The Emergency Response Intelligence Capability Tool

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Abstract. The Emergency Response Intelligence Capability (ERIC) tool, http://eric.csiro.au, automatically gathers data about emergency events from authoritative web sources, harmonises the information content and presents it on an interactive map. All data is recorded in a database which allows the changing status of emergency events to be identified and provides an archive for historical review.

ERIC was developed for the Australian Government Department of Human Services Emergency Management team who is responsible for intelligence gathering and situation reporting during emergency events. Event information is combined with demographic data to profile the affected community. Identifying relevant community attributes, such as languages spoken or socioeconomic information, allows the department to tailor its response appropriately to better support the impacted community.

An overview of ERIC is presented, including its use by the department and the difficulties overcome in establishing and maintaining a nationally consistent harmonised model of emergency event information. Preliminary results of republishing the emergency event information using the Australian Profile of the Common Alerting Protocol, an XML standard to facilitate the construction and exchange of emergency alert and warning messages, are also presented.

Keywords: Disaster Management, Situation Awareness, Situation Reporting, System Architectures, Web Feeds.

1 Introduction

The Emergency Management team within the Australian Government Department of Human Services (the department) is responsible for the coordination of the department's response to emergencies, with a focus on delivery of departmental services and disaster assistance on behalf of the Australian Government to the affected community. The Australian disaster season is from early October through to late March and often involves bushfires, floods and cyclones with many events often occurring at the same time across State and Territory borders.

ERIC allows the Emergency Management team to easily monitor events occurring around the country and provides fast and intuitive access to a wide collection of in-

formation. The aim was to provide software support to help the Emergency Management team perform their tasks more efficiently and effectively, allowing them to better utilise their time in the analysis of information.

During large scale emergency events, the Emergency Management team creates a Situation Report as a Microsoft Word document. The information recorded includes specific event details (the event type, its location, impact to the community) and the tasks undertaken by the department (the number of staff mobilised, the impact on business as usual activities, statistics about the number of phone calls received and claims made by members of the community for Commonwealth Disaster Assistance). This information is tracked and reported on during the course of the emergency events and may continue well after the initial emergency response. The Situation Report is used by senior managers in the department to make informed decisions.

Dynamic data is sourced from public 'live' web feeds that provide content to the existing State and Territory emergency services web sites. See for example the Rural Fire Service websites for New South Wales[1] and Queensland[2]. A web feed is a web accessible resource that is updated frequently as new information becomes available from the content provider. This information is produced in many formats, for example RSS, GeoRSS, ATOM, JSON, GeoJSON, KML, HTML, XML, GML, XLS and plain text.

ERIC integrates information from numerous other sources such as statistical data from the ABS including population demographics; 'departmental demographics' such as the number of people receiving different payment types; the 'live' web feeds noted above; a repository of historical data collected via these 'live' web feeds; and an archive of previous situation reports. The integrated information can be focused to a specific region under investigation where an emergency is underway and collated semi-automatically to generate a pre-populated Situation Report as a web form that is then completed by the user. This may include content from a previous Situation Report with updates to the current situation automatically highlighted.

The example screen shot of **Fig. 1** shows the status of the New South Wales (NSW) State Mine Fire. It highlights how overlaying information from two different agencies (the NSW Rural Fire Service and Geoscience Australia) provides more insight into events. This figure demonstrates some of the important features of ERIC: the recorded information remains available for review and the map provides an easy and intuitive interface for users to navigate the information available from different sources.

A public version of ERIC is available at http://eric.csiro.au/. This version does not include any of the department's data (for privacy reasons), and the situation report function is not available. Some web feeds are also excluded for copyright reasons. Notably, the state of Victoria does not allow republication of their emergency web site content.

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1 http://www.rfs.nsw.gov.au/dsp_content.cfm?cat_id=683

