

# TRAFICOM

Finnish Transport and Communications Agency



Finnish Transport  
Infrastructure Agency

## Future Fairway Elements analyses

By Traficom & FTIA

Heidi Himmanen @ S4V Fairway final  
seminar 29.9.2022





# 5G in Finnish Ports

5G Momentum ecosystem by Traficom

<https://www.youtube.com/watch?v=zJNADVHqWL8>

# Background: Key questions

- ▶ What is our vision of a future smart fairway? What is the definition of a "safe tube"?
  - ▶ What are the services in the safe tube?
  - ▶ What are the required updates to physical and digital infrastructure?
    - ▶ What is the roadmap?
    - ▶ E.g. Digital infrastructure: How does today's systems for radio communication and radio location fulfill the needs of the "safe tube" / smart fairway? What needs to be developed?
- ▶ The S4VF project should support the Finnish legislative and action plans for transport automation.

# The process and initial definitions

- ▶ Challenge of understanding demands for different elements of the future fairway
  - ▶ Pre-workshop May 21 by Traficom to identify elements
  - ▶ Workshop in June 21 with S4VF partners to improve
  - ▶ Table by Uni Turku for analyses
  - ▶ Workshops by Traficom & FTIA to describe selected elements
  - ▶ Continued analyses by Uni Turku
- ▶ **Future Fairway** vs. Smart Fairway
  - ▶ IALA: There are no smart fairways, only fairways with different levels of (navigation) services
  - ▶ Consists of elements with different capabilities and is used by ships and vessels with different capabilities
  - ▶ Goal: Situational awareness and safety, environment & efficiency

# Analysed elements and lessons learnt by Traficom & FTIA

- 1.a. **Physical** aids to navigation
- 1.b. **AIS aids to navigation**
- 2. Communication
  - a) **Dedicated maritime radio systems**
  - b) **Mobile networks & satellite services**
  - c) **User and Service registry's (tbd)**
- 3. **Electronic** position finding aids
- 4. Digital version of the physical infra (**incl. seabed**)
- 5.a Navigational charts (**static**)
- 5.b. Nautical publications
- 6. Dynamic navigational warnings
- 13. support for the emergency services, SAR, **PPR, Places of refuge, maritime assistance service**
- 17. VTS
- 18. Ice breaking / winternavigation
- 23a. Traffic management
- 23b. Port just-in-time**



# ELEMENT 1: Physical aids to navigation

<h2>Partners</h2> <ul style="list-style-type: none"><li>- <b>Maritime authorities are responsible for the fairway safety, but many aids to navigation and services are produced by private sector. Thus, partners and cooperation are needed.</b></li><li>• AtoN suppliers, remote monitoring/controlling service providers</li><li>• Buoy tenders</li><li>• Information for remote control of AtoN<ul style="list-style-type: none"><li>• FinTraffic VTS provides the traffic (AIS)</li><li>• FMI or commercial operators provide the visibility information</li></ul></li><li>• GNSS service providers and mobile network operators</li></ul>	<h2>Content/service</h2> <p>Support safety of navigation. The remote monitoring provides up-to-date information on the operation of the AtoN light and the displacement of the floating AtoN. Future:</p> <ul style="list-style-type: none"><li>- <b>New elements could include e.g. more accurate and dynamic weather, traffic and sea state information. In some visions, the Atons could also control the traffic.</b></li><li>• Enables the provision of other elements; AtoNs (especially fixed) might be used as a mounting platform for various other devices (e.g. for meteorological and hydrological (metocean) information)</li><li>• AtoNs connected to the electric grid may share the electricity connection with other devices AtoNs can be used to produce weather and sea state information using existing or added sensors (so far in very limited use).</li><li>- The remote controlling can be used to adjust the brightness of the Aton lights manually (e.g. VTS centers) or automatically based on traffic (AIS) and/or weather conditions (visibility).</li></ul>	<h2>Delivery channels</h2> <p>Through radio and satellite based communication channels</p> <ul style="list-style-type: none"><li>- New layers for e.g. ECDIS via S-100</li></ul> <p><b>Remote monitored and – controlled AtoNs transfer data via mobile networks. Remote monitoring and - controlling services for users are available via Internet.</b></p>	<h2>Customers / user groups</h2> <ul style="list-style-type: none"><li>- On-board crew, coast guard, pilots, ports, agents</li><li>- Vessels</li><li>- VTS</li></ul>
<h2>Requirements from the other elements</h2> <p>As regards to intelligent fairway, the smart Atons will need input data from other sources and communication channels are also needed. So it's not a stand-alone element. Stand-alone (Atons without remote monitoring/control). Remote monitored/controlled Atons need input and services mentioned in "Partners" section.</p>		<h2>Readiness level</h2> <p><b>The readiness level meets the current requirements. The concept of intelligent fairway is not yet established, but new innovations will be needed – the readiness level is variable in this context</b></p> <p>Remote monitoring is widely used in floating and fixed AtoNs in commercial shipping lanes, about 1800 items currently. Manual remote controlling is currently used in 142 AtoNs and it is easily expandable to all remotely monitored sites. Automated remote control (traffic/weather) will be tested during 2022.</p>	
<h2>Financing</h2> <ul style="list-style-type: none"><li>- Government-funded Through fairway dues, taxes, direct contracts, etc.</li><li>- <b>Additional funding needed for future development</b></li><li>- Municipalities and private fairways and ports</li></ul>			

