SYSTEM OF SYSTEMS FOR DISASTER MANAGEMENT: SOLUTION STATEMENT

March 2014

BUILDING A SYSTEM OF SYSTEMS

DISASTER MANAGEMENT WORKSHOP

EXECUTIVE SUMMARY

A complete picture of National Situation Awareness (NSA) in natural hazard based disaster management at any time is a challenge. Disaster managers need to integrate information from multiple disparate systems, used by a multitude of agencies across the country. To create a useful environmental picture to underpin national planning, preparedness, response, and recovery (PPRR) activities for natural hazards, it would be helpful if we were able to exchange data, models and services across organisational boundaries. Seamless exchange and integration of data would provide better support in decision-making. Although this is typically seen as an Information and Communication Technology (ICT) issue, there is a significant social dimension to this challenge: the policy, governance and organisational and institutional arrangements that contribute to realising a solution to this issue.

This Statement should be read in conjunction with the Building a System of Systems for Disaster Management Workshop: Joint Issues Statement, which articulates the key challenges to NSA. One of the key issues highlighted was the need for a national system that incorporates the many disparate existing systems and enables services and information to be integrated throughout the agencies and stakeholders involved in disasters at all stages of the PPRR life cycle. This Solution Statement provides a high level roadmap for the creation of a System to achieve improved NSA at all stages in the PPRR life cycle.

1. INTRODUCTION: SETTING THE SCENE

CSIRO held a workshop entitled "Building a System of Systems (SofS) for Disaster Management" at the Australian Emergency Management Institute on 27 and 28 November 2013. The aim was to gain an understanding of the issues associated with achieving situational awareness and develop a joint statement addressing the research and informatics factors that hamper NSA.

This Solution Statement focuses on developing a solution that addresses the obstacles to achieving improved NSA via a System of Systems approach that were highlighted in the Building a System of Systems for Disaster Management Workshop: Joint Issues Statement. It articulates a vision for a System of Systems for Disaster Management, along with a phased plan.

