TOP Grant Narrative for NYC-OEM Demonstration TSSD

Introduction

In 2002, aware of the problems faced by all levels of government in dealing with major crises such as the terrorist attacks of September 11, 2001, Volpe National Transportation Systems Center[1] (Volpe) engineers conceived of a system that could greatly improve the ability to respond appropriately to such catastrophes. Uses of such a system need not be limited to terrorist attacks; the system conceived would be applicable to almost any situation, including day-to-day operations, where knowledge of the situation and ability to intervene are required.

By the spring of 2003, Volpe and NYC-OEM[2] (OEM) had agreed on the content of a Memorandum of Understanding[3] (MOU) to work together in building test bed to demonstrate these emergency management automation concepts. The concept, named Transportation Security Situation Display or TSSD, had gone through preliminary design. A major computer vendor, Silicon Graphics, Inc. (SGI), joined to provide computational equipment on a research partnership basis[4].

The initial TSSD program contemplated that Volpe, SGI and OEM would share information and skills on a no-cost basis to develop an initial demonstration capability. That demonstration, ready as of March 2004, is intended to demonstrate the capacity of the technology to perform many of the necessary component tasks needed.

Step two in the development process is to produce a pilot of the TSSD, which can be used in a limited operational mode. The Pilot TSSD will include a fusion of Graphic Information System (GIS) data, Computer Aided Design (CAD) data, and assessor-related data to provide a fixed framework for situational awareness. Combined with that will be a selection of live data to include aviation, maritime, rail and street traffic. Such real-time data will not be exhaustive, but consist of readily available sources. The fixed framework will be the canvas on which the live data will be placed. Finally, advanced SGI displays will provide a situational depiction for OEM personnel. The TSSD Pilot is the stage of TSSD development for which this proposal seeks funding.

Volpe and NYC-OEM expect to use the pilot to gain experience with the TSSD. We hope to identify what information components are required but missing, develop insight into both what the TSSD can be used for and how to use it, and understand how the system should be modified for greater utility. That information combined with additional support OEM and Volpe hope to develop in the future will be applied to develop Step Three of the TSSD.

Step Three in the development process of TSSD is an Operational Prototype. This prototype TSSD will be capable of performing the full suite of TSSD functions, but may not

[1] See Exhibit III, Volpe Center
[2] See Exhibit II, NYC Office of Emergency Management
[3] See Exhibit I, MOU between Volpe Center and Office of Emergency Management
[4] See Exhibit IV, CRADA between Volpe Center and SGI

have been fully tested and validated. The TSSD Operational Prototype may need hardening and shakedown of computer codes and other components to become qualified as fully operational. The Operational Prototype TSSD is beyond the scope of this grant application, but Volpe and OEM are committed to finding funding and support to realize the full TSSD.

The Pilot TSSD, which is the objective of this grant application, will have sufficient capability for Volpe (and/or SGI) to put together a demonstration for other locales than NYC. It is the intention of the team members to make the system available to other cities and at regional, state and national levels. Although the Pilot discussed here will be focused on situational awareness for a city or urban region, we expect to communicate information generated at the city level to the regional, state and national levels so they will be informed and able to participate in disaster mitigation.

By putting national and regional scale data together with feeds from several cities, the regional, state and national TSSD systems will gain the ability to precisely deal with widespread events (Figure 1). Thus, the TSSD model is one that contemplates fusing many local and other data and information resources, providing visibility and situational awareness at all levels of government, using advanced models and other decision support

