Wireless broadband networks for e-Navigation – towards the future

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Krzysztof Bronk, PhD

Deputy Manager
Wireless Systems and Networks Department

National Institute of Telecommunications (NIT), Poland

e-mail: K.Bronk@itl.waw.pl

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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 technology	Merits	Flaws
GSM	Quite good ranges Existing and very good infrastructure Fair latency	Throughput often too small Costs may be substantial
UMTS/HSPA	Fair ranges Existing and good infrastructure Small latency High throughput	Costs may be substantial High load reduces quality and range
LTE	Very small latency Very high throughput	Small ranges Costs may be substantial Very poor infrastructure
CDMA 450	Very good ranges Fair latency Fair throughput	Costs may be substantial Quite poor infrastructure
WiFi	Very high throughput Very small latency Existing and good infrastructure Often for free	Very small ranges Available only near ports and cities
WiMAX	High throughput Small latency Fair ranges	Costs may be substantial Poor infrastructure Long range reduces throughput
Satellite systems	Almost global coverage Existing and good infrastructure	Often very high costs Huge latency Throughput often too small
VHF data solutions	Great ranges Maritime dedicated solution	Costs may be substantial Very small throughput Substantial latency Very poor infrastructure

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
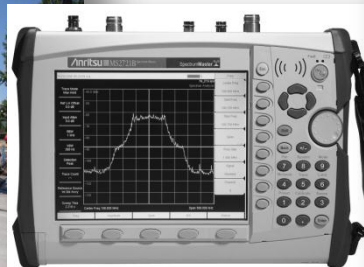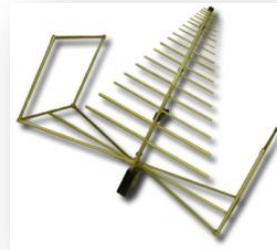
Polish Testbed Measurements Solution
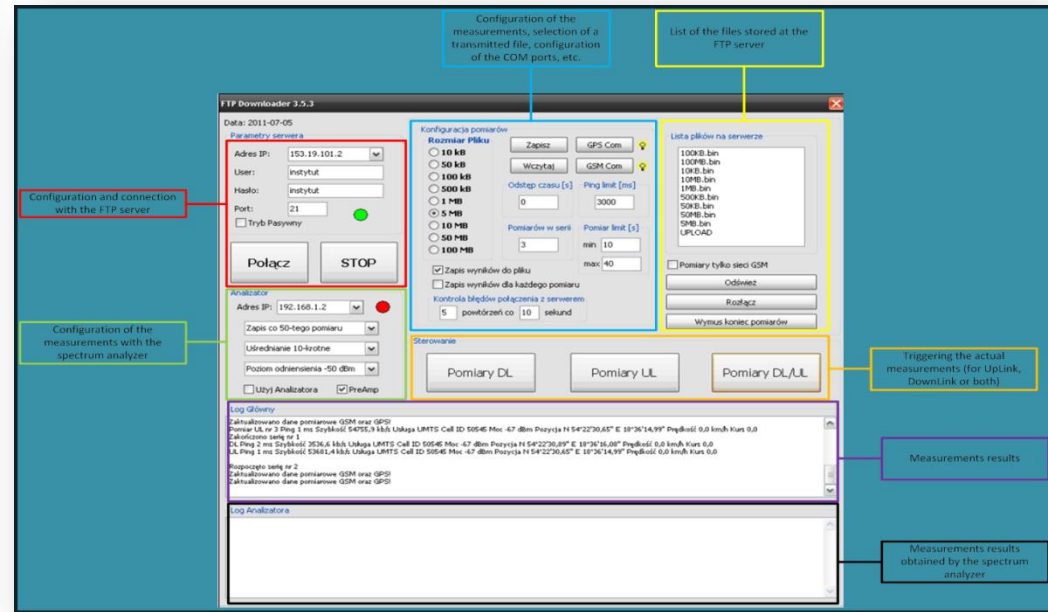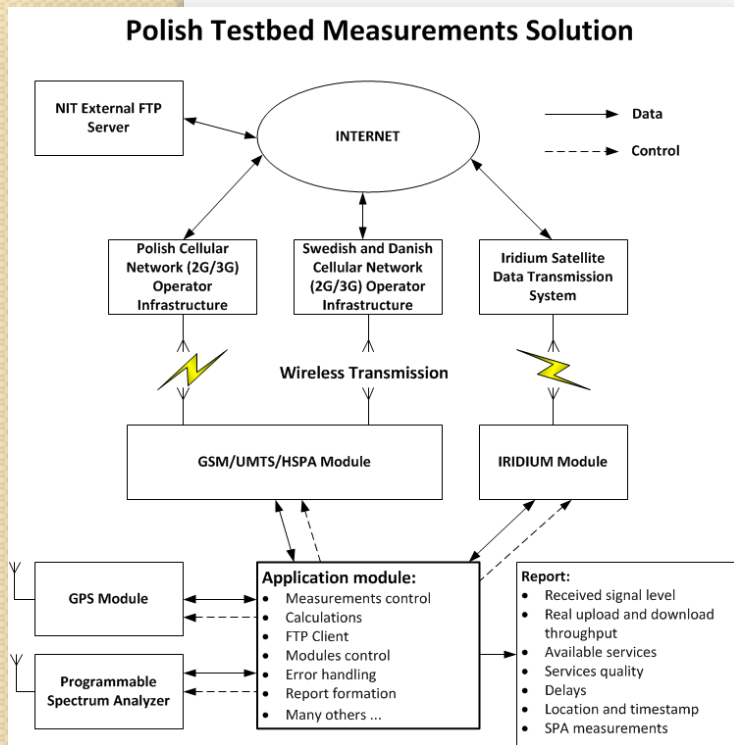
Measured parameters