2 https://ruralfire.qld.gov.au/map.html

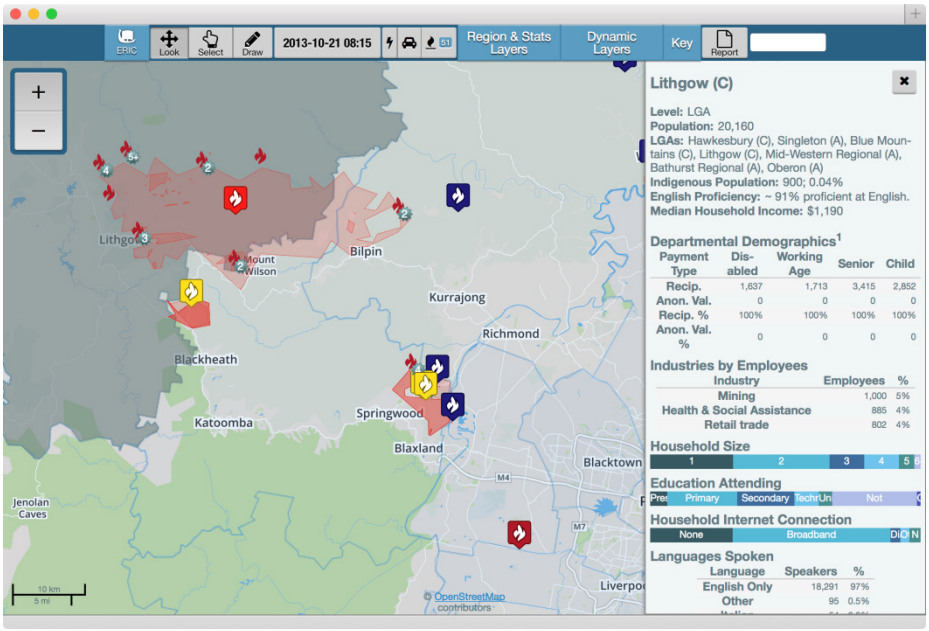

Fig. 1. State Mine Fire, near Lithgow NSW on 21 October, 2013

2 Related Work

There are existing web feed aggregators that provide some of the ERIC features to combine content from the 'live' web feeds[3], however they do not support the diverse range of formats currently managed by ERIC. Similarly, some of the ERIC mapping and geospatial features are provided by Geospatial Information Infrastructures and Web 2.0 'mashups'[4], however, they require the data to be available in specific formats and do not support the identified Situation Report features.

The central task of the Emergency Management team is to maintain situational awareness throughout the response and recovery phases of disaster events. The Situation Report embodies this knowledge. A number of Situation Awareness models exist to help characterise this process. For example, Endsley [1] defines three levels: perception (sensing the environment), comprehension (combining sensory data to discover information) and projection (using the information to predict possible futures). ERIC helps with the first two levels, perception and comprehension, by assembling information from various sources into a single coherent picture. Predicting possible consequences remains the task of the user, although this could be an area of future work.

[3] See http://www.rss-readers.org/list-of-rs-feed-reader/.
[4] For example, see GeoCommons: http://geocommons.com/.

3 Harmonising Emergency Event Information

3.1 Web Feed Aggregation

A summary of the different web feeds used by ERIC is shown in **Table 1** indicating the content, word count and formats used for each. Note that some agencies maintain multiple feeds of varying types. As shown in **Table 1**, ERIC tracks nine RSS feeds, eight GeoRSS feeds, two KML sources, 10 GeoJSON sources, and 13 GML files. The providers indicated by a 'dagger'† are discussed in more detail below.

Provider	Content				Word count		Format
	Traffic details	Fires	Weather warnings	Other incidents	Mean	Std Dev	
Australian Capital Territory Emergency Services†	✓	✓		✓	1,694	1,548	GeoRSS
Bureau of Meteorology			✓				13 GML, 8 RSS, text, XML
Geoscience Australia		✓					GeoRSS
Queensland Traffic	✓						GeoJSON
Queensland Community Safety	✓			✓			GeoJSON
NSW Roads	✓						6 GeoJSON
NSW Rural Fire†		✓			5,186	4,993	GeoRSS
Rural Fire Queensland†		✓	✓		4,053	2,906	GeoRSS, XLS
South Australian Country Fire†		✓			852	773	KML
Tasmanian Fire†	✓	✓		✓	9,833	10,979	GeoRSS, KML
Victorian Country Fire†	✓	✓		✓	3,024	2,765	2 GeoRSS, RSS
Victorian Environment		✓		✓			2 GeoJSON
Victorian Roads	✓						JSON
West Australian Fire†		✓	✓		17,948	10,822	GeoRSS

Table 1. Web Feed Summary.

3.2 Common Web Feed Model

The dynamic 'live' web feed data is polled regularly with the results stored in a database. These web sources are heterogeneous in many ways and a common model has been defined which is the basis of the database schema. The variety of data formats and information content used by the various agencies around Australia can be seen in **Table 1**. In general however, the web feed content is similar for each: a web feed has a URL endpoint which provides regular information updates. These updates consist of one or more posts describing the individual events. Each post contains: an identifier that uniquely identifies the event described; a timestamp for the individual post; the description of the event; the event category; a link to further information from the source; and the location as either a point or region. This model is shown in **Fig. 2**, from [2].

