Scenario descriptions for Mission-relevant Information Management for Integrated Response (MIMIR)

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Abstract

The kick-off meeting for the Mission-relevant Information Management for Integrated Response (MIMIR) activity took place on 28 October 2016 at Dalhousie University Institute for Big Data Analytics. The meeting identified the need for navy-relevant scenarios to help guide MIMIR information research. As a result, DRDC – Atlantic Research Centre took an action item to describe MIMIR-relevant naval scenarios that would allow researchers to better understand work associated with MIMIR. The developed scenarios involve international smuggling, fisheries patrol, and an environmental emergency. Collectively, the scenarios describe a futuristic common information resource environment that exists in a distributed cloud infrastructure, where information products, models, etc. are treated in a common manner. The scenarios are intended to generate further discussion and help solidify research topics for the MIMIR participants.

Significance to defence and security

The MIMIR project will explore information management solutions that are relevant to the future at-sea and ashore navy information enterprise. More broadly, MIMIR will provide a nexus between academic researchers in the field of *big data*, to information issues pertinent in today's defence environment.

Résumé

La réunion de lancement de l'activité MIMIR (Mission-relevant Information Management for Integrated Response ou gestion de l'information pertinente à la mission pour une intervention intégrée) a eu lieu le 28 octobre 2016 à l'Institute for Big Data Analytics de l'Université Dalhousie. Les participants à la réunion ont déterminé le besoin de formuler des scénarios propres à la Marine pour aider à orienter la recherche d'information de la MIMIR. Par conséquent, RDDC – Centre de recherches d'Atlantique a pris des mesures de suivi visant à décrire des scénarios navals pertinents qui permettraient aux chercheurs de mieux comprendre le travail associé à la MIMIR. Les scénarios élaborés portent sur la contrebande internationale, la surveillance des pêches et l'urgence environnementale. Dans l'ensemble, les scénarios décrivent un environnement futuriste de ressources documentaires communes qui existe dans une infrastructure en nuage répartie où les produits d'information, les modèles, etc. sont traités de manière commune. Ces scénarios ont pour but de susciter de plus amples discussions et de contribuer à enrichir les sujets de recherche des participants à la MIMIR.

Importance pour la défense et la sécurité

Le projet MIMIR explorera des solutions de gestion de l'information pertinentes aux activités d'information de la Marine en mer et à terre. Dans une optique plus large, la MIMIR fournira un lien entre les chercheurs universitaires dans le domaine des mégadonnées et les questions pertinentes relatives à l'information dans le milieu actuel de la défense.

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1 Introduction

1.1 Background

Dalhousie University Institute for Big Data Analytics in collaboration with Lockheed Martin and Defence Research and Development Canada (DRDC) – Atlantic Research Centre submitted a proposal to the DND-NSERC Research Partnership Program in December 2015. This proposal was accepted in April 2016 (reference number DNDPJ 490783-15), and upon completion of a Collaboration Agreement in September 2016, work commenced on the project.

1.2 Kick-off meeting

The Mission-relevant Information Management for Integrated Response (MIMIR) kick-off meeting took place on 28 October 2016 at Dalhousie University Institute for Big Data Analytics. The meeting included representatives from DRDC Atlantic Research Centre, Lockheed Martin, and professors and students associated with Dalhousie University. One action item that resulted from the meeting was a requirement on DRDC Atlantic Research Centre to describe MIMIR-relevant naval scenarios that would allow participants to better understand work associated with MIMIR. This document provides those scenarios.

The following scenarios are based on our knowledge of existing Royal Canadian Navy (RCN) past experience. We have combined this knowledge with a futuristic vision of how information exchange could be conducted. For the purpose of MIMIR, we seek seamless integration of the joining ship with the initial group. It is up to the MIMIR team to define exactly what that means.

The scenario descriptions are intended to generate ideas that are aligned with MIMIR. The scenarios do not represent a complete list of ideas or questions, nor do they represent a mandatory list of tasks.

