FIRE SERVICES COMMISSIONER VICTORIA

INFORMATION INTEROPERABILITY BLUEPRINT

Better information, better decisions, better outcomes and a safer Victoria

MAY 2013

WORKING IN CONJUNCTION WITH

CFA MFB Department of Environment and Primary Industries State Government Victoria SES ESTA 000 Saving Time Saving Lives

Leadership
Integration
Accountability

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INTRODUCTION

THE HON KIM WELLS MP
MINISTER FOR POLICE AND EMERGENCY SERVICES
MINISTER FOR BUSHFIRE RESPONSE

Improving the emergency management system in Victoria is everyone's business. Government, community, business and emergency services organisations.

To improve the system's effectiveness will require a sharp and broad focus on how information is gathered, stored and used to make decisions. Put simply, better information management will enhance decision making at all levels and across the range of stakeholders involved in emergencies.

Government must now find the most effective way to lead and enable significant change in the way the state ICT investment can be expended to best meet community needs, consistent with the Victorian Government's ICT Strategy released on 12 February 2013.

In Victoria, the regular threat of fire, flood, storm or other emergency means the resulting risk to lives and property, and potential social, environmental and economic impacts are so great that we must address whole of Government investment that resides in a range of organisations and agencies.

CRAIG LAPSLEY PSM
FIRE SERVICES COMMISSIONER VICTORIA

In designing the Information Interoperability Blueprint, the community is rightly at the centre as providers of information, local capability and receivers of information.

Individuals, families, local volunteer organisations, local businesses, and local government must be better served by improving the way information is managed and delivered for emergency management.

To ensure we can inform, activate and connect with communities in a timely and consistent way, information must be considered a core product in our service delivery model. This includes both the information we deliver and information we can get from the community that provides intelligence to emergency managers to inform and improve decision-making.

The challenge now is to ensure the sector investment is fully aligned in the Information Interoperability Blueprint. This blueprint is the backbone of realising our common vision where emergency services work with the community, Government and business as one integrated and unified team.

True success will be when the community, Victorian industry and business can get the information they need to improve their decision making and truly become a partner in emergency management. This is the future of shared responsibility.

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A SAFER AND MORE RESILIENT COMMUNITY.

OUR VISION:
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OUR ROLE:
THE COMMISSIONER OVERSEES AND WORKS WITH VICTORIA'S FIRE AND EMERGENCY SERVICES TO LEAD, ENABLE AND FACILITATE CHANGE AND A PROGRAM OF CONTINUOUS IMPROVEMENT.

1. EXECUTIVE SUMMARY

A number of recent catastrophic disasters in Victoria — notably the 2009 Black Saturday bushfires and the 2010 – 2011 floods — have highlighted the key role of information in effective emergency management. Both the 2009 Victorian Bushfires Royal Commission and the Review of the 2010 – 2011 Flood Warnings and Response noted the positive impacts that improved information sharing between agencies and with the community can have before, during and after emergency incidents.

It is the individuals, families, local volunteer organisations, local businesses, and local government in the affected areas — in other words, the community — who can be better served by improving the way information is managed and delivered for emergency management. The community is the key stakeholder in any emergency and it is imperative in the Information Age they are placed at the centre of our focus. The better informed the community is the better placed community members are to make their own decisions relevant to their particular circumstances.

Achieving this will require the development of a true common operating picture for all stakeholders in an emergency. At its core, the concept of a common operating picture calls for a far higher level of information interoperability between emergency services. Beyond that, though, it is about enabling all stakeholders to make the best possible decisions with respect to their actions before, during and after an emergency. Effective decision making is enabled by two factors: comprehensive, accurate and up to date information; and the tools to turn that information into insights that can assist with making the right decision.

While efforts have been made to improve the connectivity of information between agencies and with the community, the current state of emergency management is a long way from the ideal of a common operating picture. This Information Interoperability Blueprint proposes a platform for realising a common operating picture and enabling effective decision making for emergency management in Victoria. Called the Victorian Information Network for Emergencies (VINE), the platform aims to enable the sharing of information pertinent to an emergency, as well as the creation of tools for combining, processing and analysing this information in order to provide decision makers with added insight. VINE will be built according to the principle of resilience, using a scalable, secure, highly available and redundant architecture based on a cloud computing infrastructure. It is intended to support information exchange and decision making for the many stakeholders involved across the full lifetime of an emergency: from planning and preparation, through to emergency response and on to recovery, reconstruction and planning for the next emergency.

A key principle of VINE is to provide open access to data wherever possible. However, where sensitive or confidential information must be secured, comprehensive role based access control services will be available to ensure that this can be done and operational leaders have the capacity to swiftly reclassify information as situations develop and change. The shift to a practice of information being made as widely available as possible is fundamental to providing a true common operating picture, to spurring innovation and to engaging the community. If access to information is too heavily restricted, VINE will simply become a set of "virtual silos" with each agency managing its own information and the community continuing to turn elsewhere to find what information they can.

To function effectively in the Information Age, VINE needs to support an "ecosystem" of applications built on top of it. It is now the mandate of particular emergency services to provide timely, relevant and tailored information to the community. However, it is impossible to anticipate every need and provide truly tailored information for every set of circumstances. By building an open data model with flexible access options across the Internet and other media, VINE will allow third parties to build tools to fill the needs of the community and emergency services, as those needs arise. For example, an organisation for people with vision-impairment might create a custom smartphone application providing access to critical information for its clients.

It is intended that the community will not only use information from VINE, but will also contribute to it, both directly and indirectly via social media and other tools. This recognises that the community is not a passive mass to be managed, but is rather a valuable ally in emergency management that can and should work alongside the emergency services. It is anticipated that the community can contribute incident and condition reports directly to the system, as well as registering resources and capabilities that can be utilised in the management of an emergency. The ubiquity of Internet-connected smartphones (often with inbuilt GPS) makes the community an even more valuable source of observations and reports.

An important aim of VINE is to spur research and innovation in the area of emergency management. There is significant potential for advances in areas such as fire and flood modelling and evacuation planning. Research in this area is typically hampered by limited access to data.

The issues and opportunities discussed above are not unique to Victoria; being able to manage and optimise the available emergency information is a common theme governments and emergency services are grappling with around the world. By building VINE as an open data platform and encouraging research using the data it exposes, Victoria can become a world centre of excellence for research in these fields. At the same time, the open architecture of VINE will allow innovations to be rapidly absorbed back into the system, giving Victorian emergency services, the community and the private sector access to the latest innovations and tools when making critical decisions during an emergency.

With respect to information representation and exchange, information shared using VINE will be based entirely on open standards and common information models. Where appropriate formats do not exist, they will be created (through a collaborative process) and made available to others as part of VINE. The use of open standards provides better investment of limited resources, encourages information sharing and fosters collaboration with other innovators across the globe.

THIS INFORMATION BLUEPRINT PROPOSES A PLATFORM FOR REALISING A *COMMON OPERATING PICTURE* AND ENABLING EFFECTIVE DECISION MAKING FOR EMERGENCY MANAGEMENT IN VICTORIA.

A GRADUAL TRANSITION FROM TODAY'S SYSTEMS TO VINE WILL PROTECT EXISTING INVESTMENTS AND MINIMISE DISRUPTION, WHILE AT THE SAME TIME ENABLING RAPID PROGRESS BY FOCUSING INITIAL EFFORTS ON THOSE AREAS WHERE THE NEED FOR INTEROPERABILITY IS GREATEST.

Alongside a well defined set of data standards will be a process of data governance, which will ensure that the standards are properly adhered to so that interoperability is maintained.

A gradual transition from today's systems to VINE will protect existing investments and minimise disruption, while at the same time enabling rapid progress by focusing initial efforts on those areas where the need for interoperability is greatest.

VINE is made practical today as a consequence of the rapid evolution of 3G, smart phones, web services, Facebook, Twitter and cloud computing. What is required now is to boldly embrace the future to deliver the right information to the right people, at the right time and in the right form. VINE represents a vision of an information sharing and decision support capability that takes advantage of today's technology to fulfil that responsibility and meet the needs of emergency services and the community, now and for decades to come.

Ultimately, technology is not the answer and is not even the problem. The critical success factor for future emergency management in Victoria, and the security of our communities, will be the extent to which the emergency services agencies align and work together to provide a single cohesive emergency management capability. This is recognised at the most senior levels in our agencies and is a core principle contained in the Victorian Emergency Management Reform White Paper. Achieving this objective is based on acceptance and a thorough commitment to a single operating environment and a single information management capability. This will be a key yardstick by which we will be measured.

2. SCOPE OF THIS DOCUMENT

This Blueprint presents the future vision for information interoperability between and within emergency management organisations and the community. As such, the scope of this document is restricted to questions of information — where it comes from, who uses it, how it is represented, how it is transferred and coordinated — and how it can be used to inform decision making.

It is important to acknowledge that there are other issues outside the scope of this Blueprint that have a significant bearing on the ability to make the best use of the information available for emergency management. Chief among these considerations are organisational culture and communication technologies.

With regards to organisational culture, information interoperability is as much — if not more — a matter of the willingness and preparedness of organisations to work together and cooperate at a deep level when it comes to information sharing and operational compatibility. Technological and organisational change must proceed at a similar pace and complement each other.

The value of information is largely determined by the degree to which it can be acquired from all the relevant sources and disseminated to those who need it most in a timely way. This Blueprint presents a vision of information interoperability that is designed to take full advantage of existing and future communications systems and infrastructure. However, it must be recognised that investment is required to modernise communications networks and equipment used by emergency services so that all those in the field (including the community) can reap the benefits of modern technology. We cannot claim to have a true *common operating picture* if those at the front line of operations are unable to access information about the environment in which they are operating. **As the community is the key stakeholder in any emergency, any agenda for the future vision of communication technologies must also consider the best ways to utilise, integrate and interoperate with commercial communication networks.**

3. BACKGROUND

"…The commission does not consider that the flaws identified in connection with Black Saturday can be overcome simply by doing more of the same even if it is done better…"

— Victorian Bushfires Royal Commission[1]

"The 'all hazards, all agencies' philosophy of emergency management remains appropriate for Victoria. However, this philosophy is not being effectively operationalised because of barriers in organisational culture, communication, coordination, interoperability and information collation and sharing. This situation is not sustainable and requires major reform."

— Review of the 2010 – 2011 Flood Warnings and Response[2]

A string of catastrophic major disasters in Victoria — notably the 2009 Black Saturday bushfires and the 2010 – 2011 floods — and subsequent reflection into the handling of those disasters have made it clear that change needs to occur in how emergencies are managed. In particular, these inquiries referenced the imperative of agencies to share information between each other and the community, as one way to reduce the impact of major emergencies on the community.

An outcome of the Victorian Bushfires Royal Commission[3] (VBRC) following the 2009 Black Saturday bushfires in Victoria was the creation of the Fire Services Commissioner.

The Fire Services Commissioner, as the highest ranking operational firefighter in Victoria, has ultimate responsibility for managing all future major fire emergency responses. As such, the Fire Services Commissioner also has a mandate to institute the reforms necessary to overcome the challenges identified in the investigations and inquiries into recent major disasters. The core maxims of the Fire Services Commissioner's approach to emergency management are:

- emergency management — before, during and after an emergency — is about the actions of the community, local groups, the private sector, councils, government departments and emergency service agencies — whether it be to evacuate in a specific direction, inform neighbours of imminent danger, evacuate a nursing home, deploy emergency resources or protect a power station with sandbags
- every action is preceded by a decision
- every decision is made on the basis of the information available *at that instant in time.*

These maxims assert that the effectiveness of emergency management depends on the quality of the decisions made by the stakeholders in an emergency. In turn, the quality of decisions depends on the information available at the time those decisions are made, as well as on the tools for processing and understanding that information. Incomplete, inconsistent or delayed access to information, as well as an absence of tools to generate insight from that information, can be responsible for poor decisions (or no decisions) being made.

