AIS Vessel Identification and Techniques

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True Maritime Domain Awareness (MDA) - demands continuous, real-time identification of vessels broadcasting AIS

- Which targets are actually maritime vessels?
- Which are land-based (improperly broadcasting with Class A/B AIS)?
- Which are broadcasting:
  - the wrong identity?
  - another vessel’s identity?
  - a credential issued to another party for the same vessel?
  - expired identifiers?
  - Radio identifiers issued by a different flag than their registry?
- How many vessels’ movements cannot be audited historically by using duplicative MMSI numbers (>1 vessel simultaneously broadcasting same MMSI)?

Even as 100% identification is not possible (typically 50-100 vessels/day out of 8,500-10,000 within the U.S. NAIS System range, or ~1% unverified), allows vessels to be divided into **known** and **unknown** sets, enabling focus on unknown vessels
Background / Current State

Approximately 50% of AIS Static Data transmissions have errors

Of those with errors:
• 1/3 have ID errors
• 1/3 have Measurement errors
• 1/3 have both ID and Measurement errors

Overall, 1/3 of ALL vessels have at least one incorrect identifier of MMSI number, IMO number, Call Sign and or Ship Name – Maritime Security / Intel

Another 1/3 of ALL vessels have at least one error in measurements or some other non-identifying static data element – Maritime Safety
AIS Error Statistics by Area

Count of Unique Vessels

Based on last AIS Static Voyage Message received during 3 month period
11 May 2011 – 11 Aug 2011
AIS Error Types – by Sector

AIS Error Statistics by Area / District / Sector
Count of Unique Vessels

Based on last AIS Static Voyage Message received during 3 month period
11 May 2011 – 11 Aug 2011
AIS Error – MMSI Duplication

- Largest problem for systems consuming unvalidated AIS data
  - Safety problem when multiple ships use same MMSI in same local region
  - For historical data analysis, often difficult to track history of a vessel which uses a duplicative MMSI
- Limited domain of duplicative MMSIs
  - Only approx. 150 MMSIs over the past 3 years
  - #1 problem: Nauticast X-Pack-US default MMSI 1193046
    - Why? Keeps coming back until operators repair or replace their transponder
    - Typical MMSIs: 111111111, 123456789, 987654321, 1, 5, etc.
- If another data element is correctly configured its identity can be verified, but often spatial analysis (ports/facilities visited, nearest neighbor vessels) must be used to get “eyes on the target”
AIS Error – MMSI Duplication

Vessel Track of MMSI 111111111
(30 days, 22 Feb - 24 Mar 2011)
AIS Error – MMSI Duplication

Duplicative MMSIs in use, Jan 2008 - Jan 2011

X  <-- Today
(3-8 vessels per day)
Registration Error – Multiple MMSI assignments

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Analogous to obtaining a drivers license from multiple states
Unique tracking over time - what should be used as the fixed variable when identifying vessels?

No single legal identifier (Official Number, IMO Number, State Registration Number, Call Sign, MMSI, etc.) meets the criteria that it is available / issued to every vessel for the purpose of unique tracking.

For U.S., the USCG's Maritime Information for Safety and Law Enforcement (MISLE) and Vessel Documentation System (VDS) serves as the nation's vessel registry.
The MISLE / VDS systems represent any vessel with a unique VESSEL_ID sequence number.

This VESSEL_ID number used within the USCG's System of Record is transparent - publicly available through the USCG's CG-MIX Port State Information Exchange (PSIX) search pages and web services.

Correlation of vessels to a permanent, immutable number allows for consistent tracking of vessels over time even as other legally assigned numbers change.