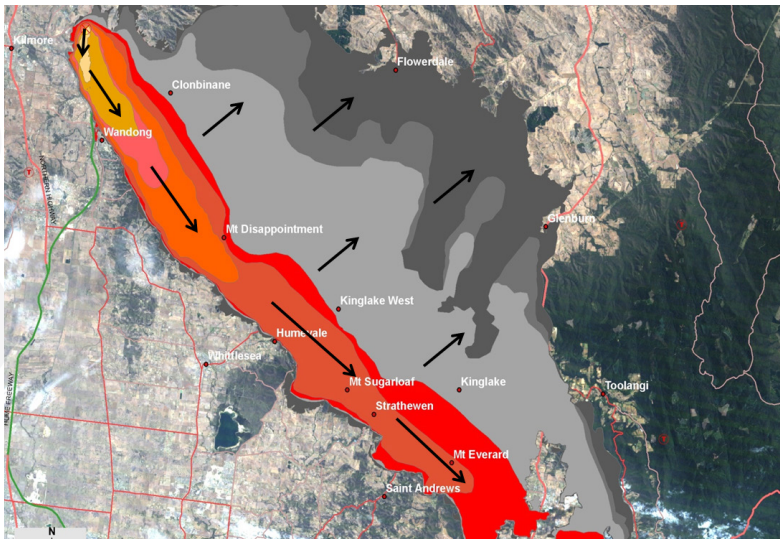
1.1 NATIONAL SITUATIONAL AWARENESS

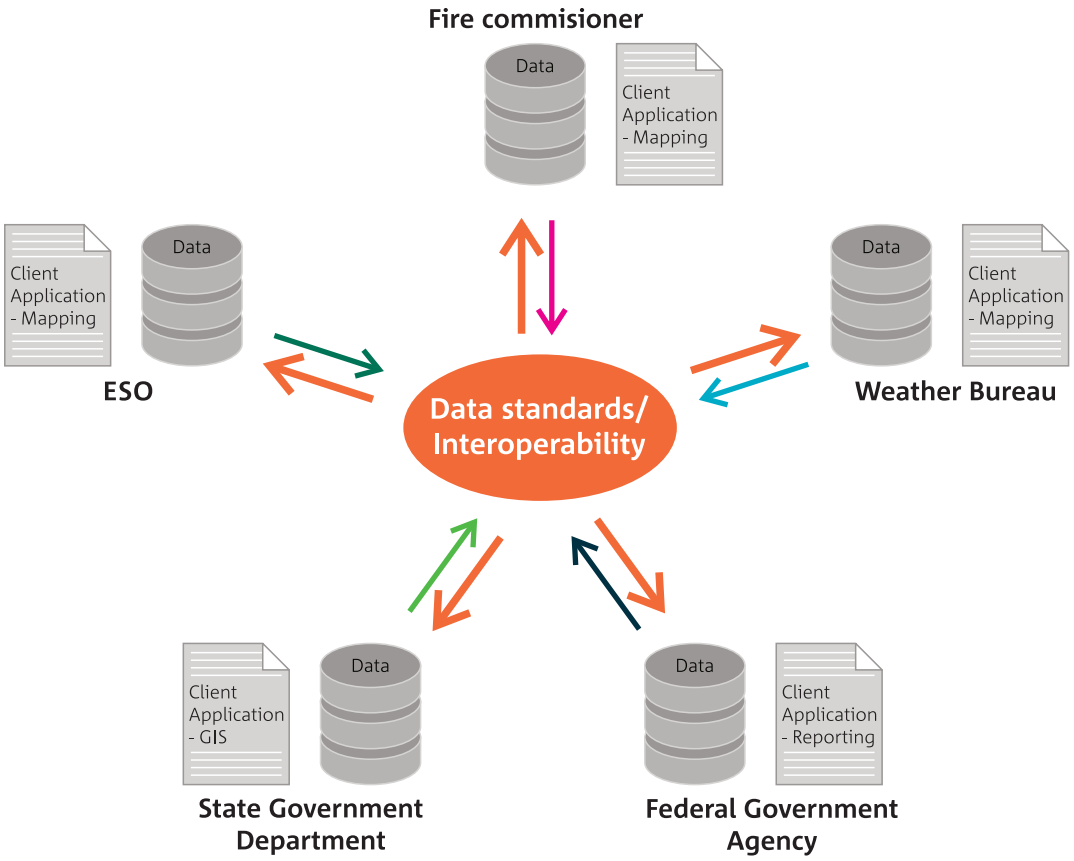
Situational Awareness has several elements:

- Collecting and processing (including validation, geo-location, time series analysis, etc) dynamic data from disparate sources (such as reports, phone calls, social media, observations and monitoring activities, etc) and relating these data to information on communities, assets, natural features, local government jurisdictions, etc;
- Visualising the resultant information to support emergency management decisions. In short, answering the simple question: "what's happening?"
- Providing accurate, up-to-date, information for dissemination to other services and the community;
- 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. This is the other simple question: "what's going to happen and what will the impact be on communities and assets?"

All this needs to be considered at a national level, with cross-organisational exchange to ensure that authoritative information is delivered in a suitable/ timely manner. This will ensure that governments and ESOs have the most comprehensive picture for understanding a natural hazard situation before, during and after an event. SA is not solely a National issue: it involves all levels of government, including local councils, agencies and organisations, all of which can benefit from improved technology, data and communication.