[1] Victorian Bushfires Royal Commission, Volume II: Fire Preparation, Response and Recovery, p. 374 – Available at: http://www.royalcommission.vic.gov.au/finaldocuments/volume-2/PF/VBRC_Vol2_Chapter10_PF.pdf

[2] Review of the 2010 – 2011 Flood Warnings and Response Final Report, p. 4 – Available at: http://www.floodsreview.vic.gov.au/images/stories/documents/review_20101011_flood_warnings_and_response.pdf

[3] http://www.royalcommission.vic.gov.au

OUR CORE OBJECTIVE IS TO BUILD A MORE RESILIENT COMMUNITY BY PROVIDING MORE TIMELY ACCESS TO THE INFORMATION THAT IS REQUIRED BEFORE, DURING AND AFTER AN EMERGENCY

The current set of systems and protocols in use by the emergency services has evolved over many decades and consequently reflects a view of information and communication technologies that has developed progressively over time.

The current infrastructure is built on a foundation of agency specific systems and voice communications. This has the effect of separating important information into silos. Voice based communication is largely inaccessible to computers, whereas digital information is instantly accessible and able to be shared as broadly as required.

Information sharing will be improved by increasing the amount of data that is transmitted digitally. This represents a significant opportunity to provide a more complete and consistent picture, in a more timely manner.

Our core objective is to build a more resilient community by providing more timely access to the information that is required before, during and after an emergency.

Before an emergency the community must have access to information that is tailored to their location (and the risk environment that relates to that location), to plan and prepare for an emergency.

During the emergency it is critical the community receives timely, tailored and relevant information to enable them to make informed decisions quickly. In addition to warnings the community will receive information regarding consequences associated with the emergency. Examples include information about road closures, power and telecommunications outages and evacuation routes.

After an emergency it is important that the affected community members can access information to assist them with their relief and recovery. Examples include information about supplies of drinking water, location of relief centres and details regarding financial assistance.

The result of achieving this will be a community that is properly engaged with emergencies and has an increased ability to make informed decisions about its own actions or to contribute to the emergency response. Implementing this Blueprint represents an opportunity to strengthen the community's confidence in our ability to operate as an integrated and unified team.

Rapid advances in technology, especially the emergence of the Internet as a pervasive communications medium, mean it is now possible to realise a *common operating picture*: a complete, consistent, up to date view of the process of emergency preparedness, response and recovery for all stakeholders — including the community.

Moving towards a *common operating picture* is the core enabler of an "all hazards, all agencies" approach to emergency management and is the key to building an engaged, informed community. A taskforce consisting of members of all Victorian emergency services investigated the key requirements to achieve a *common operating picture* for all stakeholders. The findings of the taskforce form a key input for this document, which aims to present a blueprint for a future information and decision support infrastructure for emergency management that fully realises the vision for a *common operating picture*.

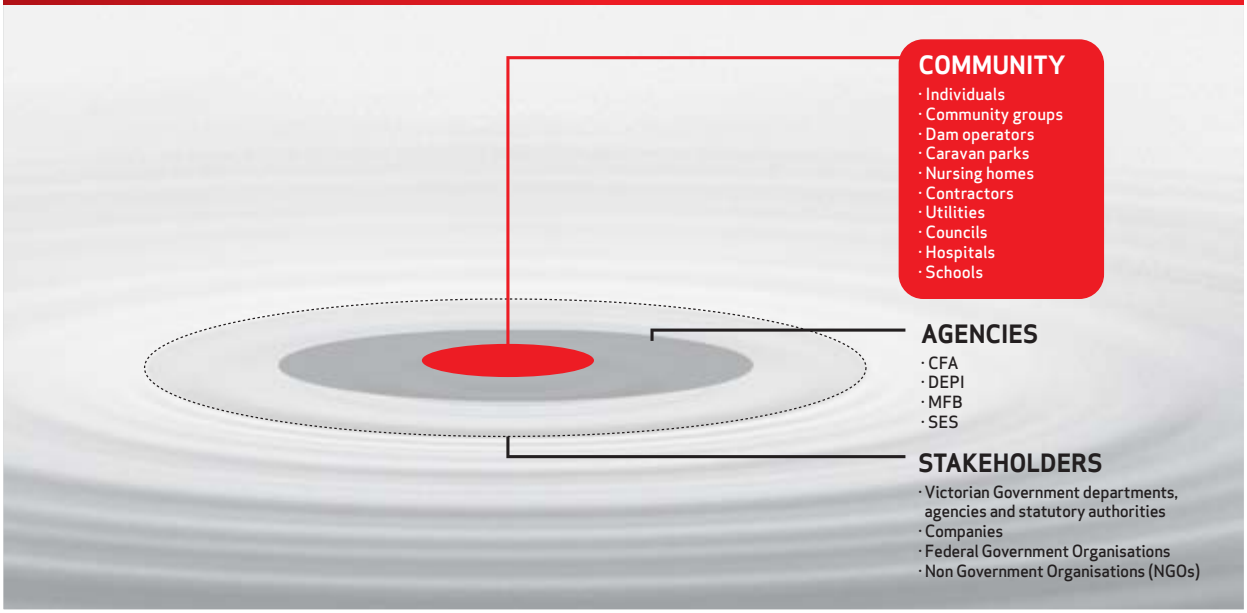
4. REIMAGINING EMERGENCY MANAGEMENT FOR THE INFORMATION AGE

The true currency of emergency management is, and has always been, information: having more or better physical assets (eg. trucks) can improve the effectiveness of an emergency response, but only when paired with good information and an effective decision making process. By contrast, good information and decision making can already be enough for an effective emergency response, especially where it concerns the key goal of preserving human life.

The past decades have seen a transformation in the way information is gathered, processed and shared. This has been driven by the rise of the Internet and high speed and wireless telecommunications, as well as by increasingly powerful, ubiquitous and portable computing devices. In what is often referred to as the Information Age, the gathering, management and processing of information has become central to most spheres of human endeavour. The Information Age represents both an enormous challenge in terms of managing the deluge of information that has become available, as well as an opportunity to use these new sources of information and tools to radically improve processes, decision making and community engagement.

There needs to be a fundamental change to how information is managed and used: in the Information Age it, and the tools to exploit it, must be placed at the very core of the entire emergency management process. There now exists the capability and, therefore, the responsibility to ensure that all stakeholders in an emergency have access to the best and most complete information available at any given moment and, as a corollary, that they all have access to the same information. This information-centric emergency management architecture is key to realising the vision of a common operating picture, and though getting there is a significant undertaking, it has the potential to revolutionise the way emergencies are managed.

Figure 1. *Community is at the centre.*



THE COMMUNITY IS THE KEY STAKEHOLDER IN ANY EMERGENCY OR DISASTER SITUATION. THIS IMPLIES THAT THE VARIOUS AGENCIES, BODIES AND DEPARTMENTS THAT ARE INVOLVED IN THE MANAGEMENT OF AN EMERGENCY DO SO IN ORDER TO SERVE THE COMMUNITY.

Facilitating an open flow of information before, during and after an emergency also works to place the community at the centre of the response in a way that previously has not been possible. It is imperative to acknowledge that the community in all its forms — individuals, volunteer organisations, small business owners, local government — is the key stakeholder in any emergency. In the past, technological limitations severely restricted the degree to which community members could be actively involved in an emergency response. Now, in the Information Age, this is no longer the case: community members must be central, both in terms of using their capabilities and keeping them fully informed throughout the emergency management process *(Figure 1)*.

If one accepts that improvements to equipment and physical capabilities (for example, in terms of trucks, aerial capacity and agency personnel) will only be incremental in the future, the ability of information processing to improve the quality of decision making represents the best opportunity for making large improvements in the effectiveness of emergency management. Participating in and engaging with innovation that is ongoing in this area has the potential to lead to radical improvements to the outcomes of emergency situations.

The following sections describe the desirable attributes of emergency management information and decision support system (illustrated in *Figure 2*).

4.1 Engaged with the Community

The community is the key stakeholder in any emergency or disaster situation. This implies that the various agencies, bodies and departments that are involved in the management of an emergency do so in order to serve the community. However, positioning the community as the central stakeholder in any emergency also means that it must be actively involved in the management of that emergency. The community must be kept properly informed about the emergency and their considerable knowledge, expertise, information gathering and communication capabilities must be

Figure 2. *Desirable attributes for information interoperability and decision support systems for emergency management.*

engaged in formulating the best possible plans for emergency preparedness, response and recovery. Important questions in emergency management are:

- How do we effectively get the necessary information to the key stakeholders before, during and after an emergency?
- How do we leverage the knowledge, information and communication network that already exists within the community?

THE MEDIA PLAY AN IMPORTANT ROLE AS BOTH AN AGGREGATOR OF INFORMATION FROM, AND DISSEMINATOR OF INFORMATION TO, THE COMMUNITY.

A shift towards an open and information-centric emergency management approach is the key to engaging the community. The VBRC and other inquiries in Australia and overseas highlighted the crucial role that easily accessible community information plays in effective emergency management. Since Black Saturday, issuing advice to the community has been enshrined in legislation as being the responsibility of emergency services. However, to simply be more vigilant about issuing the types of broad and untargeted alerts that are in common use today is to miss an opportunity to engage the community at a much deeper level. Communities would be best served by having timely[4], relevant[5] and tailored[6] information delivered to them across a variety of platforms. With modern technology, it is possible to ensure that people are able to access up to date information using any available medium and that they can take advantage of the unique capabilities of each medium. Whether it is media broadcast, fixed line telephone, SMS, website, social media, smartphone applications, door knocks, face to face and beyond, an information-centric emergency management platform would be able to deliver more and better information and advice to communities affected by an emergency.

ADVANCES IN TECHNOLOGY ALSO MAKE IT POSSIBLE TO MORE EFFECTIVELY GATHER VALUABLE INFORMATION FROM THE COMMUNITY.

The media play an important role as both an aggregator of information from, and disseminator of information to, the community. The media's involvement is integral to the effectiveness of any information platform. The media often obtains a clearer picture of the "true situation" during emergencies via calls, text messages and other feeds from the community; this additional intelligence must be made available to all stakeholders. Victoria's emergency broadcasters and media more generally are also relied upon for community warnings, especially in those areas or times where there is limited access to other people and technology. For example, during power blackouts, some people may only have access to a battery powered radio and media broadcasts will be the sole source of regularly updated information.

Advances in technology also make it possible to more effectively gather valuable information from the community. In an emergency, community members use all types of media available to them in order to share information with others. All this information needs to be captured and assimilated into the *common operating picture*. Doing so is key to engaging the capabilities of the community for emergency management, to fostering greater resourcefulness and self sufficiency of the community and to building a greater level of engagement and trust between the community and emergency management agencies.

4.2 Resilient

Resilience is a characteristic of any system that describes its ability to continue to operate in the face of disruptions, changes, interruptions and attacks (Hollnagel, Woods and Leveson 2006). A resilient system is one that can absorb a degree of damage, adapt to changed circumstances and does not fail catastrophically under any circumstances but rather degrades gracefully under stress. For example, dams typically employ sluices to control runoff during a flood *(Figure 3)*. This does some damage, but prevents a much more catastrophic uncontrolled discharge that may occur if the dam exceeds its capacity. It goes without saying that resilience is a very important characteristic of any future emergency management system.

[4] Community warnings and advice messages must be issued as a priority in the shortest time practicable.

