies do and required capabilities, is needed.

As innovative as the conceptual frameworks presented in this work are, it is important to appreciate that the potential gains from applying this work do require an investment by end-users wanting to understand their own interoperability needs. For its usefulness to be fully realised, a commitment from emergency management agencies to pursue different ways of thinking about what is done, how it is done, and the required capabilities, is needed. It is our hope that this report and subsequent research effort will contribute towards achieving this.

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