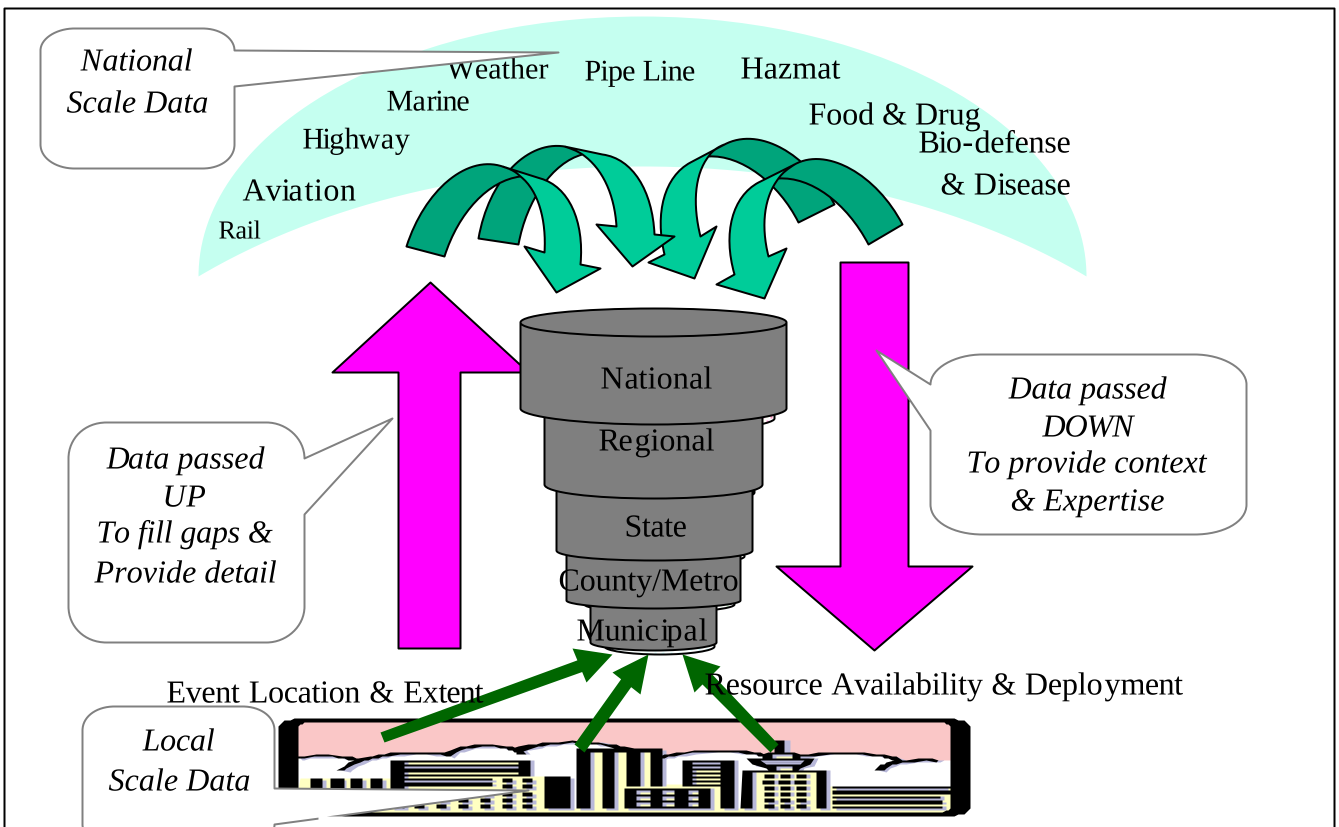

Figure 1: TSSD Operates at Every Level

tools to facilitate a quick and effective reaction, and communicating this information among all the participants.

The TSSD is compatible with varied other programs by government to provide infrastructure to deal with terrorists and disasters, and will utilize any and all such infrastructure wherever it is available. Thus, the TSSD concept has the ability to grow into a national capability based on the experience and information generated by the TSSD Pilot.

TSSD Description

The TSSD is an information fusion system and clearinghouse. The intention is to bring together every kind and instance of information required for emergency management to form a comprehensive information platform that leaves nothing out for an individual attempting to deal with a rapidly evolving and complex situation. The information the project plans to use takes two forms (fixed and dynamic) based on the different processing required to handle it.

Fixed information changes infrequently, perhaps annually. This is the street layout, building position and shape, shoreline, topography and other map detail of a site. Also included here are utilities, transportation infrastructure, and, perhaps signage and other landmarks. For the TSSD Pilot, much of this information will come from OEM efforts already underway to bring this information together. Many would call this database a GIS. Although this statement is largely true, the objectives for the TSSD will tend to organize the system differently than a GIS.