The process of harmonising the various web feeds into the common structure of **Fig. 2** is one of the tasks performed by the ERIC web server: each web feed is regularly checked for updates (currently every 10 minutes, which is configurable) with new information recorded in a database. Note that only new information is recorded in the database – new content consists of a collection of posts where some posts contain updated information while others remain unchanged. Identifying differences between subsequent posts about the same event is part of the user alerting process.

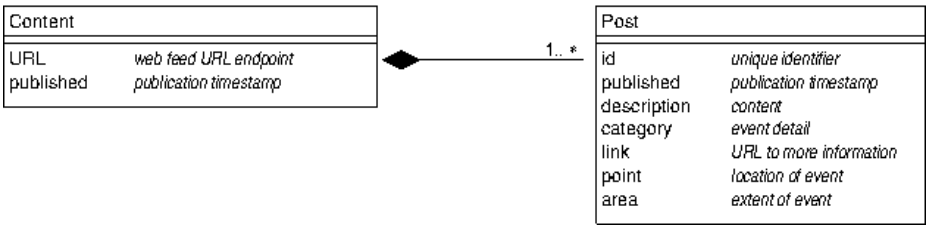

Fig. 2. Common Web Feed Model.

3.3 Harmonising Examples

Further examination of the web feed contents is focused on the seven web feeds indicated by the 'dagger'† in **Table 1**. These fire feeds were targeted since they provide coverage for the whole country, are representative of the diverse formats used and include geospatial content. The target feeds are mostly rural fire services from around the country, except for the Australian Capital Territory Emergency Services and West Australian Fire which includes posts about other event types as well. There were 21 different categories of events derived from the content of these feeds recorded for the period 1 October 2012 – 1 May 2014, ranging from hazard reduction, permitted burns, car incidents, false alarms, electrical fires and so on. Of these, the information of interest is the fire 'alert level': the fire warnings to the community.

In general, the progression of alert levels for fires are ‘Advice’: an indication that a fire has started and there is no immediate danger; ‘Watch and Act’: a heightened level of threat where preparatory action by the community is required; and ‘Fire Emergency’: the highest alert level where there is immediate threat to the community.

The different agencies report this information in different ways. Of the seven target web feeds† in **Table 1**, four produce fire warnings in the three alert level categories noted above. One has an indication in the event title that can be used to derive the alert level. The remaining two do not directly state the alert level, but instead provide detailed descriptions of the type of fire, such as ‘grass fire’. In these two cases, the alert levels are mapped as an Advice for all reported fires.

Fig. 3 shows the distribution of fire events showing the different reporting styles of the agencies: across the Eastern Seaboard, and into Tasmania, the agencies report very frequently. By comparison, Western Australia has far fewer reports, and the Northern Territory has none. Reports are widespread in Victoria, and Tasmania, but in the other eastern states they cluster along the coast with the population.

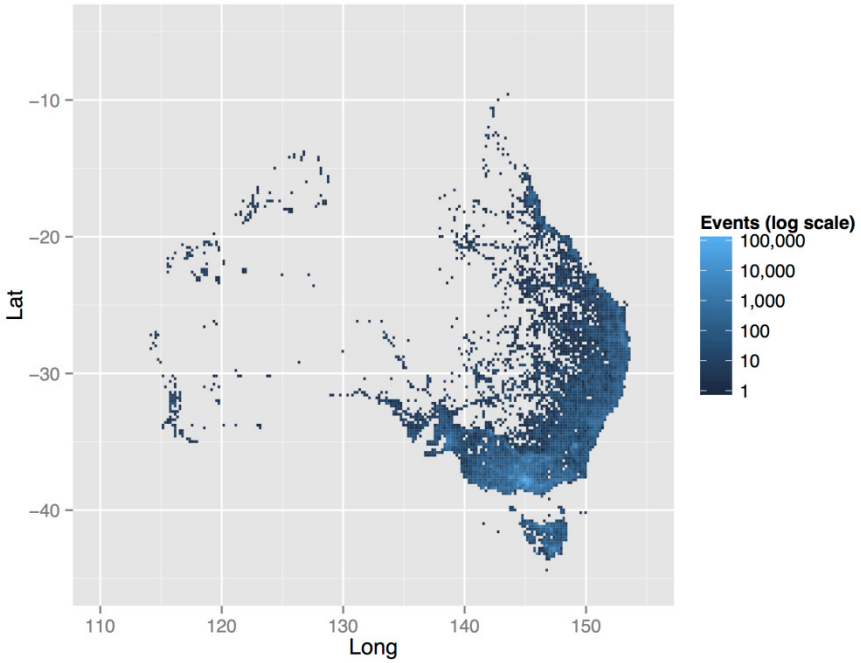

Fig. 3. Map of reports

The agencies describe events with a sequence of key-value pairs, for example the ‘Type’ and ‘Status’. Of the seven sources investigated, all but one show a strong indi-

