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Modeling and Simulation for Emergency Response:
Workshop Report, Standards and Tools

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Cover sheet graphics include screen displays of the following modeling and simulation tools included in the appendices of this report (from top of the cover to the bottom): HAZUS developed by Federal Emergency Management Agency and National Institute of Building Sciences, the screen display is from a model developed by Applied Research Associates, Inc.; CAPARS developed by Regional Atmospheric Response Center, AlphaTRAC Atmospheric Consultants and Innovative GIS Solutions, Inc.; JCATS developed by US Joint Forces Command (USJFCOM) Joint War Fighting Center (included in Appendix B as ACATS); and HOTMAC/RAPTAD developed by YSA Corporation. The background graphic is a screen display from CT-Analyst developed by Naval Research Laboratory. The cover has been designed by Bessmarie A. Young of NIST Manufacturing Engineering Lab.

PREFACE

This document provides a summary of the talks and working sessions during the "Modeling and Simulation for Emergency Response" workshop. We elected to provide a summary including the key points of the talks instead of including the presentation materials. We believe the readers will find this more useful. Based on their interest, readers can access the specific presentation through the workshop website: www.nist.gov/simresponse.

For the four working sessions, we have included the summaries as provided by moderators and scribes for the sessions. Care has been taken to present the material as collected from workshop breakout session attendees by the moderators and scribes and we have refrained from adding any material. A number of acronyms have been expanded in this material for better readability. The acronyms and abbreviations are also listed in Appendix C for reference.

While we have made every effort to summarize the talks and working sessions without losing the key message, readers and presenters are invited to send their comments, and/or suggestions for improvement of this document to *mser_report_feedback@cme.nist.gov* by January 31, 2004. An updated version of this report may be prepared by March 2004, if the feedback received warrants such a revision.

Appendix A and B of this document respectively include relevant standards and modeling and simulation tools for emergency response. The information on standards and tools has been collected using Internet searches and information provided by attendees of the workshop. The information presented for each tool and standard has been adapted from referenced websites. Readers are invited to send information on additional tools, standards, and suggested revisions on the information currently included to *mser_report_feedback@cme.nist.gov* by February 29, 2004. We would like to release an updated version of these appendices next year.

We would like to thank all the speakers who shared their valuable knowledge and time, all the participants in the workshop for providing their contribution through the working sessions, and the facilitators and scribes of the working sessions for capturing the discussions and presenting them to all attendees. We thank the vendors who provided displays of relevant tools and techniques during the workshop. We would also like to thank all the sponsors of this workshop including: NIST, NIST Manufacturing Engineering Laboratory, NIST Building and Fire Research Laboratory, NIST Advanced Technology Program, NIST Systems Integration for Manufacturing Applications program, Advanced Technology Institute (ATI), Association for Enterprise Integration (AFEI), and Oak Ridge National Laboratory. Many people contributed to the success of the workshop and it will be hard to list everyone. We would specifically like to acknowledge the efforts of the workshop organization committee who worked with the authors including: Jack Corley of ATI, David Cheeseborough of AFEI, and the following people from NIST – Sharon Kemmerer, Swee Leong, Mark Carlisle, and Cynthia Giaquinto.

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I. EXECUTIVE SUMMARY

A workshop on "Modeling and Simulation for Emergency Response" was held from March 4 to March 6, 2003 at the National Institute of Standards and Technology (NIST). Emergency response is defined as all the activities for identifying, detecting, planning, training, analyzing vulnerability and responding to unanticipated events that may result in injury and/or loss of human lives and damage and/or destruction of critical infrastructure elements. NIST has responded to recent events by including "Homeland Security" as one of the four strategic focus areas in its 2010 strategic plan. This strategic focus led to NIST hosting this workshop.

The two and a half day workshop program included talks and four breakout sessions that invited attendees to formulate recommendations in selected areas. The talks focused on topics ranging from requirements for modeling and simulation (M&S) tools for emergency response, proposals for integration of such tools into a framework for rapid deployment of this vital capability, available M&S applications for the purpose and prospective funding programs to support such developments. The summaries captured below include the key points from the talks and workshop breakout sessions.

The development of M&S tools for emergency response should be guided by the requirements of the first responders. The environment at an emergency response site can get quite chaotic. Assumptions such as someone is always in command and response is coordinated do not hold. The responders need to be trained to handle such situations and simulations can help meet this need. Responders do believe simulation can be a useful training tool though they do not want to see it totally replace the hands-on exercises (note: this belief may be based on the commonly available technology; exposure to advanced virtual reality technology may change this belief in the future). The perception is that simulations take too large an effort to build and are generally too complex. The user requirements workshop breakout recommended that requirements should be considered across all perspective levels including strategic, management, operational and tactical. The communication needs across organization boundaries need to be defined at each perspective level. Standard terminology should be used across jurisdictions, across disciplines and across levels of government.

A framework for integrating modeling, simulation and visualization tools can help address some of the requirements of the first responders, in particular, for the command and control personnel at the state, regional and national level Emergency Operations Centers (EOC). Integration of such tools will allow looking at the overall picture and help guide better decision-making. It will allow bringing together tools from various modeling domains such as plume dispersion, traffic movement, communication processes, hospital operations for rapidly building a virtual representation of an emergency response scenario. NIST with its experience of building standards for integration of manufacturing simulations has developed a concept on an integrated Emergency Response Framework. The requirements for such a framework include the capabilities for integrating non-homogenous software and a user base that includes non-computing professionals. Oak Ridge National Laboratory (ORNL) has technologies for integration, data retrieval and standardization that can help build the framework. The integration workshop breakout recommended that types of tools that need to be integrated need to be identified and features for interoperability identified. The High Level Architecture, developed under the leadership of the Defense Modeling and Simulation Office (DMSO) to support reuse and interoperability across the large numbers of different types of simulations used by the Department of Defense, can be used as an integration mechanism for emergency response simulations also. It must address protocol, syntax and semantics time synchronization. Standards to support integration should be identified and developed where lacking.

A number of modeling and simulation tools for emergency response related applications are available and more are under development. These include tools for planning such as virtual representations of city landscapes, human body representations for enhanced medical response, war theatre simulation tools that can be used for homeland security applications, and discrete event simulation tools for planning for medical resources to attend to affected population. A number of tools address training needs ranging from national level training exercises to agency level simulated exercises. Simulation tools for modeling a hazardous

plume dispersion under forecasted weather conditions are already available for use for real time support of response activity. Efforts have also focused on validation of simulation tools.

Simulations are data intensive and an information platform needs to be prepared to enable their use. Strategies are being put into place to ensure availability of required data, specifically, the geospatial data. A number of efforts are in progress for building nationwide real-time detection systems. These include placement of sensors and detectors on existing infrastructure elements. The data requirements' breakout session concluded that there is an obvious need for data exchange standards. Metadata should be developed and maintained and should connect to accessible data archives.

A roadmap for developing and implementing the proposed framework needs to be defined. The roadmap workshop breakout identified the elements of the roadmap and the issues that it should address. The goal for this effort should include moving the existing body of knowledge from expert sources such as Department of Defense (DoD) and Department of Energy (DoE) to emergency response community. A standardized body of knowledge and methodologies should be established.

This document provides brief summaries of the presentations and workshop sessions at the event. The summaries are arranged in the sequence of the workshop agenda. The appendices provide related information on modeling and simulation and supporting tools, standards associated with this area and reference information collected by the authors.

II. OPENING REMARKS

Opening Remarks by Dr. Dale Hall, Director, Manufacturing Engineering Laboratory, National Institute of Standards and Technology (NIST):

Dr. Hall's talk highlighted the wake-up call received for emergency response through many recent natural disasters and man-made events including the terrorist attacks of 9-11. Several calls for action through reports and broad agency announcements by the policymakers of the nation were listed. NIST has responded by including "Homeland Security" as one of its four strategic focus areas in its 2010 strategic plan.

A case was made for using simulation for emergency response. Simulation is a valuable tool for emergency response and can be used for vulnerability assessment, planning, training and decision support. It was identified as the only feasible approach when it is difficult to do real-life experiments, as is the case for homeland security applications.

NIST was introduced as the agency responsible for the development of standards, measurements, testing capabilities, and representing US interests in the international standards communities. A brief overview was provided of the multiple ongoing and past efforts at NIST in the area of emergency response. These include efforts for strengthening structural and safety standards, improved materials for structures, cyber-security standards and technologies, enhanced threat detection and protection, and tools for law enforcement and emergency response. Activities in emergency response include facilitating better national standards for chemical and biological protective gear, standardization of communication for first responders, standard test arena for search and rescue robot performance and developing simulation tools and standards for emergency response.

NIST has considerable experience in the area of manufacturing simulation and visualization that is being leveraged for application of simulation to the emergency response area. The strategy is based on identifying the needs of the first responders and surveying the available tools and relevant standards against the needs. An initial framework has been defined for integrating tools. The workshop had been organized to bring together leading experts in the area to provide input towards establishing a roadmap for moving forward.

Dr. Hall challenged the attendees were to achieve the goals of the workshop and those of the focused sessions on data, integration, user requirements and roadmap development.

III. REQUIREMENTS FOR M&S FOR EMERGENCY RESPONSE

III.1. **The Assumptions of Disaster Planning**

– Dr. Paul D. Kim, Area Emergency Manager, VA Healthcare System Upstate New York Emergency Management Strategic Healthcare Group, Department of Veterans Affairs

Dr. Kim based his talk on his broad experience in emergency response operations including working at the Emergency Operation Center for the City of New York following the 9/11 attacks. The U.S. approach to emergency scene management was compared to that of Israel and a summary of lessons learned was provided. The assumptions made by emergency response personnel were listed and discussed.

The big three of terrorist organizations were identified as Hamas, Hizbollah and Islamic Jihad. A video of a terrorist attack on Israel was shown. It was pointed out that no fire trucks and police cars were noticeable on the scene. The emergency response personnel in Israel stage further away from the scene to minimize exposure of their first responders to a secondary attack.

Preparedness is only as good as the assumptions on which it is based. The general assumptions made for emergency response were listed as below.

- When it happens I will know what to do.
- Someone is in command.
- Response is coordinated.
- Patients arrive in an orderly fashion.
- Resources and supplies are available as needed.
- All medical problems are traumatic.

Dr. Kim discussed each one of them and provided anecdotes indicating that all of the assumptions usually prove to be wrong. Training exercises, if done well, can help emergency personnel plan better. It was pointed out that the required twice a year exercises at hospitals have been found to be not taken seriously and hence have not proven as worthwhile as intended. Some of the incident site conundrums were also pointed out such as responders tearing the scene apart for rescue and recovery operations while law enforcement wants the scene undisturbed for evidence collection. These efforts need to be coordinated.

Dr. Kim shared experiences from the incident command post. The responders have to workaround the unplanned interruptions in basic services. The NY city incident command post used a ham radio operator network to communicate until the phone network became operational. Hospitals now-a-days use computerized just-in-time procurement systems. The procurement systems cannot operate if power supply is interrupted. This results in no orders being sent out to vendors in turn leading to a shortage of medical supplies. The plans should also ensure availability of equipment such as generators, phones, fax machines and copiers. Memorandums of Understanding (MoUs) should be established with suppliers for maintenance of the equipment during emergency response operations. Subsistence of emergency responders and assistance needs of their families should be planned for. The interoperability of equipment for use at emergency response operations centers should be ensured. The tactical and medical decision making should be combined for efficient operations of hospital emergency incident command centers.

It was pointed out that setup and running of emergency operations centers and incident command centers need personnel with special skills. These special skills include capability to predict the needs, act as scribes, and of acquiring and running the logistics equipment.

III.2. The First Responder Perspective – Mr. Jock Bond, Deputy, Emergency Management Division, Titan Group

Mr. Bond's briefing provided a perspective based on several years of conducting Weapons of Mass Destruction (WMD) exercises for first responders in communities across the nation. It described the diversity of audience and capabilities in different communities and the challenges associated with developing live exercises and table-top seminars to train all of them. It also included information from a survey of the response community on their interest in and need for including models and simulation in their training programs.

The lessons learned from exercises indicate that the following are critical for emergency response:

- Intra- Inter- agency communication/ notification
- Intra- Inter- agency coordination
- Incident command/ unified command
- Victim decontamination (on scene and at hospitals)
- Cross-contamination
- HazMat/ bomb squad interoperability
- Syndromic surveillance (determination of patterns based on emergency room visits)
- Criminal/epidemiological investigation
- Incident scene/ hospital coordination
- Public information

The diversity of first responders in different communities poses a challenge to develop emergency response training. A number of organizations are involved, each with different demographics. Of the total of approximately one million firefighters in the nation, 75% are volunteers. Most of the volunteer firefighters are based in rural areas. In metropolitan areas, firefighters are mostly professionals. The responsibilities of the different organizations overlap and sometimes are not clearly defined. For example, local police, local fire department and emergency medical service (EMS) are responsible for initial response while the role of the FBI for this function is not clearly defined for this function. Some of the organizations are easier to model such as 911 dispatch, FBI, and National Guard Bureau Civil Support Teams (NGB-CST). Similarly some functions are easier to model including protective actions, hazard identification, victim decontamination and responder decontamination. However, it is challenging to model other functions including notification, initial response, protective actions, mutual aid, victim care and public information.

The feedback from responders surveyed indicated that they feel "inundated" daily with individuals and companies identifying modeling and simulation capabilities. They are concerned about the experts who do the modeling and believe most products are too boilerplate and hard to tailor to their requirements. They believe that the city scale modeling tools that they have seen are too personnel intensive and are too focused on one approach. A hybrid approach is needed. Some believe their community is too low a threat to get into extensive modeling and simulation. Some believe that inter-personal communication "is their job," and they don't want a model to diminish the importance of that dynamic.

On the positive side, responders do believe that simulation can be a useful training tool though there is a concern that it may be perceived as replacement of hands-on exercises and worse yet, reduction of budgets. They need help separating "the wheat from the chaff." All would like an all-inclusive tool, but believe that it is currently too hard to do. In the absence of that, they recommend "focused" modeling such as bomb squad simulation, mass vaccination/ alternate care facility concepts and video games for concepts such as the Visual Purple FBI product.

It was recommended that the efforts should focus on the high threat and high vulnerability areas first. These include the 17% of the counties where 75% of the nation's population resides, and even more so the 3% of the counties among them where 44% of the nation population resides.

IV. FRAMEWORK FOR MODELING & SIMULATION FOR EMERGENCY RESPONSE

IV.1. Vision for an Integrated Emergency Response Framework - Mr. Charles McLean, Program Manager, Manufacturing Simulation and Visualization, NIST, and Dr. Sanjay Jain, Visiting Professor, NIST and Research Associate Professor, Virginia Tech

Mr. McLean provided an overview of the NIST effort for modeling and simulation for emergency response. A brief introduction to NIST's effort in developing standards for simulation applications was provided followed by a description of the vision for a framework for emergency response.

Simulation standards help make more effective use of modeling and simulation. The standards must establish interfaces, enable development of neutral simulation component libraries, lead to commercial implementations in off-the-shelf products and permit customization to meet individual user needs. The Manufacturing Simulation and Visualization program at NIST has been working on multiple facets of simulation standards including architecture, interfaces and model specification. NIST is currently engaged in a major effort to develop a manufacturing shop data model and interface specification for simulation working with Software Engineering Institute's Technology Insertion, Demonstration, and Evaluation (TIDE) program. It involves developing a hierarchical structure, resource handling, plan development and implementation, material lists, etc., all of which are applicable to emergency response simulation applications. The over 150 page specification contains Unified Modeling Language (UML), eXtensible Markup Language (XML) and text definitions of data for manufacturing simulation.

A Simulation Standards Consortium has been established including participants from government, industry, software vendors, research institutes and academia. The consortium's goal is to develop new draft

standards' specifications and prototype implementations that demonstrate their feasibility. Work groups are being formed in special interest areas including facilities layout, planning and scheduling.

The objective in the area of emergency response is also to develop standards working with partners. Addressing an emergency incident requires addressing multiple interdependent aspects of the situation. The simulation tools addressing different aspects of an emergency situation need to be integrated to provide the whole picture to planners, trainers and responders.

Dr. Jain presented a proposed framework for integrated emergency response developed at NIST. The integrated Emergency Response Framework (iERF) addresses the domain on three axes – disaster event, entities of interest and applications. The disaster event axis represents different kinds of events including man-made and natural disasters. The "entities of interest" axis represents the impact on the general public, first responders, infrastructure, etc. The applications axis captures the various uses of such tools including planning, vulnerability analysis, identification and detection, training and real time response support. The framework can help identify the gaps in availability of modeling and simulation tools and help define the integration needs.

The integration of modeling and simulation tools can be effectively carried out if they follow interoperability standards. Data standards requirements for emergency response can be developed and specified using Unified Modeling Language (UML) (OMG 2001). An architecture for integrated use of modeling and simulation tools has been proposed. The interoperability standards can be developed using a defined plan going through the stages of gathering consensus from interested agencies, developing specification sets, selecting models and test data sets and developing a prototype simulation environment. A successful prototype can lead to implementation by transitioning results to software developers and relevant standards organizations.

The availability of interoperability standards for modeling and simulation tools for emergency response will improve significantly the nation's capability in this area. The integrated set of tools can be used for developing well-coordinated response plans. They can be used for providing a complete scenario for training where the results of response actions can be evaluated immediately allowing rapid learning for the trainees. The tools can be used for rapid evaluation of alternate response plans on the occurrence of a major incident and prudent selection of the plan leading to minimization of impact of the incident.

IV.2. Developing a National Emergency Response Modeling and Simulation Framework – Ms. Rebecca Moses, Michael J. Taylor and Gary R. Steiner, Nuclear Science and Technology Division, Oak Ridge National Laboratory

Ms. Moses presented an approach for the development of a framework to allow distributed and integrated execution of a broad range of simulation systems.

The ability to accurately simulate scenario- and locale-specific emergency response (ER) incidents is crucial for administrative planning as well as for first-responder training and operational support. Given the current geo-political climate and the harsh reality that terrorist acts are globally motivated but locally implemented, it is imperative that all levels of government have access to state-of-the-art ER modeling capabilities. Unfortunately, many local agencies lack the technical expertise and computing resources to conduct such modeling studies. While simulation tools and supporting data certainly exist to model an extremely wide range of individual ER incident scenarios, these computing resources do not exist as an integrated analysis tool for use by non-computing professionals. Currently, there is neither an integrated ER simulation capability nor a dedicated infrastructure to develop and maintain such non-trivial modeling capabilities.

The vision of the framework includes a highly integrated on-demand analysis capability that covers the complete occurrence-evolution-operational-resolution problem space. It should support administrative planning, first responder training and real-time operational support. It should be available via a network to any federal, state and local agency.

Some of the numerical complexities associated with developing an integrated general-purpose ER modeling capability and providing the analysis capability to a geographically disbursed and non-homogenous user base were summarized. A methodology is required for integrating non-homogenous software and a user base that includes non-computing professionals. The analysis framework should be implemented with a "Problem Solving Environment" to manage computing complexity at run time. The software integration issues are complex and necessitate an advanced methodology such as the Cognitive Agent Architecture Open Source (COUGAAR) software originally developed by DARPA and ALPINE, a consortium currently composed entirely of BBN Technologies.

Access is needed to provide statistically consistent, locale-specific data; and software is needed for integrated analysis. The data requirements' categories are complex due to being context driven and typically being defined fully only at run-time. Even within a category, data values can vary significantly and hence on-demand on-line data identification, retrieval, and validation are needed. Potential methodologies for data retrieval and standardization include "Mercury" and "VIPAR." Both these methodologies were developed at ORNL. Mercury is a web-based metadata search and data retrieval system and can be used for building a centralized index. The Virtual Information Processing Agent Research (VIPAR) project developed VIPAR software for text analysis and clustering using software agents.

The large-scale geographically dispersed distributed computing network will pose operational management challenges. Also, many agencies do not have the computing expertise and resources to access the analysis capabilities.

The talk concluded by calling for the creation of a national user facility which would be responsible for developing and maintaining integrated ER simulation tools and high-quality supporting data. Patterned after the highly successful scientific user centers within the Department of Energy, the proposed facility would provide these computing resources free of charge to local governments via a nationwide distributed computing network.

V. PREPARING THE INFORMATION PLATFORM FOR M&S

V.1. Geospatial Information for Emergency Responders – Strategy for Nationwide Availability and Interoperability – Ms. Susan Kalweit, Chief, Interagency Geospatial Preparedness Team, Office of National Preparedness, FEMA, Department of Homeland Security.

State and local governments are engaged daily in activities that protect property and guarantee the safety of more than 284 million Americans. But they do so without the benefit of key data, tools, and standards that can ensure improved safety for first responders and citizens alike. Spatial data (information linked to an electronic map) and associated technologies significantly increase emergency response effectiveness and efficiency. They also enhance hazard mitigation and provide for non-emergency applications that will pay for themselves many times over.

Today, there is a lack of coordination that results in duplication of effort and cost among federal agencies involved in geospatial activities. States and local authorities receive mixed, conflicting, or competing guidance and direction from geospatial providers. For our nation to use geospatial capabilities as a critical underpinning to national emergency preparedness and homeland security, federal and other levels of government need to coordinate their efforts and share information.

The Federal Emergency Management Agency (FEMA) established the Interagency Geospatial Preparedness Team (IGPT) to help address these needs. The IGPT interacts with a wide array of emergency response and homeland security stakeholders at all levels of government and in the private sector. Its objective is to use geospatial information to enable state and local governments to better respond to disasters.

The merger of Global Positioning System (GPS), GIS and other technologies to provide rich geospatial data can bring about a new economy. The creation of geospatial models needs to be supported at several fronts. Standards need to be developed for integration of 3D models. For example, the models created using Light Detection And Ranging (LIDAR) and pictometry cannot be integrated currently. Creation of geospatial models will also require sharing of data and resources. National and state policies that are roadblocks to such data sharing need to be reviewed and relaxed where possible. Innovative ways for funding the efforts need to be developed. The state of Maine has issued public bonds to fund a geospatial library and has also modified policies to allow sharing of data. The availability of information has to be balanced with security concerns of making the data available.

V.2. Preparing for an Emergency: Preparing the Plan and Information Needs – Dr Frank Akers, Jr., Associate Laboratory Director, National Security Directorate, Oak Ridge National Laboratory (ORNL)

Dr. Akers identified the incident management system requirements and briefly described the efforts at ORNL in the areas of detection, assessment, command and control, response and training.

Comprehensive incident management requires an information technology infrastructure from local to national levels. It should provide a common operating picture to emergency responders through distributed access with multi-level security. It needs to be reliable, survivable and secure. It should be scalable across state, local and federal governments. The capability should be based on a common data highway that enables integration of information from all sources including local, state and federal governments agencies, law enforcement networks, transportation networks, intelligence networks, etc.

ORNL and University of Tennessee established The Law Enforcement Innovation Center (LEIC) in 2000 with Congressional funding. It provides training, technologies and innovations to law enforcement agencies and facilitates community partnerships. A public safety technology alliance involving LEIC, ORNL, state forensic laboratories and law enforcement agencies has developed a number of technologies including cyanoacrylate fingerprint, chemical characterization of fingerprints, audio and video tape reconstruction, and theft prevention encapsulated taggants.

ORNL efforts in the detection area include projects to build a Nationwide Real-Time Detection System. It utilizes an existing infrastructure for rapid deployment of sensing capabilities. Sensors are being placed on mobile-phone towers. The towers already have the telemetry to signal need for replacement for the Federal Aviation Administration (FAA)-mandated red lights on the top. Nuclear detectors are being integrated with weigh stations on highways. AquaSentinel, a photosynthetic biosensor system for drinking water developed at ORNL can detect chemical antagonists and is being tested for deployment to primary sources of drinking water. The information from these detectors and sensors can be used to identify potential risk areas and use customized phone messages based on receiver location for response.

A number of tools have been developed at ORNL for assessment. LandScan, the federal standard for population data helps estimate the population at risk based on the geographical location of a hazard. Hazard Prediction and Assessments Capability (HPAC) estimates the hazards from atmospheric release of nuclear, biological and chemical (NBC) materials. The Hydrologic Transport Assessment System (HYTRAS) predicts the transport and concentration of NBC agents in water.

ORNL has similarly developed tools to support command and control. Command center interface provide needed graphics and textual information for an incident including sensor details, time history plots and 3D fly-throughs. Hazard prediction capabilities allow estimation of exposure of population over time and help to plan the response.

Rapid response requires real time information to be sent directly to the decision-maker. It requires immediate identification of threat and predictive assessment of an event over time. It should facilitate getting the right information to first responders and fast. RAMSAFE, a tool developed originally at ORNL and being further developed by Public Safety Systems, LLC, can be used for coordinating first responders

during an incident. It is designed for use during normal operations of first response agencies allowing embedded training. The users can develop the tool expertise during day-to-day operations and use it effectively during emergency incidents.

Training for readiness can be enhanced through the use of realistic scenarios and models. Embedded training will ensure effectiveness of the tool. The tools should include projected effects on population, conquer jurisdictional issues and improve operating procedures.

Note: Brief descriptions of the tools mentioned by Dr. Akers are included in Appendix B: Emergency Response Modeling and Simulation Tools and Projects.

VI. MODELING AND SIMULATION TOOLS FOR EMERGENCY RESPONSE

This section includes a number of talks describing various modeling and simulation tools. The first five tools are focused on planning applications, the next four are focused on training applications, the tenth talk is focused on a real-time response support application and the eleventh and the last talk summarized in this section describes a study that validated emergency response simulation tools.

VI.1. Simulation-based Training to Prepare for Acts of Terrorism within the U.S. – Mr. Bob Clover, Technical Director, Institute for Defense Analyses (IDA)

Mr. Clover provided a brief discussion of Virtual Reality (VR) modeling and simulation for security planning and WMD response training and identified future needs.

The Virtual Cities program of IDA is creating virtual reality representations of several cities in the U.S. The concept originated in the Virtual Emergency Response Training Simulation (VERTS) program for training of the first response community and the military responders to Weapons of Mass Destruction (WMD) incidents. The VERTS program allowed responders to go in full protective gear inside virtual reality representations of a scene. Other responders could participate using monitors with virtual reality displays. The application highlighted the value of such representations in training. This motivated the development of virtual representations of large areas of a city that may include sensitive buildings for training and planning applications. Graphics of the area around the White House were shown as examples.

The value of developing realistic representations was shown through their use in transport and dispersion modeling of biological or chemical agents. A sample virtual scenario was used to model a dispersion plume transport using different techniques. It was shown that in an urban scenario the models could be in error if computational fluid dynamics (CFD) techniques are not used to model the impact of building geometries and locations on the plume dispersion.

A number of high resolution graphics representations have been developed at IDA. Examples shown included lower Manhattan, World Financial Center, World Trade Center, downtown Philadelphia (modeled for security planning of the Republican national convention), and Social Hall in Salt Lake City (headquarters of Olympic Committee and FBI during the 2002 Winter Olympics).

Virtual Reality technology has improved rapidly over the past few years. A number of examples showing the same scene with 5 year old technology and current technology were used to underline the advancements. The advanced technology has led to wide use of virtual cities as evident by a list of over fifteen users and uses.

The process of developing virtual cities was briefly described. Various sources of data including Geographic Information Systems (GIS) data, drawings, building plans, and city maps are processed using terrain generation software. The outputs can be used to create the virtual cities. An alternative process includes transmittal using Synthetic Environment Data Representation and Interchange Specification (SEDRIS) and visualization using Synthetic Environment Evaluation - Inspection Tool (SEE-IT). Mr.

Clover's talk closed with a short discussion of capabilities that still need to be developed to provide intelligent virtual environments.

