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AIS Binary Message Format Using XML to Provide Hydrographic-related Information

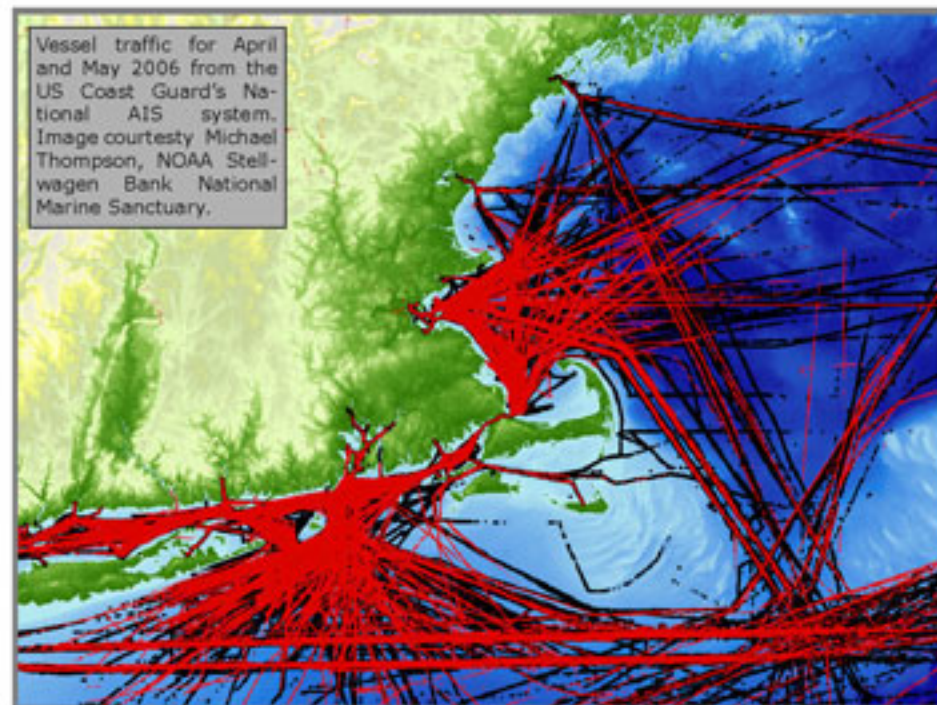
Kurt Schwehr and Lee Alexander



Abstract

A specification is being developed to enable hydrographic and maritime safety agencies to encode AIS message contents using XML. An AIS binary message definition in XML specifies the order, length, and type of fields following a subset of that used by the ITU-R.M.1371-1. The format is independent of programming language to allow vendors to integrate the system into their individual design requirements. The specification contains a reference implementation of an AIS XML to Python compiler that has been released as open-source. A XML schema and an additional program will provide validation of the XML message definitions. A XSLT style sheet produces reference documentation in 'html' format.

AIS binary messages are an effective means to digitally communicate relevant ports/waterways information related to dynamic and real-time information. One example is the "Next Generation" Electronic Chart whereby tidal information is continuously broadcast to maritime users either inport or underway and applied to "tide-aware" Electronic Navigation Charts (ENC) capable of accommodating x, y, z, and time. The XML format aligns with what IHO is planning to do in terms developing a better means of data encapsulation based on the new IHO Geospatial Standard for Digital Hydrographic Data (S-100).



Binary Message Formats

In 2004, the IMO issued SN/Circular 236 on "Guidance on the Application of AIS Binary Messages". The content of the binary messages varies depending on the application (e.g., meteorological and hydrological, tidal window, etc). While IMO defines the content and ITU the technical characteristics binary AIS messages, the text tables are not in a machine-readable format that facilitates rapid AIS binary message generation. The XML AIS Definition Language provides a method how to create an AIS Binary Message that accomplishes what the tables list.

