JAPAN COAST GUARD

Workshop on International Standardization of Next Generation AIS (VDE)

Tokyo, JAPAN
3 – 7 December, 2012

Executive Summary

The Workshop on International Standardization of Next Generation AIS (VDE) was held from 3rd to 7th December 2012 in Tokyo, hosted by the Japan Coast Guard in cooperation with the Ocean Policy Research Foundation. Six overseas experts and 20 Japanese experts in the field of AIS and e-Navigation participated in the meeting. The participants list of the meeting is attached as Annex 1.

On the first day, the presentation and panel discussion was held at the Nippon Zaidan building in Tokyo and six experts and one JCG officer made presentations regarding the next generation AIS and VDE. At the Panel Discussion, six experts discussed various matters on the next generation AIS and VDE presided over by the moderator. There were about 130 attendees and they asked various questions after each presentation.

The technical tour to the National Maritime Research Institute was carried out on the third day. The experts observed numerous test and experiment facilities on navigation and ship building. They also enjoyed Japanese tradition of cuisine and landscape along the way as well as other social events held during the Workshop.

The meeting was also held at the Nippon Zaidan building on the second, fourth and last day. The agenda is attached as Annex 2. The participants made an active and eager discussion on the agenda and developed the conclusion which is attached at the end of this executive summary.

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CONCLUSION

THE WORKSHOP,

RECALLING that AIS has significantly contributed to the safety of navigation and the carriage of AIS on board is expanding;

ALSO RECALLING that the World Radio Conference in 2012 (WRC-12) allocated two new frequencies for long range detection of AIS, allowed additional frequencies for experimental use of AIS and authorized channels for VHF Data Exchange (VDE) in accordance with Recommendation ITU-R M.1842-1;

RECOGNIZING that various applications of AIS such as AIS-AtoN, class-B AIS, AIS-SART, AIS-MOB, EPIRB-AIS, and satellite detection of AIS, are useful and valuable for not only the safety of navigation but also safety of life, marine environment protection, assurance of maritime security, assistance of search and rescue mission and efficiency of shipping ;

ALSO RECOGNIZING that a study in Japan shows 10 % increase of the load of VHF Data Link in recent four years and this 10% increase within 4 years also shows that in Japan the limiting factor of 50% as noted in IALA Recommendation A-124 Appendix 18 "VDL Loading Management" could be reached quite soon and therefore protection of AIS 1 and 2 channels is necessary;

HAVING NOTICED that a concept of VHF Data Exchange (VDE) using Recommendation ITU-R M.1842-1 technique and developed by IALA is quite useful and will be able to solve the limitation of AIS data exchange;

HAVING ALSO NOTICED that because of its advanced capability, the VDE will be able to become one of core elements in e-navigation and could also significantly contribute to the modernization of GMDSS;

CONCLUDES

1. *VHF Data Exchange (VDE) that is now being developed by IALA, should be inter-operable with the present AIS and therefore it will be better to name it "VHF Data Exchange System (VDES) ;*

2. *It will be defined that VDES is a VHF maritime data communication system that includes functions of AIS, facilitates e-navigation, supports GMDSS modernization and general maritime communication;*

3. *VDES has great capability and will influence the whole maritime society with*

enhancement of safety, security, protection of the environment, logistics and others and thus the development of VDES should be supported and promoted;

4. *In order to benefit from the full potential of VDES, the development of the peripheral equipment such as display should also be supported and promoted;*

5. *Considering the proceedings of the ITU, the top priority should be given to the development of VDES;*

6. *Also considering the purpose, timing and scale of the development of the VDES, the initiative taken by the Ocean Policy Research Foundation (OPRF) to support this workshop is greatly appreciated;*

AND RECOMMENDS

1. *The results of this workshop should be immediately reported to the next session of the IALA e-NAV Committee and its AIS and Communication Systems Working Group and IALA should continue the development of VDES by inter-acting with the workshop;*

2. *As the work progresses, the results of this workshop should also be reported to IMO and ITU by appropriate means;*

3. *The OPRF is kindly invited to consider the continuation of this workshop.*

Report of Workshop
on International Standardization of Next Generation AIS

1. Background

AIS was originally developed for mainly vessel identification and collision avoidance. However, since it is also the first practical digital data exchange device on marine VHF, the application of AIS has been, and still is, expanding to AIS-AtoN, AIS-SART, AIS Application Specific Message, satellite detection of AIS, AIS-MOB, EPIRB-AIS, etc. As more applications are implemented, there is more load on VHF data link. This increased load on the VHF data link for additional AIS capabilities will impair the main function of AIS.

In 2008, ITU issued its Recommendation M.1842-1 "*Characteristics of VHF radio systems and equipment for the exchange of data and electronic mail in the maritime mobile service RR Appendix 18 channels*". Use of this Recommendation provides a possible solution for the above mentioned problem, as well as providing for development of marine digital data communication.

Based on the Recommendation, IALA started to develop the concept of VHF data exchange (VDE), as the next generation AIS, in 2012. IALA considers that the VDE could become one of the key elements for e-navigation and modernization of GMDSS.

Taking the situation into account, the Japan Coast Guard (JCG) planned to hold a workshop in order to develop an international standard for the next generation AIS and VDE in cooperation with the Ocean Policy Research Foundation (OPRF). The JCG invited foreign and domestic AIS experts from national authorities, institutions and AIS related commercial companies and many experts participated in the workshop. The list of the participants was attached as the Annex 1. The workshop was held from 3rd to 7th December 2012 at the Nippon Zaidan Building in Tokyo, JAPAN.

2. Courtesy call to the JCG

Six foreign experts made a courtesy call to Mr. Akifumi SUZUKI, Director General, Maritime Traffic Department, JCG at the JCG Headquarters on the first morning. Mr. SUZUKI expressed his appreciation to the all experts for accepting the invitation and coming to Japan. He also said that the use of AIS in Japan is now increasing and there is a concern regarding the limitation of VHF data link (VDL). He added that this was a reason why the JCG decided to hold this workshop. Mr. SUZUKI explained his expectation of the outcome from the workshop. In response, the experts thanked the JCG and OPRF for hosting this valuable workshop.

3. Presentations and Panel Discussion

Afternoon of the first day, presentations and a panel discussion was held. The first part of this event was presentation from the foreign experts and a Japanese expert. LCDR Nakamura, engineer of Japan Coast Guard, introduced each presenter as the MC. The summary of each presentation are as follows:

3.1. Ms. Jillian Carson-Jackson (Australian Maritime Safety Authority)

Ms. Carson-Jackson presented four examples of innovative use of AIS in Australia. The first example was AIS equipped on helicopters for pilot boarding, noting the benefit for both the helicopter travelling to the vessel, and for the vessel that can then see the pilot en route. The second example was AIS man overboard units (AIS-MOB) and the third one was AIS diver unit which expands on the AIS-MOB concept. The fourth example was a Grab Bag Program to enhance safety in the Torres Strait, the far north area of Australia. The Grab Bag Program will include a small, battery powered class-B AIS transmitter for the Torres Strait Islanders who travel in small, open craft. She noted that these are only some examples of AIS use for the safety of navigation and that the capability of AIS will only increase in future. She concluded that VDE was a possible solution for increasing use of the VDL. A copy of the presentation is attached as Annex 3.

3.2. Ms. Margaret Browning (exactEarth)

Ms. Browning started her presentation by the introduction of new frequencies of AIS at WRC-12. The channel 75 and 76 allocated for the use of long range detection will enable 100% satellite detection of class-A AIS, however a detection problem for class-B AIS remains. She also showed many examples of satellite detection and concluded that VDE could enable increased satellite detection of AIS. A copy of the presentation is attached as Annex 4.

3.3. Mr. Stefan Bober (Germany Federal Waterways and Shipping Administration)

Mr. Bober began his presentation by highlighting the current status of AIS development, including the ITU recommendation M.1371 and the relevant IEC standards. He then presented a possible future state of AIS, noting that the VDE would allow greater digital data transfer, including effective use of Application Specific Messages (ASM). In conclusion, he highlighted that the VDE would play an important role in e-navigation. A copy of the presentation is attached as Annex 5.

3.4. Mr. Jan Safar (General Lighthouse Authorities of the UK and Ireland, Research & Radionavigation Department)

Mr. Safar commenced his presentation by stressing the importance of communication in e-Navigation. He highlighted various elements including: user requirements; desired characteristics for communications; and system requirements. He noted that the VDE could be a candidate to meet the needs for communications in e-Navigation. He also presented an estimated timeline for development, standardization and implementation of the solutions. It was noted that there may be a need for one organization to take the lead in the development of VDE. A copy of the presentation is attached as Annex 6.

3.5. Mr. William Kautz (United States Coast Guard)

Mr. Kautz briefed the meeting on the IALA e-navigation committee's plan for AIS and VHF Data Exchange (VDE) that was introduced to ITU and IMO. He then explained the radio frequency requirements of the VDE and noted that the details of the VDE concept were included in the IALA Maritime Radio Communication Plan (MRCP) Annex E, which is available on the IALA homepage. Finally, he introduced the latest developments related to the VDE and explained that ITU-R WP5B, IMO NAV, and IMO/ITU Joint Experts Group supported further development of the VDE. A copy of the presentation is attached as Annex 7.

3.6. Mr. Ross Norsworthy (United States Coast Guard)

Mr. Norsworthy started his presentation by explaining channel usage for VDE. He said that the single band VHF channel of 25 kHz with new modulation technique could achieve up to 8 times the speed of the present AIS. With an ability to group frequencies together, a quadruple band of 100 kHz could achieve 32 times higher speed for data transfer. He emphasized that AIS is for collision avoidance and thus SOTDMA scheme using the very stable GMSK modulation is appropriate. However, VDE could be developed to enable the provision of information and could use a different, but AIS compatible, scheme. Finally, he presented a proposed architecture of an integrated AIS/VDE system. A copy of the presentation was attached as Annex 8.

3.7. CDR Hideki Noguchi (Japan Coast Guard)

CDR Noguchi explained the various applications currently available in AIS. He then introduced the possible applications by the use of next generation AIS or VDE. He noted that these could include: exchange of information on intentions related to navigation and route; information on polar route navigation; development of a satellite downlink for SAR assistance; world-wide ocean environment monitoring; and possible commercial usage. He concluded that these applications could be possible but would need careful consideration and world consensus for practical implementation as well as technological development. A copy of the presentation is attached as Annex 9.

After the presentations, the event moved to the second part which was Q&A from the audience and a panel discussion. The moderator was CDR Noguchi and he invited five speakers, Ms. Carson-Jackson, Ms. Browning, Mr. Bober, Mr. Kautz and Mr. Norsworthy on the stage.

The first question was possibility of VDE detection by satellite and each country's view on this matter. The all speakers answered that VDE detection by satellite is possible and they had great expectation for the VDE detection.

The second question was regarding AIS malfunction caused by GPS vulnerability. Mr. Ross answered that AIS used GPS for positioning and GPS vulnerability was serious for this positioning but from the original purpose of AIS, collision avoidance, other equipment such as radar could be used at that time. Ms. Browning explained that for timing, AIS has semaphore mode and could synchronized to other AIS stations without GPS timing signal.

The third question pointed out two issues. The first one is how to avoid human error by the next generation AIS. The second one is integration of AIS communication into radar in order to preserve VHF channels. Mr. Norsworthy answered that since AIS is an open architecture, development of application which would solve a human error is possible. He admitted that there was a strong channel demand from land users but said that coexistence of marine and land users was possible. Ms Carson-Jackson emphasized that AIS information integrity is vital to ensure confidence in the system, and that there is no way to eliminate human error – the focus needs to be on managing errors.

The fourth question was the merit of an integrated AIS/VDE system. Mr. Norsworthy explained that in order to avoid co-interference between AIS and VDE, the integrated system is required. In addition, there could be economical benefit for ship owners with one-box system.

The fifth question was each panel member's view on the IMO non commitment policy for satellite detection of AIS. The speakers expressed their expectation that this workshop would note the numerous benefits of satellite detection. The development of satellite AIS is continuing and the practical implementation may require IMO to review its policy regarding AIS.

The sixth question was regarding the situation of class-B AIS in each county. Ms. Carson-Jackson answered that in Australia there was a national standard for commercial vessels that related to AIS class B carriage (available from www.nmsc.gov.au under 'standards'). These national standards are then implemented by each Australian State – at present the standards have not yet been adopted throughout Australia. Mr. Bober answered that in Germany, small boats are encouraged to equip class-B AIS but it is not mandatory. Mr. Kautz answered that the U.S. was the same situation with Germany.

Then the moderator asked the panel their views on the security of AIS data collected by shore-based network or satellite. The panel members noted that most competent authorities are against free distribution of limitless AIS data. The exactEarth representative confirmed that this is the approach that they take as well. To support maritime domain awareness, Australia encourages sharing of AIS data among shore authorities and Australia has implemented a series of data sharing agreements to facilitate this. All speakers agreed that there was a need to develop a standard approach regarding this issue.

The moderator also asked a question regarding the appropriateness of commercial use of the next generation AIS or VDE. The panel members agreed that, the commercial use of VDE could be possible as long as the VDL remained stable (i.e. no overloading of the AIS VDL). It was noted that such usage could provide motivation for owners to introduce VDE.

Finally, the moderator expressed his appreciation to the speakers for answering various questions and to the audience for coming this event. The panel discussion was concluded and the session adjourned.

4. Opening of the meeting

Cdr. Noguchi took the role of the chair and introduced Capt. Igarashi, Director, AtoN Engineering Division, Japan Coast Guard, who welcomed every participant especially foreign participants for coming Japan. He highlighted that the development of next generation AIS was necessary in order to protect the present AIS VDL and that he was looking forward to hearing the participants' opinions on this matter.

After the remarks, Cdr. Noguchi informed the participants of the administration matters during the workshop.

5. Approval of the agenda

The provisional agenda which was attached as Annex 9, was approved. However, due to the schedule of the participants, the order of the agenda was amended and the agenda item 4 “next generation AIS in GMDSS” was discussed before the agenda item 3 “next generation AIS in e-navigation”.

6. Definition of next generation AIS

Cdr. Noguchi explained that the final goal of the workshop was to develop a draft performance standard of next generation AIS or VDE. He added that the name or concept of “next generation AIS” was rejected by IMO and that “VHF Data Exchange (VDE)” may not be limited to the characteristics which defined by ITU-R M.1842-1. He therefore asked the participants how to call and to define the concept of ‘next generation AIS’ in order to progress the work.

The participants discussed the matter and agreed to provisionally to use the term “**VHF Data Exchange System (VDES)**” and to define the system as follows:

> *VHF Data Exchange System (VDES) is VHF Maritime data communication system that includes functions of AIS, facilitates e-navigation, supports GMDSS modernization and general maritime communication.*

7. VDES in future GMDSS

Cdr. Noguchi reported that at its eighth meeting, the joint IMO/ITU Expert Group agreed that the following new equipment, systems and technologies, currently not included in GMDSS, might be included in the modernized GMDSS:

.1 AIS, including Satellite monitoring of AIS and additional AIS channels for identification but not alerting;
.2 HF E-mail and data systems;
.3 VHF data systems;
.4 Application Specific Messages over AIS or VHF data systems;
.5 NAVDAT;
.6 Modern satellite communication technologies;
.7 Additional GMDSS satellite service providers;
.8 Hand-held satellite telephones in survival craft;
.9 Hand-held VHF with DSC and GNSS for survival craft;
.10 Man Overboard Devices;
.11 Cospas-Sarsat MEOSAR system; and
.12 AIS and GNSS-equipped EPIRBs.

(elements underlined are related to AIS or VDES developments)

From this, he asked the participants what functions were needed to include VDES in the modernization of GMDSS.

The participants discussed the matter and agreed that the following functions could be included.

VDES could:

- include alerting function with nature of distress using existing message;
- include acknowledgement using existing message;
- be able to receive distress alert and acknowledgement;
- include reliability on latency of the data being transmitted;
- include locating and identification capability;
- include data communication capability between ship - ship, ship - shore and ship - SAR aircraft and support subsequent communication;
- include MSI promulgation;
- be capable of urgency and safety alerting/ acknowledging and communication;
- be capable of transmitting messages with the priority of distress, urgency, safety and general.
- provide access to data or data base for assist SAR automatically and autonomously

8. Next generation AIS (VDES) in e-navigation

Cdr. Noguchi noted that the VDES could enhance e-navigation and thus the function of VDES in e-navigation should be considered. He then explained that such consideration would be done in accordance with the e-navigation solutions that had been proposed by the IMO Correspondence Group on e-navigation. The tasks under the agenda were as follows:

A) To what solution VDES can contribute and how?
B) From the above question, what functions and information are needed?

To facilitate the discussion, the chair developed a draft table with VDES contributions and functions for e-navigation solutions. The participants discussed and completed the table (attached as Annex 10). The following functions were identified.

VDES should:

- use high level interface (e.g. IEC 61162-450);
- use common phrase of communication;
- permit text message;
- use S-100 and Common Maritime Data Structure (CMDS);

- use common templates;
- use automatic timing based on events;
- use machine to machine communication;
- use user-friendly human interface;
- provide multiple access to information network amongst ships and shore users;
- have the ability to cross check multiple sources of critical navigation information;
- use a standard management method for incorrect data;
- use automation in action, integrity and interface;
- enable automatic updates based on events;
- access the update status by globally available means;
- use short text message
- use additional data beyond voice communication (machine to machine communication);
- prioritize SAR message in slot management;
- enable gathering necessary information from different data sources shore and onboard;
- provide efficient remote access to ship owners;
- provide an automated record of data transfer;
- use automatic selection of access means;
- use automatic exchange of data and information;
- use automated access to shore based data base of information regarding navigation and others (e.g. metrological, hydrographical, traffic);
- use automated broadcast of information regarding navigation and other;
- use automatic and autonomous data communication;
- use automatic and accurate logging of data communication;

During the discussion, there were two different opinions expressed regarding an automatic selection of the most appropriate communication means. One opinion indicated that it was enough to have an automatic selection of only VHF data communication means in VDES and noted it was not necessary to consider other communication means. The other opinion was that it was better to have an automatic selection of other communication means such as MF, HF, satellite in addition to the VHF. The participants noted that this matter would require further discussion as the concept of VDES develops.

Dr. Fukuto pointed out the necessity of the development of peripheral devices such as display, and that the integration of data in these peripheral devices would need to be consistent and reliable. Although this matter was out of the subject of this workshop, the participants agreed that this matter would need further consideration as the concept of VDES develops.

9. Application of next generation AIS (VDES)

The overarching functions were discussed and identified as follows:

VDES should

- provide an acknowledgement of messages;
- use S-100, Common Maritime Data Structure and high level interface (e.g. IEC 61162- 450);
- use self-diagnostic and heartbeat function;
- use Recommendation ITU-R M.1842-1 (update);
- have secure communication capability.

10. Any other business

Mr. Bober referred to some slides that were presented at the IALA e-NAV meeting by Mr. Oltmman of WSV, Germany and explained the position of VDES in e-navigation. He said that VDES was located in the physical links of e-navigation architecture and asked where the VDES may be positioned in the shipboard e-navigation architecture. The participants agreed that VDES was a unique equipment with capability of both navigational and communication equipment and therefore it was difficult to locate the position into the existing shipboard e-navigation architecture.

Mr. Norsworthy explained the issue of frequencies for VDES. His explanation was as follows;

1. Protect the integrity of the AIS/VDE shipborne receivers

AIS and VDE use efficient SDR receivers (refer to Figure 1) on the upper legs (B-side) of the channels, thus protected from the ships' VHF radio transmitters on the lower legs (A-side) by a Bandpass filter.

2. Duplex channels are used conventionally for ship-shore

In ship-shore mode, VDE is transmitted by ships on the lower legs (A-side) and by shore stations on the upper legs (B-side). This arrangement plus the higher data rate for VDE (preferably 307.2 kbps, per Table 4) minimizes potential conflicts between AIS and VDE.

3. Duplex channels are used in simplex mode for ship-ship

In ship-ship mode, VDE is transmitted by ships on the upper legs (B-side), because the VDE ships' receivers are on the B-side. The higher data rate (307.2 kbps) is preferred to shorten (by 32X) the transmission time and minimize the potential conflicts between AIS and VDE.

4. Future satellite downlink is possible

Since VDE communications ship-ship and ship-shore will prefer the higher data rate (307.2 kbps), the 50 kHz channel at 153.6 kbps (Table 4) could be made available for a future satellite downlink.
5. Ship-shore use of duplex channels for VDE is practical
Shore stations operating both AIS and VDE will prefer the higher data rate (307.2 kbps) for VDE to minimize the transmission time, and since their VDE transmissions are not time-critical, they can defer to the AIS.
6. AIS and VDE channels are frequency-contiguous
The AIS and VDE channels (Table 2) are a frequency-contiguous block in Appendix 18 of the Radio Regulations. This configuration provides the maximum spectrum efficiency, highest equipment performance, minimum implementation cost and complexity (facilitates use of SDR technology, refer to Figures 1-3) and minimum regulatory impact.

After the discussion, the participants developed the Executive Summary of the workshop and produced six conclusions and three recommendations. The Executive Summary was attached on the beginning of the report.

11. Official reception

The official reception of the workshop hosted by the JCG and the OPRF was held at the restaurant of the Nippon Zaidan Building in the evening on 4th December 2012. After the opening speech of Mr. Akifumi SUZUKI, Director General, Maritime Traffic Department, JCG, the participants and guest enjoyed conversation on the aspects of e-navigation and AIS development, and deepened their friendship.

12. Technical tour

The technical tour to the National Maritime Research Institute (NMRI), Mitaka, Tokyo, was conducted on 5th December 2012. Following the video on the introduction of the NMRI, the participants observed three facilities, the Actual Sea Model Basin, Deep-Sea Basin and Bridge Simulator for Navigational Risk Research. The participants were impressed with the latest technology studied at the NMRI and gained valuable knowledge and experience through the observation. On the return journey, the participants had an opportunity to enjoy Japanese tradition and culture at the Jindai-ji temple.

