CONSEQUENCE MANAGEMENT ELECTRONIC WATCHBOARD

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ABSTRACT

Chemical and biological weapons of mass destruction (WMD) pose a real threat to our civilian populations. Recent examples of this threat include the Sarin gas attack in the Tokyo subway system in l995, together with the bombings of the Oklahoma Federal Building and the World Trade Center in New York. Under the leadership of the Defense Advanced Research Projects Agency, and working with the U.S. Marine Corps Chemical/Biological Incident Response Force, SAIC has developed and integrated prototype systems to enhance responses to a biological or chemical event against civilian populations.

Software development is currently undergoing a dramatic change. New technologies are becoming available at an astounding pace and the Internet has added a new dimension to software development by requiring the export of data to the Web through HTML, CGI, Java, or other interfaces. SAIC has leveraged these new technologies to provide a revolutionary approach to the consequence management of a chemical/biological and WMD incident. This paper describes the architecture and new applications deployed in the development of the Electronic WatchBoard which has significantly improved our nation's response to this threat.

CONSEQUENCE MANAGEMENT ELECTRONIC WATCHBOARD

INTRODUCTION

Chemical and biological weapons of mass destruction (WMD) pose a real threat to our civilian populations. The Sarin gas attack in the Tokyo subway system in l995 together with the bombings of the Oklahoma Federal Building and the World Trade Center in New York City are three recent examples of this threat. On June 21, l995, President Clinton issued the following directive: "The United States shall give the highest priority to developing capabilities to manage the consequence of nuclear, biological or chemical materials or weapons use by terrorists."

In response to this, the White House issued *Presidential Decision Directive #39* (PDD 39). The Advanced Concepts and Systems Technology Division (Code D41) of NRaD has been tasked to support the operational development of a Biological Warfare Defense Program. This effort will leverage the technology being developed in conjunction with research efforts of the Defense Advanced Research Projects Agency (DARPA). One of DARPA's overarching goals is to integrate research efforts and demonstrate them in the context of U.S. military and government operations. To achieve this goal, DARPA and the Marine Corps System Command are pursuing high payoff hardware and software solutions pertaining directly to the area of Biological Warfare Defense (BWD) and Consequence Management (CM). The Chemical Biological Incident Response Force (CBIRF), headquartered at Camp Lejune, NC, is the primary operational unit in this effort.

The goal of the Biological Warfare Defense program within DARPA is to develop revolutionary approaches and leading edge technologies for advancing the capability of humans to collaborate on shared problems relating to BWD. This program focuses on the evolution of prototype information architectures and their ability to enhance responses to a biological or chemical event against civilian populations.

The mission of the SAIC BWD Team is to develop the Enhanced Consequence Management Planning and Support System (ENCOMPASS) architecture, information infrastructure, and situation assessment decision aids. ENCOMPASS will assist incident commanders, medical treatment providers, and consequence managers with the next-generation collaboration middleware and tools. These tools will enable national and military assets such as CBIRF, and civilian responders to:

1. Gather appropriate problem-solvers together across time and space for rapid response in time-critical situations
2. Bring appropriate information resources together across time and space within the context of a biological or chemical terrorist event.

TECHNOLOGY DESCRIPTION

Software development is currently undergoing a dramatic change. New technologies are becoming available at an astounding pace and the Internet has added a new dimension to software development by requiring the export of data to the Web through HTML, CGI, Java, or other interfaces. Complicating the problem are the addition of other technologies such as the Object Management Group's Common Object Request Broker Architecture (OMG CORBA), Persistence, Document Serving, Object Collaboration, and a more sophisticated customer demanding quality products at a "fast-food" pace.

In support of DARPA's BWD program, SAIC developed the ENCOMPASS architecture as a set of clearly defined, lightweight, reusable classes that allow programmers to create powerful objects by combining their various features through inheritance. The resulting architecture is clearly and precisely defined, yet flexible and adaptable to support the implementation of applications that support rapidly evolving requirements. SAIC developed loosely coupled, reusable classes to support access to distributed, heterogeneous data sources; support event services among Java and CORBA objects; and the instantiation of situation assessment and incident "business" components.

As illustrated in **Figure 1**, the ENCOMPASS component-based architecture combines elements of data abstraction, layering, and implicit invocation. The objective of the component-based architecture is to create small packages of independent software that are identifiable as business concepts and are loosely coupled, flexible, scalable, and robust. These independent software packages (ENCOMPASS business components) are layered on top of common services (Data Services, Plan Services, Collaboration Services, Meta Services). In Version 1 of the ENCOMPASS architecture, the common services support an abstract, business object view of the underlying persistent data. A key aspect of the architecture is the ability to integrate ENCOMPASS components from several different contractors by sharing business concepts and foundational objects (i.e., current incidents, calculation of stay time, patient triage categories) as objects such that multiple ENCOMPASS and external applications can share the state and behaviors of the objects.