[5] Community warnings and advice messages must include clear language and contain explicit information in relation to severity, location, predicted direction and likely impact of emergencies on communities.

[6] Wherever possible, local knowledge must be utilised to ensure that the community warnings and advice messages relate to the local community's general understanding of their district, with specific reference to local landmarks, names and recognisable features.

TABLE 1 - PRINCIPLES TO ENSURE RESILIENCE OF AN EMERGENCY MANAGEMENT INFORMATION SYSTEM:	
Diversity	A system that is insufficiently diverse is vulnerable to collapse because all the components of the system might have common weaknesses and could be disrupted by the same event. When designing an emergency management system it is important to allow for a diversity of infrastructure and communication channels to prevent a single failure cascading through the whole system. In order to manage diversity within a system, well defined standards for interchange and communication must be defined to ensure interoperability.
Redundancy	Redundancy means that any critical role within the system can be fulfilled by more than one component of that system, so that a failure of any one component in the system will still leave the system in a functional state. Creating redundancy in a system often competes with the goal of minimising cost, so a reasoned trade off between these two goals must be identified, taking into account the use of the system and the consequences of its partial or complete failure.
Adaptability	The circumstances under which a system operates are likely to be subject to both short term fluctuations and long term changes. For example, external temperatures can vary from hour to hour (weather), month to month (seasons) and decade to decade (climate change). A system that makes too many assumptions about its environment is likely to fail when forced to operate under changed conditions. A resilient system must be adaptable in terms of coping with a range of expected and unexpected operating conditions. Furthermore, it should be structured in such a way that it can easily be modified to account for long term changes to operating conditions.
Graceful degradation	Graceful degradation of a component or system means that it minimises the impact of any failure (Anton, et al. 2004). It comprises a variety of techniques, including load shedding, redundancy, fail safety and reversion to local control. A principle to consider when designing systems for graceful degradation is to focus on ends, not means. For example, a system that describes what communication needs to take place but does not dictate the exact medium, is focusing on the end (effective communication) rather than the means (a specific technology) and is thus less vulnerable: if the mobile network is down, it can just switch to satellite, or radio, or any other appropriate technology.
Seamless reintegration	When a resource that has previously been unavailable becomes once more available, or a stress has been removed from the system, it should be able to go back to a fully functional state of operation. An important consideration when designing a resilient system is the ability of that system to "heal itself" as quickly as possible so it can bounce back from a degraded state and be ready for whatever challenge comes next. This property is known as seamless reintegration (Paton and Johnston 2006).
Integral	Part of the philosophy behind resilient systems is that the resilience is a process that is always present in design and in operation. This means that a resilient system should not switch between "business as usual" and "red alert" but should instead embody the principles of resilience outlined above. The problem with having a "special emergency mode" is that exactly those processes and procedures that will be put under the most stress (the ones operating in red alert) are the ones that will see the least use.

Figure 3. *Dam sluices are an example of graceful degradation and seamless reintegration of a system under stress.*

ATTEMPTING TO CONTROL ACCESS TO EMERGENCY INFORMATION IS ULTIMATELY COUNTERPRODUCTIVE, AS IT SERVES ONLY TO FRAGMENT THE *COMMON OPERATING PICTURE* AND DENY THE COMMUNITY ACCESS TO THE HIGHEST QUALITY INFORMATION, FORCING IT TO RELY ON ALTERNATIVE SOURCES.

An excellent example of a resilient system is the Internet itself. Initially commissioned by DARPA[7] in the USA as a communication network that could withstand disruption by nuclear war, the Internet was designed from the ground up according to the principles of resilience. It is diverse (many types of different but interoperable servers and networks), redundant (multiple paths between any two points on the network), adaptable (many technological changes have been absorbed since the 1970s), integral (all of the above characteristics are just "business as usual"), and it degrades gracefully and reintegrates seamlessly (servers can go down and come back up without any major disruption). For these reasons, the Internet should serve as a model of resilience for emergency management systems and where possible be used as a component in order to take advantage of its resilience.

4.3 Open

Present day emergency management attempts to control the flow of information to the community. The principle is that there needs to be an authoritative version of the truth that has been vetted and cross checked and that is absolutely trustworthy, to prevent the spread of rumour, misinformation and panic through the community. It is tempting to try to manage the community's behaviour (especially during an emergency) by managing the flow of information.

This approach has become increasingly difficult to sustain, however. Mobile telecommunications and Internet access, combined with social media services such as Twitter and Facebook as well as third party information sharing services, mean that community members are already informing themselves about emergencies through diverse sources and are already making individual response decisions based on this information.

[7] The US Defence Advanced Research Projects Agency, http://www.darpa.mil/

INNOVATIONS BUILT ON A FOUNDATION OF DATA HAVE THE POTENTIAL TO GREATLY IMPROVE THE PRACTICE OF EMERGENCY MANAGEMENT.

Attempting to control access to emergency information is ultimately counterproductive, as it serves only to fragment the *common operating picture* and deny the community access to the highest quality information, forcing it to rely on alternative sources. It is already apparent that members of the community will make their own decisions during an emergency, based on the best information available to them at the time. During the March 2012 major flood event in Nathalia in Northern Victoria, an evacuation order issued by the Victoria State Emergency Service was ignored by an estimated 90 per cent of residents who made the decision to stay in town and protect their property[8]. Presumably, these residents must have made this decision based on information from sources not under the control of emergency services. Sharing information more openly in this situation may have engaged the community more directly and led to an increased level of trust.

Rather than seeing this information transformation as a challenge, it should instead be viewed as an opportunity to serve the community better by providing an open information infrastructure for emergencies. Indeed, the outcome of the Victorian *Common Operating Picture (COP)* project conducted from October to December 2011 clearly showed that the community needs essentially the same information that is required by emergency services personnel.

In the context of an information platform, openness can be characterised as providing the general public with a standardised set of tools that allows users to access, contribute and manipulate information contained in the system (within defined boundaries); and encouraging the development of a third party "ecosystem" on top of the information platform (Adam, et al. 2010). The strategy of opening up a platform to third party information is one that is commonly used by consumer oriented online services, often with great success. Some examples of open information ecosystems are Facebook, Google Maps and Amazon. By relinquishing a degree of control and providing access to the information contained within their system, and by encouraging third parties to make innovative use of this information, all these products cemented their place as the central platform for a certain type of information. For an emergency management system to have access to a single, unified, standards based platform that can provide all the information relevant to managing an emergency is a key element in building a *common operating picture*.

Despite what may be perceived as a loss of control during the transition to such an open system, full engagement with the system by the emergency services is likely to lead to their advisory messages having a greater impact on the community than at present. This is because emergency services information will become part of the community's *common operating picture*, rather than the community turning to alternative information sources for their information source. This full community engagement was seen as a key requirement by the 2010 – 2011 Victorian Floods Review.

4.4 Platform for Innovation

Providing unified access to all information pertinent to emergency management presents a valuable opportunity to derive new linkages and insights from that data. Many tools and techniques exist (and more are being developed) to mine valuable insights from data on a large scale, as well as to model, forecast, and optimise based on that data. The potential for using such tools to enhance insight and support better decision making for emergency management is immense. Fire and flood spread forecasting models are an example of data analysis tools. Other possibilities are tools that can analyse whether a series of fires may be deliberately lit and where the firebug may strike next, identify fire blackspots or help devise a recovery plan that restores services to residents in the most efficient possible way.

Innovations built on a foundation of data have the potential to greatly improve the practice of emergency management.

[8] 2012 North East Victoria Flood Review, Office of the Emergency Services Commissioner

As such, any future information platform for emergency management should be built to enable and encourage innovative use of the information it holds. Openness, as discussed in *Section 4.3*, is an important aspect of fostering innovation. Furthermore, the platform should also be designed with rich, standards based Application Programming Interfaces (APIs) that allow easy extraction and manipulation of data for research purposes. Finally, a culture of cooperation and engagement between the administrators of the platform and researchers and businesses will be necessary to create a robust ecosystem of innovators.

4.5 Mobile & Multimedia Capable

As discussed in earlier sections, the proliferation of personal devices such as smartphones presents a number of opportunities to enhance emergency management.

One opportunity is to use these devices in gathering data. Every person with a smartphone can use it to collect and transmit a broad array of information about their environment. One can imagine emergency services personnel using a smartphone — with or without customised accessories — to transmit time stamped location, audio and visual information about the emergency site, temperature, wind information and other data. At the same time, members of the community could similarly contribute location and multimedia information that, when aggregated, would potentially provide valuable intelligence on matters such as traffic density and flood extent. Combining all this data with innovative information processing and decision support techniques has the potential to enable superior emergency response decisions to be made at critical times.

Another opportunity of fully embracing mobile technologies is that many aspects of operations can be managed in the field rather than at a centralised operations centre. This has a number of advantages: personnel would be able to get a much more complete picture of operations and make better decisions in the field; and the central operations centre would be liberated from some of its decision making responsibilities in order to focus on broader strategic decisions in managing an emergency. Furthermore, delegating operational decisions to the field would increase the overall resilience of the system: field operations would depend less on having contact with a central operations centre than they do at present.

Mobile and multimedia technology have high potential to achieve a deeper level of engagement with the community. Current ways of engaging with the community during an emergency tend to be focused on broadcast (radio, television, SMS, email), while online information is limited and dispersed across multiple websites, discouraging use. Taking full advantage of mobile and multimedia technology alongside a sophisticated information platform would allow for members of the community to receive timely, relevant and tailored information that would enable them to make well informed decisions and act in a rational way. For example, a smartphone application or website could present a map of fires near a person's current location, models of the fire spread, current road and traffic conditions, locations of nearby shelters and other resources, relevant reports from other community members on Twitter, videos and aerial infrared (that can see through smoke) photos of the fire front. A person using this application could then make a decision based on sophisticated tools and the best, most relevant information that is available at the time.

MOBILE AND MULTIMEDIA TECHNOLOGY HAVE HIGH POTENTIAL TO ACHIEVE A DEEPER LEVEL OF ENGAGEMENT WITH THE COMMUNITY.

4.6 Holistic

Effective preparation for, management of, and recovery from a disaster requires that information be shared through all stages of the process. For example, in order to provide rapid compensation for victims of property loss in a disaster, it is important to know which properties have been destroyed. It is quite likely that much information relevant to making such an assessment would have already been gathered during the emergency response stage of the disaster. Similarly, knowing what preparations have been put in place by the community during the planning stage may provide valuable input to the decision making process during emergency response. The best way to facilitate a *common operating picture* throughout the stages of emergency management is to ensure that the same information architecture is used throughout.

One of the principles of resilient systems is that emergencies should be handled as part of the standard operating procedure for the system, rather than by invoking "special" emergency conditions. What this means in the context of emergency management is that, as much as possible, the same systems and procedures should be used during all phases of emergency management, from preparation and risk minimisation and training through to response and finally recovery. As well as helping preserve the *common operating picture* through time, this leads to greater resilience because the capabilities of a system will already be proved prior to a true emergency taking place and the people operating the system during the emergency response will already be familiar with how it works through regular use in less demanding situations.

