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The Fairway of the Future: Important Technical Learnings

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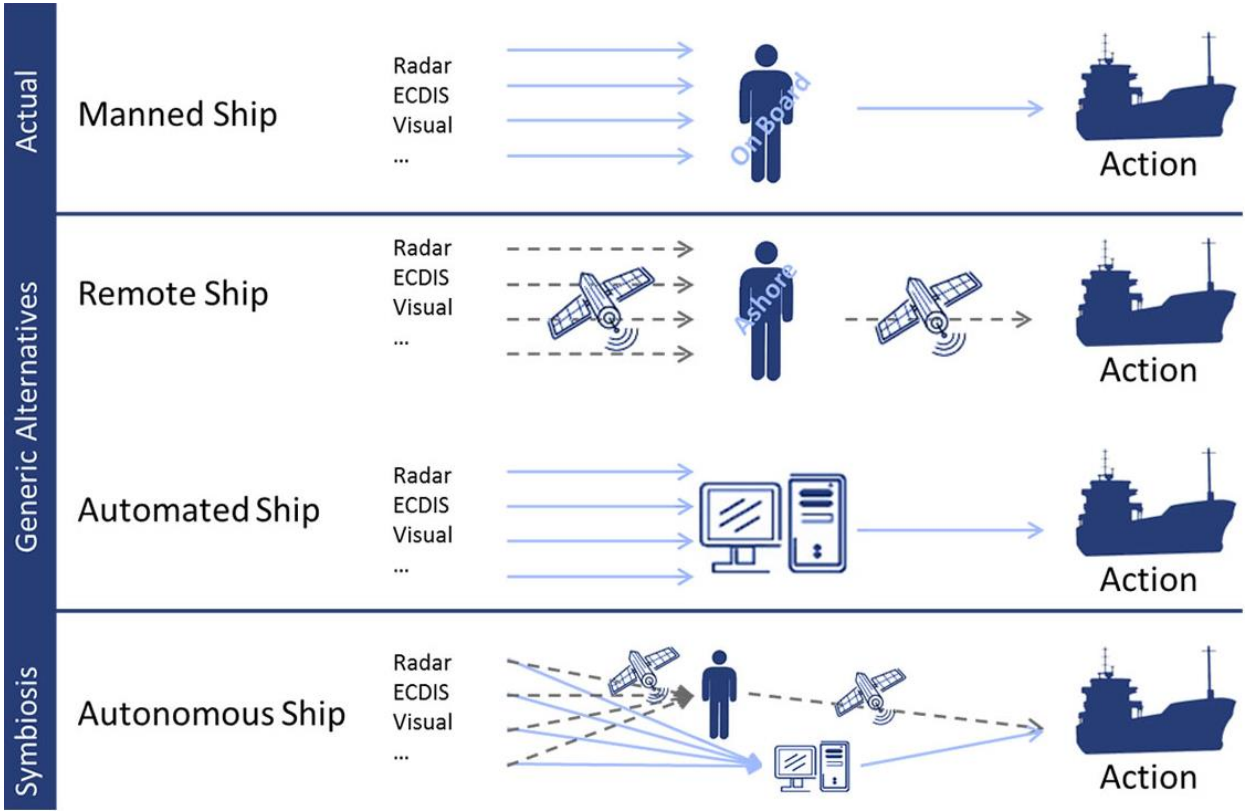
Background: Maritime Industry

- One of the oldest industries known to mankind, and is heavily regulated by maritime rules
- Remains a vital part of the global economy, responsible for over 90% of trade around the world trade
- There are heavy investments in digital transformation, for the introduction of smart ships and smart ports, which will impact the technology in fairways and waterways
- Digital transformation significantly based on advanced terrestrial connectivity, Industrial IoT developments, Data Management, Image Processing, Mapping, Artificial Intelligence and Machine Learning