> **"This will ensure that governments and ESOs have the most comprehensive picture for understanding a natural hazard situation before, during and after an event.**





1.2 KEY ISSUES

During natural hazard events, it is vital to have a coherent picture of the situation. This requires access to timely, interoperable information and services. There are solutions to the ICT challenges at an organisational level, but many problems remain when crossing organisational boundaries. Examples include:

- information and data exchange and usage
- ability to discover, understand and use data
- where and when to use computational models/ simulations to acquire predictive or near real-time information: inconsistencies and uncertainty about fitness for purpose

The Joint Issues Statement highlighted issues that need to be researched and addressed in seeking a technology solution. They include:

- Data Interoperability and Standards: Disparate systems - different data sources, formats, timeframes, terminologies, semantics, and access constraints restrict the ability to understand others' data.
- Communicating Risk: There are inconsistencies in the methods used to communicate risk at all levels of the PPRR lifecycle. Channels of communications differ and inconsistent terminologies are used.
- Data and Information Governance: Policies, processes and management around the acquisition, creation, use and provision of data for use in DM lack governance and agreed definitions of roles and responsibilities.
- Data Quality: The quality of data is at times unclear. This makes it difficult to ascertain whether it is fit for purpose.
- Linkage and Provenance: The process flow relationships between data, models and other information are unclear. The lack of provenance or lineage information collected around the process flows makes it difficult to understand if any uncertainty exists within the data.

These problems contribute to making achieving NSA difficult. Research and development is needed to remedy these issues, and the workshop highlighted the desirability of a Systems approach to resolving them.

2 WHAT IS A SYSTEM OF SYSTEMS FOR DISASTER MANAGEMENT?

A SofS includes the various technologies needed for information-sharing across agencies, accompanied by appropriate governance to ensure and enhance sustained interoperability between organisations. A system of systems therefore comprises not only a technical architecture, but the appropriate governance, policy and standards frameworks to enable all stakeholders to collaborate and interact, and ensure the best available information is present at all times during the PPRR lifecycle.

Achieving NSA requires multiple individual systems, people, and processes to link up across organisational bounds. It calls for an understanding of what is required across the patchwork of systems; tools, techniques and processes used by the various agencies providing services within DM. The ultimate goal is to have a complete understanding of all facets of an event – before, during and after the fact. New approaches are needed, and the concept of a SofS is being developed to address the issues hampering NSA.

2.1 UTILISING A SYSTEM OF SYSTEMS APPROACH - THE BENEFITS

The SofS approach can produce a structure that utilises systems from multiple agencies to provide clear, coherent and timely information for improved situational awareness. The vision for such a System will include technology, governance and policy to guide the utilisation of data, information, models and services between organisations.

Such a System will ease the exchange of data, models and services between organisations by standardisation, governance and agreements. It will make data more accessible, understandable and usable by others beyond the bounds of the originating organisation. It will make information useful to a wider audience, and provide mechanisms for ensuring consistency in communicating this information.

> **"The ultimate goal is to have a complete understanding of all facets of an event – before, during and after the fact.**

A SofS for DM will aid all ESOs in understanding the current picture and their role in it. Transparency of operations and data will be achieved, and ESOs should improve their efficiency in service delivery through access to timelier, comprehensible information.

3 NEXT STEPS: HOW YOU WOULD BUILD A SOFS

A SofS cannot be delivered in one step: it would take considerable effort to achieve an interoperable system that allows data, models and services to be more easily exchanged between agencies. It can, however, be delivered iteratively, to ensure engagement with stakeholders and the ability to remain agile. A great deal of work would be required, across multiple agencies and levels of government, to make a SofS a reality for Australia. Some of the technology to make a SofS a reality already exists: the challenge is primarily that of policy and coordination to make a SofS work effectively. Some is being addressed by existing governance boards, some isn't, and some can be handled better. Below we outline a high-level phased approach to a SofS, with key elements that would greatly contribute to improving the current approaches.

Phase 1: Research feasibility and make recommendations on preferred approach

- Define the SofS Framework. Define frameworks for exchange of data, models and services within the disaster management community, including:
  - governance
  - provenance
  - data interoperability standards and delivery mechanisms
  - standardised communication terminology
  - modelling standards
  - social media
- Produce Roadmap for delivery
- Phase 1 Pilot Development and Deployment
  - Identify key issue theme to address
  - Co-ordinate a group of participating agencies to take part in a Phase 1 deployment (pilot)
  - Provision candidate infrastructure
  - Assess outcomes of Phase 1 deployment

Phase 2: Planning and implementing pilot

Establish a production SofS framework with an appropriate governance structure, to ensure a coordinated approach in assisting key agencies to adopt the framework. Minor agencies will follow after key agencies have established the framework.