Figure 1 illustrates the client/server multi-tiered model developed by SAIC for integration of ENCOMPASS planning, situation assessment, and execution applications by specifying reusable ENCOMPASS generic services. The multi-tiered approach is an extension of the two-tiered approach. By separating the presentation layer and the generic services from the rest of the application, the functional code of the application can be turned into reusable, distributed, functional services.

The ENCOMPASS architecture specifies IONA's Orbix product and Visigenic's Visibroker as the current ORB choices. CORBA's Dynamic Invocation Interface (DII) provides a client the capability of invoking any operation on any object it may access over the network. This includes objects for which it has no stub, i.e. objects newly added to the network and discovered through a naming or trading service. This technique is very powerful for allowing applications to dynamically adapt to a changing environment.

The architecture recommends the use of ActiveX and Java for development of client user interfaces. Orbix Desktop and the Visibroker products allow ActiveX, Java, and CORBA clients and servers to interoperate. There are many issues associated with interoperability between ActiveX and CORBA. The ENCOMPASS architect is tracking the current status of the OMG's DCOM/CORBA interoperability specification.

The ENCOMPASS reference architecture provides a framework to support an orderly migration from existing legacy applications to a Defense Information Infrastructure Common Operating Environment (DII COE) compliant system operating in a distributed computing environment. ENCOMPASS incorporates features for shared global databases; distributed data; distributed processes; standard user interfaces; transparent application of business rules, information, and computing; and individual tailoring of information resources. The ENCOMPASS reference architecture prescribes an approach for localizing various concerns of a particular application with particular components. A component-based approach to reuse depends on intelligent and effective partitioning of concerns.

Information Services

The Java Enhanced DataServer (**Figure 2)** is a CORBA middleware service that uses an object-oriented schema to provide clients with an object-oriented view of distributed heterogeneous databases. This service is being developed by SAIC as part of the ENCOMPASS architecture and is migrating to the DII COE as a core service for access to distributed information in an enterprise.

The goal of the DataServer is to allow easy, transparent access and management of data that spans various databases using a variety of storage techniques (e.g., distributed relational, hierarchical, flat file, object oriented, and multimedia). Databases may exist at different geographical locations connected via a network. Clients are able to access these databases as if the data were in a single database. Automatic generation of complete object definitions within another core information service, the MetaServer, will be derived from the Designer 2000 repository to enable rapid re-generation of the CORBA gateway to accommodate underlying database schema changes to the Oracle databases.

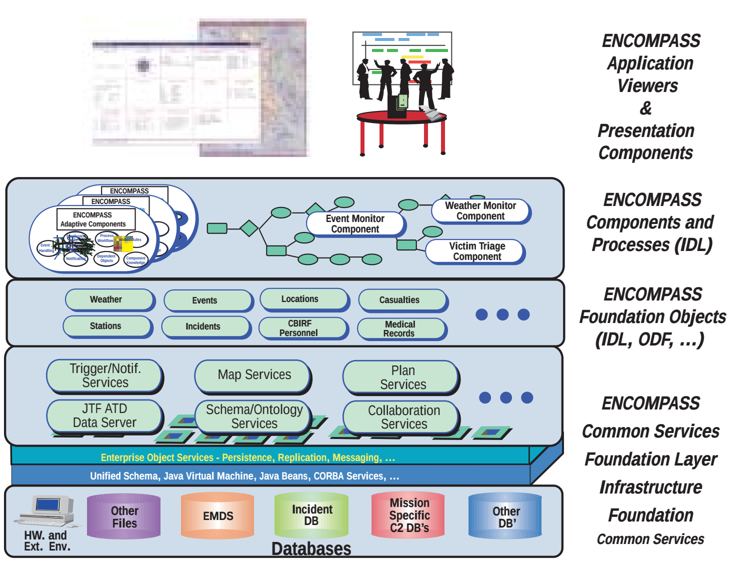

Figure 1. ENCOMPASS Component-Based Architecture

The Java Enhanced DataServer is a Visigenics-based CORBA server that provides client access to data through standard Java Data Base Connectivity (JDBC) calls. A Java Enhanced DataServer JDBC Driver is loaded into the client, performs all server connection tasks, and relieves the client application from having to locate and bind to the DataServer CORBA Server. The Visibroker CORBA services are currently being evaluated for integration, including the Visibroker Naming, Transaction, and Security Services.