1.3 Outline

The paper is structured as follows:

- Section 2 describes in very general terms, three scenarios where RCN information sharing would be important and have relevance to MIMIR.
- Section 3 provides detail on the type of information discovery, sharing, and use that is applicable to MIMIR.
- Section 4 described data sets that may be available to the two types of nodes in MIMIR (i.e., ship and shore).
- Section 5 describes how the cloud may be related to MIMIR activities.
- Section 6 provides a brief conclusion.

2 Scenario descriptions

The aircraft (e.g., plane, helicopter, unmanned aerial vehicle (UAV)), shore node, and ships in this story could be joining together for any number of reasons. Some example missions for the joining ship in such a scenario may involve:

- **International smuggling** – The tasking could be to identify at-sea smuggling activities. This task could involve other Canadian (CA) ships in the RCN, other Department of National Defence (DND) assets such as aircraft, or other ships from participating nations.

  As part of an international coalition of defence and security partners a DND ship is tasked to prevent smuggling of illicit goods. Using intelligence from ships in the task force, land-based operations centres, aircraft, and other sources, the ship's crew identifies vessels of interest (VOI) and assesses their probability of being a smuggler. This assessment may involve historic smuggling patterns, ship types, or association with known smuggling organizations. A ship with a high probability of smuggling is detected and an action plan is developed to intercept the vessel. Inputs to the plan might include known information about the capabilities of the smuggler's vessel, capabilities of the ships, aircraft, and other assets of the coalition, environmental conditions and forecasts, and other related factors. Once the plan has been made and approved by those in the coalition, the assets are engaged to intercept the vessel.

- **Fisheries patrol** – The tasking would be to identify illegal fishing activity. This task would likely involve other CA ships possibly in the RCN, other government departments (OGD) ships, or other DND assets such as aircraft.

  In this scenario a RCN ship is attempting to find illegal fishing activity. The ship has short-range sensors but needs to extend its range. It finds other currently available and relevant resources including: shore-based long-range radar, satellite-based radar, air patrol, and a Canadian Coast Guard (CCG) ship that is in the area. The RCN ship specifies that it needs relevant data for its area of interest, for the previous 48 hours from the available resources. The RCN ship then processes these data onboard or offboard depending on processing resources available in the cooperative environment with the goal of finding anomalies. Depending on what is found, anomalous ship tracks may be fed into an algorithm to forecast/hindcast the ship's location. If any ships are then suspected of illegal fishing activity there is a decision on appropriate action. This may depend on factors such as: reliability of information; probability of false identification; etc.

- **Environmental emergency** – The tasking would be to assist in clean up; and to assist with the identification of the ship responsible for the polluting. This task would likely involve other CA ships possibly in the RCN, ships from other government departments (OGDs), or other DND assets such as aircraft.

  An oil spill has occurred in Canadian waters and the polluter has not immediately been identified. The CCG is the lead agency and assumes the overall management of the incident. The CCG has environmental response barges to transport personnel and equipment, such as skimmers and booms, to respond to spills. A RCN ship works to assist

CCG and OGDs to clean up and contain the spill, ensure other ships avoid the area as the spill drifts, and identify the ship responsible for polluting.

In a general sense, the scenarios involve a RCN ship (call it the joining ship) meeting one or more friendly assets at sea (call it the initial group). The initial group could be any combination of other RCN ships, Canadian ships from OGDs, ships from a highly trusted international partner, aircraft, connected shore node, or ships from other international partners.

Different levels of seamless integration will exist between the joining ship and individual ships in the initial group (more will be described on this topic, later in the document). As well, we will assume that a Canadian shore node exists and is available to one or more of the Canadian ships in the coalition. Here we will define the coalition as being:

Coalition = the joining ship + the initial group

3 Initial approach of the joining ship

The work associated with MIMIR defines a future information vision for the coalition. Part of this vision has the information resources discoverable by the members of the coalition. Each of the ships in the coalition will have their own data sets, sensors, and models available to them onboard. The metadata descriptions of the information resources will be important to MIMIR, and these descriptions will need to be created and defined as part of MIMIR.

