SITUATIONAL AWARENESS EFFECTIVENESS USING AHP

Rahim Jassemi-Zargani Fredrick Lichacz Nathan Kashyap
Defence Research & Development Canada – Ottawa
Space & ISR Application Section/ISR Concept & Integration Group
3701 Carling Avenue,
Ottawa, Ontario, Canada K1A 0Z4
CANADA
rahim.jassemi@drdc-rddc.gc.ca / fred.lichacz@drdc-rddc.gc.ca / nathan.kashyap@drdc-rddc.gc.ca

ABSTRACT

The integration of system-of-systems (SoS) data into shared situational awareness (SA) involves a complex interplay between a collection of sensors, network architectures and exploitation capacity. To achieve the desired level of SA (i.e., information superiority) and improve the sense-to-act cycle requires an environment that is agile, interoperable, robust and efficient. To that end, this paper presents an integration concept evaluation methodology based on an Analytical Hierarchy Process (AHP) that uses technical and cognitive elements to assess the degree to which an ISR concept can facilitate shared SA in a military setting.

1. Introduction

Technology is a key driver in achieving enabled capabilities which involves exploitation of data, dissemination of information and better decision making. In evaluating technological capabilities, the physical system as well as the service providing the transfer of information in the network will be considered. However, a complete evaluation of the ISR concept's ability to facilitate SA cannot end with the technology alone. The technology does not work in isolation but must interface with human operators. As such, there are human factors (HF) elements that need to be evaluated within the performance of the service providing the data (i.e., imagery, tracks, detections) and the capabilities of the sensor platform producing the data for the service. Accordingly, a complete evaluation of the SoS concept must include an analysis of the technical elements of the concept and the concept's ability to meet the needs of the user; that being the operators' perception of how well the SoS concept facilitates their decision-making ability. The following section and subsections of this paper will present the proposed SoS concept evaluation process based on SA effectiveness.

2. ISR SA Concept Evaluations

The challenge for a SoS concept evaluation process is to develop efficient and reliable methodologies and metrics to accurately evaluate the operational effectiveness within a military environment. This paper presents a method that has been developed to evaluate the SA effectiveness based on an Analytical Hierarchical Process (AHP). Moreover, the approach taken for evaluating and assessing SA through metric evaluation has potential applications for procuring and deploying ISR assets. The use of scenarios can be applied

to perform the evaluation of SA based on a system-of-systems capability. Sets of metrics have been identified in this process, one based on a scenario and the other being scenario independent. This process relies on a hierarchical decomposition of the military objectives into lower-level measures of performance (MOPs). The MOPs are combined using weights obtained through subject matter experts' evaluation of their relative importance. The process for evaluation is shown conceptually in Figure 1. The evaluation assesses the relative performance of SoS using selected metrics to evaluate how well mission requirements are being met. The process is divided into four main steps, Systems and Infrastructure Selection, Mission Metrics Selection (scenario dependent and independent), Systems Mission & Scenario Modelling, and Overall SoS Performance Evaluation.

3. The Hierarchical Evaluation Process

The first step in the hierarchical evaluation process is to decompose the mission requirements into one or more essential elements or factors. For example, the mission requirement could be to detect and track all targets within areas of responsibility both technical and HF criteria are used in the evaluation process.

3.1 Technical Criteria

The scenario dependent elements relate to measuring or assessing the capabilities of the physical system.

3.2 Human Factors

The HF component of this evaluation focuses on the operators' perceptions of the effectiveness of the SoS concept. This cognitive evaluation is divided into hard and soft elements (see Figure 1). The hard elements pertain to the operators' perception of the quality, quantity, completeness, and latency of the data they receive from the systems. The soft elements pertain to meta-cognitive aspects of the decision-making process. As such, this part of the evaluation will assess the operators' trust in the system, their views on whether the system can meet the information requirements to produce desired SA, and how well the concept facilitates efficient dissemination of information.

3.3 Aggregation Process

To evaluate SoS, an aggregation methodology is used where criteria and MOPs are grouped together. The aggregation of both sets of metrics are applied and compared using a multi-decision criteria process such as the AHP to assess the degree to which a SoS concept can facilitate shared SA.