13. Closing of the meeting

The Chair expressed his appreciation to the participants for their contributions to the workshop. He added that despite this workshop is the first of its kind, very good results were achieved by the contributions. The participants responded by saying that they were most grateful to the JCG and the OPRF for hosting the workshop, especially to the Chair and the secretariat of junior JCG officers and an intern for their hard work. The Chair wished everyone a safe journey home and then declared the meeting closed.

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PARTICIPANTS

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	Dr. Junji FUKUTO National Maritime Research Institute
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Capt. Ko IGARASHI
Japan Coast Guard

Mr. Norihiro KOIDE
Japan Coast Guard

Mr. Kazushige HANANO
Japan Coast Guard

Cdr Hideki NOGUCHI (Chair)
Japan Coast Guard

United Kingdom	Mr. Jan SAFAR General Lighthouse Authority
United States	Mr. William David KAUTZ United States Coast Guard
	Mr. Ross Walter NORSWORTHY United States Coast Guard

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Agenda Item

1. Adaption of agenda
2. Definition of next generation AIS
3. Next generation AIS in GMDSS
4. Next generation AIS in e-navigation
5. Application of next generation AIS
6. Any other business

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Australian Government
Australian Maritime Safety Authority

AIS – looking to the future

Innovative uses of AIS

Jillian Carson-Jackson M. Ed; MNI; FRIN

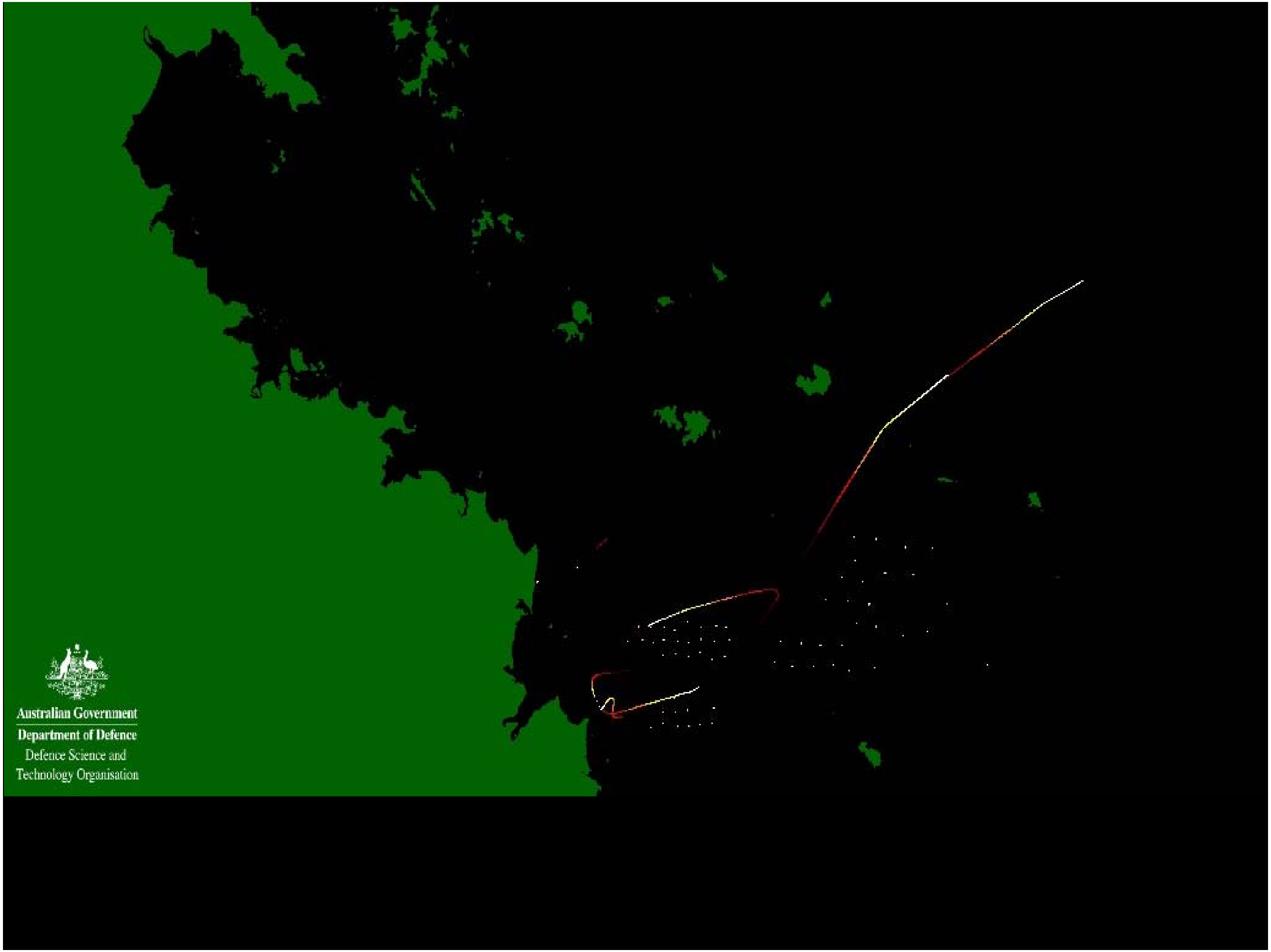
Manager Vessel Traffic and Pilotage Services

Australian Maritime Safety Authority

Australian Government
Australian Maritime Safety Authority

Developments in AIS

- Pilot boarding helicopters
- Man overboard (AIS MOB)
- Diver units
- AIS Class B (small format)


Australian Government
Department of Defence
Defence Science and
Technology Organisation

Australian Government
Australian Maritime Safety Authority

Examples of AIS data use

- Invasive Species Research
  - Looking at where ships have been / are going
  - Investigating possible monitoring of invasive species.
- Ship Emissions Inventory Baseline

  Ship movement data set challenges:
  - Dataset size
  - Data anomalies

CSIRO

AMC
AUSTRALIAN MARITIME COLLEGE

Australian Government
Australian Maritime Safety Authority

AIS on pilot boarding helicopters

Australian Government
Australian Maritime Safety Authority

AIS Antenna

Display for Pilot Viewing

Australian Government
Australian Maritime Safety Authority

AIS MOB units

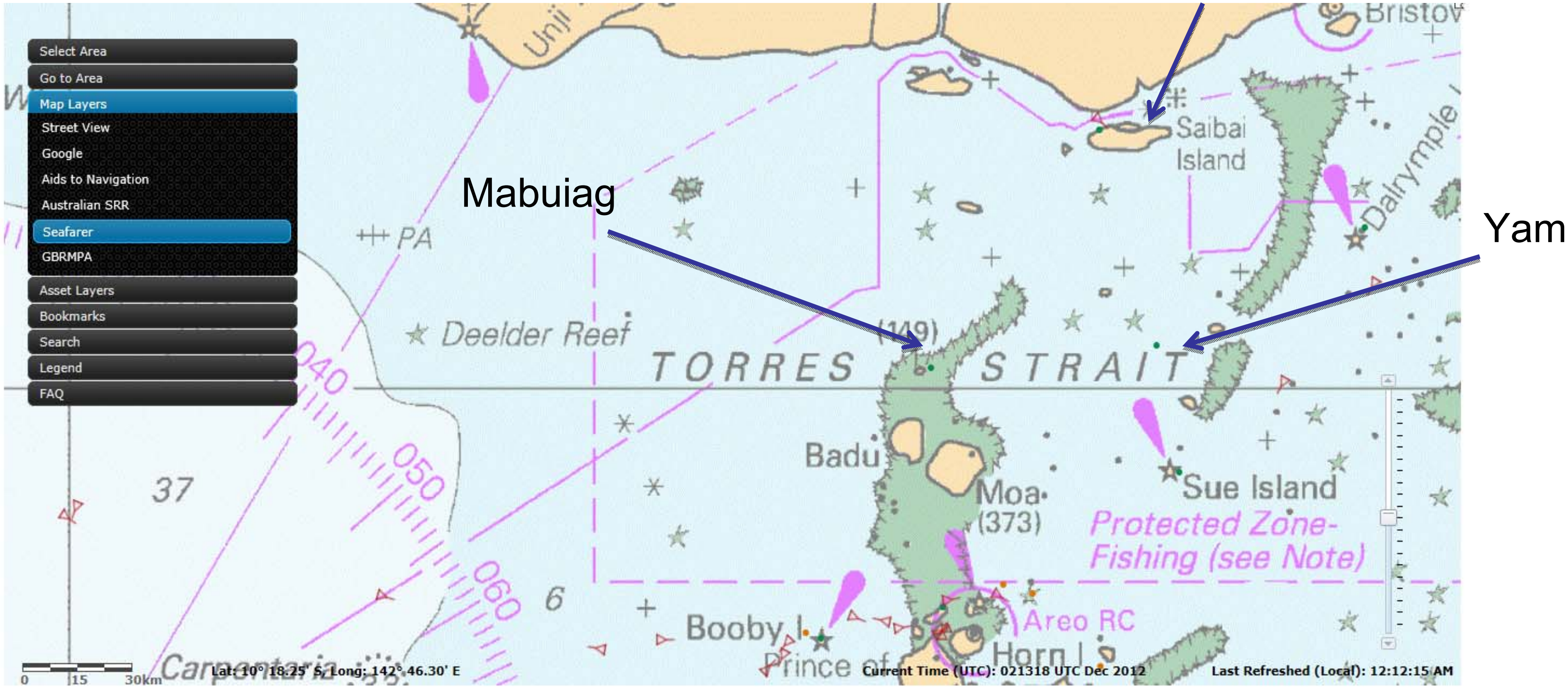
Australian Government

Australian Maritime Safety Authority

AIS diver unit

Australian Government
Australian Maritime Safety Authority

Safety in the Torres Strait



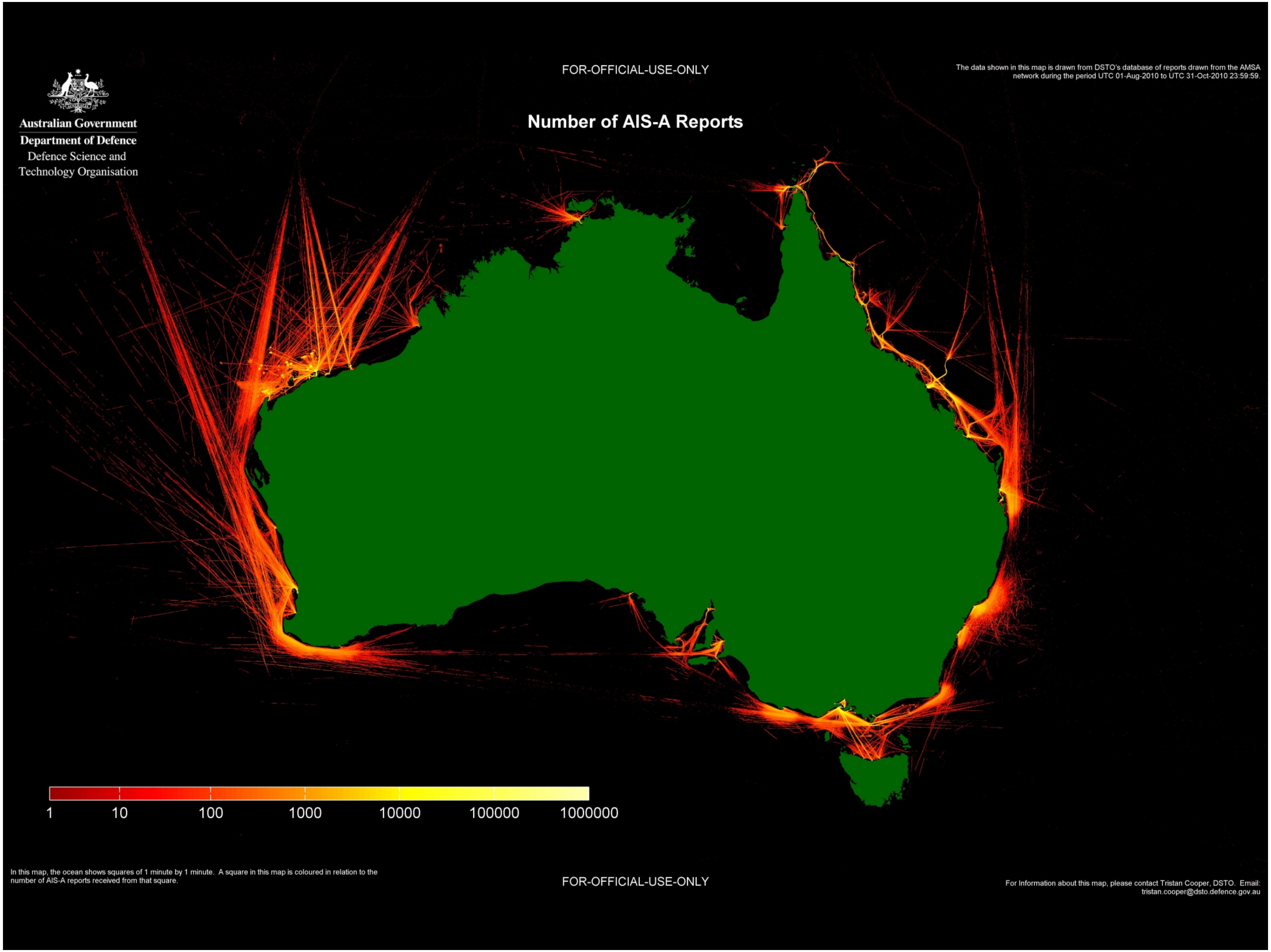
Australian Government
Australian Maritime Safety Authority

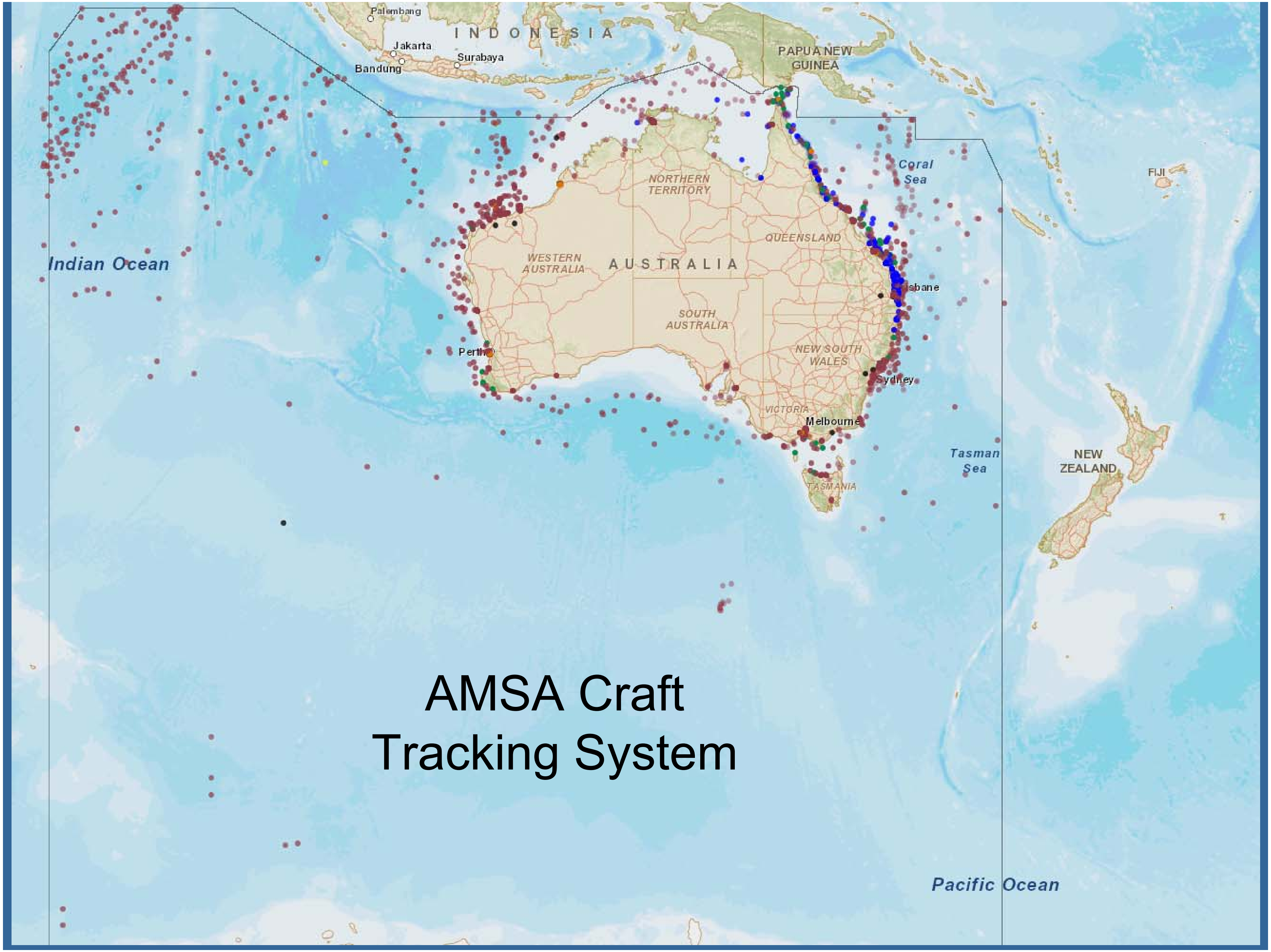
Grab Bag Program

Australian Government
Australian Maritime Safety Authority

Challenges…

- Implication for VDL
- Standards for developing units
- MMSI numbering convention
- Incorrect data in AIS
- Operational aspects
- Display / symbology
- Other issues…


FOR-OFFICIAL-USE-ONLY
The data shown in this map is drawn from DSTO's database of reports drawn from the AMSA network during the period UTC 01-Aug-2010 to UTC 31-Oct-2010 23:59:59.
Australian Government
Department of Defence
Defence Science and Technology Organisation
Number of AIS-A Reports
1
10
100
1000
10000
100000
1000000
In this map, the ocean shows squares of 1 minute by 1 minute. A square in this map is coloured in relation to the number of AIS-A reports received from that square.
FOR-OFFICIAL-USE-ONLY
For Information about this map, please contact Tristan Cooper, DSTO. Email: tristan.cooper@dsto.defence.gov.au


Palembang
INDONESIA
Jakarta
Surabaya
Bandung
PAPUA NEW GUINEA
Coral Sea
FIJI
NORTHERN TERRITORY
QUEENSLAND
Indian Ocean
WESTERN AUSTRALIA
AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
Perth
Sydney
VICTORIA
Melbourne
Tasman Sea
NEW ZEALAND
TASMANIA
AMSA Craft
Tracking System
Pacific Ocean

Ship Tracking via AIS

ONE technology TWO problems solved

Collision Avoidance

Tracking

JCG

Workshop
AIS/VDE
03.-07.12.2012
Tokyo

Ship Tracking via AIS

- Today
  - Currently there are several providers offering globally satellite AIS which includes both satellite and terrestrial feeds.
  - Administrations are combining their terrestrial AIS infrastructure with satellite feeds to obtain complete EEZ coverage.
  - Detection probability, in dense areas, varies depending upon provider between ~60% and ~80% in a 12 hour period (12 hours = global first pass for polar orbiting satellites)

Ship Tracking via AIS

- Tomorrow
  - AIS 3 and 4 should enable 100% detection of Class A units
    - Should SART, MOB, and EPIRB devices be on these channels?
  - Class B CS and SO units will not be allowed on these channels so what is this population … ??
    - Class B SO is intended for professional ships between SOLAS and Recreational and would be expected to operate outside terrestrial coverage
    - Class B CS units are intended for recreational purposes but they have been mandated unto professional ships and are routinely found outside terrestrial coverage and even outside EEZs

Ship Tracking via AIS

- The Problem with Class B Detection
  - Low Power
  - Infrequent transmissions
  - Majority of population found in the most dense regions
- Tracking is pushing AIS to ever smaller vessels
- We've solved tracking of Class A – How do we solve tracking of Class B – Can we work with AIS 5 & 6?