Java Enhanced DataServer is being designed as a plug-and-play data source service. Any type of data that can be accessed by a JDBC Driver can be accessed by the Java Enhanced DataServer. The value that the Java Enhanced DataServer currently adds is the ability to provide virtual "URLs" for accessing data, the ability to do client-

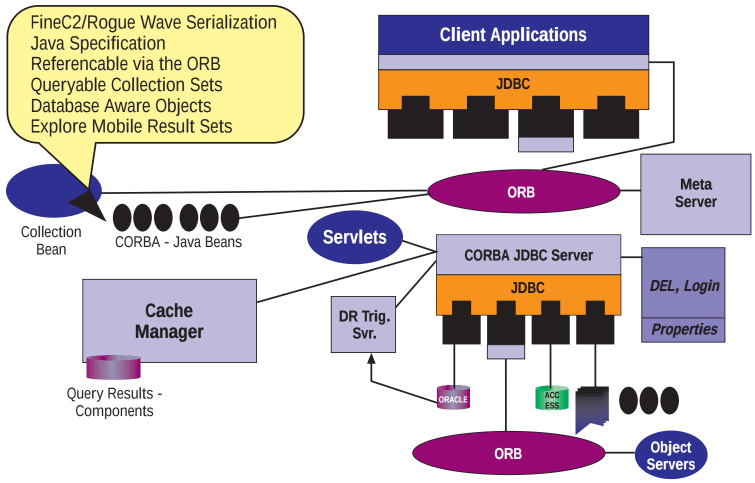

Figure 2. Java Enhanced Data Server

side caching, and the ability to provide data changed-events for the client.

The Java Enhanced DataServer is in the process of being enhanced to support queries using SQL and/or object queries across multiple databases, and to integrate object services for maintaining multiple caches of query-enabled object collections throughout the enterprise. The cached collections will appear to the user as a dynamic, virtual database. For example, if a user performs a query to retrieve "all brown-eyed employees" from a database, the results can be cached, and then a query such as "all employees under 18" could be executed against the cached results of the previous query. Obviously this will have its greatest impact when the cached results are constructed from time-consuming queries, or queries against multiple databases.

Java Enhanced DataServer provides client callbacks through the use of the Collaborator technology, which is also being developed by SAIC. The Collaborator delivers asynchronous event messages from CORBA servers to client-side objects. In Java this is accomplished by using the standard Java 1.1 Event Model (model, view, controller pattern). Currently, this service is used by the Java Enhanced DataServer JDBC Driver and the Java Enhanced DataServer CORBA Server to communicate events of interest. In addition, this service is used to deliver data source change events to objects within the client (not just to the Java Enhanced DataServer Driver).

Technology Approach

The Consequence Management Electronic WatchBoard (EWB) is the primary tool utilized by CBIRF from an incident command & control perspective. This tool is built on an advanced information infrastructure and Java Enhanced DataServer technology, developed by the Advanced Research Technology Division of SAIC in San Diego.

Figure 3 depicts the CBIRF Incident Model for Consequence Management of a biological or chemical terrorist incident.

The EWB can be deployed in four major areas:

- Incident Commanders laptop
- Command Operations Center (COC)
- Response Task Force (RTF) Center
- Hospital emergency rooms receiving casualties from the incident site.

SAIC is developing several key ENCOMPASS components in addition to the information infrastructure. These are the:

- Consequence Management Electronic WatchBoard
- ENCOMPASS Geographic Mapping System
- Video Archive News Agent (VANA)
- ENCOMPASS Telephony Interface.

The following sections describe these in greater detail.

Electronic WatchBoard

Figure 4 shows the Electronic WatchBoard, which is the primary tool utilized by CBIRF as an incident command and control application.

The EWB provides situational awareness to the on-scene commander and allows the on-scene commander to communicate events to multiple sites, including all supporting federal, state, and local agency headquarters, operations centers, and in-field information centers. The EWB helps track status of patients and on-scene responders in and out of the hot zone; records on-site medical treatment that can be forwarded to other Medical Treatment Facilities (MTF); and automatically calculates stay times based on current weather statistics.