VI.2. Vision for the Future - How can simulation and modeling help emergency responders?
- Dr. Rick Satava, Program Manager, Defense Sciences Office, Defense Advanced Research Projects Agency (DARPA)

Dr. Satava's talk provided a vision of how technological developments will affect the field of medicine. It focused on the developments in the field of computing and information technology. Current information technology has allowed development of Holomer, an application that allows building a virtual human by scanning a real human. The virtual human information can be encapsulated in small tags that can be used if the human gets injured in an incident.

Advanced technologies have allowed total integration of operative care including remote surgery, minimally invasive surgeries, training using simulations, pre-operative planning using simulations, and intra-operative navigation. Indeed the future health care provider may be a robot. The medical care can be brought to remote corners of the world by deploying knowledgebases on portable equipment such as laptops and personal digital assistants. The LSTAT "stretcher" provides a mobile hospital through provision of a defibrillator, ventilator, suction, monitoring, blood chemistry analysis, 3-channel drug and fluid infusion, data storage and transmission, on-board battery, and on-board oxygen. The LSTATs were effectively used in Kosovo in 2000.

The future of science is moving towards interdisciplinary fields. It must encompass all dimensions and domains and must include time and information. It may be the "biointelligence" age. The interaction of biology and information technology is developing genomics, bioinformatics and biocomputations. The interaction of information and physical sciences is developing robotics, micro-electronic mechanical systems (MEMS) and nanotechnology. The interaction of biologic and physical is developing biosensors and biomaterials. The interaction of all three together, biology, physical science and information technology will develop a cellular cyborg.

A number of initiatives are targeted towards the biointelligence age. These include DARPA's BioFocus 2000, NASA's bioastronautics and astrobiology, National Space Biomedical Research Institute's (NSBRI) human system integration, National Cancer Institute's (NCI) unconventional projects, NSF's national nanotechnology initiative, DoE's virtual human project and Stanford University's Bio-X. Federal investment in nano technology has rapidly grown from $270M in FY00 to $738M in FY03. The exciting developments include bugs with sensors implanted, micro-robots, capsule cameras for gastrointestial endoscopy, direct brain implant for robot arm control, use of spider silk protein as biomaterial, tissue engineering, and controlled cellular metabolism.

Technology itself is neutral, it is neither good nor evil. It is up to us to breathe the moral and ethical life into these technologies and then apply them with empathy and compassion for each and every patient. There will be controversies and different viewpoints as exemplified by the human cloning issue. The moral and ethical issues raised by technological success will be challenging.

VI.3. U.S. Joint Forces Command Joint Warfighting Center Simulation Support to Homeland Security and Defense
– LTC Charles W. Robinson, Executive Program Manager for Modeling & Simulation, Joint Warfighting Center (JWFC)

LTC Robinson's talk provided an overview of the United States Joint Forces Command (USJFCOM) mission and its role in joint training and simulation, and its involvement in the Homeland Security and Defense area. USJFCOM's JWFC improves joint readiness by providing world-wide training and training support, assisting in the preparation of integrated and interoperable forces for future joint and multinational operations. It provides management and integration of joint capable models and simulations and provides leadership in the development of joint doctrine and joint training initiatives.

The mission and experience of JWFC places it in a good position to extend simulation support for homeland defense. The JWFC simulation toolbox is being enhanced to provide multi-echelon simulation across federal, state and local government agencies. It will provide better representation of critical functional aspects of security, defense, response and consequence management. It will also provide better representation of threats and effects anticipated in homeland defense.

The Joint Theatre Simulation System (JTLS) integrates air, land and sea environments into a single simulation with logistics and intelligence capabilities. It simulates these large scenarios with a small exercise footprint and also provides web-enabled distribution. In addition to simulating combat operations it can also be used for non-combat operations, including homeland security scenarios such as the spread of disease or mass casualty evacuation.

Joint Conflict and Tactical Simulation (JCATS) provides simulation capabilities at the tactical level of war. It is a multi-service, multi-sided, interactive, entity level simulation used by military and security organizations as a tool for joint training, analyses, experimentation, planning and mission rehearsal. It allows analysis and viewing at different level of details, including region, city, and entity level. Again, the tool has non-combat applications and can be used for homeland security applications. It was used for planning of 2002 Winter Olympics in Salt Lake City, Utah.

The Joint Integrated Database Preparation System (JIDPS) accesses and retrieves data from various data sources and creates simulation-ready files. It supports JTLS, JCATS and other similar systems. It uses Extensible Markup Language (XML) data files for integration.

The JTLS-JCATS HLA federation will offer the training audience the capability to conduct multi-echelon training from the operational to tactical level. It allows resolution from theatre (continent level) to site (building) level. Terrain cultural features can be easily added. Building complexes can be replicated based on aerial pictures. A number of homeland security scenarios can be simulated including terrorist attacks, civil disturbances, domestic disaster and search and rescue. A rapid database development concept is being implemented to support the rapid creation of simulations.

VI.4. Process Oriented Framework for Emergency Response Planning, Simulation and Execution

- Mr. Robert G. Brown, Delmia Corp., Mr. George H. Collier, Telcordia Technologies, Inc., Mr. Neculai C. Tutos, Dassault Systems of America

Mr. Brown introduced the audience to the CATIA and DELMIA capabilities to support the design of improved security, emergency response planning, and to interact with advanced Digital Communication systems in security monitoring and emergency response coordination.

Sophisticated 3D simulation and modeling tools have been critically important to the aerospace and automotive industries where they are used to design products, product components and production processes. Subsequent to manufacturing these models are used to manage product life cycles, e.g., supporting the visualization of monitoring data and planning for maintenance. Dassault Systems, DS&S, SAIC and SafirRosetti -- are working to bring the power of Digital Modeling, Simulation and Communication to bear on the thorny problem of designing security and emergency response systems.

Security and emergency response planning requires an understanding of the behavior of a compromised system subsequent to an incident – and planning the human response. Statistical approaches have been successfully used in the past to model the coarse-grained structure of an incident and the response; however, 3D simulation tools can be used to create much finer grained process models. For example, 3D tools have been used to successfully model the evacuation of a facility by modeling the behavior and movement of people through a building's hallways, doors and stairwells. The same technology is used to model the behavior of the compromised system, predicting, for example, the sequence of failures of components, such as valves and pipes, as the effect ripples through the system. These predictions are based on physical simulation of the actual structure of the system, e.g., the pressure within the pipe. The feasibility of rescue, repair, decontamination and dismantling operations can be planned and simulated,

taking into account hazardous conditions. These simulations can be used to properly prepare personnel to handle the anticipated difficulties.

The development of such solutions for the emergency response community alone would not be economically justifiable. The only viable alternative is to utilize a framework based on the state of the art Digital Process Modeling solutions already proven for the aerospace, automotive and shipbuilding industries. This alternative offers large money and time savings.

Emergency response is a series of processes similar to manufacturing. The tools already provide the structure for modeling processes including interdependencies, precedence requirements, constraints and time. Emergency response workers can use the rich environment to prepare themselves without physical mock-ups. Indeed the tool has been used in the past to model fire-fighting operations. The fire itself was modeled using external processes while the human model was based on SafeWorks.

An emergency response database is needed for organizing the required data for modeling. Elements of the emergency response plans must be stored as individual elements for quick development of plans and re-planning. It should also include facility models of high risk sites, libraries of the "best practice" processes with constraints, and catalogs of resources with attributes.

Such tools can be applied for complex engineered facilities that have existing engineered models and require complex responses. The simulation models will need to be extended to support fire, explosion and hazmat release. The process models need to be extended to emergency response units such as hazmat, decon, pumpers, ladder truck, etc. The models also need to be interfaced to real time reporting systems, such as GPS reporting of location of resources, for use during actual emergencies.

A proof of concept project is recommended to prove that these tools can quickly provide value to the emergency response community. It will also help determine what adaptations and interfaces are required, and the need for interfacing with real time reporting systems.

VI.5. Computer-Aided Design of Mass Prophylaxis Strategies for Bioterrorism Response - Nathaniel Hupert, MD, MPH, Assistant Professor of Public Health and Medicine, Jason Cuomo, MPH, Mark A. Callahan, M.D., Alvin I. Mushlin, MD, Sc.M., Weill Medical College of Cornell University

Dr. Hupert's talk presented a simulation-based application for planning mass prophylaxis campaigns following a biological attack.

As demonstrated in the October 2001 anthrax attacks, successful bioterrorism response requires the ability to rapidly dispense antibiotics and other necessary medical supplies to large populations. There are few tools available to assist public health and emergency management officials in preparing scalable and modular response strategies to address a wide range of bioterrorism attack scenarios. Working under contract from the Department of Health and Human Services (DHHS) Agency for Healthcare Research and Quality (AHRQ) since 2000, researchers at Weill/Cornell have developed a series of interactive computer models that estimate the staff and other resources needed to establish and operate mass prophylaxis campaigns involving antibiotic and vaccine delivery in response to biological attacks with both communicable and non-communicable agents.

A biological attack will typically lead to a mass prophylaxis campaign to minimize the spread of the effect of the agent. The components of mass prophylaxis campaign need to be evaluated. It is anticipated that large hall-like public facilities such as indoor basketball courts will be used for such campaigns. The flow of patients through dispensing facilities can be modeled to determine the resources needed to meet the expected patient volumes. While a model developed using the ARENA simulation software was used for initial applications, the developers elected to use queuing theory models coded in Excel to allow use by a wider population of health systems professionals.

The Weill/Cornell Smallpox Vaccination Model is based on a defined flow process with paths defined for people who are being vaccinated for preventive measures and for people who may have been infected. The model can be used both for pre-event and post-event planning. It provides the spreadsheet interface for easy entry of parameters of the model such as time estimates for various tasks in the process, target population, the maximum staff available, etc. The model outputs the estimated length of the campaign under slow, baseline and fast scenarios. Graphical outputs include the plot of campaign length based on the number of available core staff. Such results can be used for planning of the campaigns.

The model has been extended to determine the impact on health care resources based on the potential of adverse reactions to the vaccination among the population. Characteristics of the adverse event can be defined including the percentage of cases with different levels of severity of reactions, time for onset, etc. The model shows that a rapid prophylaxis campaign will lead to a spike in emergency room (ER) visits and may overwhelm the ER resources in the system.

The tool provided a good methodology for estimating the number of resources compared to guesswork such as the "estimate" of 50-100,000 people required to vaccinate New York City that appeared on the World Health Organization (WHO) website. The model showed that 25,000 people could vaccinate a city of 8 million people (roughly the size of NYC population) in the desired 4-day campaign period. These numbers include only the critical dispensing staff and do not include support staff for the centers or distribution/logistics staff.

The spreadsheet modeling allows planners to "think with numbers" when designing mass prophylaxis response strategies. It forces critical examination of assumptions about the vaccination center layout and processes and the availability of resources. The model estimates are useful data to guide planning but they should not be taken as replacements for live realistic exercises.

VI.6. TOPOFF – The National Training Exercise – Major General John S. Parker, M.D. (U.S. Ret.)

General Parker described the goals, objectives and accomplishments of TOPOFF - a national-level "real-time" Weapons of Mass Destruction (WMD) response exercise. The name TOPOFF indicates involvement by Top Officials. It is designed to better prepare senior government officials to effectively respond to a terrorist attack involving WMD. In addition, law enforcement, emergency management first responders, and other non-governmental officials are involved. The Department of Justice, the Department of State, and the Federal Emergency Management Agency (FEMA) lead TOPOFF. Participants include federal, state, and local officials who would direct crisis management and consequence management response to a real WMD attack. TOPOFF was first conducted in May 2000 and involved thousands of federal, state, and local personnel, along with top U.S. officials including the Attorney General, Secretary of Health and Human Services, FBI Director, FEMA Director, and two state governors.
Originally designed to improve the response skills of senior American officials, TOPOFF now involves foreign governments since terrorism has become an increasingly global threat. Participants are confronted with a WMD attack scenario and asked to produce an integrated, coordinated response to deal with several issues across response disciplines and jurisdictions. The goal is "to support national strategy to combat terrorism by improving the capability of government officials and agencies, both within the U.S. and abroad, to provide an effective, coordinated, strategic response to all aspects of a WMD attack". TOPOFF places stress on existing response systems to demonstrate capabilities and identify areas for improvement. Following the exercise, an after-action report is conducted to identify successes, "lessons learned," and shortcomings to be addressed.

TOPOFF exercise duration varies and is conducted in "real time." In order to make the exercise as real as possible, participants are given little forewarning of what scenarios they will face, such as type of WMD involved or specific location, date, and time of the attacks.

The first TOPOFF was held in May 2000 in Denver, Colorado and Portsmouth, New Hampshire. Denver participants faced a simulated chemical attack, while New Hampshire participants were confronted with a biological attack. General Parker gave some brief insight into a second national exercise, TOPOFF2, to be

held in May 2003. It is being constructed around a systematic series of complex "building block" exercises, designed to produce a more integrated and effective WMD preparedness strategy. Numerous Federal Agencies, State and Local Emergency Responders from several states and Canada are expected to participate in the exercise.

VI.7. Training for Emergency Response
– Dr. Cortez Lawrence, Director, National Fire Programs, US Fire Administration, FEMA

Dr. Lawrence talked about the value of simulation in training in the context of fire incidents. It was pointed out that 98% of what is needed for emergency response is covered in emergency plans and training programs. However, it is hard for human beings to analyze all the options and decide on the right course of action under stress of an emergency situation. A study by Klein on decision-making concluded that most of the time a decision is made based on past experience (see note below for reference to Klein Study). The experiences create relevant knowledge and decision patterns in the mind similar to loading a relevant carousel in a slide projector. Human beings can identify a familiar situation based on the past experience and make the right decisions.

To develop the skill of decision-making in emergency response situations, people need to go through similar experiences. However, it is hard for anyone to develop a good experience base from a few emergency incidents. The answer is to use simulation. Simulations can be used to provide experiences that can then be used to prepare for future situations. There is a need for training simulations and for post fire incident investigative solutions.

The need for using simulations in emergency response training has been identified by the US Congress resulting in a directive to use technology to improve training. The fire program receives funding in three areas: equipment, training and exercises. Simulation can be used to improve at least two of the three areas.

Wild forest fires are the major challenge for fire fighters at this time. The fire fighting operations for forest fires are typically large and make huge demands on command and control. It should be noted that 80% of the fire fighters are volunteers and most of the volunteers are in rural areas. Training and educational services should be enhanced to prepare fire fighters to meet these challenges.

The simulation lab at the National Fire Academy uses 2D simulations for command and control exercises involving multiple fire companies.

Note: G. A. Klein, "Recognition-Primed Decisions" in William B. Rouse (ed.), *Advances in Man-Machine System Research* (Greenwich, CT: Jai Press, 1989).

VI.8. Beyond the Shooting House: Tying Training to Education in Homeland Security
– Dr. David McIntyre, Deputy Director, ANSER Institute for Homeland Security

Three factors have changed our world recently – (a) the flow of information, (b) the resulting shift of power in the world, and (c) vulnerability due to just-in-time systems based on rapid flow of information. The world is experiencing a different type of terrorism than in the past. Splinter groups of followers of Islam are out to change the system and they do not accept middle ground.

The concerns for terrorist strikes include, conventional attacks on strategic infrastructure elements such as bridges, attacks on strategic chemical facilities, radiological attacks that can cause severe damage to economy of an area, cyber and biological attacks with similar severe repercussions.

Simulations, gaming and exercises provide us with the means to prepare for response. Simulation was defined as replication of physical phenomenon. Simulations should be used for evaluation of capabilities. Gaming also includes replication of physical phenomenon but includes an opponent. Educational games do not provide any answer but focus on learning from experience. Training teaches the answers.

In improving emergency response training, the following factors need to be addressed:

- Inertia of trainees
- Structure of silos of expertise
- Local vs. federal budgeting
- Education for homeland security personnel

The culture needs to be changed to get trainees out of their inertia of staying involved in day to day responsibilities. People from different fields should be put together as training partners to improve understanding among functions. The local communities should be involved.

Simulation tools need to be further improved. The best simulation tools should be identified through competitions.

VI.9. Simulation Technology for Community Readiness, Training & Exercise Support – Mr. Robert Coullahan, Senior Vice President, SAIC and Certified Emergency Manager

This session improved awareness of an emerging capability, the Automated Exercise & Assessment System (AEAS), sponsored by the National Guard Bureau (NGB). The AEAS program has the objective of developing a simulation-based exercise and training tool specific to WMD terrorist attacks on the United States. A spectrum of chemical, biological, radiological, nuclear and conventional explosive (CBRNE) threats are presented in comprehensive scenarios within the AEAS application.

The tool is designed for multiple exercise audience groups including debris management, environmental health, elected officials, emergency management, fire, EMS, HAZMAT, law enforcement and medical facilities. A number of scenarios are available including an anti-abortion domestic anthrax hoax, radiological retribution by a foreign group, rogue state-sponsored military diversion smallpox at a resort hotel, and white supremacist caused derailment of a train carrying multiple chemicals.

The components of AEAS include an agency survey, community profiler, map viewer, controller station, players station and after-action review. The tool provides features for constructing a survey of the community including functional areas, resources, personnel, facilities and mutual aid pacts. Trainees can also use existing surveys of typical metropolis, urban and rural towns.

The exercise proceeds through the following steps: player training, backstory brief, exercise setup, exercise run and after action review. Player's actions are captured during the exercise and analyzed against vetted expected actions. An assessment is made for each expected action. The actions can be sorted by function though an overall assessment is not assigned. The after actions review enables emergency responders to discover how to sustain their strengths and how to improve upon their weaknesses.

AEAS is designed for use by emergency response and emergency management practitioners from the infrastructure owner/operator and local and State jurisdictional levels, and is adaptable for wide-scale federal interagency simulation events. It provides for community readiness testing using simulation-based applications, scientifically and operationally validated WMD scenarios, and the resources and response standards for the community under assessment. The AEAS supports training, exercise, and readiness assessment requirements. It will be deployed in local jurisdictions across the nation in CY2003.

VI.10. Nationwide NARAC Support for the Civil Sector - Mr. Hoyt Walker, Computer Scientist, National Atmospheric Release Advisory Center, Lawrence Livermore National Laboratory

The National Atmospheric Release Advisory Center (NARAC) provides tools and services that map the probable spread of hazardous material accidentally or intentionally released into the atmosphere. NARAC provides atmospheric plume predictions in time for an emergency manager to decide if taking protective action is necessary to protect the health and safety of people in affected areas. Located at the University of California's Lawrence Livermore National Laboratory (LLNL), NARAC is a national support and resource center for planning, real-time assessment, emergency response and detailed studies of incidents involving a

wide variety of hazards, including nuclear, radiological, chemical, biological or natural emissions. It provides 3-D plume model predictions within minutes using Internet/web tools. It develops contours of health effects or protective action guidelines.

NARAC's primary function has been to support the Department of Energy (DOE) and other select federal agencies. The center is in the process of greatly expanding its support for the civil sector within the U.S. It has several DOE-sponsored projects to provide interfaces into the nation's atmospheric release emergency response system to cities, countie and states.

NARAC is a distributed system, providing modeling and geographical information tools for deployment to an end user's computer system, as well as real-time access to global meteorological and geographical databases and advanced three-dimensional model predictions from the national center. The NARAC Web provides a simple browser-based interface and the NARAC IClient provides a more sophisticated system that is installed on an end-user's computers. Both allow users to enter information about an atmospheric release, send it to NARAC for processing and receive results within 5-15 minutes in the form of hazard-zone contours displayed over a variety of maps. These tools are described in some detail on the center's web site (http://narac.llnl.gov). NARAC also provides technical and scientific support, including quality assurance of model input data and predictions, until all airborne releases are terminated, the hazardous areas are refined by combining field measurements with model predictions and the long-term impacts are assessed. The ability of NARAC to meet the wide-ranging requirements implied by this expansion is predicated on effective use of current technologies and standards such as Common Object Request Broker Architecture (CORBA), Java 2 Platform Enterprise Edition (J2EE), XML and Simple Object Access Protocol (SOAP).

The NARAC model has been tested and evaluated through several applications. The models have been tested using field experiments at Project Prairie Grass, Savannah River mesoscale atmospheric tracer studies, etc. Its operational applications include Chernobyl, Kuwait oil fires and Cerro Grande (Los Alamos) fires.

The Local Integration of NARAC to the Cities (LINC) program is demonstrating NARAC support for pilot cities. Initial installation, configuration of network and firewalls and testing of the iClient laptop software was successfully completed in Seattle and New York City. Access to additional, special meteorological sensors is being developed. Initial users have been successfully trained. Testing and integration with city as well as state and federal emergency response plans and procedures are ongoing.

VI.11. Data Resources for Hazard Modeling in Building Interiors – Dr. Donald R. Ponikvar, Senior Vice President, Defense Group Inc.

One of the more difficult problems facing responders dealing with WMD in an urban environment is how to accurately model the propagation of a threat cloud inside a structure in order to predict the threat to persons inside and in the immediate vicinity.

Dr. Ponikvar's presentation summarized the data requirements for both multi-zonal models and computational fluid dynamics approaches for interior building modeling, and the usefulness of hazard prediction modeling inside buildings. Correctly predicting indoor hazards depends critically on facility characterization data, heating ventilation and air conditioning (HVAC) characterization data, source characterization and meteorological data.

A study of modeling and simulation tools was carried out under the Consequence Management (911-Bio) Advanced Concept Technology Demonstration (ACTD) with the purpose of enhancing the military capability to respond effectively to the use of chemical or biological weapons. An ensemble of models was brought together and evaluated for operational applicability.

A unique data set resulted from a set of experiments done by the Department of Defense at Dugway Proving Ground in 1997, where simulants and tracer gases were released inside two different instrumented buildings. A hangar at an army airfield was used to mock up a convention center hall and a release of

anthrax simulant used for experimentation. The impact of wind, temperature and HVAC system operation was evaluated. For the second scenario, an accidental release from a clandestine lab in an apartment/ townhouse complex was simulated. Again, the impact of wind, temperature, doors close/open and HVAC system operation were evaluated in different floors of the townhouse. The experiment included side-by-side comparisons of the predictive results from seven different models tailored for use inside buildings. Selected modeling results were discussed and compared to the ground truth data.

The study concluded that while the tools were useful, there was no one superior model for all applications. It is necessary to identify the questions that the modeling and simulation study has to answer and then choose the model type based on the question. The tools were not assessed to be useful to first responders for consequence management operations while in the "hot zone." There is an issue of confidence in simulation tools. People will not trust the computer and will send a person to go and measure the concentration levels in different rooms to determine safety status. At this time, for consequence management operations, modeling and simulation is better suited at on-site headquarters rather than in the hands of first responders.

The 911-Bio ACTD final report was distributed through the Defense Threat Reduction Agency, Chemical Biological Defense Directorate. The interior building ground truth data has been prepared as a separate package for release by the same office. The modeling and simulation data archive is maintained by DGI.

VII. WORKSHOP PARALLEL BREAKOUT SESSIONS

VII.1. User Requirements I & II

Facilitators: Jack Corley, Advanced Technology Institute; Sanjay Jain, Virginia Tech /NIST

The objective of this track was to collectively define modeling and simulation emergency response applications and to define the role of modeling and simulation for each phase. The first step is to define the needs for major emergency response organizations. These needs can then be reviewed by the modeling and simulation community to identify applications.

The needs will depend on the decision perspective. The perspectives can be defined using a matrix arrangement with perspectives in rows and the major organizations in columns as shown below. The entries in the table 1 below show the organization level to define the perspective.

Table 1: Emergency response organizations and perspectives

Organization / Perspective	Health	Law	Fire	Rescue	HazMat	EOC
Strategic	Public Health system	Mayor				Mayor/ elected head
Management	Medical Director	Sheriff or police chief				Director of Emergency Management
Operational	Emergency Room director/ EMS Incident commander	Watch commander/ substation	Battalion commander			Incident commander
Tactical	EMS	Patrol car/ Cops	Engine/ Firemen			Resource providers

Using the perspective definition as above, the needs for many of the organizations were defined collectively. For example, needs in the healthcare area captured during the session are listed below.

- Strategic
    - Communications
- Management
    - In a covert bio attack when will my medical system realize the threat?
    - ED/EMS strategic resource sizing
    - EMS strategic response plan design
    - EMS strategic plan validation
- Operational
    - What are the symptoms of this toxin?
    - Overview of casualties/ fatalities
    - Media public communication
    - EMS Operations – practice multi-disciplinary operations
    - Overview of available resources (beds, intensive care units (ICU), supplies, vaccines)
- Tactical
    - Training
    - Bed availability
    - Practice cross-discipline coordination

The group focused on communication - the major problem for emergency response capability identified by one of the speakers at the workshop. The group recommendations are as below.

- The communication needs across the organization boundaries need to be defined at each perspective level.
- Standard terminology should be used across jurisdictions, across disciplines and across levels of government.
- The language itself should be standardized and not just the transport mechanisms (radio frequencies).
- Resource planning
    - Tools are needed to generate and evaluate plans.
    - U.S. Army Communications-Electronics Command (CECOM) and others have models for determining network capacity. Need simpler tools than network simulation, similar to those described in Dr. Hupert's talk (summarized earlier in this document).
    - Simulation tools should be used to support communications system design to ensure that channels do not get overloaded.
- Information flow
    - Situational awareness and reporting
    - Simulate how to transform the data to information.
    - Recognize the natural rhythm of communications flow.
    - Latency of information needs to be addressed explicitly in simulation. Does it have to be instantaneous?
    - Filtering/abstraction capabilities should be adjustable in M&S - for planning, training, and response
    - Use optimization approaches to impact information processes. Use simulation technology to analyze the information at the command centers.
- Information flow has a rhythm that reflects the battle rhythm
    - Graphical representation to show rhythm for training.
    - Operational pause – halt information flow to make decisions
    - Use simulation to identify times when information is needed.
    - In training, stop and replay the simulation from that point to identify the operational pause points.
    - Inject another set of data into simulation to reset and play from there on.
    - Need to define metrics – response windows for different scenarios. Analyze the markers to identify decision and event milestones.
    - Simulation to practice the tempo and rhythm, setting up the net, data entry, and decision-making.
- Accurate, up to date data should be put together for emergency response personnel. This should include phone numbers, contact information, and resources.

    - Current data has problems such as no recognition of authority, and numbers are out of date. Simulation models should capture such uncertainty in the model until these problems are fixed.
    - Have federal government provide resources to check numbers regularly
- Analyze what is needed to support required communications when infrastructure resources are lost (e.g., a cell tower goes out).

The group recommended the following next steps:

- Establish an e-mail listserv to proceed further on user requirements.
    - For further evaluation, choose top issues from the list based on first responders survey in the presentation by Mr. Bond of Titan Corporation (see earlier summary in this document) to focus on - start with Communications, Coordination, command & control.
    - Identify groups working on common terminology
    - Identify available simulation capabilities and appropriate organizations
- NIST should take the requirements strawman to real users as they are ready to discuss this. The real users are represented by:
    - DHS – Directorate of Emergency Preparedness & Response – Mike Brown, and Rose Parks
    - National Emergency Management Association (www.nemaweb.gov)- Glen Woodberry, Current president, from State of Washington; Ed Jacobi, incoming president.
    - International Association of Emergency Managers – represents local government personnel.
    - Council of State Governors and National Governors Association.

VII.2. Data Requirements I & II

Facilitators: Mike Stiteler, Advanced Technology Institute; Tina Lee, NIST

The objective of this track was to broadly define the categories of data requirements for modeling and simulation of emergency response, and to identify potential data sources.