cation of a few standard ways of reporting fires. This was measured by counting the number of fields; approximated by the number of colons (:) in the description of the posts and illustrated in **Fig. 4**. West Australian Fire was the exception, with a highly prosaic format and long reports, as shown by the mean description length in **Table 1**. As such, they have been excluded from **Fig. 4** because they do not use the key-value pairs and their data obscures the other results.

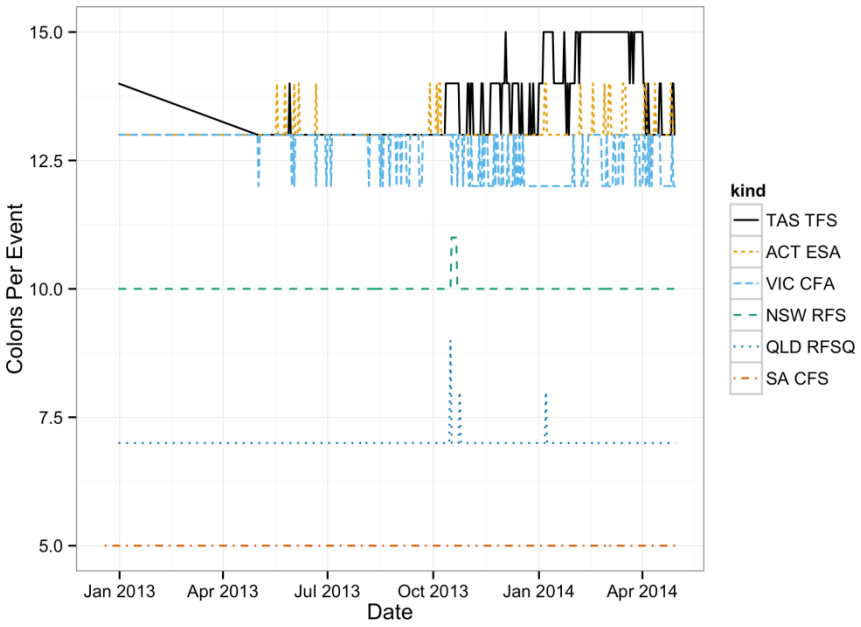

Fig. 4. Colon ':' count per event per day.

We can compare **Fig. 3** and **Fig. 4** to tease out some of the diversity of reporting present in these feeds. In Queensland, the reports are concentrated towards the south and the east, however the reporting format is very static. In fact, it is quite brief, and despite the large number of reports many of them are almost indistinguishable. This is even more extreme in South Australia. Here the reports concentrate heavily around Adelaide and the Eyre Peninsula, and are very rigidly formatted. This is in part due to the Victorian Country Fire's choice of using KML as the reporting format, which is highly structured.

In contrast are Victoria and Tasmania. Both have a spread of reports covering the majority of the state, and both have a fluctuating reporting format, although unlike Western Australia the format is still structured. This structure is not because of the format, since Queensland and Western Australia also use GeoRSS.

Different agencies have informally extended the file formats with structured text formats, such as the use of colon-seperated fields and values. In some cases, such as Queensland, this new format is strictly adhered to; however other agencies are not so

strict, changing their customisations as they feel the need. The GeoRSS format is particularly amenable to this extension, with the main 'post' tag allowed to contain arbitrary XML, although most commonly HTML or plain text is used.

4 Discussion and Future Work

4.1 Architectural Improvements

All ERIC data is managed as a data warehouse. While this is necessary for the web feed content to provide an historical archive, some of the other data layers could be provided using services provided by the data custodians. These services are currently not universally available, but it is expected they will be established over time.

Another benefit of a service based approach is the ability of users to include spatial data layers of their choosing. This is best achieved using a standards based approach to service integration, such as adopting relevant Open Geospatial Consortium service standards, such as the Web Feature Service and the Web Mapping Service.

Such integration currently requires a skill set beyond the average user. In order to empower users to integrate their own data, a new generation of supporting tools are needed. We have investigated the use of a web-based user interface to allow non-programmers to easily upload newly available data.