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5. THE WAY FORWARD – THE VICTORIAN INFORMATION NETWORK FOR EMERGENCIES (VINE)

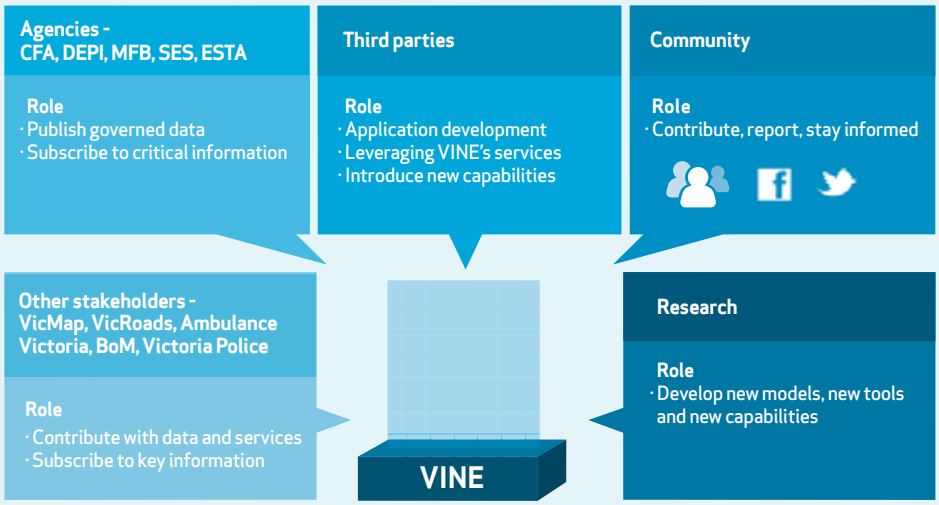
VINE is proposed as a services based, unified information interoperability and decision support platform for Emergency Management in Victoria. VINE embodies the principles described in the previous sections by providing a resilient and open platform for sharing information between all stakeholders, engaging with the community and fostering innovation. VINE will support a diverse ecosystem of users and applications, as illustrated in *Figure 4*, and will be engineered so that the many different parts of the ecosystem will enrich and strengthen each other.

Some of the key benefits enabled by VINE are:

- an "all hazards, all agencies" operational approach to emergency management, before, during and after an emergency
- a fully informed and engaged community, empowered to make better decisions and be more resilient
- the ability to rapidly assimilate innovations in modelling, predictions, visualisation and decision support
- business process reform across the agencies
- further development of existing agency systems in a way that provides the maximum benefit to the State.

VINE will place Victoria at the leading edge of emergency management worldwide, improving outcomes, sparking innovation and potentially serving as a model of best practice to other states and countries.

Figure 4. *VINE and its relationship with stakeholders.*



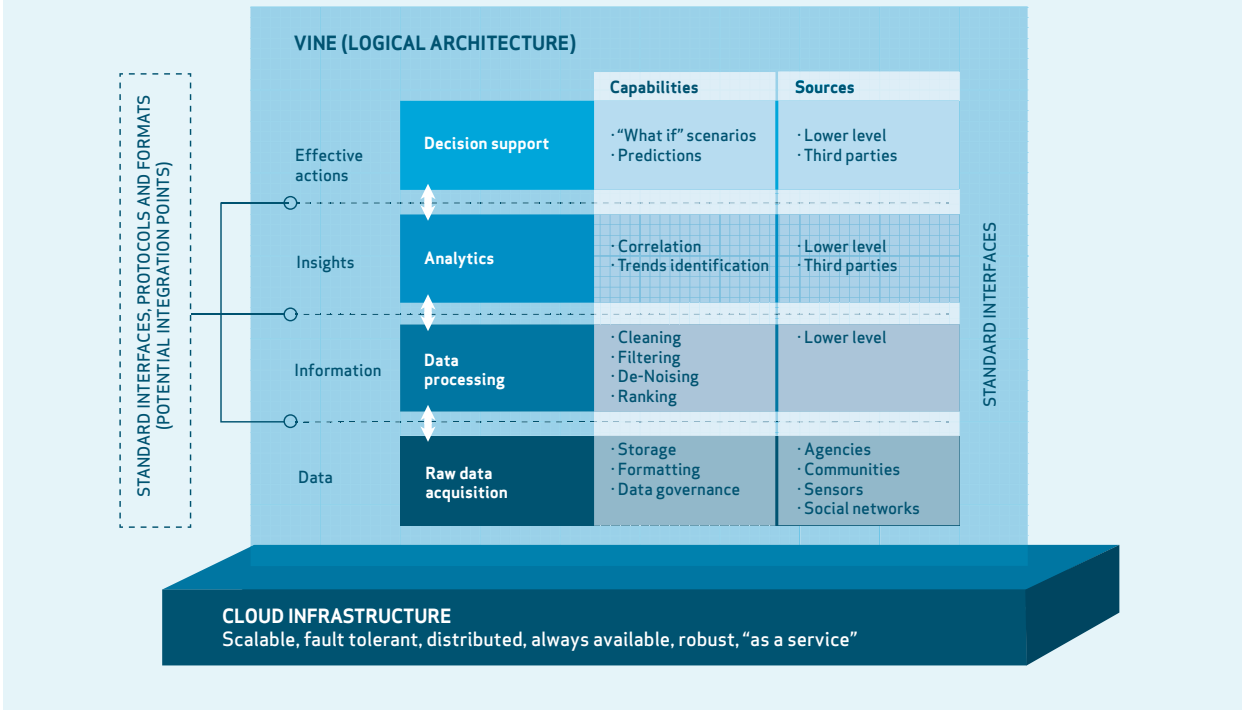
5.1 VINE High Level Architecture & Requirements

As a comprehensive platform for information interoperability and decision support, VINE must manage and process a diverse and abundant range of information. *Figure 5* identifies the conceptual model and the logical stack of capabilities that will enable VINE to deliver relevant, tailored and timely information and, ultimately, better outcomes for the State.

At the lowest level, VINE will require a scalable, elastic, robust and fault tolerant infrastructure. As a platform serving the changing needs of emergency management in Victoria, the platform must remain flexible at all levels — starting with infrastructure. The ability to dynamically repurpose physical assets and to shape the underlying environment on demand are two characteristics that VINE will build upon to provision the required support for processes informing decision making. A modular design and the capability to incrementally grow over time are also important. Together with standards, these are critical to allowing VINE to power an ecosystem of applications and tools supporting emergency management. Cloud technology and virtualisation are good candidates for VINE's infrastructure, as cloud computing exhibits most of the characteristics expressed above.

Another important requirement for VINE is the ability to access and ingest a large variety of data.

Figure 5. *Conceptual model of VINE and stacked logical capabilities required before, during, and after emergencies.*



ESSENTIALLY, ANYTHING CONSIDERED RELEVANT TO EMERGENCY MANAGEMENT SHOULD BE AVAILABLE IN OR ACCESSIBLE FROM VINE. THIS WILL ENABLE THE PLATFORM TO BECOME THE INFORMATION BACKBONE FOR ALL AGENCIES, BREAKING DOWN THE BARRIERS BETWEEN THEIR EXISTING INFORMATION SILOS

Decisions are based on available information and information is assimilated from data. Since VINE targets the entire lifecycle of emergencies, the relevant sources of data become even more numerous and heterogeneous. A non exhaustive list of data of interest that enable the operations of VINE includes:

- incident reports
- map data
- public building plans and dangerous goods information
- resource location and availability (including private sector resources)
- weather forecasts and current weather information
- data from sensor networks
- personnel data: role, responsibility, location, contact information
- *ad hoc* sensor data from personnel and the general public
- traffic information
- data from social media
- CCTV, audio visual data from the field and from the public
- fuel models
- river level measurements.

Essentially, anything considered relevant to emergency management should be available in or accessible from VINE. This will enable the platform to become the information backbone for all agencies, breaking down the barriers between their existing information silos, facilitating real time sharing of key information and delivering effective situational awareness for the entire community.

The answer to any question about where to access some piece of information about an emergency should be "it's in VINE".

A unified data backbone is the fundamental block for building the vision outlined above, but more is needed to turn data into information and then actionable intelligence.

BUILDING VINE'S CAPABILITIES IS AN ENDEAVOUR BEST SHARED BETWEEN MANY EXPERTS AND SPECIALISTS, WHETHER THEY WORK WITHIN THE EMERGENCY SERVICES OR FOR RESEARCH INSTITUTIONS AND THIRD PARTY ORGANISATIONS; THIS IS WHY IT IS ESSENTIAL THAT VINE BE BUILT AS AN ECOSYSTEM

To achieve this, VINE will require extensive analytics capabilities that can be dynamically configured according to the requirements of the present emergencies. Since VINE will deal with a variety of data types, a diverse range of analytical tools will be required: from standard analytical packages for relational data to more advanced capabilities for extracting insights from unstructured and uncertain data sources or very large datasets. The analytics capabilities are not only limited to processing and filtering data, but will include tools for modelling and simulation, forecasting, optimisation and visualisation. This will help to deliver a comprehensive toolkit to support decision making. Examples of some of the capabilities discussed here include:

- classical data analytics (relational and other structured forms)
- statistical modelling for a variety of data sources
- weather and other natural phenomena modelling (fire, floods, storms)
- model simulation (traffic, behavioural modelling)
- scenario modelling ("what if" modelling, exploration of alternatives, scenario comparison)
- social media analytics.

A variety of operational services will complement the powerful analytics characterising VINE. These will include, for example, workflow enactment and tracking, publication of alerts and notification and complete support for a unified incident management system.

Building the capabilities described above is an endeavour best shared between many experts and specialists, whether they work within the emergency services or for research institutions and third party organisations; this is why it is essential that VINE be built as an ecosystem. The development of standardised interfaces, protocols, formats and unified representations is what will facilitate the integration and assimilation of third party tools and models that will enrich the capabilities of VINE. As shown in *Figure 5*, the use of standards is a requirement that permeates the entire stack of VINE and will also prevent a project with such great breadth to be compromised by proprietary technology and formats.

5.1.1 A Resilient Cloud Based Model

VINE will be built from the ground up in accordance with the principles of resilience, and for maximum speed and scalability. The core architecture of VINE will be based on the cloud computing paradigm. Cloud computing (Armbrust, et al. 2010) is a very broad term, but fundamentally it is a view of computing infrastructure as a service or utility, rather than as collection of discrete physical assets maintained at a fixed location. With cloud computing, a layer of separation is introduced between software and the hardware on which it runs. This simplifies the relocation of software applications and systems to different physical computing assets.

Investment management to achieve the best outcome is an important goal of cloud computing. Breaking the link between computation and the physical host turns data centres into aggregations of easily replaceable, largely uniform hardware. In the cloud computing paradigm, all software runs on top of the same shared pool of computing resources, rather than each having their own exclusive server or set of servers, which are possibly of a different type from the servers used by other software. This allows more efficient use of hardware, simpler procurement and reduced deployment and maintenance costs.

Cloud computing is also ideally suited to the building of resilient systems. Abstracting software services from physical hardware reduces dependency on particular physical computers, reducing single points of failure and performance bottlenecks. For example, if a critical database is hosted on a particular physical server and that server fails, the system as a whole may subsequently fail. Configuring a new server to the desired configuration for hosting the database may take days or even weeks, making recovery slow and error prone. Contrast this with a cloud based database distributed across multiple identical servers, potentially in multiple locations. Even if one of the servers fails, cloud computing makes it easy to transfer its state to a different machine, because machines are simply generic resources. Furthermore, if there is a sudden spike in requests (for example, due to a major emergency), then it is relatively easy to add more servers to the distributed database.

This property *of scalability* is of particular importance for emergency management systems such as VINE, which are likely to be put under most strain precisely at the time when they are most necessary.

Multiscale redundancy is easy to implement in a cloud computing environment. As there is nothing to tie cloud computing software to specific machines or locations, it is easy to run the same software in the same configuration across multiple physical machines. This mitigates the damage caused by the failure of particular computer systems in a cloud environment, but the failure of entire locations can be handled nearly as easily. For the purposes of resilience, VINE will be redundantly served from two or more locations. This way, a catastrophic failure at a particular site (such as a power outage or network disconnection) will not take VINE down. The necessary cost of making VINE a robust and redundant system will be more than paid for by savings realised in transitioning from a number of individually managed silos to an easier to administer and computationally more efficient combined cloud. This translates to a better investment for the State.

