INSTYTUT ŁĄCZNOŚCI
PAŃSTWOWY INSTYTUT BADAWCZY
National Institute of Telecommunications

Task 2.3:
Robust & Seamless Roaming

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Introduction

- Seamless roaming is a mechanism which selects the most suitable (given the radio channel quality and/or service requirements) communication link

- Two major components of the Seamless Roaming
  - **Radio Monitoring Entity**
  - **Radio Link Selection block**

- Technical Readiness Level (TRL): 4-5
  - technology validation in laboratory / in relevant environment

Timeline

- **D2.7 Concept and specification for seamless roaming (2015)**
  - Implementation of the algorithms (2016)
- **D2.8 Specification of the interface to Maritime Cloud (2016)**
  - Implementation of the testbed and simulator (2017)
  - Pre-tests of the testbed (June - July 2017)
  - Seamless Roaming on-board tests in the Gdansk Bay Area (August 2017)
  - Seamless Roaming simulation tests (September – October 2017)
- **D2.9 Results of simulation and onboard testing (2017)**
  - Seamless Roaming configuration API implementation (2018)

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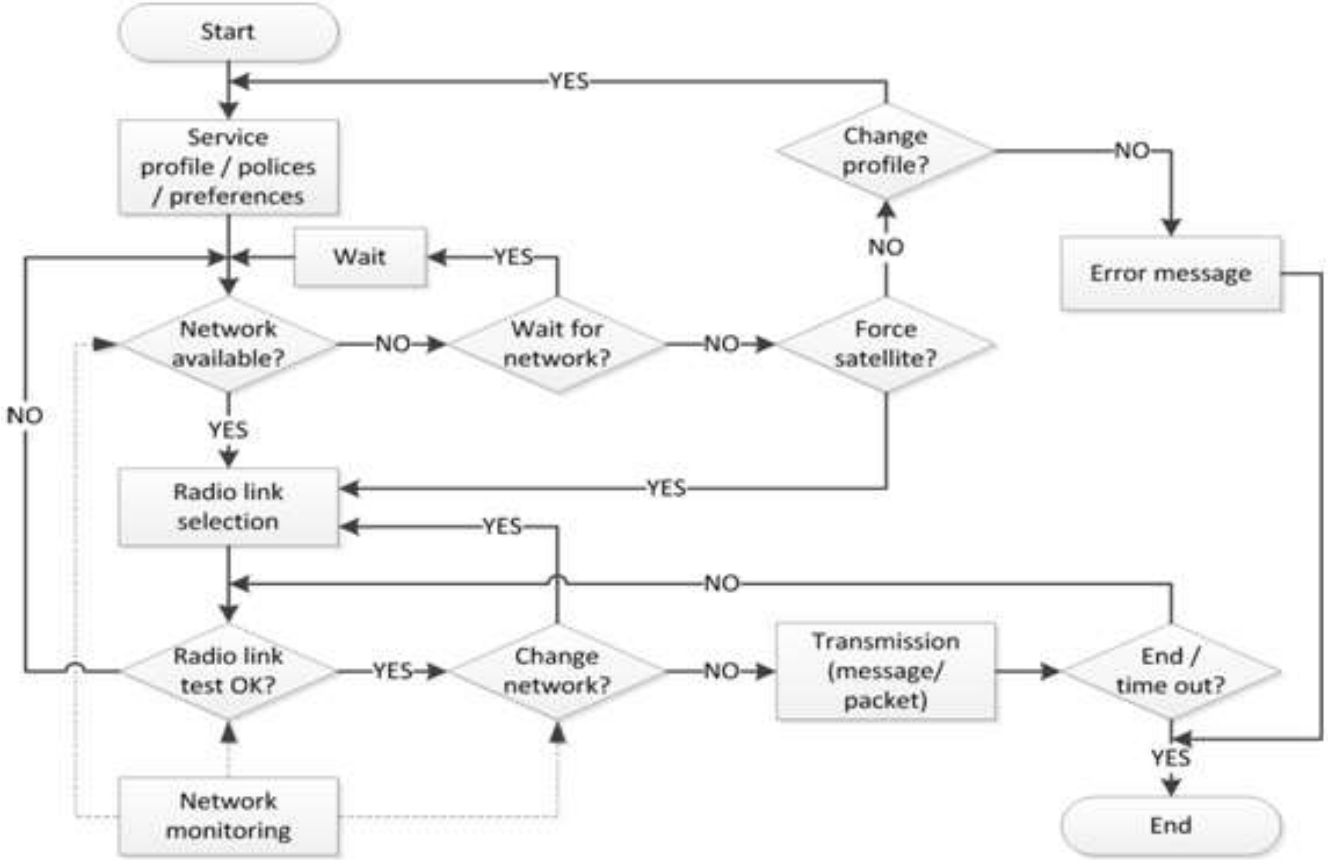
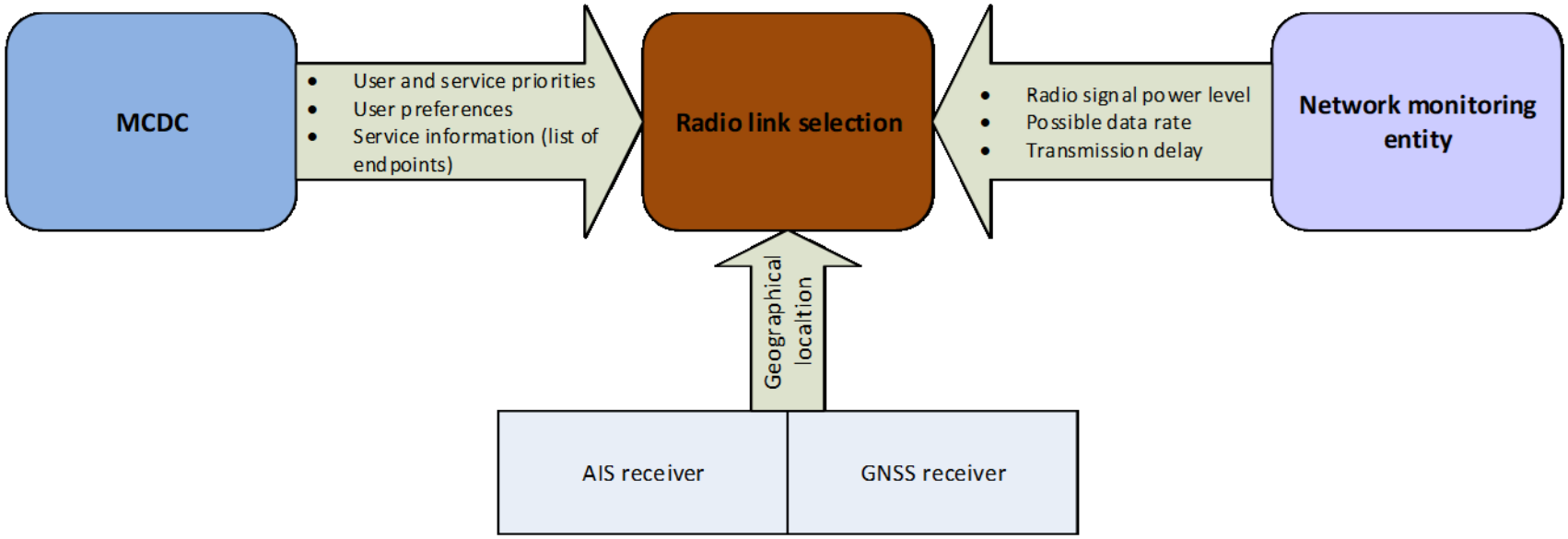
CONCEPT AND SPECIFICATION FOR SEAMLESS ROAMING

