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SUMMARY REPORT

KNOW-HOW IN NEW AND ENHANCED PUBLIC TRANSPORT SERVICES (PROJECT DELIVERABLE 4.3)

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Interreg South Baltic

EUROPEAN UNION

European Regional Development Fund

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Hereby we present you a report summarizing pilot activities under the Interconnect project.

This is a report compiling outcomes of all WP4 pilot cases and presenting what kind of hard and soft measures proved successful in achieving the higher compatibility/integration of public transport systems across the borders of the partner areas – as an attractive alternative to individual car travels.

In the work package "Control tools and business models" (WP4), we conducted three pilot cases: 1) Blekinge - Pomorskie, 2) Klaipeda County and 3) Rostock - Guldborgsund, which are presented in this report.

Throughout the project implementation period, we worked in partnership to develop and improve the regional and cross-border offer for foot passengers. The cooperation mechanisms have turned into a permanent exchange of information between partners using an electronic decision-making tool with a better balance - so that public transport services provide attractive international connections.

The report summarizes the work of all project partners and is structured in 5 thematic scopes as follows:

1. INTERCONNECT OPEN MOBILITY PLATFORM - FOLLOWING EU POLICY RECOMMENDATIONS:
   presenting solutions for implementing NeTEx data standard, Open Trip Planner, joint cross-border mobility patterns, open source code, IoT.

2. INTERCONNECT PILOT CASES - CROSS-BORDER ACTIVITIES:
   describing project partnership, collaboration and a process of knowledge exchange.

3. INTERCONNECT FINDINGS:
   presenting templates of model methods, developed solutions that could be replicated by other European regions for improving cross-border PT connections.

4. ACADEMIC RESEARCH:
   summarizing methodical work of researchers and their major ideas.

5. TECHNICAL APPENDIX:
   presenting some COMPLEMENTARY ISSUES that should be considered, when implementing proposed solutions in areas ready for replication.

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INTERCONNECT OPEN MOBILITY PLATFORM
- FOLLOWING EU POLICY

NETEX DATA STANDARD, OPEN TRIP PLANNER,
CROSS-BORDER MOBILITY, OPEN SOURCE CODE, IoT

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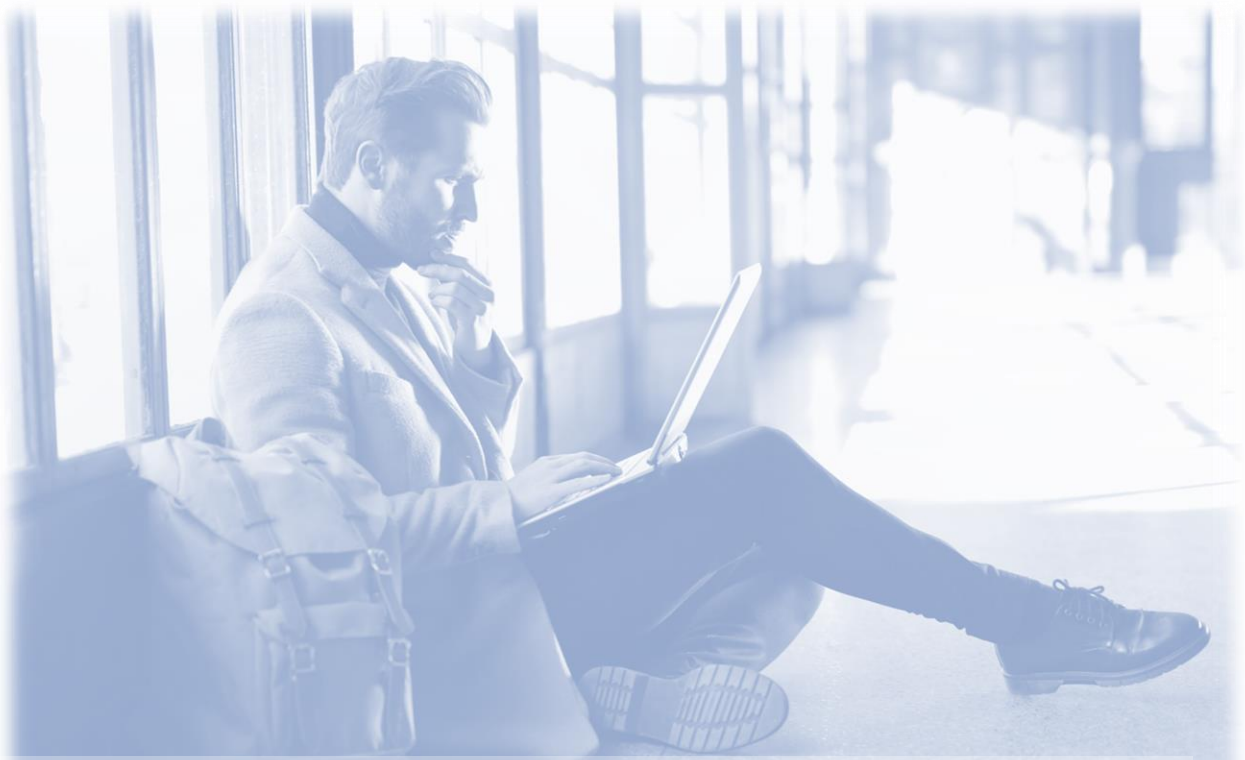

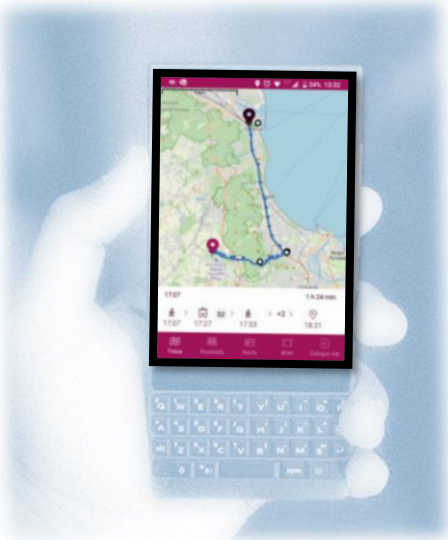

https://opendata.info.pl/en/trip-planning

AS A PASSENGER

I travel by ferry or fly by plane and move on public transport.

- Planning a trip for a specific flight to/from Gdansk airport is very simple – the planner gives the entire connection from "A" to "B".
  Planner contains timetables of many transport organizers (rail, bus, tram) – it's a great combination of information on my phone.
- It is integrated with the electronic travel card – I take advantage of promotions at the airport, in the hotel, with tourist attractions in the region

The itinerary is available both via the website and as a mobile app to install on Android or iOS devices.

Supported in Polish and English.

Adapted to settings to make your mobile device easier for visually impaired or blind people.

Able to combine timetables of carriers in partner counties (for cross-border lines).

THAT'S MORE
THAN A TRAVEL PLANNER

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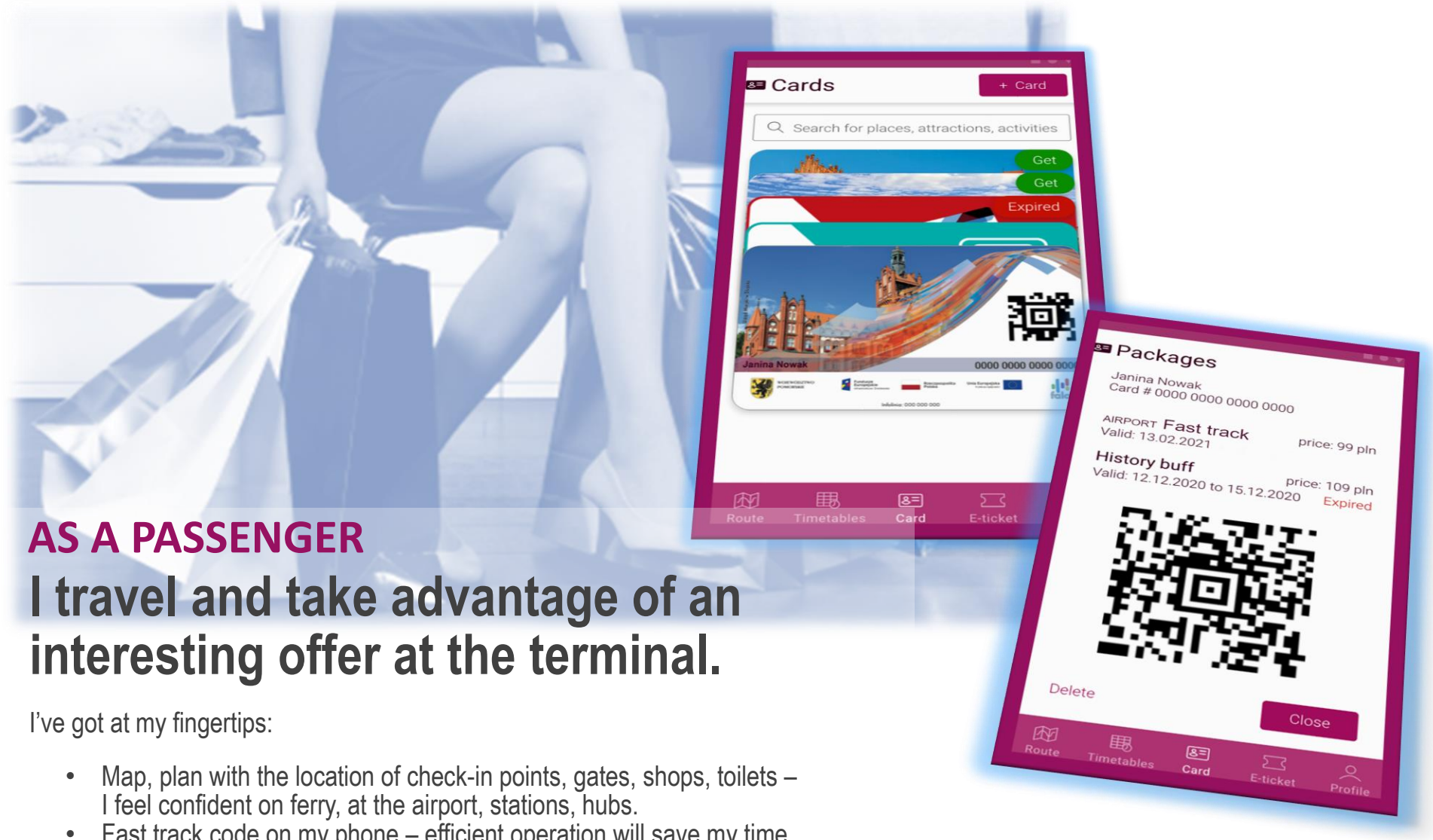

AS A PASSENGER

I travel and take advantage of an interesting offer at the terminal.

I've got at my fingertips:

- Map, plan with the location of check-in points, gates, shops, toilets – I feel confident on ferry, at the airport, stations, hubs.
- Fast track code on my phone – efficient operation will save my time.
- An Electronic discount card for selected shops, catering points, museums – I travel in business class and can count on additional benefits.

THAT'S MORE
THAN AN INFORMANT

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AS A PASSENGER

I travel and use dynamic messages.

- Depending on where I am, the sensor network selects the messages that appear on my smartphone - I will not miss an important location at the terminal.
- The travel planner will find the nearest public transport stops for me – I don't need to know the names of the stops.
- On the bus or train, the app will inform me about the next stops along the route.

