Event Response Resource Quantification and Prioritization

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***Abstract*— Disruptions to critical infrastructure from natural disasters and man-made events occur on a regular basis. For large, regional events, local infrastructure providers may find that the event goes well beyond their planning basis, requiring resources that are unavailable. Moreover, allocation of scarce resources often takes place with limited understanding of how systemic objectives in varying time frames are to be satisfied.**

The National Infrastructure Simulation and Analysis Center (NISAC), a program of the Office of Cyber and Infrastructure Analysis (OCIA), U.S. Department of Homeland Security (DHS), have worked to develop a model for quantifying and prioritizing resources for infrastructure restoration following disruptive incidents. This model, called Infrastructure Resource Allocation and Prioritization for Incidents (IRAPI), matches resources and requirements on resources within appropriate time frames to meet the overarching objectives described above. IRAPI's underlying model draws on survey data, which is used to define modeling characteristics and data requirements. Where data is unavailable, relationships to known data are made, based on historically repeatable and scalable work capturing the relationship of infrastructure density and population density.

Validation of relative valuations of resources for particular purposes at points in time within the model are the product of both the above-mentioned survey as well as the results of interactions of subject matter experts with an event type-specific system dynamics model of event response. IRAPI uses a GIS interface to present model results.

Examples of the application of the concepts of IRAPI will be discussed, including interactions with the State of New Jersey Office of Homeland Security and Preparedness (NJ OHSP) and the Federal Protective Security Advisor (PSA) for the State of New Jersey during Superstorm Sandy.

Keywords—Critical infrastructure; Prioritization; Resource allocation; Emergency response; National Infrastructure Simulation and Analysis Center

I. Extended Abstract

Disruptions to critical infrastructure from natural disasters and man-made events occur on a regular basis. For large, regional events, local infrastructure providers may find that the event goes well beyond their planning basis, requiring resources that are unavailable. Moreover, allocation of scarce resources often takes place with limited understanding of how systemic objectives in varying time frames are to be satisfied.

The National Infrastructure Simulation and Analysis Center (NISAC), a program managed by the U.S. Department of Homeland Security (DHS) and comprised of a core partnership of Sandia National Laboratories (SNL) and Los Alamos National Laboratory (LANL), performs critical infrastructure analysis, modeling, and simulation in support of the DHS mission. NISAC has worked to develop a model for quantifying and prioritizing resources for infrastructure restoration following disruptive incidents such as earthquakes and hurricanes. This model, called Infrastructure Resource Allocation and Prioritization for Incidents (IRAPI), is designed to identify available resources and requirements on those resources in a temporal fashion. The model matches these resources and requirements within appropriate time frames to meet the overarching objectives described above. This method is best used within the mitigation and preparedness phases of the emergency response lifecycle, but has been used as part of the response and recovery phases as well.

IRAPI is designed to provide users with a geographic information system (GIS)-based user interface, where an event can be described against a specified area. The underlying model draws on information solicited from an event type-specific resource priorities survey, which is used to define modeling characteristics and data requirements. Where data is unavailable, relationships to known data are made, based on historically repeatable and scalable work capturing the relationship of infrastructure density and population density. An event type-specific model of resource allocation is used to pair requirements with resources to meet objectives given logistical and communications constraints. This model is a variant of the attacker-defender model, in reality more of a "random attacker-mitigator" model. In this case, the series of objectives form a sequential game featuring imperfect information, with gradually decreasing uncertainty about the true state of the world. For some event types, this random adversary could be modified into a decidedly non-random role, one that attempts to maximize the impacts given knowledge about how the system is constructed or how response is expected. Validation of relative valuations of

resources for particular purposes at points in time within the model are the product of both the above-mentioned survey as well as the results of interactions of subject matter experts with an event type-specific system dynamics model of event response. As with the input, IRAPI uses a GIS interface (NISAC's FASTMap tool) to present the model results as an animated sequence of maps showing the ability (or inability) of an area of responsibility (corresponding to an area with allocation and disposition rights over resources in the event of activation of an emergency response plan, such as a county) to meet resource demands over time.

The concepts of IRAPI received a trial-by-fire test during Superstorm *Sandy* (2012), which battered the New York-New Jersey metropolitan area. Working with the State of New Jersey Office of Homeland Security and Preparedness (NJ OHSP) and the Federal Protective Security Advisor (PSA) for the State of New Jersey, NISAC used IRAPI to examine resource needs and priorities for select commercial sector asset classes, including fuel facilities, pharmacies, and food facilities. Data provided by NJ OHSP was combined with power outage and storm surge data produced by the Federal Emergency Management Agency to delineate effects to assets, and requirements for restoration. Key findings helped define actions taken by NJ OHSP for restoration of service to assets in these sectors.

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