Deploy a Phase 2 Implementation of the SofS Framework

- Take findings and outcomes of Phase 1 pilot deployment and address
- Develop/deploy Framework to key government agencies
- Assess outcomes of Phase 2 deployment

Phase 3: Monitor and evaluate pilot

Test and evaluate the impact of the SofS framework. Selected agencies start to make use of the framework and develop systems to exploit the standardisation of data, models and services across agency boundaries.

Phase 4: Operational System

Implement the SofS framework more broadly across the Australian DM community

ESOs and all levels of government are providing and consuming data, models and services via the SofS framework. This allows for clear, consistent messages both between agencies and with the public, regardless of which agency is providing the message or state/territory in where they are located.

APPENDICES

APPENDIX A: CONTRIBUTORS

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A.2 Organisations who partook in the System of Systems for Disaster Management workshop and contributed views to this document

LMI Group	National Safety Agency Australia
Risk Frontiers	CSIRO
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Attorney Generals Department (Commonwealth)	APCO
Bureau Of Meteorology	University of Melbourne
Geoscience Australia	Fire Services Commissioner (Victoria)
Data Agility	Centre for Australian Weather and Climate Research
NICTA	Fire & Rescue NSW
Macquarie University	ANZEMC RSC
Queensland University of Technology	NSW State Emergency Services (SES)
Office of Spatial Policy (Dept of Communications – Commonwealth)	Victorian State Emergency Services (SES)
NSW Rural Fire Service	CRC for Spatial Information
Motorola Solutions	Department of Primary Industries, Parks, Water and Environment (Tasmania)
Country Fire Authority Victoria (CFA)	Suncorp Group
Mornington Peninsula Council	Australian Broadcasting Corporation
IBM Research Australia	Curtin University
Department of Human Services (Commonwealth)	

APPENDIX B: BUSINESS CASES

The following provides a narrative of what would be entailed in a System of Systems to achieve more effective Situational Awareness at a national scale. Each case is written in the context of a particular phase of PPRR and from the viewpoint of a specific stakeholder. Though not a conclusive business case, it serves as an example of business cases for a SofS. Each assumes that a SofS is in place.

B.1 Phase: Planning; Stakeholder: Local Government

A local government council in Australia's tropical north is planning for the upcoming Wet Season. The drainage and floodplain engineers start planning several months prior to ensure all short-term measures (for example community outreach, channel deepening) can be implemented before the Wet Season and longer-term strategies (upstream reservoirs, dykes, etc) can be applied. Officers at the council are investigating what mitigation strategies need to be put in place, and where.

> **"From this modelling result, the council planners can quickly and cheaply assess the viability of various mitigation strategies and employ the most appropriate measures.**

To develop plans, officers log into their local system to conduct some forward modelling scenarios for various low-lying areas around the river plain in their council area. The intent is to understand/identify what areas could possibly be flooded, based on historical data and current terrain information, and what impact mitigation strategies would have on controlling floodwater inundation to the community and critical infrastructure.

The local government system automatically queries historical and forecast weather data for the council's jurisdiction from the Bureau of Meteorology weather services. They further query for data from Geoscience Australia (digital elevation models, bathymetry, NFRIP – National Flood Risk Information Portal and NEXIS – National Exposure Information System for the built environment). Along with all the models and data, the uncertainty and quality is noted and evaluated to provide a level of certainty for the pending modelling result.

The system then sends parts of the data collected to a flood modelling service hosted at a company servicing the emergency services in Australia. The data, along with the regional coordinates and mitigation measures (i.e.: river walling details) are sent through to the service. The service processes the data and provides the council with a result file. The council then uses its system to visualise the result as a video or dynamic GIS layer. From this modelling result, the council planners can quickly and cheaply assess the viability of various mitigation strategies and employ the most appropriate measures.

