# 6

The Exactearth Satelite – Ais Benefits for the Maritime Transport

Ryszard K. Miler*

Maritime transport is of fundamental importance to the modern world and logistics chains of supply. Over 90% of transcontinental external trade goes by sea and billions tones of freight a year are loaded and unloaded in world's ports (see figure 6.1). This means that shipping is the most important mode of transport in terms of volume. Furthermore, as a result of its geography, its history and the effects of globalization, maritime transport will continue to be the most important transport mode in developing global trade for the foreseeable future.

Figure 6.1. The world main shipping routes
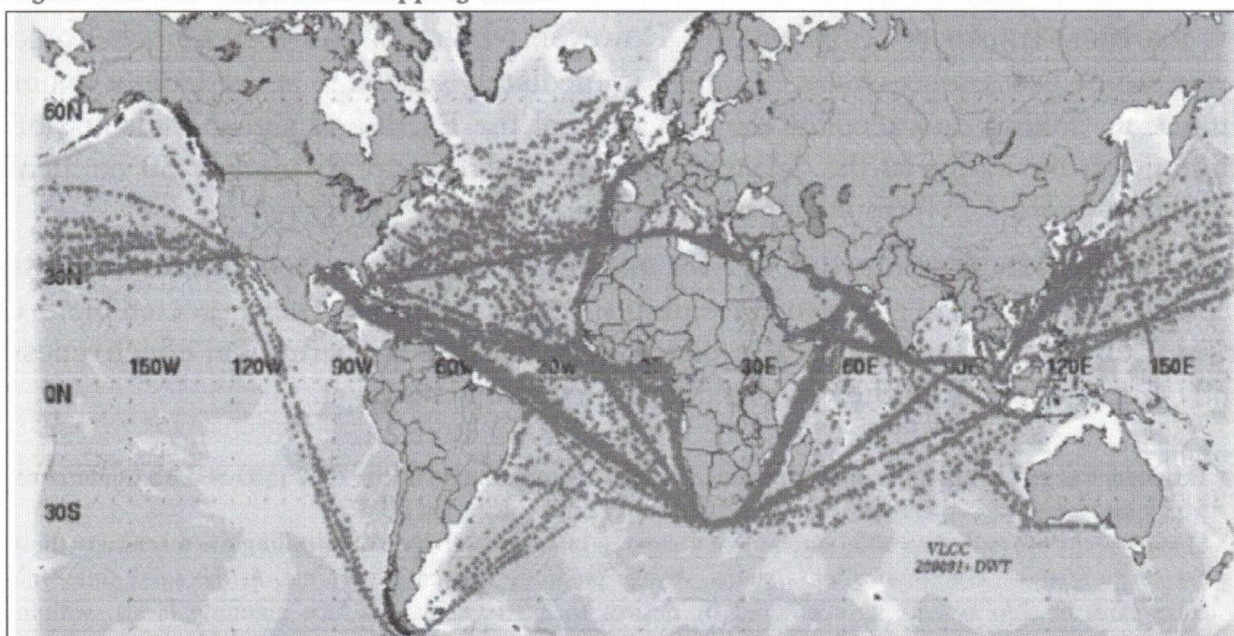
Source: R.K. Miler, *Security and Safety Aspects of the Maritime Logistics Chain of Supply*, [in:] R.K. Miler, A. Mytlewski, B. Pac (eds.), *Kierunki racjonalizacji systemów i procesów logistycznych*, Prace Naukowe WSB w Gdańsku, tom 15, 2012, p. 23.

* Dr, adiunkt, Katedra Logistyki, Wyższa Szkoła Bankowa w Gdańsku

The days of anonymity at sea has gone years ago. With LRIT[1] [Miler, 2009] and satellite based AIS tracking[2] the ship owner has access to the precise location of its ships in real time over the world. A scheme of constructing shipping monitoring and control system has been already proved.

It should consist of monitor sensors and fusion center, data communications, ship-borne terminals and user terminals at least [Kai Ma, 2009, p. 254-310].

Automatic Identification System (AIS), which is the first shipping monitoring system introduced in this scale, is an Radio Frequency (RF-based) communications system, with the main task as a collision avoidance system designated for large Safety Of Life At Sea (SOLAS) class vessels[3].

Selection of a safe course is possible even when conditions prevent visual contact, by utilizing broadcast of the ship's key details over VHF (Very High Frequency). Information is sent every few seconds and includes data about their identification, current position, heading and speed. That is why AIS almost immediately has become one of the most efficient systems [Kościelski, Miler, Zieliński, p. 12].

From the very beginning of its existence, increased value of AIS data has been utilized not only by ships, ship owners and their agencies, but also by naval forces, coast guards, port authorities and other competent maritime authorities, including some of the maritime transport organizations. Taking advantage of AIS data is the best way to enhance the SOLAS convention and to improve maritime situational awareness. It also improves competitiveness and reduces unnecessary costs of the maritime transport organizations. However, while AIS has been launched and deployed by users successfully, it almost immediately started to suffer from a major limitation. Taking into account the curvature of the Earth and signal transmission limitations, the range of the "classic AIS" is limited to approximately 50 nautical miles (see figure 6.2) [http://www.exactearth.com/products/exactais].

Very soon after introduction of AIS, maritime agencies realized limitations of its capacity and wished to gain greater visibility into vessel traffic. They expected picture from over a much broader area in order to enhance their operational effectiveness and competitiveness on the modern maritime transport market.

---

[1] The Long Range Identification and Tracking of ships has been debated by the 2002 IMO SOLAS Conference, which had adopted Conference resolution 10 on early implementation of LRIT.

[2] Modern ships are equipped with much more systems – in addition to those controlling the machinery there are cargo systems, communication systems, voyage planning and navigation etc. At the same time, this complexity of ship systems is countered by desires to cut costs and reduce manning levels, without compromising efficiency or safety – for more information see http://www.wartsila.com/en/condition-monitoring-provides-key-to-ship-automation – author's note

[3] Since 2004, the International Maritime Organization (IMO) has required AIS transponders to be aboard all vessels that exceed 300 gross tons. Over 60,000 ships worldwide have installed these transponders at a combined cost of several hundred million dollars, making AIS one of the most successful maritime technology deployments of all time. Additionally, AIS technology is increasingly being deployed in smaller vessels as well as Aids-To-Navigation (AtoN) and Search and Rescue (SAR) transponders.

