Maritime-Area Connectivity and Autonomous Ships

Juha Kalliovaara, TUAS/5G Test Network Turku

@5GTNT

25.3.2019, IEEE 5G Summit, Levi, Finland

Basic systems for navigation in remote and autonomous vessels

Data sources for situational awareness and remote control

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Sensor data fusion

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Example orders of magnitude for uplink data rate requirements

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Remote & autonomous ferry demonstration

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5G & Connectivity Manager

5G enablers for efficient and flexible use of resources to meet the application needs:
- Separate and prioritize resources
- Network slicing
- Virtual networks
- Multi-connectivity (communications of a single user with several different network nodes and radio access technologies)

A connection manager (defined in the reference) is needed to ensure the quality of service (QoS) for a multi-connectivity system. The connection manager will:

- Prioritize and allocate different types of data to available communication channels and routes.
- Ensure that there is enough capacity for data to be transferred.
- Ensure that the data reaches its destination with integrity within latency requirements.
- Cooperate with other ships in vicinity to ensure that everyone will obtain required service. Safety is always prioritized
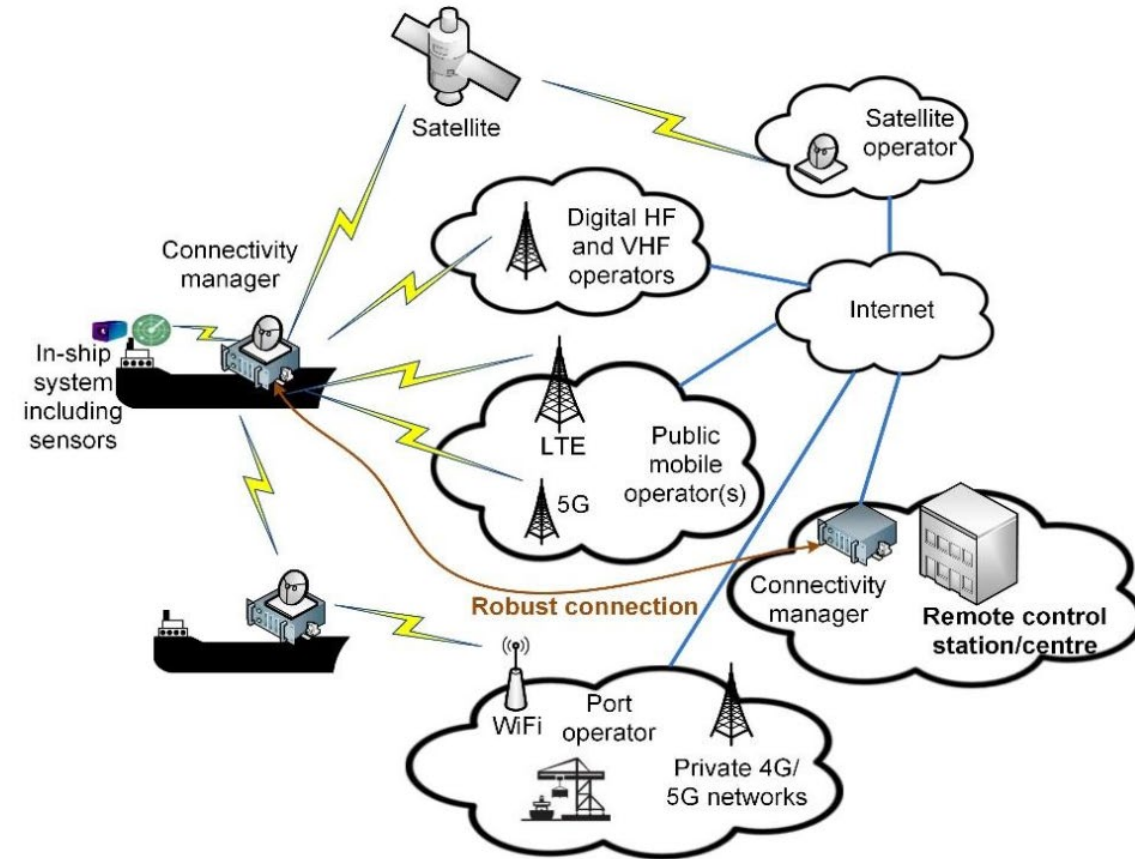
M. Höyhtyä, "Connectivity manager: Ensuring robust connections for autonomous ships", International Conference on Intelligent Autonomous Systems, March 2019.

