Argonne NATIONAL LABORATORY

Synergistic Tools for Emergency Management Residing within the Decision and Information Sciences Division

Modeling and Simulation Tools Program Target Area

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WHITE PAPER DRAFT

PREPAREDNESS ■ RESPONSE ■ RECOVERY

Emergency Management as a Process

Multiple planning, response, and recovery tools, as well as highly trained people, are needed to effectively and efficiently operate within an environment fraught with innumerable hazard challenges and responsibilities to protect a community.

Emergency management is a continuous process of organizing and managing resources and responsibilities associated with preparing for, responding to. and recovering from the myriad of potential hazards facing a community. Emergency management involves plans, structures, and arrangements established to engage government agencies, volunteers, businesses, and nonprofit organizations in a comprehensive and coordinated way to mitigate the implications of an emergency or disaster and provide for a community's needs.

Argonne National Laboratory's Decision and Information Sciences (DIS) Division has conceptualized, developed, and implemented a wide array of modeling and simulation tools and processes for many sponsors within this domain for a combined development time of several hundred years. The tools and processes developed continually build on the accomplishments of preceding versions and the integration of components. This synergistic DIS activity has resulted in a comprehensive, systematic, and successful emergency management capability related to logistics, planning, training, simulation, resources, demographics, hazard detection, infrastructure, and incident impact. With further integration, it will be possible to seamlessly apply existing DIS tools across three phases of emergency management: preparedness, response, and recovery (Figure 1).

