



# E-Navigation Infrastructure: Communications and the Maritime Cloud

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# Background

- The overarching e-navigation architecture, decided by IMO, assumes seamless information exchange between maritime actors onboard and ashore
- Testbed experience with potential e-navigation solutions has shown a need for a framework to support this data exchange

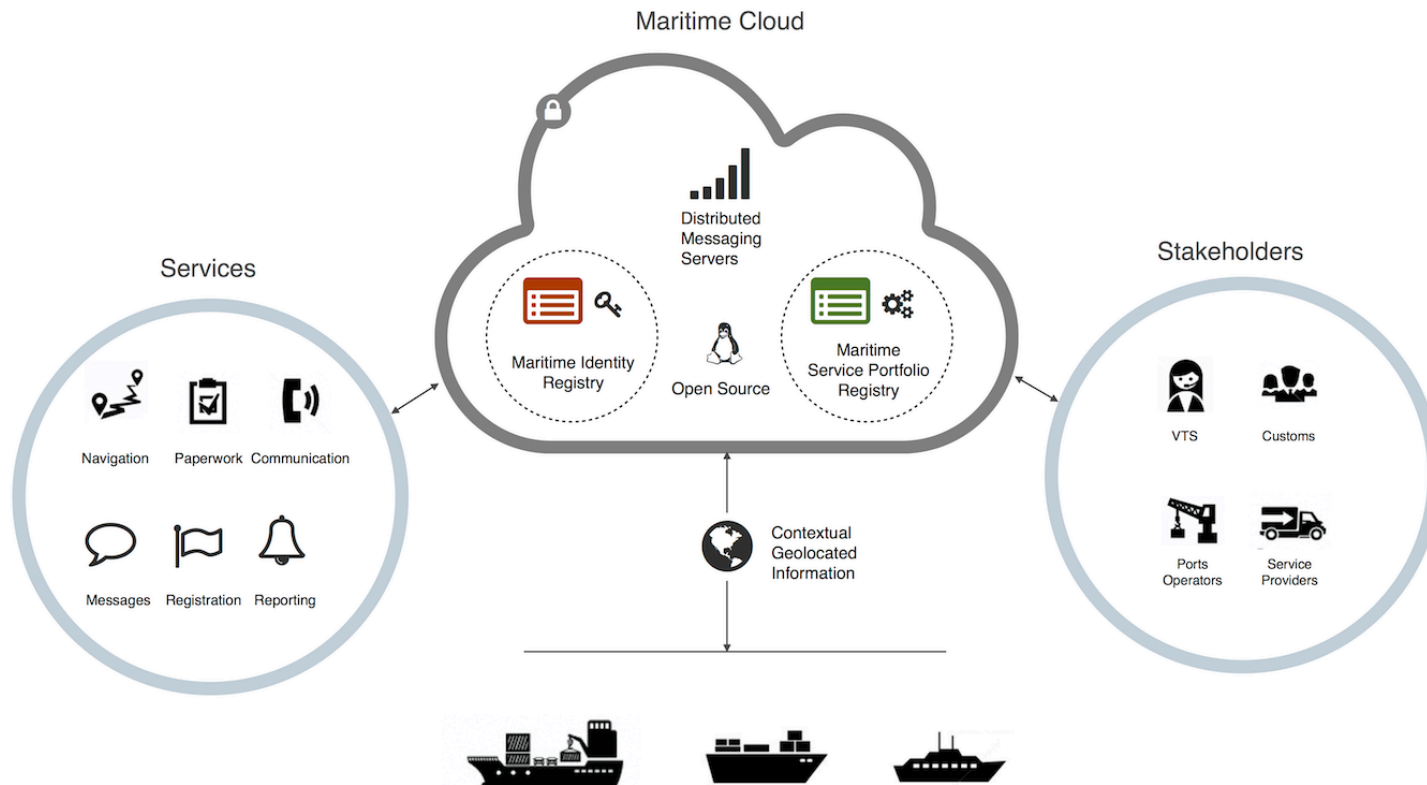


# Identified infrastructure requirements

1. New communication means
2. Service consumers must easily be able to locate provided services in an area
3. Service providers must easily be able to register their provided services
4. All maritime actors must have a unique maritime ID with attached attributes as role and nationality, etc.
5. Means for secure communication
  - Authenticity – Guarantee of who I am talking to
  - Integrity – Guarantee that data is unaltered
  - Confidentiality – Guarantee that data is not accessible by third party