The major disasters to be considered for emergency response include:

- Man-made disasters
    - Chemical agent release
    - Biological agent release
    - Subsurface hydrology events (poison, leaks, etc.)
    - Human biological threat
    - Dirty Bomb explosion
- Natural disasters
    - Hurricane
    - Earthquake
    - Flooding
    - Fires
    - Volcanic Eruptions

The data for the above scenarios should include both geo-specific and geo-typical items. It should include:

- Metadata
- Data Quality Information
    - Data assurance
    - Pedigree
    - Certification
    - Verification
    - Knowledge of source
- Environmental data
- Census data
- General physical data

- Population Evacuation data

The specific data categories and sources are summarized in table 2. The table indicates a wide range of data that resides in different systems at different agencies and organizations, and some that is not available. The idea is not to create a centralized data warehouse but to develop standards and interfaces that will allow access of the data for response to emergency incidents. All involved will need to adhere to standards, meeting both semantic and syntactic specifications. Procedures need to be developed for capturing data that is not currently available.

The following conclusions were drawn from the discussion of data requirements and sources:

- There is an obvious need for data exchange standards.
- Detailed literature searches should be carried out to document development of specifications and de facto standards.
- Metadata should be developed and maintained by authoritative sources for describing data sets.
- Accessible data archives, such as indexes and repositories, should be developed.
- "Reference Part" paradigm should be used for common data requirements. The data for common model components should not be duplicated over and over, instead references should be used to a location that maintains the data.

Table 2: Potential sources for data relevant to emergency response.

TYPE OF DATA	POTENTIAL DATA SOURCES
Terrain data	US Geological Survey
Streets/highway data	City Offices, Map software companies, Atlas publishers
Response agency locations and response plans	City office, police, fire and health departments
Utility and infrastructure locations	Utility companies, telecom companies
Weather	National Oceanic and Atmospheric Administration (NOAA)
Population density	US Census Bureau
Business area population density, Transportation patterns	Local transportation departments
City evacuation plans	City office
Building design records	City office, building management
Building evacuation plans	Building security
Space information (near and far)	NOAA
Source characterization	Civil support teams/ first responders, Source reference materials (some sources will be classified)
Analysis results (simulation results)	Simulations!
Sampling measurements	On scene personnel/apparatus
Specialized attributes vice bulk data	- existing sources to be identified - Centralized database (in future)
Health-related data (patient, diseases, prophylactics, diagnoses)	Center for Disease Control and Prevention (CDC), Secure patient database
Exposure history	Interview patients, then document and share
Critical Infrastructure	National Infrastructure Simulation and Analysis Center (NISAC), State and local governments
Agricultural product characteristics	US Geological Survey (USGS), State Soil Geographic (STATSGO) soils data compiled by the Natural Resources Conservation Service (NRCS) of the US Department of Agriculture (USDA)
Human behavior/performance, organizational behavior	- No known central organization, perhaps intelligence services? - Can be modeled after Human Factors Lab, possibly in Israel?
Equipment characteristics and performance	Manufacturers

Location/inventory of equipment	Owners of equipment
Location of data (index)	Database, but which? National Spatial Data Clearinghouse (NSDI)
Ocean information (ports, depths, currents, waves, etc.)	Navy, NOAA
Emergency response language	Model after International Civil Aviation Organization (ICAO)/ North Atlantic Treaty Organization (NATO)
Hazard labels	Defense Threat Reduction Agency (DTRA), Occupational Safety and Hazards Act (OSHA) – Material Safety Data Sheets (MSDS)
Human physical characteristics	Air Force work with NIST (Contact: Sandy Ressler), 3D anthropometric landmark standard (Society of Automotive Engineers & NIST), Choreography standard notation

The second session of the track focused on identifying existing and needed standards for data, representation and storage/access. Data standards are required broadly for defining the disaster event, different entities of interest, resources, response agents, the local area of the event, etc.

The relevant data standards include:

- Intelligence Community Metadata Standards
- Environmental Protection Agency's (EPA) Biological, Chemical, Facility standards
- FAA standards on National Airspace System
- Institute of Electrical and Electronics Engineers (IEEE) standards for intelligent transportation systems
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards for building automation and control networks
- US Health Information Knowledgebase
- Organization for the Advancement of Structured Information Standards (OASIS) Emergency Management Technical Committee (announced Feb. 2003)
- International Organization for Standardization (ISO) standards for physical data exchange (CAD- Computer Aided Design, PDM- Product Data Management, Electro-mechanical, Engineering Analysis,…)

Some of the relevant data representation models include:

- ISO/International Electrotechnical Commission (IEC) 11179-X Information technology - Specification and standardization of data elements
- W3C Extensible Markup Language (XML) 1.0
- ISO/IEC 14772-1:1998, Information technology - Computer graphics and image processing - The Virtual Reality Modeling Language
- ISO/Technical Committee(TC) 211 Geographic Information/ Geomatics
- ISO/10303 Application Protocol (AP) 203 (CAD), AP210 (Electro-mechanical), AP209 (Analysis)

Standards and representation for some of the specific data categories were discussed as examples of the overall task. These categories include weather, terrain, ocean and space, man-made systems and human behavior.

Weather data standards and representation

- Standards
    - Exist: World Meteorological Organization (WMO) standard for observations: Binary Universal Format for the Representation of meteorological data (BUFR), Weather models)
    - Need: Simpler standards for Emergency Response
        - ◊ Distribution format (XML)

- Representation

- Models: Have point model & Gridded Binary (GRIB) models (grid data including spectral models).
- Organization: Uses File format

Terrain, Ocean and Space data standards and representation

- Standards
  - Exist: ISO-IEC
  - Need: Space, 3rd and 4th dimensions
- Representation
  - Models: 18023 (Synthetic Environment Data Representation and Interchange Specification, SEDRIS) UML, ISO-IEC 18025 (Environmental Data Coding Specification, EDCS), ISO 19115 (metadata, principally focused on terrain), ISO/10303 Standard for the Exchange of Product model data (STEP), Hierarchical Data Format (HDF), Network Common Data Form (NetCDF, used in DoD for ocean data, not much in weather data), ISO-IEC Spatial Reference Model ISO-IEC 18026, STEP for Thermal Analysis for Space STEP-TAS (Jet Propulsion Lab's Thermal Modeling in Space), GML (Geography Markup Language), SDTS (Spatial Data Transfer Standard)
  - Organization: Specified transmittal format (file), Specified access format

It should be noted that terrain models might include man-made structures.

Man-made Systems data standards and representation

- Standards
  - Exist: International Maritime Organization (IMO)/Lloyds/National Bureau of Shipping, Department of Transportation (DOT), FAA, Product Life Cycle Support (PLCS), Architectural Organizations (International Alliance for Interoperability IAI/ Industry Foundation Classes, IFC), Simulation Data eXchange, SDX (NIST and Electronic Data Systems Corporation), Federal Communications Commission (FCC for networks and communications and EMERGENCY BROADCAST SYSTEM)
  - Need: Resource information
- Representation
  - Models: ISO/10303: (PLCS AP239, CAD, Engineering Analysis (EA)/ Finite Element Analysis (FEA)),
  - Organization: everything from files to database to XML

Human behavior data standards and representation

- Standards
  - Exist: ISO-IEC, Psychology/Sociology Communities, Intelligence Services, Political Scientists, JCATS/JTLS models capture and surrender
  - Need: Detailed models that will enable behavior predictions, mob response, crowd/city panic (evacuation, flight from event or perceived event)
- Representation
  - Models: ISO-IEC Humanoid Animation Specification (H-ANIM)
  - Organization: Web3D Consortium is supporting H-ANIM.

Following conclusions were drawn from the discussion of standards and representation:

- Detailed human behavior models are needed. The attendees for the session knew of very few such models.
- Modeling techniques for representing/defining standards should be defined.
- Meta-modeling capabilities should be identified.
- Recommended practices for VV&A (Verification, Validation & Accreditation) should be used.
- For integrated models, the same requirement of standard formats for both data input and output should be used.

The group recommended the following next steps:

- Use email distribution list to:
    - Refine requirements
    - Enhance list of available data, models and standards
- Contact standards agencies and enhance knowledge of available data, models and standards

VII.3. Integration I & II

Facilitators: Steve Willet, NIST; Frank Riddick, NIST

The objective of this track was to identify the integration requirements through discussions of the types of tools that need to be integrated, the kind of interfaces they have and the features required for interoperability.

The modeling and simulation tools for emergency response operate at different "levels." One way to classify the tools could be as below.

- Battlefield
- Emergency response
- Fire
- Plume
- Natural disaster

Another way to classify the tools could be by levels as below.

- Strategic
- Management (EOC) level
- Operational Level
- Tactical

Yet another way to classify the tools could be by application categories such as planning versus training.

The types of tools that need to be integrated include:

- Plume simulation tools such as Hazard Prediction and Assessment Capability (HPAC) and CONTAMW
- DBST – Static Database access tool
- Data collection tools
- Analytic tools
- Scenario generation tools
- Data migration tools
- Security tools
- Reliability – anti-spoofing tools
- Testing/validation
- Tools with multiple features
- User interface
- Data mining
- Transport and dispersion
- Casualty/population
- Logistics
- Environmental (fixed and dynamic)
- Weapons effect
- Infrastructure
- Terrain representations

The features required for interoperability include:

- Standard messaging

- Data gathering
- Analytical
- Security/surety
- Scenario generation
- Database synchronization
- Anti-spoofing
- Real-time data input (interfaces)
- Data mining
- Database modeling and conversion
- Web services
- Scalability
- Common “operational picture”
- Must be predictive

The issues in making the tools interoperable include:
- Licensing of data
- Large number of municipalities that are potential users

The High Level Architecture (HLA) can be used as an integration mechanism. It must address:
- Protocol
- Syntax
- Semantics time synchronization

The second session of the track focused on identifying the interoperability standards and need, security and architecture requirements.

The relevant interoperability standards organizations include:
- Institute of Electrical and Electronics Engineers, Inc. (IEEE)
- Object Management Group (OMG)
- World Wide Web Consortium (W3C)
- Open GIS Consortium (OGC)
- Symbology (ISO standards)
- Web Services
- Text Messaging
- Health Level 7 (HL7) – Health Care Standards
- Operational terms
- Standard for the Exchange of Product model data (STEP)

A scenario-based analysis needs to be carried out to determine the applicable available and needed standards. The more apparent needs for emergency response relevant standards are:
- Federation Object Models (FOMs) & XML Schemas
- Geographical/GIS
- Global System for Mobile Communications (GSM)/Wireless
- Validation Verification and Accreditation (VV&A)
- Simulation Interoperability Standards Organization (SISO) standards
- Mature metadata for modeling, simulation and visualization

The security requirements and issues include:
- MLSI (Marks Left by a Suspected Intruder) intelligence community
- Time and need to know constraints
- Physical security issues
- Exportability and concurrence
- US/international distribution

- General communication/authentication
- Access control by view
- Audit trail
- Constraints put on by technology owners
    - Autonomous challenge/response system
    - Non-repudiation
- Forensic evidence
- Chain of custody
- Data integrity
- Access control by view (CRUD- Create Read Update Delete)
- Audit train
- Event specific security requirements
- Availability/reliability

The architecture requirements include:
- Security and access control
- Device portability
- HLA (rules/library/object modeling)
- Scalable architecture
- Streaming data feed
- Multiple views capability
- Data warehouse/shared data stores
- Multi-user role playing gaming scenarios (e.g. red and blue forces)
- Repository for neutral format standards supporting the framework
- Hierarchy of fidelity
- Standard API's, common services, data syntax
- Tactical/strategic
- Independence for telecommunications
- Predictive, historical, indicators
- Levels of integration
- Minimum requirements to play

The work in the integration area should build on the work by the Department of Defense. The focus should be on data organization since that takes the longest time in creating a federated simulation.

VII.4. Roadmap I & II
Facilitators: Skip Crane, Advanced Technology Institute; Sharon Kemmerer, NIST

The goal of the roadmap track was to define an approach for development of a framework for modeling and simulation for emergency response.

The starting point for the roadmap is the current state of a number of varied ongoing and new efforts addressing different aspects of the emergency response area. An approach should be defined for a comprehensive identification of what currently exists. The end point for the roadmap is a mature analysis capability in a distributed environment that can be used anytime, anywhere, and for any reason. One candidate definition of the endpoint is provided by the integrated Emergency Response Framework (iERF) proposed by NIST. The roadmap needs to identify the barriers between going from starting point to end point and define approaches to overcome the barriers.

A roadmap needs to provide a body of knowledge and methods to get to the end. Its elements include the following:
- Doctrine, policies and procedures
- Organization, training and material

- Hardware, Software and "Liveware"
- Leadership and management
- Infrastructure, architectures and facilities

A roadmap for emergency response modeling and simulation framework needs to:
- Define configuration management policies (firewall, interfaces, standard clients)
- Consider reliability necessities (contingencies)
- Understand the stakeholders
- Understand the stakeholders' user requirements
- Include software, hardware and liveware considerations
- Scope the whole of what one wants to do to capture the end goal and vision
- Have an ER version of HLA
- Define start and end states, and how to get from start to end state.
- Be based on the foundation of knowing and understanding what's already out there
- Develop the conduit for continued communication
- Develop complete inventory of activities
- Develop complete inventory of standards
- Develop methods to certify and/or validate to ensure application of standards/interoperability
- Develop venting process/accreditation/authority as a part of the solution
- Identify potential users
- Provide a process to identify all the existing models, simulation tools, and solutions
- Be defined by the mission.

The effort of developing the roadmap needs to decide between two major approaches: top down, deciding it in a high level central group and implementing it down; or bottom up, getting input on definition of the road map from people involved in related efforts. The ability to visualize the end point better will help the effort of developing the roadmap.

The end point can be visualized as a tool box that:
- Is versatile enough to accommodate the imagination
- Allows the user to play "what if" games in the extreme
- Ensures that there are rules that allow/enforce reliability to maintain the validity and flexibility of the serving toolbox

An integrated holistic approach is needed to help planning and administration of the solution. To achieve this end point, the roadmap needs to build on outputs of other workshop sessions including definition of:
- What data you need, where to get it?
- What models should be used?
- What security access and control are needed?
- What should be the format of standards?
- What is the extensibility?
- How do we ensure intelligent users and uses?

The roadmap should also address the following issues:
- Funding for development and maintenance of tools and interfaces
- Funding for validation of outputs
- Standards to define the data and exchange formats
- Selection method to download/acquire the product
- Knowing what goes into the toolbox
- Support users at all levels (first responders, operators, planners)
- Development of a common vocabulary
- Validation, accreditation, and certification

The group recommended the following next steps:

- Follow-on meeting is absolutely necessary.
    - An interim meeting should be conducted to define the proposal, a strategy, and charter.
    - The group should proceed with ready contributors (Joint War Fighting Center, Oak Ridge National Labs, NIST, and others)
- The goals for this effort should focus on:
    - Moving the existing body of knowledge from expert sources such as DoD, and DoE to emergency response community.
    - Establishing a standardized body of knowledge and methodologies.
- Work on issues--
    - Review projects/existing work captured in Appendix B of NIST's report on "Modeling, Simulation, and Visualization for Emergency Response" to determine:
        - ◊ What can be integrated?
        - ◊ What should be integrated?
        - ◊ Data owned by someone, is it accessible, reusable, continued value for future use?
    - Determine the reuse and salvage value of the one-time development effort for modeling and simulation tools
    - Determine design of a "funding scheme" for efforts to integrate legacy and new tools developed independently.

VIII. FUNDING PROGRAMS

VIII.1. Modeling and Simulation for Emergency Response: NSF's Role – Dr. Miriam Heller, Program Director, Infrastructure & Information Systems, National Science Foundation.

Dr. Heller's talk defined the key role played by NSF in disaster research and emergency response. The emergency response modeling and simulation area can benefit from research in the full range of disaster life-cycle area, including social sciences. It invited practitioners, developers and other government agencies to partner with fundamental researchers for problem definition, solution conception and development and technology transfer.

Research relevant to emergency response is funded through the Civil and Mechanical Systems (CMS) Division in the Directorate for Engineering at NSF. The division's mission is to:

- Provide a fundamental underpinning for the engineering profession in application to mechanical systems and the constructed environment including infrastructure systems, and
- Support the rapid development of new technology in service to society and to reduce risks induced by natural, technological, and intentional hazards.

A major program of the CMS division focuses on reduction of risks to critical infrastructure of the nation. The critical infrastructures include transportation, telecommunications, electricity, oil and gas, emergency response, government, banking & insurance and potable & wastewater. These critical infrastructures operate under stress due to deterioration, regulations, globalization, devolution, deliberate and accidental threats, natural threats, deregulation and innovation. The infrastructures have many interdependencies and stress and failure in one area can lead to stress and possible failure in others. For example, the infrastructure for emergency response relies on transportation infrastructure for transport of emergency personnel and for evacuation of the injured. It relies on water infrastructure for fire suppression, on telecom for contacting emergency personnel, on electricity for operation of medical equipment and so on.

The concept of risk-based life-cycle infrastructure engineering and management includes:

- Predictive maintenance, sensing, monitoring, data storage, transmission and retrieval
- Modeling, simulation and prediction
- Planning, training and preparedness
- Detection, life time extension, early warning
- Emergency response and diagnosis

- Recovery and corrective maintenance
- Post event analysis to determine internal & direct impacts and external & indirect impacts.

Each of the above areas has challenges that need to be addressed.

A number of overarching issues need to be considered. The focus should not be narrowly set on terrorism. There are multiple hazards and stressors that make the whole system of interdependent infrastructures vulnerable. A portfolio of risk intervention options is needed that can address different stages of technological developments over the system life cycle. A long-term view should be taken to address security without compromising other objectives. Synergistic objectives and collateral benefits should be exploited. Non-consequential issues such as workforce education and training must be addressed.

The George E. Brown Network for Earthquake Engineering Simulation (NEES) is a research effort that will develop an integrated distributed capability for earthquake modeling, simulation and visualization. It is an $81.8 million national and international resource for research and education distributed across several universities in the US. It provides full scale testing of complex structural and lifeline systems and a network for real-time experiment sharing, access to curated databases and to advanced computational resources and visualization tools through NEES "collaboratory." Its resources include a geotechnical centrifuge at University of California (UC) Davis, a tsunami wave basin at Oregon State University, and a reconfigurable reaction wall at UC Berkeley. It will also include a simulation tools repository, a curated database repository, and leading edge computation facilities available through high performance networks. The NEES infrastructure will allow geographically distributed hybrid simulation, teleobservation, tele-operation and a number of other advanced capabilities.

A number of research efforts funded by NSF focus on learning from urban disasters. An effort at George Washington University is extending the emergency response knowledgebase. It is studying the inter-organizational coordination of emergency management, medical efforts, law enforcement and military resources. It will document the information flow and compare man-made and natural disasters. An effort at the Natural Hazards Center at University of Colorado-Boulder is investigating use of GIS in emergency response. Other relevant research efforts include:

- Emergency preparedness planning and on-line evacuation of large buildings
- Evacuation management decision support system
- Modeling and simulation of wind loads for wind hazard mitigation
- Forecasting change in hurricane risk over time
- Robust on-line location and routing for urban service systems

NSF has a few programs for funding research in emergency response area. These include the NEES Grand Challenge program, Workshop on HAZUS: the next generation, and the multi-disciplinary research into critical infrastructure and related systems – mitigation, preparedness, response and recovery regarding disasters and other extreme events.

VIII.2. Department of Homeland Security Office of Domestic Preparedness & Interoperability Efforts – Mr. Frank Lepage, Supervisory Program Manager

Mr. Lepage's talk provided an overview of interoperability efforts funded by Office of Domestic Preparedness (ODP). Congress through the FY1999 Appropriations Act created the office. The services include equipment acquisition, training and exercises and technical assistance. ODP's budget for FY'03 is $1 billion.

The interoperability efforts include:

- State and local equipment grant program
- Prepositioned equipment program
- Dissemination of terrorist threat information
- Research and development

The state and local equipment grant program provides funding for first responder equipment including interoperable communications equipment. All new or upgraded radio systems and new radio equipment should be compatible with a suite of standards developed jointly by the American National Standards Institute (ANSI), Telecommunications Industry Association (TIA), and Electronics Industry Association (EIA) called ANSI/TIA/EIA -102 Phase 1 (Project 25). These standards have been developed to allow for backward compatibility with existing digital and analog systems and provide for interoperability in future systems.

The prepositioned equipment program sustains a community's response to WMD terrorist incidents, whether chemical, biological, radiological, nuclear or explosive, by promptly bringing equipment to the emergency responder and replenishing assets consumed in the response. This program aims to place eleven pods of equipment across the nation over a two-year period. These placements will allow a nationwide response within 12 hours.

The program for dissemination of terrorist threat information is aimed at increasing information sharing between federal, state, and local law enforcement agencies. The intent is to link capabilities on to the existing Department of Justice and intelligence community infrastructure. The system must be secure and provide information only to those authorized to receive sensitive data.

The research and development program has a funding of $23 Million in FY03 and will be coordinated through the science and technology directorate. Its focus is on identification of emerging technologies, technology integration efforts, and conducting testing & validating standards.

VIII.3. NIST Advanced Technology Program – Dr. Jack Boudreaux, NIST

The Advanced Technology Program (ATP) is aimed at bridging the gap between the research lab and the marketplace stimulating prosperity through innovation. It is intended to help researchers develop the technologies that are needed to bring new, innovative products and services to market more quickly, and the scientific and engineering advances that are needed for dramatic improvements in process or manufacturing technologies. It thus provides the technical edge for tomorrow's markets.

The ATP provides cost-share funding in the critical early stages of R&D, when research risks are too high for other sources of funding. It can fund up to $2 million in direct costs over a period not to exceed three years for a single company and up to half of the total project costs for a maximum of five years for a joint venture involving more than one company. It encourages R&D partnerships and consortia, and can provide guidance in putting together a joint research venture. It allows independence of the companies in controlling and retaining the intellectual property rights to the results of their research.

The ATP's bottom line is broad benefits for the nation – jobs, economic growth, and better quality of life through innovative technologies. It looks for R&D projects that create:

- Technologies with benefits that extend well beyond the companies involved in the project.
- Technologies with broad potential applications, particularly across different industrial sectors, and,
- Path-breaking technologies that open up new potential markets or make possible wholly new products or industrial processes.

Since its creation, ATP has awarded 642 projects with 1,329 participants and 967 subcontractors. It contributed $11.7 billion in funding $22 billion of advanced technology development. Out of the projects funded, 65% were led by small businesses. The participants include more than 160 universities and 25 national laboratories.

ATP projects have identified 4,696 potential applications and produced over 100 new technologies that are commercialized, as products, processes, or services. A large fraction (86%) of the projects report that they are ahead in their R&D cycle as a result of ATP funding.

Companies developing advanced technologies for modeling and simulation for emergency response are invited to apply for ATP funding.

IX. CONCLUSION

Mr. Charles R. Mclean concluded the workshop with thanks to the participants for their contributions and recommendations. NIST will endeavor to follow-up on the next steps recommended by workshop breakout groups (listed earlier in the description of the breakout sessions).

This conference provided a strong foundation for collaborative follow-on efforts among government agencies, the response community, industry and academia to:

- identify information sources, simulation systems, and data requirements
- develop the emergency response simulation framework
- develop standards for interoperability and integration
- develop and demonstrate distributed simulations using commercial simulation software and the simulation framework

The workshop brought together a number of people from government agencies, academia and industry. Based on the discussions and feedback received from the attendees, the workshop succeeded in promoting the concept of the simulation framework.

It is too early to determine the strength of collaborative relationships established at the workshop, but the workshop did succeed in creating a network of people working in the area of modeling and simulation for emergency response applications. Some follow-up meetings have already taken place and more are being arranged. It is hoped that tangible collaborations will be established in the near future to address the critical steps towards building a simulation framework for emergency response and developing necessary simulation standards for interoperability and integration of emergency response requirements.

With the strong interest expressed by the participants, NIST plans to hold the next workshop on this topic in early 2004.

APPENDIX A. RELEVANT STANDARDS AND EFFORTS

The following is a partial list of established standards and efforts that may be relevant to modeling, simulation and visualization for emergency response. The list is organized by the area of applicability.

A.I. Distributed Simulation

1. 610.3-1989 IEEE standard glossary of modeling and simulation terminology.
   This glossary defines terms in the field of modeling and simulation. Topics covered include general modeling and simulation concepts, types of models and simulations, modeling and simulation variables, game theory, and queuing theory. Terms were excluded if they were considered to be parochial to one group or organization; company proprietary or trademarked; multi-word terms whose meaning could be inferred from the definitions of the component words; or terms whose meaning in the computer field could be directly inferred from their standard English meaning. Some technical terms that appear in the definitions are defined in other P610 glossaries and are not included as entries in this document.

2. 1278.1-1995 IEEE Standard for Distributed Interactive Simulation--Application Protocols
   (Revision and redesignation of IEEE Std 1278-1993)
   Data messages, known as protocol data units (PDUs), that are exchanged on a network between simulation applications are defined. These PDUs are for interactions that take place within specified domains called protocol families, which include entity information interaction, warfare, logistics, simulation management, distributed emission regeneration and radio communications.

3. 1278.1a-1998 IEEE Standard for Distributed Interactive Simulation--Application Protocols
   Data messages, known as protocol data units (PDUs), that are exchanged on a network between simulation applications are defined. These PDUs are for interactions that take place within specified domains called protocol families, which include entity information/interaction, warfare, logistics, simulation management, distributed emission regeneration, radio communications, entity management, minefield, synthetic environment, simulation management with reliability, live entity information/interaction and non-real time.

4. 1278.2-1995 IEEE Standard for Distributed Interactive Simulation--Communication Services and Profiles.
   Communication services to support information exchange between simulation applications participating in the distributed interactive simulation (DIS) environment are defined. These communication services describe a connectionless information transfer that supports real-time, as well as non-real-time, exchange. Several communication profiles specifying communication services are provided.

5. 1278.3-1996 IEEE Recommended Practice for Distributed Interactive Simulation--Exercise Management and Feedback.
   Guidelines are established for exercise management and feedback in distributed interactive simulation (DIS) exercises. Guidance is provided to sponsors, providers and supporters of DIS-compliant systems and exercises as well as to developers of DIS exercise management and feedback stations. The activities of the organizations involved in a DIS exercise and the top-level processes used to accomplish those activities are addressed. The functional requirements of the exercise management and feedback process are also addressed. This standard is one of a series of standards developed for DIS to assure interoperability between dissimilar simulations for currently installed and future simulations developed by different organizations.

6. 1278.4-1997 IEEE Trial-Use Recommended Practice for Distributed Interactive Simulation--Verification, Validation, and Accreditation.
   Guidelines are established for the verification, validation, and accreditation (VV&A) of distributed interactive simulation (DIS) exercises. “How-to” procedures for planning and conducting DIS exercise VV&A are provided. Intended for use in conjunction with IEEE Std 1278.3-1996, this

recommended practice presents data flow and connectivity for all proposed verification and validation activities and provides rationale and justification for each step. VV&A guidance is provided to exercise users/sponsors and developers.

7. 1516-2000 IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA)---Framework and Rules.
   The High Level Architecture (HLA)-Framework and Rules is the capstone document for a family of related HLA standards. It defines the HLA, its components, and the rules that outline the responsibilities of HLA federates and federations to ensure a consistent implementation. Simulations are abstractions of the real world, and no one simulation can solve all of the functional needs for the modeling and simulation community. It is anticipated that technology advances will allow for new and different modeling and simulation (M&S) implementations within the framework of HLA. The standards contained in this architecture are interrelated and need to be considered as a product set, as a change in one is likely to have an impact on the others. As such, the HLA is an integrated approach that has been developed to provide a common architecture for simulation.

