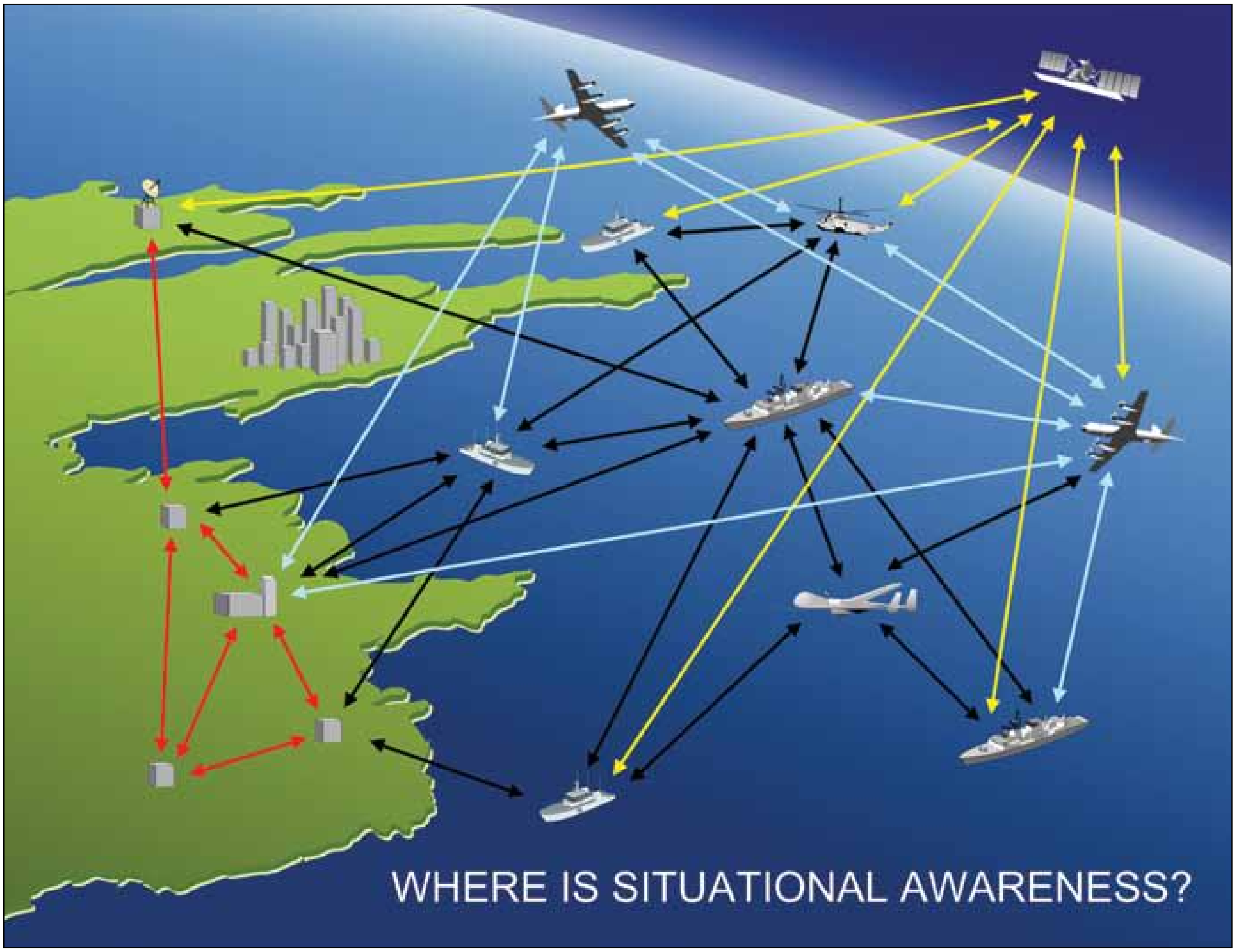

SITUATIONAL AWARENESS: INSPIRING OPERATIONAL CLARITY

by Wayne M. Renaud and Anthony W. Isenor

Between crises, the proverbial Canadian Forces (CF) 'operator' spent his time contemplating the military of the future. There were so many competing demands, and it was all very complicated. One day, the operator happened upon a magic lamp. When the lamp was rubbed, a genie appeared, endowed with magical skills in information technology (IT). The genie was called the 'techie,' and he granted the operator three IT wishes. The operator could not believe his good fortune, and he called upon the techie to solve the most vexing of his IT problems — how to use the power of IT to gain the 'situational awareness' needed to command and control modern military operations. For his first wish, the operator commanded: "Let there be machines to help us collect and display the information we need!" "Yes sir," said the techie, and computers were given to the operator. And it was good, until the operator realized that the computers were not compatible with one another. So the operator called for his second wish: "Let all of our computers be interoperable!" And the humble techie readily complied with this wish by creating the concept of the Joint Command and Control Information System. And it was very good. The operator believed that with one more wish he would have the tools for complete situational awareness, and

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thus he blurted out "Let the computers talk to one another so we may share information and build our knowledge!" "Yes sir," said the techie, and the computer systems of all the services and commands were joined in a series of remarkably efficient networks. And the result was brilliant. The jubilant operator shouted: "At last I have situational awareness!" Alas, it was not so in spite of all the computers and all the networks. Feeling the growing wrath of the operator, the techie scurried back into his bottle, leaving with these words: "You've had your three wishes, and I cannot grant you a fourth. Besides, you now have all the tools required to create the situational awareness you seek — all you have to do is make them work together!" And thus the operator returned to his contemplation, pondering the techie's words and muttering to himself, "If only I had just one more wish …."