# The Maritime Cloud – components

- Consists of three key components



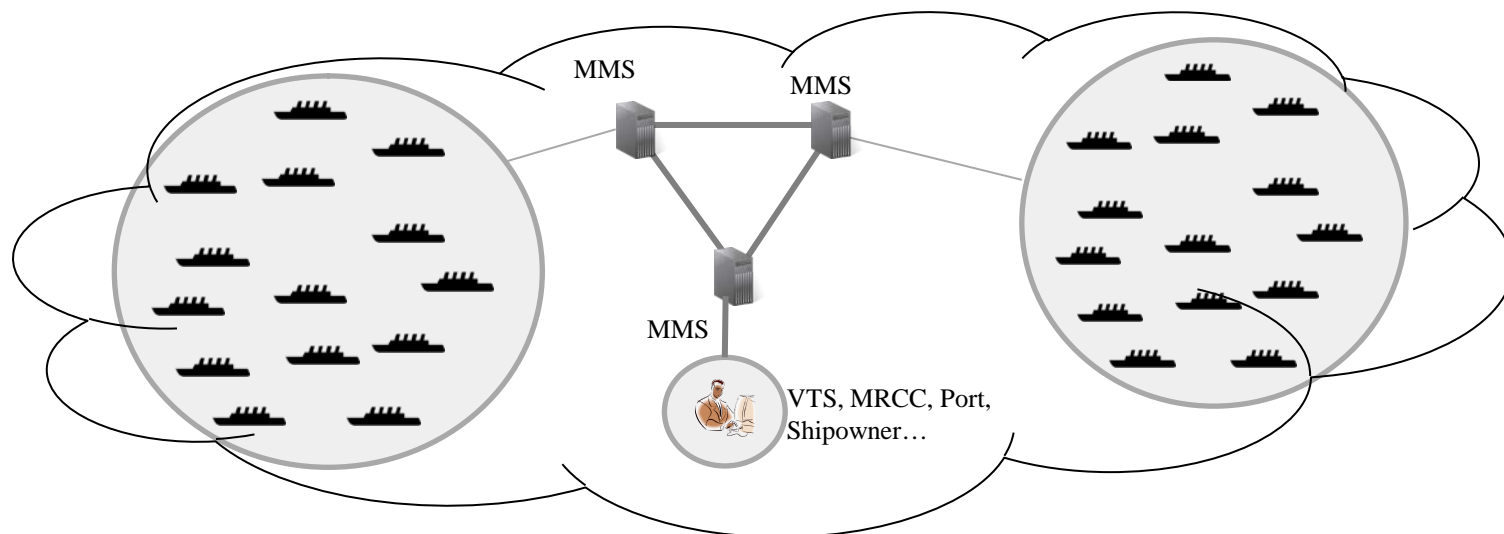


# Communication

- Digital communication means are essential for a communication framework
- Currently we have only one general purpose digital communication mean universally available
  - AIS ASM
- In some cases we have
  - Commercially available Internet (TCP/IP)
  - Stand alone text based or limited data package transfer systems via satellite or HF
- Questionable if AIS ASM will be sufficient for the prioritized e-navigation solutions
- New dedicated communication systems (like NAVDAT and VDES) need to be developed and demonstrated before they can be assumed – i.e. not available in the short term.
- The cloud must be able to utilize different communication systems
- (Seamless roaming between available communication systems)