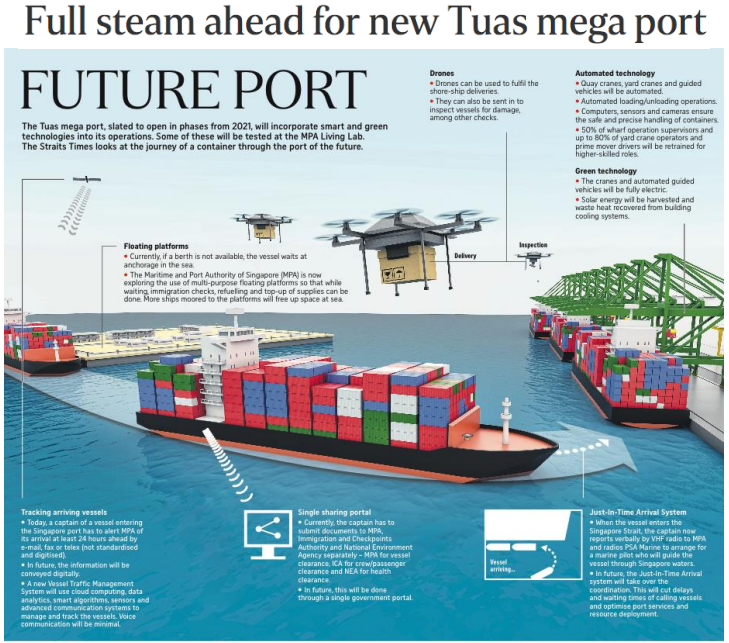
Preparing For Increasingly Smart Ships



Smart Port Developments Around The World

DIGITISATION **PRESS RELEASE** 31 January 2018

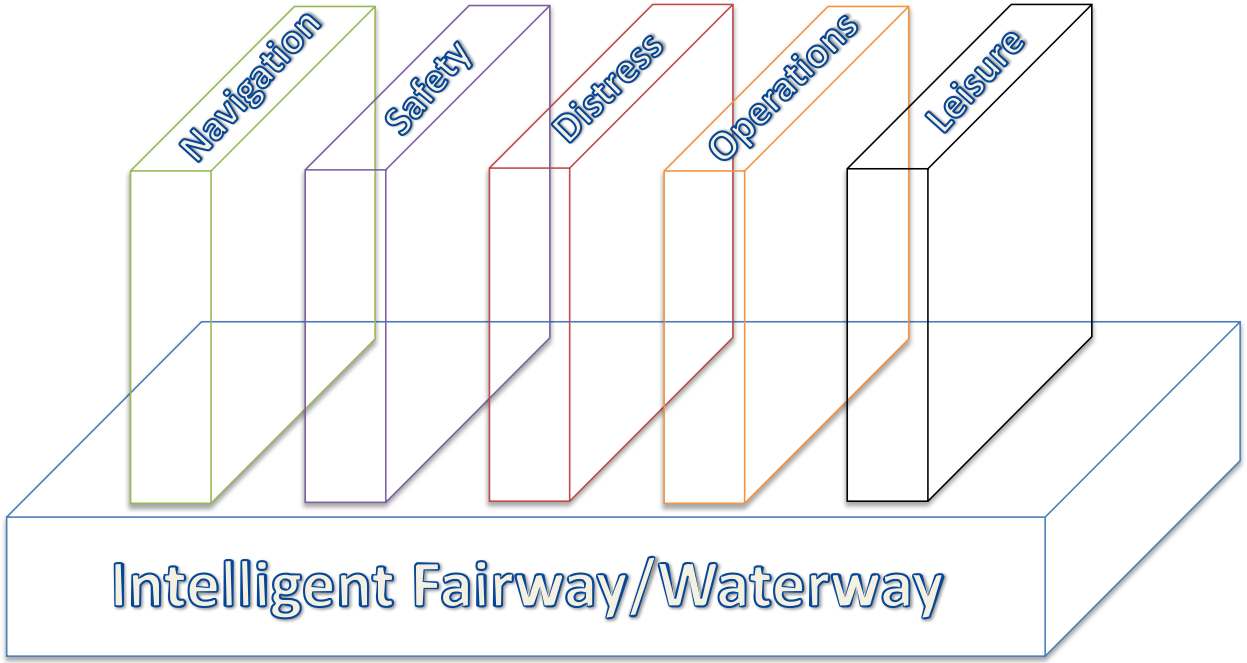
Port of Rotterdam teams with IBM Internet of Things to digitize operations



Intelligent Fairway Infrastructure (or Platform)

- Sensors
  - Bathymetric, acoustic, positioning, movement, environmental
- Processing
  - Visual Analytics, Sensor Fusion, Trajectory Detection and Forecasting
- Communication and Cloud
  - Base stations, Transponders, Gateways, Access Points, VHF
- Auxilliary Systems
  - Vessel Tracking Services, AIS

Intelligent Fairway Infrastructure and Services



Testbed Requirements for Intelligent Fairways

- Testbeds serve as a fundamental technical block to understand what the infrastructure and service needs can be
- Form a stepping stone to providing a digital twin
- Emulate, develop and deploy shore-based maritime services, such as clouds and data servers
- Technically delineate how and where the “edge” lies. Is it the fairway, is it the vessel
- Provide edge infrastructure for testing digital communication, traffic shaping and integrating various network topologies
- Deliver connectivity for sensors and equipment
- Understand, model and visualize security risks and threats

Testbeds As A Stepping Stone Towards Digital Twins

- Many ports, ships and fleet-based operations system depend heavily on legacy systems
- Compared with other industrial sectors, cybersecurity awareness is low in the maritime industry
- 87% of survey respondents from the shipping industry believed cyber attacks would increase over the next five years - a level that was higher than counterparts in the aviation, rail and logistics industries.