Figure 6.2. AIS system information flow
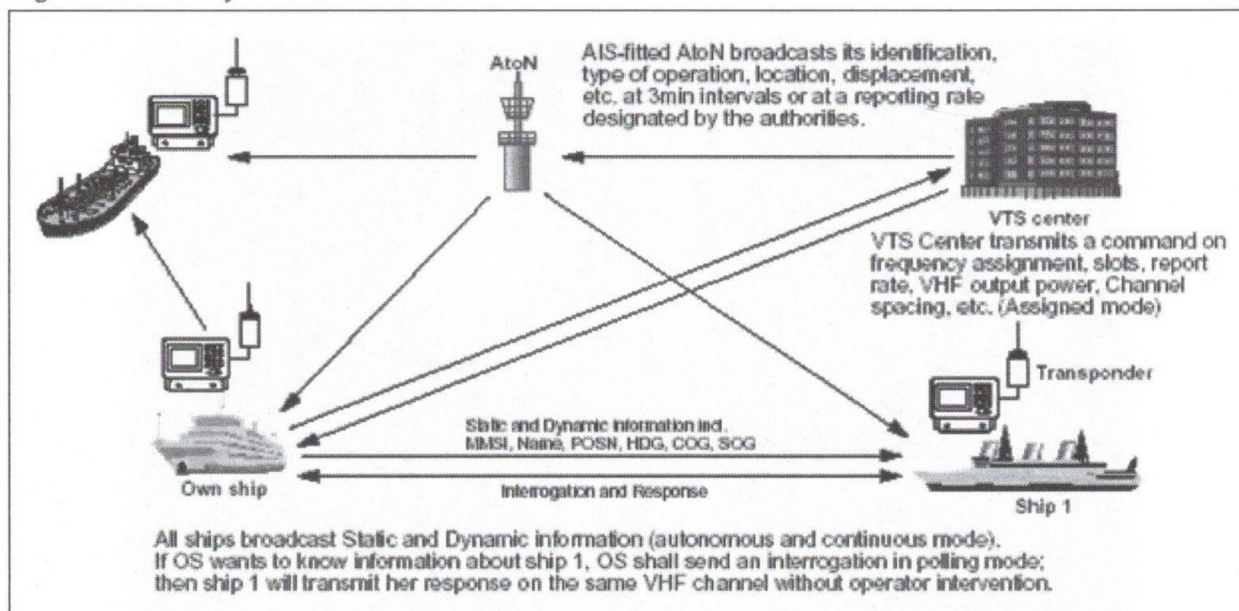
Source: www.busse-yachtshop.de/pic/ais-system-grt.gif – 04.05.2007.

A solution appeared through the exactEarth idea of collecting AIS signal transmissions from space [http://www.exactearth.com/products/exactais].

6.1. Satellite AIS

AIS, as an RF-based system has never been designed for signals reception from space, however exactEarth has extended the range of the original system by deploying a constellation of microsatellites that orbit the Earth. In addition Satellite AIS as a new system creates many new applications for competent maritime authorities. The visibility scope is significantly enhanced using microsatellites, the same time creating an increased maritime situational awareness, which is now well beyond the range of 50 nautical miles from shore as it was before [http://www.exactearth.com/products/exactais] (figure 6.3).
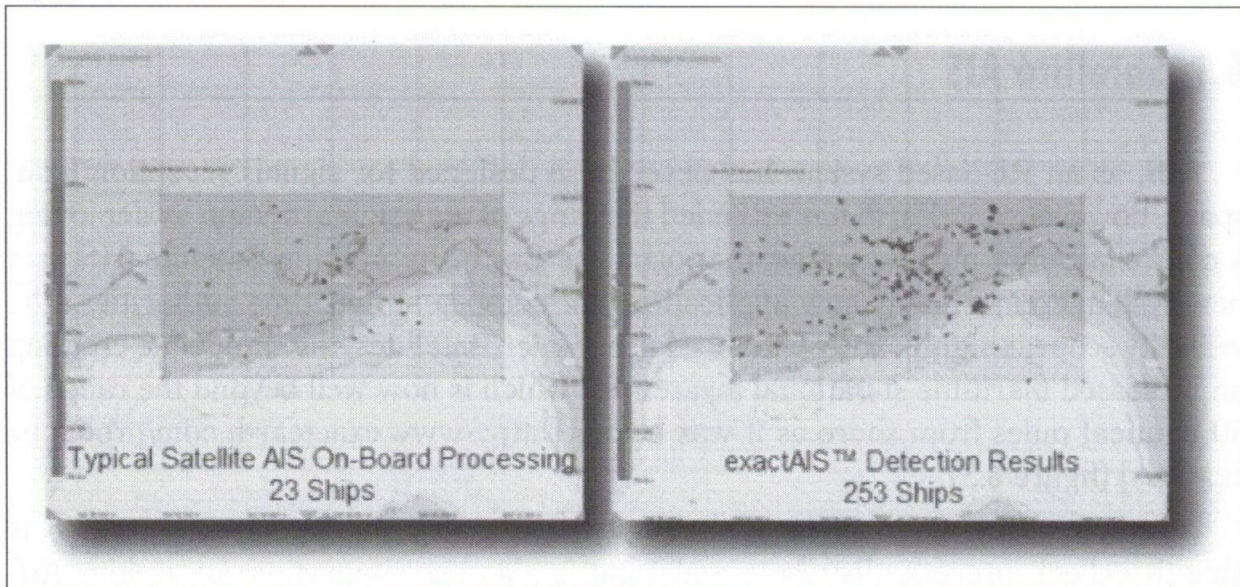
A unique technology has been developed by the exactEarth company, which is able to collect, process, distribute and what is also very important, to archive AIS messages received from ships all over the globe. A technology utilizes a global satellite system and a patented advanced Satellite AIS detection capability. According to the exactEarth announcements, capturing thousands of distinct vessels in a single satellite pass as a part of complete global coverage, exactAIS detects many times more vessels than any other system (figure 6.4) [http://www.exactearth.com/products/exactais].

73

Figure 6.3. Field of view from an AIS satellite at 650 km altitude and 850 km altitude