## ELEMENT 1a: AIS aids to navigation

<b>Partners</b> <ul style="list-style-type: none"><li>- Maritime authorities are responsible for the fairway safety</li><li>- <b>Ports are responsible of fairways in harbour areas</b></li></ul>	<b>Content/service</b> <p>An AIS AtoN is a digital aid to navigation (AtoN) promulgated by an authorized service provider using AIS Message 21 "Aids to navigation report" that is portrayed on devices or systems (e.g. Electronic Chart Display and Information System (ECDIS), radar or Integrated Navigation System (INS)).</p> <p>An AIS AtoN can be implemented in two ways:</p> <ul style="list-style-type: none"><li>• <b>Physical</b> AIS AtoN is an AIS Message 21 representing an AtoN that physically exists; and</li><li>• <b>Virtual</b> AIS AtoN is transmitted as a AIS Message 21 representing an AtoN that does not physically exist.</li></ul> <p>AIS AtoN messages can also be used to communicate the AtoN's status i.e. if the AtoN is off-position or unlit.</p>	<b>Delivery channels</b> <p>AIS on VHF</p>	<b>Customers / user groups</b> <ul style="list-style-type: none"><li>- Vessels</li><li>- VTS</li><li>- Port authorities</li></ul>
<b>Requirements from the other elements</b>			
<b>Financing</b> <ul style="list-style-type: none"><li>- Government-funded Through fairway dues, taxes, direct contracts, etc.</li><li>- Additional funding needed for future development</li><li>- Municipalities and private fairways and ports</li></ul>	<b>Readiness level</b> <p>AIS messages are standardised and in use. Older on-board navigational equipment are not capable to display the information.</p> <p><b>Today AIS is mainly used for identification of ships and their positions. AIS messages can also be used for providing ships with other information, such as virtual AtoN's, weather information or navigational warnings.</b></p>		