THAT'S MORE

THAN AN APP

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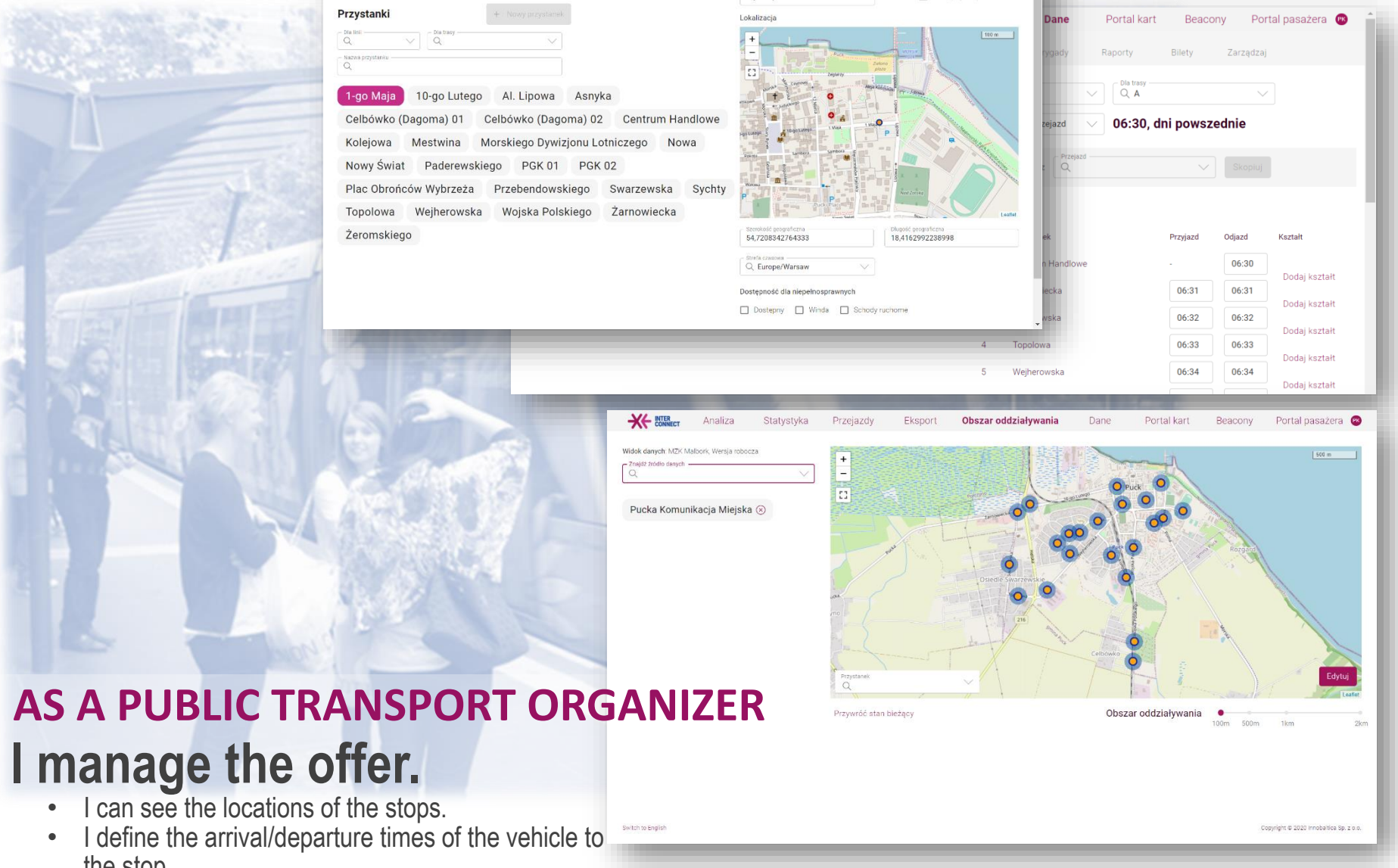

AS A PUBLIC TRANSPORT ORGANIZER

I manage the offer.

- I can see the locations of the stops.
- I define the arrival/departure times of the vehicle to the stop.
- I check the spatial availability of my offer.
- I print stop plates.

THAT'S MORE
THAN AN ACCESSIBILITY

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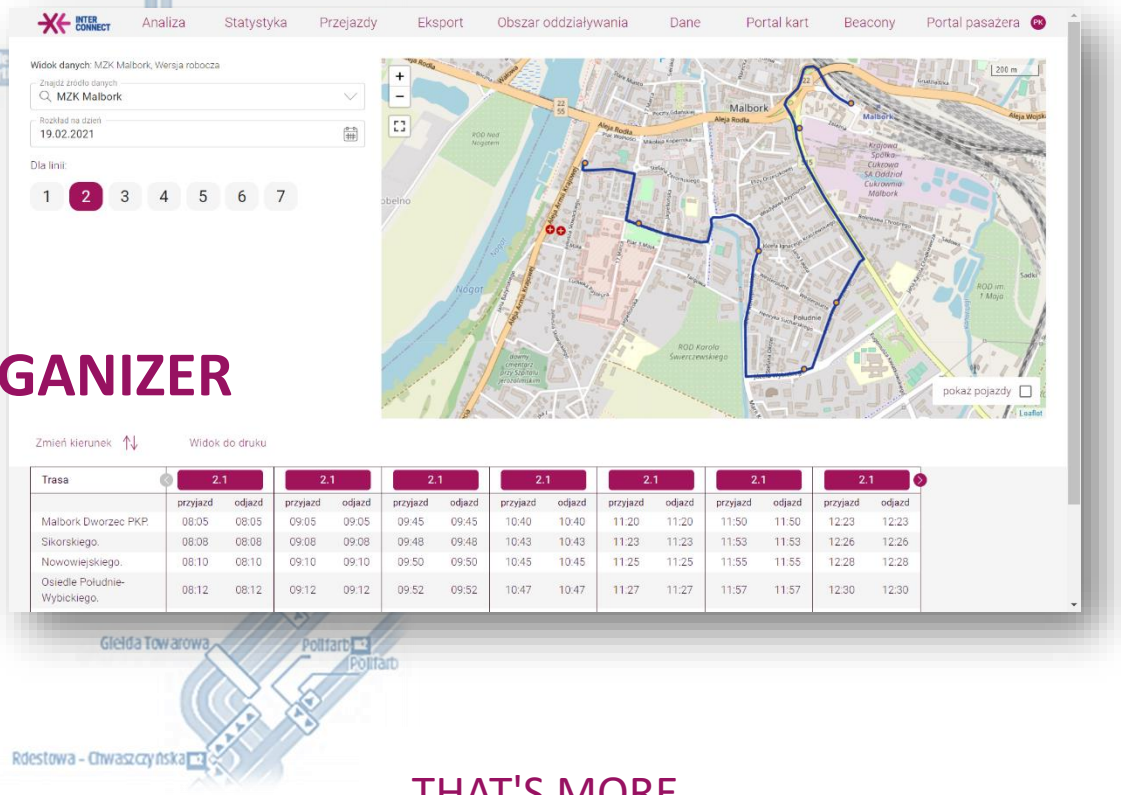

The ability to enter timetable data both by the carrier and by the organizer.
Quickly and easily publish schedule changes in the passenger app.

AS A PUBLIC TRANSPORT ORGANIZER

I collaborate with many carriers.

- I call communication lines, I select stops, I define routes.
- I verify the length of each route.
- I print reports on the offered services.

THAT'S MORE
THAN MODERN PLANNING

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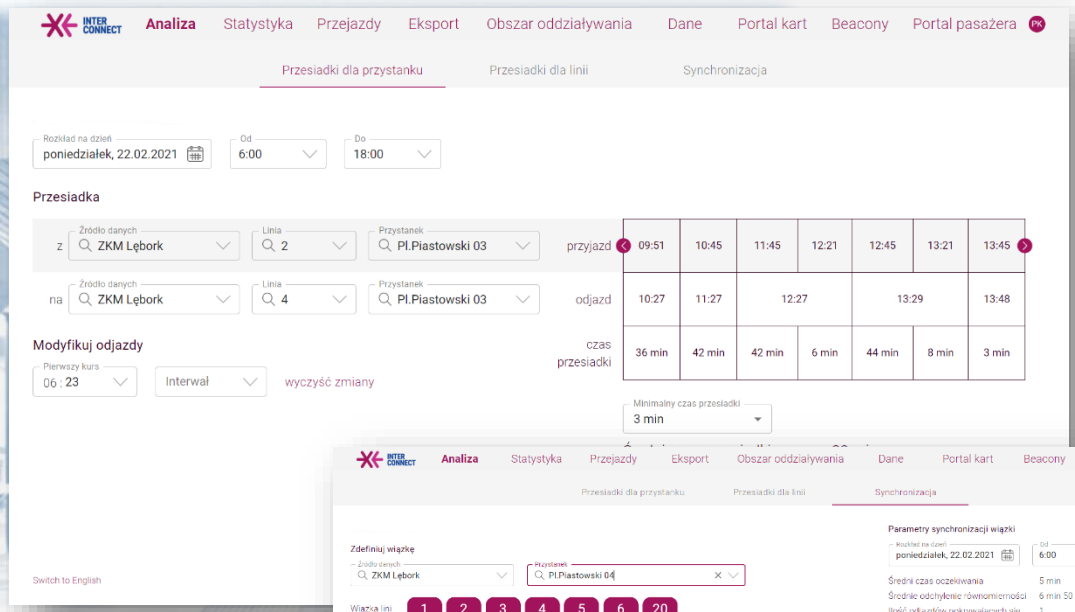

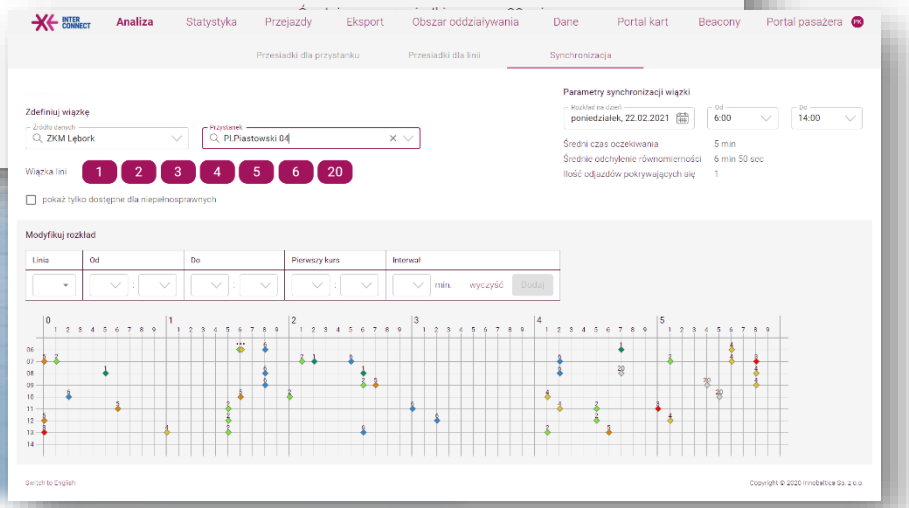

AS A PUBLIC TRANSPORT ORGANIZER

I build an attractive offer.

