STAR-TRANS Modeling Language:
Risk Modeling in the STAR-TRANS Risk Assessment Framework

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ABSTRACT

Transportation networks are open and accessible, by design, and thus vulnerable to malicious attacks. Transportation networks are integral parts of larger systems, where individual transportation networks form a network-of-networks within a defined geographical region. A security incident on an asset can propagate to new security incidents in interconnected assets of the same or different networks, resulting in cascading failures in the overall network-of-networks. The present work introduces the STAR-TRANS Modeling Language (STML) and provides a reference implementation case. STML is a feature-rich, domain specific, high-level modeling language, capable of expressing the concepts and processes of the Strategic Risk Assessment and Contingency Planning in Interconnected Transportation Networks (STAR- TRANS) framework. STAR-TRANS is a comprehensive transportation security risk assessment framework for assessing related risks that provides cohered contingency management procedures for interconnected, interdependent and heterogeneous transport networks. STML has been used to produce the STAR-TRANS Impact Assessment Tool.

Keywords: *Contingency Planning, Risk Analysis, Security, STAR-TRANS Modeling Language (STML), Transportation*

INTRODUCTION

The transportation networks are by design open and accessible and therefore extremely attractive as terrorist targets. Transportation networks are integral parts of larger systems; therefore individual transportation networks form a network-of-networks, given a specific geographical region. An attack on a specific asset of a transportation network is assessed in terms of how it will impact the network-of-networks within which it resides, since it can

DOI: 10.4018/jiscrm.2013040104

have swelling-effects on it that could result in cascading failures. The Strategic Risk Assessment and Contingency Planning in Interconnected Transportation Networks (STAR-TRANS) proposal (Leventakis et al., 2011) defines a semi-empirical risk assessment framework for transportation networks, which introduces the innovative approach of estimating risk for security incidents triggered upon previously instantiated incidents. The modeling process forms a chain of incidents with the common characteristic that a newly created cascading incident can be the potential trigger for other incidents. . Based on this assumption, the STAR-TRANS framework provides a security risk assessment framework for transportation networks and coherent contingency management procedures for interconnected, interdependent and heterogeneous transportation networks.

The current work is based on the STAR-TRANS framework in order to develop a domain specific language, the STAR-TRANS Modeling Language (STML), for modeling risk assessment in heterogeneous and interdependent transportation networks. STML models the objects required for defining the STAR-TRANS impact assessment process, i.e., incidents, network assets and asset interdependencies, consequences, incident risk, incident propagation etc. and implements the STAR-TRANS algorithm defined by the STAR-TRANS framework. STML enables the execution of a fully featured threat scenario, presenting to the end user all the available security options. The end-user (security manager or security expert) is responsible to make the appropriate scenario decisions in order to execute a complete threat scenario, based on his/her experience and the security particularities of the target networks and the overall network-of-networks.

BACKGROUND

For performing risk assessment, the first and most important step is identifying, as comprehensively as possible, the set of risks involved. In the vast majority of cases the number of such risks is large enough, so that aggregation, filtering and ranking methodologies should be applied. Carr, Konda, Monarch, Walker and Ulrich in "Taxonomy-Based Risk Identification" (1993) followed a field test risk identification process consisting of a series of interviews with groups of selected personnel. Webler et al. (1995) outlined a risk ranking methodology through an extensive survey example dealing with a public utility infrastructure in New Jersey. Morgan et al. (2000) proposed a ranking methodology designed for use by federal risk management agencies, calling for interagency taskforces to define and categorize the risks to be ranked. Berdica (2002) proposed that vulnerability analysis of transport networks should be regarded as an overall framework through which different transport studies could be conducted to determine how well a transport system would perform when exposed to different kinds and intensities of disturbances. Haimes (1998) created a Hierarchical Holographic Model (HHM) for the transportation system and the facilities it supports. Haimes, et al. (2002) offered a methodological framework that identifies, prioritizes, assesses and manages risks to complex, large-scale systems. The risk filtering, ranking, and management (RFRM) methodology captures all six questions of risk assessment and management. Di Gangi (2005) recommended a quantitative method in order to figure out if the infrastructure of an area is strong enough for evacuation procedure.

The main issue with the above frameworks is that they are found somewhat lacking in their ability to capture and model interconnections among assets in a way that enables impact propagation between them and consequently their respective networks. However, a combination of the above components can be most useful in the development of a framework that copes with the aforementioned weakness yet still be generic enough to retain its applicability to any kind of network, which can be described on an asset-interconnection-asset basis such as