Cloud computing, with its tendency to abstract implementation and geography, works very well when paired with the Internet. The Internet is a resilient and open network platform with global reach. Using the Internet as the primary means for interacting with VINE makes it unimportant precisely where VINE is located, while at the same time making it easy for VINE to be accessed by the widest range of devices and in the widest range of locations. For these reasons, VINE will be built from the outset to capitalise on the Internet's capabilities and to provide a rich set of services that can be accessed over the Internet.

Deployment of a "private cloud" infrastructure (Smoot 2011) is envisaged as part of the rollout of VINE. A private cloud is a system that adheres to the principles of cloud computing (computing power as a utility) but where all infrastructure is fully controlled by the entity, or entities, consuming the resource. This approach provides the benefits of a cloud solution while the full ownership and control enables adherence to best practices in data location, physical security, software platform security and compliance.

THIS PROPERTY OF SCALABILITY IS OF PARTICULAR IMPORTANCE FOR EMERGENCY MANAGEMENT SYSTEMS SUCH AS VINE, WHICH ARE LIKELY TO BE PUT UNDER MOST STRAIN PRECISELY AT THE TIME WHEN THEY ARE MOST NECESSARY.

VINE WILL PROVIDE A PUBLISH/SUBSCRIBE (PUBSUB) SERVICE (EUGSTER, ET AL. 2003). THIS SERVICE WILL ALLOW STAKEHOLDERS TO SUBSCRIBE TO TOPICS OF INTEREST TO THEM (TOTAL FIRE BANS IN THEIR LOCAL AREA, FOR EXAMPLE) AND TO INSTANTLY RECEIVE UPDATES RELATING TO THAT TOPIC FROM ANY INTERNET CONNECTED DEVICE

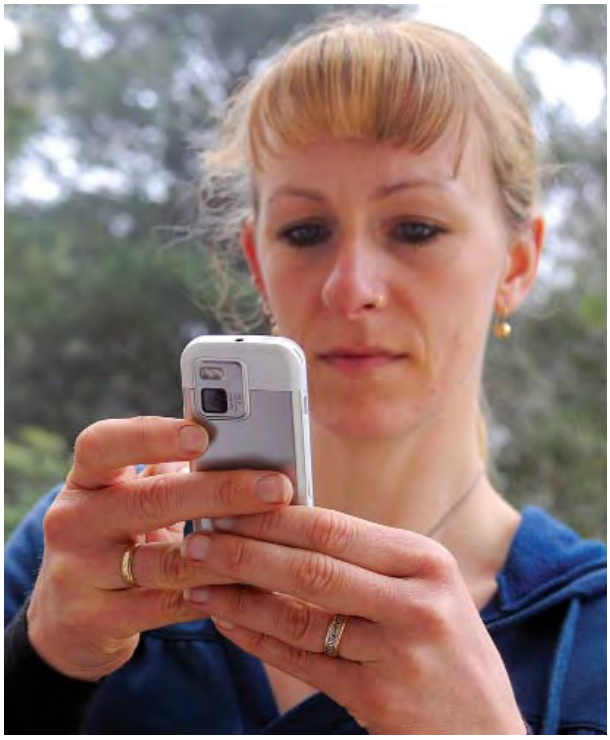
5.1.2 Open Data and Role Based Access Control

Providing access to the data and tools within VINE allows the community for the first time to engage deeply with the process of emergency management. Information contributed by the community about plans, incidents, conditions and more can be used to improve preparation, response and recovery. At the same time, individual communities can build tools that use the data in VINE to help their constituencies stay better informed and make better decisions.

VINE will be a driver of innovation in Victoria. Open access to a world class repository of data will allow researchers to build new analytics and decision support tools (new fire prediction models, for example). They will also have the means to contribute their work back into the system, allowing emergency services to leverage cutting edge innovations — as they become available — to enhance their ability to manage emergencies. The level of mutual access between researchers and emergency services afforded by VINE could make Victoria one of the best places in the world to conduct research into emergency management.

Open access to data in VINE over the Internet as well as traditional channels will turn it from a system into an ecosystem. Stakeholders, businesses and researchers will all be able to build applications using VINE's data repository and toolkit, tailoring information to their needs, innovating, and enriching each other and the system in the process.

In order to realise the goal of fostering an ecosystem, VINE must provide powerful data storage and transport mechanisms, as well as ways to locate, query, manage, submit and receive data. VINE's data store will consist of a number of modules for storing and querying different types of data, with strong geospatial capabilities to support the location based dynamics of emergency management. In order to ensure that information about events reaches all interested stakeholders in near real time, VINE will provide a publish/subscribe (PubSub) service (Eugster, et al. 2003). This service will allow stakeholders to subscribe to topics of interest to them (total fire bans in their local area, for example) and to instantly receive updates relating to that topic from any Internet connected device.



It is essential for the utility of VINE that sharing of data within the system is *loosely coupled:* that is, that there need be no relationship or direct transaction between a contributor of data and its consumers; all interactions are mediated through VINE. This will obviate the need for the types of special bilateral arrangements currently in place to share certain data, which are inefficient, slow and exclude the community as well as many other stakeholders. The PubSub model for event data sharing is loosely coupled by definition; for the data store, it is essential that an appropriate data custodianship and access model be put in place and that there be sufficient metadata in the system, to enable any stakeholder to consume data to which they have access without having to interact with its producer.

ROLE BASED ACCESS CONTROL MEANS THAT ACCESS TO DATA CAN BE DEFINED BY THE ROLE A PERSON IS CURRENTLY ENACTING, RATHER THAN THEIR ACTUAL IDENTITY. THIS MAKES IT EASY, FOR EXAMPLE, WHEN HANDING OVER DUTIES FROM ONE PERSON TO ANOTHER FOR THE NEW PERSON TO INSTANTLY HAVE ACCESS TO THE VIEW OF THE SITUATION THAT THEY NEED TO FULFIL THEIR NEW DUTY

Although making information publicly available by default is important in realising the vision of a *common operating picture*, there is a clear need to control or restrict access to certain sensitive information, as well as to limit write access to many of the data streams. As such, VINE will have a sophisticated authentication and access control system built in. The goals of this system will be:

- fast, highly available, standards based authentication
- non password and multifactor authentication options, for example, certificate based authentication for devices
- authentication possible from any device
- easy revocation of authentication credentials
- role based access control to all data in the system
- a sophisticated management interface and protocols to allow easy role assignment and handoff to users in the system.

Role based access control means that access to data can be defined by the role a person is currently enacting, rather than their actual identity. This makes it easy, for example, when handing over duties from one person to another for the new person to instantly have access to the view of the situation that they need to fulfil their new duty.

As with any system that aggregates large quantities of data about people and places, privacy within VINE is a pivotal concern. As such, the following safeguards will be designed into the system from the beginning:

- a comprehensive privacy policy, specifying how data in the system will be used and handled
- encryption both for data at rest (disk encryption) and data in transit across the Internet (SSL[9] connections for any sensitive information)
- per field access control allowing personally identifying information to be blanked out while other useful data remains openly available
- data aggregation capabilities allowing certain types of data to be accessed from the system only in aggregated form, where personal identification will no longer be possible
- full data lifecycle management, including strict policies on data disposal
- simple console interface allowing any individual to view and manage all private information concerning them on the system.

5.1.3 Workflow Management and Role Tracking

VINE will allow tools to be built that automatically filter, process and analyse data in a way that supports far more informed decision making than is possible today. At the same time, though, human judgment will still be critical in evaluating and classifying information. It is recognised that many types of information (for example, fire spread forecasts) may need to be assessed for veracity and plausibility by experienced personnel prior to being published and acted upon.

For this reason, VINE will incorporate workflow capabilities that can be used to employ the skills of appropriate experts in classifying and verifying information as it comes into the system. The key characteristics of this system are:

- detailed registers of the role, skills and expertise of personnel for the purposes of data assessment
- a workflow specification utility where the manual processing steps for particular types of information can be defined, including actions to be taken in cases of timeouts or if qualified personnel are not available
- a workflow engine, well integrated with VINE's information architecture, that applies the workflow specifications to incoming data
- detailed, persistent record keeping for workflow actions to enable full audit of the process at any time
- dynamic reconfiguration allowing both the role and expertise information and the workflow specifications to be changed at any time, with the changes reflected immediately in the execution of the workflow

[9] SSL stands for Secure Socket Layer, and is the standard way for safely encrypting information transmitted across the network (Internet Engineering Task Force 2011).

FOR THIS REASON, VINE WILL INCORPORATE WORKFLOW CAPABILITIES THAT CAN BE USED TO EMPLOY THE SKILLS OF APPROPRIATE EXPERTS IN CLASSIFYING AND VERIFYING INFORMATION AS IT COMES INTO THE SYSTEM

- broad availability of workflow interaction tools: it should be possible for authenticated personnel to perform the workflow tasks (verification, classification) from any Internet connected device.

This last point is particularly important given that appropriately qualified personnel tend to be a rare and valuable resource: they should be able to participate in the workflow task whether they are at a control centre, at home, in the field, or even if they are interstate or overseas.

Proper management of user identity is implicit in the implementation of such a workflow system, as well as the role based access control described in *Section 5.1.2*.

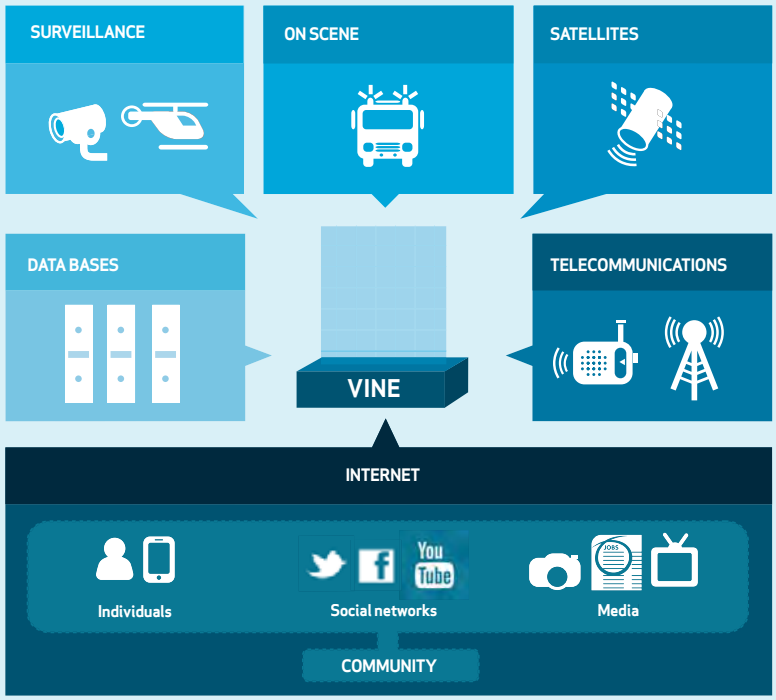
For these reasons, VINE will need to incorporate an authentication and identity management system that spans across all relevant services and agencies as well as the community.

5.1.4 Near Real Time Data Processing

By its very nature, emergency response is a real time process. All parties involved need to make effective decisions while working from incomplete data about a fluid, rapidly changing situation. In an emergency, it is not possible to wait until all the data comes in, reflect on it as a whole and only then make a decision.

Every aspect of VINE will be engineered to minimise delays in information transmission, processing and delivery. This encompasses many aspects of the system discussed in earlier sections, including a fast and responsive cloud based system infrastructure, high speed multichannel network connectivity and a PubSub model for event data that allows all stakeholders to access data from many parties as soon as it becomes available.