- The parable of the operator and the techie, as originally told by Captain[N] (ret'd) Darren Knight[1]

"Almost a decade has passed since the 'operator' voiced his frustration at not having a fourth wish; a final wish for the attainment of situational awareness."

Introduction

Almost a decade has passed since the 'operator' voiced his frustration at not having a fourth wish; a final wish for the attainment of situational awareness (SA). Since the 'techie's' granting of the operator's three wishes, the CF has made significant progress in the realization of the operator's vision. The three pillars of machine, interoperability, and networking were well within the CF techie's domain of influence, and, therefore, easily attainable. Yet, sadly, the genie's final declaration that "*… you now have all the tools required to create the situational awareness you seek — all you have to do is make them work together!*" continues to herald as-of-yet unrealized operational capability.

Strategy 2020[2] charts the operational course for the new millennium and with every minor course alteration and new positional fix, the future is slowly taking shape. SA remains the concept of understanding the operating environment so that timely and effective decisions can be made with respect to the employment of military force in operations ranging from disaster relief to high-intensity combat. In striving to attain SA, the CF has integrated numerous internal networks, thereby lessening the struggle to push and pull essential operational information across multiple networks. Specifications from the Open Geospatial Consortium (OGC),[3] principles such as open source code, and data and metadata (data about data) standards and protocols, have eased the sharing and displaying of disparate information across multiple and varied networks and systems. As well, the C4ISR Campaign Plan Interim Report[4] and Command Guidance and Campaign Plan[5] have provided an information baseline from which informed discussion and decision making can be initiated, and a single consistent context for C4ISR capability development, thereby ensuring an integrated approach that maximizes effectiveness, efficiency, and economy. Finally, the creation of Regional Joint Operation Centres (RJOC) has placed highly skilled personnel in the 'eye of the information storm,' earnestly searching the unsettled data horizon for glimmers of digital intelligence, and fusing individual bits in hopes that the assembled whole will be greater than the sum of its parts.

Regrettably, the axiom that Operational Information Management (OIM)[6] is essential to SA remains unwittingly confused with rudimentary Information Management (IM), or worse, with calls for increased Information Technology (IT). What has become increasingly apparent is that SA, as institutionally defined and depicted in the title figure, will not provide the 'awareness' Strategy 2020 or the C4ISR campaign plans are envisioning. In fact, the continued deluge of vastly dissimilar information stores into CF networks, the crippling inadequacy of current information management and processing methodologies, and the CF's abject refusal to thoroughly pre-process information and data streams, has strengthened the overwhelming information vortex within which operators and decision-makers must function. This over-saturation of information will not inspire SA, as the wholly personal experience of 'awareness' requires the added components of contextual relevance, operational application, and inference. Context and application can only be provided through operational IM as it pertains to information processing, and inference through new concepts and representations of operational information. The CF must reexamine and adjust the concepts and practices that were born out of a different reality. In naval parlance, the time has come to 'take some way off, assess position and course made good' with respect to SA and IM, and to plot a new course towards their final attainment.

Defining Situational Awareness

By default, the Common Operating Picture (COP) has become the military's ubiquitous representation of the operating environment. A COP is a singular representation of relevant operational information, such as the position of own units and enemy units, or position and status of important infrastructure such as bridges, canals, roads, and so on. As an application-based tool used to display order of battle information on top of digital maps, the COP may be shared by more than one command, and this sharing facilitates the collaborative planning of operations.

Over the past few decades, operational information sources deemed essential to SA have grown exponentially, resulting in the implementation of increasingly aggressive information routing and assimilation policies designed to ingest entire information streams. This wholesale 'siphoning' and 'fusing' of pre-existing information 'stovepipes' into the COP has proven to be an indelicate approach that does not distinguish between generic, organizational, and operationally relevant information. More importantly, siphoning does not identify the specific items within the information stream relevant to current operations (i.e., the singular information attributes or *information threads*) that lend themselves directly to immediate SA needs. It seems the CF's nebulous approach to SA remains based upon "… he who gathers and displays the most information will attain persistent awareness and decision superiority." Regrettably, *more* information does not equate to *better* information, and the CF's obsolete approach is proving ineffectual when dealing with the prodigious volumes of information being generated by today's plethora of modern operational information systems.