The descriptions not only refer to the content of the information resource, but also to the potential connection between resources. For example, suppose a particular information resource (e.g., sensor) could be attached to a helicopter or could be attached to a UAV. The fact the sensor has multiple platforms on which it could operate should be captured in a metadata description thus allowing the system to understand the potential for multiple uses.

1. Open question: This combining of sensors and platforms indicates a level of compatibility between the two entities. Could the same level of compatibility measure be used on the data files that are used as input in numerical models?

For clarity, let us assume we have a metadata structure within which the metadata content is housed. This may look like:

<resource>AIS data file</resource>

Where <resource> is part of the metadata structure while "AIS data file"[1] is part of the metadata content. Note that we may have situations where the metadata content is controlled by internal or external vocabularies [1]; with internal control meaning the metadata structure defines the allowable content, with external control meaning the content is controlled independent of the structure; and finally there may be no control on the content (i.e., free text).

The vocabulary used in both the metadata structure and content could vary within the coalition. Between two RCN ships we can assume effectively the same structure and the same content vocabulary. Between RCN and OGD ships or between RCN and navy ships from nations that Canada regularly operates with, we can assume similar structure and similar content vocabularies (but not the same). Between the joining ship and the other non-Canadian ships, we can assume the content vocabularies will be very different.

When the joining ship enters the region of another ship that is in the initial group, we can assume the joining ship and the other ship have physical and protocol interoperability (see Figure 1). Anything beyond that level of conceptual interoperability is dependent upon the second ship in the connection. For example, the joining ship connecting to another CA ship or a CA shore node could be expected to have data/object model interoperability.

When the joining ship approaches a ship in the initial group, processes on the two ships must assess (e.g., scan) the other ships. This scan is controlled by the level of access granted to the ships, by the other ship.

[1] AIS indicates Automatic Identification System.

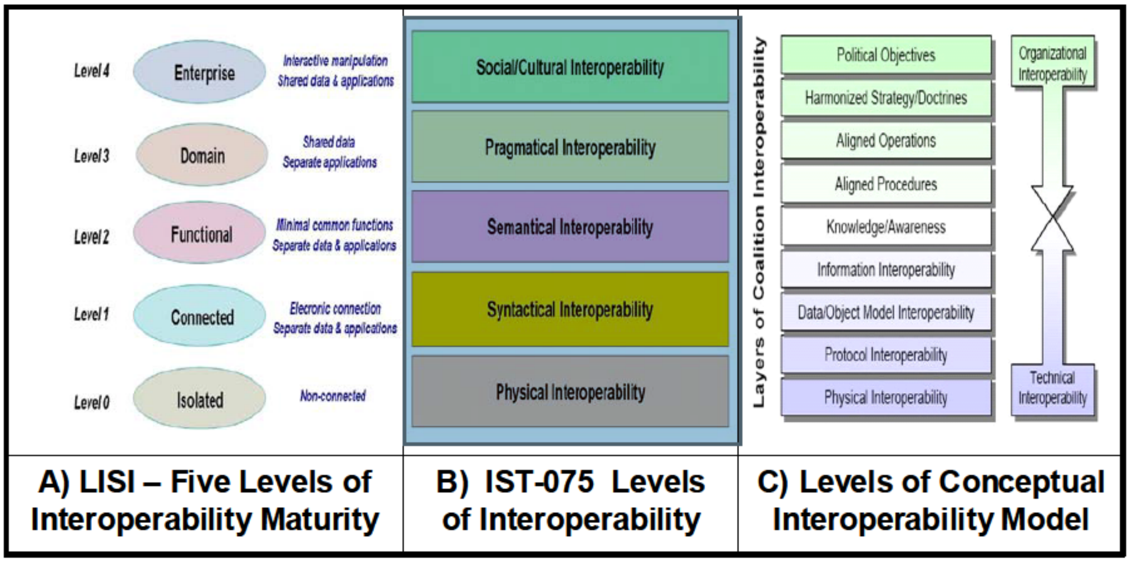

Figure 1: Levels of interoperability. Reproduced from [2].

