International developments in e-Navigation

AMPI Autumn Workshop
Wollongong, 28 and 29 April 2016

Mahesh Alimchandani
Australian Maritime Safety Authority
Seven IMO Member States - to the Maritime Safety Committee in May 2006

IMO to develop (by 2008):

- a strategic vision to use existing and new navigational tools in a holistic manner
- an overarching system ...to provide a greater level of safety and incident prevention...reduce navigation-related accidents

**Concern:** If the introduction of new technology remains uncoordinated, it will result in a lack of standardization on board and an increased (and unnecessary) level of complexity.
From individual equipment & systems
To this ....
The case for e-Navigation

- Majority of collisions and groundings are caused by human error
  *(costs to industry and administrations are rising each year)*
- Despite BRM training, decision-making for navigation and collision avoidance being made in isolation (partly due to reduced manning)
- **A check on decision-making can improve human reliability by a factor of 10**
  - Well designed on-board systems
  - Close cooperation with systems ashore

*Submissions to IMO*
Broad scope:

✓ Modifications to:
  - charts
  - bridge equipment
  - communications
  - electronic aids to navigation
  - shore services and infrastructure

✓ Benefits beyond safety of navigation
  - (SAR, pollution response, security etc.)

✓ Changes to SOLAS and other regulatory instruments
In 2008, IMO ....

✓ ...approved a strategy for e-Navigation
✓ The strategy has:
  ▪ Vision
    • On board (standard user interfaces, alert & alarm management etc.)
    • Ashore (more effective Vessel Traffic Management)
    • Communications (seamless information exchange: ship-ship & ship-shore)
  ▪ 11 core objectives (safe navigation, data exchange, global coverage etc.)
  ▪ ....and a definition ...
IMO definition

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.

IMO NAV 53, July 2007
What *is* e-Navigation?

1. The harmonised exchange and presentation of navigational information in electronic formats.
2. Improved and harmonized data exchange and communications.
3. Creation of a ‘wide area navigation team’ which allows the OOW and VTS Operator to share tactical and planning information.
4. Improved design of navigational equipment.
World Wide Radionavigation System (WWRNS) ofIMO (incl. GNSS, GNSS augmentation and terrestrial backup)

Note: There are operational and technical interactions between different shipboard environments. These are not shown for simplicity’s sake in this figure.
What does the ‘e’ stand for ??

Electronic ...
Enhanced ...
Efficient ...
Essential ...
Extraordinary ..??
Everything ..???

International agreement - no need to define ‘e’ !
2014: IMO’s e-Navigation Strategy Implementation Plan (SIP) agreed

IMO will progress five outputs by 2019:

1. Revise INS Performance Standard – add modules on harmonised bridge design and display

2. Revised guidelines for Ship Reporting Systems (SRS) - standardised ship reporting

3. Built In Integrity Testing for navigation and radio equipment
4. Guidelines on standardized (or S) mode of operation of navigational equipment

5. Guidance on harmonised display of navigation information received via communications equipment

6. Not yet agreed - Define and harmonize Maritime Services Portfolios (IMO MSC to consider in May 2016)
SOLAS Regulation V/15 – decisions shall aim to:

- Navigate ship safely
- Promote BRM and easy access to essential information
- Standardised symbols
- Minimise extra work, distractions and risk of human error

No actionable responsibility associated with bridge design-related issues

Linking the guideline to Regulation V/15 – a non-regulatory approach

Role of insurers - risk of ships not compliant with V/15
IMO Guideline on SQA and HCD

To support the principles of SOLAS V/15

Primarily for developers and testers of e-navigation systems

HCD’s basic premise - systems to be designed to suit intended users and their tasks…*rather than requiring users to adapt to a system*

SQA - defining and testing software quality, to ensure high quality and stable software

AMSA’s leading work (MSC.1/Circ.1512) & video: https://www.youtube.com/watch?v=dXi2Q7An9fw
1. Guidelines for the harmonized display of navigation information (received via communications equipment)
   - IMO / IHO Group on data modelling
   - Needs a Common Maritime Data Model based on S-100
     - Norway to coordinate a joint proposal to next meeting

2. Guidance on S-Mode
   First raised in 2008
   Standardization of design of displays, interfaces and functionalities
   Manufacturers are supportive
   Australia is (informally) coordinating this work - AMC, Korea, Nautical Institute and international experts
   Seeking seafarer input (the Nautical Institute and CIRM)
   ISO standards & user needs developed for e-navigation
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<td>VTS Information Service (IS)</td>
<td>VTS Authority</td>
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<td>Navigational Assistance Service (NAS)</td>
<td>National Competent VTS Authority/Coastal or Port Authority</td>
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<td>Traffic Organization Service (TOS)</td>
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<td>Local port Service (LPS)</td>
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<td>Search and Rescue Service</td>
<td>SAR Authorities</td>
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Recognition of Iridium mobile satellite system as GMDSS service provider (US submission)

- Broad support. Breaks INMARSAT monopoly, has better polar coverage.
  - Can be incorporated in GMDSS (subject to compliance with outstanding issues. Assess cost and impact on RCCs). Provides assurance to Iridium.

