Arrival Analysis Report (AAR) Technical Report

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Defence R&D Canada
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Abstract

The Arrival Analysis Report (AAR) is the first operational module of the Recognized Maritime Picture (RMP) Analysis Toolset (RAT). The module was developed to integrate the predicted arrival data from Transport Canada (TC) with the current positional data held by the Department of National Defence (DND). The module performs data validation and provides integrated results in Google Earth and Microsoft Excel formats. The work directly supports the Marine Security Operations Centres (MSOCs) and was performed as part of Applied Research Project (ARP) 11hn, Maritime Security Planning Tools and Analysis.

Résumé

Le rapport d'analyse d'arrivée (RAA) est le premier module opérationnel de l'ensemble d'outils d'analyse (EOA) de la situation maritime générale (SMG). Le module a été élaboré pour intégrer les données d'arrivée prédite de Transports Canada (TC) avec les données de position actuelles détenues par le ministère de la Défense nationale (MDN). Le module effectue une validation des données et procure des résultats intégrés dans les formats Google Earth et Microsoft Excel. Le travail soutient directement les centres d'opérations de la sécurité maritime (SOSM), et a été effectué dans le cadre du programme de recherche appliquée (PRA) 11hn, Maritime Security Planning Tools and Analysis.

Executive summary

Arrival Analysis Report (AAR): Technical Report

Jim Tough; Dave Morash; Brian Stroud; DRDC CORA CR 2011-059; Defence R&D Canada – CORA; August 2011.

Introduction or background: The Arrival Analysis Report (AAR) is the first operational module of the Recognized Maritime Picture (RMP) Analysis Toolset (RAT). The module was developed to integrate the predicted arrival data from Transport Canada (TC) with the current positional data held by the Department of National Defence (DND) as part of the RMP and stored in the Global Positioning Warehouse (GPW).

The predicted arrival data provided is a subset of the 96 hour Pre-Arrival Information Report (PAIR) which announces the intention of a vessel to enter Canadian waters. The data provided includes identifying information about the vessel, its next port of call in Canada, and its last three ports of call.

Results: The vessel identity information is used to compare with vessel data held in the GPW in two ways. The first is to compare and validate the provided data against the Additional Reference Table (ART) data which holds reference values for vessel identities of some vessels. If there is a conflict in any of the values, the user is alerted to investigate whether the vessel provided data or the reference data may be incorrect.

The second way is to compare the vessel data with current positional data of vessels held in the GPW. This allows the current track of those vessels identified to be entering Canada to be selected for analysis in the AAR's two output report formats. The first format is a Google Earth report which geographically displays all of the current vessel positions and tracks. These tracks can also be dead reckoned to a future point in time and are linked to the Canadian arrival port. Any vessels not currently found in GPW are listed separately. These vessels may still be too far away or may warrant investigation as to why their position is not currently known. The second format is an Excel spreadsheet which summarizes the information. The Excel spreadsheet also compares and validates the input data against the current values in GPW which represent the operational values.

Requirements: Daily, the Marine Security Operations Centre Atlantic (MSOC(A)) sifts the North Atlantic ocean to determine the intent of each vessel. The intent of any vessel reported through TC's PAIR system is already determined. Therefore, to identify these vessels and report on their current position in the RMP directly supports their mission. Although, MSOC(A) was the initial audience, the tool obviously applies to Marine Security Operations Centre Pacific (MSOC(P)) as well.

The applicability of the AAR can also extend beyond the identification of vessels reported to be entering Canada by providing a different list of ships as input for the AAR report generator. For example, if the input list is changed to those vessels with known safety violations, the AAR could generate a Google Earth report showing the locations of all those ships currently held by DND and could be used to alert the responsible department. The type of interdepartmental coordination is naturally in place in the MSOC and therefore makes this type of analysis very useful.

Other interested parties may also use the AAR to report on any list of vessels that they want to analyse such as the current location of Vessels of Interest (VOIs).

Limitations: The current version of the AAR has one main limitation. Although the names of the last three ports of call are provided for each vessel, they could not be mapped accurately to specific ports. The current version of the TC PAIR records the last port of call as text fields and only requires the city and country. These entries can therefore be ambiguous if a country has multiple cities with identical names (perhaps in different states or provinces). These entries can also be inconsistently identified due to varying spellings or different languages being used.

Future plans: TC has indicated that they intend to standardize more of their report, removing free text fields where possible. As part of this process they intend to use the same UN LOCODE standard that the RAT team has suggested. With this step, the AAR port limitation may be addressed so that with further development the last ports of call may also be mapped and displayed in Google Earth. Standardizing the port codes will also improve the matching of domestic ports of call by removing spelling inconsistencies.

Sommaire

Arrival Analysis Report (AAR): Technical Report

Jim Tough; Dave Morash; Brian Stroud; DRDC CORA CR 2011-059; R & D pour la défense Canada – CORA; Août 2011.

Introduction : Le rapport d'analyse d'arrivée (RAA) est le premier module opérationnel de l'ensemble d'outils d'analyse (EOA) de la situation maritime générale (SMG). Le module a été élaboré pour intégrer les données d'arrivée prédite de Transports Canada (TC) avec les données de position actuelles détenues par le ministère de la Défense nationale (MDN) dans le cadre de la SMG, et entreposées dans la mémoire de positions de type mondial (MPM).

Les données d'arrivée prédite fournies forment un sous-ensemble du 96 hour Pre-Arrival Information Report (PAIR) qui annonce l'intention d'un bâtiment de pénétrer dans les eaux canadiennes. Les données fournies comprennent l'identification de renseignements concernant le bâtiment, son prochain port d'escale au Canada et ses trois derniers ports d'escale.

Résultats : Les renseignements portant sur l'identité du bâtiment sont utilisés pour faire une comparaison avec les données sur le bâtiment conservées dans la MPM de deux façons. La première façon est de valider les données fournies et de les comparer aux données de l'Additional Reference Table (ART) qui maintient des valeurs de référence pour l'identité de certains bâtiments. S'il y a conflit au niveau de n'importe laquelle des valeurs, on avise l'utilisateur qu'il doit voir si le bâtiment fournissait des données ou si les données de référence ne pourraient pas être incorrectes.

La deuxième façon est de comparer les données du bâtiment aux données de position actuelles des bâtiments conservées dans la MPM. Cela permet à la trajectoire de ces bâtiments qui, selon les informations disponibles, sont en train de pénétrer en territoire canadien d'être sélectionnée aux fins d'analyse dans les deux formats de rapport de sortie du RAA. Le premier format est un rapport de Google Earth qui affiche géographiquement la totalité des trajectoires et positions du bâtiment. Ces trajectoires peuvent aussi être estimées à un point futur dans le temps, et sont liées au port d'arrivée canadien. Tous les bâtiments que l'on ne trouve pas dans la MPM sont énumérés séparément. Ces bâtiments pourraient encore être trop éloignés ou pourraient justifier une enquête visant à déterminer pourquoi leur position est inconnue. Le deuxième format est une feuille de calcul électronique Excel qui résume les renseignements. De plus, la feuille de calcul valide les entrées, et les compare aux valeurs actuelles dans la MPM qui représentent les valeurs opérationnelles.

Exigences : Sur une base quotidienne, le centre d'opérations de la sécurité maritime Atlantique (SOSM(A)) passe l'Atlantique Nord au peigne fin pour déterminer le but de chaque bâtiment. Le but de tous les bâtiments rapportés par le biais du système PAIR de TC est déjà établi. Donc, le fait d'identifier ces bâtiments et de faire rapport concernant leur position actuelle dans la SMG soutien directement leur mission. Bien que le SOSM(A) était le public de départ, l'outil s'applique évidemment au SOSM(P) aussi.

L'applicabilité du RRA peut aussi aller au-delà de l'identification de bâtiments qui, selon les informations disponibles sont en train de pénétrer en territoire canadien en fournissant une liste de bâtiments différente de celle saisie pour le générateur du RAA. Par exemple, si la liste saisie est modifiée pour faire place aux bâtiments dont le personnel a commis des violations à la sécurité, le RRA pourrait produire un rapport de Google Earth montrant l'emplacement de chacun de ces bâtiments possédés actuellement par le MDN; de plus, le RRA pourrait être utilisé pour alerter le ministère responsable. Le type de coordination interministérielle est naturellement en place dans le SOSM et, donc, rend ce type d'analyse très utile.

D'autres partis intéressés peuvent aussi utiliser le RRA pour faire rapport sur n'importe quelle liste de bâtiments qu'ils désirent analyser, p. ex. l'emplacement actuel des navires d'intérêt (NI).