- I verify the planned connecting time at selected stops.
- I check timetables synchronization.
- I decide on the publication of the timetable in the passenger's travel planner app.

Possibility to restore archival timetables.
Possibility to simulate changes in the timetable.
Ensuring consistency of the transport offer.

THAT'S MORE
THAN SCHEDULING

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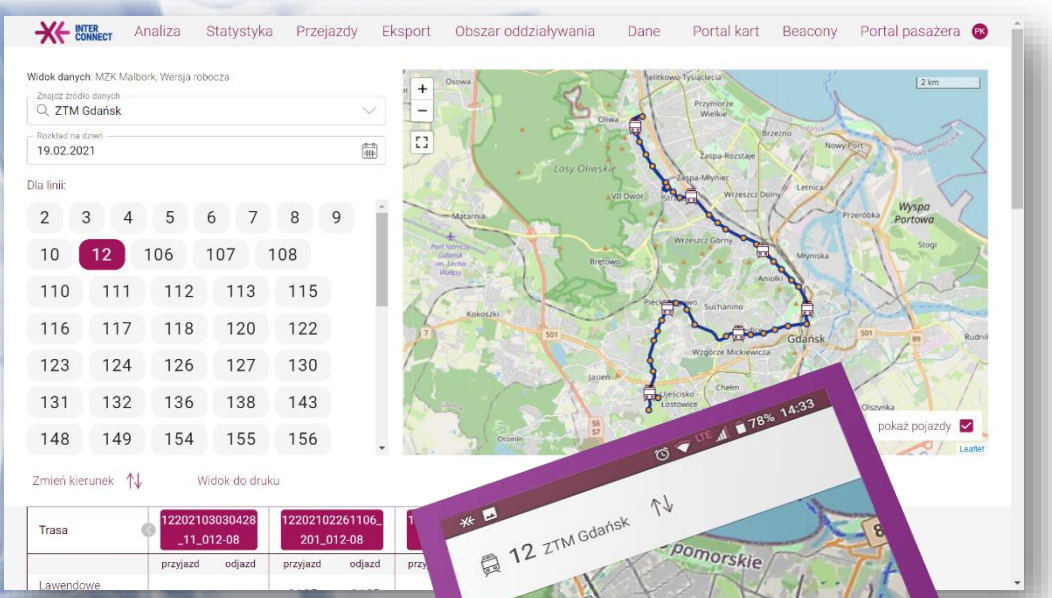
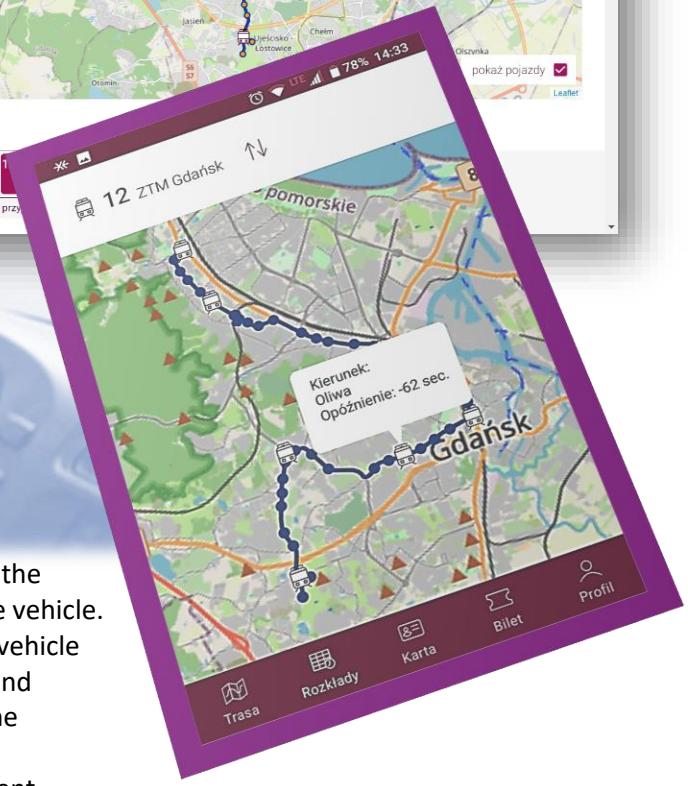
BLE+LTE+GPS





AS A PUBLIC TRANSPORT ORGANIZER

I care about the quality of services.

- I keep track of the location and speed of movement of vehicles.
- I inform passengers about accelerations/delays of selected routes.
- I am open to automating some processes with be-in/be-out intelligent system and automatic detection of passenger flows.

The ability to observe the current location of the vehicle.
The ability to analyze vehicle delays at peak times and adapt timetables to the capabilities of drivers.
Easier fleet management.

THAT'S MORE
THAN A SMART MANAGEMENT

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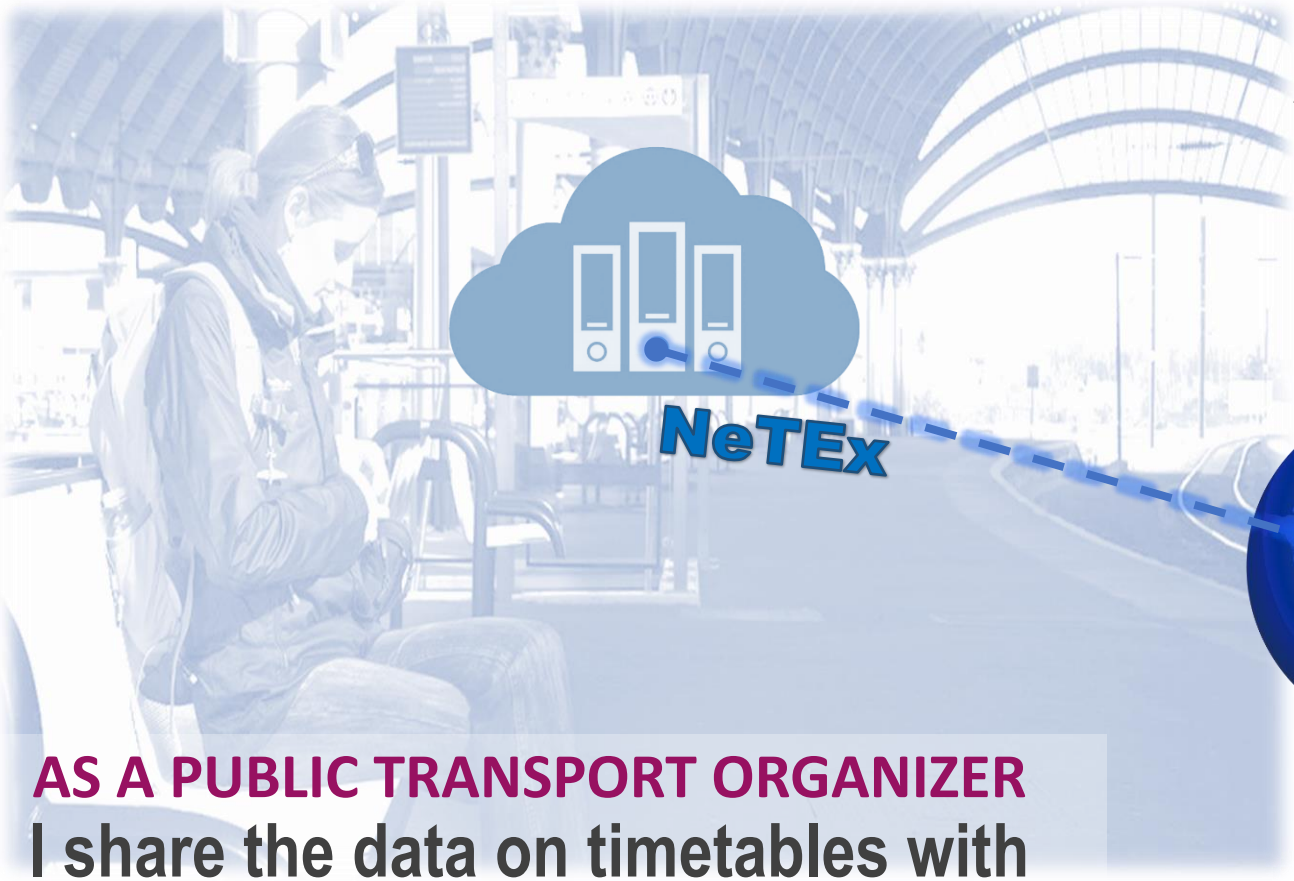

Implementation of Commission Delegated Regulation (EU) 2017/1926 of 31 May 2017, supplementing Directive 2010/40/EU of the European Parliament and of the Council as regards the provision of EU-wide multimodal travel information services.

https://eur-lex.europa.eu/legal-content/PL/ALL/?uri=CELEX%3A32017R1926

AS A PUBLIC TRANSPORT ORGANIZER

I share the data on timetables with other organizers.

- I carry out an obligation to inform about PT offer.
- My data complies with the Pan-European Network Timetable Exchange (NeTEx) standard.
- My data can be used to plan interregional and international travel.

THAT'S MORE THAN A DATA BASE

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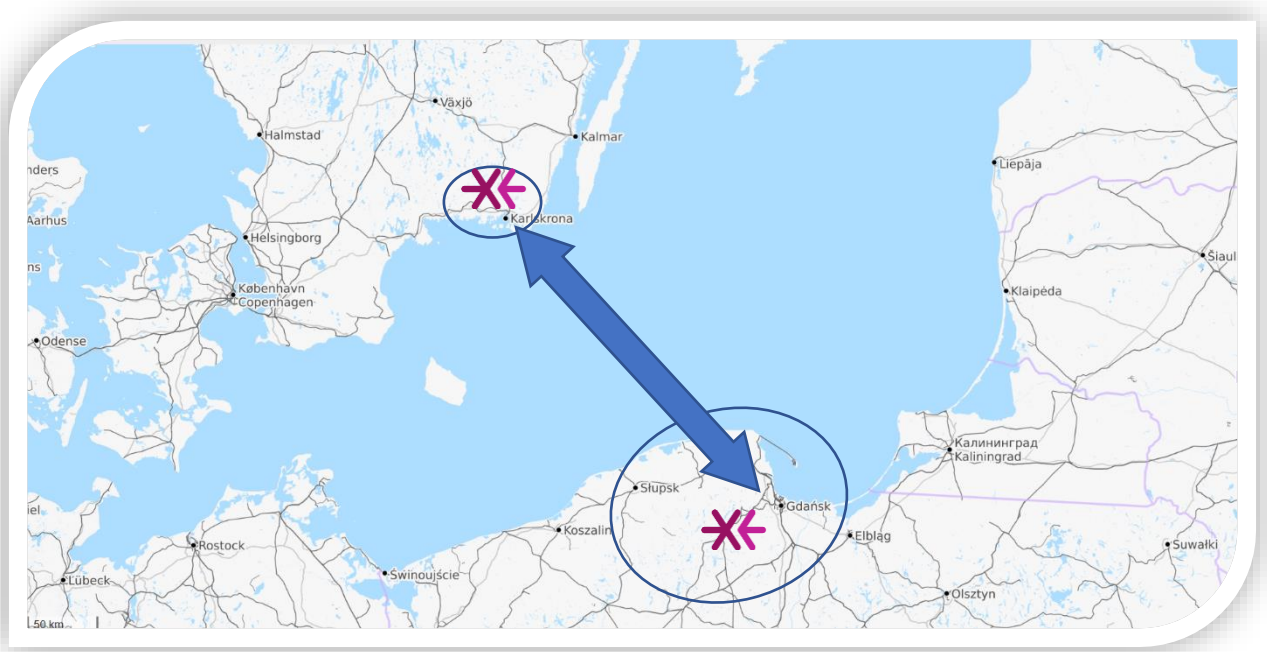
INTERCONNECT PILOT CASES
- CROSS-BORDER ACTIVITIES

PARTNERSHIP, COLLABORATION, KNOWLEDGE EXCHANGE

PILOT CASE BLEKINGE-POMORSKIE



Introduction

When preparing the project, 3 areas with potential to improve PT operations were identified. The first one was information to passengers, the second was improvement of timetables and the third was the ticketing system.
To achieve this improvement, we had to tackle very ambitious aims, as the PT system on Pomorskie side was not integrated at all on a regional level – so it was not prepared for any cross-border cooperation. The public transportation system in Pomorskie was both complicated and defragmented (when taken as a whole), which made it immensely unmatching with orderly organized Blekinge system at the start of the project.
The basic problem with the organization of collective public transport in the Pomeranian Voivodeship was the lack of a common ticket and the multitude of transport organizers, carriers, but most of all a multitude of tariffs.