Source: http://www.exactearth.com/products/exactais/
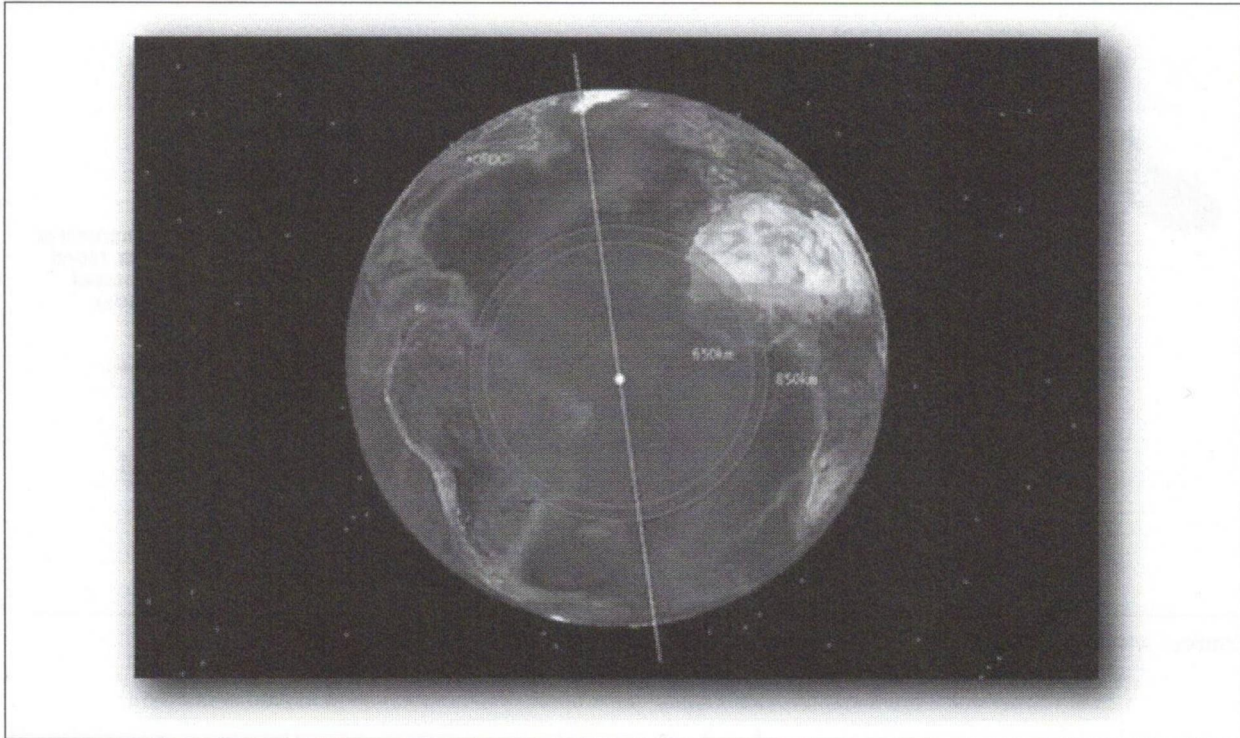
Figure 6.4. exactAIS detection result

Source: http://www.exactearth.com/products/exactais/

Utilizing patented technology, it is possible to provide to the exactEarth's customers better information allowing them to make better decisions for traffic management, safety and security, environmental and safety issues. exactEarth ensures that system provides both: the best detection rate in the industry and, in the same time, the best quality required. It facilitates exact data flow that reaches

customers in a timely and highly secure way.

6.2. Distribution of the exactAIS data

ExactAIS data is, according to the strict rules, distributed to authorized users only. Only organizations that meet the criteria of a "competent maritime authority", as defined by the International Maritime Organization (IMO), are eligible to subscribe to the exactAIS service [Grzybowski, Miler, 2008, p. 123-127. In addition there are strict controls on the distribution of the data. For example, a competent maritime authority from a particular country is eligible to receive data on the following Class-A AIS-equipped vessels [http://www.exactearth.com/products/exactais]:
- all vessels within 1,000 nautical miles of that country's coastline,
- all vessels destined for ports in that country,
- all vessels carrying that country's flag.

ExactEarth, as a company, continues to work with international regulatory and export authorities to develop the appropriate regulatory and data policy framework to ensure the security of its AIS data.

The service level for any given customer depends on several factors shown below (table 6.1). It is also closely linked with the subscription price.

Table 6.1. The influence of different factors on the final exactEarth AIS data subscribed

Area of Interest (AOI)	Describes which geographical area(s) is to be monitored. Customers can choose specific areas in accordance with the exactEarth Data Policy. Multiple Areas of Interest (AOI) can be supplied.
Data Licensing	The Data is provided under a Subscription Agreement which controls its use and there are 3 levels of Data Licenses available; User, Agency and Government Wide.
Data Usage	Describes the various data usage scenarios for which to receive the exactAIS™ message feed; Operational (full use), Historical or View Only.

Source: http://www.exactearth.com/products/exactais/

For visualization a special application called exactAIS Message Feed is needed. The application provides the following AIS message content of the all detected [www.exactearth.com/products/exactais]:
- AIS static messages including ship name, type, dimensions, IMO number, call sign, destination and other relevant information,
- AIS position reports including ship ID (MMSI), position from GPS, course and speed, navigational status and other relevant information,
- Aid to Navigation (AtoN) messages,
- Safety Text messages,

- position reports and commands from a base station,
- application specific messages.

The exactAIS Message Feed service has been introduced to provide users with correct data format and to deliver flexibility in choosing options, which are best tailored to their needs. The following table (table 6.2) illustrates the various AIS message types that can be detected with the exactAIS Data Service.

Table 6.2. AIS message types of the exactAIS Data Service

Message Categories	Contents	AIS Reporting Intervals
Position Reports (types 1,2,3,4, 18)	1. Ship ID (MMSI) 2. GPS Position 3. Course 4. Speed 5. Rate of Turn	1. 2 seconds at full speed (>23 knots) 2. 6 seconds at speed of 14-23 knots 3. 10 seconds < 14 knots 4. 3 mins at anchor 5. 3 mins (Satellite pos rpt – 27)
Static/Voyage Reports (types 5, 24)	1. MMSI 2. Name 3. IMO 4. Callsign 5. Length 6. Destination 7. ETA, etc	1. 6 minutes or when data amended
AtoNs (Aids to Navigation) (type 21)	1. MMSI 2. Type 3. GPS Position 4. AtoN status, etc	1. 3 minutes
SAR Aircraft (type 9)	1. MMSI 2. Name 3. GPS position 4. Altitude 5. Speed	1. 10 seconds
Safety (12,13,14)	1. Various	1. As required
Binaries (6,7,8,25,26)	1. Various	1. As required

Source: http://www.exactearth.com/products/exactais/

ExactAIS messages can be retrieved and streamed directly from the exactEarth Data Processing Centre (DPC)[4] over an encrypted link. Technology uses a TCP/IP socket based connection. Additionally, in order to maintain a persistent connection to the DPC, company provides exactAIS Subscriber Proxy software (figure 6.5), which can be installed at the customer site.

This Proxy receives filtered AIS data according to initially defined customer's area of interest. Then data is routed to another TCP/IP socket for insertion into customer operational systems [http://www.exactearth.com/products/exactais].

An additional option is available for customers who are oblige to follow with security policies that do not allow the installation of 3rd party software components.

---

4 Once the AIS signals recorded in orbit by a constellation of the microsatellites are downlinked to ground stations, they are routed to the exactEarth Data Processing Centre (DPC) in Ontario, Canada.

It enables to retrieve the data directly from the exactEarth Data Processing Centre utilizing a secure data link (point-to-point) provided by the customer.