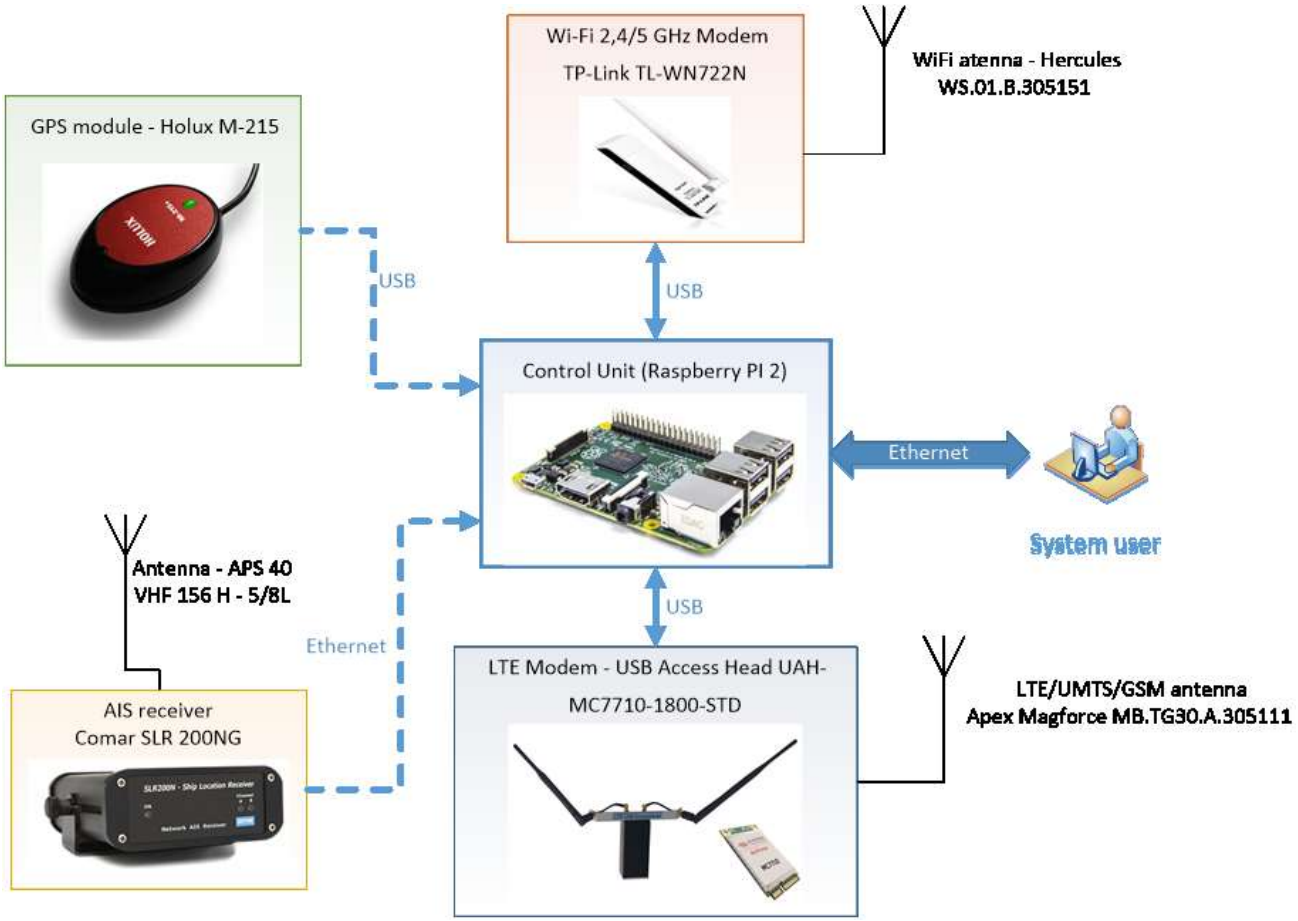
Seamless roaming algorithm



Seamless roaming concept



Testbed prototype



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