Limites : La version actuelle du RRA a un inconvénient principal. Bien que le nom de chacun des trois derniers ports d'escale est fourni pour chaque bâtiment, il ne pourrait être relié sur une carte avec précision à son port. La version actuelle du système PAIR de TC enregistre le dernier port d'escale en tant que zone de texte, et nécessite seulement la ville et le pays. Ces entrées peuvent donc être ambiguës si un pays comporte plusieurs villes ayant le même nom (peut-être dans différents états ou provinces). Ces entrées peuvent aussi être identifiées de façon inconstante à cause de graphies changeantes et de langues différentes utilisées.

Recherches futures : TC a indiqué qu'il a l'intention de normaliser une plus grande partie de son rapport, en enlevant les zones de texte libres lorsque cela s'avère possible. Dans le cadre de ce processus, il a l'intention d'utiliser la même norme UN LOCODE que l'équipe EAO a suggérée. Avec cette étape, la limite de port du RRA peut être adressée de sorte que, avec un développement supplémentaire, les derniers ports d'escale peuvent aussi être cartographiés et affichés dans Google Earth. Le fait de normaliser les codes de port améliorera aussi la correspondance des ports d'escale domestiques en enlevant les inconstances d'épellation.

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1 Introduction

The Arrival Analysis Report (AAR) is the first operational module of the Recognized Maritime Picture (RMP) Analysis Toolset (RAT). The module was developed to integrate the predicted arrival data from Transport Canada (TC) with the current positional data held by the Department of National Defence (DND) as part of the RMP and stored in the Global Positioning Warehouse (GPW).

The predicted arrival data provided is a subset of the 96 hour Pre-Arrival Information Report (PAIR) which announces the intention of a vessel to enter Canadian waters. There is one report produced for each coast called the Vessels Entering Eastern Canada (VEEC) and the Vessels Entering Western Canada (VEWC). The data provided in these reports include identifying information about the vessel, its next port of call in Canada, its last three ports of call, its cargo and any remarks.

The RMP data is managed in the Global Command and Control System (GCCS) and then archived in the GPW. GPW stores all of the vessel contact reports in a historical database. This data includes but is not limited to the vessel identification information, vessel positions, and what source and sensor reported the position. While GPW stores the historical archive it is updated from the GCCS data every couple minutes and therefore also provides a near real time feed.

Bringing the predicted arrival data together with the current reported position allows the user to determine whether the expected vessels are in the RMP yet, and whether they appear to be on course. The Google Earth output visualizes the vessel track history and connects them to the next port of call. The AAR can also dead reckon the tracks allowing the report to predict where to expect ships to be at a particular time in the future. Then the report can be run ahead of time and predict the positions at the same time as the regular situational briefing is scheduled for.

The AAR also performs validation of the input vessel data. The vessel identification information compares the vessel name, flag, and IMO against both the Additional Reference Table (ART) and GPW data. Comparing against ART identifies conflicts between the input data and the ART reference data which acts as the correcting dictionary for vessel identity data[1]. Comparing against GPW identifies conflicts between the input data and the data reported in the RMP. At the same time the port data is matched and compared to the AAR's master port list.

The AAR can also be used to analyze an alternate list of vessels. By providing a list of vessels in the VEEC format, the AAR validation and reporting capabilities can be applied to any group of vessels.

[1] Incoming contact reports that pass through the Attribute Correction Engine (ACE) are compared first to the ART and then to Lloyds reference data. If a vessel match is found in ART, any conflicting fields are updated according to the ART entry which is taken as the truth data. If there is no vessel match found in ART, the contact report is compared to the Lloyds register. If conflicts are found in certain fields, the contact report is updated to match the Lloyds entry. ART is designed to contain all vessels which are not found in Lloyds or which are incorrect in Lloyds. ART must be kept up to date by the RMP users.

1.1 Aim

This document aims to capture the technical details of the AAR module. From the module's requirements to how it was developed and implemented. The AAR User Manual [1] is a complementary report which documents how a user should operate the application. The AAR User Manual is written in the format that conforms to other documentation provided by MARLANT N6 staff in support of operational software such as GPW.

2 Requirements

Daily, the Marine Security Operations Centre East (MSOC(E)) sifts the North Atlantic ocean to determine the intent of each vessel. The intent of any vessel reported through TC's PAIR system is already determined. Therefore, to identify these vessels and report on their current position in the RMP directly supports their mission. Although, MSOC(E) was the initial audience, the tool obviously applies to Marine Security Operations Centre West (MSOC(W)) as well.

The applicability of the AAR can also extend beyond the identification of vessels reported to be entering Canada by providing a different list of ships as input for the AAR report generator. For example, if the input list is changed to those vessels with known safety violations, the AAR could generate a Google Earth report showing the locations of all those ships currently held by DND and could be used to alert the responsible department. The type of interdepartmental coordination is naturally in place in the MSOC and therefore makes this type of analysis very useful.

Other interested parties may also use the AAR to report on any list of vessels that they want to analyze such as the current location of Vessels of Interest (VOIs).

The following requirements were collected from various meetings with stakeholders over a period of time and have been documented and reviewed. Table 1presents the AAR requirements in a standard documentation format for requirements in the MCOIN project.

Table 1. Arrival Analysis Report Requirements Matrix

REQ ID#	DONE	DESCRIPTION	NOTES
2.12	**Y**	Shall generate Arrival Analysis Report (A.K.A. Pre-Arrival Reports or 96 Hour Reports)	
2.12.1	**Y**	**Shall provide an Arrival Analysis Report in KMZ and KML format**	
2.12.1.1	**Y**	The latest contact associated with track shall be rendered using user selected symbology set (default for now is milspec 2525)	DIRECTION GIVEN: Adapt the code such that it will use the same symbology as the RMP report from GPW wherever possible. Any styling that is specific only to this report can be done at Jim Tough's discretion and demonstrated later to the group. LCdr Fredericks has asked that we try to use symbology that has a high contrast with the Google Earth globe so the visibility is good.

REQ ID#	DONE	DESCRIPTION	NOTES
2.12.1.2	**Y**	Shall provide information popup based on the latest contact report: a) reported course b) reported speed c) NPOC d) NPOC declared arrival date/time (DTG format) e) LPOC f) LPOC declared departure date (DTG format) g) unique list of source-sensor codes contributing to the track	DIRECTION GIVEN: Use the DTG format that is commonly seen in GPW (ex: 311159ZOCT10) wherever possible. It is not desirable to deviate from this standard format.
2.12.1.3	**Y**	Shall provide the historical contacts found in the active track	
2.12.1.4	**Y**	Shall provide a dead reckoning indicator using the following algorithm: a) Calculated from the vessel's last contact report lat/lon as the starting point b) Distance is determined using the calculated average speed (based on last two contact reports) and a user-provided absolute "time at endpoint" c) Course used is the estimated course (calculated based on last two contact reports)	
2.12.1.5	**Y**	Shall provide a track line connecting contacts for each track	
2.12.1.6	**Y**	Shall provide a line from the latest report to the NPOC along a Great Circle path	
2.12.1.7	**Y**	Shall provide a list of vessels not detected, where a vessel not detected is defined as an expected vessel that does not have an active track	
2.12.1.8	**Y**	The report shall be stand-alone and require no additional querying from external sources	
2.12.1.9	**Y**	Shall provide an Information popup containing a list of expected vessels for each declared destination port	
2.12.2	**Y**	**Shall provide an Arrival Analysis Report in MS Excel format**	

REQ ID#	DONE	DESCRIPTION	NOTES
2.12.2.1	**Y**	Shall provide the following data columns: a) VEEC/VEWC vessel name b) VEEC/VEWC flag c) VEEC/VEWC IMO d) next port of call (city, prov/state, country, arrival date, arrival note) e) last port of call 1 f) last port of call 2 g) last port of call 3 h) VEEC/VEWC CDC i) VEEC/VEWC Remarks	Requirement is simply stating which data fields from the imported VEEC/VEWC need to be included in the Excel-based report. The column titles in the Excel report will not exactly match those specified in the requirement text (ex: "VEEC/VEWC vessel name")
2.12.3	**Y**	**Shall provide a user interface that allows the operator to maintain the Pre-Arrival Report vessel list and generate reports**	
2.12.3.1	**Y**	Shall validate the IMO, vessel name and country against the ART table	DIRECTION GIVEN: Provide a visual cue on the "draft" report page during validation when a VEEC/VEWC imported vessel does not match the ART table. No other action is necessary.
2.12.3.2	**Y**	Shall allow the operator to open the "Add Entry to ART" interface if vessel details are not validated	DIRECTION GIVEN: Provide a link to the "Add Entry to ART" page from the "draft" report page in an appropriate location. If the user gets a visual cue that a VEEC/VEWC vessel does not match the ART table, then they simply click the link and edit the ART entry in another browser window. According to Brad G, the "Add Entry to ART" page is hosted at: http://hostname/art (where 'hostname' is the server that will host both the GPW and RAT webapps)
2.12.3.3	**Y**	Shall validate the port information against a port reference list	

REQ ID#	DONE	DESCRIPTION	NOTES
2.12.3.4	**Y**	Shall allow for a choice of symbology sets for track icons	DIRECTION GIVEN: Adapt the code such that it will use the same symbology as the RMP report from GPW wherever possible. Any styling that is specific only to this report can be done at Jim Tough's discretion and demonstrated later to the group. LCdr Fredericks has asked that we try to use symbology that has a high contrast with the Google Earth globe so the visibility is good.
2.12.3.5	**Y**	Shall allow the operator to save an Arrival Analysis Report	
2.12.4	**Y**	**Shall provide a port reference list that allows for validation of port information during data entry - including port name, port code, country, prov/state, city**	The "Master Port List" is used to satisfy this requirement.
2.12.4.1	**Y**	Shall provide user interface for maintenance of the port reference list	

3 Dependencies

The following list contains the system dependencies for the AAR:

- Supported Browsers: Tested with MS Internet Explorer 7. Expected to be compatible with FireFox 3.6x. Required for the user interface.
- Google Earth: Tested with version 5.2.x. Required for viewing KML output.
- MS Excel: Tested with MS Office 2003. Required for viewing Excel spreadsheet output.
- GPW: As the AAR is a subsystem of GPW, the GPW database and application must be available to the AAR.