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What we see today

- The following slides show the traffic density globally and in several of the more heavily trafficked areas of the world
- Red indicates the highest density
- The data is satellite only

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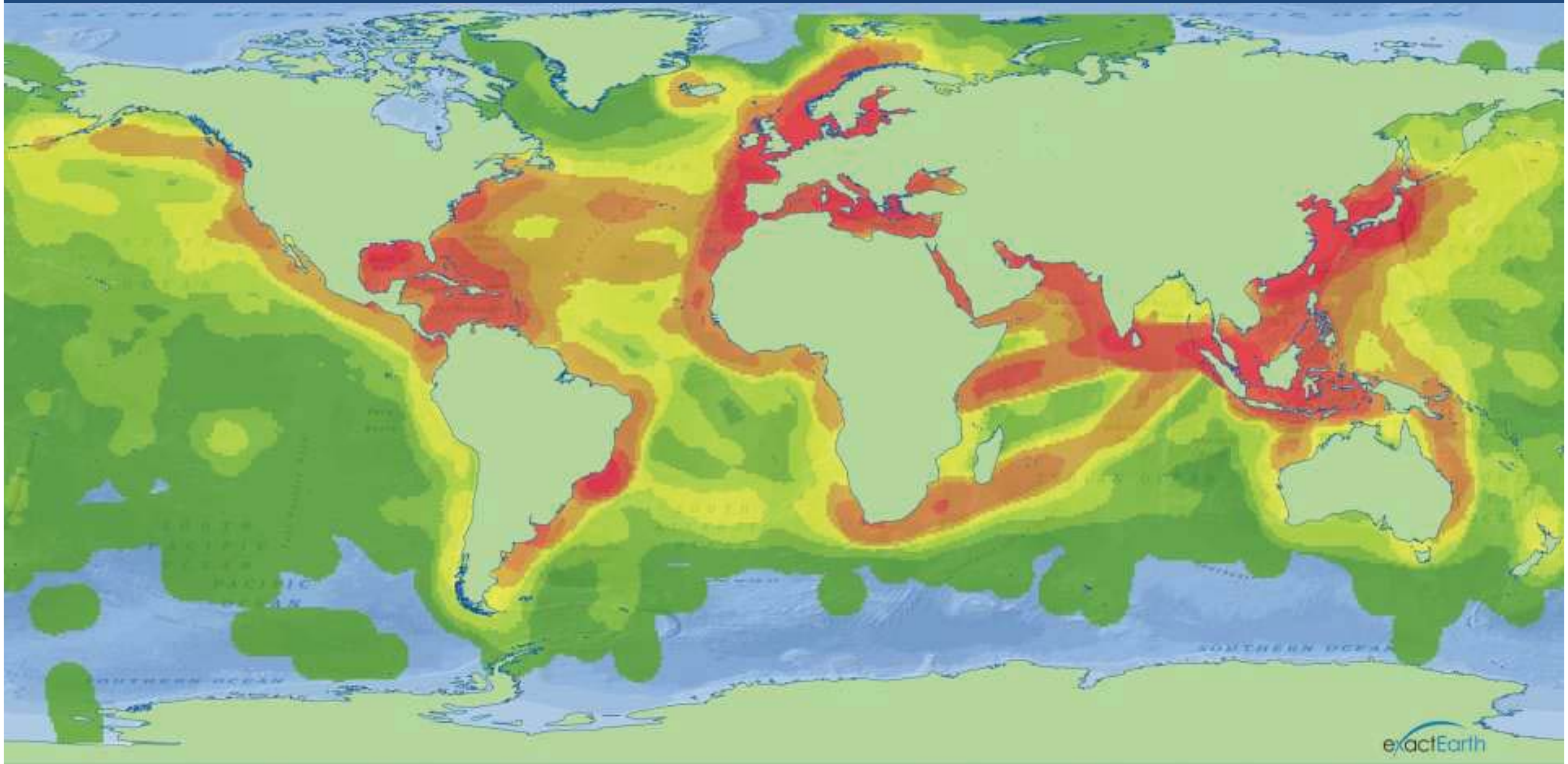
Global Density, November18 – 20, 2012



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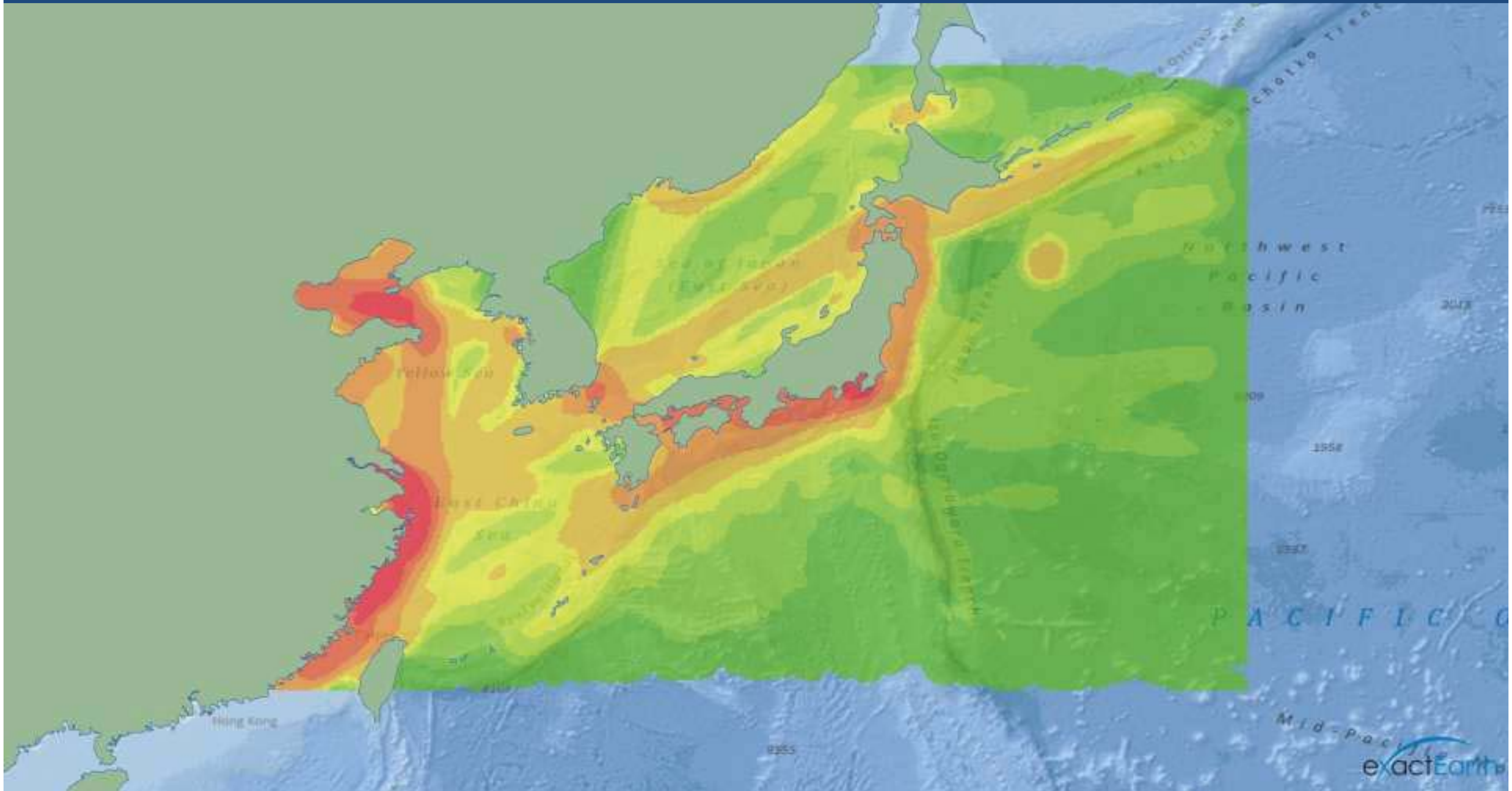
Japan Density, November 1 - 7, 2012



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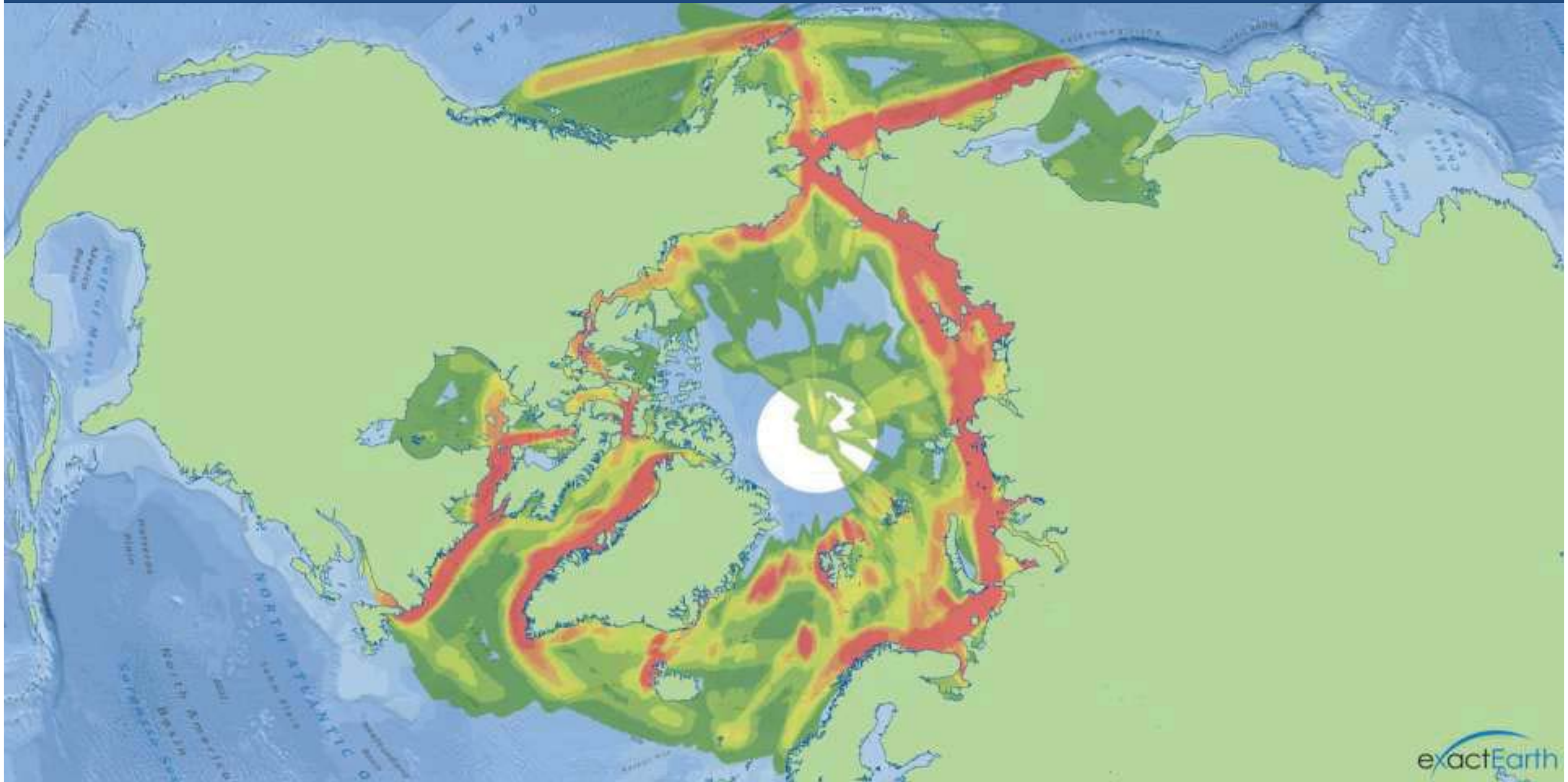
Arctic Density, July – October 2011



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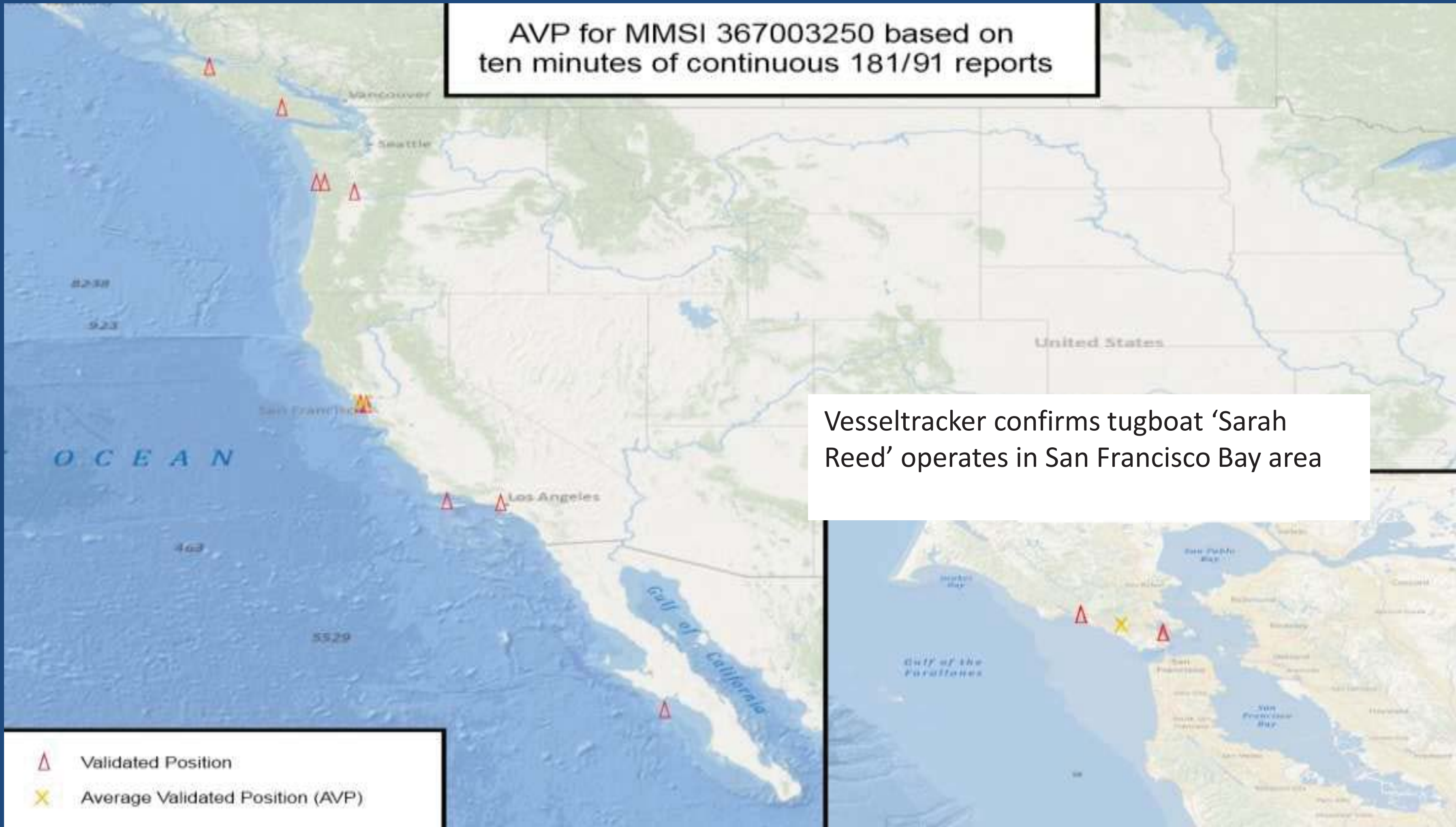
Who is Who?

- Satellite view often captures 181/91
- Satellite view often captures duplicate MMSI's
- These problems are NOT unique to satellite reception
- Positional Validation can not only resolve intentional spoofing but also these operational problems

181/91 – where are they?



Vesseltracker confirms tugboat 'Sarah Reed' operates in San Francisco Bay area

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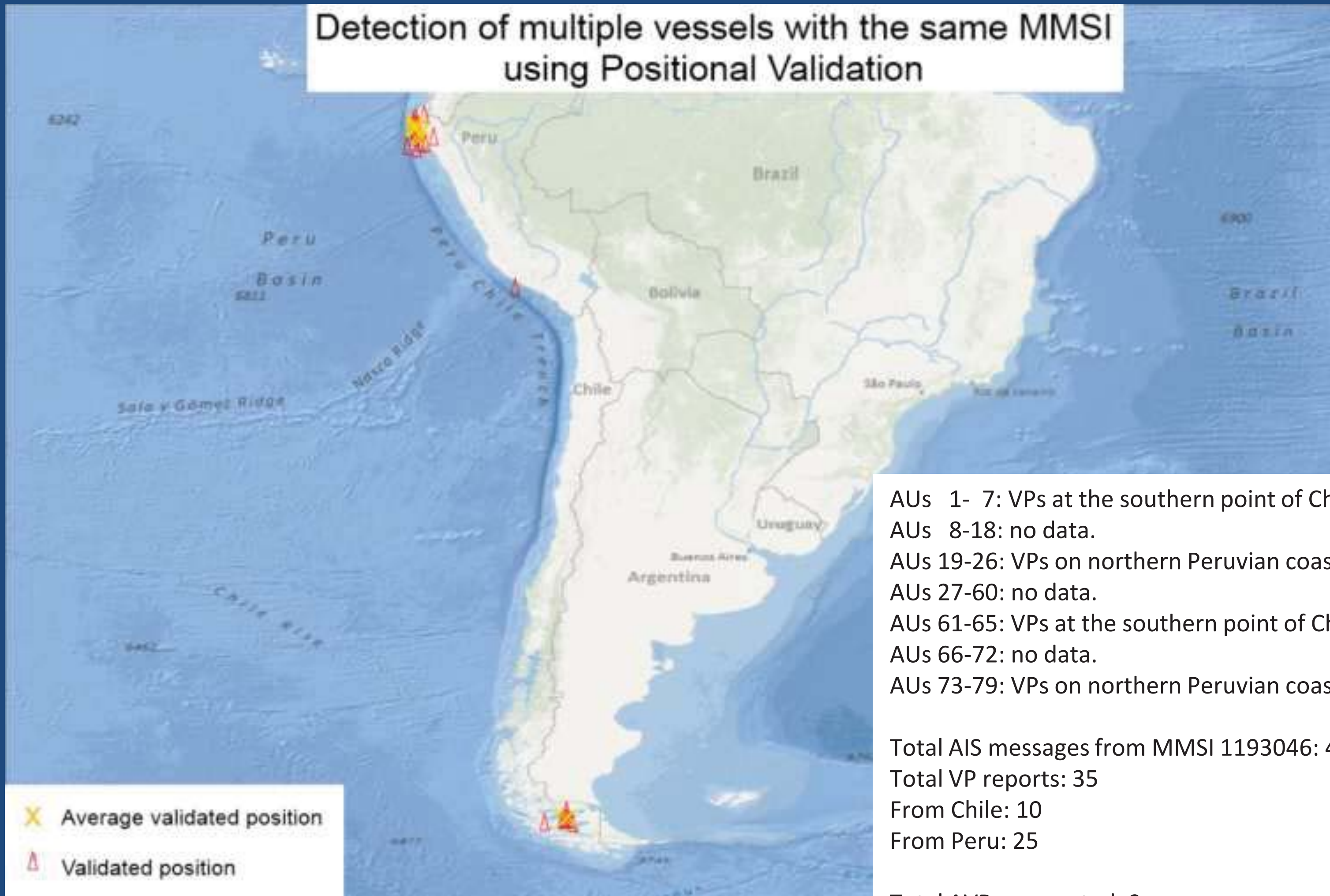
Duplicate MMSI – who is who?



AUs 1- 7: VPs at the southern point of Chile.
AUs 8-18: no data.
AUs 19-26: VPs on northern Peruvian coast.
AUs 27-60: no data.
AUs 61-65: VPs at the southern point of Chile.
AUs 66-72: no data.
AUs 73-79: VPs on northern Peruvian coast.

Total AIS messages from MMSI 1193046: 43
Total VP reports: 35
From Chile: 10
From Peru: 25

Total AVPs generated: 9
From Chile: 2
From Peru: 7

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How is AIS tracking being used?

- Environmental Protection
- Traffic Routing and Planning
- Vessel Monitoring including:
  - Suspicious behavior
    - Illegal fishing
    - Smuggling
  - Distress
- Fusion with radar and optical to identify:
  - Dark targets (not transmitting AIS)
  - Oil Spill violations

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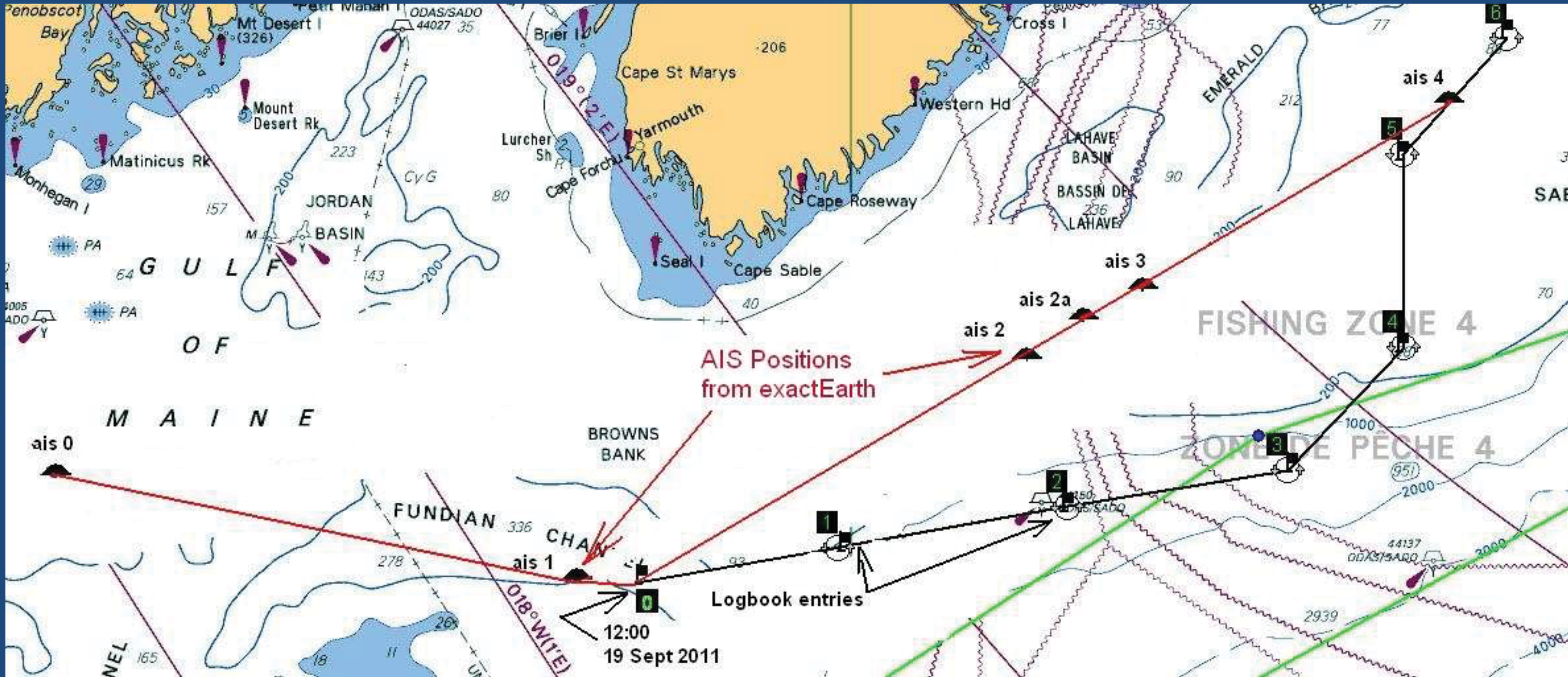
Environmental Protection –

Ballast Exchange



Without satellite AIS authorities must rely on aircraft routine patrols for periodic checks. With satellite AIS providing a track with time, position, heading and speed it becomes a very easy task to track whether a ship made the required deviation in course.