So, what is SA? SA is a common term used throughout the world by military and non-military organizations alike. Unfortunately, it often means different things to different people, as its definition is both contextual and temporal in nature – what a commodore in command of a task force at sea engaged in multi-ship operations considers SA is completely different from what a provincial emergency response team (ERT) responding to a forest fire considers SA. One common definition states that SA is:

> *The knowledge of where you are, where other friendly elements are located, and the status, state, and location of the enemy.*[7]

While this definition focuses upon the subjects of awareness, its narrowness in scope ignores the critical constituents of time, intelligence, and environmental factors; constituents that inevitably affect potential outcomes and the selection of courses of action (COA). The definition also has a distinctive geospatial aspect that may limit our thinking. *Meaning* and *context* must be ascribed to what is being presented, and this can come from non-geo-referenced sources such as intelligence, personal knowledge, or interpretation of the facts.

Others have taken a more general view of SA. Dr. Mica R. Endsley, an acknowledged expert and pioneer in the field of SA, and founder of SA Technologies, described SA as:

> *The perception of the elements in the environment within a volume of space and time, the comprehension of their meaning and the projection of their status in the near future.*[8]

Other definitions of SA can be summarized to include:

> *The ability to reliably, accurately, and continuously collect information on the situation, enemy or friendly, when and where required … it is the mechanism which pinpoints targets and threats to represent the Battle space situation ... it is a matter of degree and not an absolute.*[9]

In these later definitions, we find the constituents of intelligence, environmental factors at both present and future times, and the additional truism that SA is attained by *degree*, and are not an absolute. Equally important, SA is the result of an individual's perception and comprehension of what is being presented to him or her. It appears that SA is much greater than the sum of its informational parts.

Awareness exists only in the mind of the observer; it is neither a singular nor a concrete entity. SA is thus a personal experience. As a product of numerous cognitive variables, one's view of SA may or may not agree with everyone else's perception of operational reality. Comprehension, personal and operational priorities, operational knowledge, experience, training, and the stress and overall intensity of operations, are all factors that impact each individual's state of awareness. It is the combined influence of these factors upon the information being presented that enables SA, and that awareness remains continuously beholden to the effects of time and space.

The COP assists command echelons in achieving this required awareness. The COP is a dynamic representation of amassed operational information previously identified as conducive to the attainment of SA. It attempts to answer generic operational questions either before they are asked (i.e., all the ships in an area are plotted in anticipation of the question: "Where is ship X?"), or specific operational questions as they arise (i.e., an aircraft has crashed in a mountainous region, and all access routes to the crash site are plotted and communicated to the rescue teams). Therefore, to inspire SA at a tactical level, the COP must provide the following four essential information components to the observer:

- the operating environment / battle space;
- the subject(s);
- the subject's activity; and
- the reason/intelligence for that activity (this component may or may not be displayed on the COP).

These four essential components must also be framed in time. The temporal aspect is necessary if we are to understand our current view of the operational environment as presented by the COP. The COP inherently displays historical information; information which may be seconds to days old. It is this mixture of historical information (at time $t<0$) with real-time information and cognitive processes (at time $t=0$) that allows the operator or decision-maker to infer potential outcomes (at time $t>0$) and decide upon a possible COA.

Therefore, if we blend the four essential components with the temporal nature of SA, we acquire a new definition of SA:

SA is the cognitive product of combining the operating environment with the subjects of interest, their activities, and any available intelligence, to infer and weigh potential outcomes over time.

It is important to note that, as a product of four essential components that vary over time, the absence of any one component, or the failure to appreciate temporal variability (past, present, and future), negates SA; *all must be present to inspire SA*.

While reliability, accuracy, and the continuous collection of information are important characteristics when attaining SA, they are not essential to the attainment of 'awareness' of a particular situation. The human mind is capable of forming an awareness based upon minimal input. Thus, given that awareness is attained by *degree* and is not an *absolute*, the aforementioned desirable characteristics of SA only assist in forming awareness that is closer to reality. They, in fact, contribute to the quality of SA.

Lastly, the temporal nature of SA means that it is a dynamic and cyclical process. Initial SA is modified through the acquisition of additional or new information, and, as the decision-maker acquires more information, his/her SA changes. Changes in SA may modify the inferred potential outcomes and how they are weighed or compared against each other. In turn, this may modify the selected COA.[10]

Impediments to the Attainment of Situational Awareness

An operational force subsists on a steady diet of timely, accurate information, and the processing power, tools, and expertise necessary to put relevant information into context. The operational information requirements of the CF typically originate from operators and decision-makers after an information gap has revealed itself. The revelation then forces the present CF IM process to *react* to the new information demand. Information needs either expose themselves as previously unsatisfied operational needs (i.e., some operational situation highlighted a need for information that was not available), or real-time episodic needs (i.e., search and rescue (SAR); once the operation is completed the information can be discarded). The typical CF IM solution is to provide the entire unfettered information stream to the operator and decision-maker, burdening them with the arduous task of sorting through the information muck in hopes of identifying the operationally vital tidbits that comprise their information needs.