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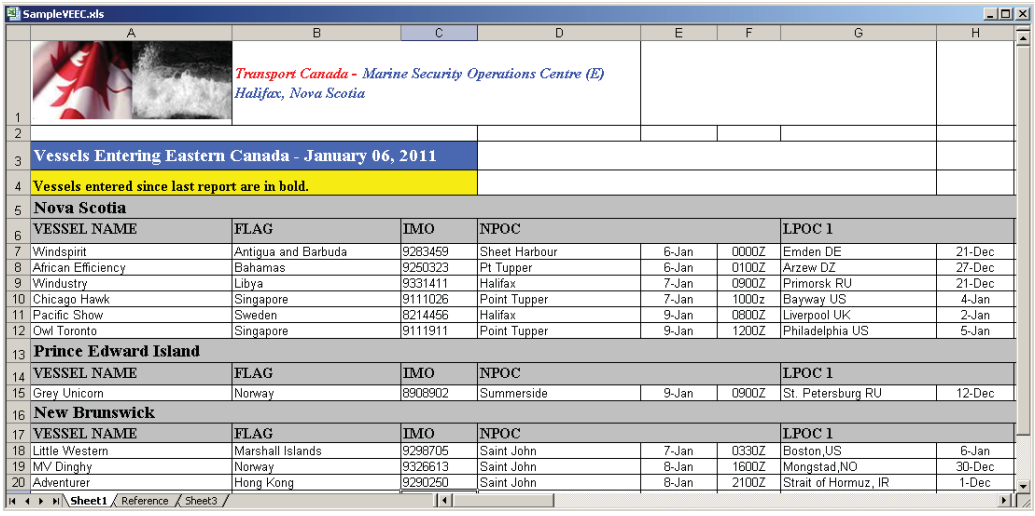
4 Inputs

There are two types of inputs, VEEC/VEWC and Alternate Lists. Each is listed below with their described input values.

This is a spreadsheet provided by Transport Canada as part of their PAIR reporting process. Table 2 lists the input columns of a VEEC/VEWC spreadsheet while Figure 1 shows a screenshot of the Excel spreadsheet.

Table 2. VEEC Input Columns

Column	Description
PROVINCE	the province the vessel is entering
VESSEL NAME	the given name of the vessel
FLAG	the country's flag where the vessel is registered
IMO	the unique identifier given to the vessel
NPOC	the next port scheduled to visit
Date	the date of the next scheduled port to visit
Time	the time of the next scheduled port to visit
LPOC1	the last port visited
Date	the date of the last port visited
LPOC 2	the previous port visited to LPOC1
Date	the date LPOC2 was visited
LPOC 3	the previous port visited to LPOC2
Date	the date LPOC3 was visited
CDC	cargo descriptors
Remarks	remarks/comments with regards to this vessel



SampleVEEC.xls

Transport Canada - Marine Security Operations Centre (E)
Halifax, Nova Scotia

Vessels Entering Eastern Canada - January 06, 2011

Vessels entered since last report are in bold.

	VESSEL NAME	FLAG	IMO	NPOC			LPOC 1	
Nova Scotia								
	Windspirit	Antigua and Barbuda	9283459	Sheet Harbour	6-Jan	0000Z	Emden DE	21-Dec
	African Efficiency	Bahamas	9250323	Pt Tupper	6-Jan	0100Z	Arzew DZ	27-Dec
	Windustry	Libya	9331411	Halifax	7-Jan	0900Z	Primorsk RU	21-Dec
	Chicago Hawk	Singapore	9111026	Point Tupper	7-Jan	1000z	Bayway US	4-Jan
	Pacific Show	Sweden	8214456	Halifax	9-Jan	0800Z	Liverpool UK	2-Jan
	Owl Toronto	Singapore	9111911	Point Tupper	9-Jan	1200Z	Philadelphia US	5-Jan
Prince Edward Island								
	VESSEL NAME	FLAG	IMO	NPOC			LPOC 1	
	Grey Unicorn	Norway	8908902	Summerside	9-Jan	0900Z	St. Petersburg RU	12-Dec
New Brunswick								
	VESSEL NAME	FLAG	IMO	NPOC			LPOC 1	
	Little Western	Marshall Islands	9298705	Saint John	7-Jan	0330Z	Boston,US	6-Jan
	MV Dinghy	Norway	9326613	Saint John	8-Jan	1600Z	Mongstad,NO	30-Dec
	Adventurer	Hong Kong	9290250	Saint John	8-Jan	2100Z	Strait of Hormuz, IR	1-Dec

Sheet1 / Reference / Sheet3

Figure 1. Screenshot of a sample VEEC input file

4.1 Alternate Lists

Alternate lists can be loaded into AAR by copying the VEEC format. They may be useful when wanting to do a quick check on vessels of interest. The vessel data may contain any of the VEEC columns, but Table 3 lists the essential columns that must be entered at a minimum. If the next port of call is unknown or not applicable, it is suggested that Ottawa, Ontario be used as shown in Figure 2.

Table 3. Minimum Input Data Required

Column	Description
VESSEL NAME	the given name of the vessel
FLAG	the country's flag where the vessel is registered
IMO	the unique identifier given to the vessel
NPOC	the next port scheduled to visit

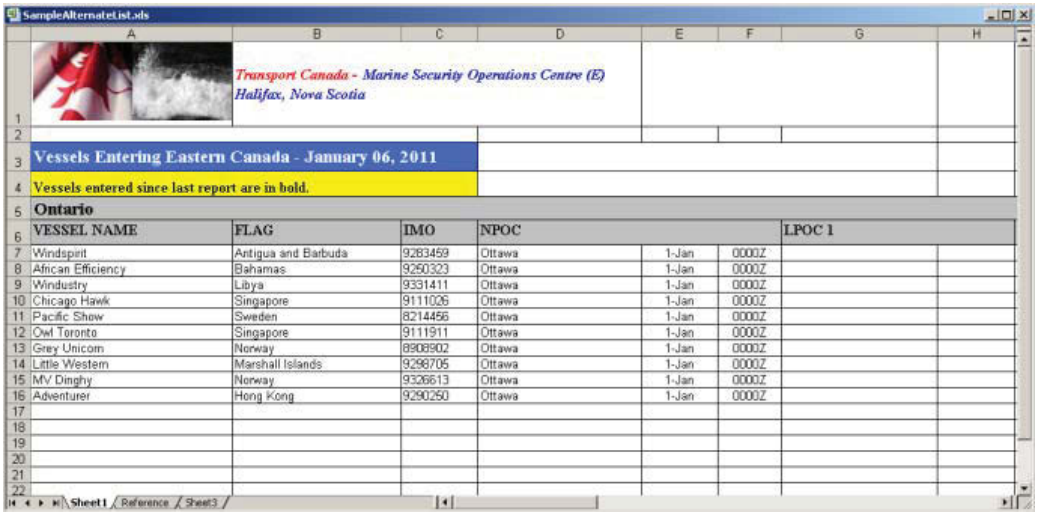


Figure 2. Screenshot of an alternate list being provided in the VEEC format

The master port list is first populated with a UN port list. This is a standardized list of international ports that is maintained by the UN. Each port has a unique code, called a UN LOCODE, which is referenced to eliminate spelling errors and provide consistently. Most of these ports have latitude and longitude coordinates associated with them that have been provided by the UN. The AAR master port list can be edited by the user to add or delete ports and to edit details of ports in the list. This master port list will also become available to other GPW and RAT modules in the future.

5 Algorithms and Calculations

5.1 Dead Reckoning

The user can select the option to dead reckon all contacts to a time in the future. Normally in the RMP, all vessels are shown in their last reported position which could all be at different times. This feature allows the user to visualize where all vessels are expected to be at a common time. Dead reckoning can only be calculated for vessels with an active track that contains at least two contact positions. The time and distance between the last two reported positions are used to determine the estimated speed, by dividing distance by time. The course is also estimated by calculating the angle between the last two positions. The dead reckoning calculations are done using an open source library called GeoTools.