Using the web-based upload/update tool, users may upload their data in a number of file formats (currently ESRI Shapefiles and CSV, with nested data formats like XML/JSON to follow, for example: KML, RSS and RDF). The tool then presents the schema of the uploaded files against an ontology (a conceptual schema), terms from which are then used to describe the semantics of the uploaded data. The user's description of their data in ontology terms describes a 'mapping', which is automatically interpreted and executed by the tool to extract data from the uploaded file, transform it to the relevant data structure and load it into the system, completely automating the manual Extract/Transform/Load process.

This process was aimed at allowing the user to update the data warehouse with new versions of data without the need of a system administrator. This tool could be adapted to semantically integrate new data sources from service end points. Instead of simply providing a new dataset as a visual layer in ERIC, the content could optionally be merged with existing data layers.

4.2 Common Alerting Protocol

The Common Alerting Protocol (CAP)[5] is an international XML standard to facilitate the construction and exchange of emergency alert and warning messages. The Australian Government has created an Australian Profile of the standard[6] and are encour-

[5] http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2.html
[6] http://www.em.gov.au/CapAuStd

aging all Australian emergency agencies to adopt it. This is a significant undertaking with only one agency listed in **Table 1** doing so to date[7].

Since ERIC harmonises web feed data from various emergency related agencies, initial work has been carried out to evaluate the difficulty for ERIC to produce CAP compliant messages. The most challenging task to date has been determining the mapping between each agency's category of events to the standard CAP event categories. For example some agencies describe an incident as a 'scrub fire' to which there is no direct CAP mapping. The options in this case are: fire, bushfire, forest fire, grass fire, structure fire and industrial fire.

Data integration would be simplified if the agencies published information using CAP. This is an area of further work requiring liaison with key agencies to demonstrate how this can be done using the CAP messages produced by ERIC.

4.3 Social Media Integration

The tasks achievable using ERIC can be extended by including crowd sourced social media. Some progress has been made in ERIC by linking to the CSIRO Emergency Situational Awareness (ESA) platform [3] which continuously retrieves and analyses new Twitter posts originating from Australia and New Zealand. It is able to detect high frequency words and alerts the user to these using a tag cloud. ESA also uses machine learning methods to classify Tweets containing earthquake and fire related keywords, to see if they relate to current or new emergency events. ESA provides a search interface allowing the user to search for Tweets matching specific criteria.

ERIC includes a hyperlink in an event's popup to the ESA search interface for every fire event. The search terms are preset so that ESA will search for Tweets from the region surrounding the selected event that have been classified as positive fire related Tweets. Tweets from official agencies and the general public often contain extra information that is not available via the official web feeds. This extra information may include pictures or videos of the event and detailed impact information.

In future we plan to explore a more comprehensive integration of web feed and social media content. Instead of simply linking ERIC and ESA, we would like to present the social media data within the ERIC tool. An identified issue to be resolved is the trustworthiness of this information source [4,5]. This is especially important for emergency managers who are mainly concerned with verifiable information.

5 Conclusions

CSIRO has developed the ERIC web based tool that demonstrates the usefulness of data integration for emergency managers. ERIC improves the situational awareness of the Emergency Management team in the Australian Government Department of Human Services by integrating information from authoritative public real time web feeds with demographics data to provide a national picture that is available for historical

[7] http://www.rfs.nsw.gov.au/feeds/majorIncidentsCAP.xml

review. ERIC also identifies when the current situation changes and informs the user, reducing the need for the operator to do so.

ERIC was developed to support the intelligence gathering and situation reporting activities performed by the department's Emergency Management team. This has been successful, reducing the time taken to produce a Situation Report from approximately two hours to about 20 minutes. This is one of the main activities of the team during emergency events and their aftermath. It is critical that this information be reported in a timely manner. There have been other benefits also: the workflow of creating a Situation Report has been revised and improved; a standard Situation Report template defined and a method of naming events established.

A public version of ERIC is available at http://eric.csiro.au/ demonstrating the utility of data integration for the purposes of emergency management. All departmental information has been removed from the public version for privacy reasons and the situation reporting features disabled. While ERIC was developed for the department's Emergency Management team, we are actively promoting it for use by other agencies, the not for profit sector and the general public.

Acknowledgements

ERIC was funded under the Human Services Delivery Research Alliance between the CSIRO and the Australian Government Department of Human Services. The ESA project was originally financially supported through the National Security Science and Technology Branch within the Department of the Prime Minister and Cabinet.

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