Figure 6.5. The exactAIS Subscriber Proxy

Source: http://www.exactearth.com/products/exactais/
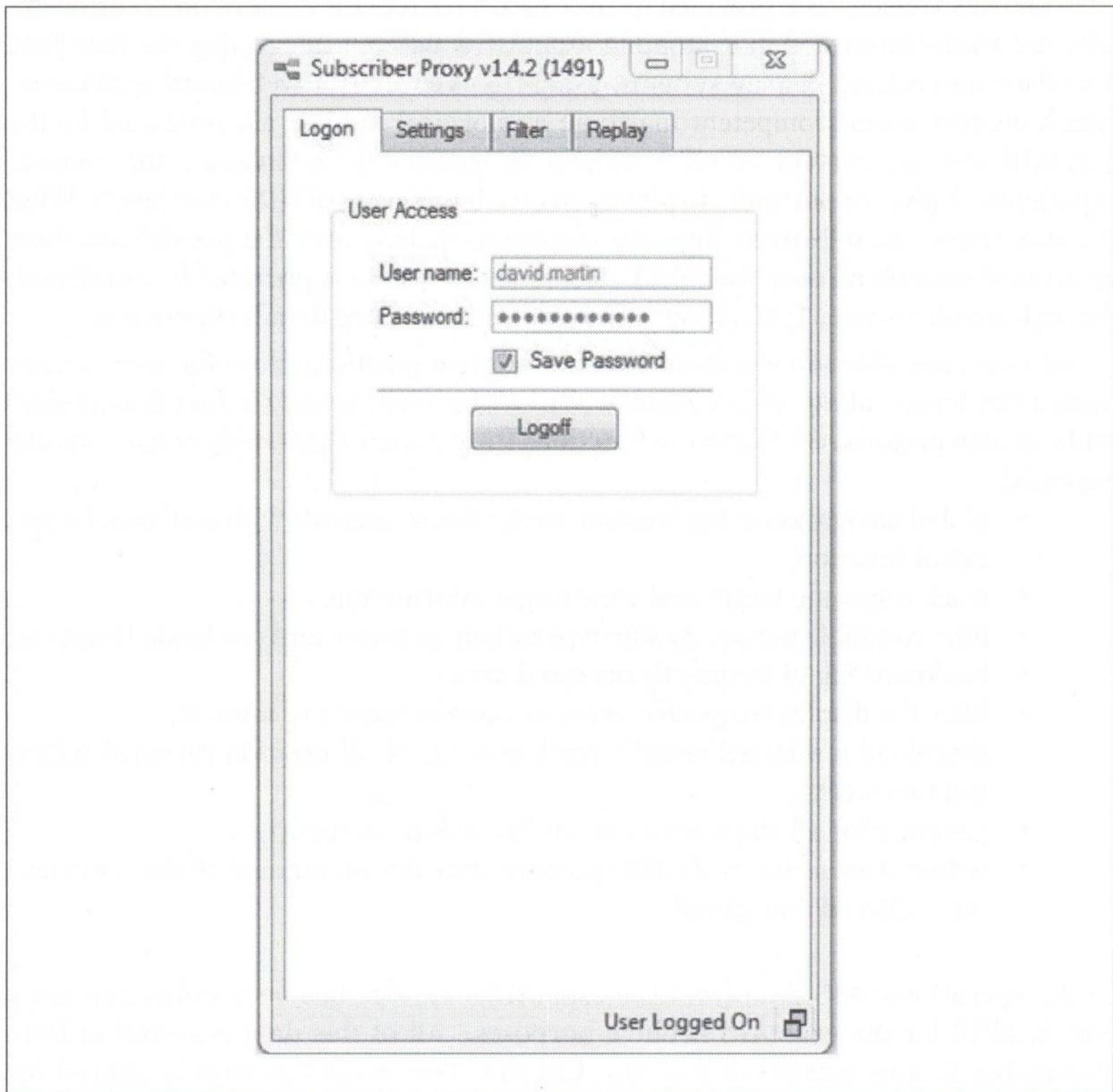
6.3. Benefits for Maritime Transport Operators

There are several additional features of the exactAIS™ that can be utilized by customers [http://www.exactearth.com/products/exactais]:
- exactAIS Viewer;
- exactAIS Archive;

- exactAIS Geospatial Web Services (GWS) – Maritime Vessel Information (MVI) on-demand;
- exactAIS Premium™ service.

ExactAIS Viewer™ is a provided by the exactEarth tool for those of their customers who are vitally interested in evaluating exactAIS® without integrating the data feed into their operational display systems. exactAIS Viewer is a web-based application which enables users (competent maritime authorities) to view all, produced by the exactAIS service, current vessel positions. Subsequently, to enhance the viewing experience, it gives opportunity to plot them on a familiar set of GIS[5] map layers. What is more, users can selectively filter the display to include only the pre-defined ships or areas of interest all over the world. Access to the system is provided by exactEarth through a web browser URL along with login and password details (figure 6.6).

All users are able to view their vessel of interest positions from the most recent period (24 hours) along with a historical track for each vessel (5 days if available) and can also perform the following functions [http://www.exactearth.com/products/exactais]:

- global navigation using familiar navigational controls with additional zoom in/out function,
- track a specific target and view target information,
- filter available picture by ship type utilizing custom and pre-loaded features,
- bookmarking of frequently accessed areas,
- filter the display to specific areas or narrow targets of interest,
- download a selected vessel's track consists of all position reported within last two weeks,
- generate for all ships currently visible a ship list report,
- within Area of Interest (AOI) prepare statistics on number of ships in view, both: filtered and global.

An operational AIS data from the exactAIS® service has been collecting since July 5, 2010 for the exactAIS Archive purposes. All of this data is stored at Data Processing Centre located in Toronto, Canada. This historical data is offered for customers to be purchased according to their current needs. The main features of this application can be defined as [http://www.exactearth.com/products/exactais]:

- comprehensive coverage back to mid 2010,
- available over 250 million individual and separate maritime vessel locations
- historical data can be extracted and displayed with flexible access to the database – (figure 6.7)
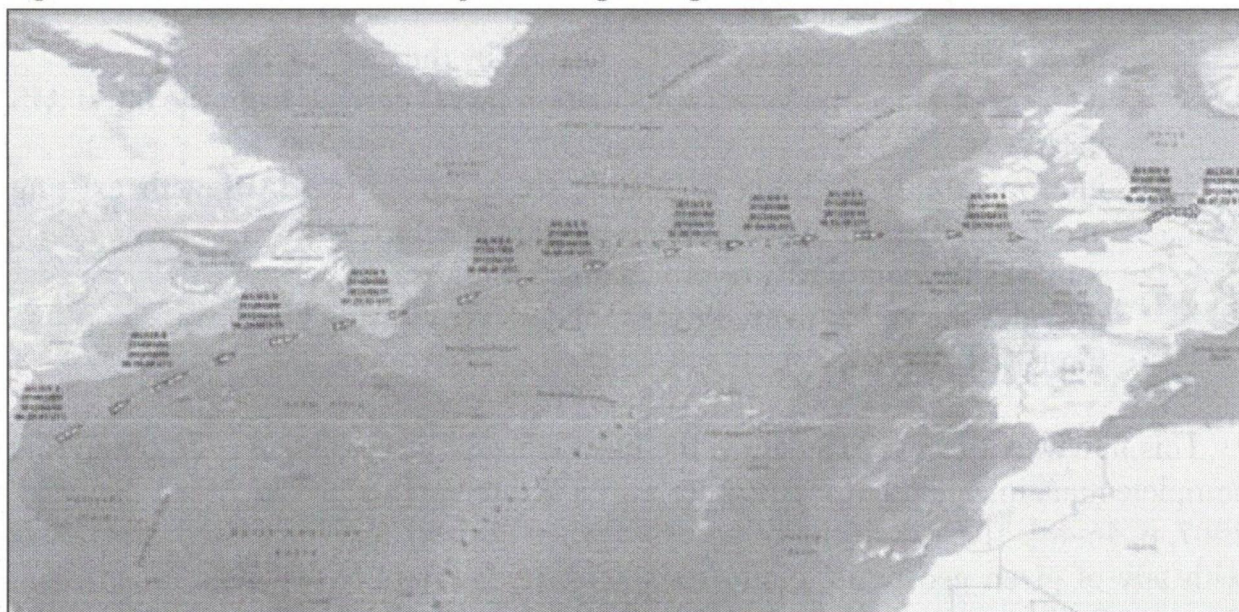- archive of over 300 million Satellite AIS messages , both: filtered and global.

---

[5] GIS – Geographic Information System.

Figure 6.6. A sample view from exactAIS Viewer

Source: http://www.exactearth.com/products/exactais/
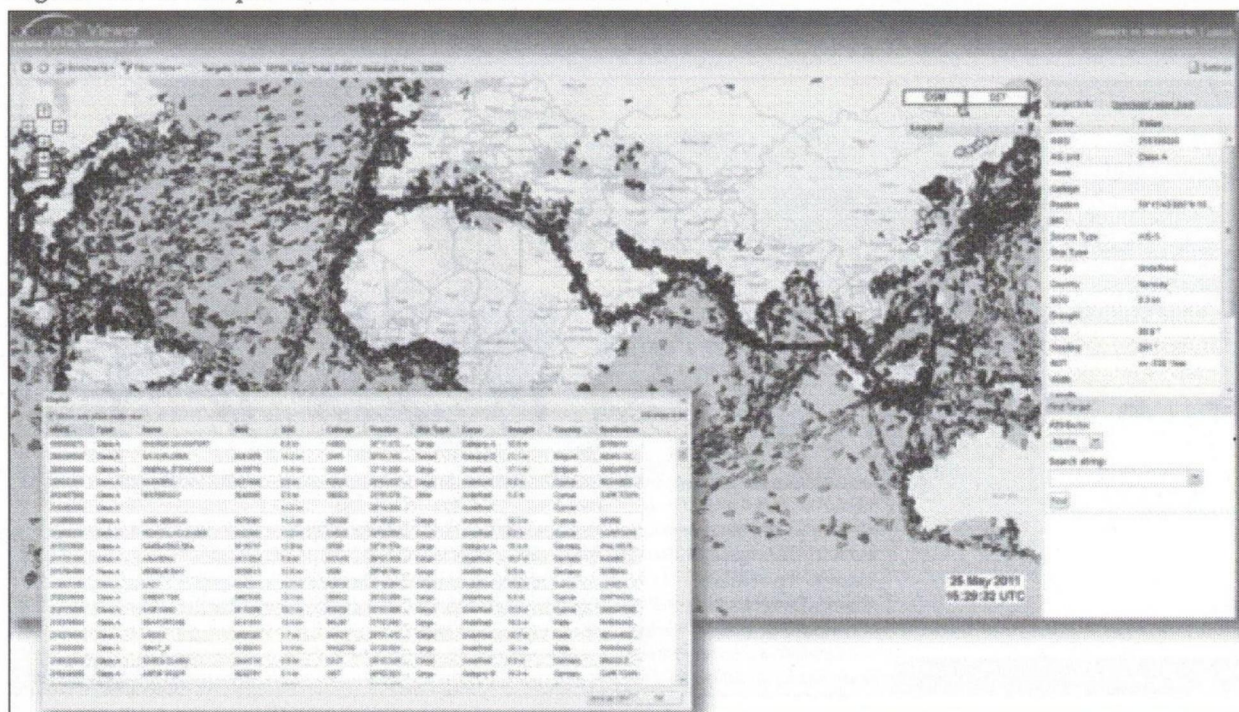
Figure 6.7. The Julius container ship traversing through the Atlantic Ocean

Source: http://www.exactearth.com/products/exactais/

Another feature of the exactAIS™ – exactAIS GWS delivers maritime vessel information on-demand, including maritime vessel information (MVI). Information is derived from Satellite and Terrestrial AIS sources, directly into customer's geospatial platform of choice. Thanks to this solutions exactEarth can offer a web service that allows instant access to their exactAIS® data in an on-demand environment (figure 6.8).