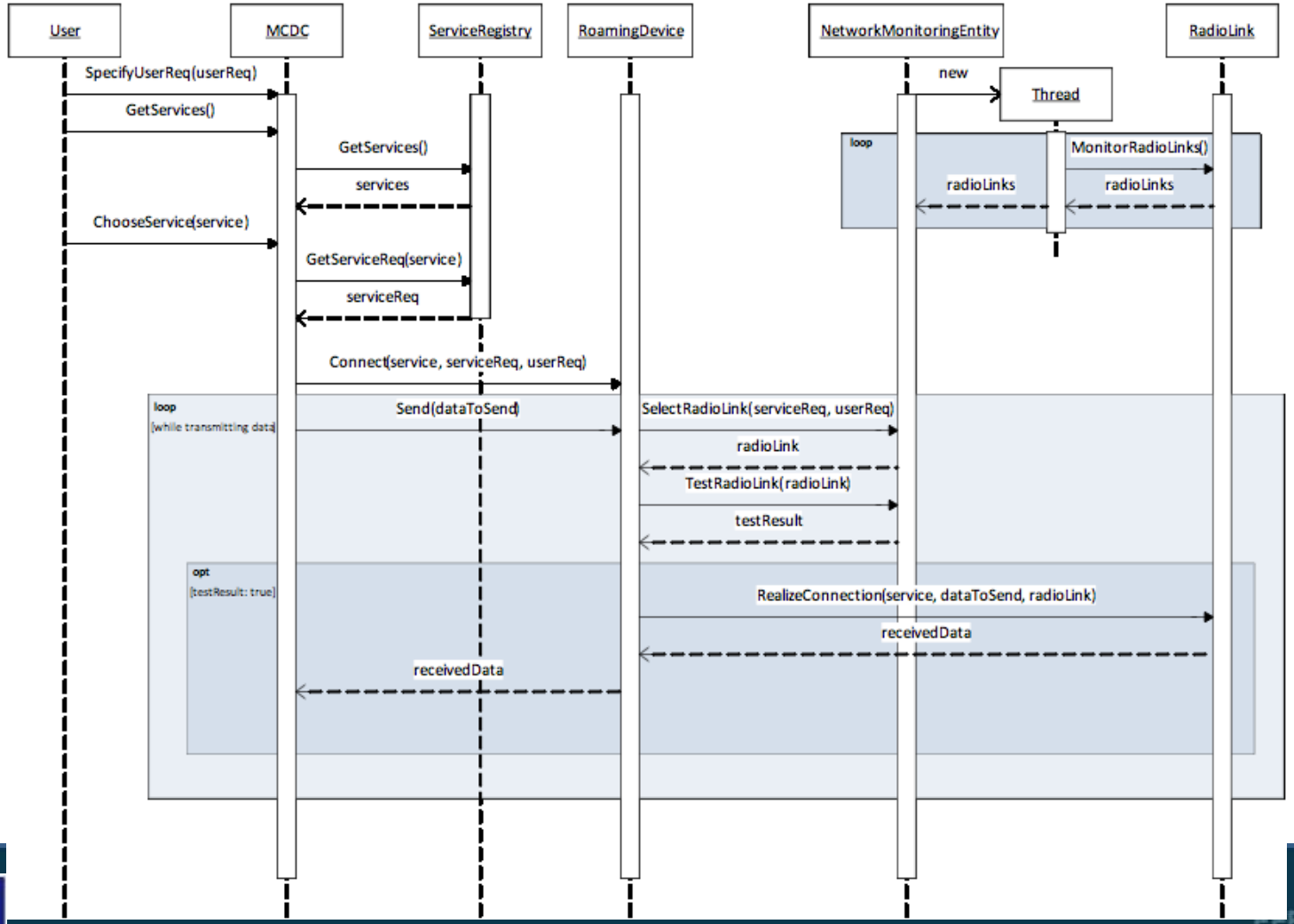
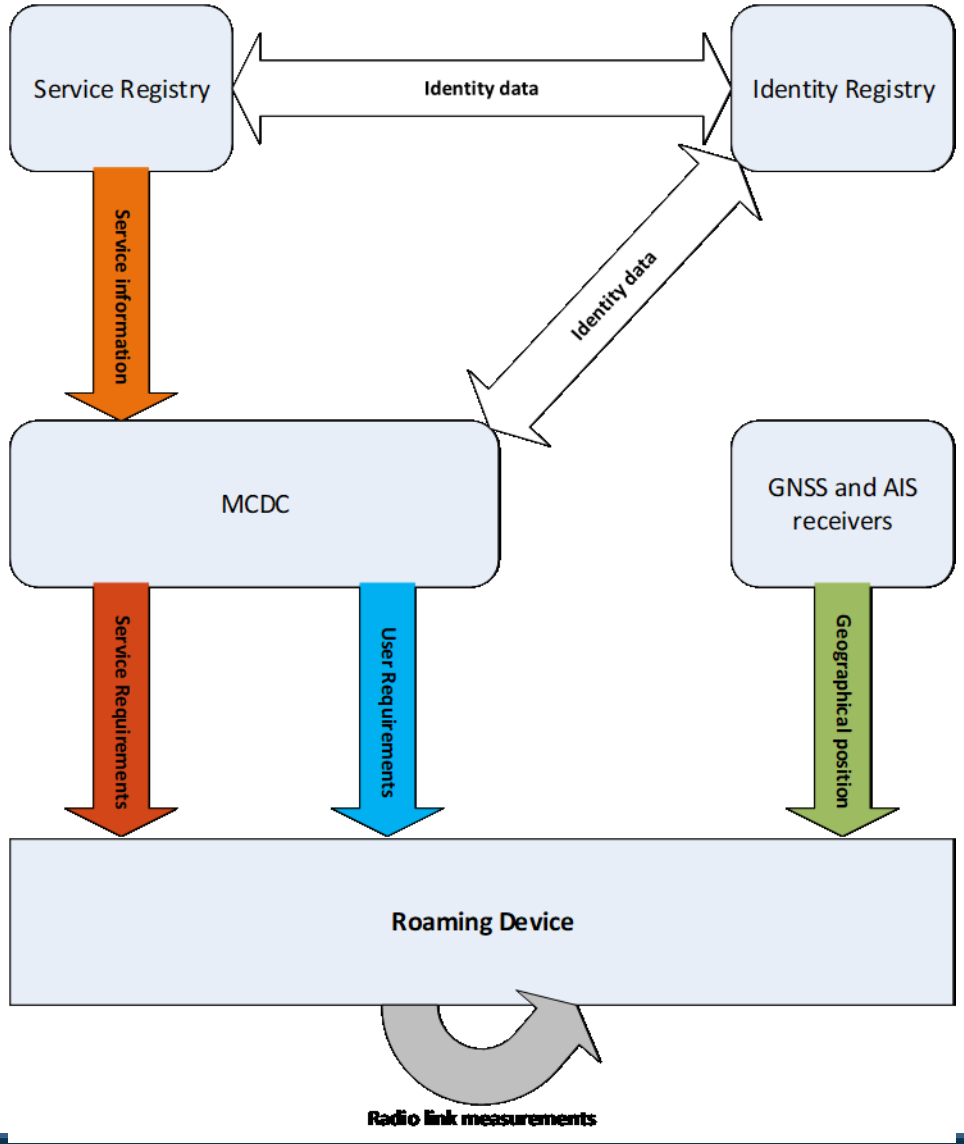
SPECIFICATION OF THE INTERFACE TO MARITIME CONNECTIVITY PLATFORM