The TSSD Pilot will be able to assemble and present the fixed data set in a way that will allow operators to view it from many points of view. For instance, TSSD Pilot user will be able to position the display to see a street in exactly the way a first responder (such as a police officer) standing on the street would view it, then move smoothly into a plan view from above, and then move in a single jump to the view of another first responder. This example, while not the only application, illustrates the difference between the TSSD and a conventional GIS.

A TSSD Pilot user will have the ability to access information about the fixed infrastructure on the display. For instance, the name and characteristics of a building (size, materiel, facing, occupancy, owner & contact information, tenants, use, hazmat, etc.) that may be stored in the database but not immediately shown on the display could be called up. The user may also wish to highlight all the buildings that have a particular characteristic. Similar queries will be possible for dynamic data. The TSSD will also assemble and present dynamic data. This refers to information about things, which are changing at a rapid rate. From a few seconds per update (such as with fast moving aircraft or trains) to a few hours per update (such as an encroaching storm system), these items require significantly different handling than fixed data. Dynamic items must be incorporated into the presentation "on the fly." Whereas a fixed data update may be prepared in a separate environment and incorporated into the data structure at a convenient time, dynamic information must be processed directly by the active TSSD and be ready for presentation with minimal delay.

Simulations and models also generate dynamic data. They will provide monitoring and advice on complex events to TSSD Pilot users. For instance (Figure 2), a spill of toxic gas may result in a toxic dispersal plume. Use of weather data, fixed topography and building data, and chemical characteristics allow a simulation of plume progression to be modeled. The plume will typically have one appearance, and affected buildings be shown in a different highlight color. Using the dynamic display capability of TSSD, predicted or actual progression of the plume can be depicted.

Figure 2: Depiction of Toxic Gas Release

The TSSD team anticipates obtaining access to several live sources for the pilot system:

- Aviation (aircraft position) data is available to all qualified recipients through application to the FAA. Volpe Center has significant experience with this information and can arrange access.
- Maritime (ship position) data for most US ports is available in real time to qualified recipients. In this case, Volpe Center would provide the information from direct feeds with the consent of the USCG.
- Traffic data for major highways in NYC is collected and provided in real time by TRANSCOM, a consortium of metro NY agencies. OEM can sponsor the provision of a feed for TSSD. This feed shows roadway congestion status, not individual vehicles. Never-the-less, it is dynamic data that gives TSSD users significant situational awareness.
- Subway movement data is clearly important to the TSSD. At this time, it is not clear whether this information can be generated for TSSD purposes. If OEM can develop such a feed, it will be presented as a component of the TSSD.
- Movement and position of emergency vehicles can be collected from wireless position reporting by the vehicles. Such systems exist for many NYC vehicles. OEM will attempt to link this information to TSSD so users can monitor and locate emergency vehicles as part of the allocation of resources to an emergency event.
- Weather is a major component of any disaster scenario, and TSSD must provide the best information possible. Volpe Center and OEM will cooperate with Massachusetts Institute of Technology (MIT) Lincoln Labs in re-establishing an ITWS (Integrated Terminal Weather System) capability for use in the TSSD. Information from ITWS would be available as a direct display or integrated into the TSSD views. The team will investigate other available weather information as well.

Another type of dynamic data is available in NYC. The various agencies in New York have placed approximately 6,000 surveillance cameras at strategic location around the City. These video signals are collected to a single site via optical fiber cables. OEM and Volpe will develop a digitized feed of these images to the TSSD. Users will be able to select live camera icons depicted in actual camera positions in the display. The TSSD would then overlay the image from camera in question on the display. Then the user would have a live depiction of the area in question. All images would be available, and users could hold any image on screen as long as necessary. However, the user would not select explicitly form a list of 6,000 cameras; the selection would be from the overview display.

The TSSD is structured as a series of processes (or objects, see Figure 3). These run independently under the UNIX operating system. The processes connect and operate on a peer-to-peer basis, and spawn subordinate helper processes, which also run independently. This architecture creates a process-rich environment that takes advantage of the operating system's resource allocation efficiencies. It also facilitates flexible addition of new functions and upgrading of existing routines without disturbing the rest of the system. This structure is ideal for the TSSD Pilot, which will be the baseline architecture for the anticipated Operational Prototype, and will require frequent change and upgrades during its development and evaluation.