Consider an example (Figure 1) where a decision-maker has an operational requirement for information on atmospheric visibility (i.e., the specific information attribute or information thread) in a given geographic area for SAR purposes. He/she is typically provided with a network connection to numerous information streams and Web sites, one of which hosts weather forecast products (i.e., the information source). The weather forecast products are made available as stand-alone products, in a non-geo-referenced image (i.e., JPEG) or text format. The difficulties introduced by multiple sources and formats are compounded by the inability of the operator to display the weather with other relevant operational information, such as ship track reporting or satellite imagery, because some sources will be accessible and fusible, while others will not. Thus, sharing the composite product with other operators and decision-makers will be nearly impossible. The operator's only recourse is to present the information to the decision-maker as a stand-alone product or a presentation slide, thereby forcing the decision-maker to mentally extract the desired information thread and to mentally combine it with other information.

As it currently exists, IM in the CF consists of making information available at Point A (the information gatherer or product generator) for stand-alone use at Point B (the operator and/or decision-maker), with only passing regard for intended operational application or contextual relevance (i.e., the specific information attribute contained within the information stream). In the best of cases, the SA end result is an aggregation of individually prepared presentation slides covering different topic areas presented *en masse* to a geographically fixed target audience. In the worst case, the SA end result remains a collection of presentation slides, but with significant portions of operationally relevant or critical information lost because Point B could not access or understand the information provided at Point A. Unfortunately, both scenarios accurately describe today's operational reality and the CF's continued failure to attain high-quality SA.

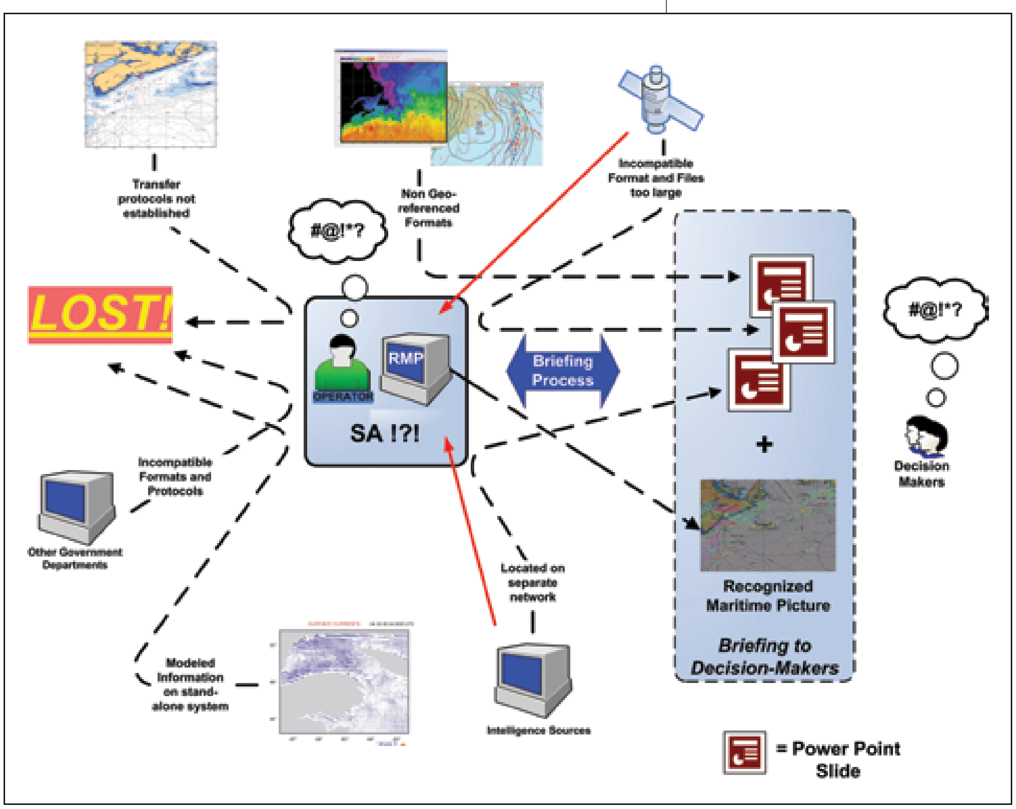

Figure 1 – The Current State of IM and SA

This 'reality' highlights the crucial need to thoroughly process and manage information that pertains directly to ongoing or potential operations *before* it is accessed by the operator and decision-maker, or ingested, fused, and displayed on a COP. Unfortunately, the Canadian C4ISR Campaign Plan falls short in addressing this type of information requirement. The Campaign Plan Interim Report[11] notes a staggering

82 percent of projected spending is on the collection and dissemination of information, and only a paltry 8 percent on processing. Sadly, processing's 'behind-the-scenes' transparency makes it hard to champion – hence, the insufficient funding. It is therefore not surprising that significant deficiencies in turning raw data into value-added information (via processing) have been identified. This dearth of thorough pre-processing is a significant impediment to inspiring SA. As time and technology continue to move forward, and information sources continue to multiply at a breathtaking rate, the cost of recovering from this precarious position may soon become prohibitive.