Data sharing between IT systems and different organizations is vastly improved as multiple systems, including but not limited to AIS, rely upon the same fixed variable for vessel identification.
Techniques for vessel identification

• Correlation – from what?
  • Single identifying elements of MMSI, IMO, Call Sign and Name cannot be relied upon
    • Individual data elements may be wrong or missing
  • Composite of 4 discrete identifiers are turned into an “AIS Vessel Signature”
• AIS Signature is tokenized into a 45-character string
  positions 1-9=MMSI                      positions 10-18=IMO
  positions 19-25=Call Sign             positions 26-45=Name
  • Use vertical pipe character to prefix (front pad) any identifiers which do not use all allocated characters
• selected because it is not part of the NMEA 6-bit dictionary
• Remove all non-alphanumeric characters
  • Usually variations in punctuation, spacing, or even inclusion of emoticons :-(
  • Can be regarded as non-significant differences
  • Only affects strings (Call Sign and Name)
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Vessel Correlation Statistics

AIS Vessel Correlation Counts
(Previous 7-day sliding window aggregated daily)
In order to measure whether a vessel is properly identified, a standard must exist which can be used to compare the AIS data against

“Official” data sources exist within authoritative systems of record, but that does not guarantee they are correct, complete, current or unique!

- Consider for which data elements a system of record serves as the **data steward**
  - FCC is the steward of the Call Sign and MMSI, but not the ship name
  - USCG is the steward of a *documented* vessel’s name, but not call sign
  - Lloyds is the steward (for the IMO) of the IMO #, but not the owner

A proper standard should incorporate the authoritative and verified data elements from each authoritative information source in order for comparisons with raw AIS data to yield proper decisions as to whether a vessel is properly identified
Vessel Catalog – Data Sources

U.S. Radio licenses
- FCC / Boat U.S. / SeaTow / Shine Micro / U.S. Power Squadrons

International radio registrations
- ITU MARS Database

Official Vessel Registration
- U.S. Certificate of Documentation (CG-MIX PSIX) / International Flag State registries

Lloyds Register / IHS
- Equasis

Classification Society records
- IACS member societies’ data is regarded as legal record by many flag states

Notice of Arrivals, Fishing Treaty Organization databases, etc
An effective vessel catalog will maintain only those basic data elements which form the basis for a Common Recognition Context for a vessel

- Each data element should be maintained / verified for completeness / correctness / uniqueness

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While AIS signal is visible, publicly available information, only flag states have the authority to enforce correct AIS configuration.

The **cost** of misconfigured AIS is **far greater than the cost of enforcement**, but:
- costs are not well defined – not easy to quantity ($$$)
- spread across multiple organizations
  - Multiple government agencies, commercial and academic entities rely upon AIS information for security, safety, economic and environmental analysis.

For the U.S., 33 CFR 164.46(b) and 46 USC 70114 allows for commercial vessels with an improperly configured AIS to be issued penalties of up to $25,000/day and $50,000 maximum as defined in 46 USC 70119.

Estimates for 70% / 30% compliance / non-compliance with a 3-month enforcement program would:
- Correct >95% of all known AIS misprogramming in the U.S. within 3 months
- Collect approximately **$4,000,000** in fines after initial warnings ignored
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Interagency Cooperation

Federal Initiative for Navigation Data Exchange (FINDE)
- A federal working group focused on data sharing and standardization of vessel, port, commodity, owner/operator information
- Partners include USACE (lead), USCG (co-lead), CBP, IRS, NOAA, MARAD
- Achievements include interagency Information Sharing Agreements (ISAs) to share AIS information and reference data sets from the USCG to USACE and sharing of USACE’s inland AIS transceiver network data with USCG

(Other similar efforts exist – learned of the UNCLOG working group at RTCM)

Federal-Industry Logistics Standardization (FILS)
- Focused on data standards and information sharing, both industry-industry and industry-government
- Increased automation of reporting to government intended to alleviate reporting requirements to multiple agencies – one-stop reporting is the goal
- USACE is lead agency – Institute for Water Resources (IWR) Navigation Data Center (NDC)
Take-aways

• Understand the scope of AIS identification and measurement data error

• USCG can share AIS data feeds and corrective analysis with partner government agencies today (perhaps with a broader audience in the future)

• Participate in interagency working groups – engage in data sharing and standing up data services for improved efficiencies between agencies

• White paper and additional resources for the USCG Authoritative Vessel Identification Service (AVIS) may be made available on request

• If your agency manages maritime vessel information, standardize / verify against authoritative sources

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