13

Ship Modeling for Traffic Patterns

- Identify traffic patterns to allow for in depth ship modeling and analysis
  - Ships that have travelled the same routes previously, deviating from course .

Detailed tracking of the ill-fated Costa Concordia showing it had successfully made the same route previously before deviating off course.

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Ship in Distress

Clelia II

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Radar/AIS Correlation 6th Fleet Obtained Radar (ASAR); AIS Identified 14 of 20

Location: Ivory Coast

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AIS today

ASM and more

VHF Data Link

AIS

What do we have ?

What do we need ?

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AIS – a succesful story

AIS today

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VHF Data Link

- IMO introduced AIS in 2002
- Mandatory for SOLAS vessel
- regional requirements like fishing fleet, inland shipping, port vessel
- Voluntary equipped ships like recreational vessel
- More than 100.000 AIS stations globally

IMO

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AIS stations – a variety for different users

AIS today

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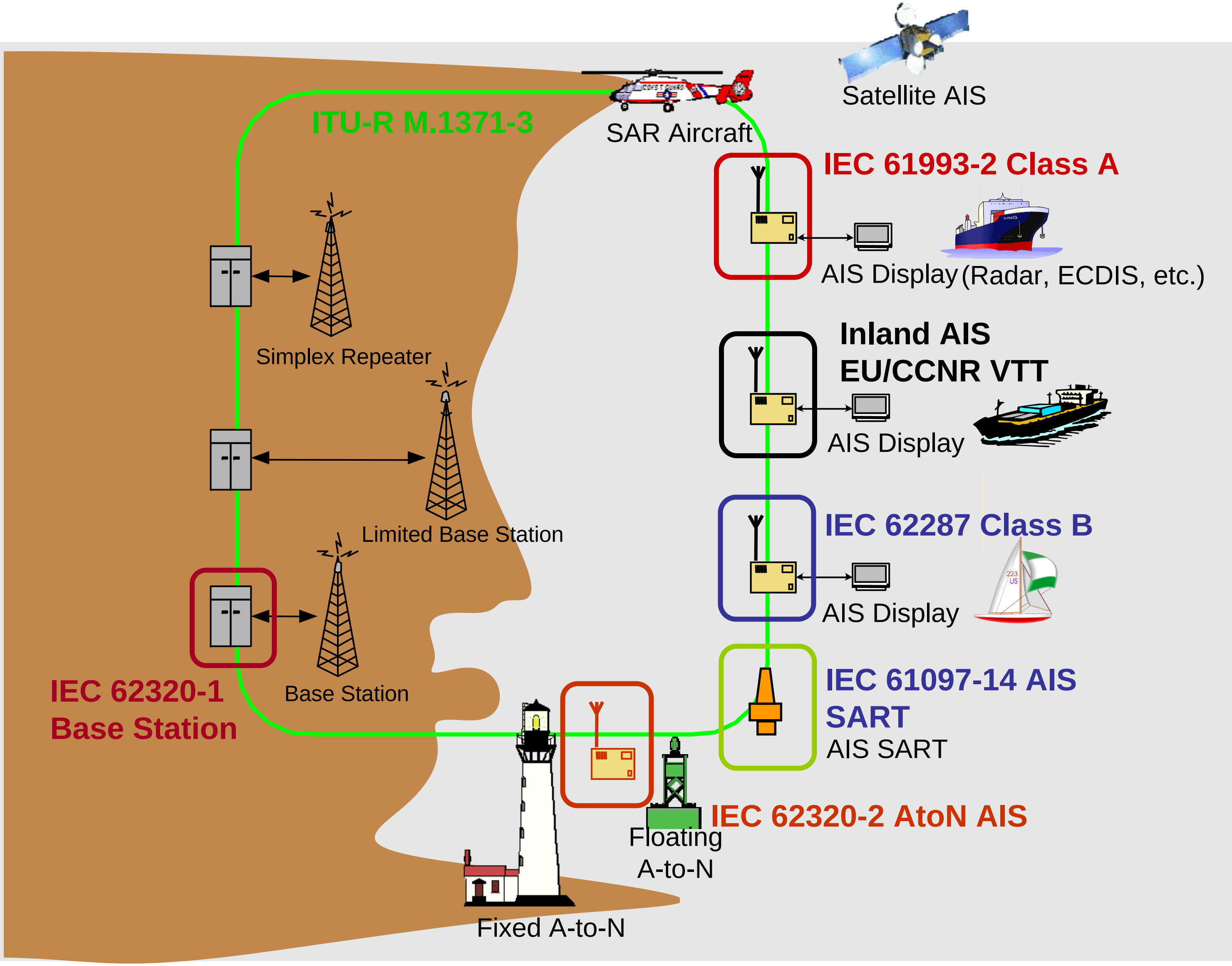
VHF Data Link



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Data available by AIS Class A station

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VHF Data Link

Dynamic Ship Data

- Navigational status
- Position
- Speed SOG
- Course COG
- Heading HDG
- Rate of turn ROT
- Position accuracy

Static Ship Data

- Name of Ship
- Call Sign
- IMO Number
- MMSI
- Type of Ship
- Length
- Beam

Voyage Related Data

- Destination
- ETA
- Draught

Safety Related Data

Addressed or broadcast

- Safety related text
- Application Specific Messages

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Overview of AIS stations and messages

AIS Station	Description	Message ID
Class A Mobile Station	Position Report	1,2,3, 27
	Static and Voyage Related Data	5
Class B Mobile Station	Class B Position Reports, static data	18, 19, 24a/b
SAR AIS Station	SAR Aircraft Position Report	9
AtoN AIS Station	Aids to Navigation Report	21
All AIS Station (if implemented)	Safety Related Message	12, 13, 14, 25, 26
	Binary Message	6, 7, 8
	UTC/Date - enquiry and response	10, 11
	Interrogation	15
Base Station	Base Station Report	4
	DGNSS Broadcast Binary Message	17
	Assignment Mode Command	16, 23
	Data Link Management Command	20
	Channel Management Command	22

Wir machen Schifffahrt möglich.

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Automatic Identification System

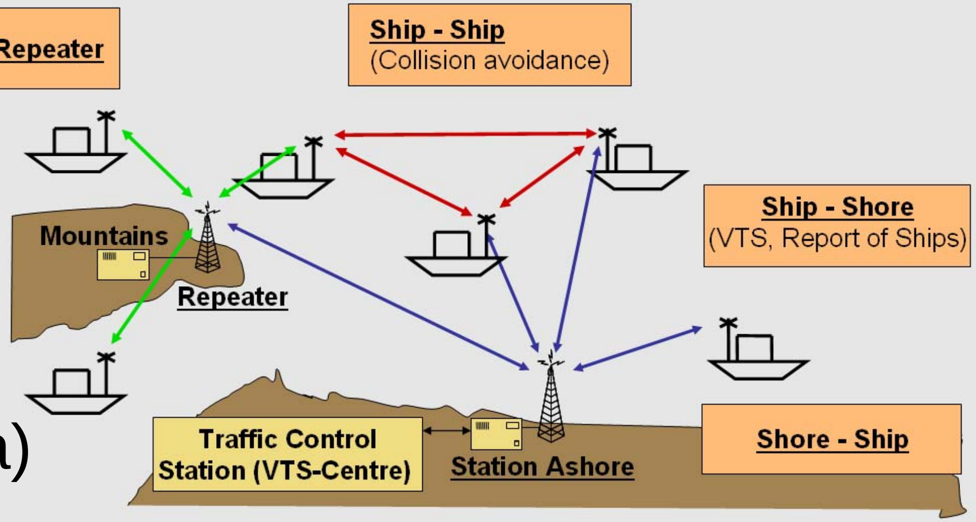
AIS today

ASM and more

VHF Data Link

AIS mainly identification and position reporting

(dynamic and static ship data)



Some additonal capability for data exchange via Application Specific Messages (ASM) using binary messages

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Application Specific Messages ASM and more

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AIS today

ASM and more

VHF Data Link

IMO SN.1/Circ.289 „ Guidance on the use of AIS Application Specific Messages"

ASM provides pre-defined information packages

- 14 ASM are defined by IMO recommened for international use

IALA Collection of regional / local Application Specific Messages

IALA establishes a collection of ASM used in different regions, e.g.

- Saint Lawrence Seaway , Inland AIS in Europe, Danish Maritime Authority, USCG RDC, …

IMO gap analyses

Identifies the need for inproved communication e.g.

- ships to report information to other ships and shore stations;
- shore stations to report navigation information, conditions and warnings
- ship reporting to be simplified
- may reduce verbal communication and enhance reliable information exchange and reduce operator's workload.

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Application Specific Messages ASM

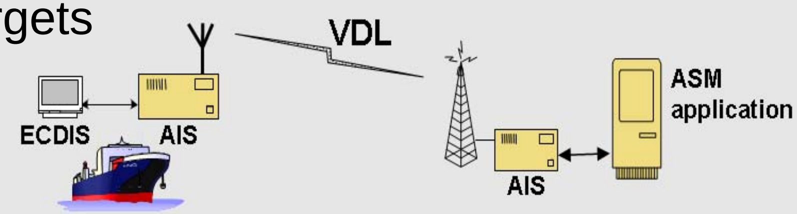
AIS today

ASM and more

VHF Data Link

IMO SN.1/Circ.289 „ Guidance on the use of AIS Application Specific Messages"

- Number of persons on board
- VTS-generated/synthetic targets
- Clearance time to enter port
- Marine traffic signal
- Berthing data
- Weather observation report from ship
- Area notice – broadcast / addressed
- Extended ship static and voyage-related data
- Dangerous cargo indication
- Environmental
- Route information – broadcast / addressed
- Text description – broadcast / addressed
- Meteorological and Hydrographic data
- Tidal window



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Sharing the VHF Data Link

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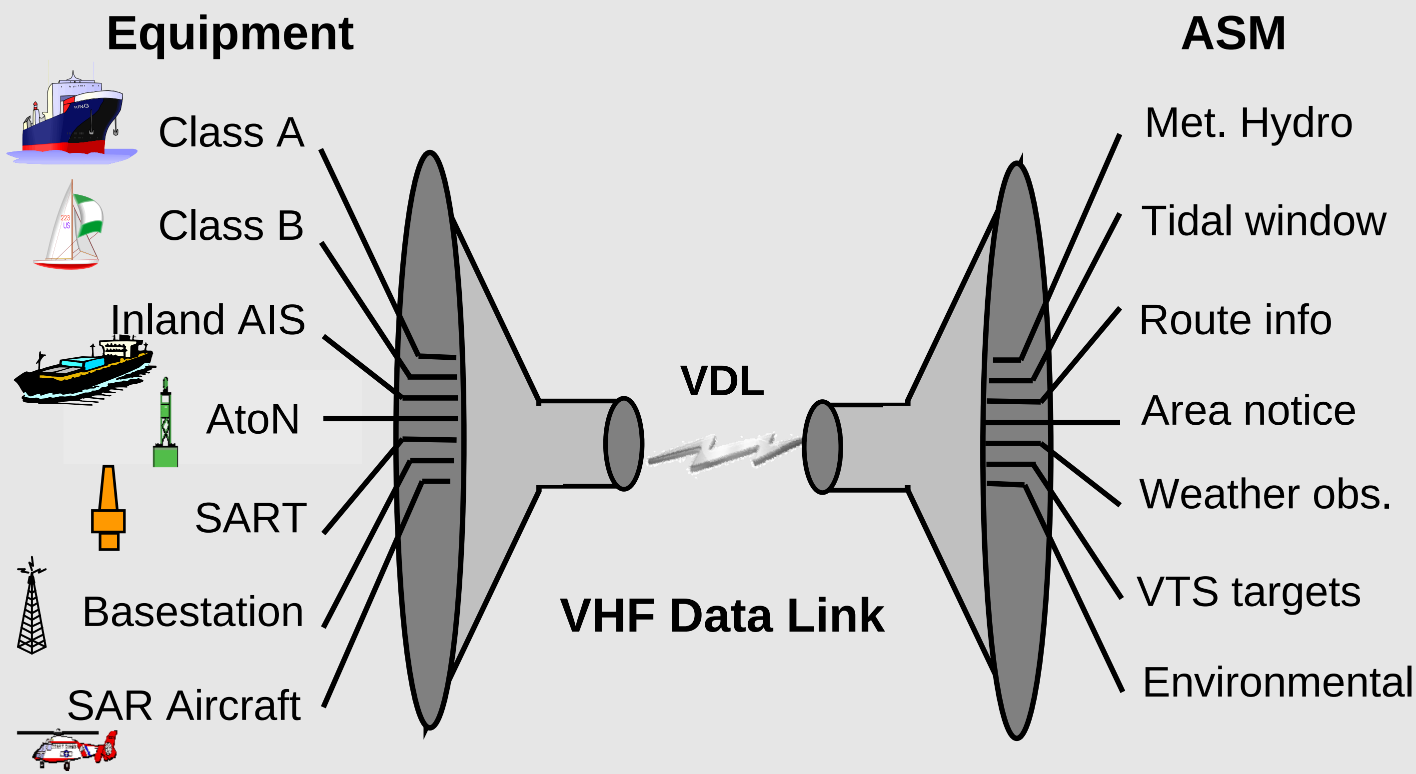
AIS today

ASM and more

VHF Data Link

All Stations using the same VHF Data Link with restricted capacity to transfer all information.



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Sharing the VHF Data Link

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VHF Data Link

Need more capacity

for safety of navigation data communication

Expansion of AIS capability by VDE

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What has been proven in AIS

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AIS today

ASM and more

VHF Data Link

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- Maritime VHF mobile band
  - use of exclusive channels for communication for safety of navigation
- Operation
  - Ship to ship, ship to shore, shore to ship
  - Broadcast and addressed messaging
  - Reservation of certain capacity (quality of service)
- Technical solution
  - Selforganising TDMA system
  - Robustnes in overload szenarios

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AIS - bounds and limitations

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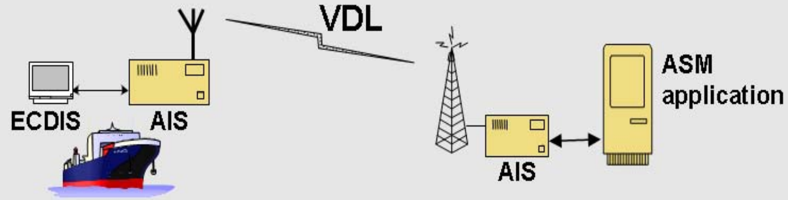
AIS today

ASM and more

VHF Data Link

- Restricted ASM capability (few bytes)



- Broadcast system
  - Oversampling principle
  - no error correction
  - error detection results in no message delivery

Number of slots	Maximum binary data bytes
1	12
2	40
3	68
4	96
5	121

Message 8: Binary broadcast message

- Addressed communication
  - addressee is AIS station
  - no application to application communication

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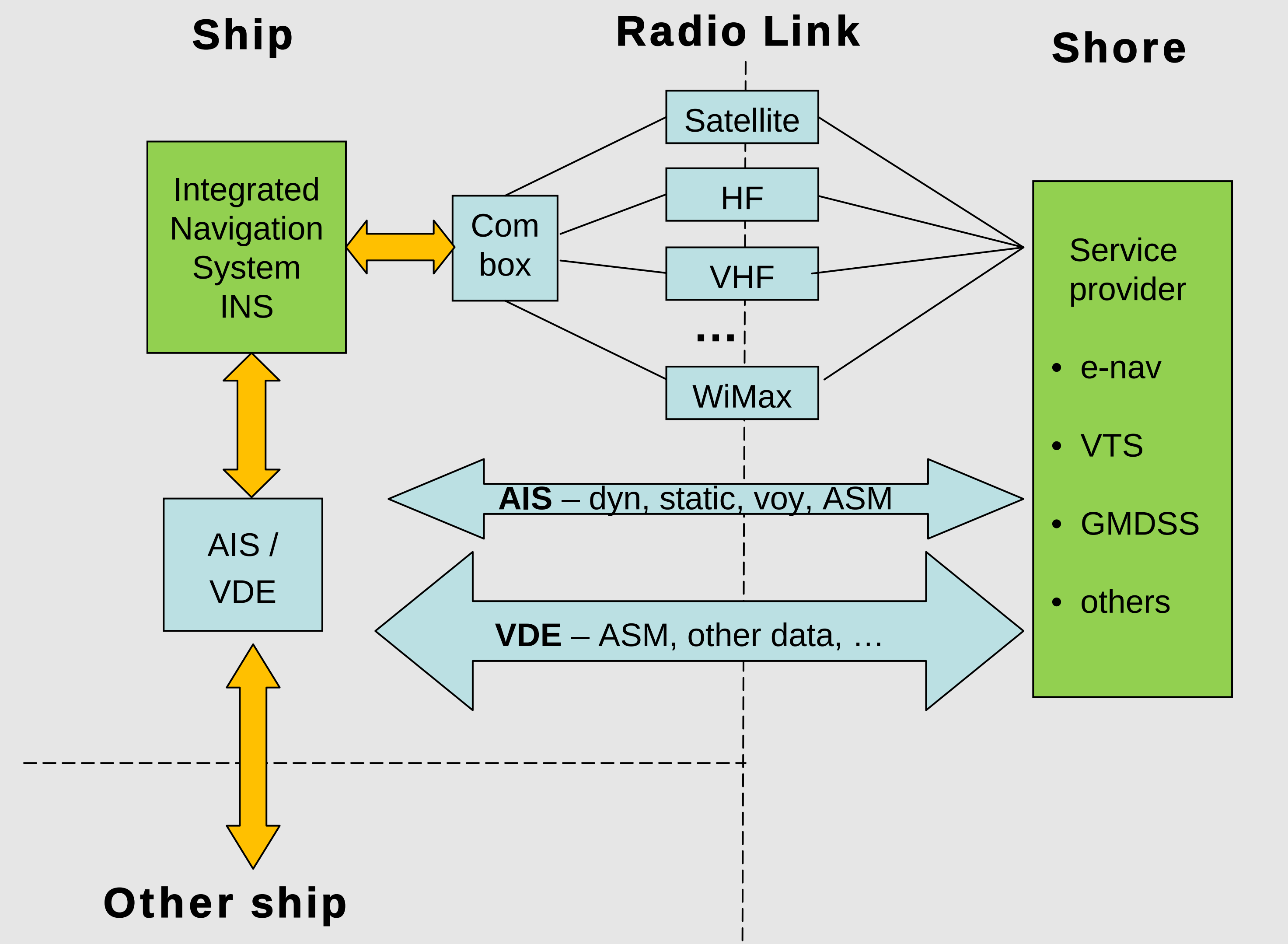
AIS / VDE – part of communication system

AIS today

ASM and more

VHF Data Link



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IALA Plan for future VHF Data Communication

	VHF Data Communications (including VDE)		AIS	
Sub-group	**Data communications using existing AIS protocol**	**Data communications using ITU standard protocol**	**AIS for safety of navigation**	**AIS long range**
Radio channels	• Channels 27 and 28 • World-wide dedicated channels (WRC-15 target)	• Channels 24, 84, 25, 85, 26, 86	• AIS-1 & AIS-2 (simplex)	• Channels 75 and 76 (simplex) o WRC-12
Functionality	• Marine safety information • Marine security information • SSRMs • General purpose information communication	• General purpose data exchange • Robust high speed data exchange	• Safety of navigation • Maritime and inland distress and safety communications (Subject to inclusion in GMDSS Modernization by IMO)	• Space detection of AIS • Future SAR
Message types for AIS protocol	• IMO SN.1/ Circ.289 international application specific messages • Regional application specific messages • Base Station		• Vessel identification • Vessel dynamic data • Vessel static data • Voyage related data • Aids to Navigation • Base Station	• Space detection of AIS • Other messages for support of future SAR
Sub functionality	• Area warnings and advice • Meteorological and hydrological data • Traffic management • Ship-shore data exchange • Channel management	• High message payload	• Ship to ship collision avoidance • VTS • Tracking of ships • Locating in SAR • VDL control (by Base Station)	• Detection of vessels by coastal states beyond range of coastal AIS base stations • Future distress alerting (Subject to inclusion in GMDSS Modernization by IMO)

Wir machen Schifffahrt möglich.

