

Emergency Information Synthesis and Awareness Using E-SOS

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ABSTRACT

In an emergency, people need to be able to report and find relevant information quickly. Fulfilling these information needs is the design goal of E-SOS: Emergency Situation Overview and Synthesis, a research project in progress. E-SOS will consist of (1) a website where users can report information, (2) web services that find and synthesize related information from multiple sources, and (3) interface tools that visualize and display links to this information. In this paper we describe three of these services and tools: the topic, geographic, and information space awareness tools. When a user writes a report, the topic awareness tool will execute a federated search and display links to related information. The information space awareness tool will highlight these links in a visualization of the information space. If the user refers to a location, the geographic awareness tool will focus a map on this location and display topic-related icons.

Keywords

Emergency response information system, HCI for emergencies, human-computer interaction, user-centered design, cognitive overload, information management, information synthesis, information visualization, awareness tool

INTRODUCTION

The most destructive emergencies in terms of human life have been global health emergencies. In 1918-1919, 40 million people may have died from the Spanish flu and nearly one billion people – half of the world’s population – may have become ill (Schoch-Spana, 2000). According to a Dark Winter exercise, a bioterrorism event such as a smallpox attack in the USA might result in one million deaths and three million cases within seven weeks without sufficient vaccine (deRugy and Pena, 2002). Influenza pandemics and bioterrorism events, then, can be far more deadly than earthquakes and hurricanes. Yet few emergency information systems focus on the daunting information requirements of such global emergencies, where many different kinds of information are critical, from scientific and medical information to local reports of symptoms from around the world.

What are the requirements for such a system?

First, the system needs to synthesize information from a wide range of heterogeneous information sources. These include public and private databases, repositories, and digital libraries; physical sensors such as weather sensors and body sensor networks (Lo and Yang, 2006); “social sensors” such as blogs, social networking sites, and reports from social networks of individuals who do not have direct access to the Internet; and traditional broadcast media.

Second, the system needs to help experts and the public manage information quickly by bringing to their awareness a synthesis of all, and only, the information that is relevant to their current situation. Information needs to be displayed in visually intuitive forms with standard icons so that users of different ages, languages, and cognitive abilities – including those who are cognitively impaired temporarily because of illness, confusion, or panic – can comprehend it.

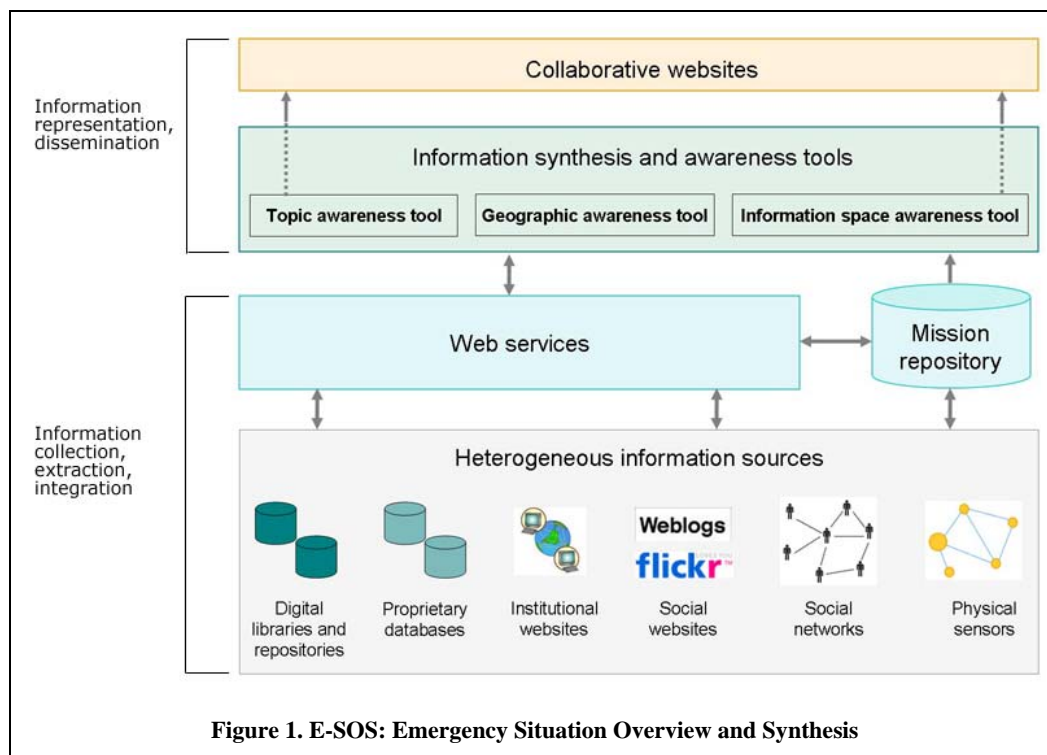
These requirements motivate the design of E-SOS: Emergency Situation Overview and Synthesis, a research project in progress. The project builds on Web 2.0 and Digital Library 2.0 concepts and standards (Miller, 2005), open

source software, and our digital library of 94 million bibliographic records and 14 million full-text papers. The goal is to optimize information flow during global emergencies through advances in the collection, extraction, integration, representation, and dissemination of information from heterogeneous information sources.

