Digital broadcasting systems under development within ITU-R of interest for the maritime community

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IHO, WWNWS 5
Monaco, 2nd October 2013
Background for the 500 kHz band

The TITANIC sent its SOS on 500 kHz in telegraphy mode,
The TITANIC sank on April 15th, 1912 at 2:20

After the Introduction of the GMDSS, the frequency has been gradually phased out and quickly lost for the mariners

... 100 years afterwards

On the French initiative:
The World Radio Conference 2012 approved the worldwide exclusive usage of the frequency band 495 - 505 kHz for the maritime mobile service.

“Characteristics of a digital system, named Navigational Data for broadcasting maritime safety and security related information from shore to ship in the 500 kHz band”
Use digital Modulation allowing more important flow

- Allow 15 to 25 kbit/s in a 10 kHz channel (more than 300 times the NAVTEX transmission)

- Offer faster transmission time per message

Transmissions files not limited to the texts but also:

- Drawings
- Graphs
- Pictures
- Data…

- This band procure a stable propagation on surface wave

- Good radio coverage of 250/350 NM by coast station

Transmissions files:

- NAVDAS 500 kHz
- NAVTEX 490 kHz
- NAVTEX 518 kHz
- NAVTEX 500 kHz
- 495 kHz
- 505 kHz
- 490 kHz
- 518 kHz
Broadcast of digital files from coasts to ships
Sequential transmission: like NAVTEX (Also possible on Single Frequency Network SFN)

Broadcast modes:
- General for all ships
- Selective:
  - By geographical area
  - By group of ships
  - For a specific ship

Possibility of encryption for confidential information
NAVDAT: Synoptic
**Given as example:**

- Type of messages: PRIORITY
  - Navigational warning
  - Meteorological warning
  - Search and Rescue
  - Piracy warning
  - Ices warning
  - Distress and Emergency Message
NAVDAT functionalities (2)

**Given as example:**
- Types of messages: INFORMATION OF NAVIGATION
- Meteorological forecast
- Local meteorological information
- Tides and current information
- VTS Traffic
- Cartography Ices and Icebergs
- Pilot Information
- Aids to Navigation Status
- AIS Report

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**LEGEND:**
- Light rain
- Showers
- Sun
- Dark cloud
- Hazy
- Slight < 1.2m
- Moderate 1.2m - 2.5m
- Rough 2.5m - 4.0m
- Very rough > 4.0m

Issued by Meteorological Service Singap.

- Full circle w/ w line indicates calm or light and variable wind
- One half fleche represents 5 knots
- One full fleche represents 10 knots
- One solid triangle represents 50 knots
- Centre of Typhoon, max wind speed 55 knots and above
- Direction of movement indicated by arrow and speed in knots

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**Figures:**
- Satellite Environment (3 day)
- Electron Flux
- Gauss Hp

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**Updated:** 2012 Mar 5 13:31:07 UTC

NOAA/SWPC Boulder, CO USA
Given as example: Types of messages: WIDE SERVICES

- Update of cartography
- Graph of weather evolution
- Harbour Message
- Information for Fisherman
- Graphs of Traffic evolution
Conclusion for NAVDAT 500 kHz

The NAVDAT system:

- Use a radio band allocated by ITU (International Telecommunication Union) for a MARITIME EXCLUSIVE usage on a WORLDWIDE basis.
- Can re-use the current infrastructure NAVTEX for the information sources.
- Simple and safety coastal network. (NAVDAT station can also be use for NAVTEX)
- System very open on the next future.
The World Radio Conference 2012 has made substantial changes in the HF band (Appendix 17) in order to introduce digital technology in the maritime mobile service
After the 500 kHz band, France has proposed a NAVDAT system in the HF Band. For the HF band, the propagation is mainly in sky wave. In this situation, NAVDAT HF will be complementary to NAVDAT 500 kHz in terms of radio coverage.