12 subsystems of public transport, 67 regional bus carriers and 2 regional railway operators are actively operating in the voivodeship. Each of them has its own separate tariff system.

There are nearly 10,000 transport stops in the Pomeranian Voivodeship. Each year, residents and tourists make about 350 million journeys by public transport. This means that nearly a million people travel by buses, trains, trolleybuses and trams every day. Annually, the capital of the Pomeranian Voivodeship alone records over 170 million passenger transports.

The transport ticket distribution network is diffused. Depending on the city and carrier, the rules for the sale and validation of tickets differ. Sometimes tickets are sold as single tickets, and sometimes in multi-journey tickets. Some tickets must be validated in mechanical validators, others are valid for travel only by the nearest means of transport of the carrier and do not require validation. The system is unreadable both for residents and, of course, for tourists. Tourists are also faced with a noticeable lack of passenger information in English and with paper tickets printed only in Polish.

The transport network in the Pomeranian Voivodeship is based on the backbone of railway lines to which passengers are transported by bus, trolleybus and tram lines. Traveling around the voivodeship requires from the passenger to change vehicle several times during single journey. In this situation, unsynchronized timetables of coexisting and complementary means of transport turn out to be uncomfortable. Passengers often have to wait a long time for the next means of transport, which discourages multimodal travel, even in the main transport corridors.

Faced with the described problems, the organizers, operators and carriers do not have professional tools enabling or facilitating their cooperation. They use a variety of public transport management applications. These applications are characterized by a closed programming code and thus the inability to exchange data without significant investment in the software owned.
This is the picture of cross – border public transportation system with its major weaknesses on Pomorskie side that we encountered at the start of project implementation. Within the Interconnect project timeline we conducted several pilot implementations that are meant to raise the assessment of public transportation offer to be made by cross-border foot passengers.

New information system in the Blekinge County public transport buses – Buss TV

Before the official start of the project it was decided to focus the efforts with information to passengers by installing an infotainment system onboard the busses. This was also written into the project.
Historically it has been a challenge to communicate and interact with customers/passengers. The only way to reach them have been via traditional commercial channels as papers and advertisement at our bus stops. In our strive to increase the number of passengers commuting with public transport in Blekinge we have many challenges, one of them is to give our passengers a more pleasant and smoother travelling experience – our theory was that if we succeed with reducing the perceived time of travel – the number of passengers will increase.
About one year before launching in autumn 2018 preparations started by involving municipalities in the Blekinge County. Technical preparations were made in cooperation with companies Scantech and Geosignage among others. After procurement of 260 screens they were installed in 130 busses. As a bonus it was also possible to provide Wi-Fi onboard the vehicles. Content for passengers is partly produces inhouse and partly bought from external suppliers. Exchange information was not provided by Blekingetrafiken earlier helps to guide passengers when changing bus lines and making the travel easier and more efficient. This was very appreciated by the passengers.

When the system was launched, we also got extra promotion as the local radio stations and the local newspapers gave the infotainment system a lot of space in media. On a national level the system was also highlighted by transport related media.
An example how the system also provided support to cross border passengers is that information in polish language is given when the bus is leaving the ferry terminal in Karlskrona.
Directly after the launch Blekingetrafiken received positive response from the passengers, which confirmed that they perceived the information provided. Looking into the big perspective we have had and will have even in the future, have a lot of and good usage of this new way to communicate to our customers.

Better timetables in the Blekinge County

Public transport plays an important part of Blekinge's society and has several stakeholders. The goal which shall be fulfilled are sometimes contra dictional (for example costs and frequency) and are therefore proceeded by various considerations. By using an approach with a lot of governance input from several groups of stakeholders can be considered.
During 2018 the process with the makeover of the timetables in Ronneby municipality started. There were some iterations of the currently best alternative to make it even better, or more according to the preferences. These iterations were regarded as fruitful for the final decision. As with everything in this world changes demands trade-offs between different aspects and" You can't have the best of two Worlds". Due to this fact there were some aspects in which was not made better off with the iteration, rather the on the contrary. It can't at this point be said that the trade-offs were bad for the final decision. On the other hand, there is nothing that says that the final version was the most optimal solutions all aspects considered. To be sure that that's the case there should have been a benchmarking made between different alternatives, aspect by aspect. This could be made with some method for multi-criteria decision analysis. With the result from an MCDA the project group could be more certain that the right decision is made.
We used the mooring effect to our advantage and have made our decisions process between different packages of bus route solutions and possible timetables. Due to the nature of this, it's not possible to see the alternatives presented as a smorgasbord with different parts that you can compose freely according to your own preferences. The governance process was also used as input to the projects WP5.
Due to the implementation of a new ticket system in 2019 it was decided not to make any major changed in the timetables due to lack of recourses.

The launching of a new ticketing system - Easier ticketing in the Blekinge County

When developing a new ticket system in cooperation with Skånetrafiken, during 2018-2019 it was decided to develop a module for digital resellers of tickets. The project Interconnect was mainly involved with input in order to develop the module for external resellers and general marketing of the new ticket system as such. In general there is a wish that the customer buy the tickets before entering the bus or other public transport vehicles for instance in phone application (which requires to download an app and connect a credit card), on the website of Blekingetrafiken from a ticket machine available on some selected stations or stops. All in order to save time for the driver. This issue become extra important when the customer is a tourist and there might be language barriers. During the Interconnect project it was realized at an early stage that public

transport tickets for tourists must be easy to purchase and preferably purchased together with other services required for the trip. In the case of the Karlskrona-Gdynia connection the ferry ticket it the most expensive part of the trip and it makes sense to add the first and last mile of the trip to the ferry ticket. This way the passenger can travel without the need of a car which is the whole purpose of the project. With a clear aim to develop a module for public transport tickets that can be integrated in the booking system of Stena Line the work started. The module would allow the traveller to buy all tickets that Blekingetrafiken offers including the train to Copenhagen directly when buying tickets to the ferry. It would also make it very helpful to Polish customers since the dialogue on the polish version of Stena Line website would appear in Polish language.
As one of the projects objectives was to integrate our ticketing system with Stena Line ticketing system, there was a need for dialogue between the technical departments. On the 11th of March 2019 a meeting took place in Karlskrona between Stena Line and Region Blekinge including Blekingetrafiken. Purpose of the meeting was to investigate how the new ticket system Blekingetrafiken is implementing could work together with the booking system of Stena Line. First step is to investigate deeper how these two systems could communicate. After the physical meeting several other contacts were taken. Due to the technical complexity it was not possible to implement any solution before the summer. During late 2019 Region Blekinge was informed that the implementation of a new ticketing system in Stena Line was delayed. New meetings were held in beginning of 2020 in order to find temporary solutions before a new system could be implemented. Different kinds of solutions with vouchers were discussed. This model has been in use since long time in Karlskrona and now it was discussed to implement the same solution in Gdynia.

Ways to counteract PT market challenges in Pomeranian Voivodeship

The solution chosen by the regional and local authorities was to build a modern electronic ticket and passenger information system in the voivodeship, which would enable data exchange and cooperation on building timetables with foreign partners in the South Baltic area. The task was entrusted to the company InnoBaltica, in which the regional and local authorities acquired shares. In this way, a ticketing system integrator was created in the voivodship (a new role), responsible for the development and implementation of a system integrating transport data and enabling the combination of tickets of project partners into one virtual electronic ticket.

The implementation of the solution was divided into the following thematic areas:

- Legal and marketing analyses, studies,
- Designing high-level architecture of the solution,
- Designing the functionality of individual system components,
- Initial demonstration of designed IT solutions to selected participants in PT system.

As part of the legal analyses, a model of financing public tasks performed by the company acting as an integrator was developed. As this task is a public utility task, performed each time by the organizer of public collective transport - the foundations of the financing model were based on SGEI services. Based on these regulations, individual local governments entrusted the implementation of selected public tasks to InnoBaltica, which thus became, in the scope of a joint transport ticket, a local and regional organizer of public collective transport. Individual local governments have secured funds in their budgets for the purpose

of the annual payment of compensation to InnoBaltica, which covers the costs of implementing the entrusted public tasks. Thus, stable mechanisms of financing the construction and maintenance of this modern IT system were created.

As part of marketing analyses, knowledge was obtained, among others, about the structure of the smartphone market and the operating system used on mobile devices of public transport passengers. Basing on conclusions from market researches, software development for two programming platforms iOS and Android was confirmed.

The analyses carried out by InnoBaltica were reflected in the provisions of the preliminary feasibility study for the pilot actions. It defines the architectural framework of the IT system, i.e. one based on a cloud, fully scalable, using proximity identifiers and applications on mobile devices for subsequent travel planning, ticket purchase, validation and presenting electronic travel authorization to the controller.

In order to design and implement detailed functionalities and parameters of individual parts of the system, it was divided as follows:

- Cloud computing – scalable core system infrastructure,
- Database and integration tools – with data exchange format validator for GTFS and NeTEx standard,
- Travel planner – with information about local attractions for cross-border tourists,
- Tools for PT Organizer and the PT Carrier – for better cooperation in building synchronized time-tables in cross-border routes,
- Modern IoT solutions – for delivering modern passenger information, helping visually impaired people to travel with better convenience.