Current emergency information systems tend to focus on a subset of information sources. PEARL (Portable Electronically Accessible Reference Library) was developed by the Centers for Disease Control and Prevention (CDC) and includes medical papers, reference materials, and CDC documents (Swain, Oliver, Rankin, Bonander and Loonsk, 2004). Sahana, which was created in Sri Lanka following the Indian Ocean tsunami, allows organizations to share information in a collaborative website (Currion, de Silva and Van de Walle, 2007). HUODINI integrates information from the web including blogs, images, and sensor data (Fahland, Glaber, Quilitz, Weibleder and Leser, 2007). E-Response constructs repositories of local resources, images, and related information (Potter, Kalfoglou, Alani, Bachler, Shum, Carvalho, Chakravarthy, Chalmers, Chapman, Hu, Preece, Shadbolt, Tate and Tuffield, 2007).

In a global health emergency, users will need a system that can collect and organize all of these kinds of information – scientific, medical, technical, social, and local information – as well as their own reports and comments. In order to render the information useful, rather than overwhelming, the system will need to synthesize and display the information that is most relevant to the user's current situation, as evidenced by the user's reports or comments, and do so in an unobtrusive manner.

E-SOS is being designed to meet these needs. (Figure 1) The system will manage information from many sources by leveraging both open-source and locally-developed tools and services. In this paper, we describe three of the synthesis and awareness tools.



SYNTHESIS AND AWARENESS TOOLS IN E-SOS

When users visit E-SOS and write a report about their current situation or concern (Figure 2):

- The **topic awareness tool** will execute a federated search and display links to information about the topic that the user is currently writing about.

- The **geographic awareness tool** will focus a map on the location and display icons about the topic that the user is currently writing about.
- The **information space awareness tool** will highlight links to relevant information in an interactive visualization of the information space.