Figure 6. *Possible data sources of VINE*



BY ITS VERY NATURE, EMERGENCY RESPONSE IS A REAL TIME PROCESS. ALL PARTIES INVOLVED NEED TO MAKE EFFECTIVE DECISIONS WHILE WORKING FROM INCOMPLETE DATA ABOUT A FLUID, RAPIDLY CHANGING SITUATION.

VINE will require the ability to deal with imperfect or irrelevant data during an emergency, as well as to distinguish between what is essential and what is peripheral. For example, voice calls and messages received by the media could be appropriately classified by importance as they are streamed into VINE. Data that pertains to an irrelevant location may be filtered out, while the most important information can be reviewed directly by key decision makers.

5.1.5 Standards Based Data Engineering and Data Governance

VINE is intended to connect and provide open access to the many sources of data and information that are critical to the optimal management of an emergency (see *Figure 6*). However, simple aggregation of data is not enough to achieve the goal of information interoperability. No matter how good the tools are, effective communication cannot take place if everybody is speaking a different language. The vision of a *common operating picture* for all stakeholders can only be realised if everybody can understand the information being deposited in the system by others. Therefore, as part of developing VINE, it is critical to establish an agreed set of standards for data representation, as well as a process for verifying compliance with these standards.

The data standard will consist of a set of specifications for storing structured data, as well as an ontology describing the meaning and relationships between the data that is being represented in the standard (Gruber 1993).

In building a standard for data representation, VINE will, as much possible as possible, take advantage of existing standards.

This can range from the underlying structured data format such as XML[10], JSON[11], or MessagePack[12] through to established semantic representations for the emergency management domain such as the Common Alerting Protocol (CAP). The advantage of building on established standards is twofold: firstly, it will save effort both in terms of development time and in terms of capitalising on familiarity with existing protocols; and secondly, it will increase the interoperability with systems outside VINE, allowing information and innovation to be shared with other existing systems.

Below is a sample — far from complete — of the types of questions that need to be concretely answered when establishing the standards for information representation in VINE:

- What information might need to be represented when reporting an incident?
- Which information is necessary and which is optional?
- How complete is the data currently captured by various stakeholders?
- How do we represent locations: street address, or via coordinates? What do we do if only one is available?
- What do we mean when we say the temperature is 27 degrees at a particular location?
- How do we represent time?
- What format do we use to represent grid based geographical data?
- How do we identify that two items in the system are referring to the same incident or resource?
- How do we communicate that an earlier report in the system was inaccurate?

[10] http://www.w3.org/TR/REC-xml/

[11] http://json.org

[12] http://msgpack.org

In order to develop a data representation standard that satisfactorily answers these questions (and many more like them), it will be necessary to engage in a consultative process with the core stakeholders of the system. This will facilitate the discovery of a suitable data structure based on the stakeholder needs and ways in which data is used. The ideal data standard should be neither too constrictive (no way of representing important information) nor too loose (many ways of representing the same information; specification for unnecessary information).

The process of data governance addresses two related issues surrounding the established data standard. The first of these is a policing role, ensuring that publishers are complying with the data representation standards for VINE.

It is necessary to ensure that the mandated standards are being used correctly, and to have a process in place to resolve any issues surrounding improper implementations of a standard. The second issue is that of the evolution of the standard. Just as emergency services and the world they operate in do not stand still, neither can it be expected that a data standard will continue to meet the needs of all stakeholders indefinitely without modification.

Key to avoiding abuse of the standard is to make sure it is thoughtfully and responsively extended when necessary. The consultative process required to extend the standard is also part of the data governance role that will be built into the administration of VINE.

5.2 Sample Scenarios in Tomorrow's World

In this section we provide scenarios to highlight the positive difference VINE will make to emergency management.

5.2.1 Example 1 – Capability and Resource Management

Objective

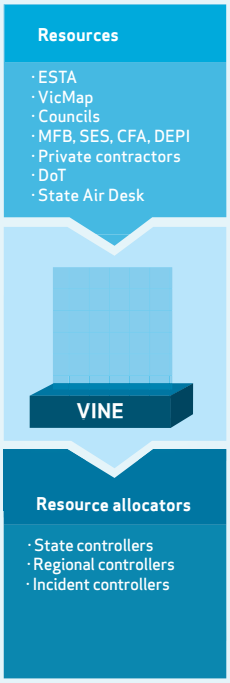
To allocate resources to achieve maximum effectiveness before, during and after an incident, the decision maker needs to know what resources (people and equipment) are available, their capability and the options for transporting and deploying to an incident. In addition, as an incident progresses, knowledge of the location and duty cycle of these resources becomes critical.

Process

Figure 7 provides an overview of the stakeholders involved in this scenario that includes the following steps:

1. All personnel and equipment capability information is published to VINE.
2. All ESTA's tracking and dispatching information is published to VINE.
3. All GPS devices of various appliances publish their data to VINE.
4. All personnel publish their location and when they are on the job and off it via the application on their smartphone or through other means such as call ups on their radios.
5. The Incident, Regional and State Controllers make their resource allocation decisions based on the complete picture and a joined up emergency management force.
6. Planners can see (in real time) the status of the State's emergency management team and call on resources from other states or the Australian Defence Force (ADF) in a timely way and with precision.

Figure 7. *Capability and resource management example.*



5.2.2 Example 2 – Cross Community Collaboration

Objective

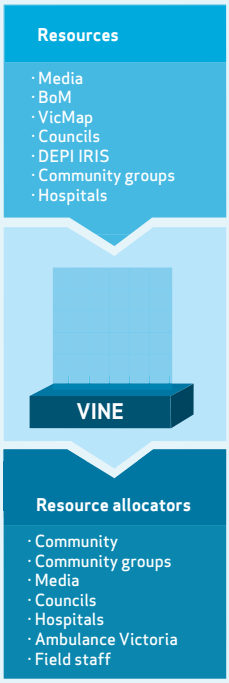
To build rapid predictions for any natural emergency event (fire, flood) and make this information available to all stakeholders, enabling them to make the best possible decisions to minimise death, destruction and displacement.

Process

Figure 8 identifies the major players in this scenario whose key steps are described below:

1. Bureau of Meteorology (BOM) publishes key weather data to VINE.
2. Vicmap publishes spatial data to VINE.
3. The DEPI Incident Resources Information System (IRIS) and similar systems use this and other data to produce rapid fire, flood and other predictions.
4. Councils, hospitals, schools, utilities publish key information about vulnerable people and assets.
5. The local media publishes important information gained via talkback.
6. All stakeholders have immediate access to the incident information and who and what is under threat.
7. Councils and community groups are empowered to take actions to protect vulnerable people and their community.
8. The up to date information on road conditions (provided by real time monitoring and community contributions) assists evacuations.
9. As the evacuation of a hospital is completed the hospital updates VINE to confirm the action is complete. Agency field staff focus their attention elsewhere.

Figure 8. *Cross community collaboration example.*



5.2.3 Example 3 – Flood Recovery

Objective

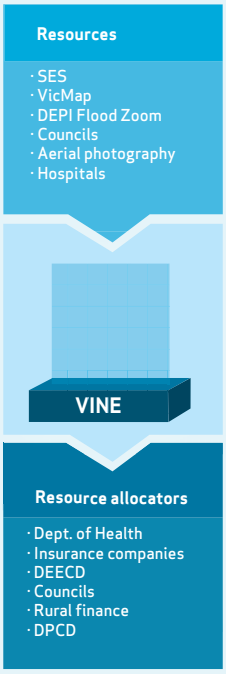
To ensure the health and safety of people affected by overflowing sewage, to ensure insurance claims are processed rapidly, to provide hardship grants quickly, to repair roads and essential infrastructure in the optimal sequence.

Process

Figure 9 identifies the key stakeholders involved in this scenario. The following list is a description on how they can interoperate by using VINE:

1. Using the information gained through the incident and aerial photos the Department of Health can immediately see those people at the greatest risk and when access and help can be provided.
2. Despite being unable to enter the area, insurance companies can quickly see the assets that have been flooded and process claims.
3. The Departments of Education and Early Childhood Development (DEECD) and Human Services (DHS) can see the affected schools and human impact and make immediate alternative plans.
4. Councils can focus their repair efforts on the critical infrastructure.
5. Rural Finance can quickly validate and process applications for hardship assistance.
6. The Department of Planning and Community Development (DPCD) can quickly make plans to provide the required community support.

Figure 9. *Flood recovery example.*



5.2.4 Role and Responsibility Management

Through VINE, roles and responsibilities can be formally defined and made clear to all, with clear and auditable processes for handover and acceptance of responsibilities. If, through negotiation, there is a change in the individual responsible for a particular matter, the existing responsible party will nominate the new party using VINE. Handover is complete when the new party "accepts" the responsibility. This will be seamlessly integrated with the role based access control described in *Section 5.1.2.*

6. IMPLEMENTATION STRATEGY

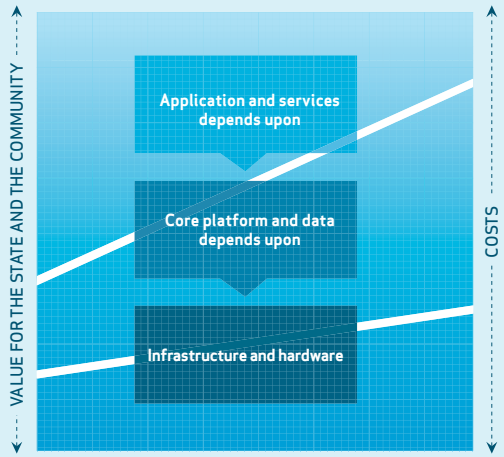
Achieving the full set of capabilities of VINE is a challenging endeavour. Such a comprehensive platform will require considerable investments in terms of budget, technical and governance efforts. As a result, it is likely to be some time until the full vision for VINE can be realised. It is essential to ensure that Victorians enjoy the benefits of VINE as soon as possible. Therefore, it is necessary to delineate a strategy that will deliver value incrementally and will allow all the stakeholders involved to iteratively evaluate success and risk and to take timely action.

6.1 Balancing Investments and Value

VINE must provide a compelling case in terms of benefit derived against the cost of delivery. It is envisioned as a platform encompassing the entire stack of computing: from hardware and infrastructure, to the platform and data enabling the delivered capabilities and to applications and services, which are the point of contact between VINE and the community. What is most valuable and beneficial to the State and Victorians resides in the services and applications layers, which can be used by emergency services organisations and the community to obtain timely, tailored and relevant information and to perform effective decision making. However, building such services requires that many capabilities from lower in the stack be put in place.

Investments in terms of time and, more importantly, budget will be necessary to develop each of these layers. *Figure 10* gives a qualitative representation of the comparison between the distribution of costs and value across all the required conceptual layers of VINE. What emerges is that there is an imbalance between the projected implementation costs and benefits of each of the layers of VINE. In particular, infrastructure requirements can potentially lead to large upfront investments whose outcomes can only be evaluated at the later stages of the implementation of VINE, thus increasing the level of risk of the project. A sequential implementation of VINE, where infrastructure is first implemented, followed by the core platform and finally applications and services, would maximise the upfront costs while deferring the majority of the benefits towards the later stages of the project. Such an approach increases risk by separating the investment from the realisation of benefit; if human or organisational changes led to changes in direction for the project in the interim, much of the initial investment may be wasted.

Figure 10. *Cost and value metrics for VINE.*



Even though sequential implementation is the most obvious approach, since it follows the dependencies between layers, it does not constitute the only option that we have. There is another solution that allows us to govern this project in a more controllable way.