Progress towards recognition of GALILEO as a part of the World Wide Radio Navigation System

Review and modernization of GMDSS – report of CG (USA)

- No new carriage requirements

Work underway on guidelines for PNT processing unit (Germany)
IHO monitoring of ECDIS matters (2012 directive, to focus on anomalous operation of some ECDIS)

Increase in number of reports of ECDIS data presentation and performance checks. **No new issues identified.**

- 73 % of reports indicate no problems
- 95 % of reports indicate no anomaly in the display of new objects
- Steady growth in medium and large scale ENC\(s\) (top 800 ports)
- Small scale coverage ~100%
IALA E-Navigation Committee – deals with shore-side aspects

**Harmonisation**
Development of S-100 based ‘product specifications’

**Communications (includes AIS)**
Development of the newly-agreed VHF Data Exchange System (VDES)

**E-Navigation Services**
Developing (with IHO) the sixteen Maritime Services Portfolios

**Implementation**
Guidance on planning and reporting on testbeds ([www.e-navigation.net](http://www.e-navigation.net))

**Positioning, Navigation and Timing**
Guidance on SBAS, eLORAN and high accuracy positioning services in critical areas. Development of the Ranging (or R) Mode.
The quest for resilient PNT

A system to complement GNSS:

- Independent and dissimilar (low frequency, high power) to GNSS
- Similar levels of performance to GNSS
- Support all phases of navigation – precision for berthing

eLORAN trials in 2013 by Trinity House, UK:

- Successful demonstration of prototype system
- Automatic and seamless transition of critical applications

‘Third way’: Ship sensed (e.g. ePelorus, eRacons)
Enhanced LORAN (e-LORAN)

- Modernised version of LORAN
- Terrestrial system – independent and dissimilar
- Needs to meet the IMO accuracy, availability, continuity & integrity requirements

- However:
  - Europe ceased transmissions in 2015
  - Under review in US
  - CHAYKA operational in the Far East
The Ranging (or R) Mode

- Terrestrial backup system, based on ranging signals transmitted from MF radio beacons (DGPS) and AIS base stations.

- Modifications to existing infrastructure would create a terrestrial backup.

- Concept proved in 2015.

- Development work in NW Europe and IALA.
“It is difficult to make predictions, especially about the future.”

Neils Bohr, Danish physicist
A proposed communication framework for **efficient, secure and reliable** electronic information exchange between authorised stakeholders

- Standards, protocols, infrastructure and governance
- NOT a storage cloud ..nor is it cloud computing
- Fits neatly within the IMO definition of e-Navigation
- Framework introduced in the North Sea Region for the ACCSEAS project *(which was completed in 2015)*

Acknowledgement: Danish Maritime Authority
Development influenced by the System Wide Information Management (SWIM) concept

(United States’ Federal Aviation Administration initiative for better sharing of Air Traffic Management system information)
Maritime ‘actors’ must have a unique maritime ID with attributes such as role, nationality, etc.

Concept builds on the URN (Universal Resource Name) adopted by the IETF (Internet Engineering Task Force).

Names to be registered with the Internet Assigned Numbers Authority (IANA).

Two ongoing European projects – EfficienSea 2 and Sea Traffic Management – aim to develop the concept through testbeds.
The problem …

- The success of AIS. Proliferation of its many uses.
- Significant loading on VHF Data Link in busy areas. *Gulf of Mexico (64%), Japan and Korea (40% each)*
- e-Navigation will need more capacity for data exchange
- Existing AIS system will not cope with future requirements for data exchange.
VHF Data Exchange System (VDES)

VDES concept addresses the need for additional capacity for digital data exchange:

- protects the original function of AIS (collision avoidance, VTS tool & information transfer)
- provides data exchange capability with globally interoperability and availability
VHF Data Exchange System (VDES)

World Radio Conference 2015 (WRC-15):

AIS 1 and 2 to remain as is – no change

From 1 Jan 2017, VHF channels 24, 84, 25, 85 and 26, 86 are identified for use of VDES. Higher reliability of message reception and capacity. From 2019, can merge first four.