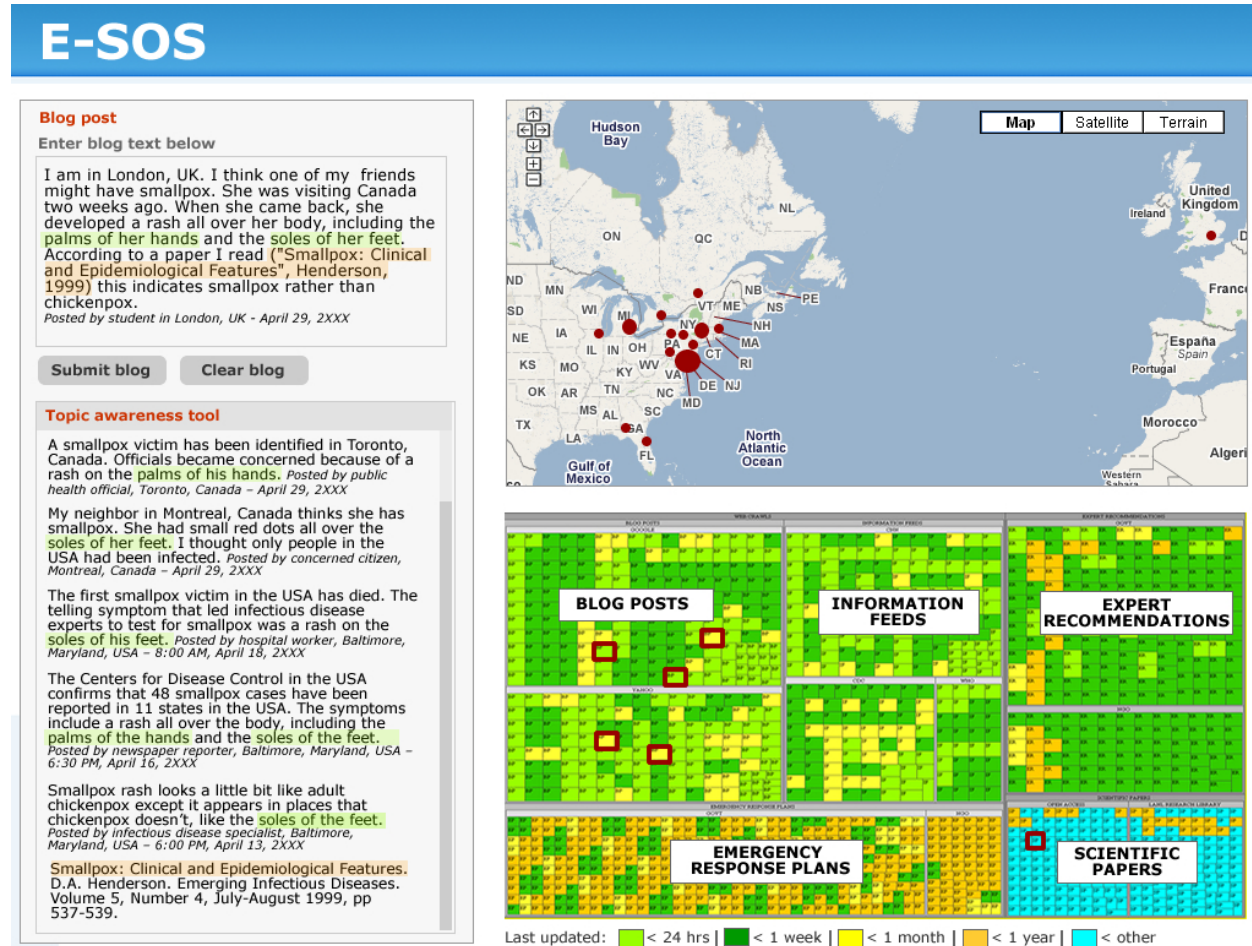


Figure 2. E-SOS Synthesis and Awareness Tools

User scenario

User scenarios based on reports, briefings, and interviews with experts have motivated the design of these tools. The following scenario about a fictional smallpox attack in the USA, for example, was used in a bioterrorism preparedness exercise in 1999 (Neergaard, 1999; O'Toole, 1999):

April 1. The FBI gets a tip terrorists might release smallpox during the vice president's speech at a Baltimore college. The tip is too vague to warn health officials. Smallpox incubates for two weeks so no one has yet become sick.

April 12. A college student and electrician come to the emergency room with fever and other flu-like symptoms. Doctors suspect mild illness, maybe flu, and send them home...

April 29. Two hundred are ill in eight states. Canada discovers two victims, Britain another. People with mild fevers jam hospitals. Doctors tell them to stay home so they don't breathe on others - there are no hospital beds left. Unvaccinated health workers walk off the job.

Figure 2 illustrates how E-SOS could be used in such a scenario to help users report and find relevant information. A fictional student in London writes in an E-SOS blog post that one of her friends has a rash on her body, including the palms of her hands and the soles of her feet. Since no victims of smallpox have been identified in the UK she isn't sure her friend has smallpox. In her post, she refers to a medical paper she read to learn about the differences between smallpox and chickenpox (Henderson, 1999).

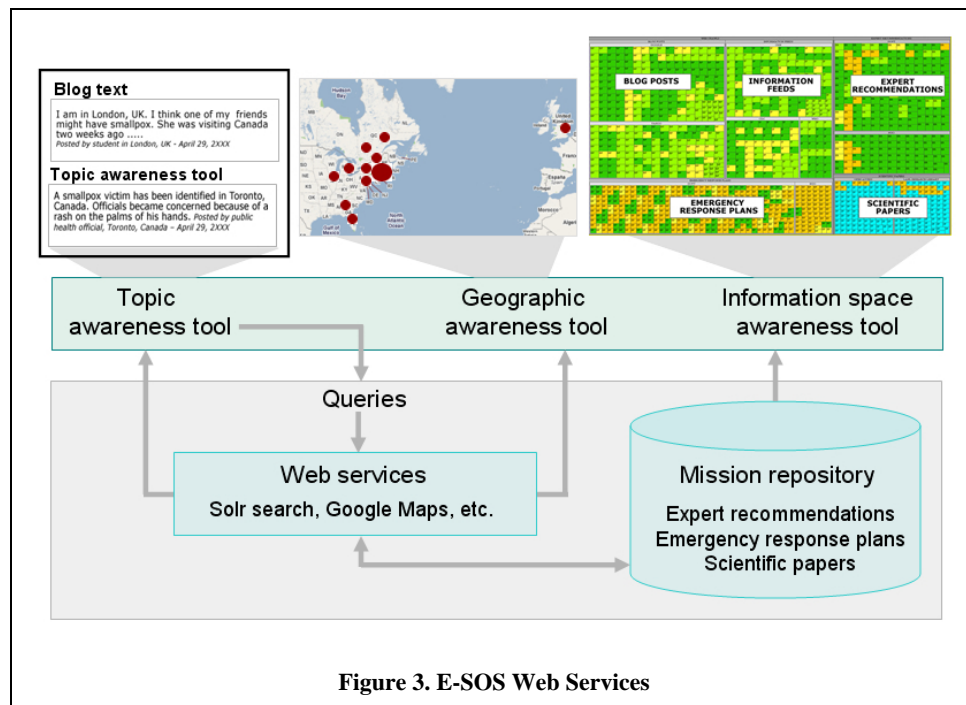
As she writes her post, E-SOS displays links to related posts and to the paper she references. All of the posts refer to a rash on the palms of the hands or the soles of the feet, the symptoms which differentiate smallpox from chickenpox. By the time our fictional user in London has posted information about her friend's symptoms, thousands of people may have posted to the system; however, only those posts that are relevant to hers are displayed by the topic awareness tool.