Innovative solutions – technological achievements of the flagship project

Due to daily close cooperation between Region Blekinge and InnoBaltica (Pomorskie Region) numerous modern system technologies have been worked out in the pilot actions. These modern solutions are as follows: state-of-the-art automated trip detection technology based on intelligent Bluetooth Low Energy (BLE) beacons, the mobile apps which include trip planning, as well as e-ticket and discount card manager functionalities, and the scalable backbone infrastructure for PT providers which integrates transport data.
These key IT elements can bring new experiences, and may improve quality of services to commuters, tourists, persons with disabilities, city dwellers, and last but not least - to communities living outside the metropolitan areas. These solutions thereby not only encourage to use public transportation in cross-border journeys but also enable independent trips of some individuals (in case of e.g. disabled persons).
Delivered modern system solutions reached TRL 6 or TRL7, so they are easy- to – copy by other regional innovation leaders in any European area, and include the following components:

- a cloud service which automatically integrates public transportation data from Blekinge Region in Sweden and Pomorskie region in Poland (schedules, station / stop geographical data, real-time data on vehicle locations, and departures from specific stops). At the moment the service also integrates current schedule data from 20 actual providers of transport services in two corridors in Pomorskie: including bus, tram and trolley service data from all the major cities (including Gdansk, Gdynia, Słupsk) as well as

smaller towns, metropolitan area train and inter-city rail schedule data. Technology and architecture used to implement this service has proven effective, as demonstrated by continuous operation in the relevant environment (TRL 6) by continuously providing service for large, real-life transport data sets from multiple providers from the region.

- a cloud service for automatically finding multi-modal connections based on Open Trip Planner (OTP), complemented by geolocation search engines, integrated with transport data service described above. This trip-planning and geolocation system uses the most up-to-date information, thanks to automated update mechanisms. It currently allows the user to search for addresses and points of interest (POIs) in Pomorskie and Blekinge regions, and find (in real time) multimodal connections between user-specified points (and for a specified date and time). This component was demonstrated to provide relevant search results, requested by early-stage, beta users through Interconnect mobile apps, i.e. it has reached TRL 6.
- a web portal for PT providers, allowing them to store, edit and import transport data, analyse and optimize their transport network, passenger streams, and synchronize their routes with routes of other providers. The portal undergoes evaluation by local transport providers, during which actual transport data have been entered to the system. TRL 6 for this subsystem has therefore been demonstrated.
- an intelligent BLE vehicle-installed beacon network, broadcasting information which identify vehicles via Bluetooth, as well as their GPS positions via cellular network. Pilot installation of the beacons in buses serving Gdansk - Kartuzy route #801 (operated by PA GRYF transport services) has been successfully completed. It has been demonstrated in a relevant environment that the designed and manufactured beacons are operating correctly and continuously, i.e. they have reached TRL 6.
- a state-of-the-art trip and passenger stream detection and registration technology. This technology consists of 4 elements: 1) smart BLE vehicle-installed beacons (described above), 2) novel trip identification algorithms implemented within the mobile passenger apps, 3) trip verification algorithms operating on the cloud servers, which match information received from the beacons with the information received from the apps, and the schedule information available through Provider's portal to create complete information about a trip, 4) state-of-the-art passenger stream identification algorithm, which automatically splits passenger flows into streams, and identifies the start areas, destination areas and main transfer points for each passenger flux (stream). Actual passenger trips which occurred on regular, scheduled bus route #801, line Gdansk-Kartuzy (operated by GRYF) were successfully identified and recorded using this technology, i.e. TRL 7 has been demonstrated for this technology.
- a Beacon management web portal, along with mobile apps for beacon service persons. Beacon management portal successfully recorded service actions performed in the BLE beacons. Also, it was shown to automatically gather information about beacon health from the installed beacon network, which has demonstrated TRL 6 for this subsystem.
- a web portal and mobile applications for passengers. The Interconnect passenger apps (in particular the trip planning, navigation, trip detection features) were evaluated by beta testers in the relevant environments (i.e. at bus stops, inside buses), which has demonstrated TRL 6 for these components.
- a Traveller card offer management portal, including a mobile app for validating travel cards (with electronic ticket) stored in passengers' mobile applications. This subsystem has been evaluated by an

early-access pilot partner - the City of Slupsk. Card packages for actual attractions have been successfully specified in the portal, which has demonstrated TRL 6 for this subsystem.

COVID -19

As we all know the pandemic Covid-19 hit the world with full force in beginning of 2020. All of a sudden, the work shifted from promoting public transport to informing how to travel safe and best of all to avoid travelling with public transport. For Blekingetrafiken the infotainment system once again proved to be an efficient information channel. The effects were even bigger for our associated partner Stena Line who had to take extreme measures to reduce costs and secure the operations. Unfortunately, the technical staff involved in our project had to leave the company and investments were put on hold until further notice.
Since all partners in Blekinge - Pomorskie pilot case are interested in full integration an agreement to continue cooperation for another 5 years were signed in connection to the Final Conference of the project in October 2020.

Remaining issues to be solved

1. As explained above the integration with Stena Line will be implemented after the project's implementation period is over.
2. The travel planner of Blekingetrafiken does not cover cross-border traffic at this point. The system of InnoBaltica does, but since Blekingetrafiken cooperates with Skånetrafiken it is not possible to use the system from Poland. Because of technological and procedural reasons some of the data has to be manually entered to the Interconnect system. This issue would generate need for additional personnel on either side of the cross-border connection, so alternative solution will be also developed after completing the Interconnect project.
3. Some pilot innovative products (IoT devices) are valuable for further development and for broad PT market implementation (TRL-9).

PILOT CASE KLAIPEDA

The pilot activities were carried out in connection with 20 feeding lines, servicing on more than 2 m. kilometres per year and providing more than 1.5 m. trips in 2019.

As in other post-Soviet European cities, explosive suburbanization took place in Klaipeda after the 2000s. The city's population has fallen from 200 000 to 150 000, largely due to emigration and the negative birth / death balance. However, more than 10,000 former residents of the city moved to the nearby Klaipėda district municipality. As a rule, these are young upper-middle-income families with children. Those suburbs did not have - and still have almost - social infrastructure and job places. This results in the daily shuttle trips of suburban residents to and from the city.

As everywhere in the world, integrated public transport between different municipalities is primarily a political issue rather than a traffic engineering one. The problem of excessive car traffic in Klaipeda became apparent to local city politicians as early as 2010: finding solution with these topics - the parking fee, congestions and ecology.

Initially, there was a political debate in the city about road widening and increasing parking spaces for cars. However, Klaipėda PT authority has taken the initiative to prepare an alternative plan for the development of public transport to the region, which was approved in 2011 after discussions.

As different political parties traditionally govern Klaipeda city and Klaipeda district, we needed to find arguments in favour of both city and district politicians.

For Klaipėda city politicians, such arguments of benefit were less motorization and the solution of its problems.

The argument of direct benefit to Klaipėda district politicians was more attractive areas in terms of public transport service for settlers - more population that is affluent, more taxpayers.

The main interest group was also the suburban residents, who put pressure on the Klaipėda district government to agree with Klaipėda city politicians on public transport.
Klaipėda PT authority, which has a professional understanding of the principles of operation of the regional public transport system and possible financing mechanisms, had to perform the delicate work of coordinating all those interests and delicate push to agree.
The first integrated regional routes (feeding lines) were launched in 2011-2012, and the principles of system management and financing have not changed since then:

1. Management

At the operational level, the regional system is managed by the Klaipeda PT authority, authority has contracts the carriers, managing routes and timetables, and the ticketing system. In addition to the representatives of Klaipėda city, there is one representative of Klaipėda district in the Board of authority. In the course of regional development, PT authority also cooperates with suburban communities, which elect the Klaipėda district government.

2. Financing

The district government pays compensation for the carriage of its preferential passengers and compensates for route losses. Klaipeda city government contributes to the financing of the system by setting flexible zonal ticket prices, which encourage to continue travel by city buses upon arrival.

3. Principles of route geography

The starting point of integrated suburban routes in the city is set in the most popular transfer hubs, where there are most urban routes, express buses and shuttle taxis. At the same time, we aim to avoid suburban routes to the city centre or other targets as much as possible.

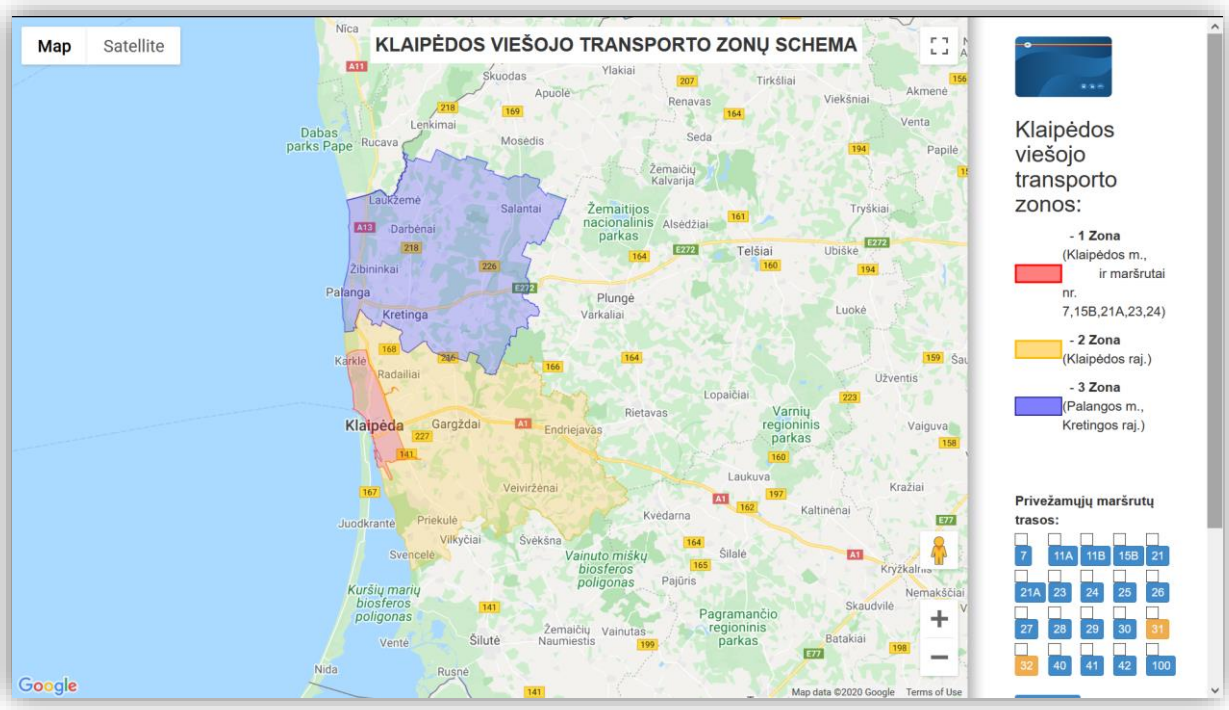
4. Ticketing system

Within last 3 years, plans to upgrade Northern Hub (Ligonines stop) were shifted to modernization of existing ticketing system. Decision was made keeping in mind investment to premises, customer support centre.
Main problem we noticed during managing of regional PT network, was time losses because of old fashion ticketing system – buying tickets with cash ant the drive cashier. Ticket price there depends on distance passenger is traveling, so pre-printed tickets are not an option.
Main goal for last 3 years was to offer reliable and fast ticketing solution / payment method. Firsts actions were promote combined zone periodical (monthly) ticket. This type of ticket in last 2 years covers ~10% of all trips. Usage of those ticket directly related to status of PT service, if traffic conditions more or less predictable, service is reliable, it convince commuters to buy monthly ticket. Another issue with such type of ticket – price and transport privileges. Pricing allows saving of 20-30% comparing with single tickets, but our ticket shows problem of transport privileges. Pupils 10-19 years old in region somehow were out of scope to get similar discount comparing pupils within city. Hopefully cooperation with region municipality (main interest group) and there elected Member of Parliament helped a lot, we have “hot” decision to equalize discounts from 2021-09-01. It means better pricing for young commuters and more flexible and easy understandable ticketing.
Another topic was to provide fast solution for single rides. For those trips we started check in / out payment – Klaipeda travel card and possibility to use wallet money for single rides, taping twice entering and going out from the bus. Since 2020 we stated kind on additional marketing providing price gap – check in/out transaction is cheaper comparing with paper ticket sold out by derive. Payment without cash, fully

contactless (wallet can be top upped by internet) helped a lot during Covi-19 pandemic – 2020 9 month statistic is showing more transactions comparing full 2019.