The GeoTools class used for the dead reckoning calculations is org.geotools.referencing.GeodeticCalculator. For brevity, this class will now be referred to as GeoCalc.

To calculate the speed of the vessel, we determine the time and distance between the last two contact reports (point A and point B). The distance is calculated using the Great Circle distance between two points because vessels crossing the ocean are most likely to use great circle routes since this is the shortest route between two points. The great circle distance is calculated using the function GeoCalc.getOrthometricDistance(). The speed of the vessel is then estimated using this distance and the time difference between the reports.

The course from point A to point B is calculated using GeoCalc.getAzimuth(), where the azimuth is then converted to degrees.

To dead reckon to a future point C, we use the estimated course and speed, together with the time from the last reported position (point B) to the dead reckoning time provided. The estimated distance travelled is calculated and then now having a course and distance, the function GeoCalc.getDestinationGeographicPoint() is used to determine the location of point C.

The course and speed cannot be estimated accurately if points A and B are too close or too far in either time or distance. Threshold values are set for the time difference as a minimum of 60 seconds and a maximum of two days; and for the distance as a minimum of 100 meters and a maximum of one quarter of the circumference of the earth.

5.2 Google Earth Line Drawing

When Google Earth draws lines between two points, several facts should be understood:

- Lines are drawn on the surface of the globe taking into consideration the curvature of the globe;
- Lines are drawn as rhumb lines not as great circle lines; and
- Lines do not consider land mass and therefore a direct line may be drawn from one point to another across land.

These points must be kept in mind when considering any of the lines produced by the AAR for display in Google Earth. Specifically, they apply to subsections 5.3, 5.4, and 5.5 below.

5.3 Vessel to Port Lines

Since the AAR is combining the expected arrival data with the current position, one feature is to link these two pieces visually. The vessel-to-port lines draw a direct line from the vessel's latest position to its Next Port of Call (NPOC). Plotted with the vessel's track line (see Section 5.4) can quickly show whether the vessel is heading towards its next port of call. If the NPOC or its latitude and longitude coordinates are undefined, a line cannot be drawn because Google Earth will not have a position for the port.

5.4 Vessel Track Lines

A vessel's track line is drawn by connecting all of the vessel's contact positions with straight lines. The contact positions are sorted by chronological order of the report time. They are not sorted by the receive time because delays in one process may cause reports to arrive in the RJOC out of order. In order for a track line to be drawn, a vessel must have more than one reported position.

5.5 Course/Speed Indicator Lines

This is calculated the same way as the dead reckoning, described in Section 5.1, except that instead of a user-supplied time in the future, the vessel's latest contact report + X hours is used. The value of X is loaded as a parameter from the report generator configuration file. Therefore the length of the line provides a linear indication of the vessel's speed while its direction indicates the vessel's course.

5.6 Google Earth Symbology

The three choices of KML symbology and styling use different icon sets and rules for styling the vessel tracks and port locations. The underlying report data remains unchanged regardless of the user's choice. The three choices are described in the following subsections: MILSPEC 2525 (Section 2.6.1); Google Earth (Section 2.6.2); and Proud Canadian (Section 2.6.3). The variety of

choices was provided to demonstrate the ability to customize the KML output. If a user needs a new style developed, they should discuss their requirements with Mr. Andrew Wind.

5.6.1 MILSPEC 2525

The MILSPEC 2525 is a standard common warfighting symbology[2]. This choice of KML styling uses a limited set of symbols for displaying the latest contact report (track heads). The historical reports then use icon shapes indicating the classification of the source providing that position.

The historical reports in the track history are either hollow circles or hollow triangles. A hollow circle indicates that the report was provided by a source which can be matched to a list of known unclassified sources. A hollow triangle indicates that the report was either provided by a classified source or that it didn't match the list of unclassified sources. This distinction was requested by the MSOC(E) users to quickly identify whether there are unclassified reports in the track history to share with other partners who do not have access to the classified data. The list of known unclassified sources is stored in a configuration file for the AAR and can be updated quickly if required when new unclassified sources are added to the picture.

The colour of the icon is related to the contact's affiliation. Blue is used for friend, green for neutral, red for hostile, and yellow for unknown. These colours are applied to both the track head and history icons. Table 4 presents a list of the icons used in this style.

Table 4. Table of icons for MILSPEC 2525 KML symbology

ICON	MEANING
	historical contact report (from a known unclassified source)
	historical contact report (from a classified or unknown classification source)
	latest contact report (FRIENDLY AIR)
	latest contact report (FRIENDLY SURFACE)
	latest contact report (FRIENDLY SUBSURFACE)

[2] See http://en.wikipedia.org/wiki/MIL-STD-2525 for a reference.

ICON	MEANING
	latest contact report (HOSTILE AIR)
	latest contact report (HOSTILE SURFACE)
	latest contact report (HOSTILE SUBSURFACE)
	latest contact report (NEUTRAL AIR)
	latest contact report (NEUTRAL SURFACE)
	latest contact report (NEUTRAL SUBSURFACE)
	latest contact report (UNKNOWN AIR)
	latest contact report (UNKNOWN SURFACE)
	latest contact report (UNKNOWN SUBSURFACE)
	domestic port

5.6.2 Google Earth Symbology

The Google Earth KML symbology and styling choice is a simple style using icons provided with Google Earth. Every vessel is reported with a ship icon for the track head and a hollow circle for historical positions. This option was provided first as a test style. Table 5 presents a list of the icons used in this style.

Table 5. Table of icons for Google Earth KML symbology and styling choice

ICON	MEANING
	historical contact report
	latest contact report
	domestic port

Latest and historical contact report icons will be colored green. Domestic ports will be colored light blue.

5.6.3 Proud Canadian Symbology

The Proud Canadian symbology and styling is provided with much of the same capability as the MILSPEC 2525 but as an alternative without the military icons. The icon colours follows the same affiliation legend - blue is used for friend, green for neutral, red for hostile, and yellow for unknown. Table 6 presents a list of the icons used in this style.

Table 6. Table of icons for Proud Canadian KML symbology and styling choice

ICON	MEANING
	historical contact report (from a known unclassified source)
	historical contact report (from a classified or unknown classification source)
	latest contact report
	domestic port

6 Data Validation

The AAR uses two levels of data validation to check the input data for completeness and to compare it against reference sources. The first level of validation occurs in the AAR draft screen and is described in Section 6.3. The second level of validation occurs with the final AAR data, is reported in the Excel output and is described in Section 6.2. These validation messages highlight varying levels of severity and indicate that either the input data or the reference data may require editing.

6.1 Draft Validation

The first level of validation occurs on the Arrival Analysis Report Draft page. Here the input data is first checked for completeness. The vessel fields Name, Flag, and IMO are compared against the reference vessel records stored in ART. If a vessel match is found by either IMO or by the name/flag combination but the other field(s) don't match, a warning is issued. This indicates that a conflict was found and either the input data or the ART record should be corrected. When a conflict with ART is identified, a special icon is used which can take the user to the ART manager interface to correct the ART record if required.

Keeping the ART records up to date and correct is important because they are used to correct data coming into the RMP. Many, but not all, sources pass through the Attribute Correction Engine (ACE) portion of the GPW architecture which compares the contact reports to the ART and Lloyds reference data for vessels[3]. ACE and ART try to correct mistakes in vessel identity fields found in the incoming data and thereby improve the quality and consistency of the RMP. Therefore, correcting the ART records will improve the quality of the RMP data and will also prevent the same conflict from occurring again in future uses of the AAR.

The port details provided in the next and last ports of call fields are compared against the master port list stored in the PORTS table. Where provided port data conflicts with a reference record or cannot be matched, a validation message is produced. This may mean that the provided details need to be edited or that the master port list should be updated. Note that for the purposes of displaying in Google Earth, the latitude and longitude of a port must be known and this is stored in the master port list.

[3] ACE compares incoming contact reports first against vessel records in ART and then against vessel records in Lloyds. The purpose of ART is to contain reference records for all vessels that are either not contained in the Lloyds or are out of date in Lloyds. Therefore, the input vessels may not be matched in ART if the vessel is either up to date in Lloyds or simply missing from ART.

6.2 Final Validation

After the draft data has been accepted, the draft validation messages are hidden. When the final Excel report is produced, a final validation is performed. In the final validation, the input data is again checked for completeness. The draft validation performed against the vessel records in ART is repeated. Additionally, the vessel Name/Flag and IMO data is compared to the RMP data stored in GPW. The GPW data represents the values actually recorded in the RMP and could be different from the ART records. The results are listed in the second sheet, Errors and Warnings, of the Excel report.

