Wireless broadband networks for e-Navigation – towards the future

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Presentation outline

- Introduction
- Currently existing and utilised wireless technologies
- EfficienSea measurement campaign conclusions
- NetBaltic – R&D project
  - Main concept
  - Proposed architecture
  - Potential benefits - Summary
Introduction

Wireless broadband network for e-Navigation

- High downlink and uplink throughput
- Small latency
- High time availability
- Dedicated services
- Low costs
- Global coverage
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<thead>
<tr>
<th>Wireless technology</th>
<th>Merits</th>
<th>Flaws</th>
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<tr>
<td><strong>GSM</strong></td>
<td>Quite good ranges</td>
<td>Throughput often too small</td>
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<td></td>
<td>Existing and very good infrastructure</td>
<td>Costs may be substantial</td>
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<td></td>
<td>Fair latency</td>
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<td><strong>UMTS/HSPA</strong></td>
<td>Fair ranges</td>
<td>Costs may be substantial</td>
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<td>Existing and good infrastructure</td>
<td>High load reduces quality and range</td>
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<td>Small latency</td>
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<td>High throughput</td>
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<td><strong>LTE</strong></td>
<td>Very small latency</td>
<td>Small ranges</td>
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<td></td>
<td>Very high throughput</td>
<td>Costs may be substantial</td>
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<td>Very poor infrastructure</td>
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<td><strong>CDMA 450</strong></td>
<td>Very good ranges</td>
<td>Costs may be substantial</td>
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<td>Fair latency</td>
<td>Quite poor infrastructure</td>
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<td></td>
<td>Fair throughput</td>
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<td><strong>WiFi</strong></td>
<td>Very high throughput</td>
<td>Very small ranges</td>
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<td></td>
<td>Very small latency</td>
<td>Available only near ports and cities</td>
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<td>Existing and good infrastructure</td>
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<td>Often for free</td>
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<td><strong>WiMAX</strong></td>
<td>High throughput</td>
<td>Costs may be substantial</td>
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<td>Small latency</td>
<td>Poor infrastructure</td>
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<td>Fair ranges</td>
<td>Long range reduces throughput</td>
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<td><strong>Satellite systems</strong></td>
<td>Almost global coverage</td>
<td>Often very high costs</td>
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<td>Existing and good infrastructure</td>
<td>Huge latency</td>
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<td>Throughput often too small</td>
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<td><strong>VHF data solutions</strong></td>
<td>Great ranges</td>
<td>Costs may be substantial</td>
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<td>Maritime dedicated solution</td>
<td>Very small throughput</td>
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<td>Substantial latency</td>
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<td>Very poor infrastructure</td>
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EfficienSea measurement campaign

✓ Over 1500 miles and 41127 measurement locations !!!
✓ Along Polish coast, bay of Gdansk, Øresund strait, along south-west Swedish coast to Bornholm
✓ Multiple data system
✓ GSM, EDGE, UMTS, HSPA, Iridium, Telenor VHF Data
EfficienSea measurement campaign

Measured parameters

- Signal strength
- Basic data transmission services availability
- Average throughput in downlink and uplink
- Average transmission delays
- Position, speed, course and timestamp
- Serving network and base station identification parameters
EfficienSea measurement campaign conclusions

- **The cellular networks** are almost always available in the Gulf of Gdansk and in the Øresund strait. The throughput exceeds (50% cases) 250 kbps in the uplink and 500 kbps in the downlink. In many cases the speed of data reached 3 Mbps especially in the Danish Straits.

- For the antenna height of 3 m AMSL availability of the **cellular networks** 2G/3G services does not exceed 12 NM. For the antenna height of 10 m AMSL the communication ranges reached 35 km with a data speed up to 800 kbps.

- If minimum data transmission delays are the priority, the 3G networks appear to be the most attractive solution.

- Increasing the receiving antenna height improves the range as well as the throughput.

- **VHF Data system** provides better ranges (up to 50 km from the base station) but with the maximum data speed of 22,5 kbps. In the cellular networks the ranges are up to 35 km, transmission speeds are higher and the land infrastructure is definitely better.

- **The Iridium system** provides nominal transmission speeds (it depends on the satellite constellation visible from the particular spot) with much bigger delays than terrestrial systems, but its main advantage is that it is operational globally.
NetBaltic – Main concept

“NetBaltic – self-organizing multisystem broadband network for the purposes of the e-Navigation, Baltic monitoring and internet services availability enhancement”

• Definition of the infrastructure elements (based on existing wireless technologies) for the new self-organising wireless broadband network for data exchange between ships, between ships and data storage/processing centers and between ships and the Internet network

• Novel procedures for the wireless access-network, based on the self-organizing mesh network structure, and the multi-hop transmission algorithms

• Test-bed in the Bay of Gdansk
NetBaltic – System architecture

Zone A (direct access)

Zone B (mesh network)

Zone C (store and forward)

Coast
NetBaltic – System architecture

- The **A-zone** covers water areas having a **direct** connection with a shore-based infrastructure
  - The communication in this zone is organized in a typical manner
    - The radio-link is considered to be a wireless access link
  - Depending on the propagation conditions, the zone’s range will change
  - Terminals within the zone will have unlimited Internet access
  - The most appropriate wireless technology will be selected
    - **User demands (service), costs, technical capabilities and hydro-meteorological conditions**
NetBaltic – System architecture

• The **B-zone** expands the A-Zone’s range through the self-organising mesh-network
  
  • The terminals with the direct connection to the shore base stations (within the A-zone) can share their links with the terminals that are currently outside the A-zone
    
    • **Indirect transmission and dynamically changing network topology**

• The **C-zone** is where the vessel has no network access (it is outside A- and B-zones)
  
  • The **store-and-forward** transmission is anticipated to be used
  
  • The vessel can redirect some data packets to ships which are likely to reach A- or B-zones earlier than the vessel itself
    
    • **Possible AIS utilization**
Potential benefits - Summary

• The system efficiency verification
  • In its destined area of operation
  • To prove its superiority in comparison with existing solutions

• Potential benefits
  • Service-oriented wireless technology selection
  • E-Navigation dedicated solution
  • Quality and availability enhancement
    • Higher throughput
    • Smaller delays
    • Greater ranges
  • Lower operating costs
Thank you for your attention!

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