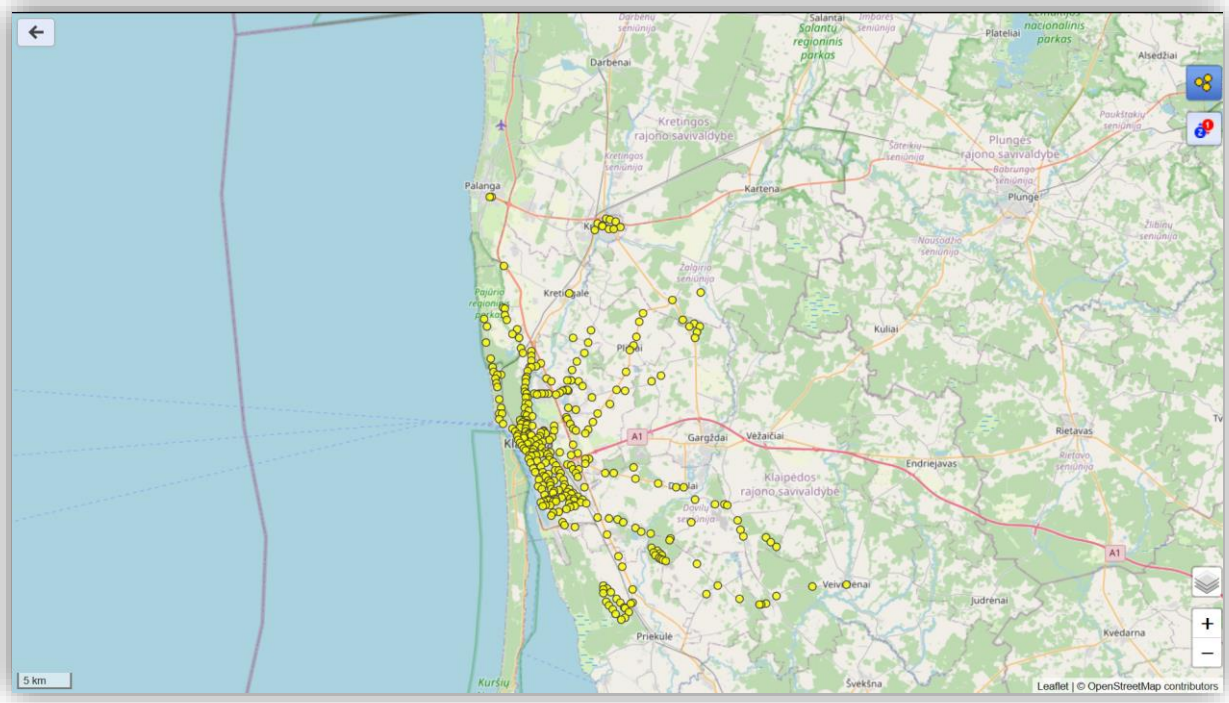
Check in / check out system has been implemented, which insured a passenger an elasticity of payments http://senoji.klaipedatransport.lt/maps/bilietaiEN.php.

Ticket zones are as shown on the map below.



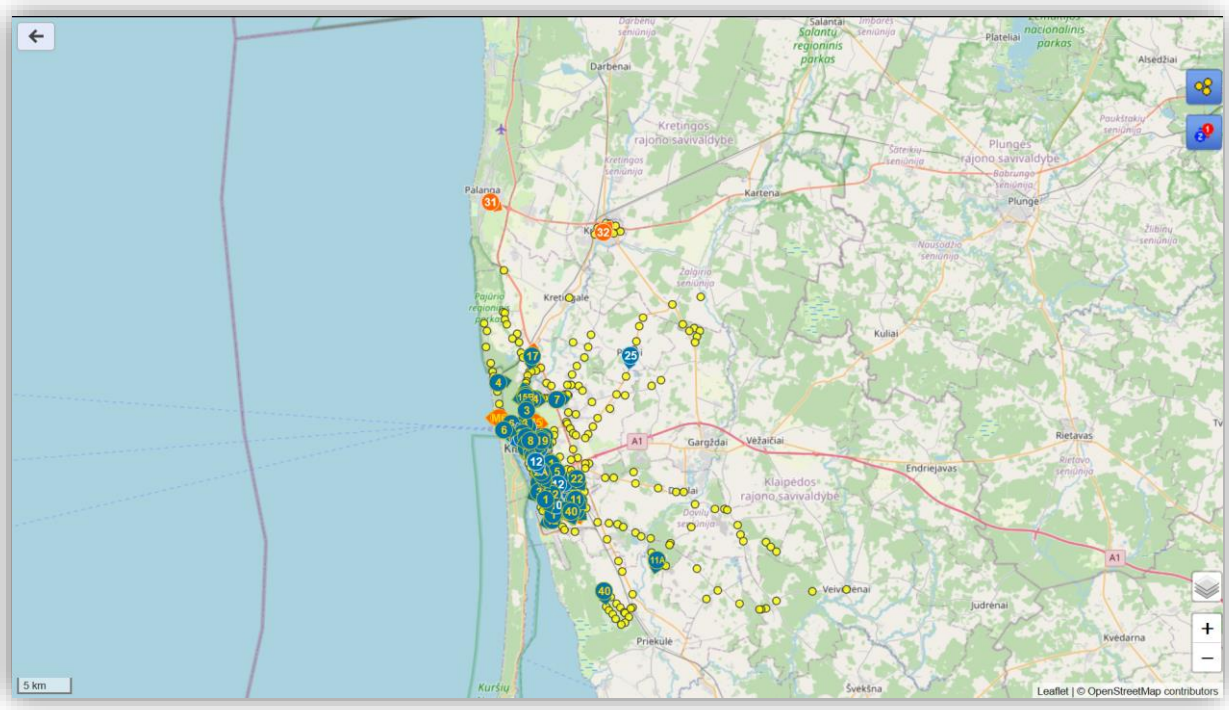
Source: http://senoji.klaipedatransport.lt/maps/zone.php

An electronic map showing public transportation stops



Source: https://m.stops.lt/klaipeda/#klaipeda/map

A passenger has a possibility to check the precise location of running buses.



Source: https://m.stops.lt/klaipeda/#klaipeda/map

With map enlarged you can get information about current location and speed of a particular bus.

Source: https://m.stops.lt/klaipeda/#klaipeda/map

PILOT CASE ROSTOCK-GULDBORGSUND

IMPROVING CROSS-BORDER PASSENGER TRANSPORT AT THE ROSTOCK-GULDBORGSUND AXIS: A LONG-TERM INVOLVEMENT IN GERMAN-DANISH COOPERATION.

The efforts to improve public transport services at the Rostock–Guldborgsund transport axis is part of a long term and broad development strategy between regiopolis Rostock City and its and Guldborgsund Municipality.

Guldborgsund Municipality is located at the southeast corner of Denmark and Rostock located in the northeast corner of Germany. Instead of accepting their periphery location in relation to their capital regions, both Rostock and Guldborgsund Municipality have instead defined themselves of being located in the favourable triangle of Copenhagen, Berlin and Hamburg and part of the South Baltic Sea with a wealth of international cooperation opportunities.

One such opportunity is the north-south transport corridors that goes between Scandinavia-Copenhagen-Guldborgsund Municipality-Rostock-Berlin and eastern and south Europe. Another opportunity for Guldborgsund is the transport and development corridor Øresund Region-metropolis region of Hamburg; which will be completed with the Fehmarn-Belt fixed link. Early in Rostock-Guldborgsund co-operation the so-called Y-strategy was developed: the two axes coming from Berlin and from Hamburg meet in Guldborgsund and continues toward Copenhagen. The transport connections are in this respect transformed into a growth driver and transport used as a tool for regional cooperation for mutual development.

Therefore, the transport axis Rostock-Guldborgsund have been part of earlier Interreg-projects Baltic Gateway, Interface, Interface+ and Transgovernance.

The Interface project improved the total travel connection between Nykøbing Falster and Rostock City fitting bus-ferry-bus/public transport time plans, connecting bus terminals with ferry terminals, improving passenger information about travel plans and established the InterCombiTicket, a single ticket for the total connection Nykøbing–Rostock City involving bus-ferry-bus.

The Interface+ project expanded the service by establishing the real-time passenger information system covering the total distance from Nykøbing to Rostock City and its region. This system covering different travel modes and crossing two countries was probably the first of its kind in the world, and different from the limited real time systems that sometimes are seen in large cities covering only one transport mode and one company, e.g. a city bus or city tramp.

The BSR TransGovernance project expanded the understanding of transport projects with focusing not only on "means to go" but also on "reasons to go". TransGovernance managed to show how multi-level governance contribute to a better alignment of transport policies and general cross-border development. The project was finalised with a city twinning agreement between the Rostock City Council and Guldborgsund City Council and the two mayors.

The two-digit million Euro support from the TEN-T programme to the Nykøbing bypass road for heavy traffic and the ferry harbour investments in Gedser and Rostock is a separate and important part of this long-term development on the Rostock-Guldborgsund axis.

On this background, the Interconnect project has been an important project and instrument for Rostock and Guldborgsund Municipality for improving the common transport connection and expanding the cooperation; developing the "means to go" as well as the "reasons to go".

Through Interconnect a number of solutions have been developed to improve the public transport / foot passenger travels at the Rostock-Guldborgsund transport axis. Five of such solutions are:

1. Promotional campaign for the cross-border public transport connection Rostock-Guldborgsund;
2. Upgrading of the booking system for the InterCombiTicket;
3. Establishing a new bus service between Gedser and Marielyst (Guldborgsund);
4. Establish cross-border bicycling routes;
5. Solution catalogue for better rural hinterland mobility to interchange points.

Promotional campaign

The promotional campaign for the cross-border public transport connection Rostock-Guldborgsund had focusing on both old and new target groups and was based on the earlier developed InterCombiTicket which was launched as a marketing tool already in 2010.

The point of departure was the very low proportion of foot passengers and that the ferry passengers mainly are travelling by private cars and trucks, though also by tourist busses. The foot passengers are mainly German tourists making day trips to Guldborgsund and weekly commuters from Germany and Poland working in Denmark.

The elements in the campaign had both focus on "means to go", i.e. the public transport offer and service on the Rostock-Guldborgsund axis, and on "reasons to go", i.e. on developing the cross-border knowledge and connections between citizens on both side of the Baltic Sea.