# ELEMENT 2: Communication – dedicated maritime radio systems

<p><b>Partners</b></p> <p><b>Distress network</b> (incl. VHF base stations on shore) operated by MRCC.</p> <p><b>Safety network</b> (incl. VHF base stations on shore) operated by FinTraffic/VTS.</p> <p>Traficom grants <b>radio licenses and radio operator certificates</b>. FTIA together with Fintraffic VTS could provide the maritime specific free of charge communication infrastructure (either inhouse and via service contracts with commercial companies)</p> <p>(In case of VDES SAT, providers may be commercial operators, but not likely to be used in the Finnish Fairways)</p>	<p><b>Content/service</b></p> <ul style="list-style-type: none"> <li>MF, HF and VHF maritime radios             <ul style="list-style-type: none"> <li>Speech</li> <li>DSC (Digital Selective Calling)</li> <li>AIS (automatic identification system, can also be satellite-based)</li> <li>NAVDAT for general data</li> <li>HF for general data</li> <li>LF for eLoran</li> <li>MF for DGNSS</li> </ul> </li> <li>Emergency beacons, satellite-based             <ul style="list-style-type: none"> <li>EPIRB (Emergency position-indicating radio beacon)</li> <li>PLB (Personal Locator Beacon), not recommended for professional use</li> </ul> </li> <li>Future:             <ul style="list-style-type: none"> <li><b>VDES (VHF data exchange system) e.g. for eNavigation (AIS, ASM, VDE TER/SAT) for general data</b></li> <li><b>Autonomous Maritime Radio Device (AMRD) on VHF</b></li> </ul> </li> </ul>	<p><b>Delivery channels</b></p> <p>This is the dedicated delivery channel for maritime speech and data.</p> <p>Enables the provision of other elements (exchange of digital information services and reports between providers and consumers).</p>	<p><b>Customers / user groups</b></p> <p><b>Obligatory communications channels for commercial / professional maritime operations.</b></p> <p>Optional for recreational boating.</p> <p>Vessels, VTS, generally the providers and consumers of data and information elements.</p> <p>MRCC</p>
<p><b>Requirements from the other elements</b></p> <p>Infrastructure element – carrier to other services</p> <p>Enables provision of other elements.</p>		<p><b>Readiness level</b></p> <p>In operation. <b>Development of GMDSS, eNavigation and VDES ongoing on international forums.</b></p> <ul style="list-style-type: none"> <li>GMDSS, AIS and MF (DGNSS) – standardised (ITU, IEC) and widely used by vessels (GMDSS and AIS mandatory)</li> <li>VDE ASM, VDE TER/SAT – ITU recommendation exists, pending for test specifications</li> <li>VDES R-Mode and MF R-Mode – no ITU recommendation yet</li> </ul> <p><b>Old systems are not supporting cyber security, e.g. AIS. Authentication is not supported.</b></p>	
<p><b>Financing</b></p> <p>State financed. Publicly funded</p> <p>Fairway Service fees</p>			



## ELEMENT 2: Communication— mobile networks & satellite services

<p><b>Partners</b></p> <p>Satellite and mobile network operators</p>	<p><b>Content/service</b></p> <p>Today:</p> <ul style="list-style-type: none"> <li>• Inmarsat with VSAT (user eq) satellite service for speech and data</li> <li>• 2G-4G commercial mobile networks for speech and data</li> <li>• VIRVE (TETRA technology)</li> </ul> <p>Future:</p> <ul style="list-style-type: none"> <li>• Iridium approved for GMDSS</li> <li>• 4G/5G networks built today on market basis <ul style="list-style-type: none"> <li>• Also satellite component in the future?</li> <li>• Models for dedicated capacity/QoS for transport and public-private partnership?</li> </ul> </li> <li>• VIRVE2 (4G/5G technology) for defined user groups</li> <li>• What will be the role of future non-GSO satellite systems (e.g. SpaceX, OneWeb megaconstellations)?</li> <li>• (5G, VIRVE2 and sat com not maritime specific but shared by other user domains)</li> </ul>	<p><b>Delivery channels</b></p> <p>-</p>	<p><b>Customers / user groups</b></p> <p>All fairway users</p> <p>Vessels, passengers, VTS, generally the providers and consumers of data and information elements.</p> <p>Leisure yachts</p>
<p><b>Requirements from the other elements</b></p> <p>Mainly stand-alone elements</p>			
<p><b>Financing</b></p> <p>Service financed by user fees (vessels pay to get connectivity)</p> <p><b>We need to find new models to complement the commercial services to enable co-operation between the MNO and other actors to complement the communication network, where it is not profitable to build the required service level and availability on commercial basis.</b></p>		<p><b>Readiness level</b></p> <p><b>Iridium approved, 5G is being built on commercial basis, VIRVE2 is being built, non-GSO satellites are being launched but service level in Finland uncertain. IMT systems for maritime use under development by 3GPP (tested widely in Korea) and currently discussed in IALA and IMO. Old implementations are not supporting current cyber security requirements. Cyber security built in to many systems but when implemented in maritime, cyber security need to be considered.</b></p>	