8. 1516.1-2000 IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA)---Federate Interface Specification.
   The high level architecture (HLA) has been developed to provide a common architecture for distributed modeling and simulation. The HLA defines an integrated approach that provides a common framework for the interconnection of interacting simulations. This document, the second in a family of three related HLA documents, defines the standard services of and interfaces to the HLA Runtime Infrastructure (RTI). These services are used by the interacting simulations to achieve a coordinated exchange of information when they participate in a distributed federation. The standards contained in this architecture are interrelated and need to be considered as a product set, when changes are made. They each have value independently.

9. 1516.2-2000 IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA)---Object Model Template (OMT) Specification
   The High Level Architecture (HLA)-Object Model Template (OMT) specification defines the format and syntax (but not content) of HLA object models. Simulation are abstractions of the real world, and no one simulation can solve all of the functional needs for the modeling and simulation community. It is anticipated that advances in technology will allow for new and different modeling and simulation (M&S) implementations within the framework of the HLA. The standards contained in this architecture are interrelated and need to be considered as a product set, as a change in one is likely to have an impact on the others. As such, the HLA is an integrated approach that has been developed to provide a common architecture for simulation.

10. Object Management Group (OMG), Distributed Simulation Systems Version 2.0, available through http://www.omg.org/technology/documents/domain_spec_catalog.htm. A common technical framework facilitating the interoperability of all types of models and simulations among themselves and with command and control systems, as well as facilitating the reuse of modeling and simulation components.

11. Object Management Group (OMG), Common Object Request Broker Architecture Version 3.0.2, available through
    http://www.omg.org/technology/documents/corba_spec_catalog.htm#CORBA_IIOP.
    Specification of an architecture for middleware technology called an Object Request Broker that provides interoperability among clients and servers distributed over a heterogeneous environment.

A.II. Visualization

12. ISO/IEC 14772-1:1998, Information technology - Computer graphics and image processing - The Virtual Reality Modeling Language - Part 1: Functional specification and UTF-8 encoding. Available through http://www.iso.ch/iso/en/ISOOnline.frontpage. Defines a file format that

integrates 3D graphics and multimedia. Conceptually, each VRML file is a 3D time-based space that contains graphic and aural objects that can be dynamically modified through a variety of mechanisms. This part of ISO/IEC 14772 defines a primary set of objects and mechanisms that encourage composition, encapsulation, and extension (Also see, ISO/IEC 14772-1/FDAmd1 Information technology - Computer graphics and image processing - The Virtual Reality Modeling Language - Part 1: Functional specification and UTF-8 encoding - Amendment 1: Enhanced interoperability).

13. ISO/TC 211 Geographic Information/ Geomatics (www.isotc211.org) is focused on standardization in the field of digital geographic information. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations. The work shall link to appropriate standards for information technology and data where possible, and provide a framework for the development of sector-specific applications using geographic data. The following standards are available or under development:

    International Standards and Technical Reports

    ISO 6709:1983 Standard representation of latitude, longitude and altitude for geographic point locations
    ISO 19101:2002 Geographic information — Reference model
    ISO 19105:2000 Geographic information — Conformance and testing
    ISO 19108:2002 Geographic information — Temporal schema
    ISO 19113:2002 Geographic information — Quality principles
    ISO/TR 19120:2001 Geographic information — Functional standards
    ISO/TR 19121:2000 Geographic information — Imagery and gridded data

    Final Draft International Standards

    ISO/FDIS 19111 Geographic information — Spatial referencing by coordinates *(approved)*
    ISO/FDIS 19115 Geographic information — Metadata

    Draft International Standards

    ISO/DIS 19104 Geographic information — Terminology
    ISO/DIS 19106 Geographic information — Profiles
    ISO/DIS 19107 Geographic information — Spatial schema
    ISO/DIS 19109 Geographic information — Rules for application schema
    ISO/DIS 19110 Geographic information — Feature cataloguing methodology
    ISO/DIS 19112 Geographic information —Spatial referencing by geographic identifiers
    ISO/DIS 19114 Geographic information — Quality evaluation procedures
    ISO/DIS 19116 Geographic information — Positioning services
    ISO/DIS 19117 Geographic information — Portrayal
    ISO/DIS 19118 Geographic information — Encoding
    ISO/DIS 19119 Geographic information — Services
    ISO/DIS 19125-1 Geographic information — Simple feature access — Part 1: Common architecture
    ISO/DIS 19125-2 Geographic information — Simple feature access — Part 2: SQL option

14. ISO/IEC 8613-7:1994, Information technology -- Open Document Architecture (ODA) and Interchange Format: Raster graphics content architectures, available through http://www.iso.ch/iso/en/ISOOnline.frontpage. Applies to the interchange of documents by means of data communication or the exchange of storage media. Provides for the interchange of documents for either or both of the following purposes: to allow presentation as intended by the originator and to allow processing such as editing and reformatting. Also provides for the interchange of ODA information structures used for the processing of interchanged documents. Defines a raster graphics content architecture.

15. ISO/IEC 9636-6:1991, Information technology -- Computer graphics -- Interfacing techniques for dialogues with graphical devices (CGI) -- Functional specification -- Part 6: Raster, available through http://www.iso.ch/iso/en/ISOOnline.frontpage. Describes those functions of the interface concerned with creating, modifying, retrieving, and displaying portions of an image stored as pixel data.

16. ISO/IEC 7942-1:1994, Information technology -- Computer graphics and image processing -- Graphical Kernel System (GKS) -- Part 1: Functional description. Specifies a set of functions for computer graphics programming, the graphical kernel system. Provides functions for two dimensional graphical output, the storage and dynamic modification of pictures, and operator input. Applicable to a wide range of applications that produce two dimensional pictures on vector or raster graphical devices in monochrome or color.

17. ISO/IEC ISP 15124-1:1998, Information technology -- International Standardized Profile FOD126 -- Open Document Format: Image Applications -- Enhanced document structure -- Character, raster graphics, and geometric graphics content architecture -- Part 1: Document Application Profile (DAP)

18. ISO/IEC 16485:2000, Information technology -- Mixed Raster Content

19. ISO/IEC 15444-6:2003, Information technology -- JPEG 2000 image coding system -- Part 6: Compound image file format. This standard defines a normative but optional file format for storing compound images using the JPEG 2000 file format family architecture.

A.III. Data and Interfaces

20. ISO/IEC 11179-6:1997 Information technology -- Specification and standardization of data elements -- Part 6: Registration of data elements.

21. ISO/IEC 11179-1:1999 Information technology -- Specification and standardization of data elements -- Part 1: Framework for the specification and standardization of data elements.

22. ISO/IEC 11179-2:2000 Information technology -- Specification and standardization of data elements -- Part 2: Classification for data elements.

23. ISO/IEC 11179-3:1994 Information technology -- Specification and standardization of data elements -- Part 3: Basic attributes of data elements.

24. ISO/IEC 11179-4:1995 Information technology -- Specification and standardization of data elements -- Part 4: Rules and guidelines for the formulation of data definitions

25. ISO/IEC 11179-5:1995 Information technology -- Specification and standardization of data elements -- Part 5: Naming and identification principles for data elements (available in English only)

26. World Wide Web Consortium (W3C), Extensible Markup Language (XML) 1.0 (Second Edition), http://www.w3.org/TR/REC-xml, accessed on January 31, 2003. This standard can be applied to define data exchanges between modeling and simulation applications for emergency response. XML provides a mechanism to impose constraints on the storage, layout and logical structure of a document.

A.IV. Architecture Specification

27. Object Management Group (OMG), Unified Modeling Language (UML) Version 1.4, available through http://www.omg.org/technology/documents/modeling_spec_catalog.htm. A specification

defining a graphical language for visualizing, specifying, constructing, and documenting the artifacts of distributed object systems.

A.V. Secure Communications

28. ISO/IEC ISP 10608-8:1998 Information technology -- International Standardized Profile TAnnnn -- Connection-mode Transport Service over Connectionless-mode Network Service -- Part 8: Security employing the Network Layer Security Protocol -- Connection-mode with SDT-PDU based protection over X.25 packet switched data networks using virtual calls, for TA1111/TA1121 profiles.

29. ISO/IEC ISP 10613-20:1998 Information technology -- International Standardized Profile RA -- Relaying the Connectionless-mode Network Service -- Part 20: Security employing the Network Layer Security Protocol -- Connection-mode with SDT-PDU based Protection over X.25 packet switched data networks using virtual calls, for RA1111/RA1121 profiles.

30. ISO 15892:2000 Space data and information transfer systems -- Protocol specification for space communications -- Security protocol.

31. ISO/PAS 16917:2002 Ships and marine technology -- Data transfer standard for maritime, intermodal transportation and security.

A.VI. Domain-Specific Data

32. OASIS Emergency Management Technical Committee - OASIS (Organization for the Advancement of Structured Information Standards, http://www.oasis-open.org) is a not-for-profit, global consortium that drives the development, convergence, and adoption of e-business standards. Members of the OASIS standards consortium have announced plans on Feb. 10, 2003 to collaborate on the development of XML-based standards for emergency management and incident preparedness and response. The new OASIS Emergency Management Technical Committee will define standards to enable vital information exchange between local, state and federal agencies including law enforcement, medical professionals, companies and other responders to natural and man-made disasters and emergency situations.

33. ISE/IEC 18023 Information technology – Computer graphics and image processing – Synthetic Environment Data Representation and Interchange Specification (SEDRIS) - This part of ISO/IEC 18023 addresses the concepts, structure, syntax and semantics for the representation and interchange of environmental data. It specifies: a) a data representation model that allows the consistent and cohesive expression of the semantic and syntactic relationships of environmental data; b) conceptual models of the represented data objects and their relationships; c) the dictionary of data elements used by the data representation model; and d) the application program interface that supports the storage and retrieval of environmental data. The technologies specified in this part of ISO/IEC 18023 apply to the four domains of environmental data representation: terrain, ocean, atmosphere, and space.

34. ISO/IEC 18025 Information technology – Computer graphics and image processing – Environmental Data Coding Specification - This International Standard provides mechanisms to unambiguously specify objects used to model environmental concepts. This is accomplished by specifying a collection of nine EDCS dictionaries of environmental concepts and a functional interface. The dictionaries are defined for the following categories of information:
    a. *classifications*: specify the type of environmental objects,
    b. *attributes*: specify the state of environmental objects,
    c. *attribute value characteristics*: specify information concerning the values of attributes,
    d. *attribute enumerants*: specify the allowable values for the state of an enumerated attribute,
    e. *units*: specify quantitative measures of the state of some environmental objects,

f. *unit scales*: allow a wide range of numerical values to be stated,
g. *unit equivalence classes*: specify sets of units that are mutually comparable,
h. *organizational schemas*: useful for locating classifications and attributes sharing a common context, and
i. *groups*: into which concepts sharing a common context are collected.

35. Intelligence Community Core Metadata Standard - An HTML Implementation for Intelink, April 20, 2001. The IC Core Metadata Working Group focused on defining the minimum set of metadata tags needed to identify and manage an information object. The development of these core tags is based upon a previous set of HTML metadata tags published by the Intelink Management Office in 1997. These original guidelines have been expanded by the IC Core MWG using inputs from the major production centers and now include the minimum set of HTML tags necessary to identify the product, provide indexing content for search engines, and some records management tags. They also meet the required implementation of security markings as directed by the Controlled Access Program Coordination Office.

36. IC Metadata Standard for Publications v1.0 DTD and DED released July 15, 2002. Contains XML Document Type Definitions, Data Element Dictionary, supporting modules and entities for data relevant to intelligence community.

37. IC Core Metadata v1.0 Released July 15, 2002. The IC Metadata Core Standard is currently under development. The "Core" metadata is that metadata common across all domains. The purpose of the "Core" metadata is for information discovery across the shared space.

38. Version 1.0 of the Information Security Marking July 15, 2002. The Intelligence Community Metadata Standards for Information Assurance are being developed to ensure the security of XML-based transactions throughout the community. The IC Security effort is being continued by the Information Security Marking (ISM) effort. Additional efforts to facilitate secure transactions within the Intelligence Community are included in the IC MSIA effort.

39. IC Metadata Standard for Publications DED v1.0a released Sept 16, 2002. Version 1.0a corrects omissions and errors in the Data Element Dictionary, and does *not* affect the DTDs.

40. IC Metadata Standards Configuration Management Plan, Version 1.0 31 December 2002.

41. EPA Biological Taxonomy, 1-19937:1. Specifies the data elements that are required for identification of biological taxonomy.

42. EPA Chemical Identification, 1-19938:1. The Chemical Data Standard was developed by a Chemical Data Standard Work Group comprised of representatives from across agency programs. The consensus standard defines what information is required to identify a chemical substance and how that information should be recorded. It provides for the use of common identifiers throughout the Agency for all chemical substances regulated or monitored by EPA environmental programs.

43. EPA Facility Identification, 1-19936:1. The Facility Identification Data Standard was developed by a state/EPA Action Team chartered by the ECOS-State-EPA Information Management Workgroup as part of the Agency's plan to improve environmental information. With the approval of this standard, the Environmental Protection Agency is taking a step forward in standardizing the collection of identification information related to regulated facilities and facilitating public access to that data.

44. FAA-STD-060 July 18, 2001, Data standard for the National Airspace System (NAS). This standard describes the detailed NAS data specifications for use in defining all data in interfaces controlled by the NAS Configuration Control Board. Each individual data standard is a description of a data element shared among NAS information systems and is portrayed through a common set of metadata.

45. IEEE Std 1489-1999 IEEE standard for data dictionaries for intelligent transportation systems. The expanding use of digital communications among subsystems of the transportation infrastructure has spawned the development of data dictionaries for the communications between these subsystems. A format for intelligent transportation system (ITS) data dictionaries, including common terms (e.g. time, date, location), as well as the meta-attributes necessary to document ITS data concepts, is addressed in this standard.

46. IEEE Std 1488-2000 IEEE Trial-Use Standard for Message Set Template for Intelligent Transportation Systems. A format for Intelligent Transportation System (ITS) message sets, including common terms (e.g., object identifier), as well as attributes necessary to document ITS data messages, is addressed in this standard.

47. ASHRAE Standard 135-1995 -- BACnet® - A Data Communication Protocol for Building Automation and Control Networks. This communication protocol prescribes a detailed set of rules and procedures that govern all aspects of communicating information from one cooperating machine to another.

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APPENDIX B. **EMERGENCY RESPONSE MODELING, SIMULATION AND SUPPORTING TOOLS AND PROJECTS**

B.I. INTRODUCTION

This appendix provides brief descriptions of known modeling and simulation tools for emergency response that are currently available or are under development. The tools for general-purpose simulation have not been included though many of them can be used to build emergency response applications.

This appendix has been compiled based on Internet searches and information gathered from the attendees of the workshop. While that does not ensure that this list is comprehensive, this appendix provides a good compilation of modeling and simulation tools for emergency response. It is recognized that since September 2001 public access to homeland security related information may have been restricted. Such restrictions may have resulted in exclusion of some of the relevant tools.

The brief descriptions of the tools and projects are adapted from the websites referred to in the "Information Sources" section. The qualitative statements in the descriptions are those provided on the sponsor/owner websites and are not based on any assessment by the authors.

The tools are listed in alphabetical sequence. There is no explicit or implicit endorsement by NIST of the tools included here.

Each tool/project has been classified using axes defined for the integrated Emergency Response Framework (iERF) defined by NIST. The framework is depicted in figure B-1 below followed by a description of the axes.

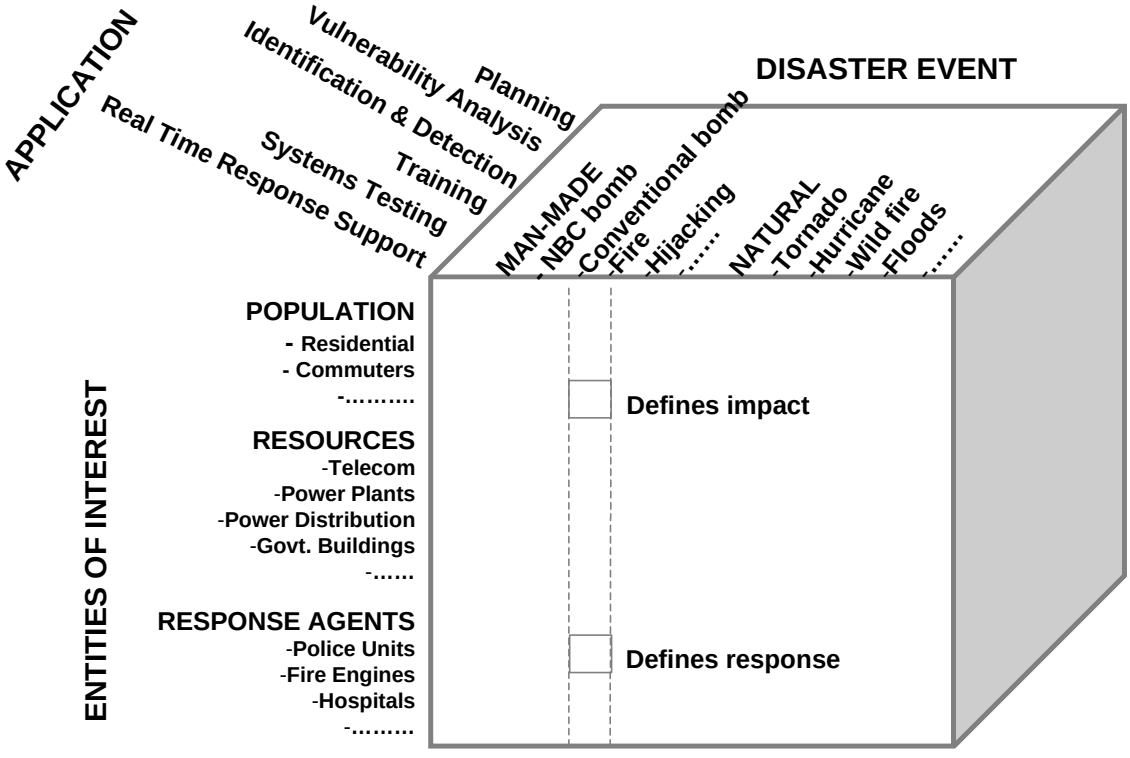

Figure B-1. Integrated Emergency Response Framework (iERF) proposed by NIST

IERF Axis- Disaster Event

The emergency response agencies have to respond to a number of man-made and natural disaster events. The disaster event will have a large influence on the kind of modeling and simulation capabilities that need to be brought together. For example, a building explosion and fire event requires capabilities for modeling the impact of explosion and fire on the building structure and its occupants, while a hazardous release in the atmosphere requires capabilities to model the dispersion of the release in the atmosphere. Admittedly there are some capabilities that are required for a number of scenarios. These include capabilities such as traffic simulation and information flow simulation. Also, a few of the man-made and natural disaster may have similar impact. For example, forest fires can be initiated by intentional or unintentional actions of people or by natural causes.

IERF Axis- Entities of Interest

The interest of all the agencies is to minimize the impact of disaster events on entities of interest. These include first and foremost, the human population. The impact of the disaster also needs to be understood and contained on the resources, in particular, on the infrastructure resources.

The response agents are the second major class of entities of interest. The actions of response agents need to be modeled to understand how they can contain and mitigate the impact of the disaster event. It is quite possible that the response agents will become the affected entities of interest themselves, for example, fire personnel suffer injuries while fire fighting. The models should allow understanding of the risk exposure for the response agents. The planners can test out different strategies that minimize the risk exposure for the response agents while allowing them to contain and mitigate the impact of the event.

IERF Axis- Applications

The capability of the needed modeling and simulation tools will differ based on the application they are designed for. An application for understanding the impact of the disaster event will have capabilities somewhat different from one for training emergency response personnel. The training applications will have more interactive features and the ability to unfold alternate simulated event sequences based on the response of the trainees. Similarly, applications for identification and detection of threat will have capabilities for pattern matching against a number of historical scenarios to determine the likelihood of threat development. Various applications for the emergency response domain are briefly described below.

Planning

The planning application will include tools for determination of impact of a disaster event and the tools for aiding development of the response action plans and strategies. The planning applications can range from those for long term issues such as location of emergency response facilities and manpower or for focused issues such as aiding development of specific response procedures. Examples of planning applications include:

- Location of police and fire stations and hospitals
- Development of evacuation procedures
- Setting up a communication infrastructure

Vulnerability Analysis

The vulnerability analysis application is focused on evaluation and assessment of emergency response preparedness plans and strategies. Modeling and simulation tools can be used to create a number of disaster event scenarios and evaluate the performance of action plans and strategies. Examples of vulnerability analysis applications include:

- Evaluation of security plans and procedures at a nuclear plant
- Evaluation of city emergency response plans

Identification & Detection

The identification and detection application will include use of tools that study given scenarios and determine the possibility of the occurrence of a disaster event. It is anticipated that such tools will use pattern matching logic and past history databases to identify and detect potential threats. Examples of identification and detection applications include:

- Selecting security sweep targets in areas with majority of inhabitants from a target background

- Identifying the potential of tornado occurrence given the weather conditions

Training
The training application will include tools that allow training response agent personnel for handling emergency events. These may include interactive simulations where the tools create an imaginary scenario and the trainees input their response actions. The tools will help evaluate the response actions and thus help the trainee learn what works best under a given situation. These tools may range from interactive simulations using a monitor to totally immersive environments. Examples of training applications include:

- Antidote deployment sequence
- Evacuation management

Systems Testing
The systems testing application will include tools that allow testing of systems and equipment used for emergency response. These may include applications that allow hardware emulation and software simulation to create a scenario where part is simulated in software while remaining is simulated in real live exercise. It will allow testing of systems such as those for tracking emergency response vehicles and those .that provide information to emergency operations centers. It will also allow testing of hardware such as communication devices in emergency response situation with severe overloading of bandwidth. Examples of systems testing applications include:

- Testing of emergency operations command and control systems
- Testing of remotely operated search and rescue devices

Real-time Response Support
The response application will include tools that evaluate the impact of a disaster through real-time updates on the situation, and use the available information to project current and future impact of the disaster. It also includes tools for evaluating alternative response actions and strategies based on the current and projected impact. The evaluations are then used to direct the response actions on the ground. Examples of response applications include:

- Antidote deployment sequence
- Evacuation management

The available descriptions of tools/projects are used to assess their alignment with the iERF axes. Project sponsors and tool developers are invited to send their comments on the classification through the e-mail address: mser_report_feedback@cme.nist.gov.

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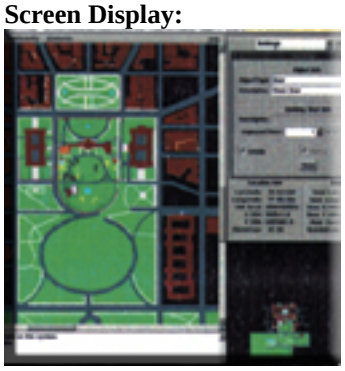
(1) ACATS - Analytical Conflict and Tactical Simulation

Developer/Sponsor Organization(s):

Lawrence Livermore National Laboratory

Screen Display:



Brief Description:
The Analytical Conflict and Tactical Simulation (ACATS) is an offshoot of the Joint Conflict and Tactical Simulation (JCATS) that the military uses for training, analysis, mission planning and mission rehearsal. ACATS applies JCATS' cutting-edge simulation capabilities to the scenarios that may take place in an urban setting, from the spread of a chemical or biological agent within a building to the search for survivors in the rubble of a bombed building.

The goal is to make ACATS available to local and state agencies to help them be better prepared for terrorist attacks, natural disasters and large-scale accidents.

Emergency managers in Lee County, Alabama, tried out the system earlier this year during a scenario that involved a hypothetical terrorist attack on a water treatment plant. Seattle first responders tested the system during an earthquake simulation.

Livermore has already established a new lab next to the existing JCATS laboratory where scientists are fine-tuning the ACATS system to better model city- and state-level events such as public health response and the effects of panicked citizens.

ACATS eventually would be able to take in real-time data from sensors and tracking devices attached to first responders, which would allow it to be used as incident control software in addition to emergency response planning and training.

Inputs:
Data describing the location, environment and the incident

Classification using iERF axes:
Disaster event: Weapons of mass destruction (WMD) incidents
Applications: Planning, training, vulnerability analyses, real time response support
Entities of interest: Population, response agents, infrastructure

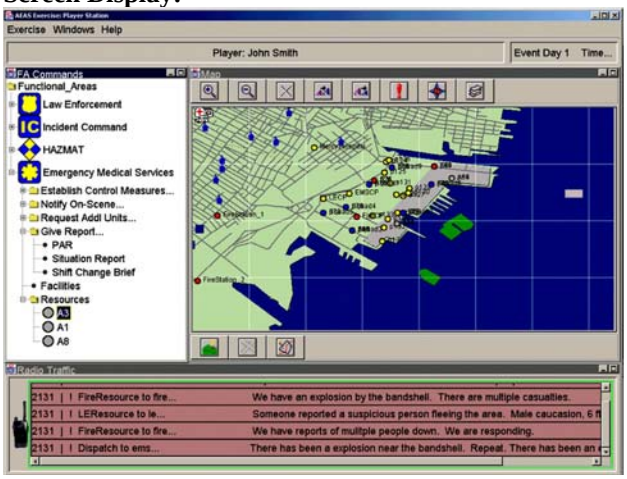
Information source:
http://www.llnl.gov/llnl/06news/NewsReleases/2002/NR-02-12-07.html
http://www.llnl.gov/hso/emergencyprog.html

(2) AEAS – Automated Exercise & Assessment System

Developer/Sponsor Organization(s):

Science Applications International Corporation (SAIC)

Screen Display:



Brief Description:
AEAS was designed and developed by a team of SAIC scientists and homeland security experts. This homeland security training and readiness assessment system leverages the simulation technology SAIC has developed for training members of the armed forces. The system has successfully been evaluated during field exercises in Utah and West Virginia, establishing baselines for training local emergency responders across the U.S.

AEAS allows participants to respond as a team in real-time to simulated emergency scenarios that may include explosions and the release of radioactive contaminants or biological agents. The software that drives the simulation creates a realistic training environment without the cost, safety and logistics concerns of live, on-location training involving hundreds of role players, dozens of emergency vehicles and other equipment.

Each participant plays one of 41 different roles on PC workstations, including communications, law enforcement, fire department, emergency management, medical facilities, public health, military support, public information, elected officials, donations and volunteer management. The training software provides an accurate record of how the participants act and react in the simulated emergency, allowing each jurisdiction to determine strengths and areas of concern in advance of a real emergency.

Inputs:
Selection of scenario and definition of local area

Classification using iERF axes:
Disaster event: Chemical, biological, nuclear agent release
Applications: Training
Entities of interest: Population, response agents, infrastructure

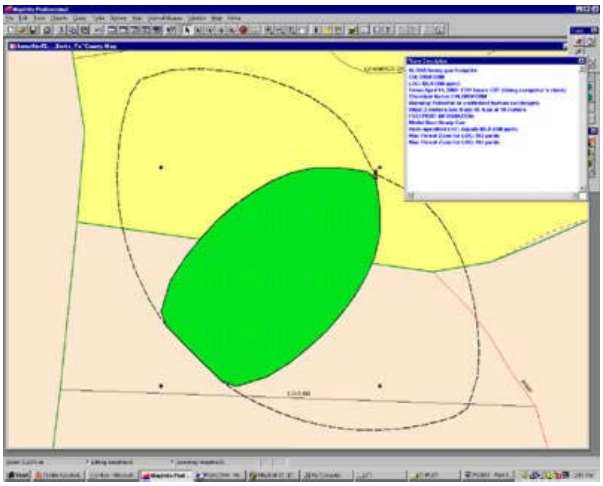
Information source:
http://www.saic.com/news/dec02/news12-02-02.html

(3) ALOHA

Developer/Sponsor Organization(s):

US Environmental Protection Agency

Screen Display:
ALOHA model generated footprint plotted using PlotALOHA



Brief Description:
ALOHA is an emergency response model, intended for rapid deployment by responders and for emergency planning. It incorporates source strength as well as Gaussian and heavy gas dispersion models and an extensive chemical property library. Model output is in both text and graphic form, and includes a 'footprint' plot of the area downwind of a release where concentrations may exceed a user-set threshold level. ALOHA can accept weather data transmitted from portable monitoring stations, and can plot footprints on electronic maps displayed in a companion mapping application, MARPLOT.