Initializer starts system, makes sure processes connect. *Director* handles real time events, simulations, and archives. *Interact* accepts user input, formulates queries & commands, delivers results. *Picture* manages the display, coordinate transforms, and view windows.

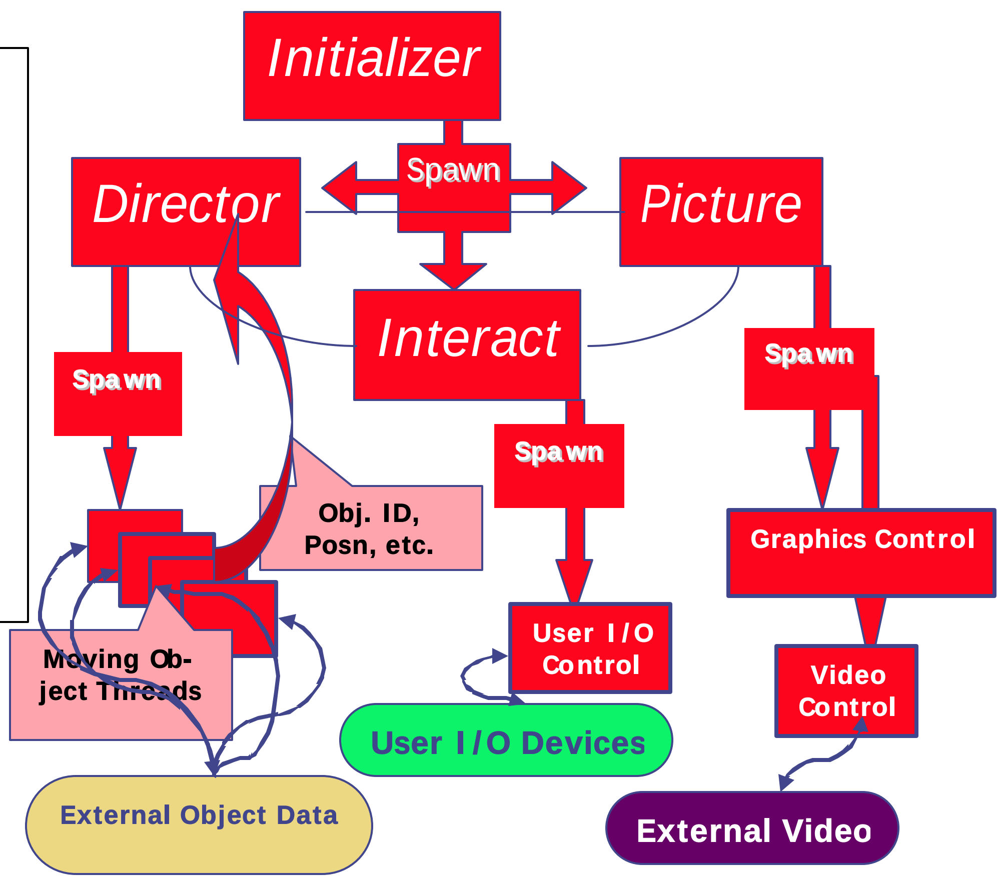

Figure 3: Top-level TSSD Architecture

TSSD Pilot Implementation Process

The TSSD Pilot will be implemented using Commercial Off-the-Shelf (COTS) and Government Off-the-Shelf (GOTS) components wherever possible. Much of the TSSD implementation consists of joining existing elements, and the TSSD team does not suggest reinventing such components. The focus will be on interfacing existing components and filling in any gaps in the necessary applications. This approach allows the project to control the overall architecture, since component G/COTS will exist, each within its own process environment. The ability to interconnect many different components into a functional whole is one major innovation of the TSSD.

The supporting hardware for the principal or main system component of TSSD will be SGI computers running UNIX. The development and data concentration site will be located at the Volpe Center. This site will connect by high speed Internet and separate T1 communication line to a site at the NYC-OEM. The Volpe site will contain processors and storage necessary to accommodate all foreseeable configurations, archives, and anything else required for TSSD. The NYC-OEM site will be configured to supply local capability to OEM with a smaller SGI system. Both sites will initially use an SGI ONYX running the SGI IRIX operating system. The Volpe site will also use an SGI ALTIX for computation and storage archives. The ALTIX uses an enhanced version of LINUX. The ONYX at OEM will supply a large "situation room" display and interconnect the OEM network of PC's with TSSD functionality.