## ELEMENT 2: Communication – User and Service registry’s – to be developed

<p><b>Partners</b></p> <p>FTIA Fintraffic VTS Service providers</p>	<p><b>Content/service</b></p> <p>Platform to enable digital authentication and services discoverability for facilitating the provision of Maritime Services. (Such as Maritime Connectivity Platform, MCP)</p> <ul style="list-style-type: none"> <li>• The Maritime Identity Registry (MIR): Facilitating authentication of entities exchanging information</li> <li>• The Maritime Service Registry (MSR): Facilitating service discoverability</li> </ul> <p><i>Enables safe information exchange and service provision, authentication of users.</i></p> <p><b>Cyber security: certificates and control mechanisms are important</b></p>	<p><b>Delivery channels</b></p> <p>IP-connections</p>	<p><b>Customers / user groups</b></p> <p>Service providers End-users</p>
<p><b>Requirements from the other elements</b></p>		<p><b>Readiness level</b></p> <p>Development and testing ongoing</p> <p><b>Unclear, who would be in charge of this nationally</b></p> <p><b>Are the certificate and security policies defined? – Partly</b></p>	
<p><b>Financing</b></p>			

## ELEMENT 3: **Electronic** Position finding aids

<p><b>Partners</b></p> <p>GNSS: GPS operated by US, Glonass by Russia, Galileo by EU (the only civil system!?), (Beidou by China)</p> <p>VTS center (Fintraffic)</p> <ul style="list-style-type: none"> <li>• SBAS by EGNOS service provider</li> <li>• IALA Beacon DGPS service by Fintraffic VTS</li> <li>• DGNSS, RTK and PPP services by many commercial service providers</li> </ul> <p>Future possibilities:</p> <ul style="list-style-type: none"> <li>• HAS (high-accuracy service) by Galileo service provider</li> <li>• Local RTK/PPP over VDES by Fintraffic VTS</li> <li>• <b>VDES R-Mode and MF R-Mode by Fintraffic VTS</b></li> <li>• eRacon service by FTIA inhouse or via service contract</li> </ul>	<p><b>Content/service</b></p> <ul style="list-style-type: none"> <li>• <b>Maritime radar</b> <ul style="list-style-type: none"> <li>• Professional use (9 GHz band)</li> <li>• Recreational use (3 GHz band)</li> </ul> </li> <li>• <b>GNSS</b> (Global Navigation Satellite System) <ul style="list-style-type: none"> <li>• GPS</li> <li>• Glonass</li> <li>• Future: Galileo and its PRS (publicly regulated service)</li> <li>• (Often combinations of the above)</li> </ul> </li> </ul> <p><b>GNSS service and in the future MF/VDES R-mode and eRacon service provide vessels with absolute position information which can be displayed in electronic nautical charts.</b></p> <p>SBAS service, commercial DGNSS/RTK/PPP services, IALA Beacon DGPS service and in the future Galileo HAS and local RTK/PPP over VDES provide augmentation (integrity and better accuracy) to GNSS services.</p>	<p><b>Delivery channels</b></p> <ul style="list-style-type: none"> <li>• GNSS satellites</li> <li>• DGNSS terrestrial components via MF, VHF, SAT, internet (via 4G/5G to cloud)</li> <li>• eRacon via radar frequencies</li> <li>• VHF radio for AIS to report position to other fairway users or VTS center (also virtual AIS and AIS AtoN)</li> </ul>	<p><b>Customers / user groups</b></p> <p>Obligatory communications channels for commercial /professional maritime operations.</p> <p>Optional for recreational boating.</p> <p>Vessels</p>
<p><b>Requirements from the other elements</b></p> <p>VHF communication channel used for AIS</p> <p>Communication channel for providing signals/data must exist</p>		<p><b>Readiness level</b></p> <p>In operation. Galileo is being built. <b>Services for Interference Detection and Mitigation available and under development</b> (e.g. Orolia M-SecureSync available for military use -&gt; for commercial).</p> <p>GNSS, IALA Beacon DGNSS - standardized and widely used by vessels (room for improvement related to MCMF).</p> <p>SBAS, VDES R-Mode and MF R-Mode – standardisation for maritime use ongoing. Others pending for standardisation.</p>	
<p><b>Financing</b></p> <p>Galileo is being built by EU</p> <p>Public funding for public services</p> <p>User fees for commercial services</p>			