To serve the evolving needs of the State, VINE is envisioned as a modular platform that will enable the creation of an ecosystem of applications and services built by a larger community than the one directly involved in its implementation. Such an ecosystem will be made possible by standardised interfaces, protocols and unified representation of information.

STANDARDS AND INTERFACES DEVELOPMENT CAN ONLY BE SUCCESSFUL WITH THE ACTIVE PARTICIPATION OF THE ALL STAKEHOLDERS IN EMERGENCY MANAGEMENT. IT IS ONLY WITH THEIR DEEP AND PROFESSIONAL EXPERTISE AND AN UNDERSTANDING OF THE NEEDS OF COMMUNITY MEMBERS THAT VALUABLE AND LONG LASTING ASSETS FOR THE STATE CAN BE DELIVERED.

Clearly defined interfaces and standards are also fundamental for introducing loose coupling between infrastructure, platform and applications and services. With loose coupling, capabilities and applications can be developed in parallel across all the levels of the computing stack required by VINE. It then becomes possible to identify those capabilities across the entire stack that can deliver a feature of VINE and organise them into a project that provides benefits at early stages. What is essentially achieved by using this strategy is to overlap the implementation of the three constituent layers of VINE, thus passing from a sequential approach to an integrated approach *(Figure 11)*. The advantage of using this approach is not only a quicker delivery of value but it also enables the evaluation of the outcome earlier and possibly with less expenditure. This approach can result in much better risk management of the project.

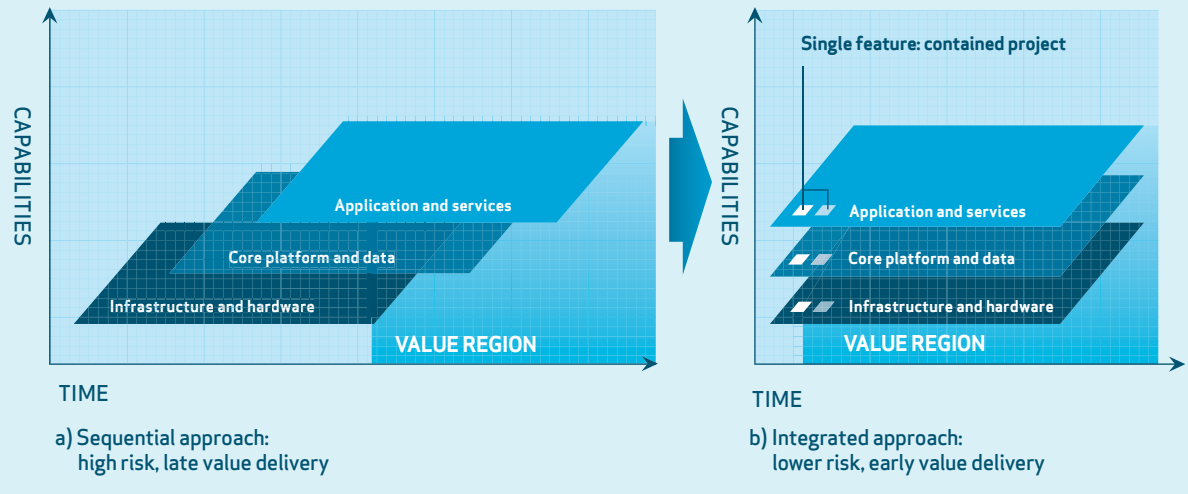
As VINE materialises, outcomes can be assessed in advance and requirements can evolve in light of the early deliverables, with less impact on the existing architecture of the platform. The benefit of this approach is that failures are detected earlier and potentially there are smaller costs associated with addressing these failures.

The process can engender greater confidence from stakeholders, since they participate closely in the evolution of the project and their feedback is integrated earlier in the process.

6.2 The Critical Role of Standards and Interfaces

Building VINE incrementally requires that the interactions between components be well defined from early in the development process. To do so, it is critical to specify interfaces and standards, primarily used between the layers identified above. Interfaces and standards serve to connect the various components of VINE and will thus be expensive to modify once in place; for this reason it is important to start early and give due consideration to their definition. As with the development of components, an incremental approach to defining standards can be beneficial and when possible, focus should be concentrated on developing those interfaces and standards that serve immediate future projects. In this way, these can be evaluated early on and the risk on a critical architecture element can be contained.

Figure 11 *Sequential versus integrated approach.*



As new projects are identified, the set of interfaces and standards will grow incrementally with less risk of inconsistency as each new development will be made in light of immediate future needs and existing capabilities.

Standards and interfaces development can only be successful with the active participation of all the stakeholders in emergency management. It is only with their deep and professional expertise and an understanding of the needs of community members that valuable and long lasting assets for the State can be delivered. The development of standards will also give the opportunity to establish a common agreement on what information is relevant and accessible before, during, and after an emergency. Therefore, standards and interface design and development have to be preceded by the identification of the key stakeholders that will depend on them. They will become active participants in the process ensuring that the architecture of VINE will deliver what it is meant to.

Finally, standardisation efforts in VINE can open the door for interoperability beyond Victorian borders. By building VINE on top of a solid foundation of standards, it could eventually become an important component of a broader interoperability initiative extending across Australia, and internationally.

6.3 Harmonising Early Wins with the Long Term Vision

Short term projects will build incremental value for VINE, but by themselves they will not realise the long term vision of a platform of such breadth. These projects need to be backed by a long term plan whose goal is to realise the vision that inspires VINE. This plan must put in perspective each development effort by prioritising and selecting which features of the platform will be delivered over time through early wins and assessing their outcomes against a reference architecture fostering the long term goals of VINE. The risk of not having such a long term plan is to build capabilities that are unable to become part of a more comprehensive platform, thus wasting time, funding, and increasing the potential of failures in the long run. VINE is envisaged to be an ecosystem of services and applications supporting the community during the entire life cycle of emergencies and it can only be realised if there is a coherent vision driving its evolution.

The need for long term planning not only covers the architectural aspects of VINE, but such planning is also essential for making the process for the development of VINE happen. In this sense, a fundamental element of this plan is the strategic identification of which subsets of the standardisation efforts and data governance initiatives need to be ready, by when and what resources need to be available in terms of funding and stakeholder commitment.

THE BETTER THESE NEEDS ARE UNDERSTOOD AND SATISFIED THE GREATER THE USE AND INTERACTION WITH VINE. THIS INCREASED INTERACTION WILL RESULT IN MORE COMPLETE AND TIMELY INFORMATION THUS MAKING VINE MORE USEFUL TO ALL STAKEHOLDERS

The balance between delivering early value and fulfilling a long term plan is what will give vitality to the project and help maintain momentum. At all times when considerable investments need to be made, we will be well positioned to make effective decisions that have a large impact on the future evolution of VINE. For instance, critical decisions for the future of VINE will include:

- provision and deployment infrastructure supporting the operations of VINE
- resolution of the data governance issues controlling the information managed by VINE
- definition of the overarching reference architecture for VINE
- definition of standards and publicly available interfaces to VINE
- definition of policies and procedures for extending the capabilities of the platform and for transforming VINE into an open ecosystem.

Each of these activities characterises the long term evolution of VINE and present challenges that once resolved, constitute a steady progress of the long term plan. More importantly, in many cases they can be carried out incrementally.

6.4 Stakeholder Engagement

To achieve the optimum outcome from this initiative it is important that all stakeholders have input to ensure their ability to interact with and provide and receive information that reflects their specific needs in respect to their role. Stakeholders include the media, the emergency services organisations, government departments, local government, private bus operators and the community as a whole.

The better these needs are understood and satisfied the greater the use and interaction with VINE. This increased interaction will result in more complete and timely information thus making VINE more useful to all stakeholders.

VINE is designed as an open information platform that will be able to sustain the ongoing development of different applications and systems as part of the one ecosystem.

This greatly reduces the delays resulting from excessive needs analysis prior to starting to build core VINE components. The core platforms can be built with the focus on initial priorities. As the next stage of priorities become clear these can be addressed as separate small projects making up the same ecosystem.

7. SUCCESSFUL ADOPTION OF STANDARDS: CASE STUDY

7.1 GSM Wireless Telecommunications

GSM (Global System for Mobile Communications)[13] was one of the first digital mobile telephony standards that, while originating in Europe, became adopted globally. Today terrestrial GSM networks cover more than 90 per cent of the world's population. It has become one of the world's most impactful electronic developments in terms of global reach. One of the keys to its success was the realisation that economies of scale (for example, research and development expenditure, production costs) could be achieved by growing beyond traditional boundaries and the network becomes more valuable the larger it becomes. Global coverage was seen early on as a goal for the technology. *Figure 12* shows the timeline for the evolution of GSM.

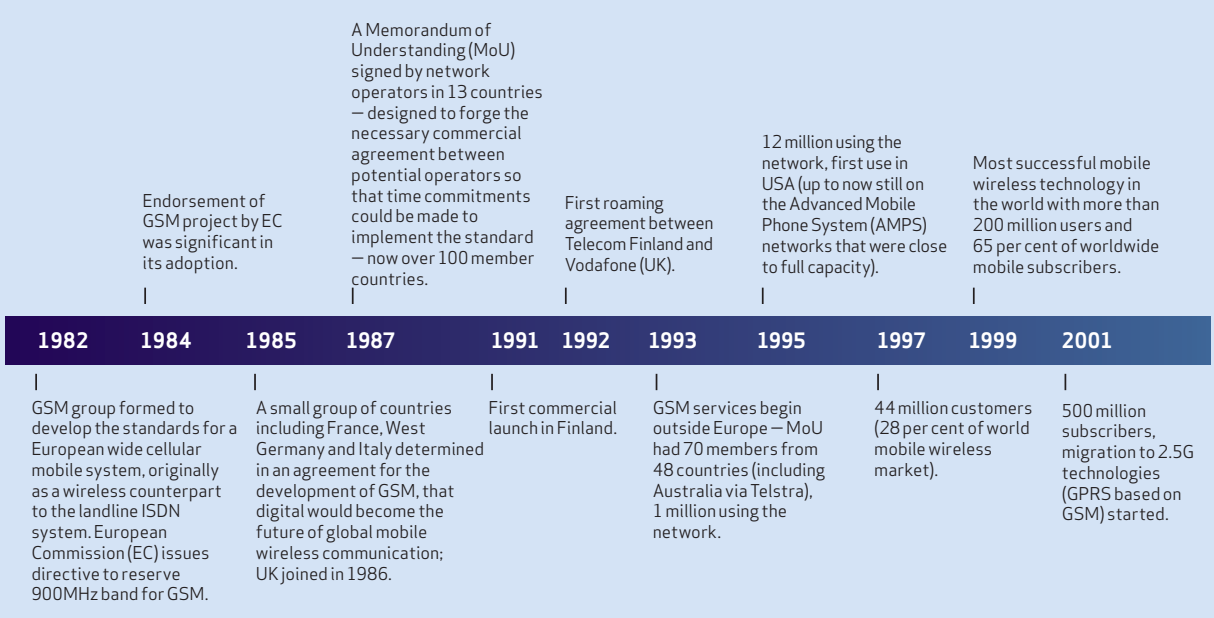
Prior to its adoption, there were no fewer than nine competing analogue (1st generation) standards in Europe. In essence, each country had its own independent mobile system, making it impossible to use the same phone across geographical borders. By the early 1990s, a lack of network capacity created a need for a new technology.

7.1.1 Reasons for Success and Lessons Learnt

The almost worldwide adoption of GSM was due to cooperation facilitated by the political and economic environment at the time. The EC backed the necessary regulatory changes that led to its acceptance across Europe initially, while favourable economic conditions enabled the necessary investment by telecommunication providers. Technological innovation was key to providing sufficiently attractive technical features in the standards (for example, roaming ability, efficient use of spectrum) to overcome the thinking that a leap from analogue to digital would be too costly.