Enough of a common understanding must exist between the ships to allow one ship to assess the resources on another ship, against the resources of their own ship.

2. Open question: How do the ships gain this common understanding?

3. Open question: Once a connection between ships is attained, can the common understanding be visualized as a resource picture between the ships involved?

4. Open question: How do the ships agree upon the resource-sharing rules?

5. Open question: How might future and current technologies support the data visualization challenges that are likely to occur?

6. Open question: What mode (i.e., 2D, 2.5D, 3D, god's-eye view, first-person) might be best suited to the presentation of data?

As an example, consider the emergency response scenario. In this scenario, the joining ship may have data sets on board such as an historic current field and a wind field. Those data sets may be compatible with a processing algorithm (call it the model) on the other ship, where combining the data sets and the model would provide a forecast of the oil spill trajectory. In such a case, both ships should be aware of the compatibility. In the joining ship's case, the existence of the model may provide a capability that is not available on the joining ship (i.e., they do not have such a model for forecasting the trajectory). In the case of the other ship, the data sets may represent updated versions of data sets that exists on their ship and is thought to represent "better" input to the model.

We also must allow for the communications between ships to potentially be as bad as a V.92 modem (i.e., a dial-up modem operating at 56 kbit/s). As well, each connection between ship/shore nodes will have a different level of connectivity. For example, two ships belonging to the same country will likely have better connectivity as compared to communication capability between ships from different countries.

There are potential investigations related to trade-offs when considering product[2] generation. For example, in the smuggling scenario two or more ships in the coalition may generate an expected track for the VOI (i.e., a prediction of the VOI's movement). The expected tracks could be generated using different data inputs that are available at different times. If the joining ship identifies a "better" data set (i.e., one of the tracks) on another ship, then the joining ship is faced with a decision. Using the joining ship's data set (i.e., their expected VOI track) they could generate a plan for intercept; but using the other ship's data set could show improvement on their plan. However, acquiring the other ship's data set takes time and valuable communication bandwidth[3].

7. Open question: How is the situation or the trade-offs identified?

8. Open question: How are these trade-offs displayed for the decision maker; or can the system make that decision and automatically acquire the data set and generate the product?

9. Open question: If there is sufficient cooperation between the ships, can the joining ship request that the other ship generate the product using the other ship's data set, and then send the product to the joining ship?

10. Open question: How does point of view (the joining ship vs. a ship in the initial group) change the visual presentation of the data?

Data exchange must support the decision makers' information requirements within the context of the coalition's task objectives. In other words, rather than exchanging all available information, the ships must share the key information that is necessary and sufficient to achieve the task at hand.

11. Open question: What metadata is required to represent decision requirements and task objectives and how can these be linked to the metadata for exchanged data and information products.

There is also the issue of how to know if the other ship's data set is "better".

12. Open question: What level of metadata (e.g., pedigree, quality, trust, environmental conditions at the time of the collection, who collected it, the collection method such as the sensor used) is required on the two data sets to assess whether or not the data set on the other ship should be used?

This raises the question of pedigree for the data sets, and in this case, pedigree of the product.

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[2] A product is considered output from a process that combines or integrates multiple information resources.
[3] An expected track for a single VOI would be small volume and therefore unlikely to be a bandwidth consideration. However, the same data set assessment needs to be made for products generated on the joining ship, or even for numerical model outputs that the joining ship may have.

When ships and information resources have overlapping areas of applicability, one must also ensure that multiple reports related to the same real-world object are correctly identified as such; otherwise, the understanding of the shared data set can become confused by issues such as duplicate tracks or data incest.

The issues raised above may apply not only to data sets but to the individual reports within data sets. For example, in a highly dynamic environment with multiple information resources, the source of the “best” data may change over time between vessels, shore node.

Once generated, the product becomes part of the resources available to appropriate members of the group. However, this product needs to be distinguished from other products.