## ELEMENT 4: digital version of the physical infra

Seabed also part of physical infra

<p><b>Partners</b></p> <p>For the S-102 Bathymetric Surface the production of the datasets will done by Traficom and global distribution is planned to arrange with Primar RENC .</p> <p>Collection and maintenance of the S-102 source data will be done in close cooperation between Traficom, FTIA and Ports (Public, Industry, Muncipal).</p>	<p><b>Content/service</b></p> <p><b>(A part of the fairway digital twin)</b></p> <p>Future:</p> <ul style="list-style-type: none"><li>• S-102 <b>Bathymetric Surface</b> = The high resolution and up to date bathymetric data (seabed) on the major fairways and routes used by a merchant shipping.</li><li>• The <b>Aids to Navigation (AtoN)</b> Information (S-125/S-201) (today physical, in the future also digital)</li><li>• <b>Landscape data</b> (above water)</li><li>• (Digital twin could facilitate e.g. remote ship operations)</li></ul>	<p><b>Delivery channels</b></p> <p>Primar RENC Services (Global distributor of the S-102 Bathymetric Surface data products)</p> <p>Via internet (or other means)</p> <ul style="list-style-type: none"><li>• Dedicated portals and apps</li><li>• Dedicated machine-readable interfaces</li></ul>	<p><b>Customers / user groups</b></p> <ul style="list-style-type: none"><li>• Shipowners: SOLAS / ECDIS vessels</li><li>• Pilotage: Pilots PPU users</li><li>• VTS: VTS operators</li><li>• Icebreaking (vessels)</li><li>• Coastal Authorities: Navy, Border Guard, ...</li></ul>
<p><b>Requirements from the other elements</b></p> <p>The S-102 BS will (in the future) have interoperability with the S-101 ENC and S-104 Water Lever data products (run by the ECDIS/INS systems).</p>	<p><b>Financing</b></p> <p>The service will be financed by the end user fees. Service fees will be collect by the Primar RENC. The distribution system is under development in the Primar RENC. No major additional investments are required from Traficom.</p> <p><b>Readiness level</b></p> <p>S-102 Bathymetric Surface: Production capability already in place in Traficom. Test data sets will be available in 2022 and the production of official data sets for a navigational use will start in 2023.</p>		

## ELEMENT 5a: Navigational charts (static)

### Electronic Navigational Chart, S-57 and S-101 ENC

#### Partners

The he S-101 datasets is produced by Traficom. Distribution by Primar RENC.

Maintenance of the source data is done in a close cooperation between Traficom, FTIA, Ports (Public, Industry, Muncipal), the National Land Survey and some other source data providers.

#### Content/service

Today: (S-57) A Electronic Navigational Chart = A data set containing all relevant information for vessel's route planning and safe navigation. ENC's must be produced according the relevant IHO Standards.

**Future: S-101**

#### Delivery channels

Primar RENC Services  
(Global distributor of the S-101 ENC data products)

#### Customers / user groups

Shipowners: SOLAS / ECDIS vessels  
Pilotage: Pilots PPU users  
VTS: VTS operators  
Icebreaking (vessels)  
Coastal Authorities: Navy, Border Guard, ...

#### Requirements from the other elements

The ENCs can be used as a standalone products in the ECDIS/INS systems, but customers will benefit greatly when ENC is used alongside the S-102 Bathymetric Surface and S-104 Water Level data products.

