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Scientific Brief

National Critical Infrastructure Interdependency Model: Way Ahead

Background

In 2009 the Federal Government, the Provinces and Territories agreed on a National Strategy and Action Plan for Critical Infrastructure (CI) [1, 2]. The purpose of this initiative was to strengthen the resilience of the Canadian CI though building partnerships, implementing all hazards risk management approaches, and advancing the timely sharing and protection of information among partners. The Strategy identified that CI was at risk from natural, intentional and accidental hazards and that the risk could be exacerbated by the complex system of interdependencies among CI, which can lead to cascading effects across borders and sectors. The action plan describes the implementation of the strategy which includes the establishment of sector networks and a cross sector forum as the basis for collaborative work and information sharing.

Among several CI initiatives, Public Safety (PS) Canada supported a Canadian Safety and Security Program project to model CI interdependencies (CSSP-2012-TI-1142, Development of a National Critical Infrastructure Interdependency Model).

Purpose of the Document

This document summarizes project CSSP-2012-TI-1142, which resulted in the development of a high level CI cross-sector interdependency model using "RiskOutlook™" software [3], and recommends a way ahead for the transition of the project to Public Safety Canada.

Results

The model developed in the project is based upon Bayesian network or probabilitistic graph theory in which

- CI entities are modeled as nodes in a network and are characterized by intrinsic likelihood and impact of failure, where ‗instrinsic' refers to the likelihood and consequence in isolation from the rest of the network,
- directed links between nodes gives the conditional probability that a a downstream entity will fail if an upstream entity fails, and
- logarithmic likelihood, impact and dependency scales are used to promote consistency in rating and facilitate knowledge elicitation. Impact scoring was informed by a statistical analysis of Gross Domestic Product (GDP) data published by U.S. Bureau of Transportation, Statistics Canada and sector associations.

An early attempt to develop a national interdependency model by the *RiskOutLook*™ software provider proved to be unsatisfactory to the CI sector groups because entities were at different levels of fidelity. In addition, it was known through the Department of Homeland Security that asset-based approaches were not practical due to the amount of data associated with asset inventories. Therefore, the North American Industry Classification System (NAICS) [4] was adopted and adapted to define *entities*. The NAICS provides an established and exhaustive characterization of national economic activities, an integrating framework and accepted definitions. The related data collected by Statistics Canada was used to inform consequence assessments [5. 6, 7].

Concepts of operations (CONOPs) were generated for each sector describing and elaborating logic model developed to illustrate dependencies. In many cases sub-models were required to characterize sectors e.g. Electricity, Petroleum and Natural Gas models to characterize the Energy Sector. Entities and relationships were transferred into a relational (Microsoft ACCESS) database. Meetings were held with lead departments and nominated Subject Matter Experts (SMEs) to review the CONOPs and *RiskOutLook*™ model. Focus groups representing CI sectors will be convened to *validate* and refine the model.

This *baseline* model provides an overview of day-to-day risks on a national level. A British Columbia-based earthquake scenario was developed to illustrate how the model might be extended and exploited to support contingency and investment planning. The list of model entities was reviewed to determine which ones would be affected directly and the impact, likelihood and strength of dependency scores were adjusted e.g. the outbreak of fires would increase reliance on firefighting services. The geographic siting facilitated factoring in asset location e.g. an earthquake in BC would have very little if any direct, national impact on the Animal Production, Banking or automotive supply chain (Manufacturing). Conversely a disruption in Vancouver port operations would have a significant national impact, and statistical analysis was conducted to inform the scenario-based risk assessments.

Sector CONOPs and an integrated national CI interdependencies model will be delivered 31 March 2016. Potential *end users* have been identified and include Public Safety, the National Cross-Sector Forum (NCSF) and Multi-Sector Network (MSN), CI lead departments, the RCMP's CI Intelligence Group, provinces and territories and municipalities. The model and databases can be used to support vulnerability identification and risk assessments, supply chain analyses, return on investment analysis, capability-based portfolio management, business continuity and contingency planning, exercise design and support.

Discussion of Results

The project has demonstrated that a functional approach is practical and that using the NAICS as an integrating framework offers substantive advantages—a familiar taxonomy and objective basis for impact scoring.

The overall scope of this work was to develop an integrated national critical infrastructure interdependency model to inform decision-making and increase critical infrastructure resiliency. The project outcomes include:

- Support implementation of the National CI Strategy and Action Plan.
- Enhance understanding of dependencies, interdependencies, and associated risks to assist in the prioritization of prevention and preparedness activities for CI resilience.
- Facilitate discussions among and between CI sectors and explore the effects of changes in dependency relationships.
- Contribute to more resilient CI and community development/partnerships.
- Promote information sharing and CI community involvement.
- Support well informed decision making and S&T CI investment coherence.

Maintenance and exploitation of the model and databases will require resources, not least analytical assistance to coordinate and facilitate knowledge elicitation and to incorporate extensions and —best practices" lessons learned e.g. a knowledge of probability theory and model structure is required to fully appreciate the —black box" calculations. Continued support from DRDC's Centre for Security Science (CSS) for refining the methodology and tools is thereby recommended. A DRDC Targeted Investment (TI) is being prepared to support a transition strategy that will recognize the role of CSS in supporting PS and the CI portfolio.

Conclusion

Project CSSP-2012-TI-1142 has created an integrated National CI Interdependencies model based on a functional approach using the NAICS. A *baseline* model in *RiskOutLook*™ provides an indication of the day-to-day cumulative impact and likelihood of the failure of CI entities, and a scenario-based model has been developed to illustrate how this model can be extended and exploited. The National CI Interdependencies model is ready for transition to the sponsor, Public Safety Canada, but continued support from CSS will be required to further institutionalization, operationalization and methodological validation and enrichment.

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