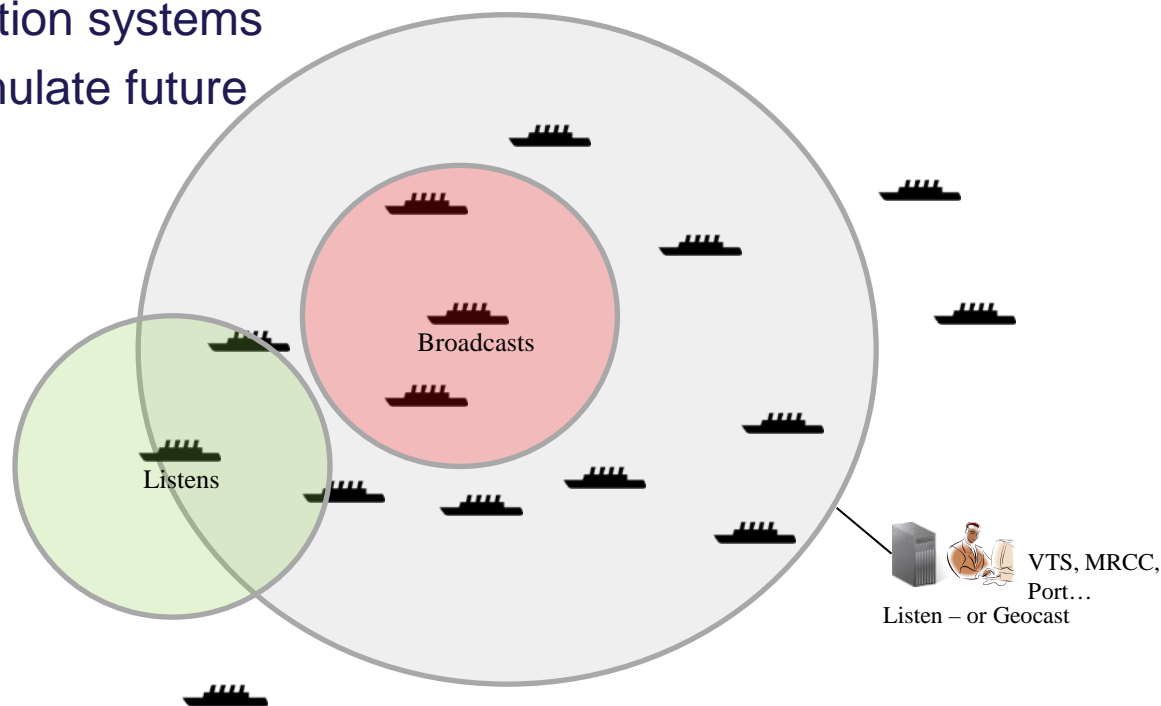
# Geo-messaging

- Geo-aware messaging protocol on top of TCP/IP (overlay network)
- Actors connects to a Maritime Messaging Server (MMS) to send and receive messages, and send position at a protocol level
- The servers maintain a geographical awareness of actors
- Can be supplemented by AIS data
- Any available Internet connection can be used (prioritized)
- Resilience by store and forward functionality



# Geo-messaging – features

- Actors can send messages directly to other actors (no range limitations)
- Geographical awareness enables **geocasting** (broadcast to given area)
- Actors can listen to a specified area – or a specific service
- Geocast is an implicit feature of many radio based communication systems
- Emulate current and simulate future communication systems





# Maritime Identity Registry

- Distributed registry maintained by a number of identity brokers in a peer-to-peer network
- All actors in e-navigation will obtain a Maritime Identity in the Maritime Identity Registry
  - Similar to callsign or MMSI but not tied to role or specific technology
- Security through public-key infrastructure
  - All actors will obtain a digital certificate (with variable trust)
- The registry contains information about the actors
  - Static information (e.g. contact information, callsign, comm. capabilities etc.)
  - Maybe also dynamic information integral for e-navigation (e.g. position and voyage information)



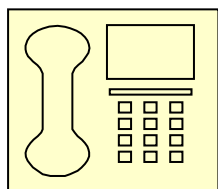


# Maritime Service Portfolio Registry

- Contains a service specification register and a service instance register
- The specification of a service is envisioned to be located in the product specification part of the IHO S-100 GI Registry
- The service instance register links
  - Service (specification)
  - Service provider (identity)
  - Area / leg / junction where the service is offered
  - Metadata like quality and service endpoints
- All stakeholders can act as both service providers and consumers
- Spans all maritime services

# Almanac

- Offline version of the public part of Maritime Identity Registry and Maritime Service Portfolio Registry
- Comparable to an advanced electronic “white pages / yellow pages” phonebook
- Updated regularly (downloaded or carried onboard)
- Identity and service concepts available offline
  - Identities can be authenticated
  - Data encryption for full confidentiality
  - Find contact information etc. for actors
  - Find provided services for areas
  - Etc.



## SHIPS

- ENRICO III
- EMA MAERSK
- ESVAGT ALPHA

-...

## Ports

- Aberdeen
- Amsterdam

-...

## MRCC

- Reykjavik
- Thorshavn

-...

## VTS

- Brevik VTS
- Fejde VTS

-...

## WEATHER

- Danish Meteorological Institute

-...

# Highlights

- e-navigation as an infrastructure and services as “apps”
- Seamless Service Provision: Services will be able to evolve dynamically and can be provided by all maritime stakeholders, including commercial
- Builds on existing proven technology i.e. cost effective
- Security solution is proven and used today in e.g. the financial sector
- Identity allows data sharing policies to be enforced
- Facilitates seamless transfer from existing to new communication means
- Availability and scalability addressed through distribution in a peer-to-peer architecture
- Testbeds will early on be able to utilize the Maritime Cloud as a communication infrastructure to evaluate potential e-navigation solutions, and to evolve and mature the infrastructure itself
- Has been submitted to the IMO e-navigation process as a proposed infrastructure that will support e-navigation in the short and the long run



# Status and the way forward

- The infrastructure is currently being progressed in the ACCSEAS project where the Maritime Cloud will serve as the testbed infrastructure
- Agile approach in which the the concept is continuously demonstrated and evaluated in practice
- Conceptual and practical work progresses in parallel
- Source code is open source for evaluation and collaboration  
<http://dev.maritimecloud.net/>
- Political aspects to be investigated
  - Possible governance structures
  - Legal, cost and operational issues

# Thank you!

## Contact information

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Google group

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