It is part of CAMEO, a system of software applications used widely to plan for and respond to chemical emergencies. It is one of the tools developed by EPA's Chemical Emergency Preparedness and Prevention Office (CEPPO) and the National Oceanic and Atmospheric Administration Office of Response and Restoration (NOAA), to assist front-line chemical emergency planners and responders.

Inputs:
Information defining the chemical release and weather information

Classification using iERF axes:
Disaster event: Chemical agent release
Applications: Planning, training, real time response support
Entities of interest: Population, response agents

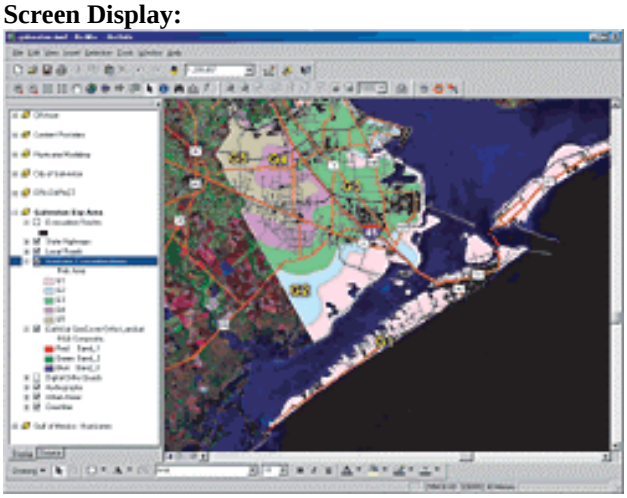
Information source:
http://www.epa.gov/ceppo/cameo/what.htm##haz

(4) ArcGIS

Developer/Sponsor Organization(s):

ESRI

Screen Display:



Brief Description:
GIS software tools enable users to collect, organize, analyze, display, and model information. The ArcGIS software suite offers industry-strength GIS tools that provide the vital scalability and performance for deployment throughout the homeland security enterprise.

Homeland security programs will be developed and implemented through analysis of information. The vast majority of this information is spatial and can be brought into a GIS and mapped. Once this occurs, homeland security analysis and planning can begin. When information on life, property, and critical infrastructures is combined with risk and probability, managers can formulate mitigation, preparedness, response, and recovery program needs.

The ArcGIS software components include:

- ArcGIS provides sophisticated functionality, such as editing, analysis, and modeling, along with cutting-edge data models and management.
- ArcInfo is the professional GIS system with capabilities for automation, modification, management, analysis, and display of geodata.
- ArcView is a powerful tool for management, display, and analysis of spatial information.
- ArcEditor software includes all the functionality of ArcView and adds the power to edit features in a multiuser geodatabase. Additional functionality includes support for multiuser editing, versioning, custom feature classes, feature-linked annotation, dimensioning, and rasters in a multiuser geodatabase.

Inputs:
Geographic information

Classification using iERF axes:
Disaster event: Various events
Applications: Can support various applications
Entities of interest: Can support modeling of various entitities

Information source:
http://www.esri.com/industries/homelandsecurity/arcgis_solutions.html

(5) A-TEAM, Advanced Training System for Emergency Management

Developer/Sponsor Organization(s): **Screen Display:** Not available

Environmental Software and Services GmbH

Brief Description:
The main objective of the A-TEAM project is to develop and test a new approach to advanced technical training using an integration of artificial intelligence (AI) technologies and dynamic simulation modeling to create fully interactive multi-media content within a real-time knowledge-based system framework for the domain of emergency management applications. The underlying client-server architecture supports easy access in Intranet/Internet distributed systems.

Inputs:
Data describing the training scenario

Classification using iERF axes:
Disaster event: Aims to model a wide range of events, test cases focused on chemical plants
Applications: Training
Entities of interest: Aims to model a wide range, specifically mentioned - traffic control systems, emergency medical teams (EMTs), infrastructure – utility and water supply

Information source:
http://www.ess.co.at/A-TEAM/section7.html

(6) BioSimMER

Developer/Sponsor Organization(s):

Sandia National Laboratories

Screen Display:

Brief Description:
BioSimMER is a VR application that immerses first responders in a computer-simulated setting - a small airport in which a biological warfare agent has been dispersed following a terrorist bombing. Simulated casualties with a variety of symptoms are found throughout the airport. The computer simulation engages the rescuer's eyes, ears, and decision-making abilities through goggles that display the scene's images. The rescuer wears sensors on the arms, legs, and waist, allowing the player's motions to be fed back into the simulation. During a simulation, the trainee must do triage, diagnose, and attend to the medical needs of each casualty. After making a diagnosis, a trainee can administer medical treatment by reaching for and using tools in a virtual medical kit. Trainees may need to attend to initial decontamination procedures, place masks over a patient's nose and mouth, or place sensors or other monitoring equipment near the patient. Most important, they need to learn to protect themselves.

The tool can help emergency personnel make better decisions if ever they are called upon to respond in a real chem-bio attack.

Inputs:
Based on a defined airport scenario.

Classification using iERF axes:
Disaster event: Chemical and biological agent release
Applications: Training
Entities of interest: Population, response agents

Information source:
http://www.sandia.gov/LabNews/LN07-30-99/vr_story.html

(7) CAMEO®

Developer/Sponsor Organization(s):

USEPA
Chemical Emergency Preparedness and
Prevention Office

Screen Display: Not Available

Brief Description:
CAMEO contains a chemical database of over 6,000 hazardous chemicals, 80,000 synonyms, and product trade names. CAMEO provides a powerful search engine that allows users to find chemicals instantly. Each one is linked to chemical-specific information on fire and explosive hazards, health hazards, firefighting techniques, cleanup procedures, and protective clothing. CAMEO also contains basic information on facilities that store chemicals, on the inventory of chemicals at the facility (Tier II) and on emergency planning resources. Additionally, there are templates where users can store EPCRA information. CAMEO connects the planner or emergency responder with critical information to identify unknown substances during an incident.

It is part of CAMEO, a system of software applications used widely to plan for and respond to chemical emergencies. It is one of the tools developed by EPA's Chemical Emergency Preparedness and Prevention Office (CEPPO) and the National Oceanic and Atmospheric Administration Office of Response and Restoration (NOAA), to assist front-line chemical emergency planners and responders.

Inputs:
Search terms for suspected chemical

Classification using iERF axes:
Disaster event: Chemical release events
Applications: Real time response support
Entities of interest: Population, response agents

Information source:
http://www.epa.gov/ceppo/cameo/index.htm

(8) CAPARS - Computer Assisted Protective Action Recommendation System

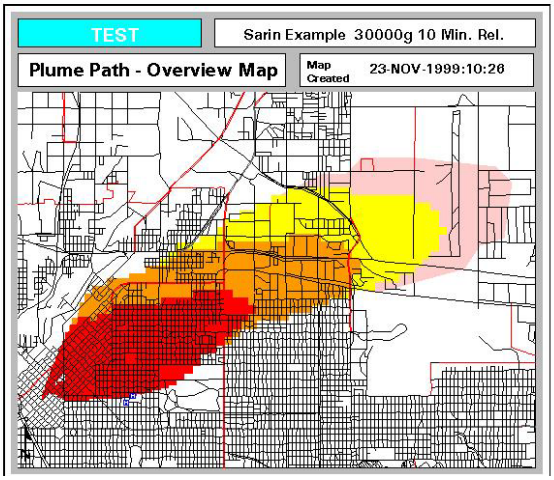
Developer/Sponsor Organization(s):

Regional Atmospheric Response Center

AlphaTRAC Atmospheric Consultants

Innovative GIS Solutions, Inc.

Screen Display:



Brief Description:
CAPARS is a state-of-the-art plume prediction system, the DoE TRAC (Terrain Responsive Atmospheric Code) model, that addresses the needs of emergency responders. The CAPARS system is the technical backbone of the recently established Regional Atmospheric Response Center (RARC) in Westminster, Colorado. RARC is a prototype response center recently established by the Dept. of Energy's Rocky Flats Environmental Technology Site for addressing emergency response scenarios for tracking hazardous chemical plumes and spills. RARC is a 24 hour a day, 365 day center that is available to municipalities, cities, government, and private industry on a subscription basis to address real-time hazardous material emergency response.

Key components of the system include:

- A comprehensive Graphical User Interface (GUI) for real time operation and interaction with CAPARS and the TRAC model, resultant output (maps, reports, and charts), and spatial database including data update and quality assurance procedures
- A Source Inventory Database Subsystem to manage and maintain key facility data and source inventories including support for commercial chemical databases (CHEMTOX), custom chemical/substance databases (RARC, EPA (numerous), SARA Title III, custom facility databases (e.g., Rocky Flats), etc.).
- An Output, Display and Communication subsystem for visualizing TRAC model output and distributing output to predefined team members and/or sites.

Inputs:
Definition of the release event and location

Classification using iERF axes:
Disaster event: Chemical agent release
Applications: Planning, training, real time response support
Entities of interest: Population, response agents

Information source:
http://www.innovativegis.com/services/projects/capars_trac.html

(9) CAPS - Counterproliferation Analysis & Planning System

Developer/Sponsor Organization(s):

Nonproliferation, Arms Control, and International Security (NAI) Directorate, Lawrence Livermore National Laboratory

Screen Display:

Brief Description:
The Counterproliferation Analysis and Planning System (CAPS) is a versatile and powerful tool for analyzing the proliferation activities of foreign countries. These analyses provide valuable technical input to the decision-making agencies and individuals with responsibility for determining the U.S. response to proliferation activities.

Drawing on information from many sources, CAPS can model the various processes (chemical, biological, metallurgical, etc.) that proliferants use to build weapons of mass destruction and their delivery systems. By modeling proliferation activities at a high level of detail, we can analyze the country's specific approach to weapons production. Our goal is to identify critical processing steps or production facilities which, if denied, would prevent that country from acquiring weapons of mass destruction.

CAPS contains demographic data and atmospheric plume models, developed for the National Atmospheric Release Advisory Center. CAPS also includes a suite of chemical databases that are used to evaluate the effects of chemicals that could be released into the environment.

Inputs:
Information on proliferation activites

Classification using iERF axes:
Disaster event: Nuclear attack
Applications: Identification and detection
Entities of interest: Population, infrastructure

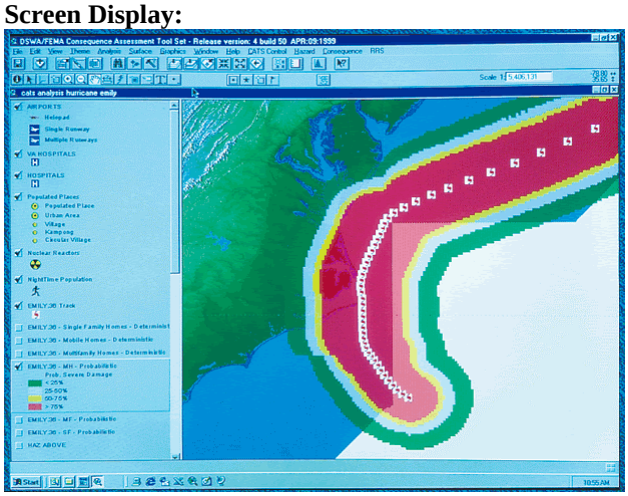
Information source:
http://www.llnl.gov/nai/technologies/techinfo2.html

(10) CATS - Consequences Assessment Tool Set

Developer/Sponsor Organization(s):

Science Applications International Corporation (SAIC)

Screen Display:



Brief Description:
The Consequence Assessment Tool Set (CATS) assesses the consequences of technological and natural disasters to population, resources and infrastructure. Hazards accounted for in CATS range from natural disasters such as hurricanes and earthquakes, to technological disasters such as industrial accidents, terrorism and acts of war. It has been developed under the guidance of the US Defense Threat Reduction Agency (DTRA) and the US Federal Emergency Management Agency (FEMA). CATS provides significant assistance in emergency managers' training, exercises, contingency planning, logistical planning and calculating requirements for humanitarian aid.

CATS predicts the damage and assesses the consequences associated with that damage as a result of a technological or natural hazard. The technological portion of CATS provides for the calculation of damage and consequence using real-time weather and a variety of sources, particularly those associated with weapons of mass destruction (WMD), as employed by military forces or terrorists.

The natural hazard portion of CATS provides for the calculation of damage and consequence from earthquakes and hurricanes. The earthquake model is a collection of programs that models the severity and the geographical extent of the damage due to the primary earthquake hazard of ground shaking as well as to the collateral hazards of ground failure, tsunami, and fire following the earthquake. The consequence of a damaging earthquake is assessed in terms of the facilities, infrastructure, and population at risk. The hurricane model predicts the tracking of the storm and the damage to the areas surrounding the track of the hurricane caused by the wind.

Inputs:
Hazard description parameters and local GIS data

Classification using iERF axes:
Disaster event: Natural or man-made disasters
Applications: Planning, training, real time response support
Entities of interest: Population, response agents, infrastructure

Information source:
http://www.saic.com/products/simulation/cats/cats.html

(11) CERRTS – Civil Emergency Reaction and Responder Training System

Developer/Sponsor Organization(s): **Screen Display:** Not available

Raytheon

Brief Description:
The Raytheon Civil Emergency Reaction and Responder Training System (CERRTS) is a computer driven, emergency response and crisis rehearsal training system that provides realistic Homeland Security (HLS) environments to train key members of Emergency Operations Centers (EOC) and First Responders. It uses detailed modeling to provide a stress-filled, simulated, emergency environment at the municipal, county, state, regional and national levels of government. It also integrates Global Information Systems Technology (GIST) Collaborative Training and Operational Planning System (CTOPS) that permits collaborative planning among team members over the Internet including full duplex voice over IP, and offers a dynamic interface for scenario generation with CERRTS execution simulation.

CERRTS also provides Object Raku Technology's Sextant software, a lap-top based mapping and rapid 3D visualization tool kit. It directly supports interactive training and education for Emergency Operations Center staffs, First Responders (fire, police, medical), National Guard's Civil Support Team (CST), and associated emergency communications, operations, and planning staffs at any level of civil government.

Inputs:
Selection of scenario and definition of local area

Classification using iERF axes:
Disaster event: Natural and man-made disasters
Applications: Training
Entities of interest: Population, response agents, infrastructure

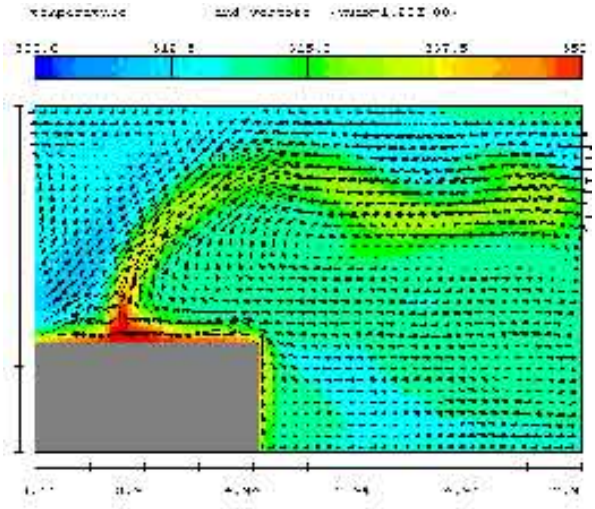
Information source:
Http://homelandsecurity.raytheon.com/pdfs/CERRTS_Slick_Sht.pdf

(12) CFD - Computation Fluid Dynamics modeling tools

Developer/Sponsor Organization(s):

Innovative Technologies Solutions Corporation

Screen Display: Aerosol transport modeling



Brief Description:
A number of tools have been developed using CFD, including:

- Isis-3D - multi-dimensional, computational fluid dynamics (CFD) code with reactive flow, turbulence, variable evaporation, and compressible flow models for the predicted response of systems to fires.
- FLOW-3D - Generalized commercial CFD code for the analysis of thermal effects from fire, aerosol transport, and complex terrain fuel spill analysis.
- RADTRAD – uses numerical models of source term reduction phenomena to determine the time dependent radiological dose at user-specified locations for a given accident scenario.

The tools can be used for a variety of applications including:

- Prediction of thermal loads to surfaces/structures in building fires to facilitate optimum placement of sensors, assess vital equipment vulnerability, etc.
- Prediction of soot generation and transport within buildings for assessing optimum emergency response scenarios
- Response of hazardous cargo (weapon systems, waste containers, etc.) to fires resulting from various accident scenarios
- Prediction of the dispersal and transport of hazardous and radioactive contaminants due to fire mechanisms in manufacturing or waste management facilities
- Prediction of the thermal load encountered by response teams as a result of oil platform fires

Inputs:
Data describing the building geometry, material dispersion rate, wind speed, etc.

Classification using iERF axes:
Disaster event: Fire
Applications: Planning, training
Entities of interest: Infrastructure elements including buildings, cargo vehicles, facilities.

Information source:
http://www.itsc.com/mod.html

(13) C-Insight

Developer/Sponsor Organization(s):

MetaEdge Corporation

Screen Display:

Brief Description:
C-Insight is a Public Safety/Homeland Defense solution for Secure Intelligence Sharing, Predictive Modeling, real-Time Analysis and Closed-Loop Feedback. C-Insight unifies disparate data sources and illustrates analysis through reporting tools such as geographic maps. Unlike "map-driven" GIS tools that offer static data models, C-Insight is "data-driven" and its dynamic modeling process adapts to any new data.

C-Insight's key value for Public Safety and Homeland Defense is the flexibility in data modeling, allowing for the integration of disparate data sources and the inclusion of any new data source on the fly. The platform also provides for predictive functionality, which recently allowed Westminster Police Department (CA) to join two disparate data sources and engage in proactive crime fighting. Unlike other GIS tools that offer a static data model confined to an arduously built data warehouse, C-Insight offers an innovative dynamic modeling process that adapts to ever changing influx of new data from any data source.

Inputs:
GIS information, information on disaster events

Classification using iERF axes:
Disaster event: Various disaster events
Applications: Planning, identification and detection
Entities of interest: Population, response agents, infrastructure

Information source:
http://www.metaedge.com/products/architecture.htm

(14) CoBRA® - Chemical Biological Response Aide

Developer/Sponsor Organization(s): **Screen Display:** Not Available

Defense Group Inc.

Brief Description:
The Chemical Biological Response Aide (CoBRA®) software coordinates the full spectrum of HAZMAT and fire response, on-scene forensic investigation, medical procedures and law enforcement. Pre-loaded accredited SOPs and on-scene checklists are designed to address chemical identification, evidence collection, decontamination and general response to terrorist use of a weapon of mass destruction. Information from the Emergency Response Guide 2000 is also included.

The tool can be used to provide real time inputs that can be used for modeling and simulation tools for real time response support applications. Other features include:

- Accredited standard operating procedures and on-scene checklists are designed to address evidence collection, investigative procedures and general response to terrorist use of a WMD.
- These documents, developed in consultation with a number of recognized international authorities in the field, are fully modifiable by the user, and can be customized to fit any agency.
- Data can be sent via email, Internet, LAN or WAN, all wireless (RF), infrared or through a hard-wired serial connection.
- Allows consolidation of all procedures and preplans in one easy-to-navigate interface without the need to re-enter that data.
- Organizes all the needed information for an emergency in one spot.
- Actions are recorded with a time and date stamped log of the activities.
- Digital image viewing, manipulation, and attachment to CoBRA® incident reports
- Electronic Form Tool—complete standard format reports quickly with electronic submission to headquarters
- National Institute for Occupation Safety and Health (NIOSH) Pocket Guide chemical hazard database
- Expanded information for Improvised Explosive Devices (distribution restricted to authorized government agencies)

Inputs:
Incident scene data

Classification using iERF axes:
Disaster event: Chemical and biological release events
Applications: Real time response support
Entities of interest: Population, response agents

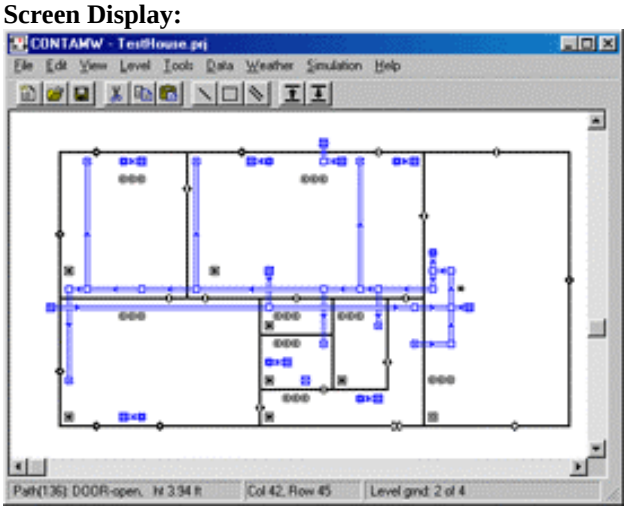
Information source:
http://www.epa.gov/ceppo/cameo/index.htm

(15) CONTAMW

Developer/Sponsor Organization(s):

Building and Fire Research Laboratory
NIST

Screen Display:



Brief Description:
CONTAMW is a multizone indoor air quality and ventilation analysis computer program designed to help predict airflows, contaminant concentrations and personal exposure. It can be useful in a variety of applications. Its ability to calculate building airflows is useful to assess the adequacy of ventilation rates in a building, to determine the variation in ventilation rates over time and the distribution of ventilation air within a building, and to estimate the impact of envelope air tightening efforts on infiltration rates. The prediction of contaminant concentrations can be used to determine the indoor air quality performance of a building before it is constructed and occupied, to investigate the impacts of various design decisions related to ventilation system design and building material selection, and to assess the indoor air quality performance of an existing building. Predicted contaminant concentrations can also be used to estimate personal exposure based on occupancy patterns in the building being studied. Exposure estimates can be compared for different assumptions of ventilation rates and source strengths.

CONTAMW was used to understand how anthrax spores may have spread throughout the Hart Senate Office Building in Washington, D.C. The results of the modeling aided the development of decontamination strategies for the structure.

Inputs:
Building design, ventilation system design.

Classification using iERF axes:
Disaster event: Biological attack
Applications: Planning, vulnerability analysis
Entities of interest: Population

Information source:
http://www.bfrl.nist.gov/IAQanalysis/CONTAMWdesc.htm

(16) CRISIS

Developer/Sponsor Organization(s):

Ship Analytics International

Screen Display(s):

Brief Description:
CRISIS is a comprehensive crisis management system capable of supporting decision makers and diverse organizations involved in the management of all types of environmental and man-made disasters. It provides capabilities in four areas: management, incident command system stations, geographic information systems and predictive models. The predictive modeling capability allows estimation of geographic spread of impact on environment, effect of applied countermeasures, weathering and aging for oil spill, flood, forest fire, earthquake, nuclear and disease disasters. It also includes models for assessing environmental impact and economic damage (tourism impact, commercial, loss of life and property.

Inputs:
Description of the disaster

Classification using iERF axes:
Disaster event: Man made and natural disasters
Applications: Training, real time response support
Entities of interest: Population, environment

Information source:
http://www.shipanalytics.com/fs_CRISIS.htm

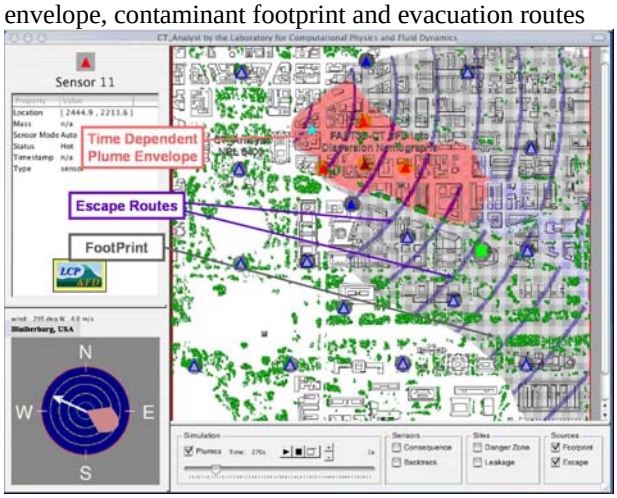
(17) CT-Analyst

Developer/Sponsor Organization(s):

Naval Research Laboratory, Laboratory for Computational Physics and Fluid Dynamics

Missile Defense Agency, Modeling and Simulation

Screen Display:
CT-Analyst™ full screen display showing plume envelope, contaminant footprint and evacuation routes



Brief Description:
CT-Analyst™ provides accurate, instantaneous, 3D predictions of chemical, biological and radiological agent transport in urban settings. A model of dynamic urban airflow supplies a 3D database of agent airflow to power CT-Analyst. The accuracy of full 3D fluid dynamics simulations with meter-scale resolution is available to the user with zero time delay.

CT-Analyst is being incorporated into another tool, PEGEM (see elsewhere in this document), under Missile Defense Agency sponsorship that will allow a user to model a variety of scenarios that encompass both large and small-scale events. The integrated tools will provide:

1. Enhanced modeling capabilities
2. More complex scenario simulation
3. Broader range of modeling resolution, from meters to hundred of kilometers

Inputs:
Information defining the event, urban surroundings and weather information

Classification using iERF axes:
Disaster event: Chemical, biological, radiological, nuclear and high explosive events
Applications: Planning, training, real time response support
Entities of interest: Population, response agents

Information source:
http://www.nrl.navy.mil/pressRelease.php?Y=2003&R=45-03r

(18) Emergency Preparedness Incident Command Simulation (EPiCS)

Developer/Sponsor Organization(s):

U.S. Army Training and Doctrine Command Analysis Center (TRAC)

Contractor: AST, Inc.

Screen Display:
Screen shot from the visualization tool used by EpiCS.

Brief Description:
The Emergency Preparedness Incident Command Simulation (*EPiCS*) is a system of tools that are used to simulate, record and display activities during the response to an emergency event. It utilizes computer-based, scenario-driven, high-resolution simulation. It is used by emergency response agencies to train for emergency situations that require multi-echelon and/or interagency communication and coordination. This cost-effective training and analysis tool allows local, state, and federal agencies to interact under simulated, realistic conditions that exercise decision making processes and allows evaluation of emergency response by each agency.

EPiCS can be used to train operations command and control personnel, rehearse operations, evaluate operations plans, analyze systems effectiveness, and assist in developing techniques and procedures. It provides crisis managers with training that is virtually indistinguishable from the real thing. Using the highly refined, accurate modeling capabilities of *EPiCS*, incident commanders and operations center personnel at all levels of the organizations can realistically evaluate response plans to various types of emergency situations. Managers and supervisors can dynamically experience the operation of plans and procedures in their native command and control environment.

Inputs:
Data describing the exercise scenario – event, location, personnel and equipment participating in exercise

Classification using iERF axes:
Disaster event: Natural and Man-made disasters
Applications: Planning, training
Entities of interest: Can be built for specific scenarios. Focus on command and control functions.