Figure 6.8. exactAIS data in an on-demand environment

Source: http://www.exactearth.com/products/exactais/
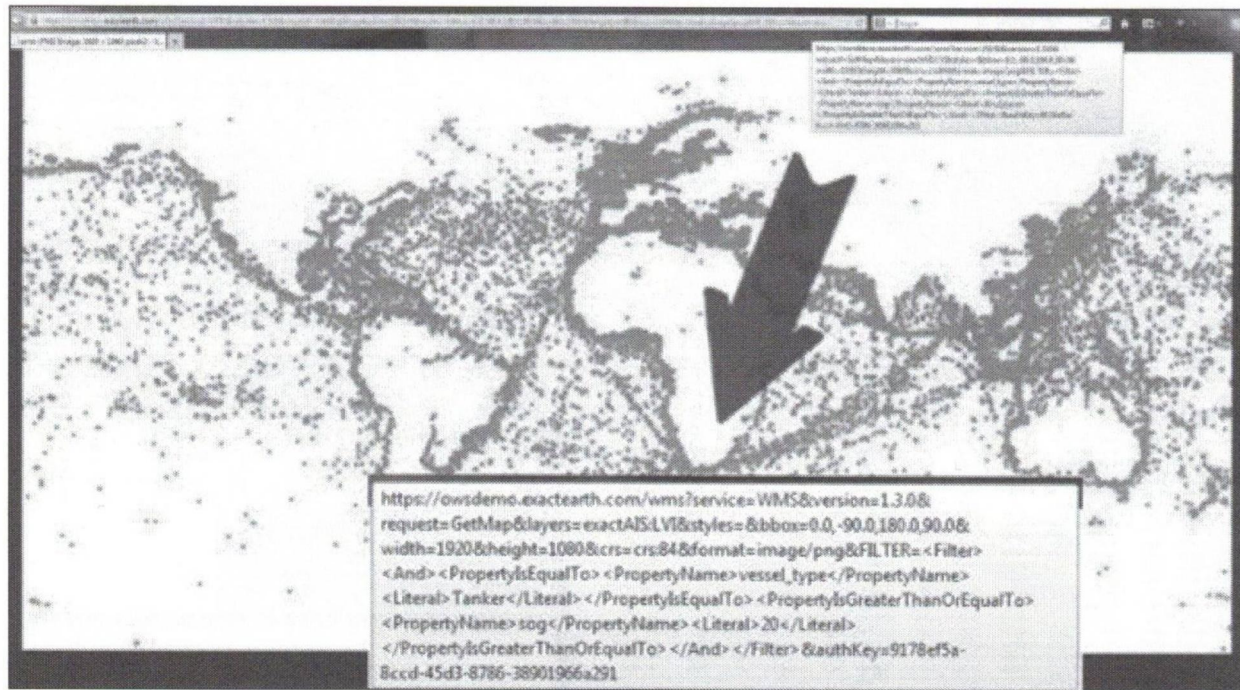
Features and benefits of using this application are easy to define [http://www. exactearth.com/products/exactais]:

- on-demand data – exactly what is needed by the customers,
- delivery of Maritime Vessel Information (MVI) derived from the latest AIS messages,
- interoperability – ability to seamlessly integrate exactAIS with existing geospatial platforms with little to no time or effort,
- removes the complexity of processing AIS messages,
- provides the ability to create custom data views using filters,
- improved efficiency[6].

This new way to view AIS data is the most efficient, accessible way to obtain the complete maritime picture for customer's area of interest [Kościelski, Miler, Zieliński, 2007, p. 46-48]. These data can be accessed when desired, and integrated effortlessly with any of given geospatial platforms – with no barriers to full data integration. Figure 6.9 illustrates a custom-add-in created specifically for Esri Arc-Map 10.1 users, showing the 30-day track for a specific vessel within the Esri platform.

The way, how the exactEarth GWS data can be utilized by Google Earth users, is depicted on the map of figure 6.10.
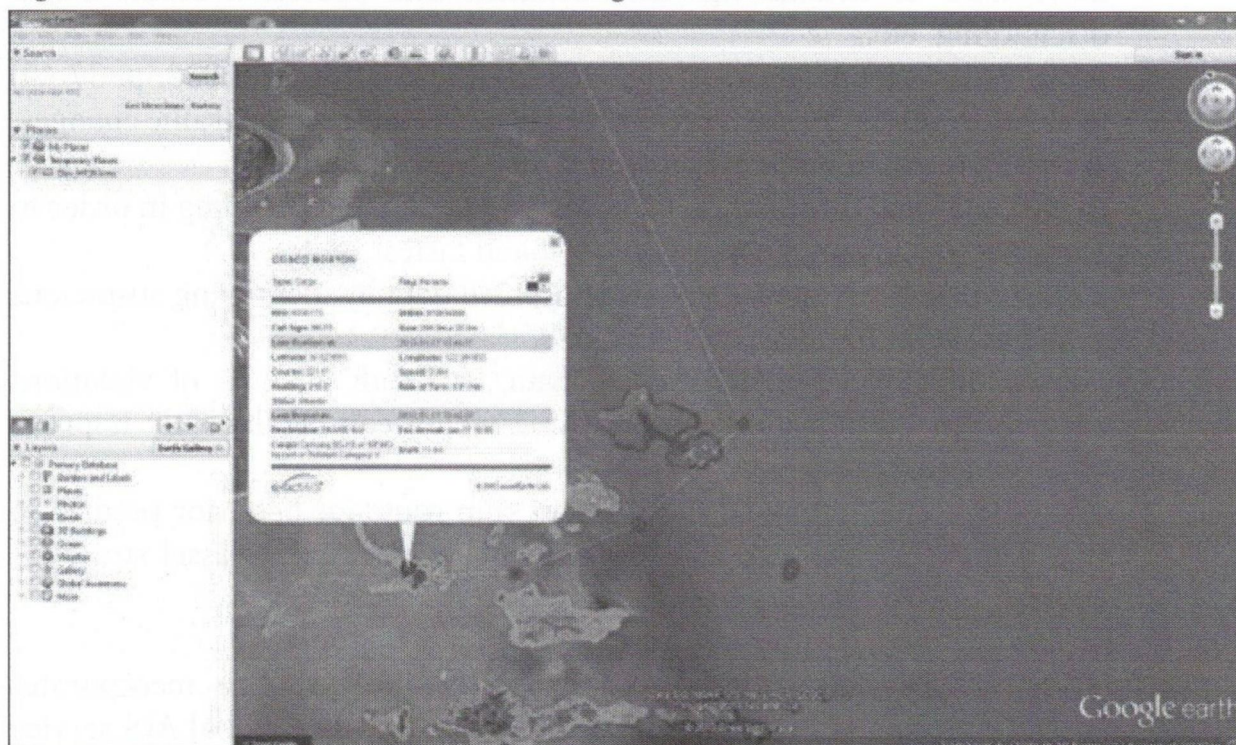
---

[6] Efficiency appears when instead of spending money (and time) setting up and managing AIS database environments, a customer allows exactEarth to 'host' the data and serve on-demand.