Seamless roaming algorithm sequence diagram



Flow of data


Service Registry
Identity data
Identity Registry
Service information
Identity data
MCDC
GNSS and AIS receivers
Service Requirements
User Requirements
Geographical position
Roaming Device
Radio link measurements

Network monitoring algorithm details

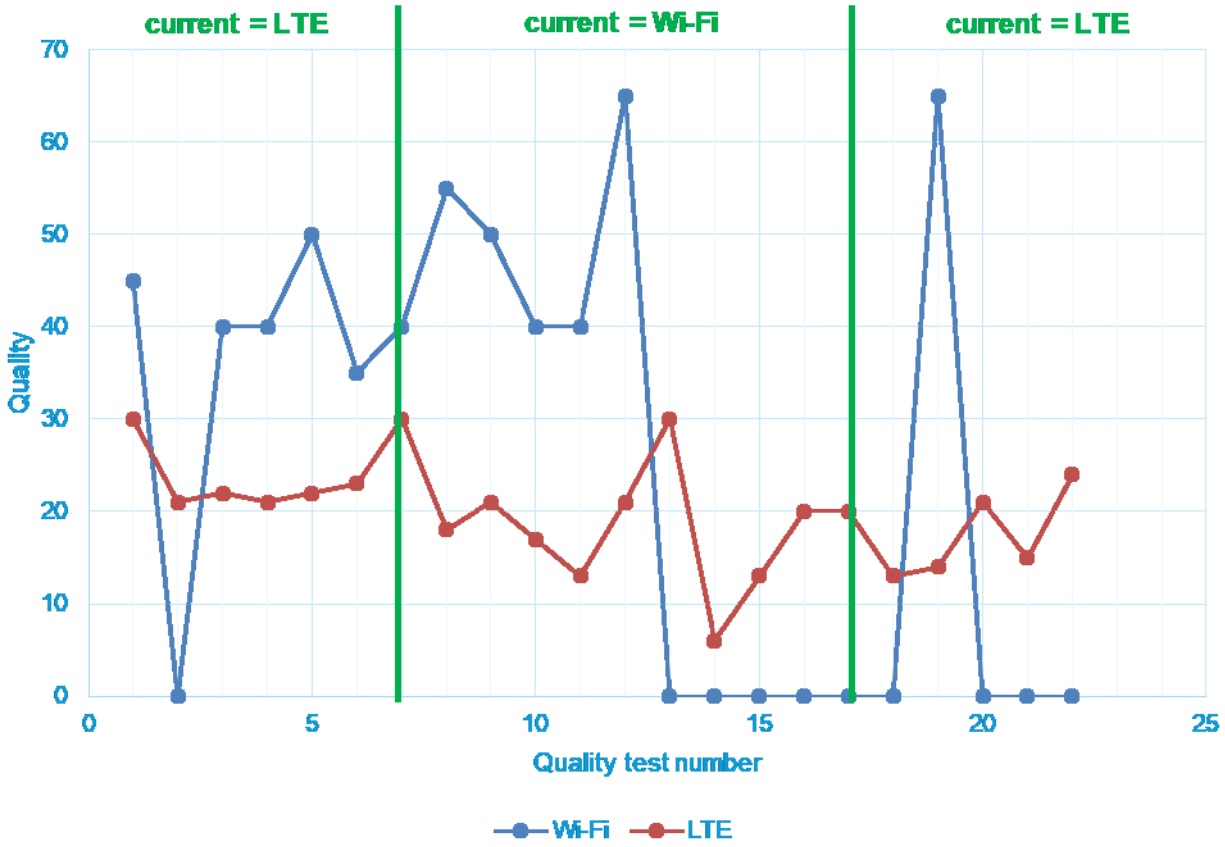
- Tests of the available radio links, in 2 steps:
  1. Testing of **signal power level** (rate from 0.0 to 1.0),
  2. Estimating **throughput** (rate from 0.0 to 1.0).
- Calculation of radio link quality parameter (weighted geometric mean):

$$quality = (throughput\_rate^{w_t} * powerLvl\_rate^{w_p})^2 * 100$$

where w_t, w_p are weight coefficients (from 0.0 to 1.0, sum up to 1.0)

- Once in every $interval$ (default value = 10 seconds) the algorithm tests if some radio link had better quality than the one currently used.
- The switching procedure takes place if the quality of a radio link proved superior to the quality of the in-use radio link during $N_{tests} = 5$ consecutive tests.