The elements in the campaign included:

- Updating the InterCombiTicket website and Scandlines website making it easier to find and book the ICT.
- New ICT flyers telling about the ITC and how to book it, were produced in Danish and German languages and distributed in Guldborgsund and the greater Rostock area.
- A short film especially targeting young people and students were produced to promote the two destinations Guldborgsund and Rostock, the ITC and the public transport connection.
- In Rostock 140 city-light posters were placed in street of Rostock during the spring 2019 targeting local citizens and tourists. Again, the message was both about the ITC and the two destinations and their attractions.

The elements mainly focusing on "reasons to go" included more than 15 exchanges and involved more than 150 people from Guldborgsund who have visited Rostock and more than 150 people from Rostock who have visited Guldborgsund. The exchanges were between our public administrations and local governments, and between our civil societies. There were specific focus on educational institutions and schools, culture and tourism associations and business organisations.

A town-twinning meeting and Guldborgsund chamber ensemble concert at the Baroksaal in Rostock in May 2019 opened the marketing campaign for the wide public visible in Rostock through posters at the city's light poster infrastructure. The concert and campaign opening was attended by the two mayors Roland Methling and John Brædder.

The campaign had different blocks, e.g.:

The Business and Tourism Association of South Falster (STEF) attended the Rostock/Warnemünde Tourism Fair Viva Touristika strengthening the cross-border tourism connections. Rostock / Warnemünde tourism organisations visited South Falster, Marielyst and STEF. Business Lolland-Falster visited Rostock "Lieferantentag" in 2018 and participated in Business Meets Hanse Sail in 2019 and a Rostock Business delegation visited Business Lolland-Falster in autumn 2019.

School classes of Sophie School and Møllebakke School as well as students from Rostock University and from College for Vocational Education Lolland Falster did several exchanges in 2019. During the exchanges, the students tested the public transport chain between Rostock and Nykøbing and had interesting programmes including discussion on cross-border cooperation and public transport.

Guldborgsund and Rostock art groups extended their long-term cooperation through an exhibition at Gedser Train Round House and Gedser Marine Station and promoted the cross-border interconnections. For the art exhibition Grauzone / Grey Zone the art products were made of the old slate roof from the old Train Round House in Gedser.

It can be concluded that addressing new target groups has been successful with a lot of positive feedback – and interconnections across the Baltic Sea have been established.

However, further measures are needed for increasing the proportion of public transport passengers. At the completion of Interconnect there is still a low number of foot passengers (10 % or lower).

The main reason is probably that for the total transport corridor, still there is a main focus on private car transport. The private and public investments are much larger in private car transport than for the public transport service. A specific issue is that most passengers on this transport corridor are travelling between long distances for example between Copenhagen and Berlin or between Sweden and Central Europe. These

travellers will probably not change their choice of transport means because of improvements at the short transport section between Nykøbing Falster and Rostock.
Therefore, it is necessary to look at the larger market and the total travel connection. The FLIX-bus between Copenhagen and Berlin is one example of comfortable public transport as an alternative to private cars.

Upgrading the InterCombiTicket booking system

The InterCombiTicket (ICT) is an all-in-one ticket between Rostock and Nykøbing Falster and includes bus, tram/city train and ferry and was launched in 2010. A new, easy and less costly booking system was required to ensure further availability of the InterCombiTicket. The original separate booking system for the ICT had very high administration cost and were not sufficiently visible and used friendly. The booking system was developed when digital payment methods and smartphone apps were not widely used.
The solution was to integration the booking of ICT into the existing booking system of Rostock public transport, Verkehrsverbund Warnow (VVW) and updating the mobile ticketing app of VVW. Furthermore, bar codes were added on mobile tickets to be readable for scanners in the Scandlines ferry terminal. A specific task was to change the complete ICT administration and accounting between VVW, Scandlines and Movia. Finally, the ICT website was updated regarding booking information and FAQs.
The integration of the ICT into the VVW booking system has ensured availability, reduced costs and added an easy app-booking facility. Still, some issues need further attention. The ICT can only be booked via the app, and no “classic” alternative (e.g. ticket shop) exists, which might not be so attractive for tourist or for people not used to purchase tickets via mobile apps (e.g. elderlies).

New summer bus service between Gedser and Marielyst

A summer bus service that goes directly between Gedser Ferry Harbour and Marielyst Tourism Resort has long been a wish by local tourism actors and local and regional tourists crossing the Baltic Sea.
Marielyst Tourism Resort is a large and popular summer cottage area and beach resort for many Danes and Germans.
For guests arriving by the Rostock–Gedser Ferry the public transport service require either the bus to Nykøbing F and there changing to local bus or long walking along the country road (there are no local taxi in Gedser).
Improving the availability of Marielyst Tourist Area by public transport especial international guests using the Rostock–Gedser ferry connection would make it much more attractive to shift from private car to cross the Baltic Sea as foot passenger and using public transport.
A new summer bus (Bus 743) between Gedser and Marielyst was launched summer 2019. The route, bus stops and timeplan was laid out through dialogue and local meetings with citizens and the tourist organisation. The bus is operated by Movia and financed by Guldborgsund Municipality.
Operation season is the six weeks of tourist peak season in July and August. A number of promotion activities introduced the summer bus and it was agreed with local stakeholders that they should take part in the promotion of the summer bus, e.g. place the posters about the bus any place where tourists may pass by at Gedser, Marielyst and Nykøbing.

The 2019 season did only have 1.050 passengers equalling 3,5 passenger per round trip. It was expected that for year 2020 the summer bus would be well known and attract many passengers. However, the COVID-19 changed that totally. Hopefully, the summer bus test period will be continued for next year and will attract many passengers. Because, when it is about public transport; you use it or you lose it.

Cross-border bicycling routes

At the Guldborgsund – Rostock axis new service, cross-border bicycling routes, has been developed to promote car-independent travels.

Both in Guldborgsund Municipality and in Rostock area there are active bicycle associations working with bicycle routes in close cooperation with tourist organisations. Despite the well-known Copenhagen-Berlin Bicycle Trail crossing the Baltic Sea, there are no framework to support local cross-border bicycling.

The Interconnect project has supported bringing the two local bicycle associations Sundgruppen in Guldborgsund Municipality and together. The two associations have made a catalogue of ten one-day bicycle routes on both sides of the Baltic Sea. The routes are together called the Bicycle Flower, because they look like a flower with the routes in the Rostock area as the base leaves and the routes in Guldborgsund as the flower stem and petal flowers.

The 50 page-catalogue includes descriptions of each route and options for overnight stays, eating places, shopping, bicycle renting and attractions. All ten routes have connections to the Berlin-Copenhagen bicycle route and may act as local routes to this international route.

The catalogue is also available on the homepage https://cykelblomsten.dk.

It is expected that the Bicycle Flower will increase the cross-border bicycling tourism and the number of car-independent travels and holidays.

Local distribution of the catalogue was part of the joint Interconnect activity, but, still there is a task of spreading the new bicycling opportunities and develop the tradition of bicycling tourism; for a one-day tours and for a longer stays

Catalogue for better rural hinterland mobility

For people living the rural areas of Guldborgsund Municipality there is a lack of suitable mobility solutions to the interchange point matching the actual needs for travels to the north-south transport corridor, used by local commuters and tourists.

The traditional public bus services are inadequate for the actual mobility needs, and at the same time very costly for the local transport authority. However, reliable, affordable and frequent service – also for outer lying hours – is necessary if local people should not depend on the alternative of one or two cars at each household, resulting in a further shift from public transport towards private cars.

This challenge of insufficient public transport service from rural areas to interchange points is probably a general challenge for the South Baltic Programme area.

To solve the above described challenge Guldborgsund Municipality has started a comprehensive process for developing new and sustainable mobility solutions fitting the rural areas of the municipality. In this process three rural pilot areas has been selected: Guldborg village and surroundings, Horbelev village and surroundings and Gedser / South Falster area.

New or enhanced mobility solutions were identified and selected in dialogue between the municipal administration, a mobility consulting company and local citizens from the three rural areas through facebook-dialogue, workshops and a questionnaire distributed to the three rural areas and to the entire municipality.

Mobility solutions were identified within three overall types:

1 Improved public transport / bus service

- Free busses.
- Improved bus stop sheds.
- Additional bus service during summer season,
- Event busses for specific larger public events,
- Call busses / call taxi.
- More options for bringing bicycles at the bus

2 Improved facilities for bicycling

- More and better connected bicycling paths,
- Bicycle parking close to the bus stop.
- Expanded lighting along biking paths / routes,
- Free testing of electrical bicycles.
- Better and unified sign boards for tourists and locals.

3 Car sharing opportunities (This may reduce the total use of private cars in rural areas).

- Joint driving / car-pooling in private cars based on a local online platform,
- Commuting parking places close to a highway entrance,
- Village car managed by the village community

Guldborgsund Municipality has started the journey for improved and sustainable mobility solutions for rural areas and some of the proposed mobility solutions have been implemented, most recently the summer bus Gedser –Marielyst – Nykøbing servicing particular the cross-border passengers at the Rostock – Gedser ferry. Mobility challenges still exist.

- The legal framework of municipalities and state aid rules provide strict limitations in selection of solutions.
- The public transport in Denmark is managed by regional public companies with limited flexibility and cost efficiency for bus services.
- Traditions and lack of knowledge of new mobility solutions.
- Most transport infrastructure solutions require large initial investments

Remaining problems still to be solved

The transport sector is very much focused on cargo and private car traffic and very large investments are continuously provided both from private, business and public sources. Consequently, it takes sustained decisive efforts to keep up the quality of public transport offers, particular cross-border connections requiring multilevel governance.

Consolidation of the developed public transport offers and information campaigns is still vital, including specific service offers like the InterCombiTicket and the booking system and its permanent update in relation to consumer behaviour.

The tourist summer bus Gedser - Marielyst needs to be further introduced and consolidated.
Hinterland connection into the transport corridor Nykøbing - Rostock, which is a short section of the Scandinavian - Nykøbing - Rostock - Berlin - South and East Europe corridor still needs attention in terms of solution development, planning, investments and implementation.

It is necessary to analyse the larger market and identify public transport solution that are viable for the total travel connection Scandinavia-East and South Europe.

The development cooperation across the Baltic Sea involving local and regional authorities, business and education sector, tourism and cultural sector including citizens associations is still a growth driver and important for the traffic in the transport axis Guldborgsund – Rostock.