- 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

CCDF for 10 meters antenna height in downlink
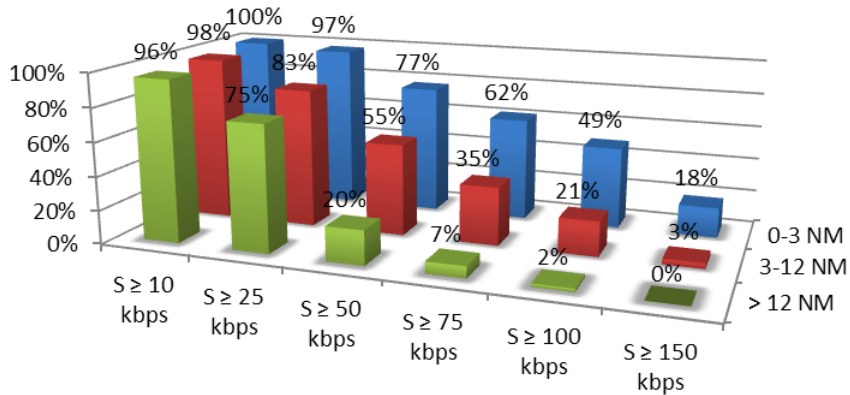
Downlink transmission speed in 2G networks (10m antenna)
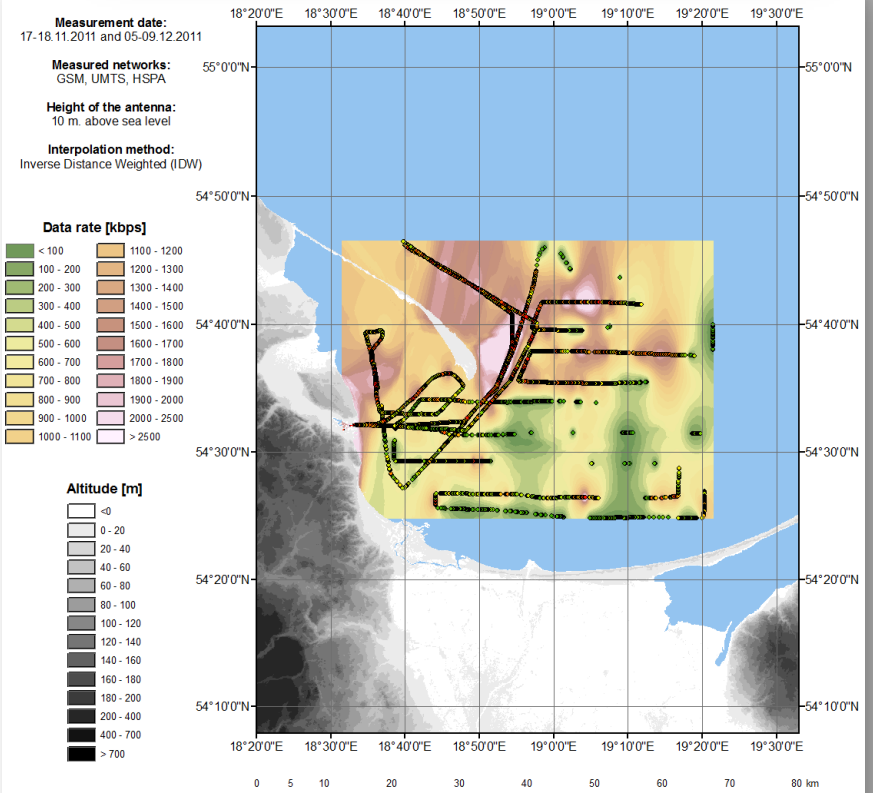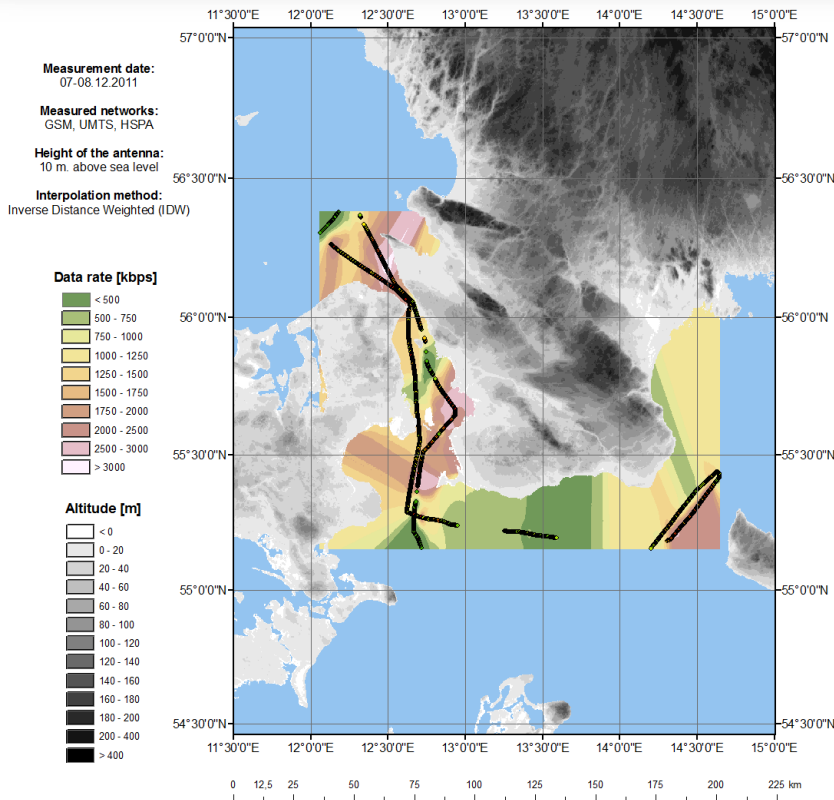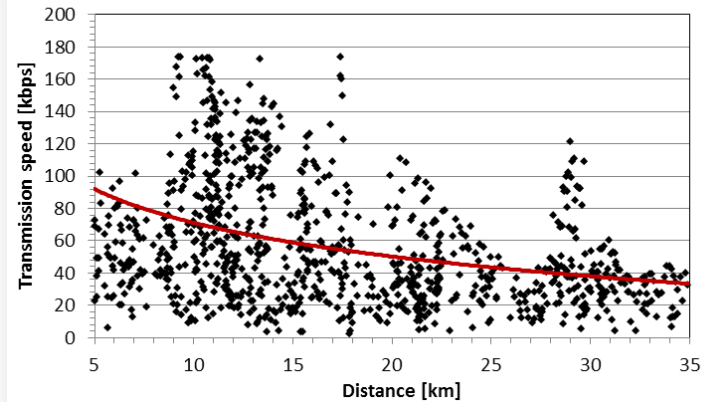
EfficienSea measurement campaign conclusions

✓ **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

"<u>NetBaltic – self-organizing multisystem broadband network for the purposes of the e-Navigation, Baltic monitoring and internet services availability enhancement</u>"

- 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 <u>self-organizing mesh network</u> structure, and the <u>multi-hop transmission algorithms</u>