Use cases for maritime-area connectivity

Authorities

Leisure boats

Cargo ships
Remotely operated or autonomous

Passenger transport
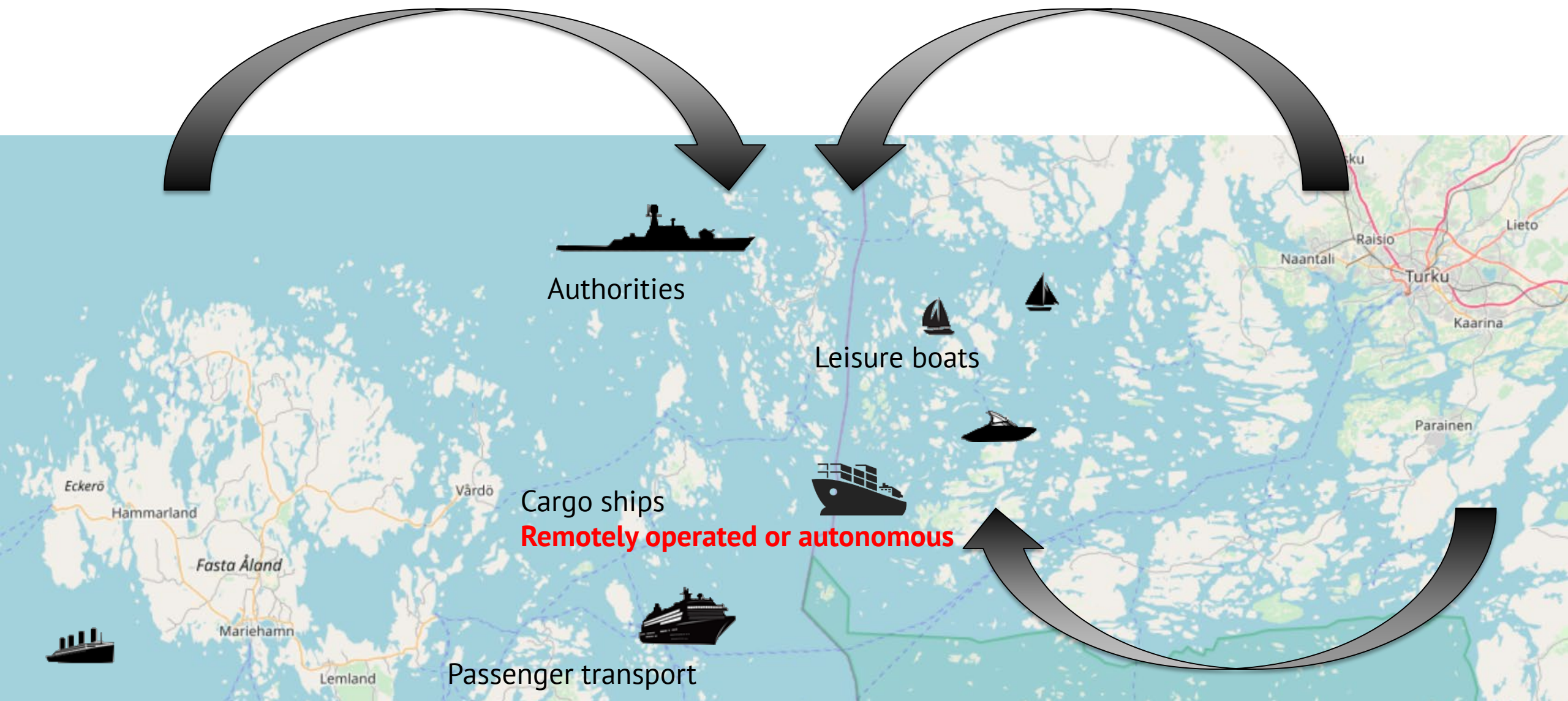
TUAS Rapidly deployable network system

- Transportable LTE-based system
- Rapid deployment; typically 15 to 45 min depending on system complexity
- Stand-alone system; independent of external electricity and Internet
- Can be built with commercial off-the-shelf equipment and software
- The Rapidly Deployable Network system is designed to provide
  - Local voice, video and data connectivity for critical communications
  - Internet connectivity through commercial mobile network (if available)

