Proposed e-Navigation System Architecture

Derived from a proposal for e-navigation shipboard technical architecture presented by Woo-Seong, Shim, KIOST, Korea

Any User Device with intuitive Human Machine Interface including Audio (i.e. INS, Workstation, Heads Up Display, Tablet, etc.)

Secure connection to e-Navigation Applications running on the Private Computing Cloud

Certified e-Navigation Applications from any vendor

On-Board		Ashore
• Collision Avoidance/Passage Planning • Route Monitoring • Route Planning/UKC/Airdraft/Weather/Fuel • Conning (Mooring/Anchoring/etc.) • Alert Management • Systems Monitoring/Trouble Shooting • Ship Reporting to Authorities (FAL Reports) • Information Subscription Management • CBT including equipment familiarization materials • Database Search Engine that allows geo-referenced and other searches	• ISM/SMS Application • Trim & Stability • Fire Fighting • (SAR) Messaging • Etc.	• MSI Publication Management • Traffic Organization Service (TOS) • Remote Inspection of Quality of Ships' Instruments • Navigation Assistance Service (NAS) • VTS Services Advertising • MRCC Incident Management • Marine Domain Awareness (MDA) • Information Subscription Management • Database Search Engine that allows geo-referenced and other searches • Etc.

Private e-Navigation Computing Cloud

Any Certified Instance of the **Open Source Reference System Architecture**

Certified Services

- Information Management System (IMS) with S-10X format subscriptions to Information Services from local & remote sensors and other equipment/sources (i.e. Radar, AIS, GNSS, MSI's, Voyage Plan, Manifest, ENC & Nautical Pubs updates, SAR Sources)
- Ship/Shore Radio Communications Network Router to automate wireless digital information exchanges via any network
- Ship/Shore Network Connection Status Updates for all available communication networks
- Security Key Manager for encrypted communications
- Any Data Base Management System and any other Application Services

Engine (Service Broker, Port, Context, HAL, UI Framework)

Middleware (Any Operating System, Containers, Discovery & Peering, Communications, Load Balancing, other generic services)

Virtualization Layer

Hardware

Redundant Physical Servers (Any CPU, Any Storage Hardware or Device)

Networking & Firewalling, Connections to local Sensors, Radar, Radio Communications Equipment, User Devices and other equipment, using any network protocol (i.e. TCP/IP, all versions of IEC 61162 and all proprietary protocols).

Data Center Mechanical & Uninterruptable Power Supply (UPS)

Security

Required Characteristics of the e-Navigation Open Source Reference System Architecture (similar to AUTOSAR for the auto industry and SAVI for avionics)

1. To make the architecture future proof for industry innovation and to avoid vendor lock-in, it should be technology neutral and thus allow certified e-navigation applications to be deployed on any server hardware, any operating system and any user device without interfering with legacy systems. Also to allow "Mixing and Matching", certified e-navigation applications from different vendors should not interfere with each other.
2. To achieve redundancy, multiple reference architecture instances should be hosted on each physical server with automatic load balancing and failover.
3. To avoid the need to customize e-navigation applications for the local and remote portfolio of sensors and other devices, they should comply with well-established interfacing standards (SensorML, UPnP, etc.) Sensors and devices should be replaceable on-the-fly with automatic discovery & peering.
4. To securely manage complex information exchanges and to allow encryption where necessary, a Pub/Sub messaging pattern should be used.