Figure 6.9. A custom-add-in created specifically for Esri Arc-Map 10.1 users

Source: http://www.exactearth.com/products/exactais/
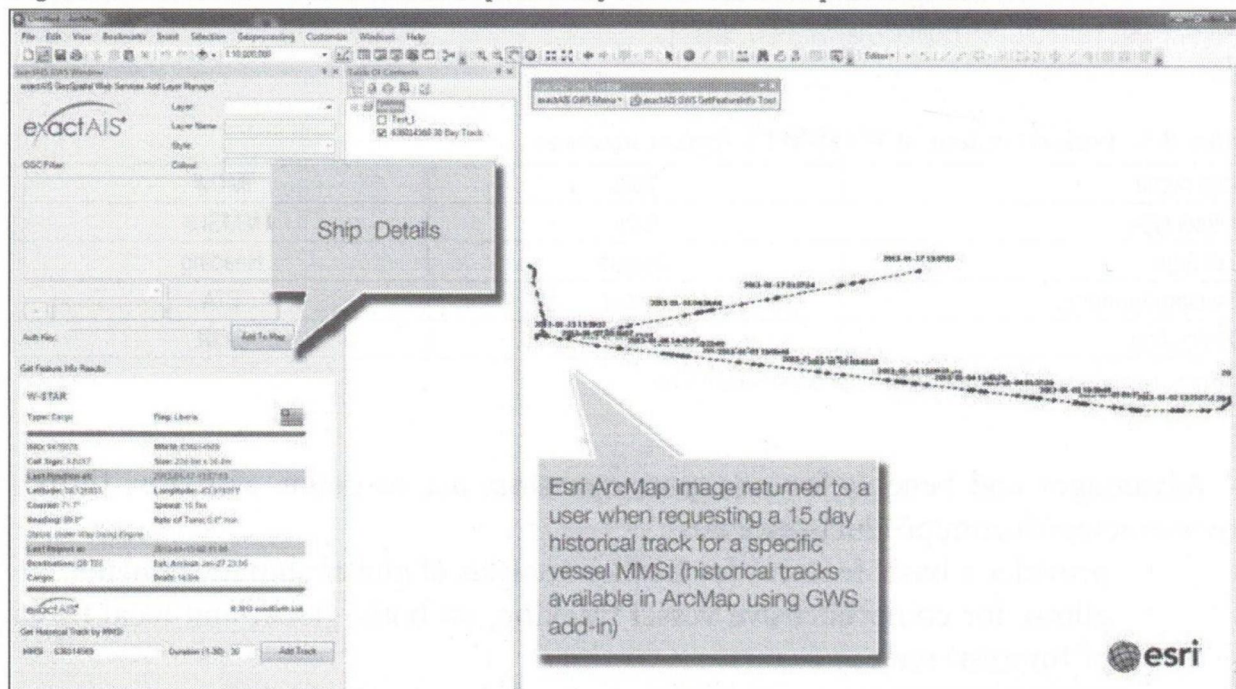
Figure 6.10. The exactEarth GWS data for Google Earth users

Source: http://www.exactearth.com/products/exactais/

This information is available either as a Web Mapping Services format (WMS) where data can be viewed, but not downloaded, or in a Web Feature Services format

(WFS) for downloading. Information includes, but is not limited to (table 6.3) [http://www.exactearth.com/products/exactais]:

Table 6.3. Typical content of WMS/WFS format message

Ship name	Flag	IMO#
Vessel type	Size	MMSI#
Call Sign	Course	Heading
Position Geometry	Speed	ETA
Destination	Cargo	Draft

Source: http://www.exactearth.com/products/exactais/

Advantages and benefits for transport operators are to define as follow [http://www.exactearth.com/products/exactais]:

- provides a basic features for further analysis of global ship movements,
- allows for comprehensive vessel tracking, on both: global and local (Area of Interest) scale,
- provides a great opportunity for deep validation of a ship's log,
- exactAIS Archive data can be useful in order to establish patterns of vessel behavior, allowing for prosecution (or to prove of being innocent) of illegal movements or actions e.g. encroachment into protected areas, illegal discharging, etc.,
- prevents the risk of accident [Kościelski, Miler, Zieliński, 2008, p. 37-49] utilizing the ability to see vessel traffic patterns and seasonal traffic changes, which can help in reducing costs and time consumption,
- provides critical information for decision-making and planning in order to allow authorities to establish the safest and fastest routes,
- aids to anti-piracy operations using archive data by identifying suspicious vessel behavior or deviations in course,
- allows, utilizing exactAIS archive data, in depth analysis of violations occurred in the Marine Protected Area which can significantly improve environmental protection,
- allows to create improved modeling of ship route for behavior prediction that can reduce the risk of any major incident, e.g. if a vessel strays off course.

Next feature of the exactAIS™ – exactAIS Premium™ service incorporates terrestrial-based AIS data in order to provide the most complete global AIS service in the market today. Regardless of their location customers can receive a complete and accurate record of all vessel movement. The comprehensive picture is built in conjunction with exactEarth's Satellite database (figure 6.11).

ExactAIS Premium provides the most complete and adequate record of AIS vessel movements on a global scale. Thanks to exactAIS Premium application all data is delivered as a single integrated data service. Having access to this premium data

service, all customers and competent maritime authorities can quickly integrate this data into their operational and analytical systems.

Figure 6.11. exactAIS Premium™ service

Source: http://www.exactearth.com/products/exactais/
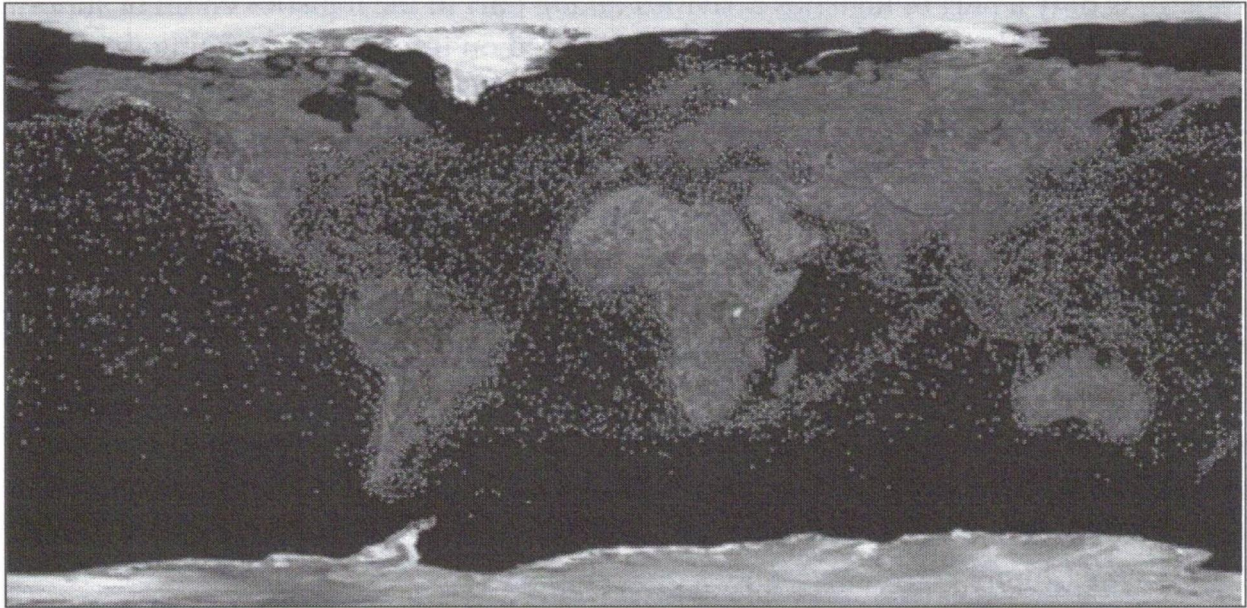
Furthermore it allows users to get instant access to exactAIS Premium's rich data set for their individual vessel tracking purposes. Finally, it enables them to benefit from all above mentioned benefits as well as special Premium Service features such as [http://www.exactearth.com/products/exactais]:

- direct access to the currently-available exactAIS® Satellite based service,
- possibility of integration with terrestrial-based global AIS data,
- various and multiple data delivery options, including:
  - dedicated secure connection to exactEarth's Data Processing Centre, utilizing previously streamed information,
  - retrieval from the exactEarth secure FTP site, utilizing data files placed on for customer use,
- availability of data in multiple formats, such as NMEA and NMEA V4.0 (no timestamps/includes timestamps), Google Earth KML, XML, CSV and others.