Standardisation in general leads to improved communication and interoperability between the parties involved. Once the standards are set and the necessary regulatory needs are met, it can be left to the market to drive the technology forward and across regions.

Figure 12. *GSM Timeline*



[13] http://www.gsma.com/history/ - Accessed May 9, 2012.

8. CONCLUSIONS

Effective emergency management depends on the quality of the information and tools available to decision makers (including the community) at the time decisions need to be made.

Advances in information and communication technology now make it possible to envisage a single, comprehensive common operating picture for all stakeholders in an emergency. This Blueprint describes a vision for the technological and organisational change that must take place for this to happen.

At the core of the vision is VINE — the Victorian Information Network for Emergencies — a unified, open, universally accessible platform for information interoperability and decision support before, during and after an emergency. VINE will be built as a resilient system for supporting the distribution of information by any means available and for processing that information to help stakeholders make the best possible decisions. It is intended to support a broad ecosystem of information production and consumption, allowing people to build customised views of the information they need, while encouraging research and innovation that improves decision making and contributes it back for the benefit of all.

With VINE, all stakeholders will have access to the same rich set of information, analysis and decision support tools, allowing them to make the best possible decisions at all times. Most importantly, VINE places the community at the centre of the emergency management process. With full access to the information platform, the community is elevated from passive bystander to active participant; contributing information and resources and making well informed decisions. VINE will enable the community to act alongside emergency services and government agencies to prevent the emergency affecting them from turning into a disaster.

The only way to make the best possible decisions before, during and after an emergency is to have all information unified and universally accessible.

VINE is the platform for achieving this vision; with the cooperation of those organisations that serve Victorians in an emergency, we can elevate the role of information in the preservation of life and property and ensure the community is a true partner in their own safety.

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10. APPENDIX

A. Frequently Asked Questions

A.1 General

Q1. WHY DO WE NEED VINE AT ALL? WHY NOT JUST DEFINE STANDARDS AND A DATA BROKERAGE MODEL?

Defining standards for publishing information is not on its own sufficient to facilitate a *common operating picture*. Although standard protocols would certainly provide value, information would still be difficult to combine, higher level models would be harder to create, inconsistencies would be more difficult to resolve and there would always be the temptation simply not to publish data, or at least delay publication of data until sometime after the completion of a project. Furthermore, a unified solution is the only way to ensure the full participation of the community. It is difficult to imagine an ecosystem developing when all the relevant information and resources are scattered across multiple services and there is no clear way for the community to contribute to the system. Finally, protocols for ensuring consistency of roles and responsibilities across all systems become much more complex and cumbersome, reducing the ability to make rapid changes.

New systems that deal with emergency management will need to adopt a design methodology that integrates VINE from the beginning. Simply doing things as they have always been done and then adding a data feed at the end of the project falls well short of the change that must be achieved to ensure a coordinated, interoperable approach to managing emergencies.

Q2. WON'T IT BE MUCH EASIER FOR VINE TO PULL DATA FROM AGENCY DATABASES RATHER THAN HAVING IT PUSHED?

Under a "pull" model, the burden is on VINE to connect to and extract data from agency silos. Changes to data format or location and the addition of new databases would need to be tracked by VINE. Such a scenario would not be workable. Changes to data over time would lead to broken connections and consequently missing data within VINE and assimilating new data sources would require configuration changes to VINE.

It would not be possible to achieve a *common operating picture* in this way. The responsibilty must be on the data owners to ensure that any changes or extensions to the data model on which they rely is pushed to, and compatible with, VINE from the outset.

The deeper issue, however, is not really about pull or push, but about where data should reside. In time, VINE will not be a simple mirror of data stored in a large number of databases scattered across dozens of agencies. Rather, it will evolve to become the primary data store for all information that is pertinent to the management of emergencies. This implies a fundamental change of approach: in future, rather than meeting a new need by designing a local database and then at some point exporting that data to VINE. New applications will be built such that any data it depends on or generates is read and written directly from and to VINE. Although this will take some adjusting, it is the only way to achieve a *common operating picture*.

Q3. HOW WILL RISK BE MANAGED DURING THE DEVELOPMENT OF VINE?

The implementation approach is not intended to be a "big bang" with all the benefits realised (or not) only at the end of a long development process. Rather, the implementation of VINE will be characterised by staggered rollouts and gradual transitions, with the most self contained, useful components to be implemented first. Lessons learned from these early partial implementations will be carried forward to later stages of the project.

A.2 VINE and the Public

Q4. DOESN'T ALLOWING THE PUBLIC TO PROVIDE INFORMATION MEAN AGENCIES HAVE TO RESPOND, DISTRACTING THEM FROM MORE CRITICAL TASKS?

VINE will not replace the Triple Zero call process though ESTA. However, it will enable more detailed information about an incident by using rich media and structured data. Nothing about VINE implies a new requirement that emergency services take action on, or that they respond to every public report of information.

Q5. WON'T VINE UNDERMINE ESTA'S ROLE IN HANDLING INFORMATION REPORTED BY THE PUBLIC?

VINE is seen as a complement or supplement to ESTA. With its broad capabilities (for example, harvesting GPS coordinates or video), a system like VINE has the potential to augment ESTA's ability to capture as much valuable information from the public as possible. Furthermore, in time it is envisaged that all information reported to ESTA will immediately be available via VINE to all emergency services, thereby reducing the time required to respond to public reports and making it easier to cross reference reported information with other incident data that is coming in from other sources.

Q6. THE PUBLIC DATA WILL NOT BE THAT ACCURATE. HOW CAN IT BE USED?

The amount of uncertain data in the world is growing and disregarding it is not an option. Part of the VINE architecture will be powerful data processing and analytic tools that can cross reference and aggregate uncertain data in order to build a clearer picture of what is going on. For example, a single Twitter report in an area about severe shaking can likely be disregarded; 10 reports within the same geographic area suggests it is quite likely that there has been some sort of earthquake or significant explosion. Modelling and prediction engines built into VINE will be able to take advantage of uncertain data in order to improve the quality of predictions or recommendations.

In many cases, publicly reported data will simply be the first stage of a workflow: potentially inaccurate data will be monitored, classified and/or verified by a responsible officer of the appropriate agency before further action is taken.

A.3 Technology

Q7. HOW CAN WE BUILD A RELIABLE SYSTEM ON TOP OF THE INTERNET, WHICH IS UNRELIABLE?

The Internet as a whole is very reliable: it was originally designed as a communication system capable of withstanding nuclear war. When properly engineered and when equipped with sufficient diversity and redundancy, critical connections across the Internet (for example, between the State Control Centre and data centres hosting VINE infrastructure) can also be extremely reliable and fault tolerant.

The Internet is viewed in the Blueprint as a model for communications resilience because of its ability to reroute information through multiple paths should one path fail. The same type of diversity will be the basis of VINE. If one type of infrastructure should fail another needs to be in place that can reroute the information. For example, a fire truck could be equipped with a standby 3G base station that, when necessary, could be made operational.

Q8. ISN'T THE CLOUD INSECURE?

The term "cloud" refers to quite a broad variety of systems. The most typical presentation of the cloud is the "public cloud" where computing resources and services are bought from a large third party provider such as Amazon. Although these systems are typically quite secure, there are legitimate concerns in some cases about sensitive data being stored and in some sense controlled by an unaffiliated organisation.

However, cloud infrastructure can also be a "private cloud" or "community cloud" where a single, easy to manage, virtualised computing infrastructure is controlled by a single organisation or a group of cooperating organisations. Many of the cost and resilience benefits of cloud infrastructure also apply to a private cloud, but with the possibility of having full control over the management and security arrangements of the infrastructure. It is this type of cloud infrastructure that is being proposed for VINE.

Q9. WILL DATA STORED IN THE CLOUD BE COMPLIANT WITH REGULATORY REQUIREMENTS ON DATA STORAGE?

Using a cloud and Internet based architecture does not mean losing control of where the data is stored. The Blueprint calls for the creation of a community/private cloud infrastructure exclusively for hosting emergency services software including VINE, which will be sited and secured as deemed appropriate and in compliance with regulations. Cloud technology is now mature enough to support the location of sensitive data within specific geographic areas.

Q10. ACCESS TO THE CLOUD IS GOING TO BE DIFFICULT IN REMOTE AREAS. WHAT WILL BE DONE TO ADDRESS THIS?

There are two parts to this answer. The first is that improved data communication capabilities are an important part of emergency service modernisation, with or without VINE. There are many options for doing this and discussing all the possibilities is beyond the scope of the Information Interoperability Blueprint.

The other part of the answer is that VINE provides benefits even where direct access to the cloud is not available in the field. Turning on VINE does not mean turning off the voice radio network, nor does it mean discounting data that comes from other sources such as telephony or broadcast media. What it does mean is that all relevant data about an emergency can be aggregated and analysed by decision makers. Information can be quickly assimilated, combined and displayed within a control centre, enabling individuals within the control centre to make better decisions and then communicate those decisions to the field over radio – just as they always have. If there is also Internet access in the field, that provides the additional benefit of real time access (and the ability to contribute) to all those people with that access.

The media also play an important role in keeping the public informed about an emergency situation. Even if members of the public are not able to access the Internet in the emergency zone, the increased access the media have to information means that the superior situational awareness imparted by VINE can still be conveyed to the community through the media.

Q11. IF THE PUBLIC HAS ACCESS TO VINE, MIGHTN'T THEY OVERLOAD IT?

One part of the solution is to adequately provision the system so that it becomes difficult to overload; after all, a big part of the aim of VINE is to involve the community – they are not a nuisance but rather the very centre of the whole effort, and they have a legitimate need to access information about the emergency situation in which they find themselves.

Of course, there will still be times when the system may not be able to handle the demand that is placed on it and at those times it is critical that the information flows for the emergency services are not disrupted. As it will be designed for resilience and in accordance with the principle of graceful degradation outlined in the Blueprint, VINE will respond to an overload situation not by failing but by shedding load in a controlled manner. Furthermore, by combining load shedding with quality of service capabilities, the system will prioritise emergency traffic and ensure that there is no disruption to high priority usage.

Q12. WHAT ABOUT DATA WAREHOUSING FOR ANALYTICS?

Data warehousing — longer term storage of data stored in a way that submits to analytics techniques — will be convenient under the VINE infrastructure. It is possible that the system itself will contain some data warehousing and querying capabilities. This is a matter for consideration when a more detailed requirements specification is developed. However, what is certainly true is that the open data PubSub model of VINE will make it straightforward for stakeholders to build data warehouses that meet their needs. By building a warehousing utility that subscribes to the appropriate data feeds, agencies and other stakeholders can build private data stores reflecting historical information that passed through VINE and mine that data to meet their own objectives. This will, of course, be subject to constraints to ensure that such warehousing doesn't have the potential to violate privacy or confidentiality conditions.

A.4 Privacy

Q13. HOW WILL VINE ENSURE DATA PROTECTION AND PRIVACY?

The Blueprint makes reference to the need for extensive and well considered measures to be put in place to safeguard sensitive data, most particularly private information. Best practice security measures will be put in place, encryption will be used throughout and sophisticated anonymisation techniques will ensure as much access to data as possible while always acknowledging that privacy comes first. A considerable part of VINE is devoted to role and access management of data to ensure that in an environment where a multitude of users operate on the system, confidentiality and integrity of information are preserved.

This will certainly be a significant challenge as the system is built out, but by concentrating resources within a unified system, much more considered and sophisticated privacy measures can be put in place than would have been the case if each agency needed to implement a privacy policy across multiple heterogeneous data silos.

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