#### Financing

The service will be financed by the end user fees.  
Service fees will be collect by the Primar RENC.  
The distribution system is under development in the Primar RENC.  
No major additional investments are required from Traficom.

#### Readiness level

The ENC's based on IHO S-57 Standard have been provided since 2010 from Finnish waters.

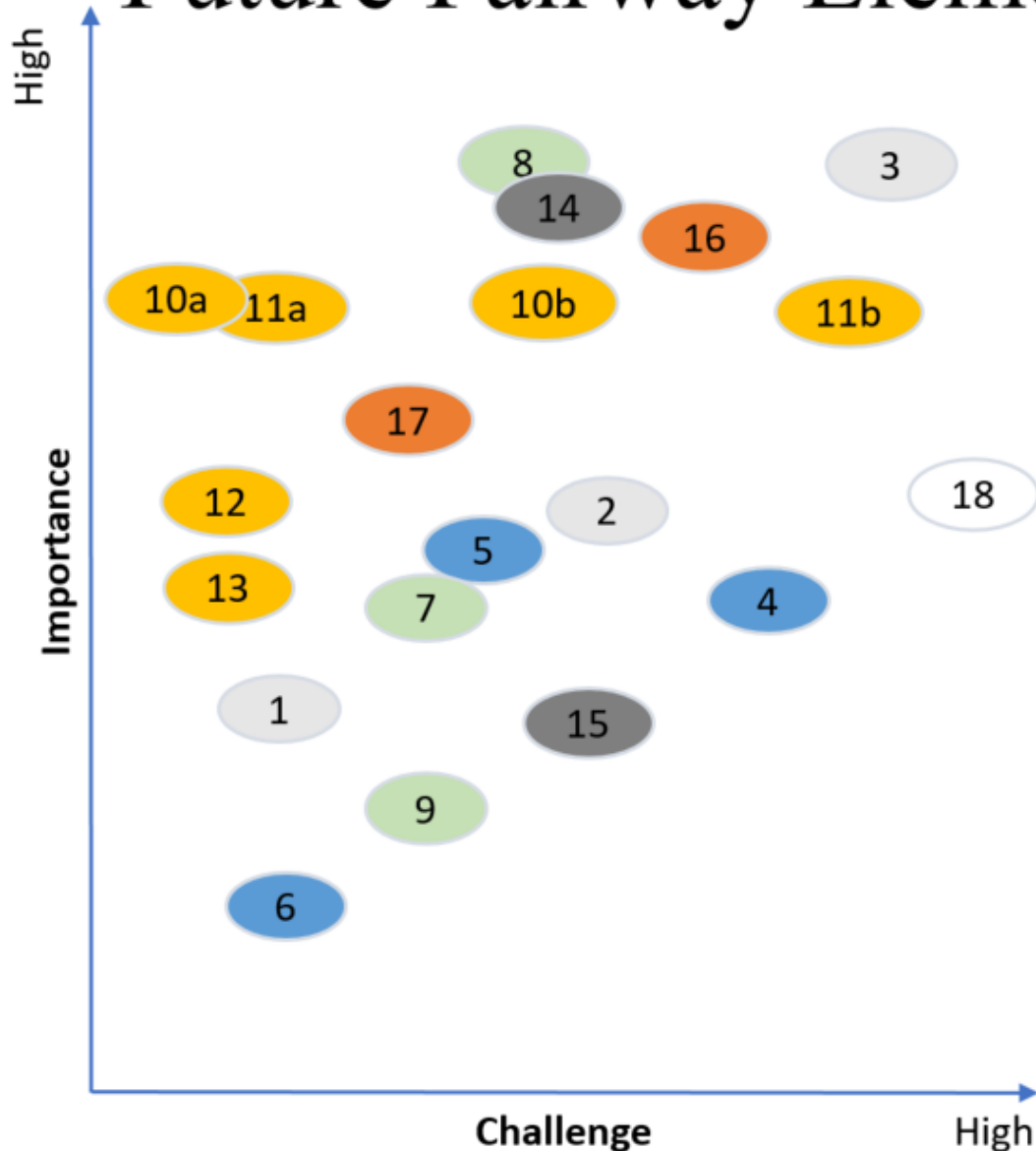
**The capability for IHO S-101 ENC production is under development in Traficom and in the chart system provider. Test data sets will be available in 2023 and the production of official data sets for a navigational use will start in 2024.**