While the topic awareness tool finds and displays links to relevant information, the information space awareness tool highlights these links in a treemap visualization of the information space (Bederson, Shneiderman and Wattenberg, 2002). The treemap consists of links to blog posts, information feeds, expert recommendations, emergency response plans, and scientific papers. Each link consists of a rectangle in a color that indicates when the information was created, resulting in a compact visualization of the amount, kind, and age of available information. At the same time, the geographic awareness tool focuses a Google map on the USA, Canada, and the UK, and displays icons indicating the location of the victims.

E-SOS will thus allow users to view the emerging situation through the lens of a collaborative website. The content of the website will be collaboratively created by the public and will reflect the current global situation. The website will serve as a "social sensor" by collecting information from users around the world.

Implementation

The awareness tools in E-SOS have been implemented as web services (<http://www.w3.org/2002/ws/>). (Figure 3)



The topic awareness tool is based on research into just-in-time information retrieval (JITIR) agents, specifically a pervasive computing application called the Remembrance Agent which uses information from the user's current writing task to formulate queries and retrieve content from locally-stored full-text indexes (Rhodes and Maes, 2000; Rhodes and Starner, 1996). The topic awareness tool, like the Remembrance Agent, includes several features of pervasive computing systems: it is proactive, it acts based on the user's writing task, and it seeks to make the user aware of new information in an unobtrusive manner. The most notable differences between the two are that the topic awareness tool is a network-aware web application and can communicate with search engines residing anywhere on the Internet.

In E-SOS, as the user writes a report, the system captures the keystrokes, builds tokens for queries, and calls web services to perform searches. The geographic awareness tool calls a Google Maps API, which provides location coordinates and centers the E-SOS map on these coordinates (<http://code.google.com/apis/maps/documentation/>). The topic awareness tool can perform a federated search against any REST-based web service that exposes a query interface and returns XML. These, in turn, serve as input to the information space awareness tool.

In the current implementation, a servlet queries multiple instances of Solr (<http://lucene.apache.org/solr/>), each of which exposes a Lucene index (<http://lucene.apache.org/java/docs/>). We are developing a version that will work with other systems, such as bioinformatics resources and triple stores containing data about experts and their social networks. This version will allow users to select which targets to search: for example, datasets and social networks, or datasets and scientific papers.

Future work

The topic, geographic, and information space awareness tools will be integrated into Drupal (<http://drupal.org/>), an open-source content management system, in the next phase of the project. We have tested instances of Drupal with 14 groups of users at the Los Alamos National Laboratory, the Department of Energy libraries, and the University of New Mexico (Collins, Martinez, Mane, Powell, Kieffer, Simas, Heckethorn, Varjabedian, Blake and Luce, 2007). We use Drupal because it has a rich feature set, supports more than 40 languages, and has a large development community. This community continues to develop solutions to problems, including the problem of maintaining information privacy, which is a key concern of the experts we have interviewed.

After we integrate the topic, geographic, and information space awareness tools described in this paper into an E-SOS instance of Drupal, we will conduct field tests. We are currently discussing options for doing so with a government agency and a university.

CONCLUSION

The design of E-SOS is motivated by information requirements for global emergencies where scientific and medical information, local reports, and many other information sources need to be integrated in order to provide situation awareness. Using E-SOS, users will be able to find and comprehend relevant information quickly. As users post their reports, the topic, geographic, and information space awareness tools will alert them to relevant information and reduce cognitive overload by:

- Displaying just those links that are relevant to the user's current task
- Providing links that are unobtrusive and appear in the users' peripheral vision
- Providing users with a visualization of the amount, kind, and age of available information
- Facilitating navigation through the virtual information space according to these criteria

These synthesis and awareness tools will initiate a synchronized display of information as soon as the user starts to write a report in E-SOS and without any explicit action on the user's part. E-SOS will thus enable users to manage information rapidly so that they can focus on understanding and solving the enormous problems posed by global emergencies.

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