13. Open question: How does the metadata support the knowledge of what data or other products were used in the generation of this product?

The numerical algorithms (or models) that are available in the coalition are also considered resources. The model metadata needs to recognize the input and output of the models to a level that will allow assessment by the other nodes. For example, the joining ship could have a particular model; with another ship in the initial group having an updated version of the model. Similar to the data set example, would it be better for the joining ship to acquire the updated model from the other ship, or request the other ship to run model on their behalf and then have the other ship make the product available to the joining ship?

There is also the issue of an information resource not providing information to the situation. For example, in the fisheries patrol scenario a radar image may indicate that no ship is present in the general area of the suspected illegal fishing; yet we have reason to believe that a ship is in the general area.

14. Open question: How does one store negative information alongside the positive information as well as more contextual information (like maps, surveillance flight paths, satellite orbits, etc.), while allowing for easy/efficient queries?

There may also be questions for MIMIR related to the extraction of negative information through queries to a database that does not store negative information.

15. Open question: How does one form queries that generate both positive and negative information from a positive information “big data” database (e.g., the current database being used to store RCN sensor information) such that the user can use the results to make inferences?

16. Open question: How can a query generate a negative information inference for the user?

4 Data sets

In terms of data sets, each of the nodes will have their own data sets both historic and real time. With regard to ships, the real-time data sets can be considered to originate from sensors or receivers onboard the individual ship. With regard to the shore node, the real-time data sets will be the result of incoming data feeds, for example, as from a space-based AIS provider.

Some of the assumed data sets are provided in Table 1.

Table 1: Assumed data sets.

Data set	Ship Node		Shore Node	
	Real-time	**Historic**	**Real-time**	**Historic**
Oceanographic related	Assume expendable bathythermograph (XBT) profiles collected intermittently	Assume a global archive was obtained just prior to departure from home port	Assume data set is from international programs that provide online data with weekly or monthly updates (e.g., Argo)	Assume the same as available on the internet
Weather	Assume observations from ship instruments	Nil	Assume access to typical weather chart-based forecasts and to numerical forecasts via internet	Assume access to climatology from internet sites
Waves	Assume observations from the bridge	Nil	Assume access to numerical wave forecasts from internet sources	Assume access to wave climatology
AIS	Assume from ship receiver	Assume in products such as traffic patterns; but assume there is no archive of global AIS	Assume will have land[4] and space-based AIS providers	Assume a global archive is available
Contextual		Marine protected areas; bathymetry; ice class of vessels; regulatory zones for ship passage	Assume access to weather forecasts; ice fields; ice forecasts; satellite imagery; all via internet sites	

[4] The Maritime Safety and Security Information System (MSSIS) provides DRDC with land-based AIS. This stream accounts for a data feed of about 25 times the volume as compared to the space-based AIS that we have acquired in the past.

5 The cloud

The ships that make up the coalition can assume to exist in a distributed cloud environment. The cloud is considered here to be the central enabling technology; ubiquitous to the ideas that we hope are developed in MIMIR. Keep in mind that this cloud must exist in an often degraded, sporadic, or low-bandwidth environment.

17. Open question: Can this cloud be multi-caveated where some partners have access to parts of the cloud that others do not have access to?

18. Open question: How would a node that joins the cloud sporadically, that possesses high processing capability, influence the partners as it enters and departs the cloud (i.e., think of an aircraft carrying the high processing capability, but can only be circling the ships for a limited number of hours)?

19. Open question: How do we ensure reliable access to data and the capability to maintain common understanding in degraded, sporadic or low-bandwidth environments?

The shore node will have access to much more computing power and a more diverse set of information resources. For example, the shore will have access to numerical weather and wave forecasts that may be updated every 4 or 6 hours. The questions around distribution of the new forecast are similar to distribution of any product.