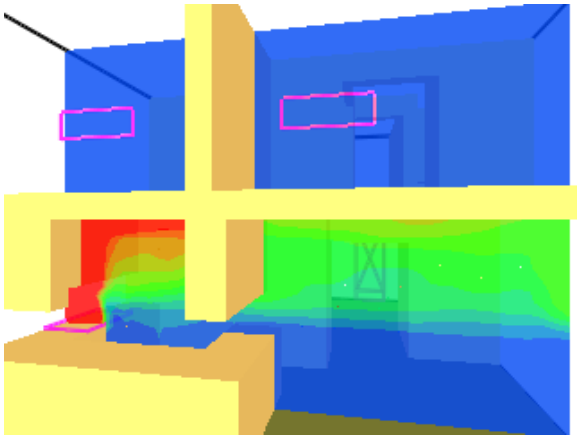
Information source:
http://epics.astcorp.com/index.html

(19) Fire Modeling Programs

Developer/Sponsor Organization(s):

Building and Fire Research Laboratory
NIST

Screen Display: PLOT3D data visualization using Smokeview. Simulation of a kitchen fire in a townhouse.



Brief Description:
NIST's Building and Fire Research Lab has developed a number of fire modeling tools. These include:

- ALOFT-FT™ - A Large Outdoor Fire plume Trajectory model - Flat Terrain
- ASCOS - Analysis of Smoke Control Systems
- ASET-B - Available Safe Egree Time - BASIC
- ASMET - Atria Smoke Management Engineering Tools
- BREAK1 - Berkeley Algorithm for Breaking Window Glass in a Compartment Fire
- CCFM - Consolidated Compartment Fire Model version VENTS
- CFAST - Consolidated Fire and Smoke Transport Model
- DETACT-QS - Detector Actuation - Quasi Steady
- DETACT-T2 - Detector Actuation - Time squared
- ELVAC - Elevator Evacuation
- FASTLite - A collection of procedures which builds on the core routines of FIREFORM and the computer model CFAST to provide engineering calculations of various fire phenomena,
- FIRDEMND - Handheld Hosestream Suppression Model
- FIRST - FIRe Simulation Technique
- FPETool - Fire Protection Engineering Tools (equations and fire simulation scenarios)
- Jet - A Model for the Prediction of Detector Activation and Gas Temperature in the Presence of a Smoke Layer
- LAVENT - Response of sprinkler links in compartment fires with curtains and ceiling vents
- NIST Fire Dynamics Simulator and Smokeview - The NIST Fire Dynamics Simulator predicts smoke and/or air flow movement caused by fire, wind, ventilation systems *etc.* Smokeview visualizes the predictions generated by NIST FDS.

Inputs:
Parameters defining the building, the place where the fire started, the material composition, etc.

Classification using iERF axes:
Disaster event: Man made and natural disasters leading to fire
Applications: Planning, training, real time response support
Entities of interest: Population, response agents, infrastructure

Information source:
http://www.bfrl.nist.gov/866/fmabbs.html

(20) FLDWAV

Developer/Sponsor Organization(s):

National Weather Service
National Oceanic and Atmospheric Administration

Screen Display:
Not available

Brief Description:
FLDWAV is a generalized flood routing model that can be used by hydrologists/ engineers for real-time flood forecasting of dam-break floods and/or natural floods, dam-breach flood analysis for sunny-day piping or overtopping associated with the PMF flood, floodplain inundation mapping for contingency dam-break flood planning, and design of waterway improvements. The model can compute the outflow flood wave hydrograph from a dam due to spillway, overtopping and/or dam breach outflows or the floodwave hydrograph can be user specified. The flood wave is then routed through the downstream channel/valley using a four-point implicit finite-difference numerical solution of the complete Saint-Venant equations of one-dimensional unsteady flow along with appropriate internal boundary equations representing downstream dams, bridges, weirs, waterfalls, and other man-made/natural flow controls.

The output of FLDWAV can be visualized using M2M Dam Failure Model, listed in this document.

Inputs:
Information on river system, water surface elevation, dam and surrounding geography.

Classification using iERF axes:
Disaster event: Floods, dam failure
Applications: Planning, vulnerability analysis, real time response suppport
Entities of interest: Population, infrastructure

Information source:
http://www.nws.noaa.gov/oh/hrl/rvrmech/fldwav1.htm

(21) GAMMA-EC: Gaming And MultiMedia Applications for Environmental Crisis management training

Developer/Sponsor Organization(s):

A number of development partners across Europe are involved, including:

- TNO- Netherlands Organisation for Applied Scientific Research
- Universitat de Barcelona
- Italsoft
- Nederlands Instituut voor Brandweer en Rampenbestrijding
- CEREN - the Experimentations and Research Centre of the Entente Interdépartementale, public establishment for the protection of the forest against fire.
- Regione Toscana
- Generalitat, Government of Catalonia

Screen Display:
Not available

Brief Description:
The project will result in a set of tools, consisting of:
1. a multimedia program for individual education of disasters managers
2. an interactive simulation program (crisis game) for training disaster managers simultaneously as a team.
In addition to these tools generic pedagogical directives will be developed for designing scenarios and for assessing team member performance in decision making and exchanging information. All tools will be developed and validated in co-operation with future end-users (fire-academies, disaster control managers). During the project, two applications will be worked out to show the GAMMA-EC concept works: large-scale forest fires and chemical accidents. To keep down the expenses for future users the GAMMA-EC tools will make use of commercial off-the-shelf hardware and software.

Inputs:
Data describing the training scenario

Classification using iERF axes:
Disaster event: Can be used to model various events.
Applications: Training
Entities of interest: Aimed at modeling various entities appropriate to scenario modeled.

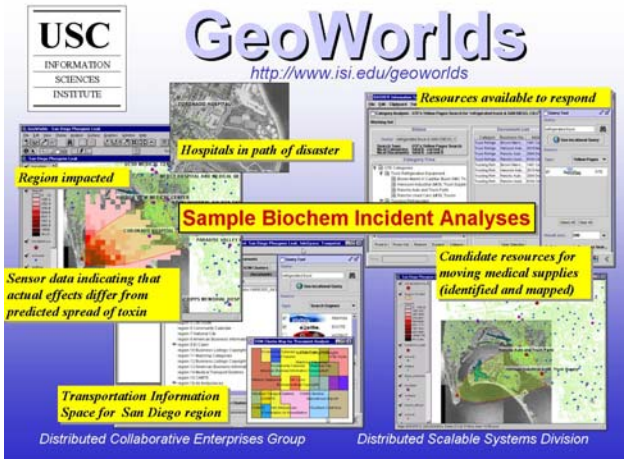
Information source:
http://www.tno.nl/instit/fel/gamma_ec/index.html

(22) GeoWorlds

Developer/Sponsor Organization(s):

Information Sciences Institute
University of Southern California

Screen Display: A group of relevant screen displays.



Brief Description:
GeoWorlds integrates Geographical Information Systems and Digital Library technologies into a single system. It extends existing services, and implements new services, for finding and organizing information about sources of goods, services and information. This will support a strategic alliance of technology developers and transfer the resulting technology to multiple military partners designated by DARPA; the partners are concerned with applying the technology in disaster relief operations.

GeoWorlds can assist in disaster relief missions to help users assess the impact of a disaster, identify assets and partners that can help respond to the problem, and help organize the application of those assets. GeoWorlds will be an extension to digital library technology that provides functionality and demonstrates feasibility of a system that relates geographical information to a corpus of "other" information in documents. The function of the system is to help a user understand facts and events in relation to space and time. It allows users to take a set of documents, relate them to places and times relevant to their contents, and provide a visual environment for presenting and exploring those relationships.

GeoWorlds has been put to experimental use in both academic and government settings for gathering information and analyzing a wide range of situations. These include preparing for hyothetical disasters, performing intelligence analysis, researching economic and business questions, and a number of other applications.

Inputs:
Documents describing the event, impact and response plans.

Classification using iERF axes:
Disaster event: Can be used to model various events.
Applications: Planning, training, vulnerability analysis
Entities of interest: Aimed at modeling various entities appropriate to scenario modeled.

Information source:
http://www.isi.edu/geoworlds/

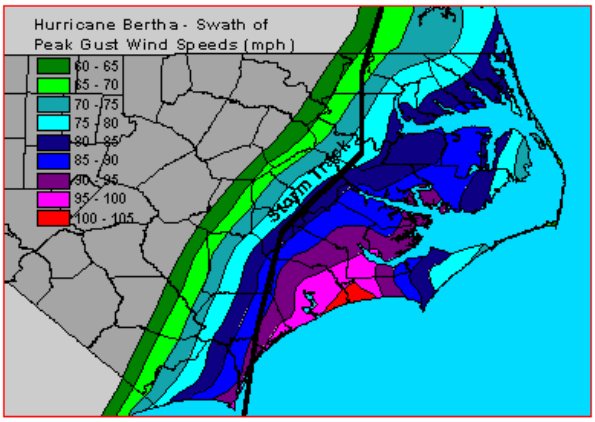
(23) HAZUS, Hazards U.S.

Developer/Sponsor Organization(s):

Federal Emergency Management Agency

National Institute of Building Sciences

Screen Display:



The above screenshot is from a HAZUS model developed by Applied Research Associates, Inc.

Brief Description:
HAZUS is a standardized, national methodology for assessing losses from natural hazards. It has been developed in support of the Federal Emergency Management Agency's commitment to encourage mitigation as a means to reduce damage and loss from natural disasters, and to lessen the effects on people and the economy. HAZUS was first developed to assess the effects of earthquakes but is now being expanded to include models to address flooding (riverine and coastal) and wind (hurricanes, thunderstorms, tornadoes, extra tropical cyclones and hail) hazards.

Inputs:
Building stock, local geology and the location and size of potential disasters, economic data, and other information.

Classification using iERF axes:
Disaster event: Natural disasters
Applications: Planning
Entities of interest: Buildings, infrastructure and Population

Information source:
http://www.nibs.org/hazusweb/

(24) Hazard Prediction & Assessment Capability (HPAC)

Developer/Sponsor Organization(s): **Screen Display:** Not Available

Defense Threat Reduction Agency

Brief Description:
HPAC is a forward deployable, NBC hazard prediction capability available for government, government related or academic use. This software tool assists warfighters in weaponeering targets containing weapons of mass destruction (WMD) and in emergency response to hazardous agent release. Its fast running, physics based algorithms enable users to model and predict hazard areas and human collateral effects in minutes.

HPAC models all nuclear, biological, and chemical (NBC) collateral effects of concern to military operations. These may derive from the use of NBCR weapons or from conventional weapon strikes against production and storage facilities for such weapons. Similar effects may result from military or industrial accidents. HPAC provides source information on potential radioactive releases from a nuclear weapon or reactor accident and has the capability to generate source terms for nuclear, chemical and biological weapon strikes or accidental releases.

Obtaining weather data is as easy as a click on a mouse with HPACs weather request generator, which provides access to forecast model and observational data in just minutes. HPAC also has embedded climatology or historical weather for use when real-world weather is not available.

Inputs:
Information on NBC attack, locale and weather

Classification using iERF axes:
Disaster event: Nuclear, biological, and chemical attack
Applications: Planning, training, real time response support
Entities of interest: Population

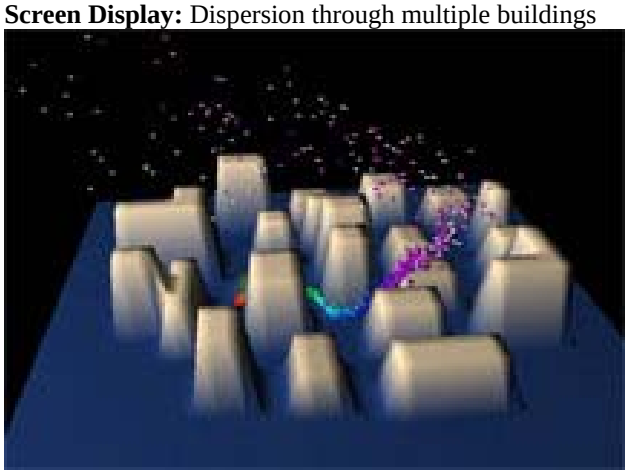
Information source:
http://navmsmo.hq.navy.mil/ (search on HPAC)

(25) HOTMAC/RAPTAD

Developer/Sponsor Organization(s):

YSA Corporation

Screen Display: Dispersion through multiple buildings



Brief Description:
The HOTMAC/RAPTAD system is a user-friendly, cost effective way to simulate various what-if scenarios in the computer, which is impossible to do with field measurements, but necessary for planning or mitigating potential environmental catastrophes. It includes a preprocessor, mesoscale meteorological code, a transport and diffusion code, a postprocessor with realistic graphical 2D and 3D displays, and extensive graphical user interfaces (GUI). HOTMAC® (Higher Order Turbulence Model for Atmospheric Circulation) is a three-dimensional mesoscale prediction model that forecasts wind, turbulence, humidity, and atmospheric turbulence distribution over complex surface conditions. RAPTAD® (Random Puff Transport and Diffusion) is a three-dimensional Lagrangian random puff model that is used to forecast transport and diffusion of air pollution materials over complex terrain. The modeling system is applicable from building scale to mesoscale (~2000 km).

Inputs:
Building profiles, agent release information

Classification using iERF axes:
Disaster event: Chemical, biological, Radiological agent release
Applications: Planning, training, real time response support
Entities of interest: Population, response agents

Information source:
http://www.ysasoft.com/solution/system.htm

(26) HotSpot

Developer Organization(s):

National Atmospheric Release Advisory Center (NARAC)
Lawrence Livermore National Laboratory

Screen Display:

Brief Description:
Hotspot, a fast-running local-scale steady-state Gaussian plume model for radiological releases was developed at Lawrence Livermore National Laboratory. This model is fast and simple, requiring a minimum amount of input data. It can provide initial predictions of the time-integrated effect (such as dosage from the entire plume passage). It can be used to make initial protective action recommendations, using conservative assumptions, before advanced model results are available.

Inputs:
Information on hazardous release, terrain, and weather forecasts.

Classification using iERF axes:
Disaster event: Chemical, biological or radiological agent dispersion
Applications: Planning, training, real time response support
Entities of interest: Population, first responders, other affected entities based on the agent

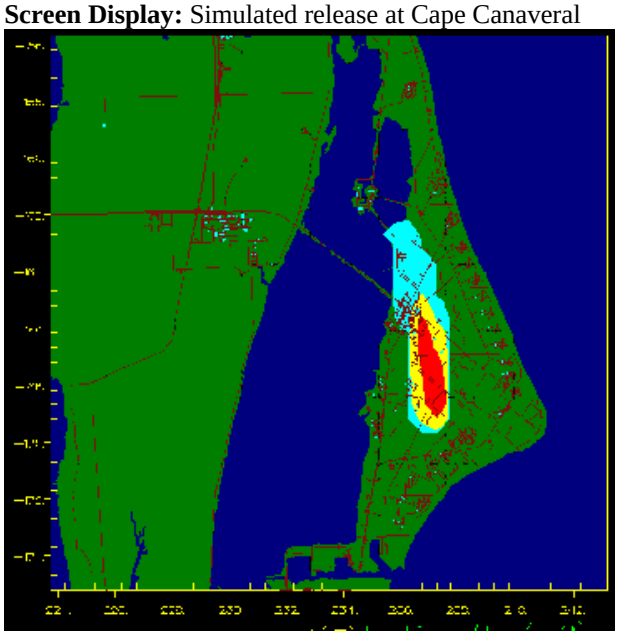
Information source:
http://narac.llnl.gov/modeling.html

(27) Hybrid Particle And Concentration Transport Model – HYPACT

Developer/Sponsor Organization(s):

ATMET, LLC

Screen Display: Simulated release at Cape Canaveral



Brief Description:
HYPACT represents a state-of-the-art methodology for predicting the dispersion of air pollutants in 3-D, mesoscale, time dependent wind and turbulence fields. *HYPACT* allows assessment of the impact of one or multiple sources emitted into highly complex local weather regimes, including mountain/valley and complex terrain flows, land/sea breezes, urban areas, and other situations in which the traditional Gaussian-plume based models are known to fail.

HYPACT, developed by the personnel at Mission Research Corporation and current ATMET personnel, represents the next generation of dispersion modeling systems. It combines the best features of grid-based Eulerian dispersion methodologies with Lagrangian particle dispersion modeling.

The product is supported by RAMS/HYPACT Evaluation and Visualization Utilities (REVU) that is a standard package for generating graphical representations and reformatting HYPACT model output.

Inputs:
Packed meteorological fields and global land and water surface data sets

Classification using iERF axes:
Disaster event: Chemical, biological and Radiological agent release
Applications: Planning, training, real time response support
Entities of interest: Population, Environment, response agents

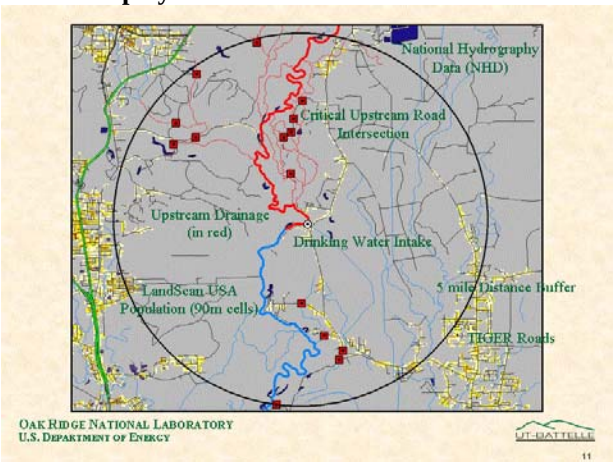
Information source:
http://www.atmet.com/html/hypact_soft.shtml

(28) HYTRAS – Hydrologic Transport Assessment System (HYTRAS)

Developer/Sponsor Organization(s):

Oak Ridge National Labs

Screen Display:



Brief Description:
HYTRAS predicts the transport of nuclear, biological, and chemical agents in surface waters. HYTRAS uses geospatial information, hydrological data, and soil and sediment characteristics to estimate nuclear, biological, and chemical agent concentrations in water and sediment. The results are produced for areas and time-periods of interest. River/Lake model is available, and estuaries and oceans could be added. At present, approximately 200 rivers worldwide are included in the river/map database. The new river database under development will have thousands of rivers including water intakes for the U.S.

HYTRAS is planned for inclusion in future versions of the Hazard Prediction Assessment Capability (HPAC; see elsewhere in this document).

Inputs:
Information on NBC release

Classification using iERF axes:
Disaster event: Nuclear, biological and chemical agent release in surface waters
Applications: Planning, vulnerability analysis, training, real-time response
Entities of interest: Water supply infrastructure, population

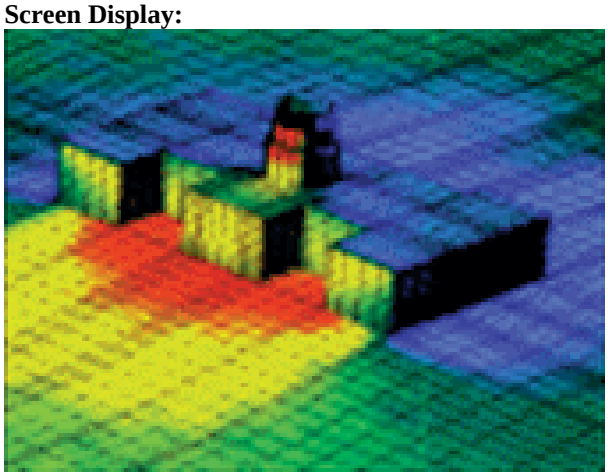
Information source:
http://computing.ornl.gov/cse_home/hytras/hytraspres.html

(29) Interior Building Hazard Modeling

Developer/Sponsor Organization(s):

Defense Group Inc.

Screen Display:



Brief Description:
As part of the management support function for the DoD 911-Bio ACTD, DGI assembled a suite of computer models to assess the hazard associated with the terrorist release of a biological agent inside a building. The DGI team developed the requirements for benchmarking the codes. In addition, they analyzed the model predictions to synthesize tentative rules of thumb for First Responders.

Inputs:
Data defining the building and the biological agent.

Classification using iERF axes:
Disaster event: Biological agent release
Applications: Planning, vulnerability analysis, training
Entities of interest: Population and Response agents

Information source:
http://www.defensegp.com/sci_tech10.cfm

(30) LandView®

Developer/Sponsor Organization(s): **Screen Display:** Not Available

U.S. Census Bureau
U.S. Geological Survey
National Oceanic and Atmospheric Administration

USEPA
Chemical Emergency Preparedness and Prevention Office

Brief Description:
The LandView product contains two software programs - the LandView database manager and the MARPLOT® map viewer. These two programs work in tandem to create a simple computer mapping system that can display individual layers of information that have spatial information associated with them. For example, the LandView EPA database shows information reported to the EPA for a selection of EPA-regulated sites while MARPLOT provides the capability of identifying the sites on a map.
The LandView database program allows users to browse and query records extracted from the Environmental Protection Agency's Envirofacts Warehouse, demographic statistics from the U.S. Census Bureau's Decennial Census, and the USGS Geographic Names Information System

LandView 5 contains selected Census 2000 demographic data from Summary File 1 (SF1) and maps based on the Census 2000 TIGER/Line® files for all states, the District of Columbia and Puerto Rico. These maps show both streets and Census 2000 legal and statistical areas (including Census 2000 Urban/Rural delineations). LandView 5 also contains recent EPA and USGS Geographic Names Information System (GNIS) data and maps.

LandView 5 includes statistical data on the following population items: sex, age, race, Hispanic or Latino origin, household relationship, and household and family characteristics. Housing items include occupancy status and tenure (whether the unit is owner- or renter-occupied). Census 2000 socio-economic data like education, occupation, income and poverty were not available for inclusion in LandView 5. LandView 6, planned for release during the Fall of 2003, will contain selected Summary File 3 data.

Inputs:
Geographical information

Classification using iERF axes:
Disaster event: Various events
Applications: Planning, real time response support
Entities of interest: Population, environment

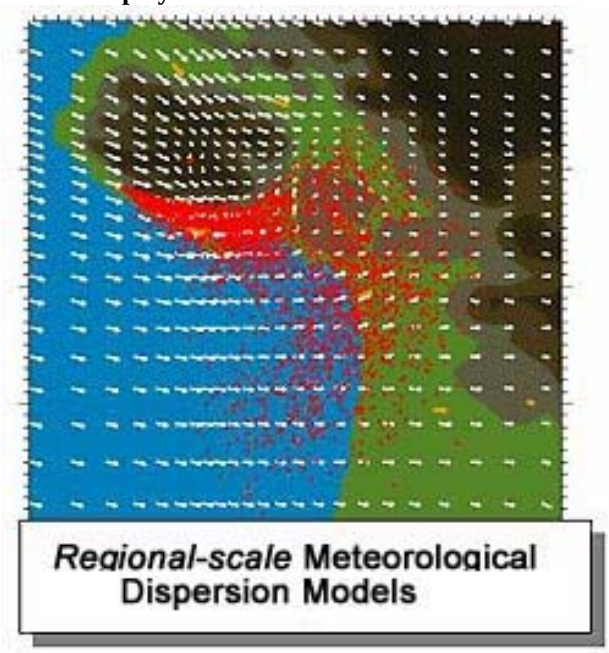
Information source:
http://www.census.gov/geo/landview/lv5/lv5.html

(31) LODI - Lagrangian Operational Dispersion Integrator

Developer Organization(s):

National Atmospheric Release Advisory Center (NARAC)
Lawrence Livermore National Laboratory

Screen Display:



Brief Description:
LODI models the dispersion for a wide range of hazards on regional and long range scales. LODI includes methods for simulating the processes of mean wind advection, turbulent diffusion, radioactive decay and production, bio-agent degradation, first-order chemical reactions, wet deposition, gravitational settling, dry deposition, and buoyant/momentum plume rise. The models are coupled to NARAC databases providing topography, geographical data, chemical-biological-nuclear agent properties and health risk levels, real-time meteorological observational data, and global and mesoscale forecast model predictions.

Inputs:
Information on hazardous release, terrain, and weather forecasts.

Classification using iERF axes:
Disaster event: Chemical, biological or radiological agent dispersion
Applications: Planning, training, real time response support
Entities of interest: Population, First responders, other affected entities based on the agent

Information source:
http://narac.llnl.gov/modeling.html

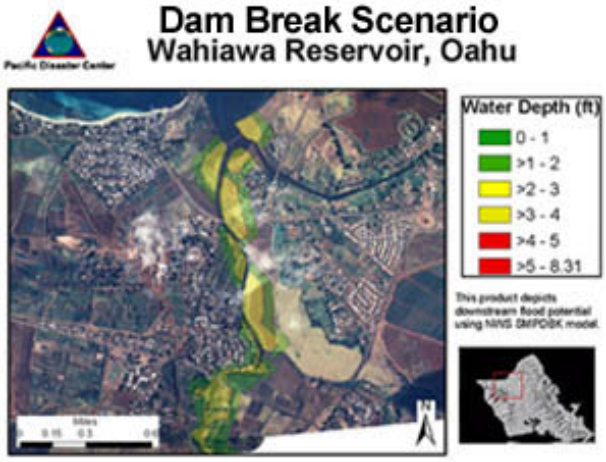
(32) M2M Dam Failure Model

Developer/Sponsor Organization(s):

Science & Technology International Industries

Pacific Disaster Center

Screen Display: M2M flood inundation path on an aerial photograph



Brief Description:
M2M Dam Failure model simulates dam break inundation. The results can be used to perform GIS-based consequence and risk analysis. The M2M model is a predictive tool that provides a bridge between the National Weather Service's FLDWAV model and ArcView GIS. By translating the FLDWAV output into an ArcView grid, or map, the M2M (Model to Map) application transports the user from a textual to a spatial context, providing a visual representation of the floodwaters, and thereby facilitating further analysis of the flood's impact.

Three types of analysis can be made from the model output: quick assessment, vulnerability assessment, and economic damage assessment. Quick assessment provides an overall view of the floodwater inundation, including water depth and total flood time. Vulnerability assessment analyzes the vulnerability of a community's infrastructure, such as schools and roads. Economic damage assessment estimates the potential economic damage to private buildings and businesses. The image above depicts the M2M flood inundation path on an aerial photograph. This allows for a visual analysis of the potential damage.

Inputs:
Information on dam and the local geographic area

Classification using iERF axes:
Disaster event: Floods, Dam Failure
Applications: Planning, vulnerability analysis, real time response suppport
Entities of interest: Population, infrastructure

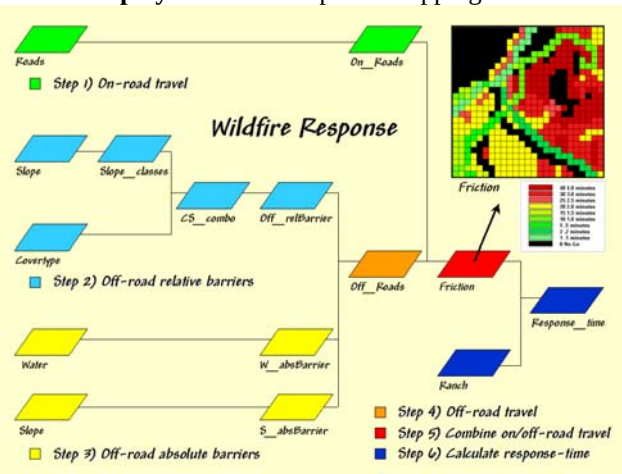
Information source:
http://www.sti-government.com/Applications/Natural_Disaster_Response.html
http://www.pdc.org/iweb/

(33) MapCalc Map Analysis software

Developer/Sponsor Organization(s):

Innovative GIS Solutions, Inc.