6.3 Validation Message Tables

The following three tables list each of the potential messages produced by the Arrival Analysis Report Draft validation grouped by severity (error, warning and info). Each message is categorized according to the type of data being validated, and contains the message displayed on the Arrival Analysis Draft Report page, along with explanatory summary and details and recommendation on how to fix the issue. These validation messages check the input data and compare it against the vessel records in ART and the port records in the master port list.

Table 7. Table of AAR Draft Errors

SEVERITY	CATEGORY	MESSAGE	DETAILS	SUMMARY	RECOMMENDED FIX
ERROR	UNIQUE VESSEL	Duplicate input records for name: YYYYY, flag: ZZ	Found multiple vessels in the draft report with the same name and flag. This message will be reported for each of the vessels.	Draft AAR contains multiple vessels with the same name and flag.	If they are meant to be different vessels, edit the vessel details (see Section 2.2 of the User Manual), otherwise delete the duplicate record.
ERROR	VESSEL FLAG	Input flag not supplied for name: YYYYY	The draft AAR vessels flag is missing and the vessels flag country name is not specified or is comprised of whitespace only.	Draft Vessel Flag not set.	Edit the vessel details (see Section 2.2 of the User Manual) and add the correct flag.
ERROR	VESSEL FLAG	Input flag: ZZ not matched to a known country for name: YYYYY	The draft AAR vessels flag is missing but the vessels flag country name is specified.	Draft Vessel Flag and Country don't match.	Edit the vessel details (see Section 2.2 of the User Manual) and correctly match the flag.
ERROR	NPOC	NPOC not supplied for name: YYYYY, flag: ZZ	Draft Vessel Next Port of Call is null.	Draft Vessel has no Next Port of Call set.	Edit the next port of call details (see Section 2.3 of the User Manual) and add the correct port.
ERROR	NPOC	NPOC port name not supplied for name: YYYYY, flag: ZZ	Draft Vessel Next Port of Call name is not specified or comprised of whitespace only.	Next Port of Call port name is missing or empty.	Edit the next port of call details (see Section 2.3 of the User Manual) and add the correct port.

Table 8. Table of AAR Draft Warnings

SEVERITY	CATEGORY	MESSAGE	DETAILS	SUMMARY	RECOMMENDED FIX
WARNING	ART	Input IMO: 99999 matches 999 ART records for name: YYYYY, flag: ZZ	GPW ART table has more than 1 record with the IMO number of the AAR draft vessel.	IMO is not unique in the GPW ART table	Use the ART manager (see Section 2.1.2.3 of the User Manual) to search for the multiple records and investigate the situation. There should only be one record for each IMO. Therefore an IMO may be entered incorrectly or a vessel may have duplicate records in ART.
WARNING	ART	Input name: YYYYY, flag: ZZ does not match ART name, flag (YYYYY, ZZ) for IMO: 99999	Found a single GPW ART entry for the draft vessels IMO, but the vessel name and/or flag don't match. The flag is only checked if the draft vessel has one.	Found a single GPW ART entry for the draft AAR vessel, but the vessel name and/or flag don't match.	Verify whether the input record or the ART record is correct. If the input record is incorrect, edit the vessel details manager (see Section 2.2 of the User Manual). If the ART record is incorrect, edit the ART record manager (see Section 2.1.2.3 of the User Manual).
WARNING	ART	Input IMO: 99999 does not match ART IMO (88888) for name: YYYYY, flag: ZZ	If the draft AAR vessel was matched to ART via the vessel name and flag, then the ART.IMO will be compared to AAV.IMO. A mismatch triggers this message.	Draft Vessel IMO does not match ART IMO	Verify whether the input record or the ART record is correct. If the input record is incorrect, edit the vessel details manager (see Section 2.2 of the User Manual). If the ART record is incorrect, edit the ART record manager (see Section 2.1.2.3 of the User Manual).
WARNING	ART	ART IMO is empty for name: YYYYY, flag: ZZ	If the AAR vessel was matched to ART via the vessel name and flag, then a null IMO value in the ART table will trigger this message.	ART.IMO is null	Edit the ART record (see Section 2.1.2.3 of the User Manual) to add the IMO.
WARNING	NPOC	NPOC port name: PPPPP not matched to a known port for name: YYYYY, flag: ZZ	AAR draft vessel Next Port of Call city or country is null.	Draft Vessel Next Port of Call can't be matched to known ports.	Edit the next port of call details (see Section 2.3 of the User Manual) and select the correct port. If the port is not available, add it to the Master Port List (see Section 2.4 of the User Manual).
WARNING	NPOC ARRIVAL DATE	NPOC arrival time not supplied for name: YYYYY, flag: ZZ	AAR draft vessel Next Port of Call arrival date is null.	Draft Vessel Next Port of Call Arrival Date is not set	Edit the next port of call details (see Section 2.3 of the User Manual) and add the expected arrival time if known.
WARNING	IMO	No input IMO supplied for name: YYYYY, flag: ZZ	AAR.IMO is null	No IMO set in AAR	Edit the vessel details (see Section 2.2 of the User Manual) and add the IMO if known.

Table 9. Table of AAR Draft Information Messages

SEVERITY	CATEGORY	MESSAGE	DETAILS	SUMMARY	RECOMMENDED FIX
INFO	NPOC POSITION	Lat/Long is not set for NPOC: PPPPP for name: YYYYY, flag: ZZ	AAR draft vessel Next Port of Call latitude or longitude are null.	Draft Vessel Next Port of Call latitude/longitude are not specified.	Edit the master port list and add the correct latitude and longitude so that the port can be displayed in Google Earth.
INFO	LPOC	LPOC not supplied for name: YYYYY, flag: ZZ	AAR draft vessel Last Port of Call is null or is comprised of whitespace only.	Last Port of Call is not set.	Edit the appropriate last port of call details.
INFO	LPOC	LPOC port name: PPPPP not matched to a known port for name: YYYYY, flag: ZZ	AAR draft vessel Last Port of Call city or county are null.	Last Port of Call does not specify a city or country and therefore can't be matched to any of the known ports.	Edit the appropriate last port of call details.
INFO	LPOC	LPOC departure time not supplied for name: YYYYY, flag: ZZ	AAR draft vessel Last Port of Call has a null departure time.	Last Port of Call has no departure time set in draft AAR.	Edit the appropriate last port of call details.

Similarly, Table 10 lists each of the potential messages produced by the final validation process. These messages are provided in the Excel report on the second sheet, Errors and Warnings.

Table 10. Excel outputs sheet 2 - Errors and Warnings

SEVERITY	CATEGORY	SUMMARY	RECOMMENDED FIX
High	VESSEL FLAG	Input flag does not match GPW flag	Verify whether the input flag was correct, otherwise this indicates that the vessel is reporting incorrectly or that ART/Lloyds is incorrect. Correcting or adding an ART record may correct this situation from recurring in the future. Although the direct link is not available from Excel, see Section 2.1.2.3 of the User Manual for related details.
High	VESSEL NAME	Input name does not match GPW name	Verify whether the input name was correct, otherwise this indicates that the vessel is reporting incorrectly or that ART/Lloyds is incorrect. Correcting or adding an ART record may correct this situation from recurring in the future. Although the direct link is not available from Excel, see Section 2.1.2.3 of the User Manual for related details.

SEVERITY	CATEGORY	SUMMARY	RECOMMENDED FIX
High	VESSEL IMO	Input IMO: does not match GPW IMO	Verify whether the input IMO was correct, otherwise this indicates that the vessel is reporting incorrectly or that ART/Lloyds is incorrect. Correcting or adding an ART record may correct this situation from recurring in the future. Although the direct link is not available from Excel, see Section 2.1.2.3 of the User Manual for related details..
Medium	GPW	Input IMO is empty in GPW	If the vessel should have an IMO, correcting or adding an ART record may correct this situation from recurring in the future. Although the direct link is not available from Excel, see Section 2.1.2.3 of the User Manual for related details.
Medium	ART	Input name does not match ART name	Verify whether the input record or the ART record is correct. If the ART record is incorrect, edit the ART record using the ART manager (a separate GPW web application. Although the direct link is not available from Excel, see Section 2.1.2.3 of the User Manual for related details.
Medium	VESSEL IMO	No input IMO supplied	The vessel IMO was not supplied to the AAR and therefore could not be reported.
Medium	NPOC	Input flag does not match ART flag	Verify whether the input record or the ART record is correct. If the ART record is incorrect, edit the ART record using the ART manager (a separate GPW web application). Although the direct link is not available from Excel, see Section 2.1.2.3 of the User Manual for related details.
Medium	LPOC	NPOC arrival time not supplied	The expected arrival time was not supplied to the AAR and therefore could not be reported.
Low	GPW	No active track in GPW	There is no recent position on the vessel in GPW. The vessel may still be far from Canada and not in our surveillance picture. Otherwise if the vessel is expected to be in the RMP, the user may want to further investigate the situation.
Low	LPOC	LPOC not supplied	The last port of call was not supplied to the AAR and therefore could not be reported.
Low	LPOC	LPOC departure time not supplied	The last port of call departure time was not supplied to the AAR and therefore could not be reported.