As an example, in the environmental emergency scenario the Canadian shore node could be responsible for informing the Canadian ship nodes of the degree of revision to the weather forecast. For illustration, the current 18 hr forecast at the location of the joining ship is for clear sky and low winds. After 6 hrs pass, the shore site gets a new 12 hr forecast for the joining ship location. Again the forecast indicates clear sky and low wind. Since there is no change, there is no need to push the more recent forecast to the ship. If the 12 hr forecast had changed to be cloudy with 40 knot winds, then should the joining ship be informed?

20. Open questions: Should the joining ship make the decision on whether or not to acquire the new forecast or is this for the shore node to decide? What visual cues could be provided to an operator on the ship to allow the decision to be made? Should operators be alerted to differences between data that are out-of-date and new data? How are historical data accessed?

Underlying many of the open questions is the need to balance the new information content of the resource (e.g., a data set, a model, a product) as compared to the communication bandwidth required to acquire the resource. Keep in mind, that if the communication channel is used to transmit the resource, it will take a finite time, and, in addition, while in transfer the ability to transfer other data is hampered.

21. Open question: Could the cloud be used to reconcile the metadata descriptions and create enough common understanding to allow the joining ship to request information resources from others in the initial group?

There are also interesting questions related to association of products among the coalition partners. For example, in the environmental emergency scenario one ship may produce a product related to an oil free area of water (i.e., a zone that indicates no oil is present and thus passage is allowed[5]). Independently of that product, another participant creates a second product that is the intended path that they plan to follow (i.e., their intended route). Can these two independent products be exposed in such a way that the automated association and reconciliation of these two views be made in the cloud?

22. Open question: Could the cloud be used to reconcile different vocabulary views from the coalition participants?

This issue is related to the independent generation of products among the coalition partners, when the products are in fact related. Note that the issue here is not a simple inclusion (e.g., a line (the intended route) being contained within an area (i.e., the safe zone)), but rather is the underlying vocabulary issues that are needed to allow the association of the products and the automatic joining across the two platforms. Effectively, this example is showing the joining of two products (the safe zone and the intended path) that were created independently. What vocabularies are required to identify if the two products are connected to one another?

23. Open question: What is the necessary metadata that would allow a system to automatically associate products? For example, is it a geospatial association? Or geospatial and temporal (because the oil spill is moving and thus the safe zone has a temporal aspect)? How is uncertainty accounted for in the products? Or perhaps a user has to be in the decision loop?

24. Open question: How does one pass the uncertainty information that is associated with information while also indicating the cause of the uncertainty? (The categories of uncertainty causes are reproduced in Figure 2, based on [3].)

25. Open question: How does one generate and transfer trust in the information? (See [4].)

26. Open question: If the user is in the loop how should data be structured to allow the user to interact with it (turn it off, on, combine various factors) without being overwhelmed?

27. Open question: In the situation where communication channels degrade to zero, and products continue to be generated on the individual ships, how do the products get combined or reconciled after communications are re-established?

The potential for the cloud to be utilized in the automated association of products has uses in other diverse areas. For example, suppose the joining ship is monitoring a critical device that is located on the joining ship. Suppose the monitoring includes processing of the monitored device in such a way that a defect can be identified (i.e., maybe a temperature spike in the device indicates a problem that should be addressed). Can the system automatically associate this product with other ships in the coalition that are using the same or similar devices?

[5] We will assume oil present in the ship engine cooling system is not desirable.

Table 1: Causal Categories of Uncertainty.