A Proposed IM Processing Model

Any proposed IM Processing Model (IPM) must first address the dynamic and complex activities required to successfully extract, process, and manage operationally relevant information from numerous information sources. Here, *operationally relevant information* refers to information that has intrinsic value to the successful completion of an operation or mission; until information is used operationally it is only information.

Secondly, given the voluminous nature of the information streams in question, the model must endeavour to automate these activities as much as possible.

The proposed IPM is defined as:

> *The process of registering, discovering, acquiring, preparing, and utilizing <u>operationally</u> relevant information derived from trusted information sources.*

The definition provides three critical constituents. First, it focuses upon operationally relevant information, and does not propose the management of all information available on all DND intranets and networks. Second, it proposes the critical processes of registration, discovery, acquisition, preparation, and utilization to the management of operationally relevant information. Third, the model relies upon trusted information sources;[12] that is, officially recognized information sources whose veracity and reliability comply with pre-defined measures. The proposed model therefore establishes the procedural acumen necessary for successfully navigating today's roiling oceans of information.

The IPM's five processes are defined as:

Registration – the process of documenting the metadata associated with the information (or information thread). By registering the information, the provider is effectively advertising the existence of the information to the discovery process. This is equivalent to placing a data advertisement in the Yellow Pages;

Discovery – the proactive and continuous process of finding information (more generally, finding any information resource) on any internal (DND or other government department [OGD]) or external (World Wide Web) network. Intrinsic in the *discovery* process is the identification of specific information threads that directly impact operations;

Acquisition – the process of obtaining the actual information. Acquisition will depend upon the size and source of the information. For example, geo-referenced information can occupy terabytes of storage space. Therefore, it may be more economical and operationally efficient to extract operationally relevant information threads, while registering the remaining details of the information stream for future requirements;

Preparation – the preparation of operationally relevant information for use, which may include conversion to specific formats or isolation of specific information threads, and identification of how specific information products will be utilized (i.e., displayed as a layer in a geo-referenced system vice being ingested as data in a model); and

Utilization – the contextual relevance, operational application and/or intended utilization of the information are critical factors that influence how and when operational information will be used. Of equal or greater importance (depending upon the nature of the situation), information must be available to the operator and decision-maker in *operationally relevant timeframes.* Therefore, interim or temporary storage of specific information threads may be required.

Each of the five processes has specific challenges. For example, discovery implies the means to find operationally relevant information in operationally relevant time frames. Technological challenges include computer disk storage, network bandwidth, issues related to cultural concerns (i.e., language barriers, vocabularies, cultural differences that affect the presentation of information) and IM issues (i.e., terminologies, local or accepted organizational 'geek-speak,' isolated networks, non-standard protocols, incomplete metadata descriptions, and data vocabularies.)[13] Discovery also implies agreements between information providers (i.e., government departments) with respect to the sharing of the metadata, while acquisition implies agreements dealing with the sharing of the information itself. Preparation also has its unique challenges. The conversion and isolation of information threads introduce the potential for alteration of the information or possible information loss. Repetitive conversions can be detrimental to information content, producing data that are of no use to anyone.

To address the necessity for automation, the IPM proposes a rule-based processing system that uses terminology familiar to users and operators of the system. Rule-based systems[14] can be thought of as '*if...then... else*' statements that establish automated rules that mirror the thought process of CF subject-matter experts (SMEs). A rule-based system takes as input the data and information from a specific, known, and trusted data provider, performs rule-based automated reasoning to identify operationally relevant components in the data stream, and outputs a filtered version of the data stream for immediate operational use. A rule-based system must be usable by experts and non-experts alike, and must use recognized terminology to represent information about the four essential components of operating environment, subject(s), activity, and reason/intelligence, to inspire SA. A rule-based system also addresses the operator's and decision-maker's need for a personal SA experience, as it allows for the expression of cognitive variables that contribute to an individual's perception of operational reality.