7 Outputs

7.1 Excel

The Microsoft Excel output provides a tabular summary of the AAR data. The first sheet provides the data summary with the fields described in Table 11. This summary can be sorted by any field for further analysis. It also quickly identifies which vessels were found active in GPW. Any final validation messages, described in Section 6.2 and listed in Table 10, will be listed on the second sheet of the spreadsheet entitled, "Errors and Warnings".

Table 11. Excel output sheet 1 - Vessel Summary

Column	**Description**
VESSEL NAME	Given name of the vessel
FLAG	The country where the vessel is registered
IMO	The International Maritime Organization (IMO) unique identifier for a vessel
NPOC PORT NAME	The next port the vessel will visit
NPOC CODE	The code of the next port the vessel will visit
NPOC CITY NPOC PROV	The city and province of the next port the vessel will visit
EXPECTED DTG	The date and time the vessel will visit the next port
IN GPW?	A Y/N indicator of whether the vessel is active within GPW
LAST CONTACT DTG	The last time the vessel was in contact
LAST CONTACT DATE	The last date the vessel was in contact
LAST LAT	The latitude coordinates of the vessel during the last contact
LAST LON	The longitude coordinates of the vessel during the last contact

7.2 KML Report

Table 12 lists the Google Earth outputs and their descriptions. Any of the items may be selected on/off for viewing in Google Earth. On the left in the Google Earth sidebar, under places, you will see a listing under Temporary Places called, Arrival Analysis Report. By expanding this, you will see each output as a branch in the tree. By drilling into each output branch, you can choose to turn the output on/off for each individual vessel. Usually, users turn an output on/off for all vessels at a time by selecting the branch. If, however, there is a specific vessel that you want to turn on/off it can be done at the leaf level.

Table 12: Google Earth outputs

Output	**Description**
Vessel Latest Contact Position	A layer displaying the last reported position for each vessel – these positions are also known as the track heads
Next Ports of Call	A layer displaying the positions of all the ports which have a vessel enroute
Vessel To Port Lines	A layer displaying lines from each vessel to its next port of call
Vessel Track Lines	A layer displaying lines connecting each vessel's contact positions – this is also known as the track history. (This layer displays the lines without marking each position.)
Vessel Previous Contact Positions	A layer displaying each vessel's previous contact positions. (This layer displays each previous position without joining those positions with a line.)
Course/Speed Indicator lines	A layer displaying lines indicating the current course and speed from each vessel's latest contact position. The direction of the line indicates its course while the length of the line indicates its speed.
Security Classification overlay	An image overlay which identifies whether the report was produced from an unclassified or classified system
No Active Track Vessels overlay	An image overlay which lists all input vessels which were not matched to an active track in GPW

8 Modularity

The AAR reporting capability is separated into two distinct module types: the **data retriever** and the **report generator**. The two modules are operated by a **report executor**. In Java, this is modelled by defining two interfaces, `DataRetreiver` and `ReportGenerator`. An implementation must conform to the defined interface, and the report executor interacts with the implementation class exclusively via the interface methods. This loose-coupling between components promotes future re-use of components for other applications and also allows for replacement of an individual component without affecting other components in this application.

AAR uses a single implementation of `DataRetriever` for both the KML-based and Excel-based reports. The actual data source, the GPW database, is the same for both reports. Two implementations of `ReportGenerator` have been created. One generates the KML-based report and one generates the Excel-based report.

Data from a data retriever is supplied to a report generator via an XML data stream. The XML conforms to an *XML Schema Definition*[4] created for the GPW project. The data retriever only needs to know how to supply data that conforms to the XML schema definition and does not needs to know any of the details of how the data will be consumed downstream. Similarly, the report generator only needs to know how to consume XML data and does not need to be concerned with its source.

Both data retrievers and report generators can be implemented to load part of their initial state from configuration files. The implementations created for AAR are using this feature. The configuration files are also XML-based and conform to schema definitions. Separate schema definitions have been created for data retrievers and report generators. Examples of the available configuration settings relevant to AAR will be discussed in the following sections.

XML schema definitions are plain-text files (usually stored with the .xsd file extension), but have a complex syntax that makes them somewhat difficult to create and maintain with just a text editor. DND has purchased licenses for an XML schema editing application named XMLSpy[5]. XMLSpy allows the user to design the schema definition in a graphical environment.

[4] Refer to this URL for details on XML Schema Definition:
http://en.wikipedia.org/wiki/XML_Schema_(W3C)
[5] Vendor web site URL: http://www.altova.com/xmlspy.html

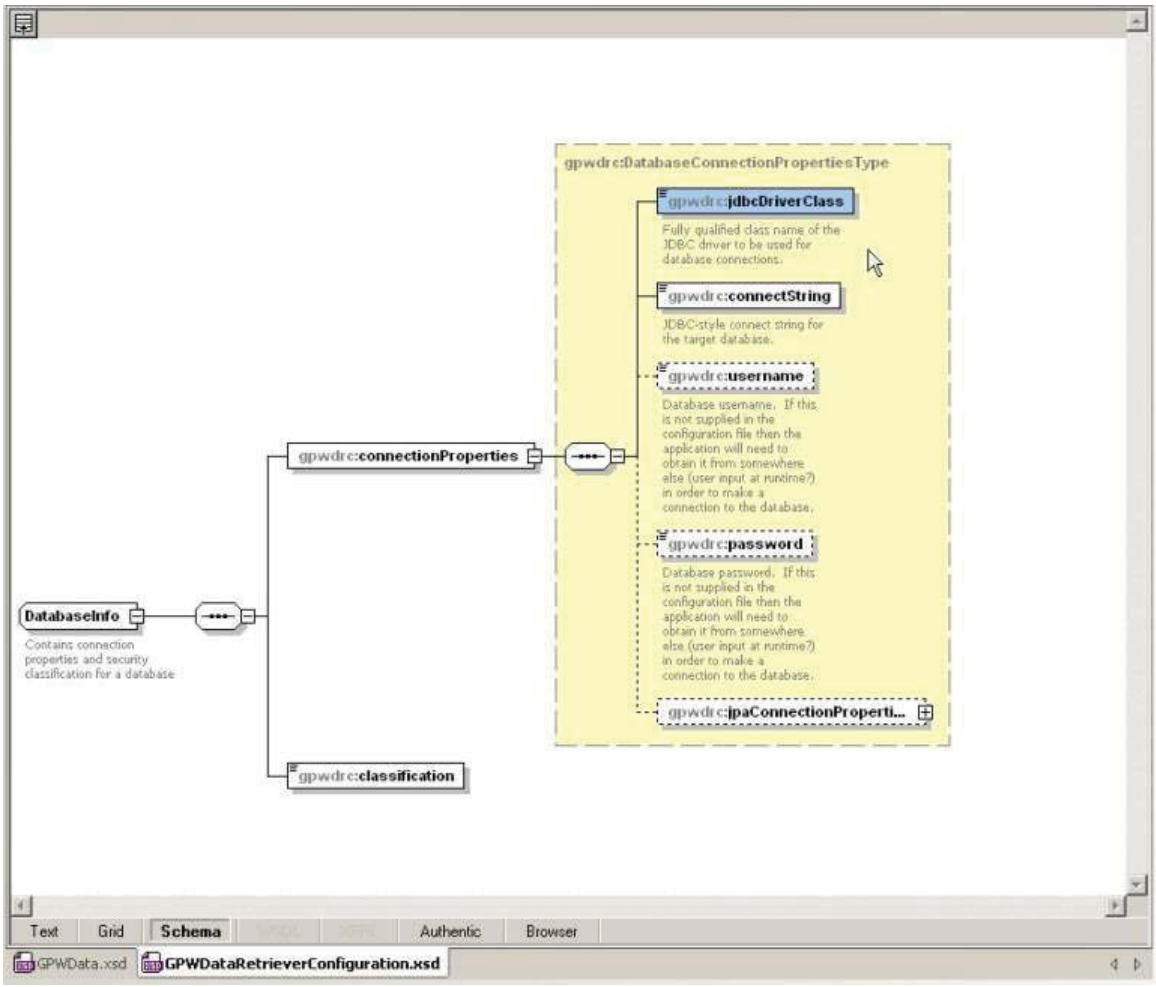


Figure 3. Screenshot of XMLSpy Application

8.1 Configuration Files

As mentioned in the previous section, the configuration files for AAR are XML-based and must conform to a strict XML schema definition. The schema definition allows the configuration file to be validated outside the application using an XML editing tool such as XMLSpy. The schema definition also provides structure that allows the file to be created or consumed by application code with minimum effort for the developers and with high reliability.