Example of radio link switching



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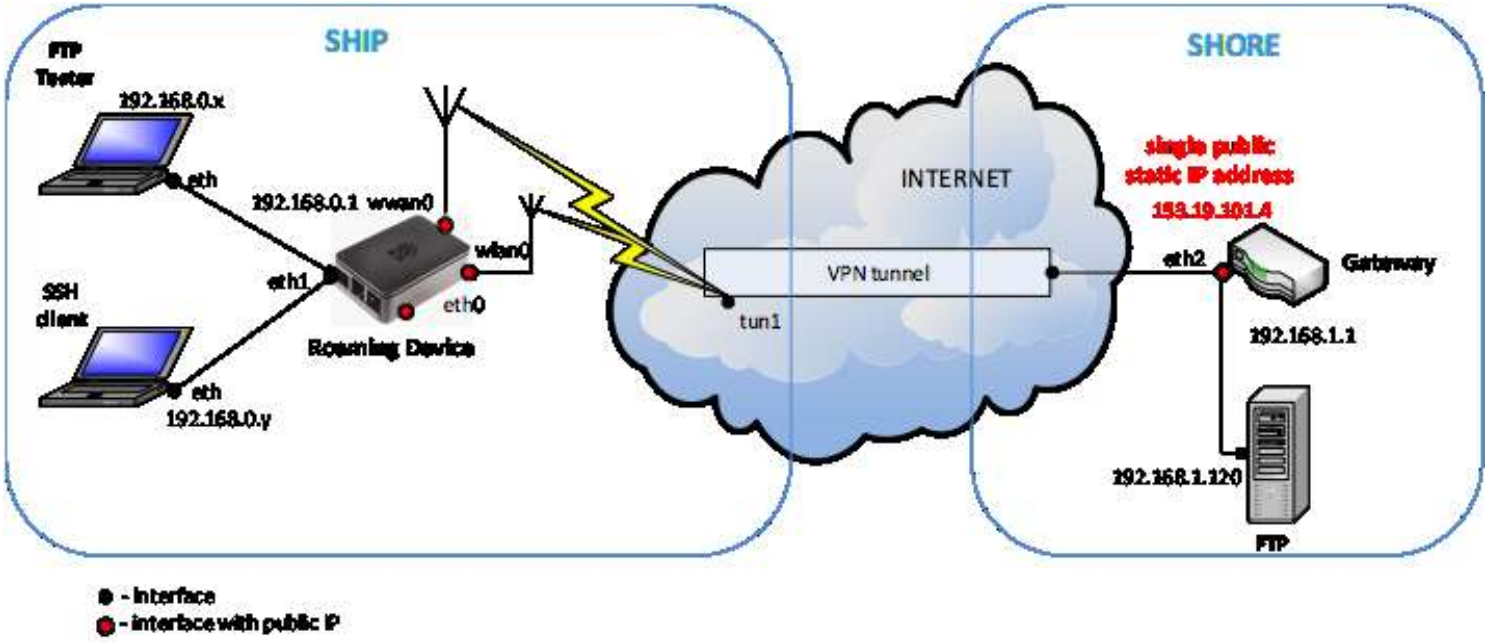
RESULTS OF SIMULATION AND ON-BOARD TESTING