Screen Display: Wild fire response mapping



Brief Description:
MapCalc is a comprehensive set of grid-based tools for advanced analysis and display of spatial information. The software can be used for planning emergency response operations. The website provides an example application for planning wildfire response.

Inputs:
Data describing the map slope, cover type, water, roads

Classification using iERF axes:
Disaster event: Can be used for events requiring spatial analysis and planning
Applications: Planning, training, real time response support
Entities of interest: Can be used to study aggregate movements and dispersions across grids.

Information source:
http://www.innovativegis.com/basis/Senarios/Fire_response_senario.htm

(34) MARPLOT

Developer/Sponsor Organization(s):

USEPA
Chemical Emergency Preparedness and
Prevention Office

Screen Display: Not Available

Brief Description:
MARPLOT is a mapping application. It allows users to "see" their data (e.g., roads, facilities, schools, response assets), display this information on computer maps, and print the information on area maps. The areas contaminated by potential or actual chemical release scenarios also can be overlaid on the maps to determine potential impacts. The maps are created from the U.S. Bureau of Census TIGER/Line files and can be manipulated quickly to show possible hazard areas.

It is part of CAMEO, a system of software applications used widely to plan for and respond to chemical emergencies. It is one of the tools developed by EPA's Chemical Emergency Preparedness and Prevention Office (CEPPO) and the National Oceanic and Atmospheric Administration Office of Response and Restoration (NOAA), to assist front-line chemical emergency planners and responders.

Inputs:
Geographical information

Classification using iERF axes:
Disaster event: Chemical release events
Applications: Planning, real time response support
Entities of interest: Population

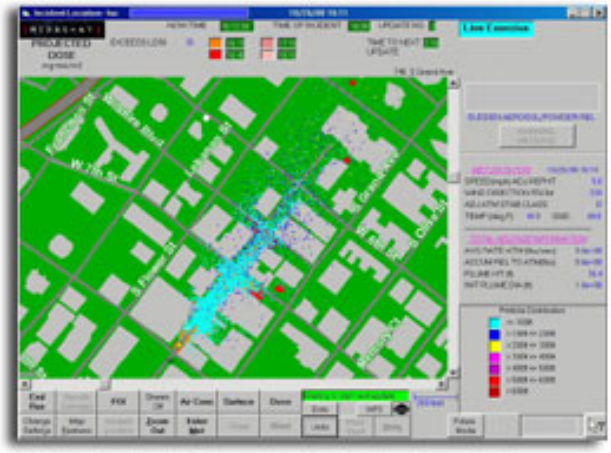
Information source:
http://www.epa.gov/ceppo/cameo/what.htm##marplot

(35) MIDAS-AT, Meteorological Information and Dispersion Assessment System Anti-Terrorism

Developer/Sponsor Organization(s):

ABS Consulting

Screen Display: Dispersion in urban area



Brief Description:
Models dispersion of releases of industrial chemicals, chemical and biological agents, and radiological isotopes caused by accidents or intentional acts. It is for use during emergencies and for planning and emergency response drills. Its graphical user interface is designed for straightforward user entry of information required to define a terrorist scenario with enough detail to provide critical hazard information during the incident. Results are based on atmospheric dispersion models tailored for the release conditions, whether they are in open flat terrain, in an urban area with tall buildings, or inside a building.

Inputs:
Local area map, building profiles, weather information, chemical and biological sensor inputs

Classification using iERF axes:
Disaster event: Chemical, biological or radiological release
Applications: Planning, training, real time response support.
Entities of interest: City air

Information source:

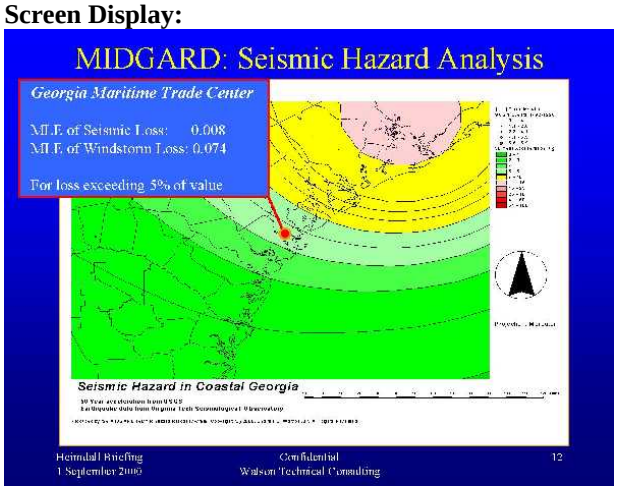
http://www.absconsulting.com/midas/index.html#

(36) MIDGARD

Developer/Sponsor Organization(s):

Watson Technical Consulting

Screen Display:



Brief Description:
MIDGARD is a modular geophysical damage model. Hazards such as earthquakes and, when coupled with TAOS tsunamis, can be modeled. When combined with the statistical analysis system, MIDGARD can provide emergency planners with the earthquake hazard data they need for mitigation planning, economic analysis, or insurance portfolio analysis.

Inputs:
Seismic event characteristics and local geography

Classification using iERF axes:
Disaster event: Earthquake
Applications: Planning, vulnerability analysis
Entities of interest: Population, infrastructure

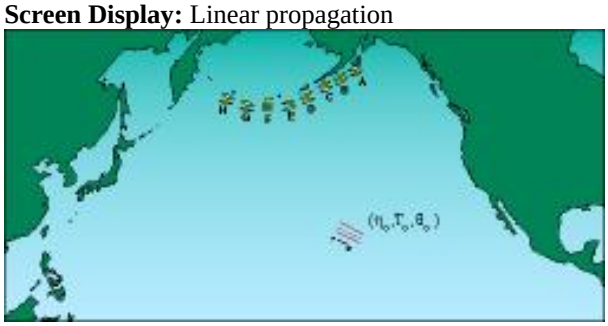
Information source:
http://www.methaz.com/midgard.html

(37) MOST (Method of Splitting Tsunami)

Developer/Sponsor Organization(s):

Pacific Marine Environmental Laboratory

Screen Display: Linear propagation



Brief Description:
A suite of numerical simulation codes, known collectively as the MOST (Method of Splitting Tsunami) model, have been implemented and tested on the Maui High Performance Computing Center (MHPCC) IBM PS2 nodes. Together, they are capable of simulating the three primary processes of tsunami evolution, i.e., generation by an earthquake, transoceanic propagation, and inundation of dry land.

Supercomputer implementation of the MOST model allows the efficient computation of many scenarios. This capability is used to perform multiple-run sensitivity studies of two closely related, but separable, processes -- offshore wave dependence on distant earthquake magnitude and position, and site-specific inundation dependence on offshore wave characteristics. The results will be organized into an electronic database, and associated software will be developed for analysis and visualization of this database, including the assimilation of real-time data streams.

Generation and propagation capabilities were tested against deep ocean bottom pressure recorder collected by PMEL during the 1996 Andreanov tsunami; inundation computations were compared with field measurements of maximum runup on Okushiri Island collected shortly after the 1993 Hokkaido-Nansei-Oki tsunami.

Inputs:
Parameters describing the earthquake and the surrounding geography

Classification using iERF axes:
Disaster event: Tsunami
Applications: Planning, vulnerability analysis
Entities of interest: Population, infrastructure

Information source:
http://www.pmel.noaa.gov/tsunami/pdctm.html

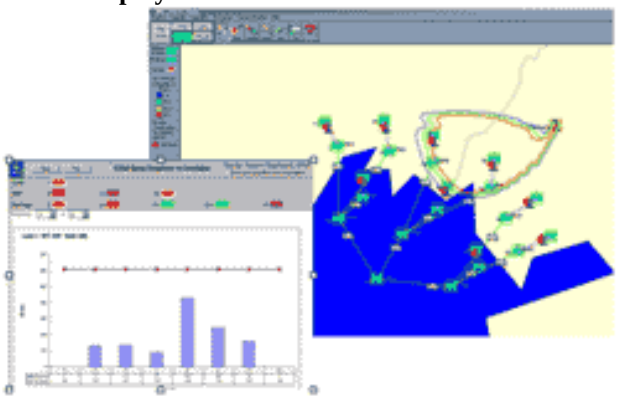
(38) NBC CREST – Casualty and Resource Estimation Support Tool

Developer/Sponsor Organization(s):

Army Office of the Surgeon General (OTSG)

ScenPro Inc.

Screen Display:



Brief Description:
The NBC (Nuclear, Biological and Chemical) Casualty and Resource Estimation Support Tool (CREST) supports deliberate medical planning in an iterative, integrated process for the US Army at the Corps, Division, and Corps Medical Brigade levels. Using scenarios as a driver for the tool, it allows medical personnel to estimate casualty streams and resource usage, and develop appropriate medical courses of action.

The user-defined deployment and defensive posture of combat and rear area personnel is coupled with one or more NBC attack scenarios on the map in accordance with the current threat assessment and planning guidance. The capability of individual deployed medical resources to meet demand is analyzed and the results are displayed. Key functions of the tool include:

- Map-based representation of operational units, support units, medical treatment facilities, medical evacuation flow, and coverage of NBC threats
- Estimation of required medical treatment resources
- Analysis of required medical resources and available resources at each level of care
- Comparison of alternative medical Courses of Action (COAs)

The figure demonstrates NBC CREST in operation. The background display features a map of the operational theater with deployed combat and support units. The colored lines represent the density gradient for a plume cloud of Tularemia bacteria originating from a point sprayer. Shown as an overlay are the resulting bed requirements for a single Level 2 medical treatment facility listed per day by bed type.

Inputs:
Scenario description, deployed combat, support and medical units.

Classification using iERF axes:
Disaster event: Nuclear, biological, and chemical release events
Applications: Planning, training
Entities of interest: Hospital resources

Information source:
http://www.scenpro.com/sec_prod_nbccrest.html

(39) NCBR - Nuclear, Chemical, Biological, And Radiological Environment Server

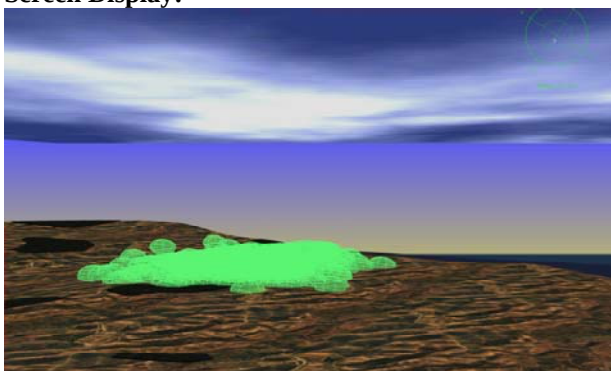
Developer/Sponsor Organization(s):

ITT Industries

US Army Soldier and Chemical Biological Command

Defense Threat Reduction Agency

Screen Display:



Brief Description:
ITT Industries designed and developed a nuclear, chemical, biological, and radiological (NCBR) modeling and simulation toolset in support of a consortium of US Government organizations led by the US Army Soldier and Biological Chemical Command. At the heart of the toolset are a distributed simulation-compliant (IEEE DIS and HLA) weapons of mass destruction (WMD) environment server, the NCBR, and an array of sensor and messaging system simulations representing both fielded and prototype systems that the Services have developed to operate in the WMD environment. The toolset is complemented by a chemical and biological extension to the Army's OneSAF code. The DoD uses this toolset to support the research, development, and acquisition and training of nuclear, chemical, biological, and radiological defense systems. The tools serve as the basis for hardware mock-up training systems and virtual testing with live systems.

Inputs:
Information on terrain, meteorological conditions, and nuclear, chemical, biological or radiological release

Classification using iERF axes:
Disaster event: Nuclear, chemical, biological or radiological release
Applications: Planning, training, real time response support
Entities of interest: Population, response agents

Information source:
http://www.msiac.dmso.mil/journal/wi9912/simcb12.html

(40) NDAC - Network Design and Analysis Capability

Developer/Sponsor Organization(s): **Screen Display:** Not available

National Communications System
Technology and Programs Division

Brief Description:
NDAC software comprises tools, models and telecommunications databases that analysts use to assess network performance, conduct modeling and simulation tasks, and visualize network topologies. One of the objectives of NDAC is to evaluate the vulnerability, survivability, and reliability of networks during local/regional outages or emergencies. It is a combination of technology, databases and published material. Microsoft's Internet Information Server, Macromedia's ColdFusion and Oracle's LECMap are the technical components. Databases that are used include the Enhanced Microwave Environmental Link File and the Federal Communications Commission's Outage Database. Publications such as the Roaming Implementation Service Guide and the Local Exchange Routing Guide also furnish data. In addition to assessing the current status of the networks, NDAC examines how emerging technologies would affect the PSN and specifically how they would change future NS/EP requirements.

Inputs:
Information on all the networks nationwide

Classification using iERF axes:
Disaster event: Various communication infrastructure events
Applications: Planning, systems testing, real time response support
Entities of interest: Communication infrastructure

Information source:
http://www.ncs.gov/n5_hp/Customer_Service/Brochures/35Anniversary/progact2.htm
http://www.us.net/signal/Archive/April02/keeping-april.html

(41) NDGPS - Nationwide Differential Global Position System

Developer/Sponsor Organization(s): **Screen Display:** Not available

U.S. Coast Guard

Brief Description:
An extensive nationwide system of precise positioning will be built throughout the United States and Puerto Rico that will transform the public safety sector's ability to protect U.S. communities. The Coast Guard developed, built, and operates the fully operational Maritime DGPS service. The applications of the NDGPS include:

- Police, fire, ambulance, and rescue coordinators will be able to cut response times and save lives and property using computer-aided dispatching and on-scene management of resources through passive tracking of assets.
- It can help locate fire hydrants, signs, and critical public safety infrastructure even in low or zero visibility, such as at night or in severe weather.
- Interagency coordination and on-scene management of disasters would be improved by using this technology to get precise positioning information to the Incident Commander.
- The precise positioning information can be used by modeling and simulation applications for emergency response.

Inputs:
Incident location information

Classification using iERF axes:
Disaster event: Various events
Applications: Real time response support
Entities of interest: Population, response agents

Information source:

- http://www.navcen.uscg.gov/ndgps/default.htm
- 2000 Annual Report, The InterAgency Board for Equipment Standardization and InterOperability.

(42) NEES - Network for Earthquake Engineering Simulation

Developer/Sponsor Organization(s): **Screen Display:** Not available

National Science Foundation and nearly 20
U.S. universities

Brief Description:
When fully operational in October 2004, the NEES program will provide an unprecedented infrastructure for research and education, consisting of networked and geographically distributed resources for experimentation, computation, model-based simulation, data management, and communication.

The system integration component of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) will design, construct, implement, test, and make operational NEESgrid, a high-performance Internet network that enables a truly synergistic national simulation resource for research and education, supporting collaborative experimentation, modeling, and simulation for the earthquake engineering community. NEESgrid will be a distributed virtual laboratory for earthquake experimentation and simulation. Its integrated tools will enable earthquake engineering simulation -- both physically and numerically -- providing an environment for researchers to develop increasingly complex, comprehensive, and accurate models of how structures of all kinds respond to earthquake loadings.

The collaboration enabled through NEES and the explicit integration within its programs of experimentation, theory formulation and validation, data curation, model-based simulation, high performance computing and education will accelerate substantially the development of technically sound and cost effective approaches to earthquake loss reduction.

Inputs:
Description of location of earthquake and surrounding geography

Classification using iERF axes:
Disaster event: Earthquake
Applications: Planning, vulnerability analysis
Entities of interest: Population, response agents, infrastructure

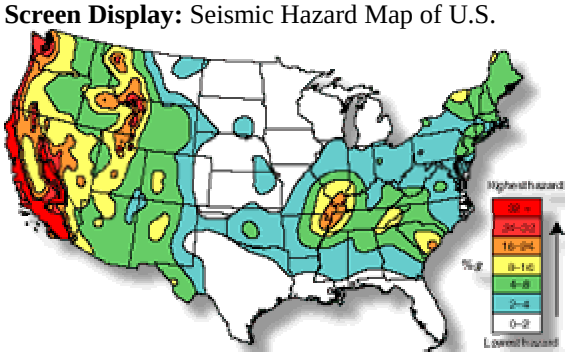
Information source:
http://www.nees.org/

(43) NEHRP - National Earthquake Hazard Reduction Program Maps

Developer/Sponsor Organization(s):

U.S. Geological Survey, MS 977

Screen Display: Seismic Hazard Map of U.S.



Brief Description:
National maps of earthquake shaking hazards provide information essential to creating and updating the seismic design provisions of building codes used in the United States. Scientists frequently revise these maps to reflect new knowledge. Buildings, bridges, highways, and utilities built to meet modern seismic design provisions are better able to withstand earthquakes, not only saving lives but also enabling critical activities to continue with less disruption.

The National Earthquake Hazards Reduction Program (NEHRP) maps were prepared by the USGS and are based on the recommendations of the Building Seismic Safety Council's (BSSC) Seismic Design Procedures Group (SDPG). The SDPG-recommended maps, the Maximum Considered Earthquake (MCE) Ground Motion Maps, are based on the U.S. Geological Survey (USGS) probabilistic hazard maps with additional modifications incorporating deterministic ground motions in selected areas and the application of engineering judgement.

Inputs:
Geographic information

Classification using iERF axes:
Disaster event: Earthquake
Applications: Planning
Entities of interest: Population, response agents, infrastructure

Information source:
http://geohazards.cr.usgs.gov/eq/index.html

(44) NISAC - National Infrastructure Simulation And Analysis Center

Developer/Sponsor Organization(s): **Screen Display:** Not available

Sandia National Laboratories

Brief Description:
The National Infrastructure Simulation and Analysis Center (NISAC) is being established as the first comprehensive capability to assess the system of infrastructures and their interdependencies. It will provide the most reliable decision support analysis for use by policy makers, government leaders, and infrastructure owners. NISAC will provide modeling, simulation, and analysis of the nation's infrastructures, with emphasis on interdependencies. This analysis will lead to optimized mitigation strategies and reconstruction planning and real time crisis support. NISAC's core partners are Sandia National Laboratories and Los Alamos National Laboratory. As the program expands, additional partners including other national labs, private industry, and universities will be added. NISAC will use distributed information systems architectures to provide virtual analysis capabilities that will accommodate a large number of providers and a large number of users.

NISAC will be fully functional by FY2005 with advanced modeling and simulation capabilities to provide policy analysis, mitigation planning, education and training support, and real-time crisis assistance for a wide variety of users.

Inputs:
Information on infrastructure and disaster event

Classification using iERF axes:
Disaster event: Significant disaster events that damage infrastructure
Applications: Planning, vulnerability analysis, training, real time response support
Entities of interest: Infrastructure

Information source:
www.sandia.gov/CIS/nisac-factsheet.doc

(45) PEGEM

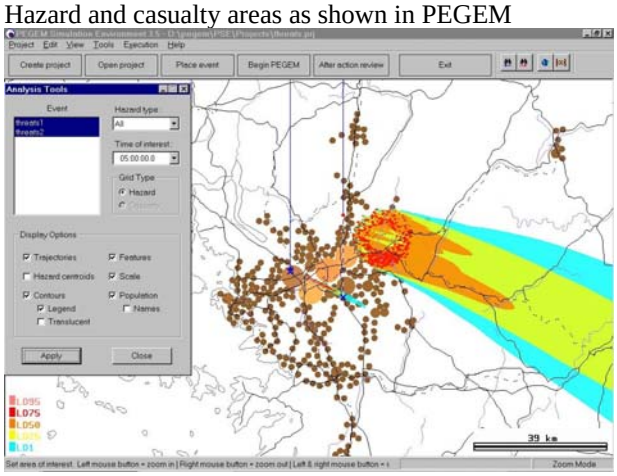
Developer/Sponsor Organization(s):

Missile Defense Agency, Modeling and Simulation

BAE Systems (previously MEVATEC Corporation)

Naval Research Laboratory, Laboratory for Computational Physics

Screen Display:
Hazard and casualty areas as shown in PEGEM



Brief Description:
The Post-Engagement Ground Effects Model (PEGEM) is a powerful software tool that can meet the challenge for accurate and timely modeling and assessment of chemical, biological and high explosive effects. Current development is under way for the addition of radiological and nuclear effects. PEGEM incorporates digital terrain information and current and forecasted weather data to provide ground hazard assessment. PEGEM is being used by over 100 organizations. PEGEM provides:

1. An operational/tactical simulation environment for assessment, planning and training
2. A tool for parametric studies of chemical, biological and high explosive agent effects
3. The decision maker a visual indication of hazard areas and potential casualty producing regions

Another tool, CT-Analyst (see elsewhere in this document) is being incorporated into the PEGEM tool under Missile Defense Agency sponsorship that will allow a user to model a variety of scenarios that encompass both large and small-scale events. The integrated tools will provide:

1. Enhanced modeling capabilities
2. More complex scenario simulation
3. Broader range of modeling resolution, from meters to hundred of kilometers

Inputs:
Information defining the event and weather information

Classification using iERF axes:
Disaster event: Chemical, biological, radiological, nuclear and high explosive events
Applications: Planning, training, real time response support
Entities of interest: Population, response agents

Information source:
http://www.mevatec.com/pegem/index.htm

(46) Port Security Simulations

Developer Organization(s):

SAIC's Applied Software Systems
Engineering Technology Group (ASSET)

Screen Display:

Brief Description:
The Port Simulation Training Software combines satellite imagery, still photography and video images with precise measurements of sea channel depth and other vital navigation information. It creates an exact duplication, above ground and under the sea, of any harbor or port in the world. The portable training system allows security teams to simulate operations from the sea, ground and air and practice the best responses. This training is suitable for U.S. Military Special Operations, U.S. Coast Guard, National Guard Troops, Port Authorities, local law enforcement, and emergency response teams.

Inputs:
Satellite imagery, still photography and video images.

Classification using iERF axes:
Disaster event: Terrorist attack
Applications: Planning, vulnerability analysis, training
Entities of interest: Port infrastructure

Information source:
http://www.asset.com/solutions/simsystm/port_sec_sim.html

(47) Radiological Accident Modeling for Emergency Response (RASCAL)

Developer Organization(s):

Computational Sciences and Engineering Division
Oak Ridge National Laboratory

Screen Display:

Brief Description:
The Radiological Assessment System for Consequence Analysis, Version 2.2 (RASCAL 2.2) has been developed for use by U.S. Nuclear Regulatory Commission (NRC) staff who respond to power reactor accidents and other radiological emergencies. The model is designed to provide a comparison to EPA Protective Action Guidance and thresholds for acute health effects. RASCAL will be used to conduct an independent evaluation of dose and consequence projections. The model was developed to allow consideration of the dominant aspects of source term, atmospheric transport, radiological dose, and consequences. The results can be displayed as text or maps. RASCAL runs on an DOS-based personal computer. RASCAL has been widely distributed to the state governments and to foreign countries.

Inputs:
Reactor configurations, possible accident scenarios, and the effectiveness of release reduction mechanisms (such as filters, sprays, etc.)

Classification using iERF axes:
Disaster event: Radiological release
Applications: Planning, vulnerability analysis, training, real time response support
Entities of interest: Population, response agents

Information source:
http://computing.ornl.gov/cse_home/cms/als.html

(48) Range 3000 XP4

Developer Organization(s):

IES Interactive Training USA

Screen Display:

Brief Description:
Range 3000 XP4 is a portable digital simulator that will enable agencies to create real-world scenarios for indoor and outdoor firearms training. It generates sounds and images to create scenarios, and an instructor evaluates how agents analyze and react to different situations. The scenarios would be run on a laptop computer and projected onto a screen. A trainee would encounter a scene and make decisions based on the situation, such as talking to a suspect or drawing a weapon. An instructor operating the system could change the path of the events based on the trainee's reaction. The system comes with more than 100 scenarios, but an organization can tape and edit them for the training program.

The system is in use at FBI, NASA, the Transportation Security Administration and the United States Border Patrol.

Inputs:
Scenarios and agent interaction.

Classification using iERF axes:
Disaster event: Terrorist incidents
Applications: Training
Entities of interest: Response agents

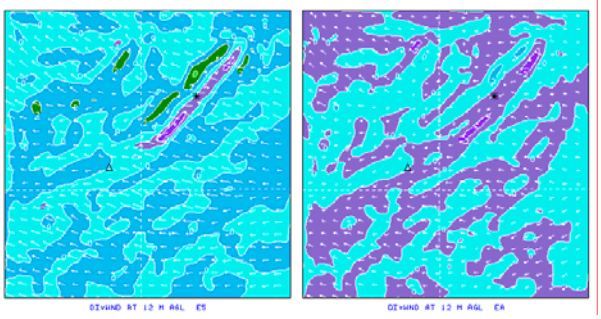
Information source:
http://www.ies-usa.com/products/range3000/range3000.htm

(49) Regional Atmospheric Modeling System - RAMS

Developer/Sponsor Organization(s):

ATMET, LLC

Screen Display: RAMS results for Susquehanna valley study



Brief Description:
RAMS is a multipurpose, numerical prediction model designed to simulate atmospheric circulations spanning in scale from hemispheric scales down to large eddy simulations (LES) of the planetary boundary layer. RAMS was primarily developed at Colorado State University and Mission Research Corporation (by current ATMET personnel), and now by ATMET. The most frequent applications of RAMS are to simulate atmospheric phenomena on the mesoscale (horizontal scales from 2 km to 2000 km) for purposes ranging from operational weather forecasting to air quality and dispersion applications to support of basic research. There are now more than 160 RAMS installations in over 40 countries.

The utility of using RAMS for real-time prediction of local-scale flows and for detailed post-event analysis was examined for a Nuclear Regulatory Commission (NRC) exercise at the Susquehanna nuclear power plant in Pennsylvania.

The product is supported by RAMS/HYPACT Evaluation and Visualization Utilities (REVU) that is a standard package for generating graphical representations and reformatting RAMS model output.

Inputs:
Packed meteorological fields and global land and water surface data sets

Classification using iERF axes:
Disaster event: Chemical, biological and radiological agent release
Applications: Planning, training, real time response support
Entities of interest: Population, environment, response agents

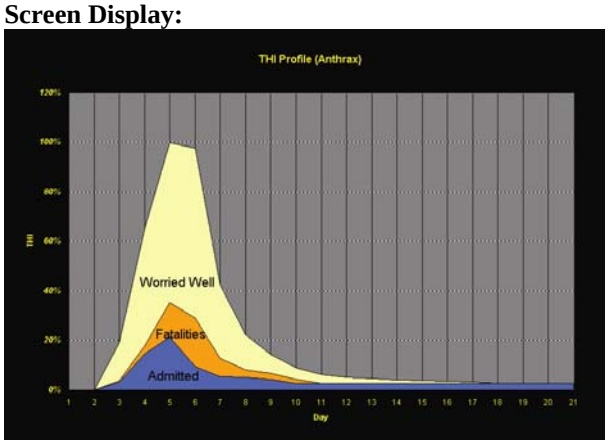
Information source:
http://www.atmet.com/html/rams_soft.shtml
http://www.arl.noaa.gov/ss/transport/fdda.html (screen display)

(50) RAMSAFE

Developer/Sponsor Organization(s):

RAMSAFE Technologies, LLC

Screen Display:



Brief Description:
RAMSAFE is designed to improve emergency first response by enabling responders, health and human services, and emergency management to better prepare for and respond to terrorism, natural disasters, special events and other emergencies. The software integrates interagency collaboration tools, operational checklists and procedures, resource management, and visual intelligence - aerial photography, floor plans, maps, iPIX 360 x 360 photography, real-time video, etc. - enabling first responders and emergency managers to conduct pre-incident preparations, operations and post-incident recovery more quickly, effectively and safely.