ITU Radiocommunication Study Group Discussion on AIS and VDE

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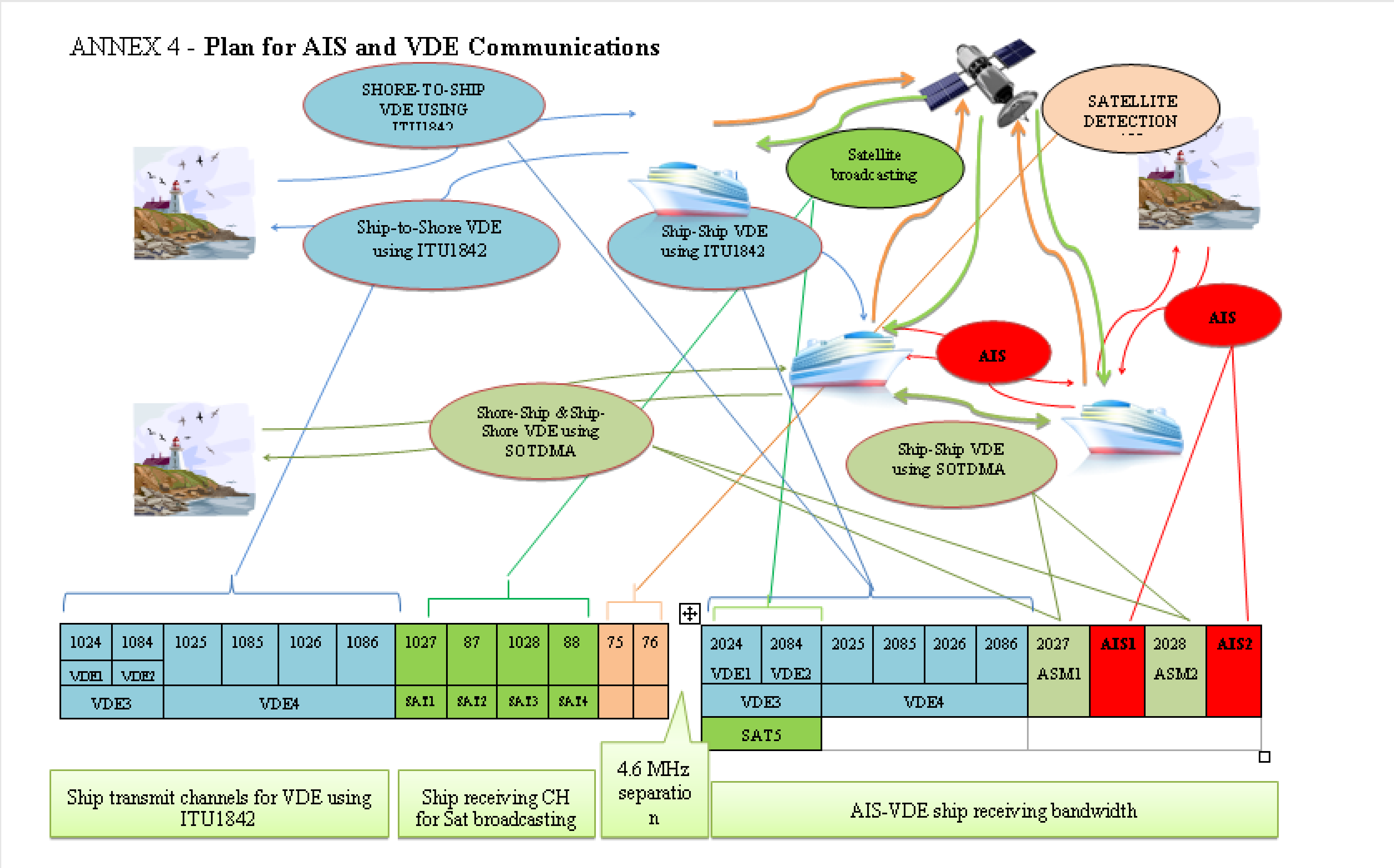

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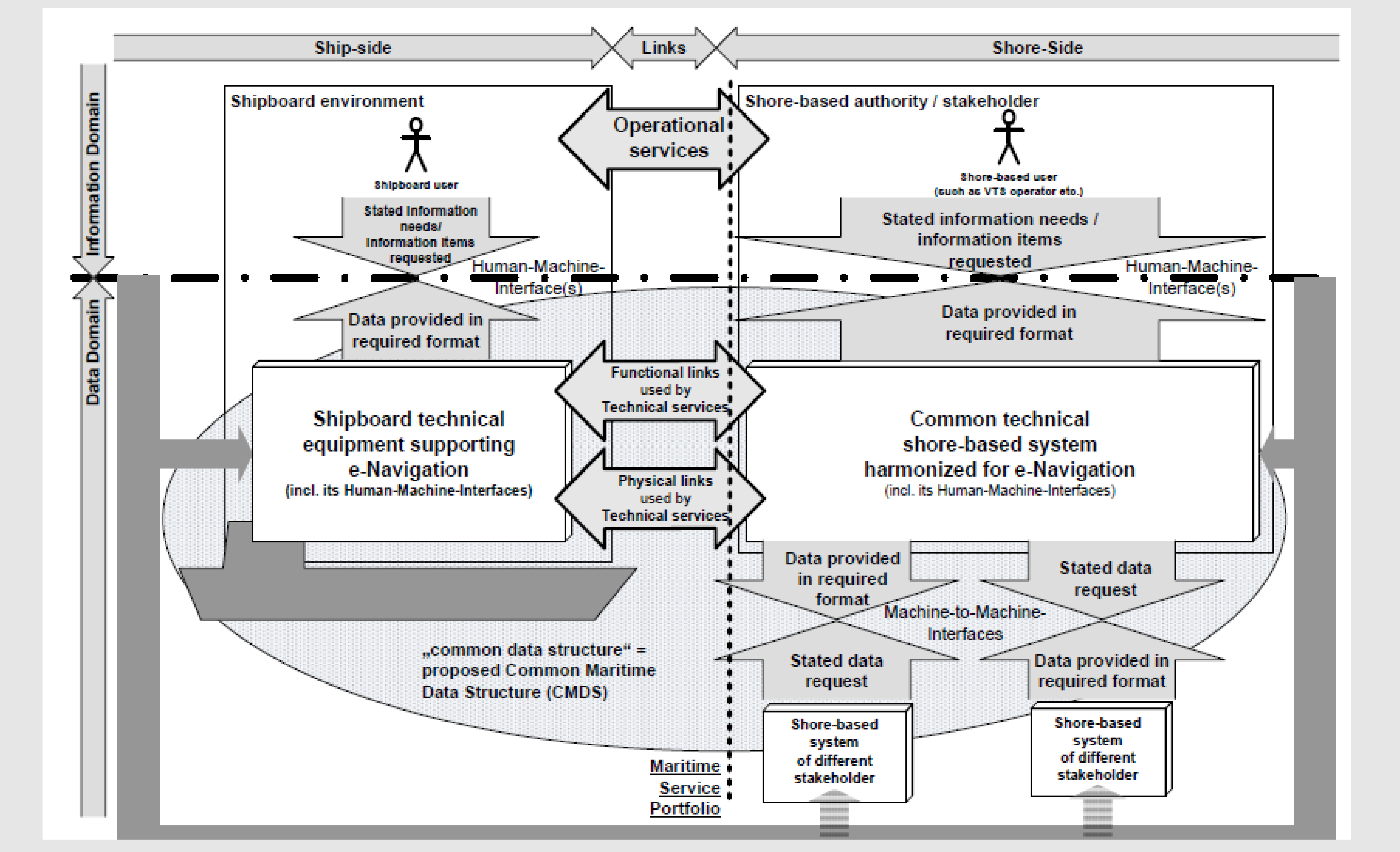
The e - Navigation architecture



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Communications for e-Navigation

Workshop on International Standardization of AIS & Future VDE

By Jan Safar & Nick Ward

December 2012

Tokyo

Research & Radionavigation
General Lighthouse Authorities
United Kingdom and Ireland

Contents

- Communications in the context of e-Navigation
- User requirements
- Desired characteristics
- System requirements
- Standardization approach
- AIS/VDE assumptions and timeline
- Conclusions

e-Navigation - definition

- e-Navigation is the future, digital concept for the maritime sector.
- Harmonized exchange of information is a fundamental part of e-Navigation:
- *"e-Navigation is the harmonised collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment"*

e-Navigation objectives

- Safe and secure navigation of vessels
- Facilitate communications, including data exchange between vessels and shore
- Integrate and present information onboard and ashore to maximize navigation safety benefits and minimize risk of confusion
- Global coverage with consistent standards and interoperability

(From MSC 85/26/Add.1)

User requirements

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GENERAL LIGHTHOUSE AUTHORITIES
United Kingdom and Ireland

- User-selectable information received via communication equipment
  - Identity, position and characteristics of vessels
  - Application Specific Messages
  - AtoNs including Virtual, AtoN information
  - SAR messages
- Promulgation of Maritime Safety Information (MSI)
- Communication between shore and ship in the transmission of safety and environmental information

Desired characteristics

- Universal standards & scalability
- No coverage or capacity limitations (global broadband?)
- Reliability and simplicity
- Compatibility with existing equipment
- Expansion potential
- Software control and updating

Image: Kongsberg

System requirements

- Capacity/data rates/traffic patterns
- Fixed Infrastructure/free-standing
- Satellite/terrestrial/private/public networks
- SDR multi-system/dedicated equipment
- Maritime/multi-sector/business model/public service

Standardisation approach

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GENERAL LIGHTHOUSE AUTHORITIES
United Kingdom and Ireland

- Several international bodies involved in the process – who takes the lead?
- Frequencies/technical characteristics in ITU-R
- Generic performance standards in IMO
- Common test specifications in IEC
- Data exchange/interfaces (S-100)
- Development, system operating guidelines in IALA – driving role?

AIS & VDE assumptions

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General Lighthouse Authorities
United Kingdom and Ireland

- AIS will use AIS-1 and AIS-2, plus channels 75 and 76 for satellite
- VHF Data Exchange (VDE) will use channels 27 and 28 for Application Specific Messages (ASM)
- PLUS the other six 25 kHz channels (see IALA MRCP)
- AIS technical characteristics defined by ITU-R 1371, effectively stabilized at 1371-5
- VDE characteristics could be based on 1371 or 1842 or …

Potential e-Navigation Communications timeline

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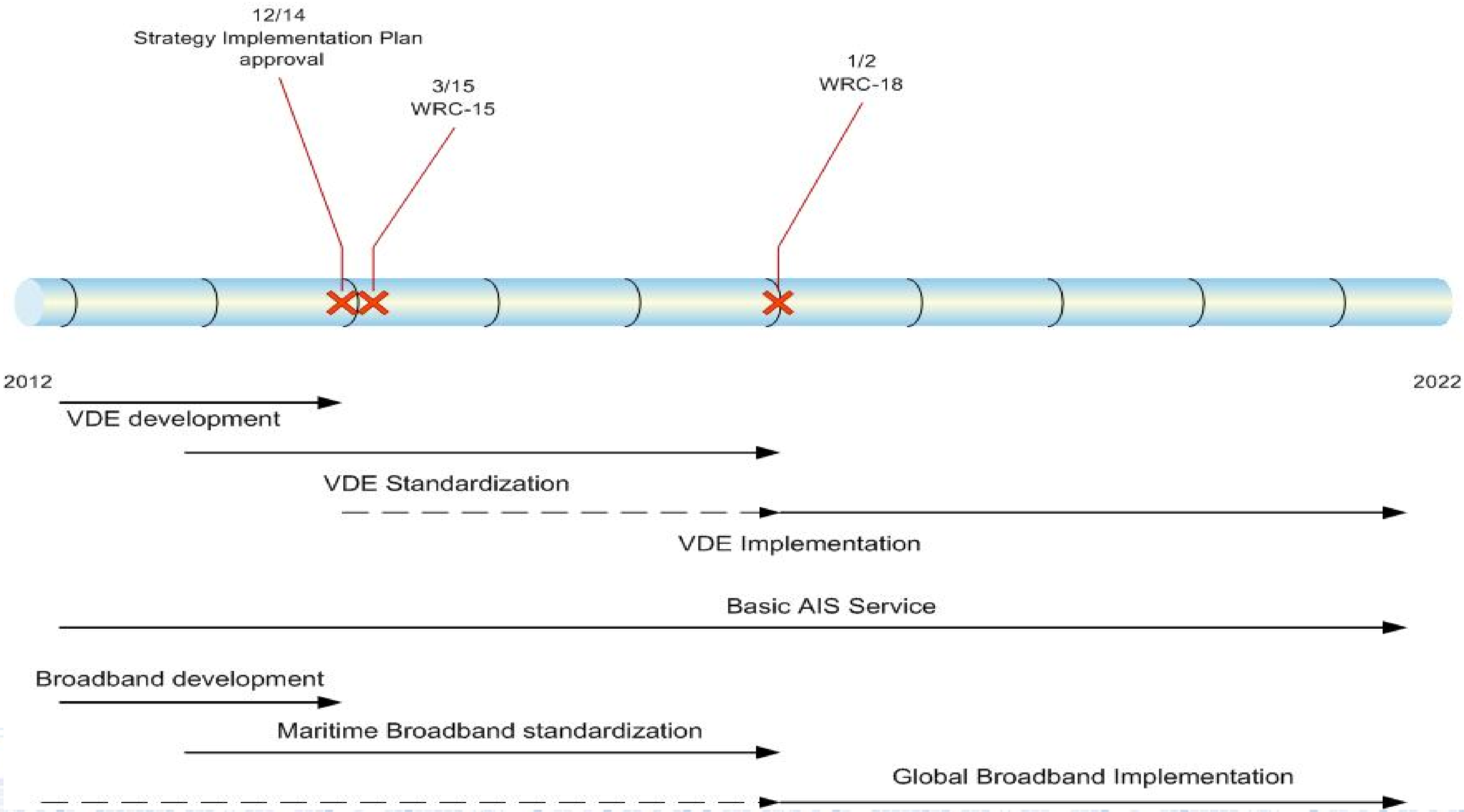

Conclusions

- Communications are crucial to e-Navigation
- May be developed from existing systems
- Generic approach to standards
- Flexibility, multi-system, software-defined
- Harmonized data exchange & presentation (S-100)
- On-line software updating and control
- IALA lead on infrastructure
- Coordination role on services?

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GENERAL LIGHTHOUSE AUTHORITIES
United Kingdom and Ireland

More information

jan.safar@gla-rrnav.org

International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA)

IALA
AISM

AIS and VHF Data Exchange (VDE)

Bill Kautz – U.S. Coast Guard
E-NAV Committee - AIS/COMMS WG
Vice Chair

AIS

- AIS is a proven technology suitable for data communications in e-Navigation.
- Increased use of channels AIS1 & AIS2 threaten AIS performance.
  - must protect these for safety of navigation
- WRC-12
  - approved the use of channels 75 and 76 for long range AIS - satellite detection.
  - approved testing on channels 27 and 28 for possible future AIS technologies

FUTURE USE OF AIS

- AIS 1 and AIS 2
  - Safety of Navigation
  - Vessel Data
  - AtoN
  - Base Station
- Channels 75 and 76
  - Long range AIS (satellite detection)
  - Future SAR
  - Vessel Tracking

IALA
AISM

VHF DATA COMMUNICATIONS

- VHF data communications will provide a robust high-speed/large volume data exchange capability for e-Navigation
- IALA plans to use six VHF data channels for data communications (*24, 84, 25, 85, 26, 86*)
- Plus two additional channels (*27 and 28*)
  - Use AIS technology - move other AIS messages here
- Create an international scheme to be known as “**VHF Data Exchange**” (VDE).

VHF Data Exchange (VDE)

- Four channels (25, 85, 26, and 86) in accordance with ITU-R M1842-1 (Annex 4)
  - *Combine four 25 kHz channels for 100 kHz bandwidth*
- Two channels (24 and 84) in accordance with M1842-1 (Annex 1 or 3)
  - *Combine for 50 kHz bandwidth or use simplex*
- Two channels (27 and 28)
  - *Data communications using existing AIS protocol*

	VHF Data Communications (including VDE)		AIS	
Sub-group	*Data communications using existing AIS protocol*	*Data communications using ITU standard protocol*	*AIS for safety of navigation*	*AIS long range*
Radio channels	• *Channels 27 and 28* • *World-wide dedicated channels (WRC-15 target)*	• *Channels 24, 84, 25, 85, 26, 86*	• *AIS-1 & AIS-2 (simplex)*	• *Channels 75 and 76 (simplex)* ○ *WRC-12*
Functionality	• *Marine safety information* • *Marine security information* • *SSRMs* • *General purpose information communication*	• *General purpose data exchange* • *Robust high speed data exchange*	• *Safety of navigation* • *Maritime and inland distress and safety communications (Subject to inclusion in GMDSS Modernization by IMO)*	• *Space detection of AIS* • *Future SAR*
Message types for AIS protocol	• *IMO SN.1/Circ.289 international application specific messages* • *Regional application specific messages* • *Base Station*		• *Vessel identification* • *Vessel dynamic data* • *Vessel static data* • *Voyage related data* • *Aids to Navigation* • *Base Station*	• *Space detection of AIS* • *Other messages for support of future SAR*
Sub functionality	• *Area warnings and advice* • *Meteorological and hydrological data* • *Traffic management* • *Ship-shore data exchange* • *Channel management*	• *High message payload*	• *Ship to ship collision avoidance* • *VTS* • *Tracking of ships* • *Locating in SAR* • *VDL control (by Base Station)*	• *Detection of vessels by coastal states beyond range of coastal AIS base stations* • *Future distress alerting (Subject to inclusion in GMDSS Modernization by IMO)*

VDE and AIS Plan

- Details available in the IALA Maritime Radio Communications Plan (MRCP) Annex E
  - AIS AND VHF DATA COMMUNICATION

- MRCP recently updated and approved by Council OCT 2012

IALA
AISM

VDE Development

- IMO NAV and IMO/ITU Joint Experts Group (JEG) support further development of VDE
- IALA VDE plan well received by ITU-R WP5B
- ITU-R WP5B has adopted the MRCP and is developing as an ITU-R Report
- Administrations testing VDE concept
- Satellite downlink being considered
- IALA AIS/COMMS WG continuing VDE work

www.iala-aism.org

Thank You!

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Technical Considerations for the Integration of AIS and VDE

Workshop on the International Standardization of the Next Generation AIS

Tokyo, Japan

3-7 December 2012

Rationale for the Integration of AIS and VDE (VHF Data Exchange)

- **Protects the integrity of the AIS VDL (VHF Data Link)**

The AIS (as a SOLAS requirement) was intended primarily for "Navigation Safety/Collision Avoidance." Increased use of AIS Application-Specific Messages (ASM) and other AIS applications and devices competes with this main purpose.

- **Increases the loading capacity of the AIS VDL**

Future AIS overload is anticipated as AIS applications, equipment types and installations increase. The AIS VDL can safely support the increased loading if non-safety-related AIS communications are moved to new channels (VDE).

- **Enhances data communications and spectrum efficiency**

Designating new channels for VDE will provide higher data rates (up to 32X) than AIS, e.g., for use in e-Navigation. The VDE network protocol is optimized for data communications (vs. AIS for navigation) so that each VDE message is transmitted with a very high confidence of reception. Integration with AIS also benefits VDE by automatically identifying and locating ship and shore stations.

- **Uses WRC -12/15/18 provisions for additional frequencies**

APPENDIX 18 (REV.WRC–12)

Table of transmitting frequencies in the VHF maritime mobile band

(See Article **52**)

Channel designator	Notes	Transmitting frequencies (MHz)		Inter-ship	Port operations and ship movement		Public corres-pondence
		From ship stations	From coast stations		Single frequency	Two frequency	
60	m)	156.025	160.625		x	x	x
01	m)	156.050	160.650		x	x	x
61	m)	156.075	160.675		x	x	x
02	m)	156.100	160.700		x	x	x
62	m)	156.125	160.725		x	x	x
03	m)	156.150	160.750		x	x	x
63	m)	156.175	160.775		x	x	x
04	m)	156.200	160.800		x	x	x
64	m)	156.225	160.825		x	x	x
05	m)	156.250	160.850		x	x	x
65	m)	156.275	160.875		x	x	x
06	f)	156.300		x			
2006	r)	160.900	160.900				
66	m)	156.325	160.925		x	x	x
07	m)	156.350	160.950		x	x	x
67	h)	156.375	156.375	x	x		
08		156.400		X			
68		156.425	156.425		x		
09	i)	156.450	156.450	x	x		
69		156.475	156.475	x	x		
10	h), q)	156.500	156.500	x	x		
70	f), j)	156.525	156.525	Digital selective calling for distress, safety and calling			

Appendix 18 (REV.WRC−12, continued)

Channel designator		Notes	Transmitting frequencies (MHz)		Inter-ship	Port operations and ship movement		Public corres-pondence
			From ship stations	From coast stations		Single frequency	Two frequency	
11		q)	156.550	156.550		x		
	71		156.575	156.575		x		
12			156.600	156.600		x		
	72	i)	156.625		x			
13		k)	156.650	156.650	x	x		
	73	h), i)	156.675	156.675	x	x		
14			156.700	156.700		x		
	74		156.725	156.725		x		
15		g)	156.750	156.750	x	x		
	75	n), s)	156.775	156.775		x		
16		f)	156.800	156.800	DISTRESS, SAFETY AND CALLING			
	76	n), s)	156.825	156.825		x		
17		g)	156.850	156.850	x	x		
	77		156.875		x			
18		m)	156.900	161.500		x	x	x
	78	t), u), v)	156.925	161.525		x	x	x
1078			156.925	156.925		x		
	2078		161.525	161.525		x		
19		t), u), v)	156.950	161.550		x	x	x
1019			156.950	156.950		x		
	2019		161.550	161.550		x		
	79	t), u), v)	156.975	161.575		x	x	x
1079			156.975	156.975		x		
	2079		161.575	161.575		x		
20		t), u), v)	157.000	161.600		x	x	x
1020			157.000	157.000		x		
	2020		161.600	161.600		x		

Appendix 18 (REV.WRC–12, continued)

Channel designator	Notes	Transmitting frequencies (MHz)		Inter-ship	Port operations and ship movement		Public corres-pondence
		From ship stations	From coast stations		Single frequency	Two frequency	
80	w), y)	157.025	161.625		x	x	x
21	w), y)	157.050	161.650		x	x	x
81	w), y)	157.075	161.675		x	x	x
22	w), y)	157.100	161.700		x	x	x
82	w), x), y)	157.125	161.725		x	x	x
23	w), x), y)	157.150	161.750		x	x	x
83	w), x), y)	157.175	161.775		x	x	x
24	w), ww), x), y)	157.200	161.800		x	x	x
84	w), ww), x), y)	157.225	161.825		x	x	x
25	w), ww), x), y)	157.250	161.850		x	x	x
85	w), ww), x), y)	157.275	161.875		x	x	x
26	w), ww), x), y)	157.300	161.900		x	x	x
86	w), ww), x), y)	157.325	161.925		x	x	x
27	z)	157.350	161.950			x	x
87	z)	157.375	157.375		x		
28	z)	157.400	162.000			x	x
88	z)	157.425	157.425		x		
AIS 1	f), l), p)	161.975	161.975				
AIS 2	f), l), p)	162.025	162.025				

Notes applicable to AIS and VDE referring to the Appendix 18 Table

c) The channels of the present Appendix, with the exception of channels 06, 13, 15, 16, 17, 70, 75 and 76, may be used for direct-printing telegraphy and data transmission, subject to special arrangement between interested and affected administrations. (WRC−12)

n) With the exception of AIS, the use of these channels (75 and 76) should be restricted to navigation-related communications only and all precautions should be taken to avoid harmful interference to channel 16, by limiting the output power to 1 W. (WRC−12)

r) In the maritime mobile service, this frequency is reserved for experimental use for future applications or systems (e.g. new AIS applications, man over board systems, etc.). If authorized by administrations for experimental use, the operation shall not cause harmful interference to, or claim protection from, stations operating in the fixed and mobile services. (WRC−12)

s) Channels 75 and 76 are also allocated to the mobile-satellite service (Earth-to-space) for the reception of long-range AIS broadcast messages from ships (Message 27; see the most recent version of Recommendation ITU−R M.1371). (WRC−12)

w) In Regions 1 and 3:

Until 1 January 2017, the frequency bands 157.025-157.325 MHz and 161.625-161.925 MHz (corresponding to channels: 80, 21, 81, 22, 82, 23, 83, 24, 84, 25, 85, 26, 86) may be used for new technologies, subject to coordination with affected administrations. Stations using these channels or frequency bands for new technologies shall not cause harmful interference to, or claim protection from, other stations operating in accordance with Article **5**.