Using XML for AIS Binary Messages

By providing a bit-level description in XML, producers of binary messages will be able to more clearly specify messages to software engineers implementing communication systems that must handle AIS messaging. The AIS binary message XML specification is a simplification of RFC-1832 converted to XML with additions that fit the specific requirements of AIS. Extensions include: bit level field lengths allowing for non-byte align data, scaling and offsets of encoded data to increase information density, units, and mandatory human-readable description of each field. The benefits:

- Readable by both humans and machines
- Automated testing and validation
- Detailed specification of the order of fields, length of fields, and type of fields
- Defined units (e.g. meters, seconds, degrees Celsius)
- A specification that is independent of programming language

The XML specification for one message is encapsulated in a XML "message" tag. The message contains the necessary information to serialize and deserialize AIS message information to and from the AIS binary message payload and the local machine representation used within an application. Messages are wrapped within a XML header and an outer "AIS-binary-message" tag that can contain multiple messages. XInclude [13] allows inclusion of predefined standard structures such as time stamps and positions, which are used in many of the messages.

a) Scaled decimal - Surface Current Speed:

```
<field name="surfcurspeed" numberOfbits="8" type="udecimal">
  <description>Surface current speed</description>
  <range min="0" max="25.0"/>
  <units>knots</units>
  <unavailable>25.5</unavailable>
  <scale>10</scale>
  <decimalplaces>1</decimalplaces>
  <testvalue>22.3</testvalue>
</field>
```

b) Integer - Surface Current Direction:

```
<field name="surfcudir" numberOfbits="9" type="uint">
  <description>Surface current direction</description>
  <range min="0" max="359"/>
  <units>degrees</units>
  <unavailable>311</unavailable>
  <testvalue>321</testvalue>
</field>
```

c) Integer with a lookup table - Sea State:

```
<field name="seastate" numberOfbits="4" type="uint">
  <description>Sea state according to the Beaufort scale</description>
  <note>http://en.wikipedia.org/wiki/Beaufort_scale</note>
  <range min="0" max="12"/>
  <units>Beaufort scale</units>
  <lookuptable>
    <entry key="0">Calm</entry>
    <entry key="1">Light air</entry>
    <entry key="2">Light breeze</entry>
    <entry key="3">Gentle breeze</entry>
    <entry key="4">Moderate breeze</entry>
    <entry key="5">Fresh breeze</entry>
    <entry key="6">Strong breeze</entry>
    <entry key="7">Near gale</entry>
    <entry key="8">Gale</entry>
    <entry key="9">Strong gale</entry>
    <entry key="10">Storm</entry>
    <entry key="11">Violent storm</entry>
    <entry key="12">Hurricane</entry>
  </lookuptable>
  <unavailable>15</unavailable>
  <testvalue>12</testvalue>
</field>
```

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<AIS-binary-message>
  <message>
    <surfcurspeed>22.3</surfcurspeed>
    <surfcudir>321</surfcudir>
    <seastate>12</seastate>
  </message>
</AIS-binary-message>
```

Source Code

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<AIS-binary-message>
  <message>
    <surfcurspeed>22.3</surfcurspeed>
    <surfcudir>321</surfcudir>
    <seastate>12</seastate>
  </message>
</AIS-binary-message>
```

XML Compiler Table Output

Field Name	Field Length (bits)	Field Type	Field Description	Field Units	Field Test Value
surfcurspeed	8	udecimal	Surface current speed	knots	22.3
surfcudir	9	uint	Surface current direction	degrees	321
seastate	4	uint	Sea state according to the Beaufort scale	Beaufort scale	12

ITU Style Definition

Field Name	Field Length (bits)	Field Type	Field Description	Field Units	Field Test Value
surfcurspeed	8	udecimal	Surface current speed	knots	22.3
surfcudir	9	uint	Surface current direction	degrees	321
seastate	4	uint	Sea state according to the Beaufort scale	Beaufort scale	12