Characteristics of a digital system, named navigational data for broadcasting maritime safety and security related information from shore-to-ship in the maritime HF band.
Possible frequencies for NAVDAT HF system

<table>
<thead>
<tr>
<th>Maritime band</th>
<th>Central frequency</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 MHz band</td>
<td>4 226 kHz</td>
<td>4 221 to 4 231 kHz</td>
</tr>
<tr>
<td>6 MHz band</td>
<td>6 337.5 kHz</td>
<td>6 332.5 to 6 342.5 kHz</td>
</tr>
<tr>
<td>8 MHz band</td>
<td>8 443 kHz</td>
<td>8 438 to 8 448 kHz</td>
</tr>
<tr>
<td>12 MHz band</td>
<td>12 663.5 kHz</td>
<td>12 658.5 to 12 668.5 kHz</td>
</tr>
<tr>
<td>16 MHz band</td>
<td>16 909.5 kHz</td>
<td>16 904.5 to 16 914.5 kHz</td>
</tr>
<tr>
<td>22 MHz band</td>
<td>22450.5 kHz</td>
<td>22445.5 to 22455.5 kHz</td>
</tr>
</tbody>
</table>

Conclusion for NAVDAT in HF bands

NAVDAT HF under development in ITU, approval in December 2013 or 2014

Approval of the frequencies by WRC-15
The VHF Data Exchange System
VDES
The World Radio Conference 2012 has made substantial provisions for the maritime community in the VHF band:

Exclusive Utilisation of AIS 1 and AIS 2 by the maritime mobile service in Region 2 and 3 (in 2025)

Allocation for the mobile satellite service for the channel 75 and 76 in order to detect the Message 27 of AIS for the Long Range AIS

Identification of the channels 27, 28, 87, 88 for testing future AIS applications, e.g. Application Specific Messages (ASM)

Identification worldwide of channels 24, 84, 25, 85, 26, 86 for utilization of digital systems

| 75 | 76 |
| 24 | 84 | 25 | 85 | 26 | 86 |
| 27 | 87 | 28 | 88 |
|  | AIS 1 | AIS 2 |

Long range AIS  
Digital systems  
Future AIS applications  
Exclusive Region 2 and 3
What to do with this treasure?

Agenda Item 1.16 for WRC-15 provides directions:
to consider regulatory provisions and spectrum allocations to enable possible new Automatic Identification System (AIS) technology applications and possible new applications to improve maritime radiocommunication in accordance with Resolution 360 (WRC-12);

So, what about AIS!

- well recognized
- important tool
- effective and useful technology
- SOLAS vessels (Class-A)
- non SOLAS vessels (Class-B)

However, so useful that its used for a lot of other applications:

- AIS SART
- AIS MOB
- EPIRB-AIS
- non SOLAS vessels (Class-B)
- ASM
- AtoN
What to do with this treasure?

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So, what about AIS!

This expanding use of AIS technology has caused significant increase in VHF Data Link (VDL) loading which has become an active concern in IMO and ITU.

NOTE: AIS is a navigation system, not fitted for data exchange.
User requirements

More Data exchange Shore to ship, ship to ship, ship to shore

Environmental Information: Meteorological, Ice, Hydrological, Aids to navigation, charts, restrictions on navigation, VTS, Pilotage Optimize port arrival operations, cargo indications Warning/alert due to navigation hazards Remote maintenance of ship SAR Operations Ship reporting ...

Simultaneously, because of increasing demand of radio spectrum for digital communication such as mobile phone and data, ITU now requests more efficient and effective use of radio spectrum
Solution?

The VHF Data Exchange System (VDES)

Objective:

1- Secure the VDL in order to protect the AIS

Use AIS for what it was designed and intended

Move some ASM applications to new channels

<table>
<thead>
<tr>
<th>Year</th>
<th>AIS1</th>
<th>AIS2</th>
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<tbody>
<tr>
<td>2027</td>
<td>2027</td>
<td>AIS1</td>
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<tr>
<td>1027</td>
<td>1028</td>
<td>1028</td>
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<tr>
<td>1087</td>
<td>1088</td>
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Future AIS applications
Solution?

The VHF Data Exchange System
VDES

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<th>27</th>
<th>87</th>
<th>28</th>
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<tr>
<td>1027</td>
<td>1087</td>
<td>1028</td>
<td>1088</td>
</tr>
<tr>
<td>AIS1</td>
<td>AIS1</td>
<td>AIS2</td>
<td>AIS 2</td>
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Future AIS applications
Solution?