From 1 January 2017, the frequency bands 157.025−157.325 MHz and 161.625-161.925 MHz (corresponding to channels: 80, 21, 81, 22, 82, 23, 83, 24, 84, 25, 85, 26, 86) are identified for the utilization of the digital systems described in the most recent version of Recommendation ITU−R M.1842. These frequency bands could also be used for analogue modulation described in the most recent version of Recommendation ITU−R M.1084 by an administration that wishes to do so, subject to not claiming protection from other stations in the maritime mobile service using digitally modulated emissions and subject to coordination with affected administrations. (WRC−12)

ww) In Region 2, the frequency bands 157.200-157.325 and 161.800-161.925 MHz (corresponding to channels: 24, 84, 25, 85, 26 and 86) are designated for digitally modulated emissions in accordance with the most recent version of Recommendation ITU−R M.1842. (WRC−12)

x) From 1 January 2017, in Angola, Botswana, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Democratic Republic of the Congo, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe, the frequency bands 157.125-157.325 and 161.725-161.925 MHz (corresponding to channels: 82, 23, 83, 24, 84, 25, 85, 26 and 86) are designated for digitally modulated emissions.

From 1 January 2017, in China, the frequency bands 157.150-157.325 and 161.750-161.925 MHz (corresponding to channels: 23, 83, 24, 84, 25, 85, 26 and 86) are designated for digitally modulated emissions. (WRC−12)

y) These channels may be operated as single or duplex frequency channels, subject to coordination with affected administrations. (WRC−12)

z) These channels may be used for possible testing of future AIS applications without causing harmful interference to, or claiming protection from, existing applications and stations operating in the fixed and mobile services. (WRC−12)

Example of Integrated AIS and VDE

Based on:
- **WRC-12 decisions, Region 2 (minimum set, globally-available channels)**
- **WRC-15 Agenda Item 1.16 (Resolution 360) for AIS and VDE**
- **Approved Recommendations for AIS & VDE: ITU-R M.1371 & 1842**

Table 1

VDE						AIS + VDE			
NOTES: a) Can be used separately as 25 kHz channels or as one 50kHz channel. b) These channels may be considered for satellite downlink.		NOTE: These four channels are combined as one 100kHz channel.				NOTE: Channels 27 and 28 are used as simplex on the upper legs (B-side), since the AIS is a simplex system.			
24A/B	84A/B	25A/B	85A/B	26A/B	86A/B	27B	AIS 1	28B	AIS 2

NOTE: Since this comprises a contiguous set of frequencies (RR Appendix 18), it can be protected by the frequency-selective receiver filter shown in Figure 1.

Example Table of Channels and Transmitting Frequencies Used for AIS and VDE

Table 2

Channel Number in Appendix 18		Transmitting frequencies (MHz) for ship and coast stations	
		Ship stations (ship-shore) Ship stations (long range AIS)	Coast stations Ship stations (ship-ship) Satellite downlink*
AIS 1		161.975	161.975
AIS 2		162.025	162.025
75 (AIS 3) (long range AIS)		156.775 (ships are Tx only)	N/A
76 (AIS 4) (long range AIS)		156.825 (ships are Tx only)	N/A
27B (VDE 1)		161.950 (27B)	161.950 (27B)
28B (VDE 2)		162.000 (28B)	162.000 (28B)
24 (VDE 3)		157.200 (24A)	161.800 (24B)
84 (VDE 4)		157.225 (84A)	161.825 (84B)
24/84 (VDE 5)*		50 kHz channel (24/84, A-side, merged)	50 kHz channel* (24/84, B-side, merged)
25/85/26/86 (VDE 6)		100 kHz channel (25/85/26/86, A-side, merged)	100 kHz channel (25/85/26/86, B-side, merged)
	25	157.250 (25A)	161.850 (25B)
	85	157.275 (85A)	161.875 (85B)
	26	157.300 (26A)	161.900 (26B)
	86	157.325 (86A)	161.925 (86B)

Comparison of AIS and VDE Data Transfer Methods on 25 kHz Channels

Table 3

	AIS1 and AIS2 (25 kHz Channels)	VDE Data Transfer Methods For 25 kHz Channels		
ITU Standard and Digital Modulation	ITU-R M.1371 GMSK	ITU-R M.1842 Annex 1 π /4 DQPSK	ITU-R M.1842 Annex 1 π /8 D8PSK	En 300392-2 v3.2.1 Section 5.11* 8-OFDM + 16-QAM
Data Rate	9.6Kbps (1X)	28.8Kbps (3X)	43.2Kbps (4X)	76.8Kbps (8X)
Sensitivity	-107dBm	-107dBm	-107dBm	-107dBm
Co-channel rejection (CCR)	10dB	19dB	25dB	19dB
Adjacent channel rejection (ACR)	70dB	70dB	70dB	70dB
AIS Message types	1, 2, 3, 5, 18, 19 …	6, 7, 8,12,13,14 …	6, 7, 8,12,13,14 …	6, 7, 8,12,13,14 …
Rationale	Optimum choice for recurring position reports in a ship-ship navigation safety environment.	Provides high (3X) data transmission. Inferior CCR (+9dB) and range discrimination.	Provides high (4X) data transmission. Inferior CCR (+15dB) and range discrimination.	Highest (8X) data rate for a 25kHz channel (compress multi-slot messages to a single slot).

* This standard should also be considered for high data rate and robustness.

Comparison of Data Transfer Methods for VDE by WRC-12 (refers to Rec. ITU-R M.1842)

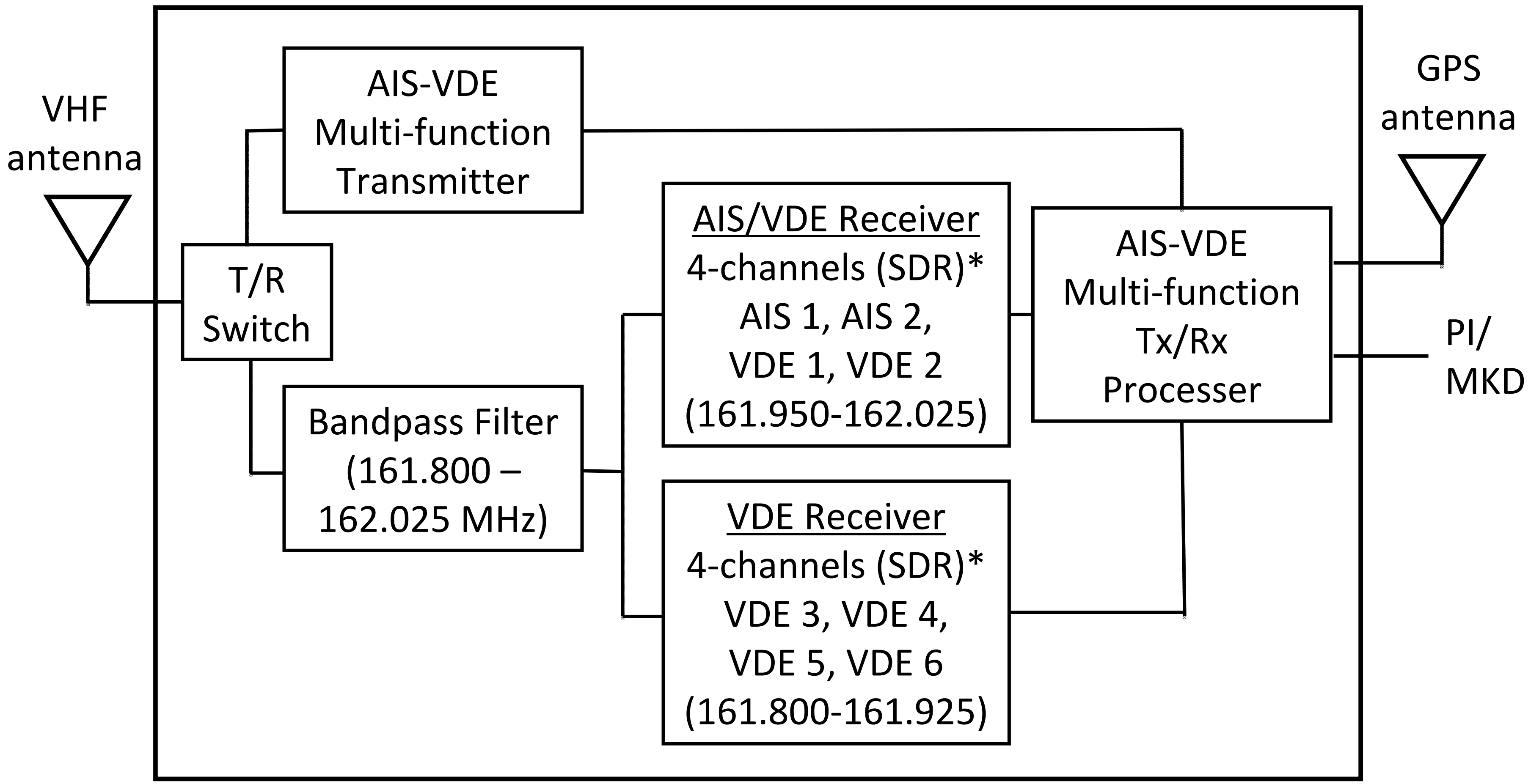
Table 4

	VDE Data Transfer Methods For 25 kHz Channels	VDE Data Transfer Methods For 50 kHz and 100 kHz Channels	
ITU Standard and Digital Modulation	ITU-R M.1842 Annex 1 π /4 DQPSK or π /8 D8PSK	ITU-R M.1842 Annex 3 16-OFDM + 16-QAM	ITU-R M.1842 Annex 4 32-OFDM + 16-QAM
Data Rate	28.8Kbps (3X) or 43.2Kbps (4X)	153.6Kbps (16X)	307.2Kbps (32X)
Sensitivity	-107dBm (ship/shore stations)	-103dBm (ship stations)	-98dBm (ship stations)
Co-channel rejection (CCR)	19dB or 25dB	19dB	19dB
Adjacent channel rejection (ACR)	70dB	70dB	70dB
Message types	AIS 6, 7, 8,12,13,14 and ASM	VDE messages TBD	VDE messages TBD
Rationale	Provides higher (3X or 4X) data transmission than AIS. Inferior CCR (+9dB or +15dB) and range discrimination compared to AIS.	Provides much higher (16X) data transmission than AIS. Inferior CCR (+9dB) and range discrimination compared to AIS.	Provides much higher (32X) data transmission than AIS. Inferior CCR (+9dB) and range discrimination compared to AIS.

Architecture of Integrated AIS/VDE

System Functional Block Diagram

Figure 1



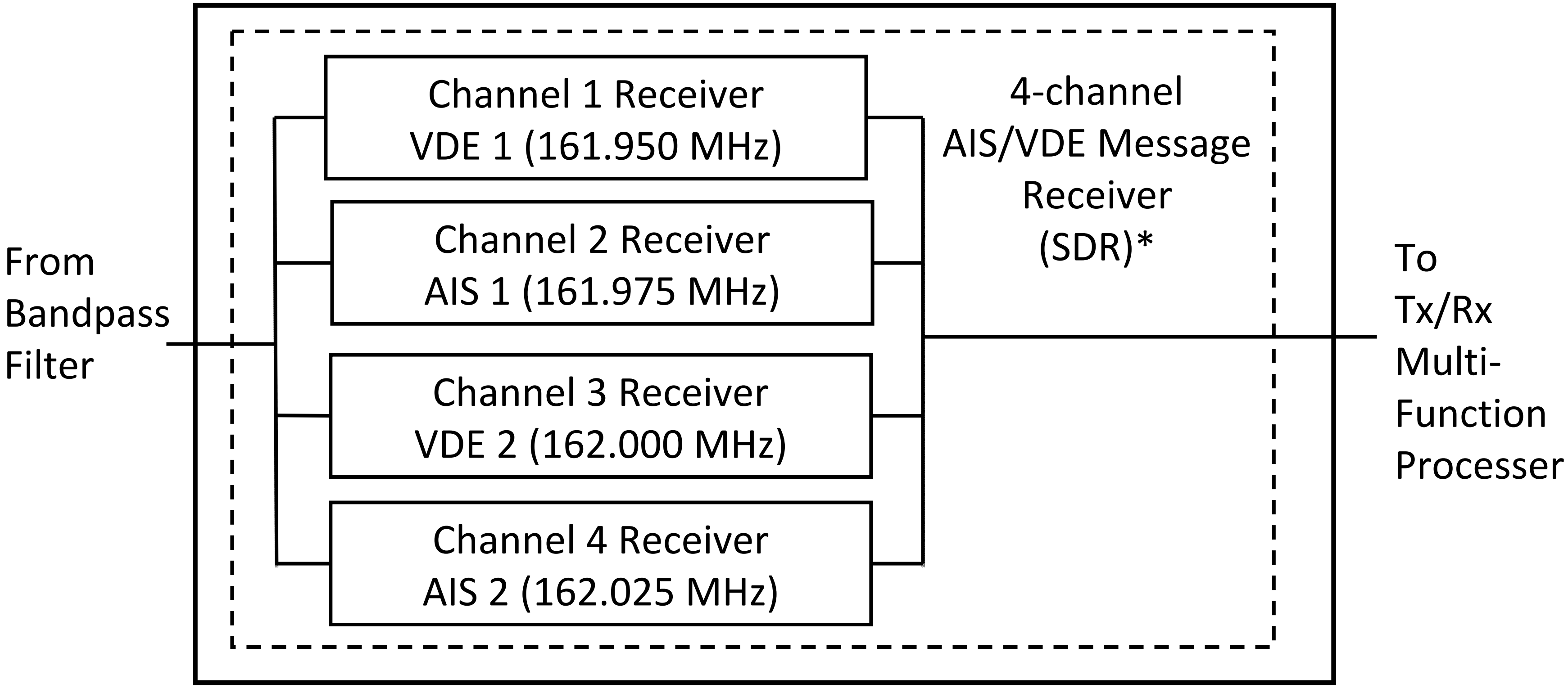
* 4-channel SDR (software defined radio) technology is used in some new AIS designs.

11

Architecture of Integrated AIS/VDE

AIS/VDE SDR Receiver Functional Block Diagram

Figure 2

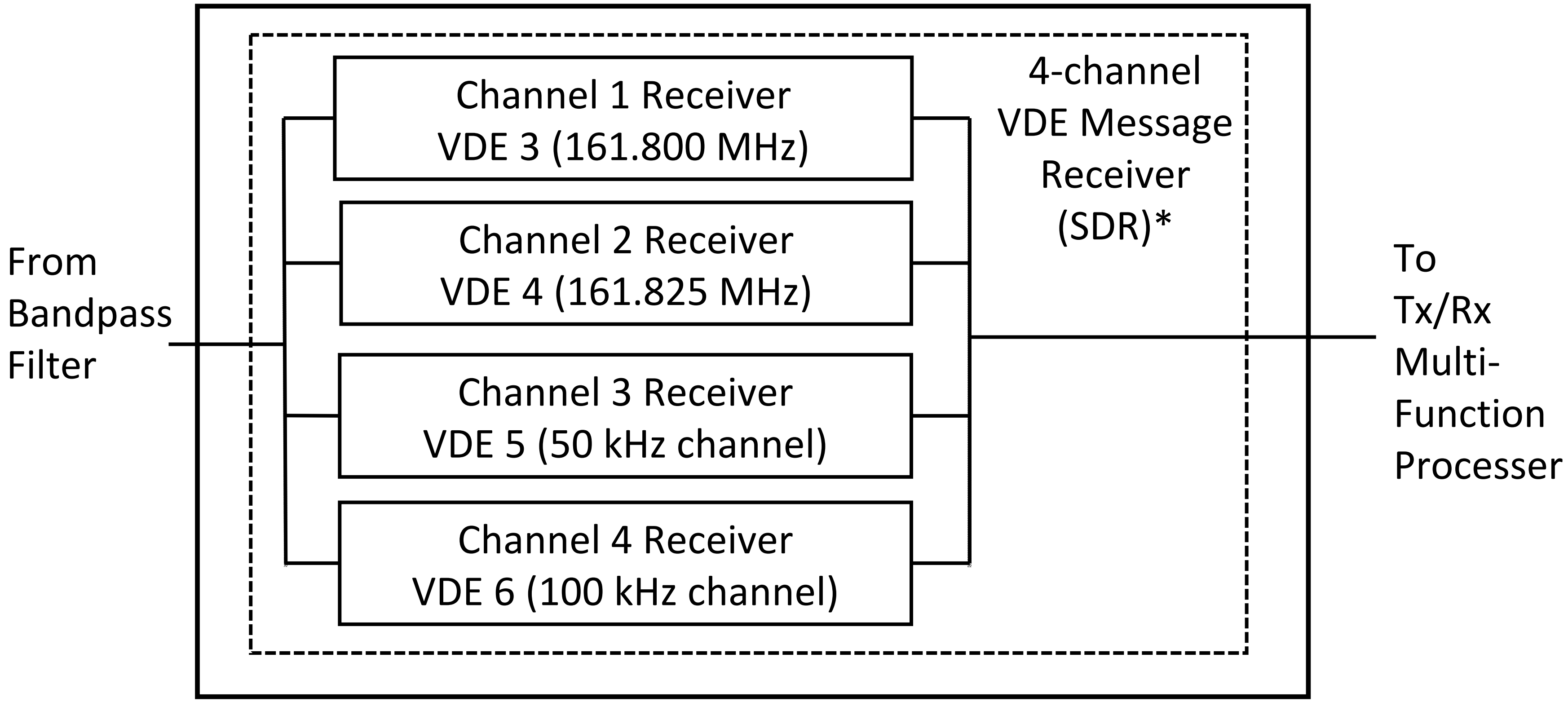


* This 4-channel AIS/VDE SDR receiver has been implemented in some new AIS designs.

Architecture of Integrated AIS/VDE

VDE SDR Receiver Functional Block Diagram

Figure 3



* This 4-channel VDE SDR receiver is similar to the AIS/VDE SDR receiver in Figure 2.

Rationale for the Selection and Use of Frequencies

1. Protect the integrity of the AIS/VDE shipborne receivers

AIS and VDE use efficient SDR receivers (refer to Figure 1) on the upper legs (B-side) of the channels, thus protected from the ships' VHF radio transmitters on the lower legs (A-side) by a Bandpass filter.

2. Duplex channels are used conventionally for ship-shore

In ship-shore mode, VDE is transmitted by ships on the lower legs (A-side) and by shore stations on the upper legs (B-side). This arrangement plus the higher data rate for VDE (preferably 307.2 kbps, per Table 4) minimizes potential conflicts between AIS and VDE.

3. Duplex channels are used in simplex mode for ship-ship

In ship-ship mode, VDE is transmitted by ships on the upper legs (B-side), because the VDE ships' receivers are on the B-side. The higher data rate (307.2 kbps) is preferred to shorten (by 32X) the transmission time and minimize the potential conflicts between AIS and VDE.

Rationale for the Selection and Use of Frequencies (continued)

4. Future satellite downlink is possible

Since VDE communications ship-ship and ship-shore will prefer the higher data rate (307.2 kbps), the 50 kHz channel at 153.6 kbps (Table 4) could be made available for a future satellite downlink.

5. Ship-shore use of duplex channels for VDE is practical

Shore stations operating both AIS and VDE will prefer the higher data rate (307.2 kbps) for VDE to minimize the transmission time, and since their VDE transmissions are not time-critical, they can defer to the AIS.

6. AIS and VDE channels are frequency-contiguous

The AIS and VDE channels (Table 2) are a frequency-contiguous block in Appendix 18 of the Radio Regulations. This configuration provides the maximum spectrum efficiency, highest equipment performance, minimum implementation cost and complexity (facilitates use of SDR technology, refer to Figures 1-3) and minimum regulatory impact.