ExactAIS Premium data can easily be integrated into a variety of platforms including Esri and Google Earth for better visualization ship tracks according to the specific customer needs and demands.

*　*　*

Maritime transport is of fundamental importance to the modern world and logistics chains of supply. exactAIS provided service (shipping monitoring and tracking system) is only a part of logistics activities taking part in the logistics chain of supply. Traditional supply chain execution system is based on tracking and tracing the order abilities. It is achieved through all supply chain disciplines such as generating and preparing the order, warehouse activities and transportation management (including sea transport). Once the order leaves the warehouse, it is in the hands of a disparate system. Bridging al of the mentioned gaps to provide a global view of physical execution is a domain of the Supply Chain Shipment Monitoring (SCSM) [http://www.aptean.com/en/Solutions/By-Product-Name-AZ/IMI-WMS/Solutions/Supply-Chain-Monitoring/Shipment-Tracking-and-Monitoring].

ExactAIS can easily support with exact data all this type systems over the world. When additional data is incorporated, immediately ability of more accurate management through entire chain of supply appears. This includes [http://www.aptean.com/en/Solutions/By-Product-Name-AZ/IMI-WMS/Solutions/Supply-Chain-Monitoring/Shipment-Tracking-and-Monitoring]:

- physical and informational control of the entire supply chain, from inbound logistics, over a logistic centers of distribution, local distribution warehouses and transportation terminals, to the final delivery at the customer's premises, by utilizing monitoring and tracking possibilities;
- support for unique identification standards for logistics units (SSCC), products (SGTIN), and returnable assets (GRAI), by utilizing communication flows;
- use of Supply Chain Shipment Monitoring (SCSM) as a traceability hub for load carriers, logistics units / containers, shipments and loads, lots and even single products,
- use of web portal components for trading partner collaboration around advance shipping notices (ASN) and proof of delivery (POD).

With added visibility into supply chain, reduced manual data entry errors and control over entire shipment, it is easier to improve lots traceability.

Unlike other Satellite AIS providers, exactEarth delivers a full range of services to enhance the value of exactAIS data. It helps in achieving better quality of operations and more efficiency in sea-born transportation, which is undoubtedly a part of logistics chain of supply.

Summary

Maritime transport, due to its characteristics, global reach and an important role it plays in economical processes, is now an area of implementation of the newest and most advanced solutions in shipping monitoring systems. Majority of the solutions are based on Automatic Identification System (AIS) signal transmission. exactAIS is a global vessel monitoring and tracking service based on Satellite AIS (S-AIS) detection technology. It supports achieving maritime domain awareness for government authorities and selected commercial organizations around the world. Delivers superior detection capability, secure distribution of information and high quality of service. This paper is an attempt at providing overview of the benefits for the maritime transportation organizations from the usage of the exactEarth application.

Streszczenie

System Exactearth Satelite -Ais jako najbardziej rozwinięty system zobrazowania żeglugi

Z uwagi na swój charakter, globalny zasięg oraz istotną rolę w procesach gospodarczych, transport morski jest obszarem implementacji najnowocześniejszych rozwiązań z zakresu systemów monitoringu żeglugi. Zdecydowana większość systemów zobrazowania żeglugi oparta jest o transmisję sygnału AIS. exactAIS jest globalnym systemem monitoringu opartym o technologię satelitarną. Z założenia wspomaga on informacyjnie systemy bezpieczeństwa żeglugi na szczeblu narodowym oraz wybranych organizacji morskich dzięki swym zdolnościom wykrywania obiektów, bezpiecznego przekazywania informacji oraz wysokiej niezawodności. Niniejsze opracowanie stanowi próbę kompleksowego ujęcia problematyki wykorzystania systemu monitoringu żeglugi exactEarth przez operatorów transportu morskiego.

Bibliography

Grzybowski M., Miler R. (2008), *MSA as the Aspect of European Maritime Security, Proceedings*, 2nd International Conference Future of Europe – Security and Economic Development, Romanian Journal of International and Regional Studies, Bucharest.

http://ec.europa.eu/transport/maritime/safety/2005_package_3_en.htm

http://www.aptean.com/en/Solutions/By-Product-Name-AZ/IMI-WMS/Solutions/Supply-Chain--Monitoring/Shipment-Tracking-and-Monitoring

http://www.busse-yachtshop.de/pic/ais-system-grt

http://www.emsa.europa.eu/end185d007d003d001.html

http://www.exactearth.com/products/exactais/

Kai Ma (2009), *TCP network architecture*, Information Engineering, ICIE '09. WASE International Conference on Technology (Shanghai) Co., Ltd., (Volume:1) China Electric Power Press.

Kościelski M., Miler R., Zieliński M. (2007), *Automatic Identification System (AIS) as a main tool of NCAGS ADP Systems*, Zeszyty Naukowe AMW, vol. 3, Gdynia.

Kościelski M., Miler R., Zieliński M. (2008), *European Maritime Safety Agency (EMSA) in the way to enhance safety at EU seas*, Zeszyty Naukowe AMW, vol. 1, Gdynia.

Kościelski M., Miler R., Zieliński M. (2007-1), *Maritime Situational Awareness (MSA)*, Zeszyty Naukowe AMW, vol. 4, Gdynia.

Miler R.K. (2009), Use of, *Vessel Monitoring Systems in Logistics Chain of Supply within EU Seas* [in:] J. Jaworski, A. Mytlewski (ed.), *Funkcjonowanie Systemów Logistycznych*, Prace Naukowe WSB w Gdańsku, vol. 2.

Miler R.K. (2012), *Security and Safety Aspects of the Maritime Logistics Chain of Supply*, [in:] R. Miler, A. Mytlewski, B. Pac (eds.) *Kierunki racjonalizacji systemów i procesów logistycznych*, Prace Naukowe WSB w Gdańsku, vol. 15.

MSC 81/25/Add.1, Annex 13 Resolution MSC.210 (81), adopted on 19 May 2006, Performance standards and functional requirements for the Long-range identification and tracking of ships, Official Journal of the European Community (2006), Luxembourg.

SafeSeaNet Bulletin (2007), no 5, April.