- **Test-bed in the Bay of Gdansk**

NetBaltic – System architecture
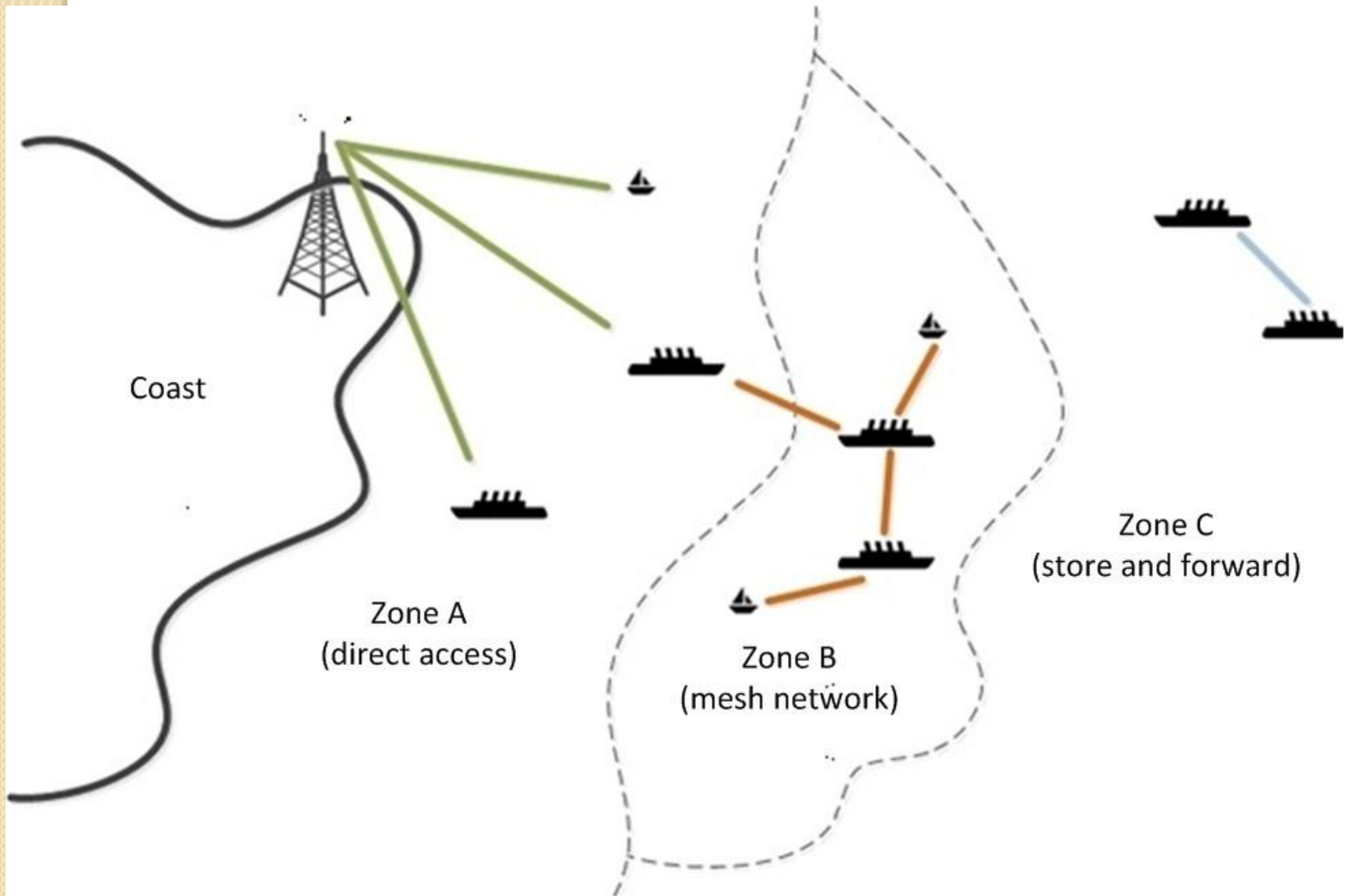
NetBaltic – System architecture

- 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 dalays
    - Greater ranges
  - Lower operating costs

Thank you
for your attention!

Contact:

Krzysztof Bronk
Wireless Systems and Networks Department
National Institute of Telecommunications (NIT)
Jaskowa Dolina Str. 15
80-252 Gdansk
Poland

e-mail: K.Bronk@itl.waw.pl
fax: +48583417112
mob: +48790019315

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