Schedule of Actions and Progress Reports

The schedule below considers the need to support the WRC-15/18 Agenda Items and the necessary reports to ITU and the Joint IMO/ITU Expert Group:

Table 5

Progress Milestone	Date
1. Administrations provide an experimental working environment for test and evaluation (e.g., RTCM SC123 in the US, and "Mona Lisa" in Europe)	November 2012
2. Workshop Session 1 (functional requirements for "Next-generation AIS")	December 2012
3. Begin test/evaluation in the working environment	January 2013
4. IALA ENAV WG3+WG4 meeting (draft selection and use of frequencies)	February 2013
5. Progress report to IALA ENAV with technical conclusions. Draft Report to ITU WP5B (for Nov 2013 meeting) on WRC-15 AI 1.16: selection and use of frequencies, sharing and compatibility studies in the band (App 18)	September 2013
6. Workshop Session 2 (technical requirements for "Next-generation AIS")	December 2013
7. IALA ENAV WG3+WG4 meeting (draft technical standard)	February 2014
8. Progress report to IALA ENAV. Draft Report to ITU WP5B (for Nov 2014 meeting) on WRC-15 AI 1.16: working document toward PDNR	September 2014
9. Workshop Session 3 (draft performance standard for "Next-generation AIS")	December 2014
10. Progress report to IALA ENAV. Draft report to ITU WP5B (Nov 2014), final draft performance standard for administrations to submit to ITU for DNR	September 2015

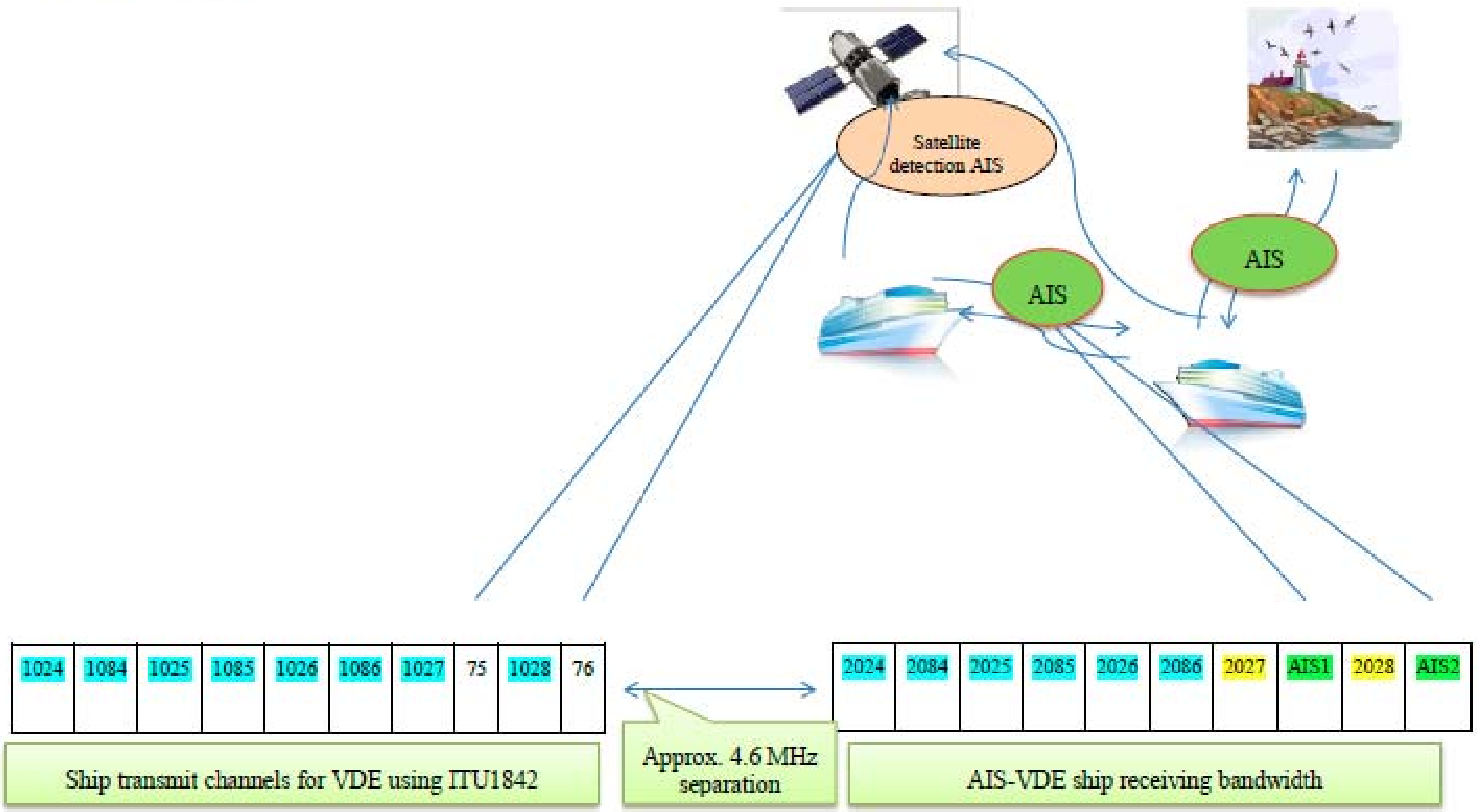
Table describing the proposed use of Appendix 18 channels and frequencies for AIS, ASM and VDE with options for satellite broadcasting

Channel number in Appendix 18		Transmitting frequencies (MHz) for ship and coast stations	
		Ship stations (ship-shore) Ship stations (long range AIS)	Coast stations Ship stations (ship-ship) Satellite broadcasting to ship*
AIS 1		161.975	161.975
AIS 2		162.025	162.025
75 (long range AIS)		156.775 (ships are Tx only)	N/A
76 (long range AIS)		156.825 (ships are Tx only)	N/A
2027 (ASM 1)		161.950 (2027)	161.950 (2027)
2028 (ASM 2)		162.000 (2028)	162.000 (2028)
24 (VDE 1)	MODE A	157.200 (1024)	161.800 (2024)
84 (VDE 2)	MODE A	157.225 (1084)	161.825 (2084)
24/84 (VDE 3) or (SAT5)	MODE B	50 kHz channel (1024/1084, merged)	50 kHz channel (2024/2084, merged)* *Could be used for satellite broadcasting
25/85/26/86 (VDE 4)		100 kHz channel (25/85/26/86, lower legs, merged)	100 kHz channel (25/85/26/86, upper legs, merged)
	25	157.250 (1025)	161.850 (2025)
	85	157.275 (1085)	161.875 (2085)
	26	157.300 (1026)	161.900 (2026)
	86	157.325 (1086)	161.925 (2086)
1027 SAT 1		N/A (ships are Rx only)	157.350* (1027)
87 SAT 2		N/A (ships are Rx only)	157.375* (87)
1028 SAT 3		N/A (ships are Rx only)	157.400* (1028)
88 SAT 4		N/A (ships are Rx only)	157.425* (88)

***Note: SAT 5 is preferred because channels SAT 1-4 can be blocked by ships VHF radio**

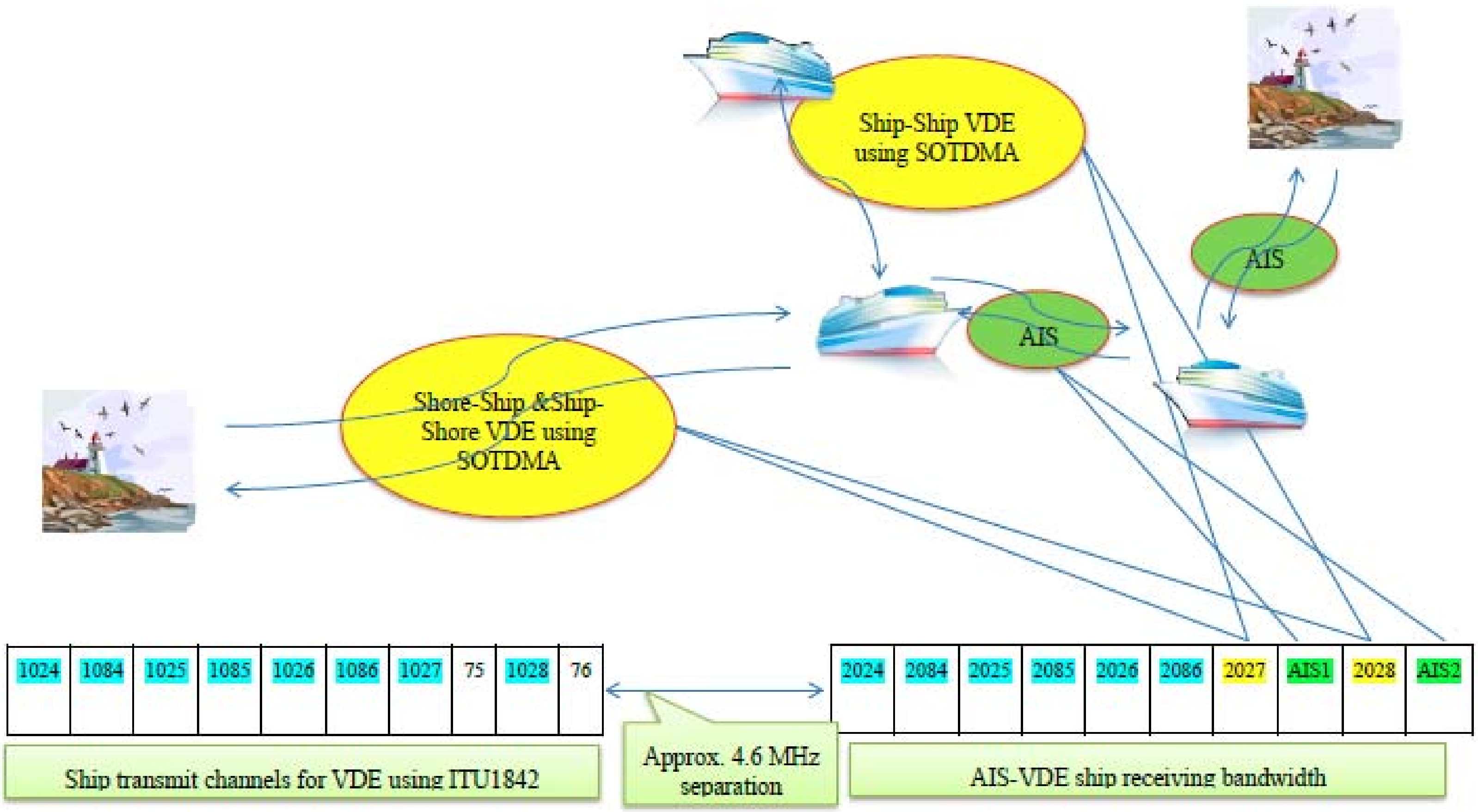
Plan for AIS and VDE Communications

1 Existing AIS only



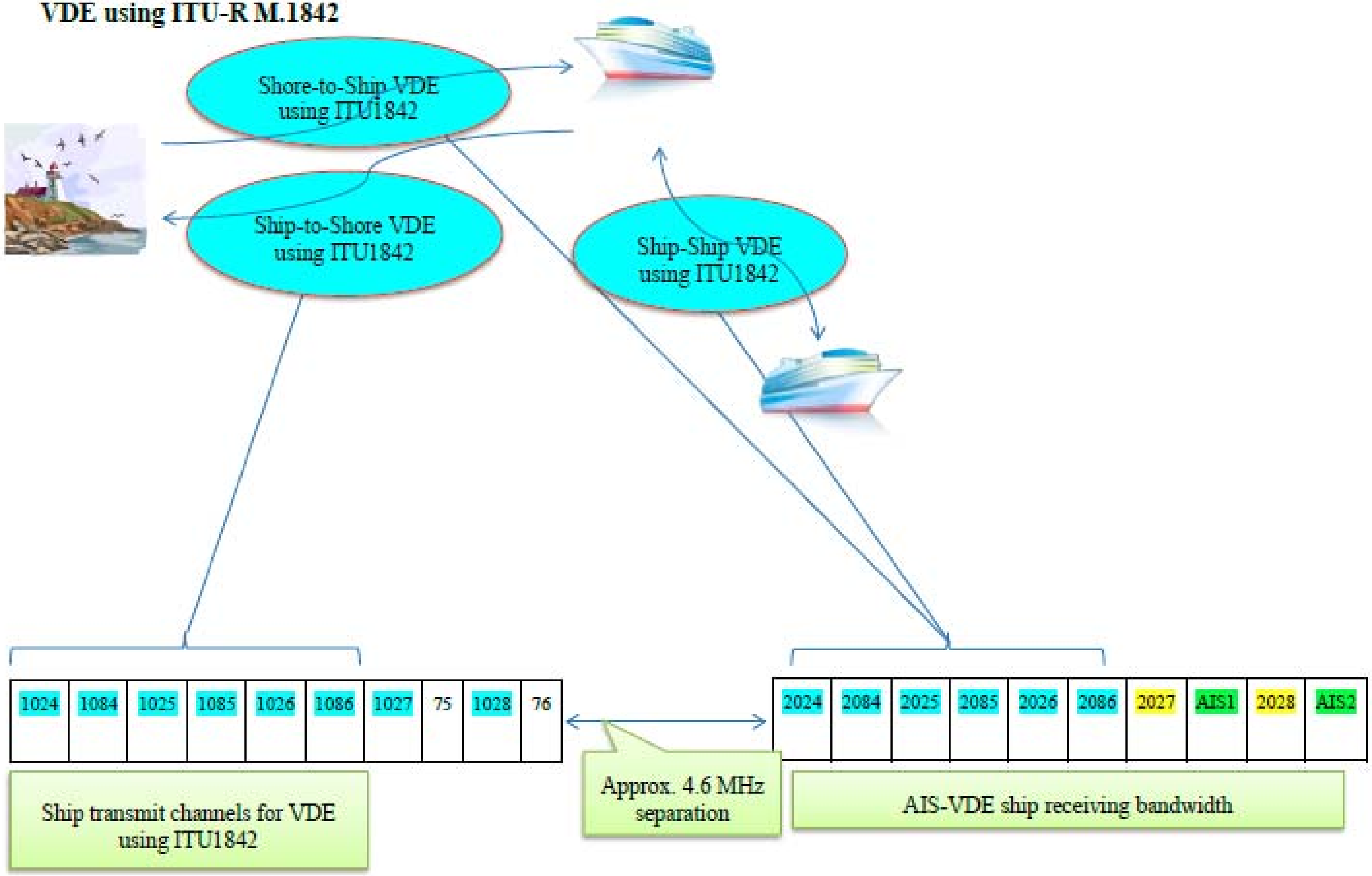
Plan for AIS and VDE Communications

2 AIS and SOTDMA VDE (ASM applications)



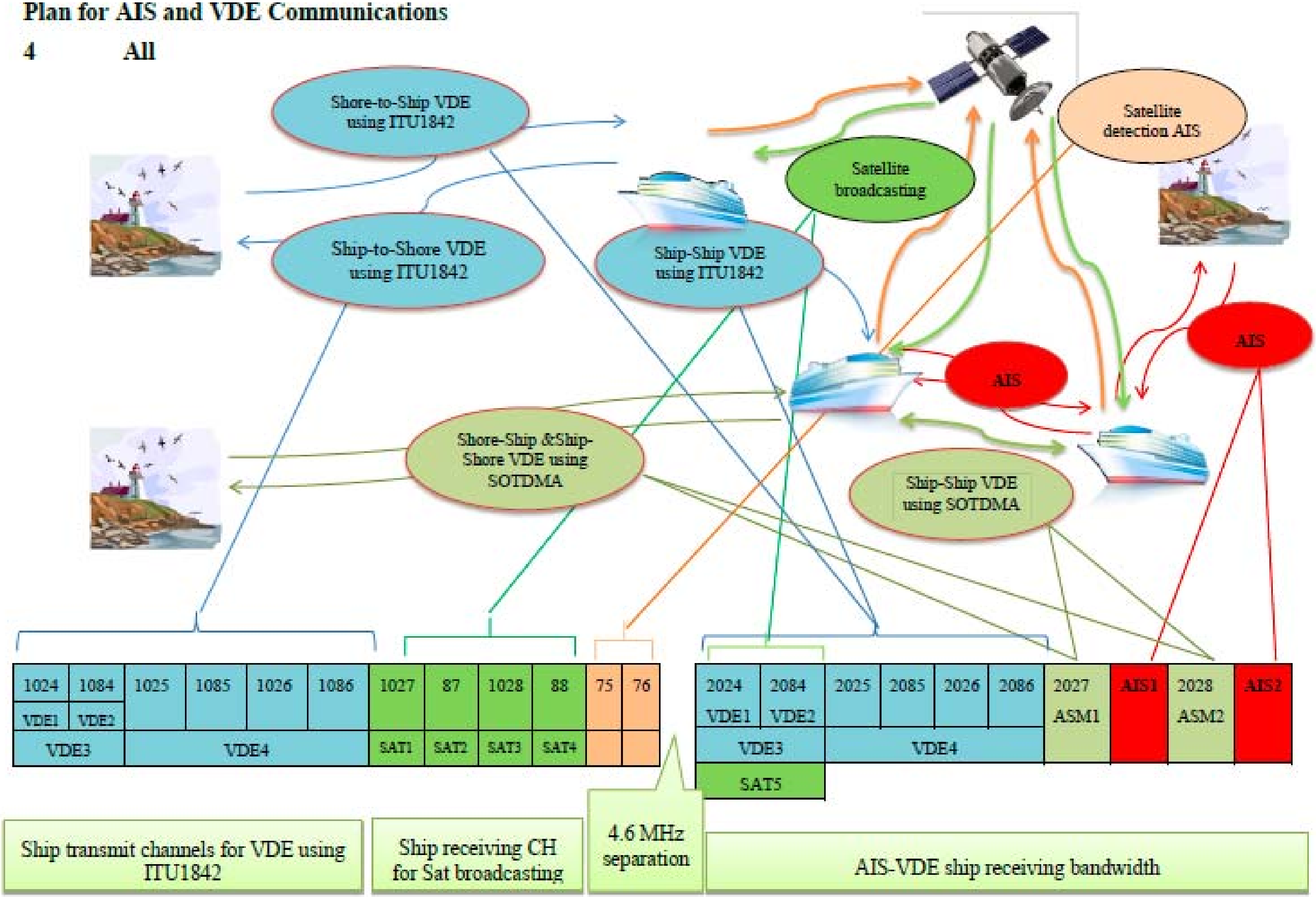
Plan for AIS and VDE Communications

3 VDE using ITU-R M.1842



Plan for AIS and VDE Communications

4 All



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AIS & VDE Expectation for future

CDR Hideki NOGUCHI
Japan Coast Guard

3 December 2012
Workshop for International Standardization of Next Generation AIS

What we can do by present AIS

Information from ship

- Statistic data
- Dynamic data
- Navigation related data

⇒Safety of navigation, Ship monitoring, Marine spatial planning

JCG

What we can do by present AIS

Information from shore

- Safety related message
- Application specific message
- AtoN message

⇒Safety of navigation

What we can do by present AIS

Satellite detection

- Ship data

⇒Monitoring

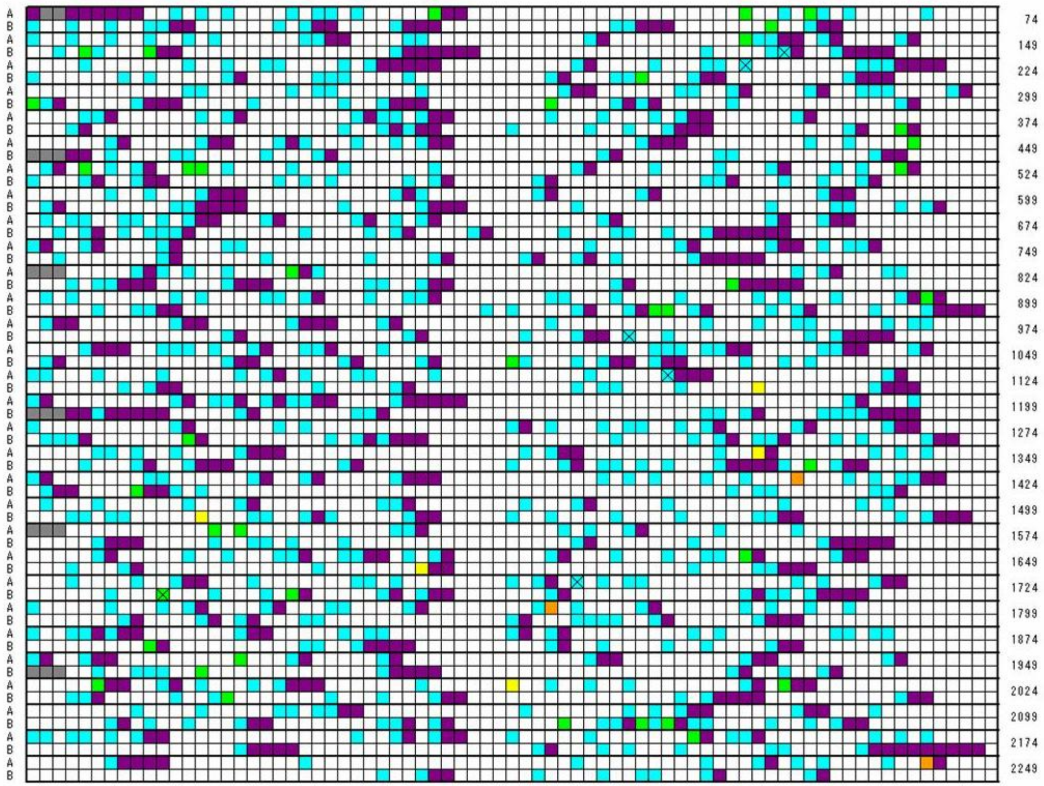
What we can do by present AIS

AIS-SART

- Position data

⇒Search and rescue

Load of VHF Data Link (2008)