2- Improved communications capacity
Terrestrial solution

<table>
<thead>
<tr>
<th></th>
<th>24</th>
<th>84</th>
<th>25</th>
<th>85</th>
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<tr>
<td>TX</td>
<td>1024</td>
<td>1084</td>
<td>1025</td>
<td>1085</td>
<td>1026</td>
<td>1086</td>
</tr>
<tr>
<td>RX</td>
<td>2024</td>
<td>2084</td>
<td>2025</td>
<td>2085</td>
<td>2026</td>
<td>2086</td>
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2- Improved communications capacity

Terrestrial solution

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<tr>
<td>TX</td>
<td>VDE1</td>
<td>VDE4</td>
<td>VDE51</td>
<td>VDE51</td>
<td>1026</td>
<td>1086</td>
</tr>
<tr>
<td>RX</td>
<td>VDE1</td>
<td>VDE4</td>
<td>VDE5</td>
<td>VDE5</td>
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2- Improved communications capacity

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<tr>
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<td>VDE2</td>
<td>VDE2</td>
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100 kHz bandwidth
2- Improved communications capacity

Terrestrial solution

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100 kHz bandwidth
Solution?

2- Improved communications capacity

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Satellite solution

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<td></td>
</tr>
<tr>
<td>RX</td>
<td>VDE1</td>
<td></td>
<td></td>
<td></td>
<td>SAT1 _down</td>
<td></td>
</tr>
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</table>

SAT2 \_down possible extension
Solution?

2- Improved communications capacity

Terrestrial solution

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<td>VDE1</td>
<td></td>
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<td>VDE2</td>
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<td></td>
</tr>
<tr>
<td>RX</td>
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Satellite solution

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</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>VDE1/SAT1 up3</td>
<td></td>
<td></td>
<td>VDE1/SAT2 up3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RX</td>
<td>VDE1</td>
<td></td>
<td></td>
<td>SAT1 down</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SAT2 down possible extension</td>
<td></td>
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</tbody>
</table>
## Comparison of AIS and VDE Data Transfer Methods by ITU-R M.1842

<table>
<thead>
<tr>
<th></th>
<th>AIS1 and AIS2 (25 kHz Channels)</th>
<th>For 25 kHz Channels VDE Data Transfer Methods</th>
<th>VDE Data Transfer Methods For 50 kHz Channels</th>
<th>VDE Data Transfer Methods For 100 kHz Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Rate</strong></td>
<td>9.6 kbps (1X)</td>
<td>43.2 kbps (4X)</td>
<td>153.6 kbps (16X)</td>
<td>307.2 kbps (32X)</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>-107dBm</td>
<td>-107dBm</td>
<td>-103dBm (ship stations)</td>
<td>-98dBm (ship stations)</td>
</tr>
<tr>
<td><strong>Co-channel rejection (CCR)</strong></td>
<td>10dB</td>
<td>25dB</td>
<td>19dB</td>
<td>19dB</td>
</tr>
<tr>
<td><strong>Adjacent channel rejection (ACR)</strong></td>
<td>70dB</td>
<td>70dB</td>
<td>70dB</td>
<td>70dB</td>
</tr>
<tr>
<td><strong>AIS Message types</strong></td>
<td>1, 2, 3, 5, 18, 19 …</td>
<td>6, 7, 8,12,13,14 …and ASM</td>
<td>VDE messages TBD</td>
<td>VDE messages TBD</td>
</tr>
<tr>
<td><strong>Rationale</strong></td>
<td>Optimum choice for recurring position reports in a ship-ship navigation safety environment.</td>
<td>Provides high (4X) data transmission. Inferior CCR (+15dB) and range discrimination.</td>
<td>Provides much higher (16X) data transmission than AIS. Inferior CCR (+9dB) and range discrimination compared to AIS.</td>
<td>Provides much higher (32X) data transmission than AIS. Inferior CCR (+9dB) and range discrimination compared to AIS.</td>
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