By including application parameters in the configuration file, the application becomes more flexible in the production environment. Configuration items can be changed by the IT support staff responsible for deploying the application, rather than having developers change these items in the source code and then restarting the long process of qualifying a new software release.

8.1.1 Report Generator Configuration

The XML schema definition for the report generator configuration file is named **GPWReportGeneratorConfiguration.xsd**. Description of some XML elements that are relevant to AAR follows.

This is the 'parent' element for all the elements shown below.

```
<AARConfig>
```

This element, with sample data included here, is used in the KML-based report. These values are used to generate a KML block that instructs Google Earth on how to center the globe when the KML report is opened.

```
<InitialLookAt>
      <!-- appropriate settings for East Coast -->
      <latitude>39.61</latitude>
      <longitude>-47.08</longitude>
      <eyeRange>5445000</eyeRange>
</InitialLookAt>
```

This element and its child elements are used when the KML-based report is creating the KML folder structure. The placemark folders shown in Google Earth will be labelled with the names shown in the **<name>** elements. Placemarks in a particular folder will either by initially displayed, or initially visible based on the value in the **<contentInitiallyVisible>** elements.

```
<FoldersConfig>

      <TrackHeads>

            <name>Vessel Latest Contact Position</name>

            <contentInitiallyVisible>true</contentInitiallyVisible>

      </TrackHeads>

      <TrackContactHistory>

            <name>Vessel Previous Contact Positions</name>

            <contentInitiallyVisible>false</contentInitiallyVisible>

      </TrackContactHistory>

      <TrackLines>

            <name>Vessel Track Lines</name>

            <contentInitiallyVisible>false</contentInitiallyVisible>

      </TrackLines>

      <!—other folder config omitted for brevity -->

</FoldersConfig>
```

This element and its child elements are used when the KML-based report is creating individual KML placemarks. Placemarks for a contact report with a known UNCLAS data source are styled differently from a contact report from a source that is classified, or whose classification is unknown. Data shown here is for example purposes only.

```
<ContactReportSourceCodes>

      <unclas>CC2</unclas>

      <unclas>OSWEX</unclas>

</ContactReportSourceCodes>
```

8.1.2 Data Retriever Configuration

The XML schema definition for the data retriever configuration file is named **GPWDataRetrieverConfiguration.xsd**. Description of some XML elements that are relevant to AAR follows.

This is the 'parent' element for all the elements shown below.

```
<databaseInfo>
```

This element and its child elements are used when the application connects to the GPW database. The database credentials will be different for each deployment of the application, so the master copy of this configuration file has a number of placeholders that require values. These values are supplied by IT support staff when the application is deployed to a particular environment.

```
<connectionProperties>

      <jdbcDriverClass>oracle.jdbc.driver.OracleDriver</jdbcDriverClass>

      <connectString>@@databaseinfo.connectstring@@</connectString>

      <username>@@databaseinfo.username@@</username>

      <password>@@databaseinfo.password@@</password>

</connectionProperties>
```

This is the classification of the data in the target database. Valid values are UNCLAS and SECRET. This is supplied by IT support staff when the application is deployed to a particular environment.

```
<classification>@@databaseinfo.classification@@</classification>
```

8.2 UN/LOCODE International Port List

As part of the AAR project, a list of international ports has been added to the GPW database. The list was obtained from the United Nations Economic Commission for Europe web site[6]. The UN maintains a list of international ports and assigns each one a unique 5-character identifier code (UN/LOCODE)[7]. This port list is used within AAR to match with declared ports of call from Transport Canada PAIR data. Now that the list has been included in the GPW database it is also available for other GPW applications in the future. A Java-based importer has been created as part of the AAR development effort to facilitate the import of future publications of the UN/LOCODE list.

8.2.1 Issues with UN/LOCODE Port List

While the United Nations port list is very useful to us, some issues regarding the list should be understood.

- Many ports do not have a latitude/longitude position included. We suspect this is the case with ports that are "multi-function". The UN/LOCODE list is not just for marine ports, but also includes airports, rail ports, border crossings, etc. When a port is listed as multi-function, but the different "ports" are not at the exact same geographic position, the lat/lon is usually not provided. Halifax, Nova Scotia is an example of this, where the port is declared as both a marine port and an airport but the locations of each facility are geographically quite far apart.

- The port list does not distinguish between "port name" and "city name". It appears that the "name" field is usually the name of the city where the port is located, but this is not well defined in the documentation.

8.2.2 Country Abbreviations List

The UN/LOCODE list uses two-character abbreviations to designate in which country a port resides. The documentation states that ISO 3166-1[8] standard list of country codes is used. As part of AAR we have added a new column to the COUNTRY_CODES table in the GPW database, ISO_3166_1, to associate the ISO 3166-1 abbreviations with their corresponding country. This new column will also be available to other GPW applications in the future.

[6] http://www.unece.org/cefact/codesfortrade/codes_index.htm
[7] Wikipedia page for UN/LOCODE: http://en.wikipedia.org/wiki/UN/LOCODE
[8] http://www.iso.org/iso/english_country_names_and_code_elements

9 Testing

The testing performed on the AAR comprised multiples levels, including automated unit, integration and manual acceptance testing.

Unit tests test one small portion of a system, and run without requiring all portions of the system to be available. Where the unit being tested depends on other system functionality, a unit test may mock that dependency to enable the test to run standalone. A mock simulates the functionality of some unit, making it easier to test units which call it, e.g. a unit test may use a mock to simulate database functionality without requiring an actual database.

Integration tests test a subset of system functionality, involve several units and may or not mock portions of the system. Integration tests are focussed on verifying both system functionality and that the units being tested work correctly when integrated.

Acceptance tests test the whole system verifying that it works as intended. For AAR a System Test Description (STD) document [2] was developed to test AAR against the requirements outlined in Section 2, Table 1. The tests within the STD exercise the standard AAR workflow from the importing of a sample VEEC, editing of the draft report to address various validation errors, acceptance of the draft, to the generation of KML and Excel reports. The reports are examined to verify they contain the expected results.

Several runs of the STD were performed in a variety of environments. The final STD run has yet to be performed as it waits on a final database installation in the target environment.

As unit and integration tests are automated, they were integrated into the AAR build process. Building AAR will automatically run the unit tests, collect the results and summarise them in a report outlining the total number of tests, failures/errors and the percentage of successful tests. The AAR build is configured to automatically fail on any unit test failure.

The following outlines the automated unit and integration tests performed on the AAR summarized by package.

A.1.1 Test Summary

Total Automated Tests	Failures	Errors	Success Rate
282	0	0	100%

A.1.2

A.1.3 Package: ca.forces.marlant.n6.io.microsoft.excel

Package Description	Test Overview	Tests	Success Rate
Provides functionality to read and write Excel spreadsheets. This is used when importing VECC reports, and when writing AAR Excel reports.	Tests include creating new sheets, adding rows, reading and setting cell values and reading and writing whole spread sheets.	42	100%

A.1.4 Package: ca.forces.marlant.n6.io.resource

Package Description	Test Overview	Tests	Success Rate
Allows applications to read *resources*, such as configuration files when they are external to, or packaged with the application.	Tests include reading external and resources packaged with the test and various tests for exceptional conditions such as attempting to read non-existent files.	4	100%

A.1.5 Package: ca.forces.marlant.n6.spatial

Package Description	Test Overview	Tests	Success Rate
Provides functionality to calculate dead reckoned positions.	Tests of dead reckoning calculations including dead reckoning to an absolute date time, or number of hours from the last known position.	13	100%

A.1.6 Package: ca.forces.marlant.n6.gpwjpa.aar.dao

Package Description	Test Overview	Tests	Success Rate
The database access layer for the AAR. This allows the AAR to store and retrieve items from the GPW database, including AAR vessel entries, Ports, tracks and vessel information including ART entries.	Tests include basic storage and retrieval of AAR vessel and port information, and retrieval of port, track and ART information by various criteria such as port name, vessel name and flag, and IMO.	18	100%

A.1.7

A.1.8 Package: ca.forces.marlant.n6.gpwreports.format.common

Package Description	Test Overview	Tests	Success Rate
Contains a number of utility functions used when generating the AAR Excel and KML reports. These include formatting lat/lon values, computing average speeds, course and dead reckoned positions for a track (via the ca.forces.n6.spatial package) and determining information displayed in the KML pop-ups such as sensor and source codes.	Tests include verifying the average speed, course and dead reckoned calculations and verifying formatted values.	18	100%

A.1.9 Package: ca.forces.marlant.n6.gpwreports.format.excel.impl.aar

Package Description	Test Overview	Tests	Success Rate
Functions to format information messages displayed in the AAR Excel report.	Verifies the text of the formatted message. This includes the specified parameters such as vessel name, IMO, etc, and message severity.	2	100%