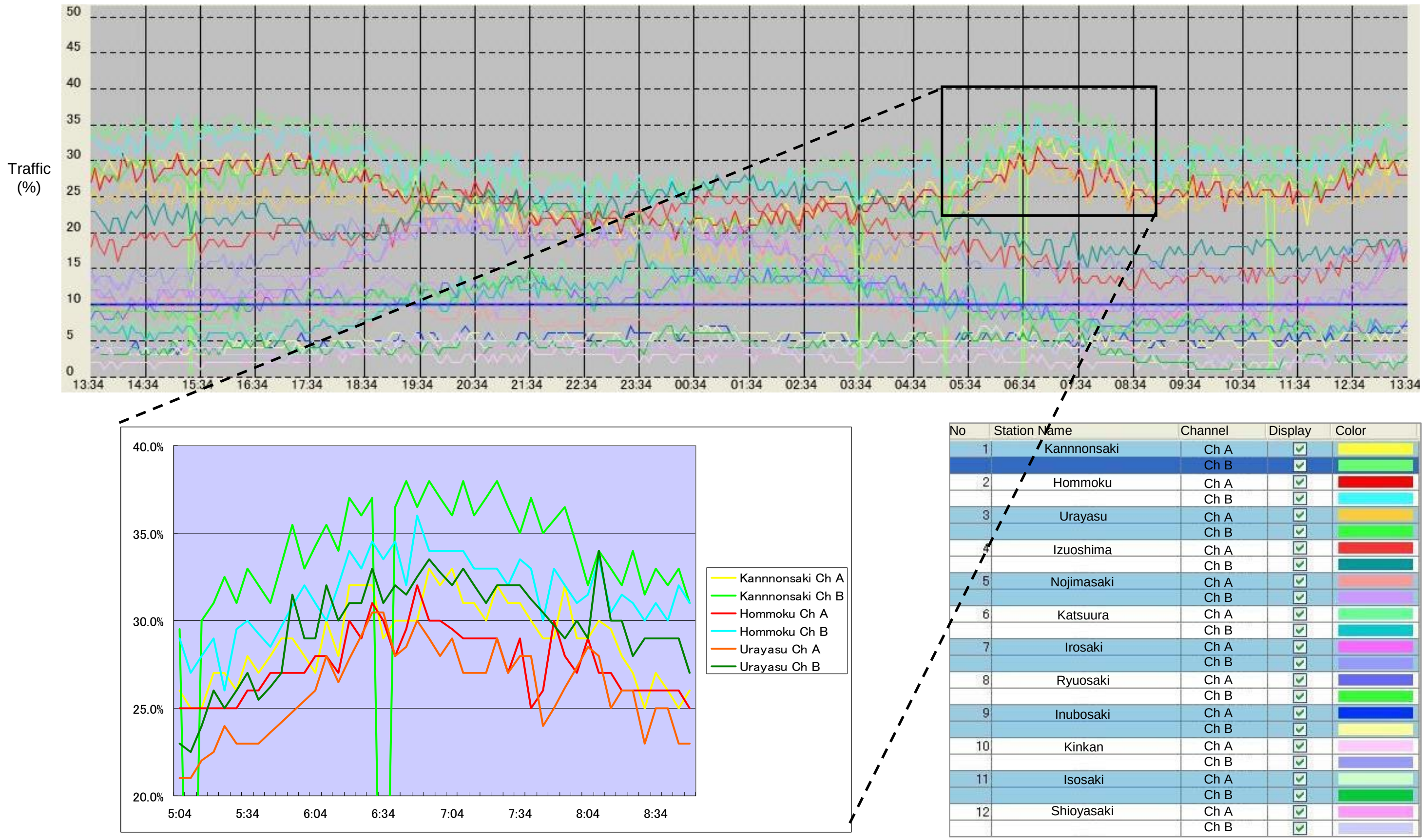


Slot Usage Rate: 27.4%
Slot Identification Rate: 61.2%

- Unknown
- Reserved by Shore Base Station
- Grade A
- Grade B
- Grade C
- Grade D
- Grade E
- Collision
- Static Message

Kannonsaki AIS shore base station at 07:41 on 5 August 2008

Load of VHF Data Link (2012)



No	Station Name	Channel	Display	Color
1	Kannnonsaki	Ch A	✓	
		Ch B	✓	
2	Hommoku	Ch A	✓	
		Ch B	✓	
3	Urayasu	Ch A	✓	
		Ch B	✓	
4	Izuoshima	Ch A	✓	
		Ch B	✓	
5	Nojimasaki	Ch A	✓	
		Ch B	✓	
6	Katsuura	Ch A	✓	
		Ch B	✓	
7	Irosaki	Ch A	✓	
		Ch B	✓	
8	Ryuosaki	Ch A	✓	
		Ch B	✓	
9	Inubosaki	Ch A	✓	
		Ch B	✓	
10	Kinkan	Ch A	✓	
		Ch B	✓	
11	Isosaki	Ch A	✓	
		Ch B	✓	
12	Shioyasaki	Ch A	✓	
		Ch B	✓	

Kannonsaki AIS shore base station on 25 July 2012

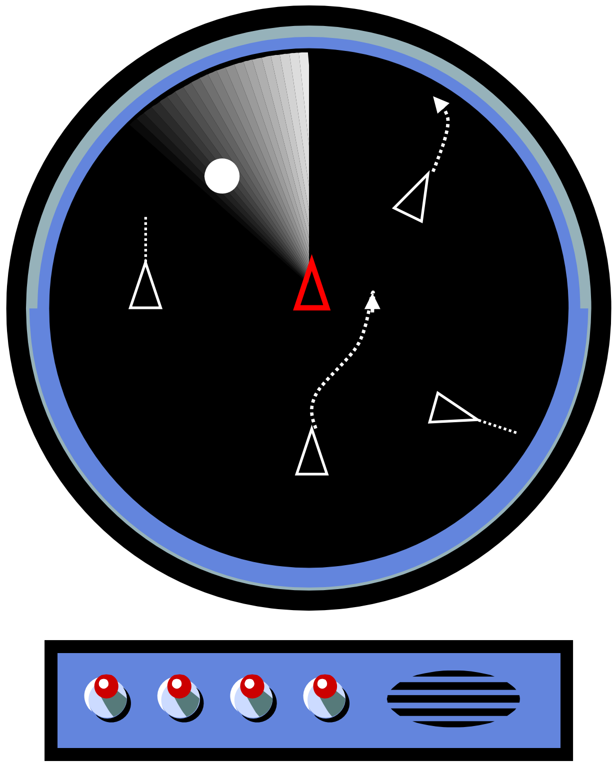
AIS & VDE

	AIS	VDE (Single band)
Speed	9,600 bps	28,800 bps or more
Channel	Data 2ch + Long range detection 2ch	Data 4ch + Long range detection 2ch + Long range transmission 2ch
Range	20 - 30 n.m. (Depends on antenna height)	World wide

Possible Application

- Navigational intention

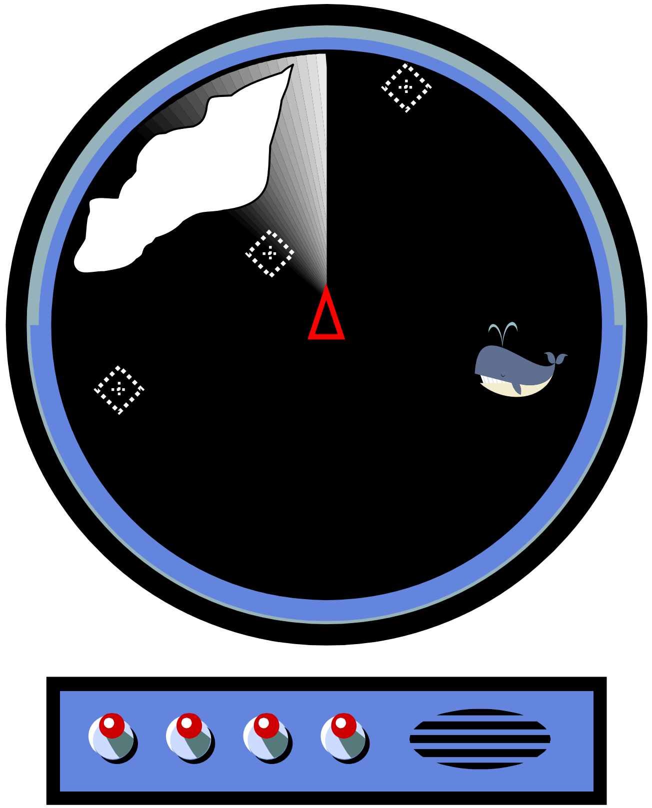
  Changing course
  Passing over
  Crossing route
  etc.



Possible Application

- Polar route

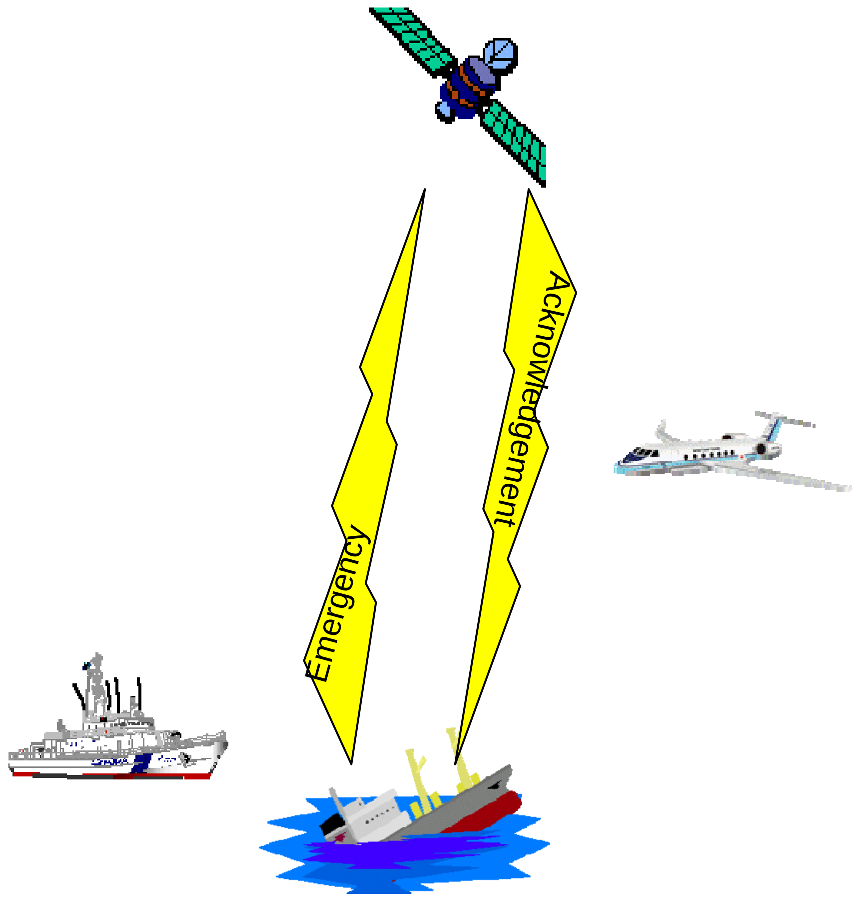
virtual AtoN
Application Specific Message
etc.



Possible Application

- Search and rescue

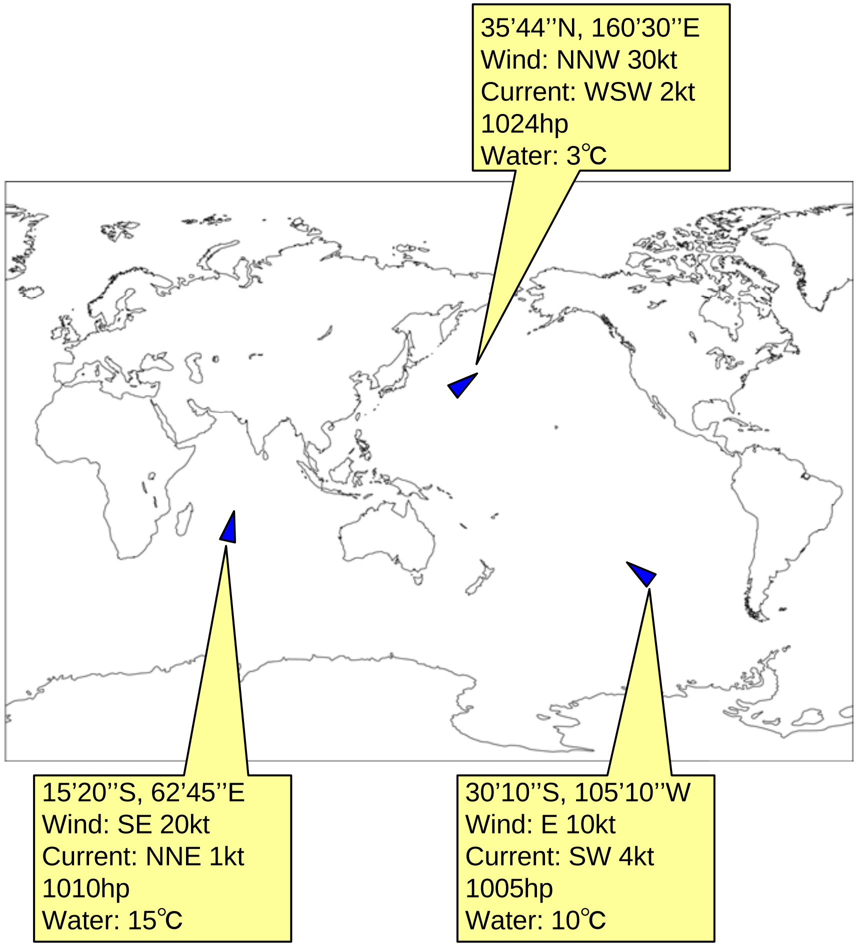
  Supplemental alert
  Acknowledgement
  Position indication
  etc.



Possible Application

- Environmental monitoring

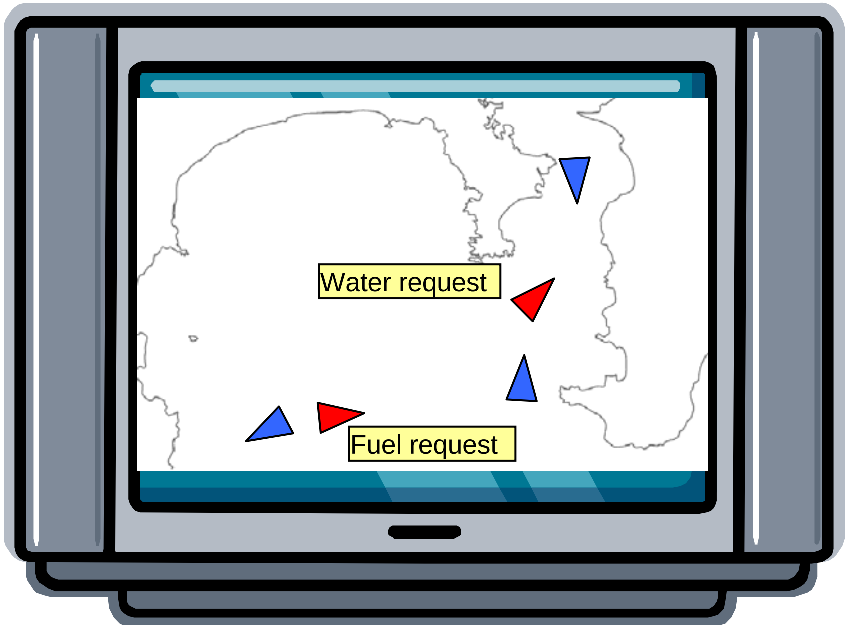
  Wind
  Current
  Air pressure
  Water temp.
  etc.



Possible Application

- Commercial and Logistics

  Fuel request
  Water request
  Repair service
  etc.



Thank you for your attention!

Any question?

VDES Contribution to and Function for e-navigation Solution

e-navigation solution	Contribution	Function	Comment
Shipboard Solutions			
S1 Improved, harmonized and user-friendly bridge system	S1.1 To minimize interface and reduce voice communication	High level interface (e.g. IEC 61162-450) Common phrase of communication Permits text message	
S2 Means for standardized and automated reporting for shipboard users	S2.1 To standardize reports and report automatically	S-100 and CMDS Common templates Automatic timing based on events Machine to machine communication User-friendly human interface	
	S2.2 Collecting necessary information automatically and autonomously	Provide a multiple access information network amongst ship and shore users	Access for gathering information from different data sources
S3 Improved reliability, resilience and integrity of bridge equipment and navigation information	S3.1 To standardize navigation information	High level interface (e.g. IEC 61162-450) Common phrase of communication Permits text message	Importance of Human machine interface aspect Navigation condition changed by area, status or others
	S3.2 Capability of checking integrity of data such as positioning, navigation status so on	Ability to cross check multiple sources of critical navigation information Standard management method for	Automatic alerting or correction

e-navigation solution	Contribution	Function	Comment
		incorrect data	
	S3.3 To reduce human error and workload of seafarers	Automation in action, integrity and interface High level interface (e.g. IEC 61162-450)	
S4 Integration and presentation of available information in graphical displays on board received via communication equipment	S4.1 To connect INS and other for graphical presentation of information and communication	Automatic update based on events (e.g. chart correction, publications) Access the update status by globally available means	Connection to INS and others need to support s-mode (default mode) Ship and shore side (M to M) Consider lack or over information
	S4.2 To automatically select the most appropriate communication means in VDES	Automatic selection in VDES communication means and possibly other means* (more discussion needed)	VDES itself contains AIS, single and multi channel communication but there are also other communication means such as MF, HF, satellite
	S4.3 To standardize data content by supporting Common Maritime Data Structure (CMDS)	S-100 and CMDS Common templates	

e-navigation solution	Contribution	Function	Comment
S5 Information management	S5.1 To update information and make it current	S-100 and CMDS Common templates	Identify the needs for update Satellite downlink capability but not large data files Human readable message for information management
SAR Solutions			
S6 Improved access for relevant information for Search and Rescue (SAR)	S6.1 To provide data communication between ship, survival craft and SAR assets	Short text message Additional data beyond voice communication (M - M communication) Prioritize SAR message in slot management	Should be one slot message for every asset and multiple transmission for satellite
	S6.2 To provide SAR pattern and track the SAR pattern	Additional data beyond voice communication (M - M communication)	
	S6.3 To provide access to data or data base for assist SAR automatically an autonomously	Access for gathering necessary information from different data sources shore and onboard	

e-navigation solution	Contribution	Function	Comment
Shore-based Solutions			
S7 Improved reliability, resilience and integrity of navigation information provided by shore-based users	S7.1 To provide two way data communications for validating and correcting information	S-100 and CMDS Common templates Ability to cross check multiple sources of critical navigation information	
	S7.2 To collect maintenance and diagnostic date from ship	S-100 and CMDS Common templates Efficient remote access to ship owner	Benefits go to marker and ship owner
	S7.3 To reduce human error and workload of seafarers and shore based users	Automation in action, integrity and interface High level interface (e.g. IEC 61162-450)	
	S7.4 To keep record	Automated record of data transfer	
S8 Improved and harmonized shore-based systems and services	S8.1 Multiple access networking of shore based stations and ships	Automatic selection of access means Automatic exchange of data and information	

e-navigation solution	Contribution	Function	Comment
	S8.2 To support onboard decision making by providing access to data on shore	Automated access to shore based data base of information regarding navigation and other (e.g. metrological, hydrographical, traffic) Automated broadcast of information regarding navigation and other	Provide bird eye view of VTS to ship
S9 Improved communication of VTS service portfolio	S9.1 To provide clear, accurate, reliable data communication from/ to VTS To provide permanent log or record of data communication from/to VTS	Automatic and autonomous data communication Automatic and accurate logging of data communication	
S10 Improved, harmonized and user-friendly shore-based design	S10.1 To minimize interface and reduce voice communication	High level interface (e.g. IEC 61162-450) Common phrase of communication Permits text message	
S11 Means for standardized and automated reporting for shore-based users	S11.1 To provide standardized and automated reporting from ships	S-100 and CMDS Common templates	

e-navigation solution	Contribution	Function	Comment
S12 Integration and presentation of available information in graphical displays received via communication equipment for shore-based users	S12.1 To connect VTS or other for graphical presentation of information and communication	Automatic update based on events (e.g. chart correction, publications) Access the update status by globally available means	Connection to INS and others need to support s-mode (default mode) Ship and shore side (M to M) Consider lack or over information
	S12.2 To automatically select the most appropriate communication means	Automatic selection in VDES communication means and possibly other means* (more discussion needed)	VDES itself contains AIS, single and multi channel communication but there are also other communication means such as MF, HF, satellite
	S12.3 To standardize data content by supporting Common Maritime Data Structure (CMDS)	S-100 and CMDS Common templates	
	S12.4 To provide integrity and validation of data from ships	Automatic and autonomous data communication	
S13 Information management for shore-based users	S13.1 To update information and make it current	S-100 and CMDS Common templates	Identify the needs for update Satellite downlink capability but not large data files

e-navigation solution	Contribution	Function	Comment
			Human readable message for information management
S14 Exchange of route segment	S14.1 Exchanging route segment information by standardized and autonomous manner	S-100 and CMDS Common templates	This function needs to be retain even IMO CG withdraw this solution Inland AIS has this kind of function and this needs to transfer to VDES
	S14.2 Exchanging pilot passage plan	S-100 and CMDS Common templates	
S15 Exchange of voyage plan	S15.1 Exchanging voyage plan by standardized and autonomous manner	S-100 and CMDS Common templates	
	S15.2 Monitoring the deviation from the voyage plan autonomously and alerting automatically	S-100 and CMDS Common templates	