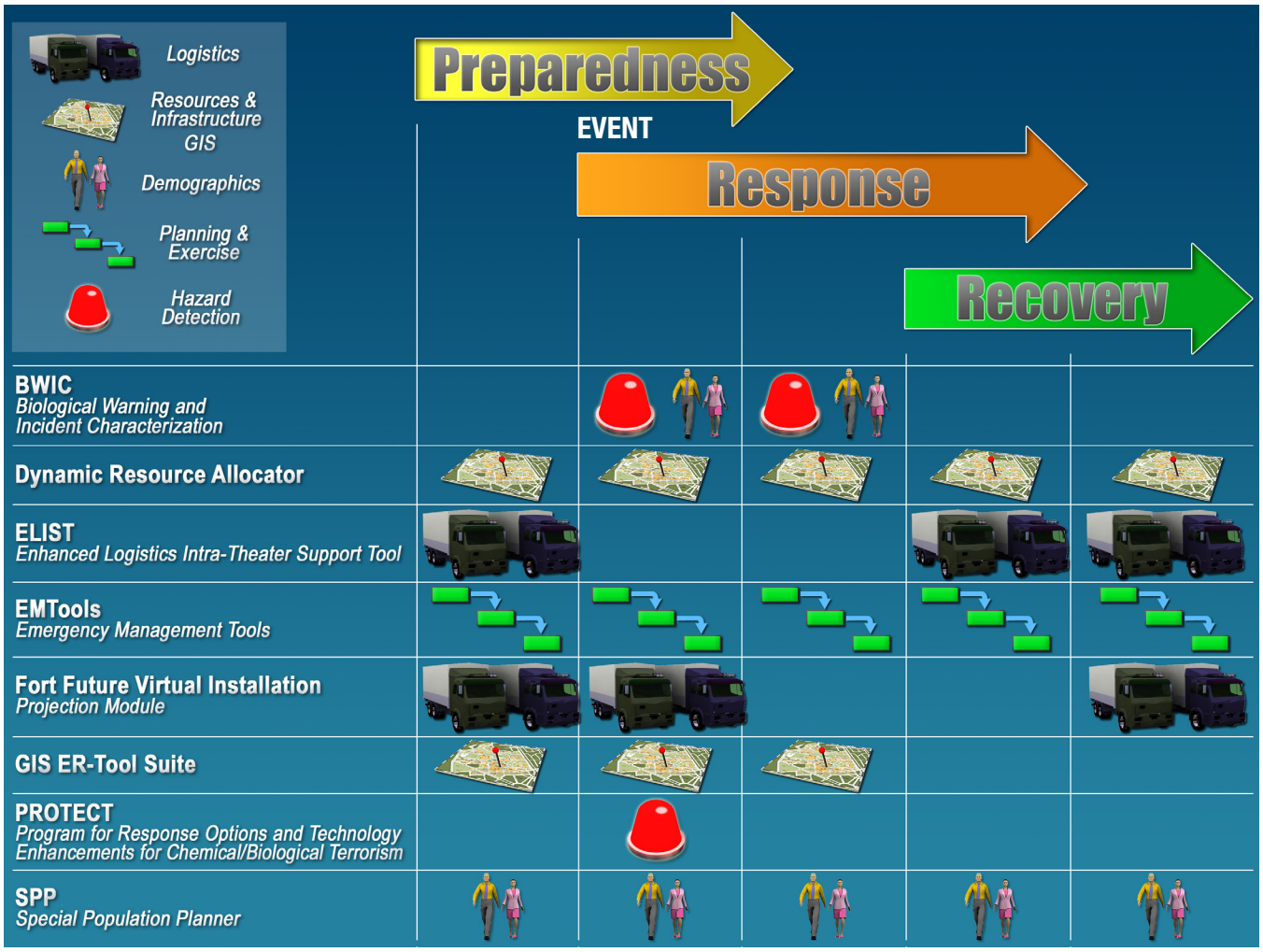

Figure 1: *DIS tools used within three phases of emergency management*

The Preparedness Phase In the preparedness phase, emergency managers develop plans, exercise those plans, and simulate actions in anticipation of possible disasters and emergencies. Emergency managers can use a combination of several DIS tools to accomplish the tasks necessary for reducing or eliminating the vulnerability of emergency response organizations and resources to the hazards that threaten a location. DIS tools available include:

- *EMTools:* Emergency managers can plan and exercise multiagency and multijurisdiction emergency plans through the use of EMTools. EMTools consists of four components—Synchronization Matrix, SM Reader, WatchBoard, and the eXercise Management Tool—designed to allow emergency managers to develop and exercise their plans to verify their correctness.
- *Special Population Planner (SPP):* Planners can assist their special populations so that they are better prepared and more able to take appropriate protective actions through the use of the SPP software and process.
- *Enhanced Logistics Intra-Theater Support Tool (ELIST):* ELIST can be used to simulate and verify the logistics of plans.
- *Fort Future:* Planners can simulate the impact of a hazard on the daily operations of a municipal entity and verify the effectiveness of planned resources and contingencies by using Fort Future Virtual Installation (Fort Future). Fort Future also has the capability to simulate the addition of resources from adjacent agencies and jurisdictions that might become available to a municipal entity.
- *Dynamic Resource Allocator:* Emergency planners can access information about ground resources and calculate the shortest route projections by using real-time traffic input.
- *GIS-ER Tool Suite:* Planners can identify infrastructure components from their emergency plans that potentially could be impacted by the hazard.

The Response Phase The response phase begins immediately upon detection of a major emergency event and includes the mobilization of the necessary emergency services and first responders in the disaster area.

DIS has two sensing technologies that detect an event.

- *Program for Response Options and Technology Enhancements for Chemical/Biological Terrorism (PROTECT):* The PROTECT system provides early warning and situation awareness for chemical attacks in subways, buildings, and airports.
- *Biological Warning and Incident Characterization (BWIC):* The BWIC system monitors the biological sensors deployed in BioWatch cities, and, when an event is detected, the tool is used to model the effects of the biological event in its beginning stages.

Once a hazard is detected, emergency managers can use the DIS tools identified above, including:

- *EMTools:* Upon detecting a hazard, emergency managers can refer to the emergency plan in EMTools.
- *GIS-ER Tool:* Emergency managers can also use BWIC to emulate the impact of the hazard on infrastructure; conversely, the hazard's effect on the plan can be determined by using the BWIC output combined with the GIS-ER Tool Suite functionality to pinpoint impacted infrastructure and make geographic interdependency associations to assist in response decision-making.
- *SSP:* Special populations that were affected can be identified and their needs determined and reviewed through the SSP software and process.
- *Dynamic Resource Allocator:* The Dynamic Resource Allocator calculates the arrival times of resources, given real-time conditions.

- *Fort Future:* Fort Future can be used to quickly simulate the application of several contingency plans as well as the incorporation of newly available resources given the nature of the hazard in play.

The Recovery Phase The aim of the recovery phase is to restore the affected area to its previous state. To assist in achieving this goal, emergency managers can use:

- *EMTools:* Emergency managers can refer to the recovery plan in EMTools and begin to review and modify emergency plans under an interjurisdictional planning process based on real-world experience from the disaster.
- *SSP:* Special population plans can be updated on the basis of their experiences in responding to the disaster, and this information can be captured in the SSP software.
- *ELIST:* Emergency managers can simulate and verify the sometimes massive logistics of the recovery plan via ELIST by updating and analyzing plans on the basis of the actual response required, which can be accomplished by modifying the expected logistics requirements with the actual requirements as well as by adding contingency events (e.g., damage to infrastructure) to understand those effects.
- *Fort Future:* Fort Future can simulate the resources and recovery plans necessary to return to the normal daily operations of a municipal entity.
- *Dynamic Resource Allocator:* The Dynamic Resource Allocator can calculate the shortest route projections and arrival times of recovery resources.

Tools and Background

EMTools: The EMTools suite is the compilation of four "all-hazard" software programs—Synchronization Matrix© (SM©) and SM Reader©, eXercise Management Tools© (XMT©), and Watch Board© (WB©)—that are designed to assist emergency preparedness planners, decision makers, and responders in all phases of the emergency management cycle. These tools provide a collaborative workspace for emergency managers to develop, exercise, and analyze emergency plans. One of the primary outputs is a graphic depiction of a response organization's plans and exercise design components. WB© results in a "run-time" display of each component's associated activities.