Featuring the automated bioterrorism forecasting and response tool designed by the U.S. Army Soldier Biological and Chemical Command (SBCCOM) and other federal agencies, RAMSAFE assists in predicting casualties, response and resource requirements for the duration of a bioterrorism incident. Dynamic forecasts are calculated based upon biological agent, such as Anthrax or Small Pox; number of infected individuals; available medical resources and city population. Responders are provided with possible response actions and resource requirements specific to each bioterrorism event, helping them to expedite response and enhance safety.

Development of the tool was initiated at the Department of Energy's Oak Ridge National Laboratory by the Department of Justice and the Department of Defense. Researchers transformed the U.S. Army SBCCOM's bioterrorism knowledge base into a dynamic, easy-to-use software solution Responder Assets Management System (RAMS).

RAMSAFE has been used for security planning for Superbowl XXXIV held in Atlanta in January 2000 and 2002 Winter Olympics in Salt Lake City, Utah.

Inputs:
Site plans, floor plans, security plans, operational plans, and other related documents

Classification using iERF axes:
Disaster event: A wide range of events
Applications: Planning, training, real time response support
Entities of interest: Population, response agents and Infrastructure

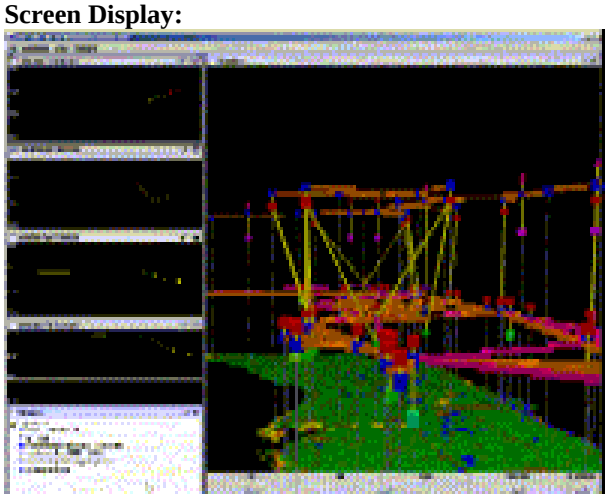
Information source:
http://www.ramsafe.com/

(51) Simulation Object Framework for Infrastructure Analysis (SOFIA)

Developer/Sponsor Organization(s):

Los Alamos National Laboratory

Screen Display:



Brief Description:
Critical infrastructure protection is a recognized problem of national importance. Infrastructure interdependence research and applications require a seamless and unified view of infrastructure as a "system of systems," but existing infrastructure modeling efforts, however, have been hampered by an inflexible software technology base. The Simulation Object Framework for Infrastructure Analysis (SOFIA), Energy Interdependence Simulator (EISIM), and Interdependence Energy Infrastructure Simulation System (IEISS) projects at Los Alamos National Laboratory (LANL) aim to research and develop a high-quality, flexible, and extensible actor-based software framework for the modeling, simulation, and analysis of interdependent infrastructures.

Inputs:
Electrical and natural gas infrastructure framework, control systems, interdependencies, disaster event.

Classification using iERF axes:
Disaster event: Explosion or natural disasters affecting infrastructure
Applications: Planning, vulnerability analysis, training, real time response support
Entities of interest: Infrastructure

Information source:
http://www.lanl.gov/orgs/d/d4/infra/sofia.html

(52) SimViz/System

Developer Organization(s):

STAR Technology Corporation

Screen Display:

Brief Description:
SimViz/System training products support individual self-paced study or instructor-controlled styles of training. The applications focus on specific learning objectives, provide personnel with the information required to participate in group exercises, and may be customized to operate in specific customer environments to meet their specific requirements and training objectives. Group exercises that are controlled by an instructor or training officer provide an environment to apply the knowledge gained from individual learning. An incident simulation system provides one or more views of an incident that is controlled by an instructor. It provides an interface for the instructor on a separate device that can control the events that are displayed to the personnel. SimViz/Systems for group training provide an 'instructor seat' and one or more 'student seats'.

The tool comes in various versions, with the highest version SimViz 5000 including a 3D Simulation Environment Model of customer selection and a PC Incident Configuration Manager and the incident of customer selection

Inputs:
Parameters describing the scenario for training

Classification using iERF axes:
Disaster event: Can be designed for various scenarios
Applications: Training
Entities of interest: Population, response agents, infrastructure

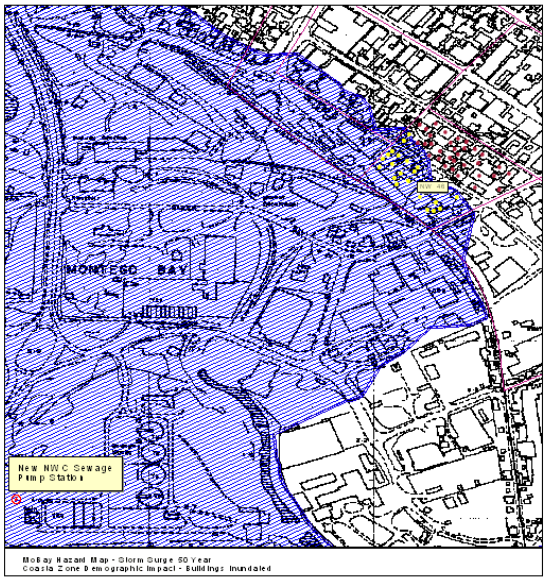
Information source:
http://www.startechcorp.com/new_page_7.htm

(53) TAOS - The Arbiter of Storms

Developer/Sponsor Organization(s):

Watson Technical Consulting

Screen Display: Modeled inundation area under 50 year storm surge in Montego Bay, Jamaica



Brief Description:
The Arbiter of Storms (TAOS) is a computer-based numerical model that estimates peak winds and storm surge heights in coastal areas resulting from tropical cyclones within the Pacific. TAOS is used to generate GIS-based maps depicting peak winds, storm surge heights and inundations. The model is designed to assist emergency managers, land use planners and meteorologists in assessing the risks associated with meteorological hazards. Integrated tools for real-time tracking, track forecasting, and modeling of storm effects are provided, as well as probabilistic tools for assessing the risk of both real time, seasonal, and overall historical risks. The integration of GIS technology as both the input and output management basis for the model allows rapid update of input data bases, and fast interaction of hazard data with existing planning data such as structure type, value and location, population, and zoning. TAOS has been used operationally for projects in Central America, the Carribbean and the United States.

Inputs:
Storm parameters and local geography

Classification using iERF axes:
Disaster event: Hurricanes, storms
Applications: Planning, vulnerability analysis, real time response support
Entities of interest: Population, infrastructure

Information source:
http://www.methaz.com/taos.html

(54) TRIMS - Total Readiness Information Management System

Developer/Sponsor Organization(s): **Screen Display:** Not available

Teledyne Brown Engineering

Brief Description:
TRIMS integrates operational plans, equipment availability, and staff contact data in emergency management operations. Having this information immediately available reduces the timeline for proper application of emergency resources and provides a common system for multiple agency jurisdictional responses. TRIMS is applicable to military (active, reserve, and National Guard) and civil agencies (federal, state, and local) emergency management staffs. Typical applications and capabilities include

- Medical stockpile management
- Emergency equipment management
- Logistics/personnel management
- Common displays for situation assessment

Inputs:
Information on operational plans, equipment availability, and staff contact data

Classification using iERF axes:
Disaster event: Various events
Applications: Real time response support
Entities of interest: Response agents and resources

Information source:
http://www.tbe.com/products/readiness_infomgmt.asp

(55) TUTOR

Developer/Sponsor Organization(s):

BCD Modelling

Screen Display:

Brief Description:
TUTOR is designed to enable decision makers in police and emergency services visualize, analyze, simulate and prepare for large and small crisis management contingencies such as:

- Public order and safety incidents
- Terrorist and firearms incidents
- Catastrophic accidents. Train/air crashes.
- Environmental disasters
- Industrial and nuclear hazard containment
- Earthquake, flood and other natural disasters

TUTOR allows highly detailed computer representation of realistic situations based on actual ground environments and force structures. Up to 1200 entities can be modeled and may consist of individuals, crowds, the various police and emergency services, casualties, agitators, any type of vehicle, trains, airplanes or any desired object. A scenario can be replicated at 1 meter, 5 meter and 10 meter resolution, for up to 400 square kms. Other technical features include:

- Behavioral representation of humans activated by rules, triggers and data
- Realistic movement modeling
- Modeling of communications factors
- User-friendly computer interface

Inputs:
Data describing the terrain, entities and activities related to emergency event and the response.

Classification using iERF axes:
Disaster event: Various events
Applications: Planning, vulnerability analysis, training, real time response support
Entities of interest: Population, response agents, Resources

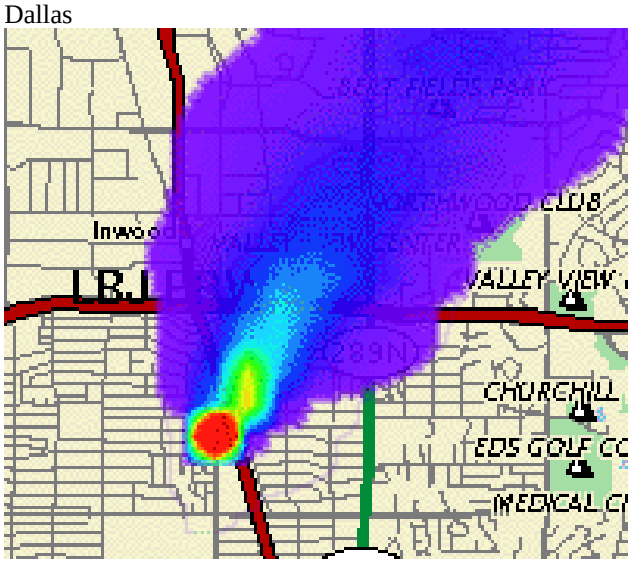
Information source:
http://www.bcd-modelling.com/tutor.html

(56) Urban Security Project

Developer/Sponsor Organization(s):

Los Alamos National Laboratory

Screen Display: Simulation of toxic vapor spill in north Dallas



Brief Description:
The urban security project is a multi-disciplinary research effort dealing with the relationship among urban infrastructures (e.g., power, transportation, and sewer systems) and the natural environment (e.g., floods, earthquakes, meteorology). As part of the first-year pilot project, the dispersion of a toxic vapor spill was simulated in north Dallas. The simulation involved modeling flow and plume dispersion around two buildings and then tracking the plume over several kilometers. The microscale modeling was performed using a computational fluid dynamics model called GASFLOW and the mesoscale modeling was done with the HOTMAC-RAPTAD system. The toxic plume concentration fields were then used along with transportation simulations performed by the TRANSIMS team to compute exposures to the cars traveling through the plume.

Inputs:
Urban terrain, building profiles, 3-D wind, temperature, street maps, traffic patterns.

Classification using iERF axes:
Disaster event: Chemical, biological or radiological agent dispersion
Applications: Planning, training, real time response support
Entities of interest: Population, first responders, other affected entities based on the agent

Information source:
http://www.lanl.gov/orgs/d/d4/aquality/urban.html
http://public.lanl.gov/bwb/#transims

(57) VERTS - Virtual Emergency Response Training Simulation

Developer/Sponsor Organization(s):

U.S. Army STRICOM

Screen Display:

Brief Description:
Virtual emergency response training simulation (VERTS) is designed for use by National Guard and Reserve weapons of mass destruction-civil support teams (WMD-CSTs). These specially trained units have been assigned responsibility to intervene in cases of domestic terrorist attacks involving nuclear, biological or chemical (NBC) weapons.

Currently, there are five main components of VERTS. First, VERTS uses two human-in-the-loop simulators for immersive training in a WMD or HAZMAT hot zone. Second, there is a programmable patient simulator for training medical teams on hazardous material (HAZMAT) medical surveillance and HAZMAT/WMD treatment. The third component is a set of several PC-based workstations for training the command group, operations team, and administration/logistics personnel. A fourth major component is a collection of digital urban databases of three major American cities (New York, Philadelphia, and Los Angeles). These databases provided realistic 3-D virtual environments in which to conduct training exercises and mission rehearsals. These virtual cities include high fidelity renderings of building interiors, which are accurately portrayed and provide correct dimensions of building spaces. The fifth part of VERTS includes support technologies, including a stealth battlemaster station and automated after action reviews (AAR).

Inputs:
Scenario description

Classification using iERF axes:
Disaster event: Nuclear, biological or chemical attack
Applications: Training
Entities of interest: Population, response agents

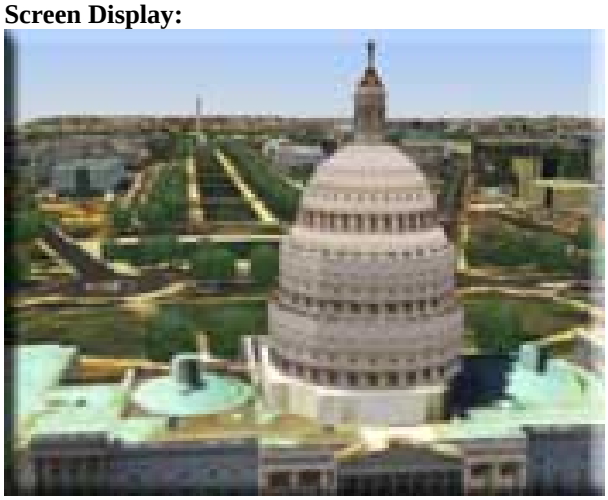
Information source:
http://www.amso.army.mil/main.htm (search for VERTS)
http://www.nationaldefensemagazine.org/article.cfm?Id=431
http://www.nationaldefensemagazine.org/article.cfm?Id=345

(58) Virtual Cities

Developer/Sponsor Organization(s):

Institute for Defense Analyses

Screen Display:



Brief Description:
The Institute for Defense Analyses is developing realistic, high resolution, virtual cities to be used for the virtual reality immersive training of both civilian first responders (fire, police, emergency medical and HAZMAT) and the military responders (the National Guard Civil Support Teams) in rehearsing their reactions to weapons of mass destruction incidents or other homeland defense issues.

The virtual cities are being constructed with geo-specific features (fire hydrants, street lights, buildings), and a mixture of geo-specific and geo-typical texturing. They are being constructed with a level of fidelity sufficient to support mission planning and immersive rehearsal, but still able to be run on standard PC's with a graphics accelerator. The terrain team at IDA is working with various software developers, and in the process of constructing these complex urban environments, is discovering special tools that need to be incorporated into the terrain modeling software.

Currently, following virtual cities are partially developed – New York, Washington DC, Philadelphia, Salt Lake City, Los Angeles.

Inputs:
Urban data

Classification using iERF axes:
Disaster event: Various events
Applications: Planning, training, vulnerability analysis
Entities of interest: Various entities

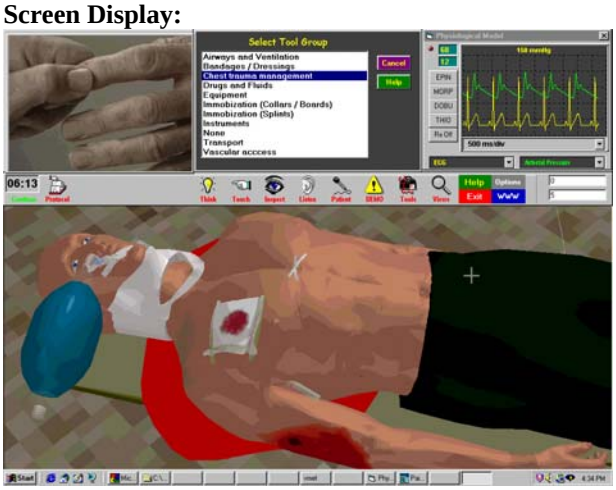
Information source:
http://virtualcities.ida.org/virtualcities/virtualcities.html

(59) VirtualEMS

Developer Organization(s):

Research Triangle Institute

Screen Display:



Brief Description:
VirtualEMS is an interactive, patient simulator which offers realistic practice to pre-hospital providers. The virtual reality simulator presents a scenario comprising a 3D scene, an incident that produces trauma or medical conditions, and one or more patients. The caregiver can navigate and survey the scene, interact and converse with the virtual patient, use medical devices, administer medications, monitor diagnostic data, and perform interventions. Its features include:

- Case-based scenarios and patients
- Physiology responds to trauma and treatment
- Integrated pharmacokinetic drug models
- Assignable probability of critical conditions
- Automatic record-keeping and reporting

Inputs:
Predefined scenarios

Classification using iERF axes:
Disaster event: Chemical and biological attack
Applications: Training
Entities of interest: Population

Information source:
http://www.patient-simulation.com/virtualems.htm

(60) Virtual LA.

Developer/Sponsor Organization(s):

Urban Simulation Team
Department of Architecture + Urban Design
UCLA School of Arts and Architecture

Screen Display:

Brief Description:
The main focus of the Urban Simulation Team @ UCLA is a long-term effort to build a real-time virtual reality model of the entire Los Angeles basin for use by architects, urban planners, emergency response teams, and government entities. The team has already finished major sections of the city including downtown, the Pico Union district, El Pueblo, Mid-Wilshire, Wilshire-"Miracle Mile", LAX, Westwood, UCLA, Hollywood Blvd. and Vine St., MacArthur Park, Playa Vista, and a portion of South Central. Negotiations are currently underway for other areas of the city.

When completed, the entire Virtual Los Angeles model will cover an area well in excess of 10,000 square miles and will elegantly scale from satellite images to street level views accurate enough to allow the signs in the windows of the shops and the graffiti on the walls to be legible. The finished model is estimated to exceed 1 terabyte in size and will be maintained on a large multi-client server that will allow multiple simulation clients to fly, drive and/or walk through the Virtual L.A. Model simultaneously.

Inputs:
Incident location in Los Angeles

Classification using iERF axes:
Disaster event: Various potential events in Los Angeles
Applications: Planning, training, vulnerability analysis
Entities of interest: Various entities

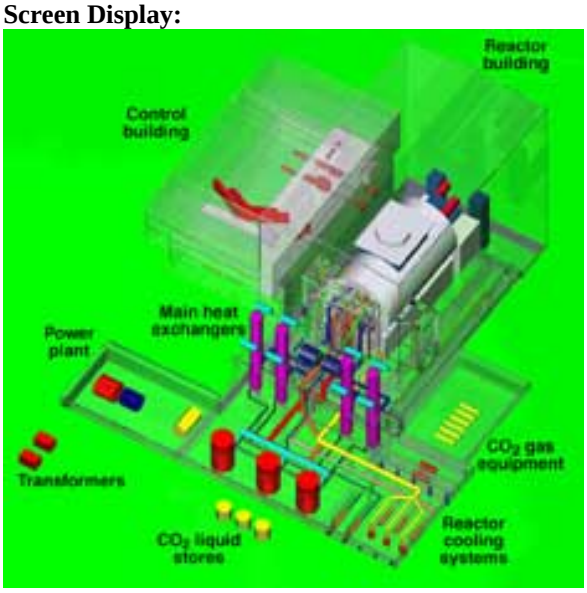
Information source:
http://www.ust.ucla.edu/ustweb/projects.html

(61) VISAC - Visual Interactive Site Analysis Code

Developer/Sponsor Organization(s):

Oak Ridge National Labs

Screen Display:



Brief Description:
VISAC is a Java-based expert system that provides mission planners with a coordinated capability to predict and analyze the outcomes of various accidents or incidents at nuclear and industrial facilities. It can also predict the outcomes of accidents at industrial facilities that use chemicals, such as nuclear reprocessing plants. For these industrial facilities, VISAC can calculate the initial direction of the plume and its chemical concentrations. This information is then fed to HPAC, which predicts how far the plume will go and where and how much of the plume's hazardous chemicals will be deposited on the ground.

VISAC also has the capability to model any nuclear facility, such as power or research reactors, and simulate the results of various incidents. Simulated incidents have ranged from simple equipment sabotage to complex sorties involving military weapons, truck or car bombs, or satchel charges. By using fault-tree methodology similar to that employed in probabilistic risk assessments, VISAC calculates the probability of facility destruction and undesirable side effects, such as a chemical or radiological release. It also estimates how long the facility will be out of service for repairs. VISAC has access to a library of models that can be customized by the user in both geometry and logic to approximate a number of facilities of interest.

Inputs:
Description of the facility and the chemical or nuclear agents used

Classification using iERF axes:
Disaster event: Release of chemical and nuclear agents at industrial facilities
Applications: Planning, vulnerability analysis, training, real time response support
Entities of interest: Population, response agents

Information source:
http://www.ornl.gov/ORNLReview/vol35_2_02/infrastructure.shtml

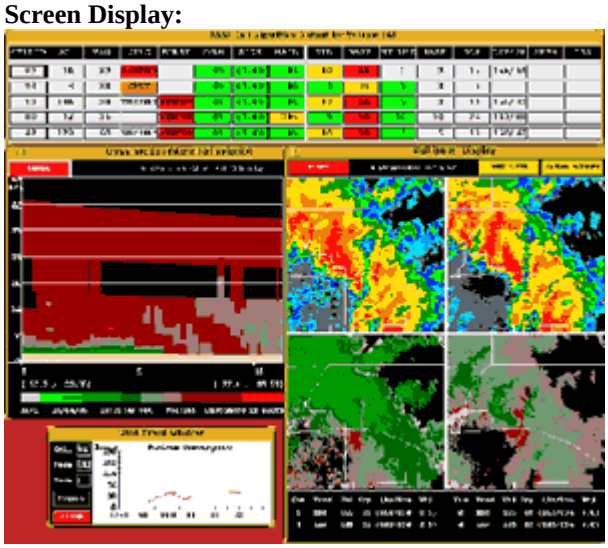
(62) Warning Decision Support System (WDSS)

Developer Organization(s):

National Severe Storms Laboratory

Severe Storms Research Center
Georgia Tech Research Institute

Screen Display:



Brief Description:
The NSSL severe-weather Warning Decision Support System (WDSS) consists of several enhanced or new severe weather detection and prediction algorithms as well as innovative display capabilities that provide information to warning meteorologists to support decision-making during times of severe/hazardous weather. Georgia Tech Research Institute's Severe Storms Research Center, in collaboration with the National Weather Service and the National Severe Storms Laboratory, is further enhancing WDSS. It is exploring ways to better detect the low-top, high-shear thunderstorms that are responsible for many of the short-lived events classified as weak tornadoes. While such storms cause much of the low-to-moderate damage attributed to tornadoes, they may in fact be rotating downdrafts rather than true tornadoes. Identifying the distinction could prove useful in improving warning of these hard-to-predict, damaging events.

Inputs:
Information on storm parameters, sensor information

Classification using iERF axes:
Disaster event: Natural disaster – tornadoes, thunderstorm
Applications: Planning, real time response support
Entities of interest: Population, infrastructure

Information source:
http://www.nssl.noaa.gov/wrd/msd/wdss.html
http://maven.gtri.gatech.edu/srrc/

(63) Weapons of Mass Destruction Decision Analysis Center

Developer Organization(s):

Sandia National Laboratories

Screen Display:

Brief Description:
The program, Weapons of Mass Destruction Decision Analysis Center, is being developed by Sandia National Laboratories as a way to simulate a war-room environment in the event of a terrorist attack. It can be tuned for training of officials of various public agencies including, police, fire departments or mayors' offices. It could also be designed to represent different kinds of threats, including a nuclear blast or a bioweapon attack.

Inputs:
Exercise parameters such as reports of effects of a biological attack

Classification using iERF axes:
Disaster event: Chemical, biological, Radiological attack
Applications: Training
Entities of interest: Population

Information source:
http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2002/08/19/BU133752.DTL&type=business

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APPENDIX C. ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
B2B	Business-to-Business
BACnet	A Data Communication Protocol for Building Automation and Control Networks
BFRL	Building and Fire Research Laboratory, one of the labs at NIST
BUFR	Binary Universal Format for the Representation of meteorological data
CAD	Computer Aided Design
CDC	Center for Disease Control and Prevention
CEO	Chief Executive Officer
CMIS	Consequence Management Interoperability Services, a system for allowing an Incident Commander to exchange tactical information with first and follow-on responders, to manage his assets and to plan for future duty cycles.
CORBA	Common Object Request Broker Architecture, www.corba.org/
DED	Data Element Dictionary
DHHS	Department of Health and Human Services
DNA	Deoxyribonucleic acid
DoD	Department of Defense
DOT	Department of Transportation
DTD	Document Type Definitions
DTRA	Defense Threat Reduction Agency
EDCS	Environmental Data Coding Specification
EIA	Electronic Industries Association
EMA	Emergency Management Agency
EMT	Emergency Medical Technician
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
GML	Geography Markup Language
GRIB	Gridded Binary data files are output files generated by computerized weather forecasting models
HLA	High Level Architecture, a standard architecture for integration of distributed simulation models
HDF	Hierarchical Data Format
HVAC	Heating, Ventilation, and Air-Conditioning
IAI	International Alliance for Interoperability
IC	Intelligence Community
IC MSIA	Intelligence Community Metadata Standards for Information Assurance
IC MWG	Intelligence Community Metadata Working Group
ICAO	International Civil Aviation Organization
ICML	Intelligence Community Markup Language
ICS	Incident Command System
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IFC	Industry Foundation Classes
IMO	International Maritime Organization
IPA	Intergovernmental Personnel Agreement
ISO	International Organization for Standardization
ISO/AP	ISO/10303 Application Protocol
ISO/IEC	ISO/International Electrotechnical Commission
ISO/TC	ISO/Technical Committee

ITL	Information Technology Lab, one of the labs at NIST
J2EE	Java 2 Platform Enterprise Edition, java.sun.com/j2ee/
JCATS	Joint Conflict and Tactical Simulation
JTLS	Joint Theatre Simulation System
LANL	Los Alamos National Labs
MEL	Manufacturing Engineering Lab, one of the labs at NIST
MS&V	Manufacturing, Simulation and Visualization, a research program at NIST
MSDS	Material Safety Data Sheets
NARAC	National Atmospheric Release Advisory Center
NATO	North Atlantic Treaty Organization
NetCDF	Network Common Data Form
NISAC	National Infrastructure Simulation and Analysis Center
NIST	National Institute for Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NRC	Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NSDI	National Spatial Data Clearinghouse
OASIS	Organization for the Advancement of Structured Information Standards
OGC	Open GIS Consortium, Inc
OMG	Object Management Group
ORNL	Oak Ridge National Labs
OSHA	Occupational Safety and Hazards Act
PDM	Product Data Management
PLCS	Product Life Cycle Support
SAIC	Science Applications International Corporation
SDTS	Spatial Data Transfer Standard
SDX	Simulation Data eXchange
SEDRIS	Synthetic Environment Data Representation and Interchange Specification
SEE-IT	Synthetic Environment Evaluation - Inspection Tool
SGML	Standard Generalized Markup Language
SIMA	Systems Integration for Manufacturing Applications, a research program at NIST
SOAP	Simple Object Access Protocol, www.w3.org/TR/SOAP/
STATSGO	State Soil Geographic soils data compiled by the Natural Resources Conservation Service (NRCS) of the USDA
STEP	Standard for the Exchange of Product model data
TAO	Tropical Atmospheric Ocean project at NOAA
TIA	Telecommunications Industry Association
TOPOFF	Top Officials, a name used for large disaster event exercises involving top government officials
UML	Unified Modeling Language, www.omg.org/uml/
USDA	US Department of Agriculture
U.S. DoJ	U.S. Department of Justice
USGS	US Geological Survey
VR	Virtual Reality
VRML	Virtual Reality Modeling Language
W3C	World Wide Web Consortium
WMD	Weapons of Mass Destruction
WMO	World Meteorological Organization
XML	Extensible Markup Language, www.w3.org/XML/