The EWB provides a situation assessment tool where views are easily tailored to support mission-objectives; configured for read-only and write access based on user permissions and requirements; and can support the recall of information for post-event analysis. Once an event is designated as a chemical or biological threat or act of terrorism, the ability to control the event and manage the consequences becomes critical. The EWB monitors the flow of casualties, variations to the

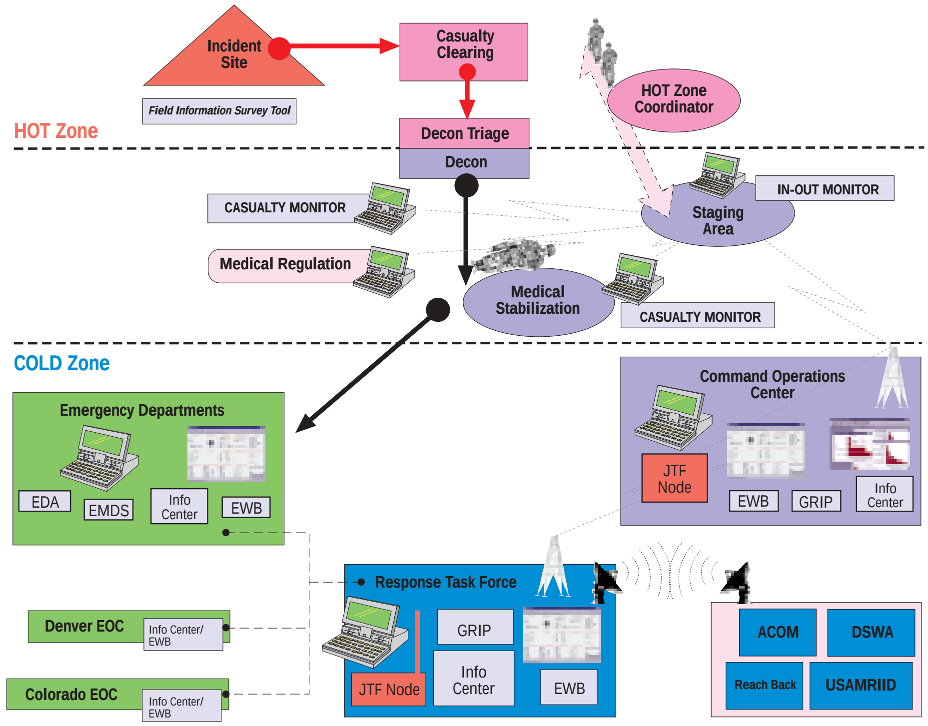

Figure 3. Incident Module

affected area, and supplies additional statistical information about the event as it evolves.

ENCOMPASS Geographic Mapping System

The ENCOMPASS Geographic Mapping System (GMS) provides information related to map-based planning of a biological warfare incident and specific factors

Figure 4. Consequence Management Electronic WatchBoard

that might assist in mitigating or decreasing the threat to the area **(Figure 5)**. The GMS is being implemented using ESRI's Internet Mapping Objects package. This allows information authored by CBIRF on the maps to be shared with clients using a standard Netscape or Internet Explorer WWW browser. CBIRF uses the GMS to:

- View resources that are in the area (water facilities, hospitals, etc.)
- Define placement of responders in the area
- Display outputs from modeling components of plume clouds spread over time, based on weather inputs
- Make important decisions about patient-staging areas in and out of the Hot Zone.

Video Archive News Agent

A Video Archive News Agent (VANA) is being integrated into ENCOMPASS as a tool to evaluate media coverage during incidents, and to provide real-time information capture of video news reports during an event. VANA, developed under an internal SAIC research and development funding, scans live television broadcasts and produces an indexed database of program transcripts, with attached story filmstrips and MPEG video clips. Through a browser interface such as Netscape or Internet Explorer, a user can instantly retrieve video clips in answer to a query using key-

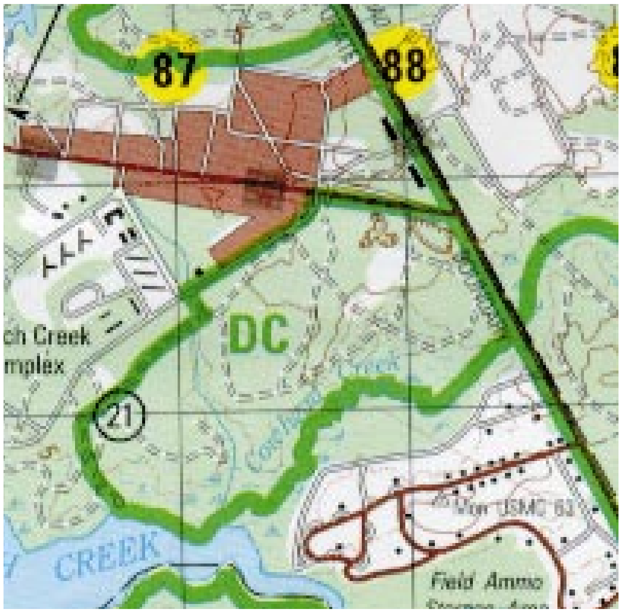

Figure 5. ENCOMPASS Mapping System

word searches. VANA supports real-time collection and management of video news stories, and provides WWW access to a video repository. Broadcast news is made up of a number of story segments, where each segment can stand on its own. When performing a search, the goal is to retrieve relevant stories in their entirety, not in arbitrary segments. VANA accurately segments video stories.