Connectivity Considerations

- When fairways are close to the shore, current cellular coverage with LTE, in Finland is excellent
- Nevertheless, different radio technologies are still needed in order to meet connectivity needs
- Fairway sensors and equipment further away from the coast or in blindspots need connectivity as well and not all sensors support cellular connectivity
- Incoming vessels may be equipped with other technologies such as VHF and Satellite for ship to shore communication

Communication Considerations

- The first attempt towards the digitalization of maritime transportation was Automatic Identification System (AIS)
- Main driver for AIS was safety, and the main goal was broadcast communication
  - But new services have arisen, with support for Application Specific Messages
- To prevent overloading AIS, ITU is standarding a new radio interface of VHF Data Exchange System which can be a hybrid of terrestrial and satellite communication
- This is in addition to using only terrestrial and satellite communication

Communication Considerations

- There exists a general consensus that IP-based communication would emerge as the dominant technology
- However what communication protocols are used on top of IP can become very confusing, especially for sensor traffic
  - The solutions are use-case and business specific currently
- Communication paradigms also differ based on needs
  - Publish/Subscribe, REST and RPC are the available options
- Commonly used protocols are based on TLS, DTLS, MQTT, HTTP and CoAP

Exchange And Transfer Of Sensor Data

- Sensor data can be transmitted over a variety of wired and wireless networks conforming to device and technology specific requirements (NMEA, CAN bus, etc) but over IP networks, sensor payloads using JSON is increasingly dominant
- JSON is well supported using HTTP APIs from 3rd party providers as well as over REST protocols
- JSON-based data representations can be converted into other formats such as XML for compatibilty, or compacted into CBOR to achieve better compression
- However, there seems to be lack of standard data models

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Security Considerations

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WEDNESDAY, DECEMBER 9, 2015

Maritime Security: Hacking into a Voyage Data Recorder (VDR)

by Ruben Santamarta @reversemode

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Port of San Diego suffers cyber-attack, second port in a week after Barcelona

Cyber-attacks have now been reported at three ports in the last two months

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Findings: Communication and Data Transfer

- When high-speed broadband communication channels exist and bandwidth is abundant, the choice of security mechanisms, communication protocol and data payload formats are not significantly different
- When radio signalling costs are high compared to amount of data transferred, again application layer performance does not matter
- However, when the radio channel is congested, lossy or experiences severe latency, then using protocols such as TLS and DTLS will become impossible
  - In such cases, consider signing and encryption of data at the application protocol layer instead of transport layer
  - Consider also smaller payload formats and sizes

Findings: Cybersecurity Strategies

- Employ preventative defensive methods (Hardening VDR, endpoint protection, user and device authentication) and securing communication
- Develop new defensive strategies which depend on information sharing, data correlation and increasing cybersecurity awareness

Findings: Data Sharing and Data models

- Scalable, able to allow multiple stakeholders to participate
  - This means it should have a standard vocabulary and data model to express data
  - Based on open standards to avoid vendor lock-in
  - Ability to integrate easily into existing workflow, particularly integration to Web and REST-communication
- Extensible and flexible data models
  - Data model should allow future extensions, such as new sensor and incident data for smart ships and smart ports
  - Format should allow expressing multiple measurements occurring within a specific time period, or associating related data happening in different locations and times
  - Format should should be simple enough for machine-based interaction, so that report generation and processing can be automated
- Resilient, secure and can tolerate connectivity disruption or intermittence
  - This allows the cybersecurity incidents to be securely exchanged between ship and shore

Looking Forward

- Sea4Value FFN as a technical blueprint for a future fairway infrastructure has been extremely informative
- Sea4Value FFN as a technical blueprint for minimum requirements for enabling remote piloting revealed it is already technically possible today with minimal disruptions to ship systems, while increasing safety and security of piloting services

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Thank you for your time!