BWIC: BWIC (for Biological Warning and Incident Characterization) is a robust, integrated decision support system that facilitates timely warning, attack assessment, communications, and effective response in the event of a biological attack by providing multiple local agencies/analysts with a single common view to support situational awareness and decision making during a biological event. The system integrates live feeds from environmental monitoring sensors, public health surveillance systems, and the BioWatch sensor system and includes analysis tools for airborne dispersion, epidemiological spread, and population movement modeling. It leverages the Disaster Management Interoperability Services (DMIS) backbone for secure communication and notification services to provide assessment information to neighboring jurisdictions and other city departments or federal agencies.

PROTECT: PROTECT is an early warning crisis management system for chemical attacks in high-threat, high-vulnerability interior infrastructures such as subways, airports, and buildings. It uses fixed facility chemical detectors, video cameras, networking, meteorological data feeds, and modeling of hazard zones, providing real-time situation awareness and optimal response strategies for each event. The PROTECT system also includes laptops to responders who can link into the system from firemen jacks or wireless connections. The system is operational in Washington, D.C., New York, and Boston and reduces organized response time to minutes, thus saving lives. The system has dual uses: (a) chemical emergencies and emergency response, and (b) routine use of video for crime interdiction and forensics.

Special Population Planner: The SPP graphically displays data about persons with special needs in households and facilities. This modeling system also allows planners to visualize nearby structures and geographic features, various threat scenarios, and response plans developed on behalf of the special-needs population. Furthermore, the SPP can accommodate additional map layers to allow customization of the display for a variety of hazards and response.

ELIST: ELIST is a flexible transportation simulation developed for the U.S. Department of Defense to analyze troop, equipment, and resupply deployments to theaters of operation. ELIST's flexible design allows analysts to determine the rules for when and how cargo and personnel can be moved. It handles multiple modes of transportation, including: self-moving vehicles, cargo on line-haul or direct delivery trucks, railcars by trains, inland-waterway barges and ships, helicopters, and fixed-wing aircraft. ELIST utilizes GIS network data and can directly import time-phased force deployment data (TPFDD) movement requirement data. It is designed to answer such questions as:

- Can people and supplies be moved on time?
- Are there enough assets available?
- Can the infrastructure support the plan?
- What are the effects of exogenous events?

Fort Future: The Fort Future Virtual Installation (FFVI) is a simulation tool that is used to test sophisticated plans. Developed to model plans that involve complex sets of concurrent and sequential tasks as well as the decision-making rules for following the main plan or any number of contingency plans, the system also allows for modeling the effects on the plan from disruptions or denial of utility services, such as electricity and water. The FFVI is a highly flexible, multiscale decision-making model that simultaneously includes individual and group-based task execution; reactive contingency plans to internal, external, and disruptive events; local facility usage and transport networks; simulation of interdependencies between models; and resource contention.

Dynamic Resource Allocator: The Dynamic Resource Allocator tracks an area's inventory of available emergency vehicle assets in real time and estimates their arrival to the incident scene on the basis of traffic conditions and distance. The real-time inventory of vehicles tracks available resources available to respond to an incident and the location of those assets. RFID (Radio Frequency Identification) tags or GPS systems can eventually be used to monitor the locations of available assets. Based on an incident's location and the requirement for specific response assets, the tool estimates realistic arrival times based on a distance analysis and/or actual traffic congestion from a real-time, city-based traffic monitoring system. Through the use of a whiteboard-based GIS tool, an incident commander can view all assets, locations, and their availability to allocate resources dynamically throughout an evolving scenario.

GIS-ER Tool Suite: The GIS-ER Tool Suite is a combination of seven different tools used for rapid response during an emergency. With minimum GIS knowledge and training on the tool suite, users can easily load critical data; analyze infrastructure facilities and/or key resources within a hazardous area; quickly identify/obtain critical information on infrastructure facilities and/or key resources; spatially analyze geographic interdependencies; connect geospatial data to relational energy data; and calculate/view population density. Output from the tool suite can be as Word documents, Excel sheets, Access databases, Shapefiles, or even pre-formatted GIS products. Future enhancements will include incorporation of real-time geospatial and relational data.

As DIS further integrates its models and simulation tools to enhance their interoperability, our nation's emergency managers will gain a significant amount of synergistic value across all phases of emergency management.

Summary

Emergency management is a complex and variable domain that requires flexibility in preparedness, response, and recovery. This flexibility can be provided through the synergistic use of the array of models and simulation tools that reside within Argonne National Laboratory's Decision and Information Sciences Division. Through the use of these tools, communities can confidently proceed with long-term mitigation measures directed at specific hazards and devote resources to risk-based preparedness measures. A systematic approach to three of the phases of emergency management (preparedness, response, and recovery) provides an aid to efforts to develop and maintain a viable all-hazard emergency management program that a community can do to protect itself from hazards either by using the resources it has or by efficiently/effectively obtaining resources to alleviate anticipated or foreseen problems.

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