A.1.10 Package: ca.forces.marlant.n6.gpwreports.format.kml

Package Description	Test Overview	Tests	Success Rate
Generic functionality for generating KML files. This includes basic generation of KML items, support for using different styles (icons and colours) and for the generation of screen overlays. This package also provides for packaging a KML file along with supplementary files, e.g. icons and graphic overlays, as a compressed KMZ archive.	Tests include the generation of KML point and line string place marks from a collection of lat/lon coordinates, and confirming that generated KML items are styled correctly when using various styles. Tests of KML packaging include basic success path testing ensuring the KML is properly packaged. Additional tests verify the packager throws the appropriate exception when errors such as being unable to read the files being packaged are encountered.	14	100%

A.1.11 Package: ca.forces.marlant.n6.gpwreports.format.kml.impl

Package Description	Test Overview	Tests	Success Rate
Provides a basic implementation of a style. A style is comprised of a set of icons, and colours and is used when generating the AAR KML report. Also provides the security classification image overlay generator, used to generate the KML UNCLAS or SECRET report overlay based on the security classification of the information contained in the report.	Tests verify that the security overlay image generator correctly reports errors when failing to generate an image.	4	100%

A.1.12 Package: ca.forces.marlant.n6.gpwreports.plugin.impl

Package Description	Test Overview	Tests	Success Rate
AAR generates reports through the use of the existing GPW Reports framework. This framework generates reports via specific report plugins. A plugin is comprised of a data retriever and report generator. Data retrievers retrieve and format data which is consumed by the report generator to produce the report. This package provides the AAR specific Excel and KML report plugins. The corresponding AAR data retrievers and report generators are provided by subpackages.	Tests the robustness of the AAR KML and Excel report plugins by generating reports using various sets of input data. These tests do not verify the report content, only that the report plugins functioned correctly with regard to the input data and any errors reported by their data retrievers and report generators. The data sets include a representative AAR data set with multiple vessels, contact reports and last and next port of call information; an empty set containing no vessel information and an invalid data set. For the first two data sets, the plugins should generate a report without error. For the third, the plugins should not produce a report but should throw an exception to indicate a report could not be produced.	12	100%

A.1.13 Package: ca.forces.marlant.n6.gpwreports.plugin.impl.generator

Package Description	Test Overview	Tests	Success Rate
AAR Excel and KML report generator implementations.	Tests that the Excel and KML report generators respond to cancellation requests, and throw the appropriate exception when passed invalid data.	6	100%

A.1.14 Package: ca.forces.marlant.n6.gpwreports.plugin.impl.retriever

Package Description	Test Overview	Tests	Success Rate
AAR data retriever implementation.	Verifies the behaviour of the data retriever by using a mock of the AAR database access layer. Using the mock, the test can verify that the retriever requests ART and active track information for the correct vessels. Additional tests verify the retriever handles various error conditions, such as being unable to write the retrieved data out, correctly.	7	100%

A.1.15 Package: ca.forces.marlant.n6.htmlrenderer

Package Description	Test Overview	Tests	Success Rate
This package provides the basic functionality for generating overlay images from template files. The security classification image overlay generator makes use of this functionality.	Tests verify that the renderer generates images for a variety of templates representative of those used in the AAR, e.g. security classification, active track listing and KML popups. The actual image content is verified manually. Additional tests verify the renderer reports errors due to invalid parameters correctly.	13	100%

A.1.16 Package: ca.forces.marlant.n6.ratui.controller

Package Description	Test Overview	Tests	Success Rate
The RATUI controller processes user actions in the AAR application, e.g. when the user selects the "Import Vessels" button, the controller receives the request, and coordinates the actions of the various software components to import the vessels and redirect the user to the AAR draft page.	As much of the controller's functionality consists of delegation to other components, the tests here mainly verify the AAR draft validation by checking that the correct validation messages are produced for a number of conditions such as invalid vessel flags, missing Next Port of Call, non unique vessels and missing IMO numbers.	8	100%

A.1.17 Package: ca.forces.marlant.n6.ratui.importer

Package Description	Test Overview	Tests	Success Rate
The importer package provides functionality to import the VEEC/VEWC spreadsheets.	Tests use the importer to import 22 sample VEEC/VEWC spreadsheets. The tests report on the next and last port of call match rate, verify the correct number of vessels were imported and ensure that the imported data can be saved to the database. This validates that the data generated by the importer is correctly formed and does not violate any database constraints.	6	100%

A.1.18 Package: ca.forces.marlant.n6.ratui.utility

Package Description	Test Overview	Tests	Success Rate
The utility package provides a number of functions used to sort the lists of countries and ports in the AAR UI.	Tests verify that the lists of countries sort alphabetically with the exception that Canada and the United States are sorted to the top. Tests verify the ports are sorted by province/state and city.	24	100%

A.1.19 Package: ca.forces.marlant.n6.ratui.validation

Package Description	Test Overview	Tests	Success Rate
Provides the individual validators which are used to validate the AAR draft. Validators can be combined together, appearing as a single validator.	The tests verify each of the AAR draft validations. These include checks for non-unique (duplicate) vessels, missing ART and IMO information and validation of next and last ports of call. Additional tests verify that when validators are combined they still function correctly, producing the same validation messages as if run individually.	59	100%

A.1.20 Package: ca.forces.marlant.n6.ratui.view

Package Description	Test Overview	Tests	Success Rate
The view package provides functionality for displaying the draft and non-draft AAR information, validation messages, and ports in the UI.	Tests verify a number of items which are difficult to validate visually, including verification of the vessel cargo designator tooltip.	9	100%

A.1.21 Package: ca.forces.marlant.n6.ratui.view.converters

Package Description	Test Overview	Tests	Success Rate
Convertors provide functionality for converting values to and from a displayable representation. This package provides one custom convertor to trim and upper case entered string values.	Tests verify the converter properly converts strings values and properly handles null values.	6	100%

A.1.22

A.1.23 Package: ca.forces.marlant.n6.ratui.view.validators

Package Description	Test Overview	Tests	Success Rate
This package provides functionality to validate user entered data and report validation errors. Specifically this package validates entered IMO numbers and ensures the input VEEC/VEWC file name points to a readable Excel spreadsheet.	The tests verify the validators report errors when IMO numbers are invalid or missing, or when the input file name does not refer to a readable Excel spreadsheet.	17	100%

10 Limitiations and Future Enhancements

The current version of the AAR has one main limitation. Although the names of the last three ports of call are provided for each vessel, they could not be mapped accurately to specific ports. The current version of the TC PAIR records the last port of call as text fields and only requires the city and country. These entries can therefore be ambiguous if a country has multiple cities with identical names (perhaps in different states or provinces). These entries can also be inconsistently identified due to varying spellings or different languages being used.

TC has indicated that they intend to standardize more of their report, removing free text fields where possible. As part of this process they intend to use the same UN LOCODE standard that the RAT team has suggested. With this step, the AAR port limitation may be addressed so that with further development the last ports of call may also be mapped and displayed in Google Earth. Standardizing the port codes will also improve the matching of domestic ports of call by removing spelling inconsistencies.

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References

[1] Tough, J, Morash, D, and Stroud, B, Arrival Analysis Report (AAR): User Manual, Unclassified, DRDC CORA CR 2011-060, May 2011.

[2] MARLANT N6, AAR Integrated System Test Description, Unclassified, May 2011.

List of Acronyms

ART	Additional Reference Table
CDC	Cargo Description Comments
DND	Department of National Defence
DRDC	Defence Research & Development Canada
GPW	Global Positioning Warehouse
ICS	Intelligence Collection Structure
IMO	International Maritime Organization
LPOC	Last Port of Call
MSOC	Marine Security Operations Centre
NPOC	Next Port of Call
R&D	Research & Development
STD	System Test Description
TC	Transport Canada
VEEC	Vessels Entering Eastern Canada
VEWC	Vessels Entering Western Canada

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The Arrival Analysis Report (AAR) is the first operational module of the Recognized Maritime Picture (RMP) Analysis Toolset (RAT). The module was developed to integrate the predicted arrival data from Transport Canada (TC) with the current positional data held by the Department of National Defence (DND). The module performs data validation and provides integrated results in Google Earth and Microsoft Excel formats. The work directly supports the Marine Security Operations Centres (MSOCs) and was performed as part of Applied Research Project (ARP) 11hn, Maritime Security Planning Tools and Analysis.

Le rapport d'analyse d'arrivée (RAA) est le premier module opérationnel de l'ensemble d'outils d'analyse (EOA) de la situation maritime générale (SMG). Le module a été élaboré pour intégrer les données d'arrivée prédite de Transports Canada (TC) avec les données de position actuelles détenues par le ministère de la Défense nationale (MDN). Le module effectue une validation des données et procure des résultats intégrés dans les formats Google Earth et Microsoft Excel. Le travail soutient directement les centres d'opérations de la sécurité maritime (SOSM), et a été effectué dans le cadre du programme de recherche appliquée (PRA) 11hn, Maritime Security Planning Tools and Analysis.

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