On-board tests photos

On-board tests photos

Network architecture for the tests

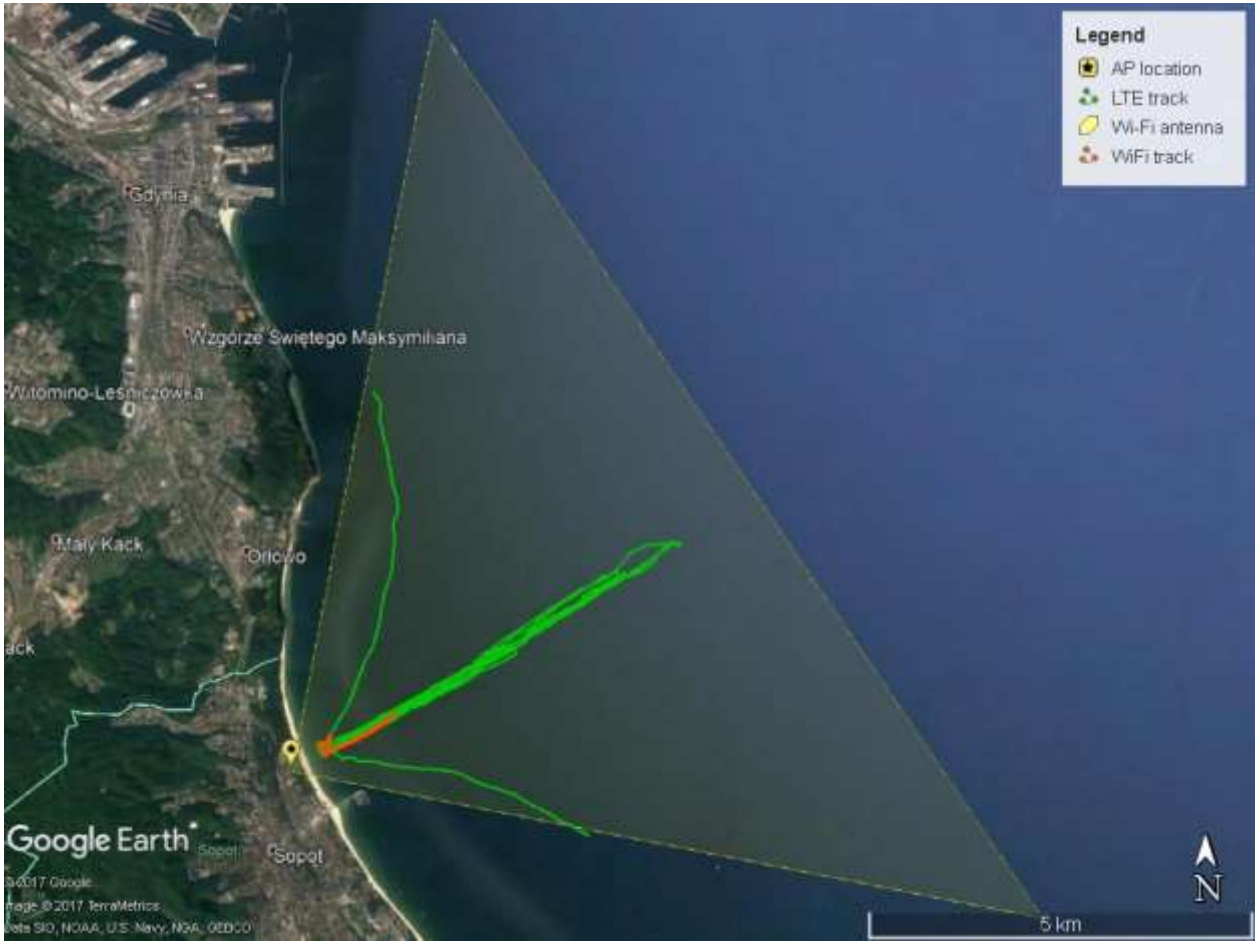


Test scenario

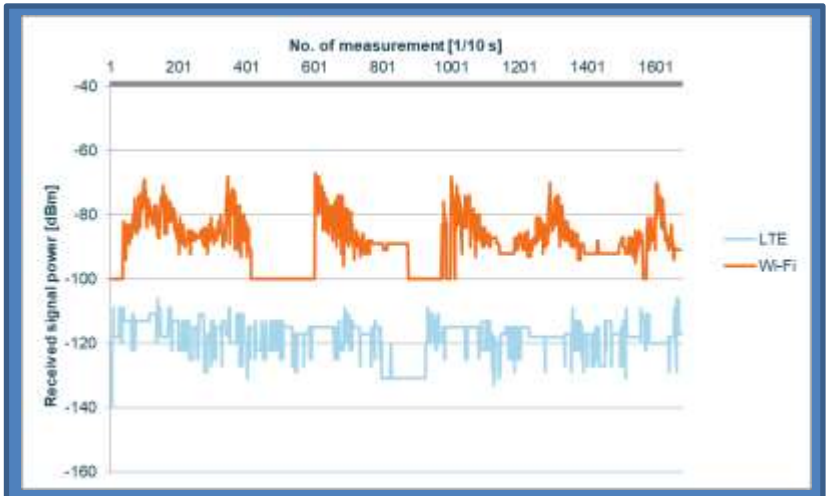
- Ship: Sonda II (IO PAN),
- Speed: up to 20 km/h,
- Distance from the shore: from 200 m to 5.6 km
- Wi-Fi AP distance from the coastline: ~250 m
- FTP service was set-up in the NIT office, connected to the NIT gateway (with known IP address)
- The NIT Mobile Measurement Platform (MMP) was continuously connecting to the server (using the Internet connection provided by the Roaming Device), and it was measuring the service quality