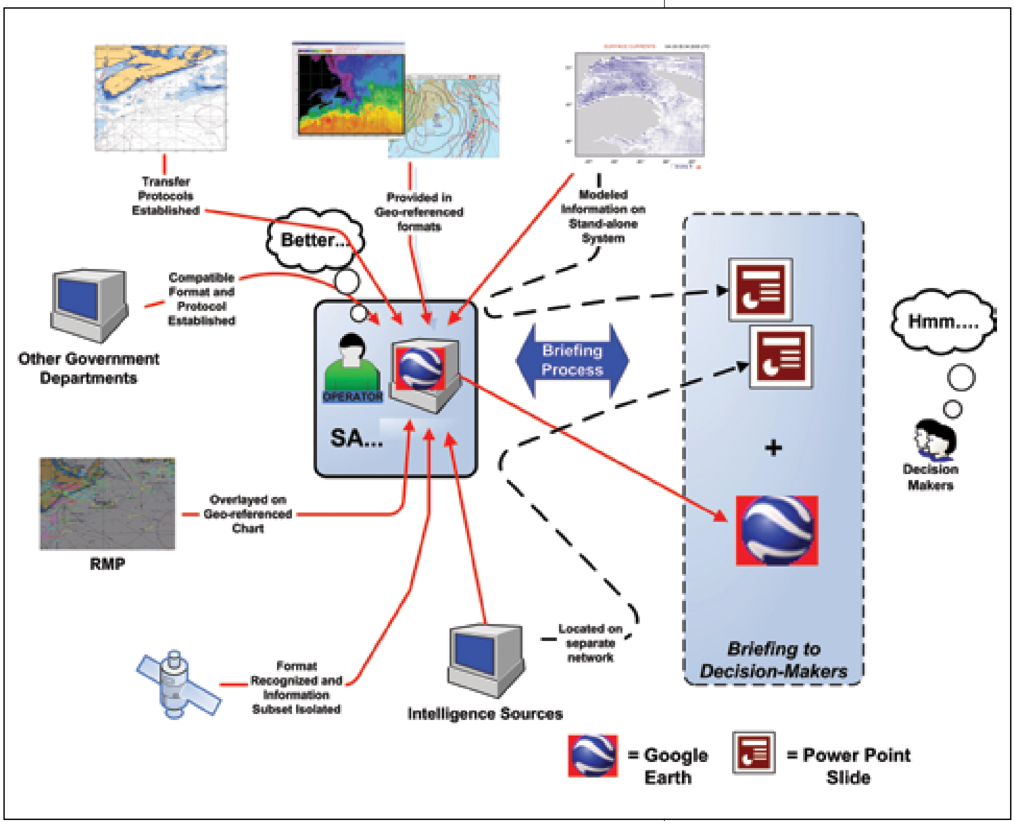

Figure 2 – A conceptual diagram of how the IPM could be used to inspire SA. A virtual globe can then be used to visualize the geo-referenced data sets.

A proposed functional implementation of the IPM is shown in Figure 2. Here, the challenge is to drive the necessary management and procedural changes essential to directing, collecting, processing, and disseminating *operationally relevant information* in support of SA; in other words, to identify the trusted sources of information and to create the rules that enable the creation of the red lines and a fully geo-referenced visualization. It is these items and lines that ultimately join the various disparate information sources shown in the figure to the operator (and, by default, to the decision-maker), and hence contribute to the formation of SA.

The basic functionality of the IPM revolves around an infrastructure that adapts to new and current information needs and sources in a goal-oriented manner. The infrastructure must be both *reactive*, in that it actively seeks and acquires information after an operational application is identified, and *proactive*, in that information and products may be added without having a pre-existing operational application in mind.

The IPM addresses operational information needs in a logical, purposeful manner by considering, not only the nature and source of the information, but also its potential utilization. It ensures that only operationally relevant information is destined for the COP, and relegates operationally desirable information to the background, and operationally unimportant information to the 'information graveyard.' As a continuous process, the IPM is vital to inspiring SA as it eliminates the 'noise' associated with today's overwhelming amounts of information, thereby allowing the operator and decision-maker to focus solely upon operationally relevant information. While SA has not yet been achieved, the IPM has provided the infrastructure from which 'awareness' can be inspired.

Inspiring Situational Awareness

To adapt an old adage, to inspire SA, we must "… begin at the beginning."[15] The identification of trusted information sources is the critical first step in establishing any solid operational information foundation. The proposed IM Processing Model is a flexible toolset ideal for pre-processing trusted information streams and for identifying the information 'gems' that lie within. Operationally relevant information of intrinsic value to the successful completion of an operation pertains directly to at least one of the four essential SA components of operating environment, subject(s), activity, and reason/intelligence, and through the logical application of a rule-based system, the operator and decision-maker can define the information threads that satisfy their specific SA needs. Once operationally relevant information is isolated and extracted, it can be used to update established databases (i.e., the ship track database), feed various models and tools whose output may also morph into operationally relevant information streams, and synthesized versions of the information may be presented to the operator and decision-maker via the COP for immediate operational use.

The IM processing model has assumed the herculean task of pre-processing the great mires of operationally relevant information prior to its presentation to the operator and decision-maker, and ingestion into the COP. Through the rule-based system, the model identifies the important information threads within each information stream, and through selective filtering, it reduces the volume of operationally relevant information being presented to the COP. The pre-processing of all operationally relevant information grants the operator and decision-maker the freedom to engage in the countless cognitive processes needed to convert displayed information into possible outcomes and courses of action. The model has therefore created the conditions from which SA can be inspired.

Tools Powered by the Model – Inference Tactical Decision Aids (*i*TDA)

The streamlining of operationally relevant information by the IPM also provides the infrastructure for the development of new models and tools that will further enable the inspiration of SA. For example, the Tactical Decision Aid (TDA) is an operational tool that typically utilizes a single information source from a single topic area to depict the effects of that attribute on performance, human resources, platforms, or weapons and sensors to assess their effectiveness during operations (i.e., the impact of oceanographic conditions on underwater sound propagation for the detection of submarines). TDAs are essentially 'stovepipes' that rely upon strictly defined *input* to create strictly defined *output*. However, in today's complex, multidimensional operational environment, single information sources rarely allow for an operational decision to be reached. Modern complex military operations require the creation and analysis of multiple TDAs before a decision can be made.