Trials in Turku archipelago

- **The Turku archipelago trials consisted of**
  - **Radio signal measurements on 700 MHz and 2300 MHz bands**
  - **Project partner application testing with Bittium Tactical Voice Service, Airbus Tactilon Agnet Push-to-Talk 'TETRA'–application and Fairspectrum Licensed Shared Access spectrum manager**
  - **Video streaming through RTMP server**
- → **Youtube video https://www.youtube.com/watch?v=uoy3YAWfnNI & a conference paper @ BMSB'19 in June.**
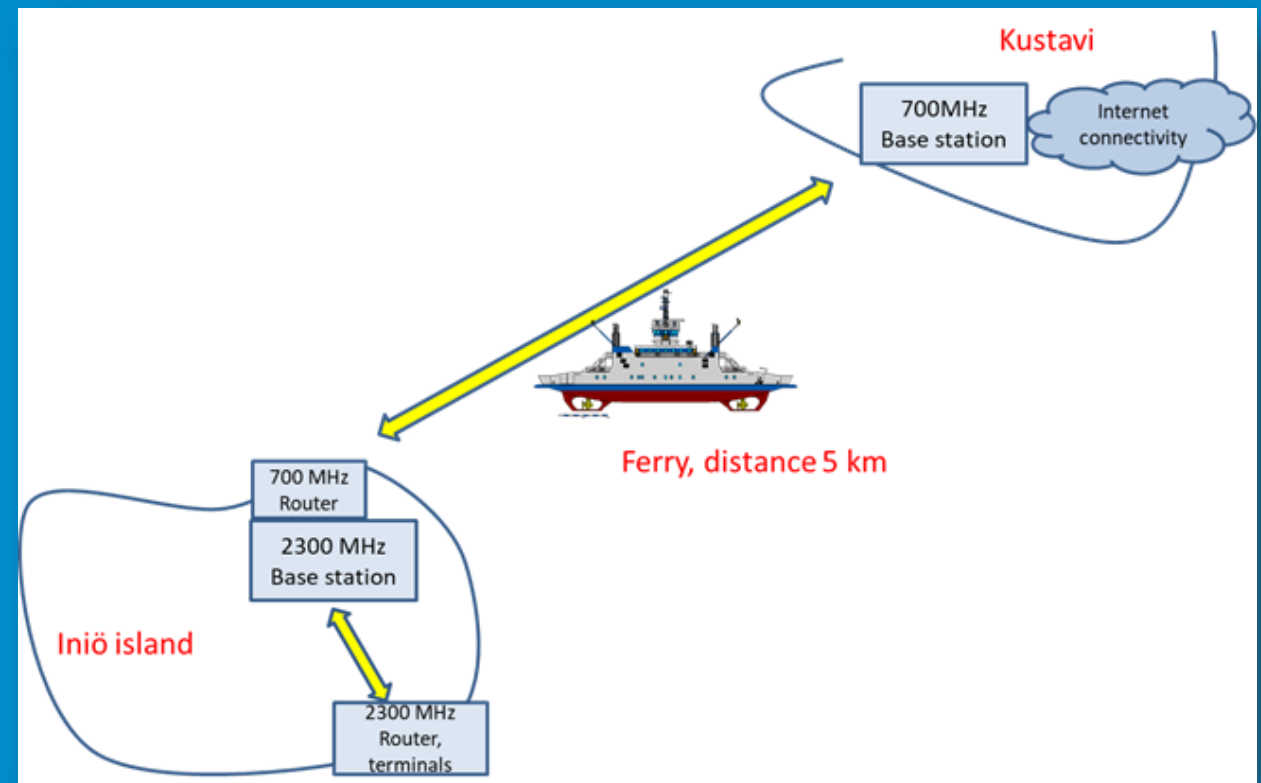
Maritime LTE connectivity and coverage measurements

- Evaluation of the communication link between the shore and a vessel
- Measurements over a distance of 15 km: DL stable, UL decreases over the distance.

Distance (km)	Downlink speed (Mbps)	Uplink Speed (Mbps)	RSRP (dBm)
1	49	15	-69
3	51	15	-75
6	48	15	-88
8	49	15	-93
11	47	14	-99
13	49	10	-102
15	51	8	-105

60 GHz link for data offloading in harbour

mmWave data links could be used to offload video data from the vessel to the ground in harbour.

Trials with commercially available 802.11ad 60 GHz data link show that
- The link can support 1-4 Gbps physical datarate when the distance is shorter than 70 meters.
- Signal level variation is +/- 2 decibels in line-of-sight conditions and margin to 1 Gbps datarate is at least 10 dB.

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Questions?

Jarkko Paavola; jarkko.paavola@turkuamk.fi

Juha Kalliovaara; juha.kalliovaara@turkuamk.fi

@5GTNT