TSSD development and releases will originate at Volpe. When ready, they will be installed at OEM. Volpe and OEM will consult on use and suitability. The TSSD team expects several development cycles during the life of the TSSD Pilot. Both Volpe and OEM sites will host numerous presentations of TSSD to further its potential use in times to come.

GIS data will be obtained using both the ESRI Systems software products ARC-Info and ARC-View and additional routines in the UNIX environment. To combine, display and manipulate the fused fixed and dynamic components, the Team will use a variety of techniques. A fixed data fusion package[5] will be used to create an OpenGL 3-D model of the fixed data in question. Moving object data will be inserted into the OpenGL package using methods provided in the package for this purpose. OpenGL will also provide a user interface.

Some interface software will be needed between TSSD and the modeling packages, including weather packages. For weather, we will use a modified ITWS package from Lincoln Labs, and various other products from the NWS. For plume modeling, we expect to use a comprehensive package from the Naval Research Labs (NRL) called CT-Analyst. We are using algorithms from work at MIT by Prof. James Fay to model disastrous burn events such as a Liquefied Natural Gas (LNG) Tanker fire. Volpe also has access to several advanced traffic models to help predict congestion related to an event. The major fo-

[5] Terrasim Corp's Terra Tools package, for instance.

cus of work by the TSSD Team will be to bring all these components together; and that fusion process is a major innovation of TSSD.

Project Evaluation

The TSSD Pilot is an approach to emergency management that, if successful, will lead to additional development and enhancement of TSSD capabilities in New York City and beyond. Success may defined through evidence that shows how a limited number of data sets can be fused and displayed in a way that supports critical functions within the OEM, and how this helps the agency perform its mission in a more effective manner. Because OEM is also a part of a much larger fabric of interested parties in the metropolitan area, a successful TSSD Pilot would also produce evidence of a more cooperative and productive environment between OEM's mission and tasks with those of other city and local agencies.

The project proposes to interview selected OEM staff at three stages during the project – within the first two months, at 12 months, and at 20 months. These interviews will be coordinated with delivery of system upgrades[6] to assure personnel are responding against a release with which they are familiar. Using a questionnaire currently under development, staff will elicit assessments of current operations, plans for future development, and the perception and utilization of advanced technologies such as TSSD. The evaluation will summarize results with the goal of understanding how the TSSD affected staff's ability to carry out job assignments, plan for future emergencies, and interact with counterparts in other city agencies.

Narrative Conclusion

The TSSD in general and the TSSD Pilot project proposed here have the potential to synthesize advanced technology, massive information and data resources, and the profound interconnectivity of the Internet to allow OEM operational personnel to instantly pinpoint anomalies, understand threats, decide action, and dispatch/allocate resources.

A fully functional TSSD in New York will have deterrent capacity through its ability to provide real-time situational awareness across the array of public officials, first responders, and organizations with critical infrastructures such as hospitals, utilities, transportation and port facilities. In the post 9/11 era, such a capability will work toward maximizing public trust and confidence:

- The TSSD enables the NYC-OEM to operate more efficiently and effectively, and by reference, allows the City to manage problems more quickly and allocate resources more effectively. The city is safer and more secure.
- By enabling a safer and more secure city, the TSSD improves the quality of life for New Yorkers and its visitors by minimizing the impact of emergency incidents on their everyday lives.
- The experience gained with TSSD in New York coupled with its national scale design will allow other cities to standardize and implement TSSD systems of their own more quickly. By acting as a model site, New York paves the way for the rest of the country and helps realize the corresponding economic benefits.

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[6] See Appendix Exhibit XI -- Schedule

- The TSSD does not operate in an intrusive way. The system makes currently available information and models more effective and provides more and better options for city officials to mitigate events. This does not mean bad things won't happen – it means they will be handled more efficiently. That means the public will enjoy an improved quality of life.