4. Conclusions

This paper will present a methodology based on AHP to evaluate SoS SA concept effectiveness using both technical and HF criteria that are complimentary in nature. Although the importance of each of the technical and HF criteria to the overall evaluation of the SoS concept will be weighted based on the context that the SoS concept is being evaluated, each type of assessment represents a quality control check on the other assessment thereby providing a more robust and precise assessment of the SoS concept than if only one of these criteria was implemented.

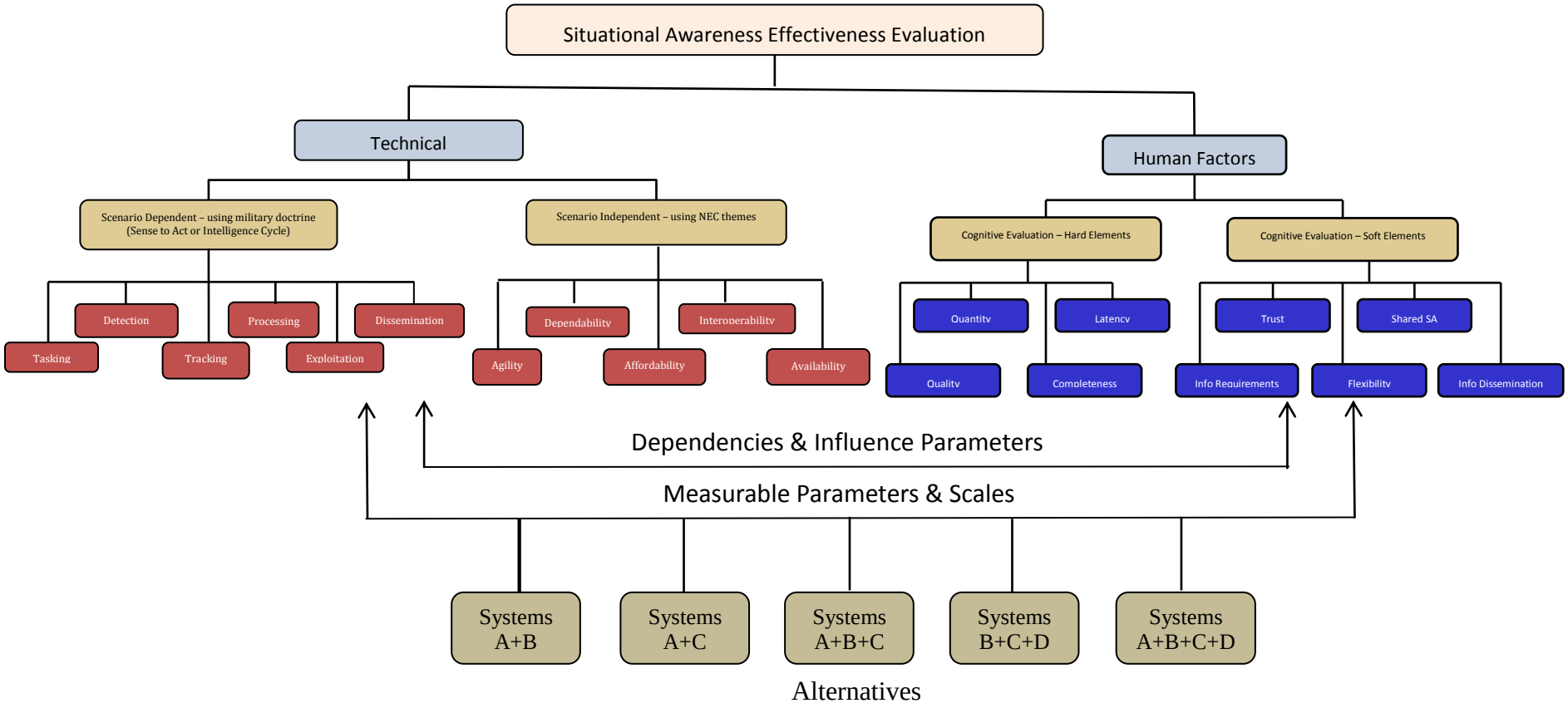

Figure 1. The Influence diagram for SoS SA evaluation using AHP