The VANA segmenting algorithm performs almost flawlessly with CNN and CNBC broadcast signals. VANA consists of a culling agent which searches video every two hours. Without a culling agent to remove "uninteresting" stories, the available storage would be quickly exceeded. The ENCOMPASS VANA solution is about monitoring breaking news, and avoiding the costly problem of massive long-term video storage.

ENCOMPASS Telephony Server

The ENCOMPASS Telephony Server provides a spoken dialogue interface to the ENCOMPASS Incident Repository. The ENCOMPASS Telephony Server is implemented using Oregon Graduate Institutes computer science laboratory unit toolkit. The Telephony Interface is being developed in Version 2 of the ENCOMPASS system to provide a dynamic spoken-dialogue interface with the incident, planning, and news data that is captured within the system. The Telephony Server is being integrated with the Incident Repository, and will also interact with the ENCOMPASS business components that are defined within the ENCOMPASS architecture. The Telephony Server allows any authorized users to enter the system using a telephone, and to access up-to-the-minute situation and planning information, or on-line news.

Other Applications

Communication is a critical component when it comes to saving lives and mitigating a terrorist attack or chemical/biological event. The first responder must quickly and efficiently gather information to accurately assess the situation. He/she must determine the causative agent, secure the scene, locate the injured, identify potential victims, and communicate all of these details to multiple locations **(Figure 6)**, including: their home office, and other supporting agencies which may include local emergency, fire, or law enforcement services; state and regional emergency operations centers; and multiple federal agencies such as the Federal Bureau of Investigation or Federal Emergency Management Agency (FEMA). FEMA, in accordance with PDD 39, coordinates the response of federal resources and military assets (such as CBIRF) which assist the local Incident Commander. The EWB can quickly, seamlessly, and securely communicate the details of an incident to all of these agencies via Internet access and the appropriate user permissions. The architecture supports the ability to interface with any local or federal databases, DoD helplines, knowledge-based systems, and domain experts that provide support for agent identification and the appropriate medical treatment information **(Figure 7)**.

Figure 6. Field Laboratory Test by On-site Commander

Treatment rendered in the field **(Figure 8)**, both in the contaminated and decontaminated areas, can be recorded, communicated to the Incident Command Post, displayed on WatchBoards located at the local EOCs and in surrounding jurisdictional areas, and transmitted to the emergency departments of the local hospitals that will be receiving patients. Emergency medical

Figure 7. Ongoing Incident Activity

Figure 8. Field Treatment

providers are thus supplied with medical information that is often unavailable or difficult to receive.

Communication to the general public, to the specific population at risk, and to the media, must be carefully managed by the local commander. The public must be provided accurate and specific information about the threat or actual event, and must receive instructions concerning what actions to take to protect life and property. The dissemination of correct, consistent information in a timely manner is critical. We are all aware of the chaos, confusion, and tragedy which occurs with the misrepresentation of events. The EWB supports the dissemination of accurate and timely information, by providing the command post, public information liaisons, and the media with up-to-date and precise information on the status of the event, including all relief and recovery operations.

The convergence of all these support agencies and coordination of all of these resources is a tremendous task. Ensuring the safety of both responders and victims, gathering and sharing of intelligence, and the coordination and control across multiple platforms and locations is one of the greatest challenges facing any Incident Commander. Although the EWB was developed for use by the CBIRF, the underlying logical concepts and theory of knowledge is based on the Incident Command System (ICS), which defines an organizational framework and strategy that is recognized and currently employed by multiple disciplines. The technology and communication infrastructure that SAIC developed, permits the cells, or views, that are displayed on the EWB to be tailored to support the needs and specific data requirements of emergency responders and medical personnel across all functions and levels of response.

The power of the EWB, and the underlying technology, is the ability to integrate disparate systems, support communication between multiple disciplines transversing several levels of response, and coordinate and manage the communication demands of emergency situations that often vary in scope, size, nature, and the hazard they pose to the community.

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