B.2 Phase: Preparedness; Stakeholder: State Fire and Emergency Rescue Department

The Fire and Emergency Rescue Department is preparing for upcoming catastrophic wildland fire conditions. The weather over the past few weeks has been 35C+ each day, with minimal humidity. The vegetation and landscape are dry and conditions are ripe for a highly volatile fire. Tomorrow's conditions are likely to be the worst yet. Temperatures are expected to be in the low 40s, with low humidity and strong winds coming from inland. The National Fire Danger Rating System indicates "Catastrophic" conditions for many parts of the state; the department is alarmed and is on high alert status.

Tactical planning officers at the department log into their intelligent bushfire behaviour forecasting system, which extracts data and information on exposure and vulnerability from multiple locations, to help them plan where to deploy fire appliances before an event occurs, in an effort to stop or reduce its impact. The officers use the system to do some forward modelling of possible scenarios, based on the risk ratings of properties in various locations (Bushfire Attack Level ratings). From this, they can easily integrate the necessary information to determine whether and where to deploy appliances, so they are on-site to either prevent the event from occurring, or at least there early to mitigate its potential effects.

> **"Preparedness for events is vastly improved through access to timely, standardised information from external organisations.**

The department's system taps into the System of Systems, where information and models from other organisation's systems are exchanged. This gives the department's officers greater insight into situations: they have access to up-to-date data that has been standardised and assimilated for their consumption, automatically in real-time. They also have access to high performance computing and cloud resources to complete scenario modelling in real-time, and therefore can provide more accurate and timely preparations. These are roughly equivalent to preventative measures prior to hazard events. Preparedness for events is vastly improved through access to timely, standardised information from external organisations. The State Fire

and Emergency Rescue Department is well prepared to deal with natural hazard events, so much so that preparedness almost becomes preventative measures.

B.3 Phase: Response; Stakeholder: ESO – Emergency Service department

A major flood has just inundated the regions off major river plains in east Victoria. Victoria Emergency Services (VES) has been called in to provide assistance. VES logs into its IT System to determine the affected areas and coordinate their response. Due to agreements put in place several years back, VES can access information in real time from other agencies involved in the response effort, and integrate that with weather data from the Bureau of Meteorology and other relevant information. The information they acquire is easily understandable as terminology across ESOs has been standardised.

Whilst VES plans how to respond, they acquire a detailed synopsis of the situation, what, who, and how people are affected. This assists them in rapidly identifying where to assist, how and with what equipment. The incident controller coordinates a plan and details the response in their system. This is also automatically exchanged with other agencies involved in the rescue operation as interoperable data layers and maps.

> **"The data is seamlessly integrated into reports for the response officers, as all data is returned to NHSA in standardised formats and terminologies.**

B.4 Phase: Recover; Stakeholder: National Human Services Agency

A cyclone has just devastated the coast of far north Queensland and the National Human Services Agency (NHSA) responsible for providing financial assistance and services to individuals in affected areas is assessing the number and location of people affected. NHSA distributes assistance on behalf of the federal government and has infrastructure and offices in various locations.

Officers at NHSA are embarking on an analysis of the current situation in Queensland, to get a clear, accurate indication of the number of people affected by the cyclone that has just passed. To complete this analysis, NHSA contacts various agencies coordinating response efforts, including the Bureau of Meteorology and various ESOs, to formulate a clear understanding of the impact. These agencies have overlapping concerns and areas of coverage and will therefore have information duplication. This is no longer an issue, with the establishment of a SofS in Australia for Disaster Management.

Officers at NHSA log into their system, which contacts various agencies for current/live data. The data is seamlessly integrated into reports for the response officers, as all data is returned to NHSA in standardised formats and terminologies. As all data, for example, address data, is standardised when exchanged between agencies, NHSA can easily remove duplication as data all lines up, and there is no room for misinterpretation. With the ability to compare and contrast with confirmed weather information, complete validation of affected areas can occur quickly from a remote office.

MORE INFORMATION

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