The IPM will provide the pre-processed information threads necessary for the creation of new, multi-data input TDAs – TDAs that utilize multiple information sets from numerous sources to model performance and *infer* potential outcomes or recommend possible courses of action. The new inference TDA (*i*TDA) could be such a tool.

The *i*TDA is a 'next-generation' TDA that exploits the IPM architecture when discovering, acquiring, and utilizing information assets from multiple topic areas. It assists the operator and/or decision-maker in narrowing the scope of the information query by focusing only upon operationally relevant information threads. The *i*TDA allows the operator and/or decision-maker to enter additional real-time information directly related to the operational context. This then allows the decision-maker's cerebral process to commence at time t=0 (the time at which the latest information was entered and the *i*TDA product was produced) thereby minimizing the expenditure of time and resources. Lastly, the *i*TDA will enable the operator and/or decision-maker to infer potential outcomes and courses of action, based upon the operational context, and, as a dynamic toolset, it will ingest new data and information, and re-compute the effects of new information thread(s) upon the operation.

It is clear that analysis cannot remain the sole domain of the operator and/or decision-maker. SA in the 21st Century demands that CF systems assume some of the low-level analytic burden to free the operator and decision-maker to address higher level cognitive processes. The *i*TDA, *enabled by the IPM architecture*, will allow designated operational systems to do some basic inference of possible operational outcomes, given the historical and real-time information threads provided.

*i*TDA Example

Consider the previous Search and Rescue (SAR) example. Using the IPM and *i*TDAs, the response to the SAR operation could develop as follows:

Through the application of the rule-based system, the operator identifies the operational situation as SAR, thereby causing the IPM infrastructure to automatically discover (based upon pre-defined maritime SAR requirements) all operationally relevant information resources. The IPM-identified resources include information threads important to a SAR operation (i.e., the atmospheric visibility in the weather forecast product), pre-existing TDAs (i.e., 'furthest-on-circles,' given a vessel's course and speed), relevant computer model output products (i.e., particle drift trajectories), relevant products from external sources (i.e., on-line wave fields from OGD), and other operationally relevant information assets.

The operator's selection of SAR also causes some *i*TDAs to initiate automatically and ask the operator and/or decision-maker for additional real-time operational information. This information is unique to the operation and may include:

- Type of distressed vessel, its size (important for imagery, visual identification, radar cross section), number of souls onboard (important for estimating the number of lifeboats, preparing emergency accommodations);
- Last known vessel position, course, speed of vessel (important for isolating and bounding the search area);
- If the vessel is suspected sunk (identifies if the SAR is for one vessel or multiple life rafts, and the influence of environmental conditions thereon).
- The *i*TDAs then create/display low-level inferred products (depicted in Figure 3), such as:
- Probability areas for distressed vessel or drifting life rafts;
- Visual search distances;
- Survivor probability areas (given computer drift model, ocean currents, water temperature, current and forecasted weather);
- List of newly acquired vessels since distressed vessel was lost (possibility that new contacts are missing distressed vessel);
- Recommended search areas, patterns, and resource allocation, given location of search units (vessels, aircraft, bases, airfields).

The creation and provision of the *i*TDA allows the decision-maker to immediately consider the next operational