## ELEMENT 5b: Nautical publications

<p><b>Partners</b></p> <ul style="list-style-type: none"><li>a) Ports, Traficom, Database manager-TBD</li><li>b) Traficom and other producers of nautical products</li></ul>	<p><b>Content/service</b></p> <p>Future:</p> <ul style="list-style-type: none"><li>a) Marine Harbour Infrastructure (IHO S-131 standard)</li><li>b) Catalogue of Nautical Products (IHO S-128)</li></ul>	<p><b>Delivery channels</b></p> <ul style="list-style-type: none"><li>a) TBD</li><li>b) Primar RENC Services (Global distributor of the Navigational data products) and via internet (Dedicated portals and apps)</li></ul>	<p><b>Customers / user groups</b></p> <ul style="list-style-type: none"><li>a) Traficom/ENC producer, Merchant shipping, Pilotage, Shipping agents</li><li>b) Merchant and domestic shipping, Pilotage, Shipping agents, VTS, Icebreaking, Coastal Authorities, Recreational boating</li></ul>
<p><b>Requirements from the other elements</b></p> <ul style="list-style-type: none"><li>a) Standalone element</li><li>b) Standalone element</li></ul>			
<p><b>Financing</b></p> <ul style="list-style-type: none"><li>a) TBD</li><li>b) TBD</li></ul>	<p><b>Readiness level</b></p> <ul style="list-style-type: none"><li>a) Standardisation (IHO S-131) is on the way. Pilot projects for data collection and management in IHO/Port of Singapore and in Norway.</li><li>b) Pdf version of the Chart Catalogue is available. Standardisation (IHO S-128) is on the way.</li></ul>		

# Future Fairway Elements



## CORE INFRASTRUCTURE

- 1 Aids to Navigation
- 2 Electronic position finding aids
- 3 Communication systems

## FAIRWAY INFORMATION

- 4 Digital twin of the physical infra (static)
- 5 Navigational charts and nautical publications
- 6 Dynamic navigational warnings

## WEATHER AND SEA STATE

- 7 Realtime weather and sea state info for the area
- 8 .. for a certain location and the planned route
- 9 Climate change information

## NAVIGATION & SEAFARING SERVICES

- 10 a) VTS services, b) enhanced VTS
- 11 a) Pilotage, b) remote pilotage
- 12 Ice breaking
- 13 Tug services

## PORT ARRIVAL & DEPARTURE RELATED SERVICES

- 14 Port just-in-time
- 15 Administrative services: customs & boarder guard

## OTHER

- 16 Support for the emergency services, SAR,
- 17 Sustainability information & services
- 18 Situational picture

By Sea4Value Fairway

# Future work: Transport automation needs for communication services

- ▶ Traficom has identified steps to understand the future needs of transport for communication services.
  1. Understand the need of **one user**. The first planned use cases are defined and the performance requirements set by the **planned use cases** for the communication network service are understood.
  2. Understand the needs on the **communication network**, i.e. scalability with all simultaneous users. The service level requirements set for the communication network for the first services are defined with the first estimated number of users.
  3. Are the KPIs and measurement methods accurate or do we need to develop new ones? Existing measurement methods and available measured data on the performance of communication networks are analysed. **New measurement methods** are developed for future analyses.
  4. How could the **networks be developed cost-effectively**? The possibilities of implementing the service level requirements in future communication networks should be explored. Dedicated channels for transport? Public-private-partnerships? New regulations?

# Thank you!

Heidi Himmanen

Chief Adviser, D.Sc.(Tech)

Digital Connections

Finnish Transport and Communications  
Agency Traficom

[heidi.himmanen@traficom.fi](mailto:heidi.himmanen@traficom.fi)

# TRAFICOM

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