1. The ship moved from Gdansk to the north, to the fixed destination within the Wi-Fi Access Point antenna coverage, at approx. 500 m distance from the Access Point,
2. The ship were moving in a straight line from the shore, up to the point where Wi-Fi Access Point signals were not received anymore,
3. The ship returned to the same fixed destination from point **1**.
4. Points **2** and **3** were repeated,
5. The ship moved from the fixed destination from point **1** to the north (to Gdynia), and it left the Wi-Fi Access Point antenna coverage.

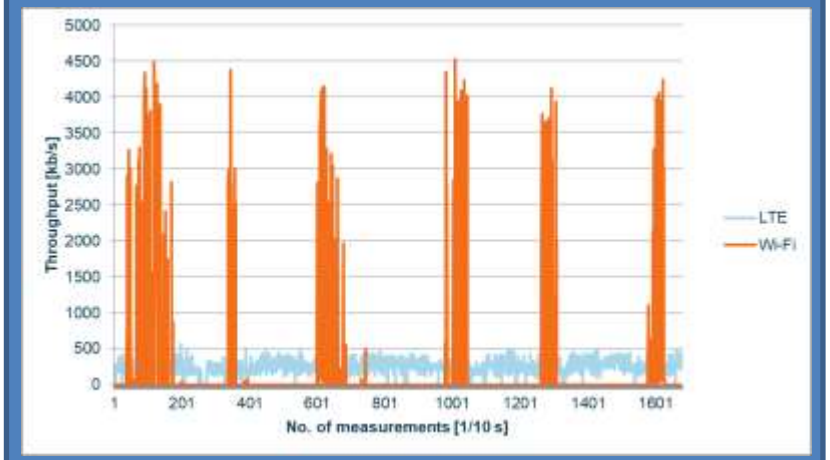
On-board test results



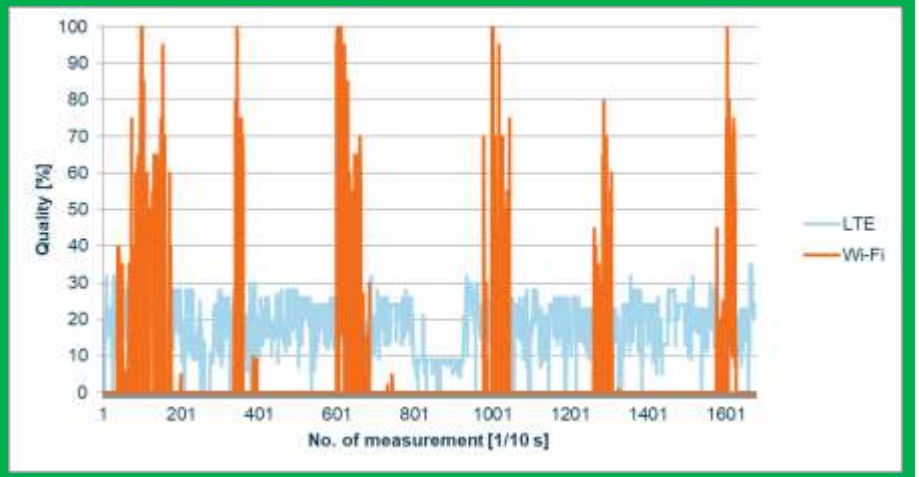
On-board test results



INPUT



OUTPUT



Conclusions and future work

- Before the on-board tests, the pre-tests were conducted:
  - 2 different localizations (with different LTE/3G signal quality),
  - 50 days of (almost) continuous tests (starting from 12th June 2017)
- The on-board tests were from 1st to 3rd August 2017
- The Wi-Fi network was preferred by the Seamless Roaming algorithm near the coast (Wi-Fi was used in the area up to 1.6 km distance from the Wi-Fi Access Point antenna)
  - at greater distances the Wi-Fi connections was very unstable ($packet\ loss > 50\%$).
- The LTE network had a significant decrease in quality at 10:00 – 11:30 UTC (when a lot of people were seen on the beach)

- The first version of the API to the Seamless Roaming algorithms was published 04.04.2018
- Examples of the API usage and a web-based interface to configure Seamless Roaming algorithms will be delivered later in April.

Thank you for your attention!

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