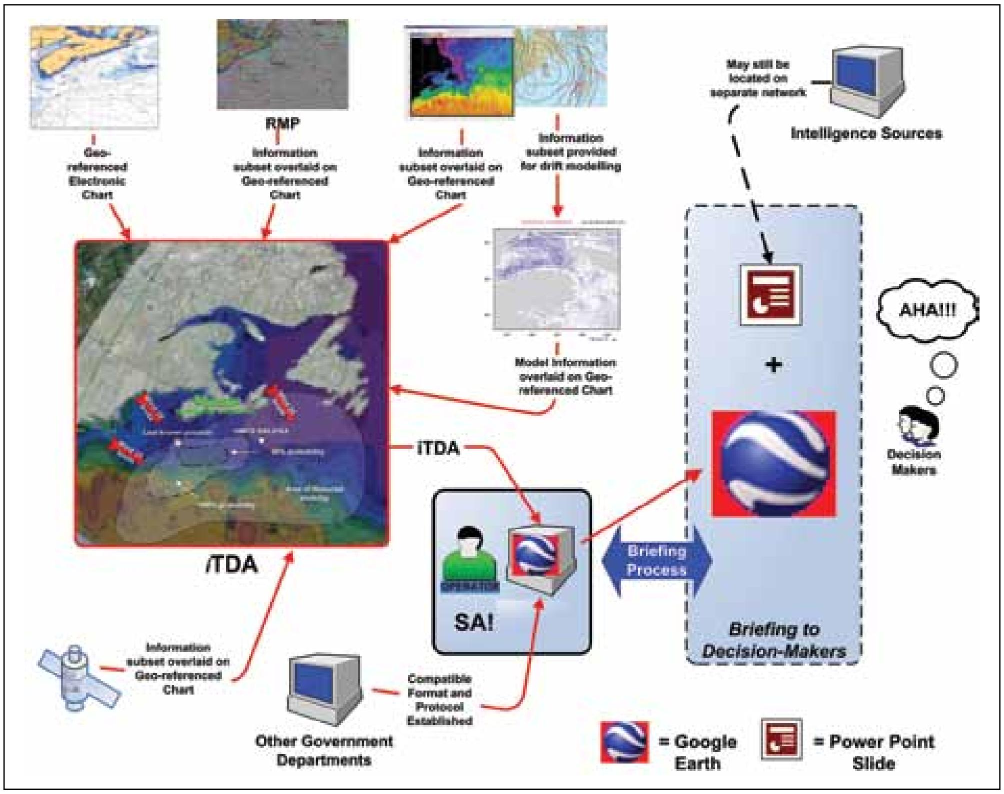

Figure 3 – The Information Management Processing Model and *i*TDAs

planning level – that of assessing possible outcomes and courses of action. In this environment, the operator and decision-maker did not waste precious time wading through masses of information. What was presented on the COP consisted of products from a low-level analysis of pre-defined operationally relevant information. The products had 'high glance' value, and they inferred potential outcomes from operationally relevant information. Therefore, conclusions were drawn, based solely upon what was already known, and this drawing of inferences within the specific operation (i.e., operational application) provided the *awareness* the operator and decision-maker needed to identify possible outcomes and to evaluate courses of action. SA was attained once the sum total of knowledge and understanding, possible outcomes, and courses of action were communicated to the entire operational team via a COP.

Conclusion/Way Ahead

The granting of the fourth wish will not come about as the end product of some new, previously unimagined marvel of information or computer technology. Nor will it result from the greater proliferation of information sources being ingested into an already overburdened and ill-defined IM capability. As the genie boldly stated "*…you now have all the tools required to create the situational awareness you seek — all you have to do is make* <u>*them*</u> *work together.*" The solution lies in a broader interpretation of the genie's cryptic prophecy. *"Them"* refers not only to the IT assets and the IM policies necessary to attaining SA, but to the inclusion of the operator and decision-maker, as they are the vessels within which SA is inspired. The CF has approached IM and SA from a technological perspective. There exists now a need to 'return to basics' and to re-visit a host of archaic assumptions. When originally envisioned, the techie's presentation of a few information streams to attain SA was manageable by the operator and decision-maker, whose cognitive processes, operational experience, and intellectual abilities were well suited to the task at hand. However, with greater and greater information chaos and the exigencies of today's multidimensional, complex operational reality, both the operator and decision-maker have reached intellectual saturation. The solution does not lie solely in the technological realm. The CF must redefine the relationship between operator, decision-maker, and IM, and their operational interaction must be transformed before progress can be made. The IPM and *i*TDA represent a first step in redefining this operational paradigm, and in attaining SA.

NOTES

1. Capt(N) [ret'd] Darren Knight, "The Fourth Wish: Operational Information Management and Situational Awareness," in *Canadian Military Journal*, Vol. 2, No. 4, Winter 2001-2002, p. 33-34.
2. Leadmark: The Navy's Strategy for 2020, Directorate of Maritime Strategy, ISBN 0-662-30934-0 Cat. No. DB3-22/2001E.
3. OGC is an open consensus process encouraging development and implementation of standards for geospatial content and services related to GIS data processing and exchange.
4. CF C4ISR Campaign Plan Interim Report, dated 27 June 2003.
5. CF C4ISR Command Guidance and Campaign Plan, dated 02 December 2003.
6. For the purposes of this article, information is defined as facts, data, or instructions in any medium or form. From the *US National Plan to Achieve Maritime Domain Awareness for The National Strategy For Maritime Security*, Department of Homeland Security, Washington DC. October 2005.
7. Provided in *Realizing the Potential of C4I: Fundamental Challenges* (Ottawa: National Research Council, 1999).
8. M.R. Endsley, "Design and evaluation for situation awareness enhancement," in *Proceedings of the Human Factors Society 32nd Annual Meeting*, 1988.
9. As defined in *Introduction – Technical Overview and State of the Art* by Dr. Ing. Luigi Crovella. NATO RTO Lecture Series 227, entitled *Tactical Decision Aids and Situational Awareness.*
10. The OODA loop (Observe, Orient, Decide, and Act) can be used as a mental description of this cyclic development of SA.
11. CF C4ISR Campaign Plan Interim Report, p. 39.
12. Defence R&D Canada – Atlantic is currently researching trusted information sources for situational awareness as part of an Applied Research Project.
13. The Marine Metadata Interoperability Project is using vocabularies in ontological formats to help discover and utilize disparate marine data sets.
14. Jean Roy, Anomaly Detection in the Maritime Domain, Defence R&D Canada – Valcartier, In Proc. SPIE, Vol. 6945, 69450W (2008); DOI:10.1117/12.776230.
15. Lewis Carroll's *Alice in Wonderland.*