Causal Categories of Uncertainty	Definition
Data Acquisition Limitation	The limitation caused by the accuracy and precision of the data acquisition device, including the human senses and mind.
Data Acquisition Error	An error in a datum acquisition that occurs at the time of acquisition. The error can be accidental or deliberate. The resulting datum can be erroneous or completely absent.
Phenomenon Discretization	The discretization, at the point of datum acquisition, of a phenomena or its attribute that is in reality continuous in space, time or another similar dimension. In other words, the act of acquiring data at intervals for something that is continuous. (Note: Discretization (or sampling) of data after data acquisition would fall under Transformation.)
Noise	Extraneous background activity that produces unwanted influence on the acquired data.
Ambiguous Data	Data that cannot be interpreted correctly without further information. The ambiguity could be due to a lack of reference or simply confusion as to how to interpret the data.
Subjectivity	Subjective influence in the data.
Data Age	The age of the data from the moment of acquisition. This is a cause of uncertainty only in cases where the data are time dependent.
Data Corruption	Corruption of data at some point during the transfer-storage-manipulation-usage process due to human or machine error. This can occur anytime after the moment of data acquisition for the entire lifecycle of the data.
Data Extrapolation & Interpolation	Extrapolating or interpolating data from indirect evidence. The extrapolated or interpolated data has an inherent uncertainty.
Transformation	The changing of data from their original form or format.
Misinterpretation	A mistake made in interpreting the data.

Figure 2: The categories of uncertainty causes (from [3]).

6 Conclusion

MIMIR participants requested scenario descriptions related to the concepts proposed in MIMIR. At a specific level, scenarios involving smuggling, patrolling of fisheries activities, and an environmental emergency were described. At a general level, all the scenarios describe shore, air and sea platforms joining at the semantic level to allow discovery, sharing and use of information resources.

The scenario descriptions are intended as a guide, setting a context that is considered appropriate to MIMIR. Although many ideas and questions are presented, many more exist. For example, topics related to indexing, data mining, application of anytime algorithms to product generation. all could apply to MIMIR but for brevity, are not included here.

The cloud is anticipated to be a central enabling technology in MIMIR. However, the overarching applicability of the cloud in a sporadic, degraded, and/or low-bandwidth communication environment represents an important question unto itself.

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List of symbols/abbreviations/acronyms/initialisms

AIS	Automatic Identification System
CA	Canada (or Canadian)
CCG	Canadian Coast Guard
DND	Department of National Defence
DRDC	Defence Research and Development Canada
MIMIR	Mission-relevant Information Management for Integrated Response
MSSIS	Maritime Safety and Security Information System
OGD	Other Government Department
RCN	Royal Canadian Navy
UAV	Unmanned Aerial Vehicle
VOI	Vessel Of Interest
XBT	expendable bathythermograph

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The kick-off meeting for the Mission-relevant Information Management for Integrated Response (MIMIR) activity took place on 28 October 2016 at Dalhousie University Institute for Big Data Analytics. The meeting identified the need for navy-relevant scenarios to help guide MIMIR information research. As a result, DRDC – Atlantic Research Centre took an action item to describe MIMIR-relevant naval scenarios that would allow researchers to better understand work associated with MIMIR. The developed scenarios involve international smuggling, fisheries patrol, and an environmental emergency. Collectively, the scenarios describe a futuristic common information resource environment that exists in a distributed cloud infrastructure, where information products, models, etc. are treated in a common manner. The scenarios are intended to generate further discussion and help solidify research topics for the MIMIR participants.

La réunion de lancement de l'activité MIMIR (Mission-relevant Information Management for Integrated Response ou gestion de l'information pertinente à la mission pour une intervention intégrée) a eu lieu le 28 octobre 2016 à l'Institute for Big Data Analytics de l'Université Dalhousie. Les participants à la réunion ont déterminé le besoin de formuler des scénarios propres à la Marine pour aider à orienter la recherche d'information de la MIMIR. Par conséquent, RDDC – Centre de recherches d'Atlantique a pris des mesures de suivi visant à décrire des scénarios navals pertinents qui permettraient aux chercheurs de mieux comprendre le travail associé à la MIMIR. Les scénarios élaborés portent sur la contrebande internationale, la surveillance des pêches et l'urgence environnementale. Dans l'ensemble, les scénarios décrivent un environnement futuriste de ressources documentaires communes qui existe dans une infrastructure en nuage répartie où les produits d'information, les modèles, etc. sont traités de manière commune. Ces scénarios ont pour but de susciter de plus amples discussions et de contribuer à enrichir les sujets de recherche des participants à la MIMIR.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g., Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

MIMIR; information exchange