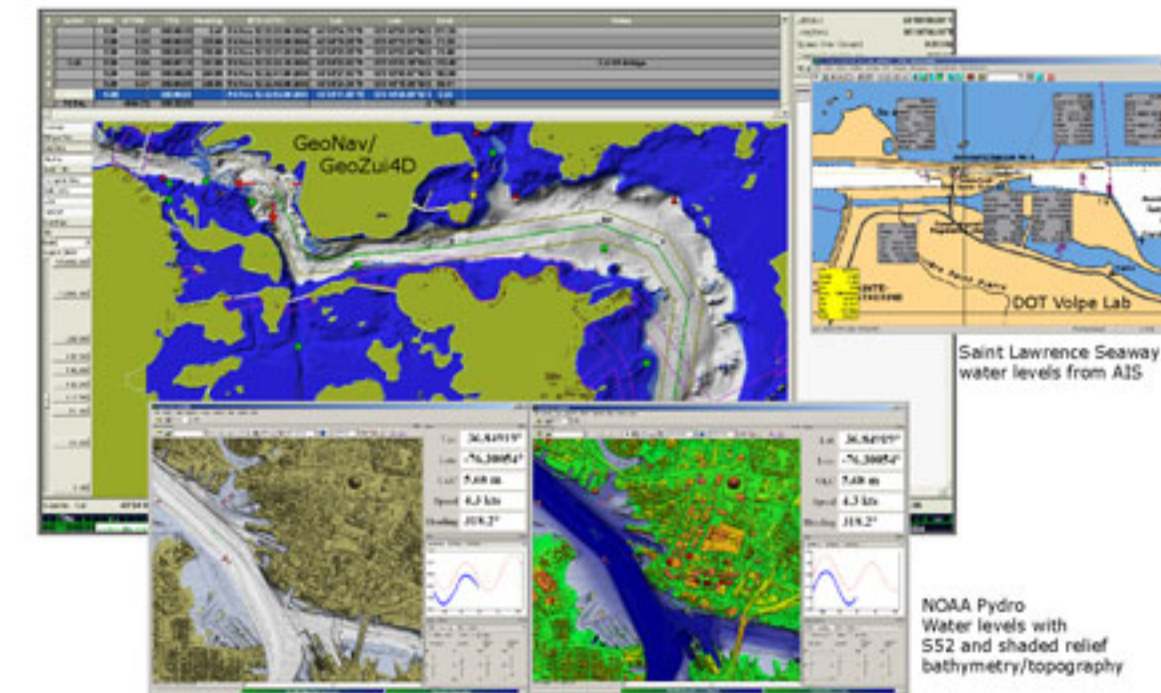
XSLT Stylesheet Output from XML

Not enough information in the ITU table to generate source code or more detailed tables.

AIS Binary Message Applications



Charting applications that use water level data:



AIS is an effective means to digitally communicate relevant ports/waterways information related to dynamic and real-time information. The "Next Generation" Electronic Chart whereby tidal information is continuously broadcast to maritime users either inport or underway and applied to "tide-aware" Electronic Navigation Charts (ENC). Water level information at a particular tide area from the NOAA Physical Oceanographic Real-Time System (PORTS) are converted into an AIS message, and then transmit it via USCG AIS Base Stations to ships in the area. Research is ongoing as to the best means to convert predicted, forecast, and "nowcast" water levels into an AIS Binary Message format. The AIS XML Definition Language allows for rapid prototyping and testing of proposed messages to ensure the final message definition meets the requirement of the maritime users of critical real-time data.

Alignment with IHO S-100

The XML formats align with what IHO is planning to do in terms developing a better means of data encapsulation based on the new IHO Geospatial Standard for Digital Hydrographic Data (S-100). S-100 is the standard intended to be used for the exchange of digital hydrographic data between hydrographic offices, and for the distribution of hydrographic data to manufacturers, mariners and other data users (e.g., environmental management organizations). Using XML to define binary AIS messages improves the transfer of all forms of hydrographic data such that the process takes place in a consistent and uniform manner.

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