✓ AIS application specific messages (IMO defined & regional) – ASM 1 & 2
✓ VDE terrestrial (6 int’l) and additional regional channels
✓ Satellite transmit on VHF Channels NOT agreed
VDES – what’s next?

From ITU:

✓ Participate in field trials
✓ Provide for VDES terrestrial component in Australian coast networks (work with ACMA)
✓ Develop operational and technical standards at IALA, IEC, IMO and ITU
✓ IALA – already developing suite of documents (recommendations, guidelines, message structures, FAQs and user requirements)
✓ IMO to develop performance standard
✓ Published as an international standard in 2010
✓ ISO-conformant registry
✓ Has many registers – for different user communities
✓ 2011: IMO agreement to use S-100 for e-navigation data exchange
✓ IALA & others (e.g. WMO) developing ‘product specifications’ (data for technical and operational services)
IHO Registry based on IHO Standards S-100 and S-99 (and underpinned by ISO 191xx series)

IHO provides the IHO Registry as a IT-based run-time-service for "Submitting Organisations".

"Main registers"
- IHO Potrayal register
- IHO Feature Catalogue

"Supplementary registers"
- Unified Operational Presentation Surface (UOPS)
- IALA Harmonized Data Model (IHDM)
- Operational presentation surface element definition(s)
- Data object / attribute element definition(s)

"Products"
- IHO defined products
- IALA defined products
- Products defined by other recognized Organisation(s)

"Registries, Layers"
- IHO domain
- IALA domain
- Domain(s) of other recognized organisation(s)

Note 1: The IHO Registry (based on S-100/S-99) is capable of supporting additional recognized organisations, other than and in addition to IHO and IALA, such as IEC, ISO, etc. This is indicated by "recognised organisation(s)".

Note 2: The "references" introduced between the registries and layers of the "main register" and the "supplementary registers" are provided as examples, only, for simplicity's sake. There could be, by default, "references" between any registry of any international organisation, provided they are of the same kind (i.e. features/attributes or portrayal elements).
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<th>Status / État</th>
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<td>Ed 1.0.0 (April 2012) / Impact Study</td>
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<th>Spécifications de produits élaborées par la <strong>Commission océanographique intergouvernementale (COI)</strong> (Numéros S-301 à 399)</th>
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| Last update / à jour : 09/03/2016 |
Pilotage matters..

**Obvious**
- Local knowledge
- Ship handling expertise
- Expert navigator
- Part of the bridge team

**Not-so-obvious**
- ‘Keeper’ of the port - key role in supply chain efficiency
- Deal with a great variety of ships, wheel house designs and bridge teams (*know what works and what does not*)
e-Navigation and pilotage

✓ Pilots (via peak bodies) can make significant contributions to:
  - Design of navigational systems and bridge layout (e.g. S-Mode)
  - S-100 product specifications and Maritime Service Portfolios
  - UKCM chart overlay S-100 product specification

✓ Pilots can expect:
  - More user-friendly systems
  - Better sharing of navigational information between ships and ship & shore
  - Improved situational awareness and incident prevention
  - Somewhat reduced workload
1. Predominance of the human element
   - mariners - the most crucial element in safe navigation
   - the expert human element on the bridge must be at the center of decision-making

2. Meet the needs of the bridge team and the pilot
   - e-Navigation must – first and foremost – give priority to responding to the needs of the bridge team and the pilot. Reduce information overload.

3. Looking out of the window remains vital
   - e-Navigation data must be complemented and validated through all the other traditional methods available to pilots
Some governments are not waiting for IMO developments. Regional, bespoke solutions being developed:

- Non-standard displays and data transfer formats - lack of harmonisation. Increases complexity.
- Detrimental to safety
- Added costs to shipowners

Parallel training of seafarers

Extra expense to shipowners in the short term

R&D costs for new products and reduced sales of existing equipment

Increased automation …with resultant reduction in human engagement
The next iteration…

✓ Success of “Phase 1” will be pivotal for success of concept

✓ Prevent e-Navigation development fatigue:
  - More user needs surveys, gap analyses, risk and cost benefit analyses - all led by IMO?

✓ The shipping industry is (understandably) somewhat sceptical

✓ Avoid:
  - being driven by vendors / marine electronics industry
  - the prescriptive ECDIS experience

✓ Development outside the IMO processes?
‘An invasion of armies can be resisted, but not an idea whose time has come’

*Victor Hugo, French poet and novelist*
Thank you for your attention!

Mahesh Alimchandani
Head of Navigation, AMSA
Tel: + 61 2 6279 5927
E-mail: Mahesh.Alimchandani@amsa.gov.au