INTER CONNECT

One ticket to the future

INTERCONNECT FINDINGS

- TEMPLATES OF METHODS, DEVELOPED SOLUTIONS

PROJECT SOLUTIONS TEMPLATES

No.1	Organisation	
	BLEKINGETRAFIKEN	
1	Title/Name of the method/service/product	
	BETTER TIMETABLES	
2	Geographical area of application	
	Blekinge	
3	Phase of implementation	
	◯ Designed	⊗ Implemented
	◯ In the implementation	◯ Tested
4	Main challenges addressed by this method/service/product	
	Challenges Public transport plays an important part of Blekinge society and has several stakeholders. The goal which shall be fulfilled are contradictional (for example and frequency) and are therefore proceeded by various considerations. General goals/challenges when doing the changes: - Increased market shares (decrease the travel with private cars) - Good cost coverage - Better possibilities to commute - Shorter travelling time for the commuters. - Increased figures of satisfied commuters In our strive to give our passengers the possible conditions to commute/travel by public transport	
5	Description of the method/service/product	
	I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.	
	In 2018 Blekingetrafiken made a makeover of the public bus system in the city of Ronneby. The initiation of this makeover was the need for more efficient public transport, better connections between local and regional transports and airport transit with regular public transport. One important purpose was to make public transport gain transport-market shares from car using. In the process of preparing a better suited bus-route structure and scheduling timetables there are several analyses made. First and foremost, it's important to keep already existing travellers within the public transport system and not lose them to other modes of transportation. Due to this much effort was made to disclose existing travellers travel patterns i.e. • which bus stops is most frequently used, • during which time periods does most of the existing travel occur, • what would be the best route and schedule for existing travellers? To answering these questions statistics from ticket validation was used. As the purpose of the makeover is to grow the number of passengers it's also important to determine where there is opportunity to gain more customers. To find these new customers the usual modus operandi is to raise the frequency of departures in the areas where there's already many daily travellers in the system. What's done is to use the Mohring effect to our advantage. Areas with a high rate of daily travellers often coincide with densely populated areas with a relatively low socioeconomic status, e.g. public housing projects, and areas of high interests, e.g. shopping centres, town centres, schools, train stations and clusters of large workplaces. The foundation of the strategy is to make few strong corridors with attractive public transport supply.	

	There are usually different ways and alternatives to get more people to travel with public transport, the routes and timetables can be organised in different ways. What's crucial on the other hand is that these different solutions are made as packages and you can't in a simple manner cherry pick parts of them and put it in a new optimal alternative. Instead the decision process involves different alternative from which to choose and with some possibility for iteration and rework. The best, and often reworked, alternative is later presented as the suggestion for the changes in the public transport system for the political management.
6	**Lessons learned – positive and negative aspects**
	The decision process is made up of decisions between different packages of bus route solutions and possible timetables. Due to the nature of this problem, it's not possible to see the alternatives presented as some kind of smorgasbord with different parts that you can compose freely according to your own preferences. During the process with the makeover in Ronneby there was some iterations of the currently best alternative to make it even better, or more according to the preferences. These iterations were regarded as fruitful for the final decision. As with everything in this world changes demands trade-offs between different aspects and" You can't have the best of two Worlds". Due to this fact there were some aspects in which was not made better off with the iteration, rather the on the contrary. It can't at this point be said that the trade-offs were bad for the final decision. On the other hand, there is noting that says that the final version was the most optimal solutions all aspects considered. To be sure that that's the case there should have been a benchmarking made between different alternatives, aspect by aspect. This could be made with some method for multi-criteria decision analysis. With the result from an MCDA the project group could be more certain that the right decision is made.

No.2	**Organisation**	
	BLEKINGETRAFIKEN	
1	**Title/Name of the method/service/product**	
	EASIER TICKETING: MODULE FOR ONLINE RESELLERS	
2	**Geographical area of application**	
	Blekinge	
3	**Phase of implementation**	
	⊗ Designed	○ Implemented
	○ In the implementation	○ Tested
4	**Main challenges addressed by this method/service/product**	
	When developing a new ticket system in cooperation with Skånetrafiken, during 2018-2019 it was decided to develop a module for digital resellers of tickets. In general there is a wish that the customer buy the tickets before entering the bus or other public transport vehicles for instance in phone application (which requires to download an app and connect a credit card), on the website of Blekingetrafiken from a ticket machine available on some selected stations or stops. All in order to save time for the driver. This issue become extra important when the customer is a tourist and there might be language barriers. During the Interconnect project it was realized at an early stage that public transport tickets for tourists must be easy to purchase and preferably purchased together with other services required for the trip. In the case of the Karlskrona-Gdynia connection the ferry ticket it the most expensive part of the trip and it makes sense to add the first and last mile of the trip to the ferry ticket. This way the passenger can travel without the need of a car which is the whole purpose of the project. With a clear aim to develop a module for public transport tickets that can be integrated in the booking system of Stena Line the work started. The module would allow the traveller to buy all tickets that Blekingetrafiken offers including the train to Copenhagen directly when buying tickets to the ferry. It would also make it very helpful to Polish customers since the dialogue on the polish version of Stena Line website would appear in Polish language.	

5	**Description of the method/service/product** I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc. The technical aspects build on a real time connection between the booking dialogue of Blekingetrafiken and the system of the digital reseller. In order to provide a good customer experience when buying a ticket on the external resellers website you need a fast internet connection. If the perceived purchase process is lagging or other ways delayed there is a risk that the customer aborts the purchase. To be able to integrate the external operator creates his own API with which you are connecting to BT´s server "Singapore". Singapore is a setup of different servers containing the following possibilities: • Buy ticket – choose product, buy, pay, get a receipt and cancel. • Use ticket – activate, validate, inspect, validate in other system. • Financial – book transactions (tickets) and book clearings. • Clearing – toward other traffic companies, other partners and other PTA´s. • Analysis – data to the analysis platform, real time analysis and fraud. • Administration – handle products, prices and users, handle odd transactions and overview quality of data. The whole setup builds on automized processes that requires a minimum of manual work and maintenance. In case of system failure technical staff is notified by an alarm and overviewing function. This solution opens up the possibility for the ferry operator to sell public transport tickets also when the customer is onboard the ferry, even if the best case scenario is that the PT ticket is bought at the same time as the ferry ticket. From a sales point of view, it is important to give the customer several possibilities to buy the PT ticket. It is first when the tickets are available through different sales channels that PT is a viable alternative to the car.
6	**Lessons learned – positive and negative aspects** Unfortunately, it was later discovered that the correct booking system of the ferry operator don't allow full integration without rebuilding large parts of the system. Therefore implementation has to wait until a new system is launched. Due to the problems with Covid-19 pandemic and the delay of investments implementation is put on hold. The module itself is however developed.

No.3	**Organisation**	
	BLEKINGETRAFIKEN	
1	**Title/Name of the method/service/product**	
	BETTER INFORMATION- INFORMATION SCREENS PLACED ON OUR BUSSES AND BOATS (BUS-TV).	
2	**Geographical area of application**	
	Blekinge	
3	**Phase of implementation**	
	○ Designed	⊗ Implemented
	○ In the implementation	○ Tested
4	**Main challenges addressed by this method/service/product**	
	The Main challenges - Better information: Blekingetrafiken information system Historically it has been a challenge to communicate and interact with our customers/passengers. The only way to reach them have been via traditional commercial channels as papers and advertisement at our bus stops. In our strive to increase the number of passengers commuting with public transport in Blekinge we have many challenges, one of them is to give our passengers a more pleasant and smoother travelling experience	

	– if we succeed with that the perceived time of travel will be shorter and in the long run – the number of passengers will increase. In the beginning of the project we identified several challenges, the most outstanding ones was • Technical implementation, several suppliers who shall deliver different parts of the system which is dependent on each other to function well. • Content. We needed a good balance of content to be able to attract all our passengers, not to bore them but also not to bother them showing things how can upset or can be political etc. • Variation, we needed variation of the content not to bore the passengers who travel with our buses ever day. Easy in the short run but in the long run it takes quite a lot of work to give the passengers a good and varied content. • Costs. To install 260 screens in 130 buses takes a lot of time and it is rather expensive. • Robust system - the time we are able to spend overviewing and managing this system when up and running are rather limited and therefore we are dependent on a well working system with very few break downs. • When installing this system we also added a technical solution giving our passengers possibility to use Wi-Fi when travelling with our busses. The speed is 2mbit/s and our goal was to give all the passengers this speed, independently how many passengers travelling for the moment. • 2017 we started a project with the goal to exchange our complete ticketing system. The result of this project partly change the traditional way of buying tickets and embarking our vehicles so we faced challenge to keep our passengers informed and updated about the ongoing process of the exchange and, when the new ticketing system is ready, inform and educating them with the help of a new information system.
5	**Description of the method/service/product** I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc. **Blekingetrafiken - information system – description and overview.** **Functionality and features**: Blekingetrafiken information system is a positioning controlled system containing of 260 screens showing real time information in 130 buses. We installed screens and modems. For the Wi-Fi we also installed separate modems. With a content management system (CMS) we control our part of what is shown at the screen, this CMS has features which makes it useful for us: **Flexible and easy to handle position controlling:** We are able to steer information to certain geographic places and spots, very convenient as real time information often are connected to certain places. **Dynamic and adaptable playing:** As parts of the content is based on position it has to get priority. The system choose what content shall be played based on priority and position. **Cost effective and easy to use:** Create playlists and connect them to places, time and actions are done relatively seldom but administration of the weekly or perhaps even daily content is also done and works smooth with the system. As the system save all media locally it works even if the internet connection is not working 100%. **The content displayed for our passengers contains of four different parts**: **Information about Blekingetrafiken**: our products, information about our traffic lines and buses, tariffs and payments, how to behave on a bus when it comes to acting towards other passengers, seat belts, trolleys, luggage – fostering our passengers so to speak. Also, amusements such as recipes, quiz, possibilities to tag us with photos, photos from the past vs today, **News and weather**: this part is managed/controlled via our supplier Geosignage who has signed an agreement with a national news channel who shows national and international news. The news part itself contains of two parts – ordinary news and financial news. Real time weather from cities all over the world is. **Commercials**: this part is managed via our supplier Geosignage who has signed an agreement with a company who work actively with selling commercial spots and is working in the south eastern parts of Sweden.

	Change information: Real time information showing all connecting buses which in reasonable time leaving from the next coming bus stop/hub. Very convenient for passengers who are about travel further with connecting buses. **Creating content – the process of creating content.** When we started this project, we made an agreement with our advertising agency doing all the work for our part of the content. This included producing movies, doing quiz, recipes, contests. We participated in meetings and brainstorming to find out what to show for our passengers. For approx. a year we worked like this. We came up with ideas and the advertising agency did all the work. Slowly we noticed the risk loosing the Blekingetrafiken-soul sort of got lost on its way from idea to final result so since one and a half year we are producing almost everything in house. So far, we have shown content on many themes for our passengers. For example: • Hometown knowledge. Did you know... • Now and then-theme. Several films showing historic photos showing the city or well-known known places/buildings/roads/buildings now and then • As we are able to geographically steer where content is shown we are showing welcoming information for passengers coming from the Stena Line-ferry. As they are entering the buss at line 6 coming directly from the ferry, they are able to watch information on the screens with the following message: Welcome to Karlskrona, we wish a pleasant stay and please use our buses and trains during your stay. Welcome back. This content is shown to the passengers about 400 meters from the ferry terminal. • When passengers are travelling to the Stena Line ferry terminal with bus number 6 we are again communication communicating directly to them. Well in time before they embark the bus we are showing a movie with the message: Thanks for your stay in Karlskrona, we hope you enjoyed your stay, welcome back. • Quiz focusing on local themes for example historical buildings. • Many different movies showing or teaching our passengers how to act and behave travelling with our vehicles. This can be how to place a trolley, how to use seat belt or that you should give your seat to an elderly person if there is hard to find seats.
6	**Lessons learned – positive and negative aspects** **Blekingetrafiken information system - Lessons learned** All and all we are very satisfied with the outcome and use of our information system. Although there are few things, we can put on our Lessons learned list: • When we started the project, an agency produced all the material witch we published on our screens. The movies were quality wise good but when leaving this kind of work to contractor it is a risk that the core or the sole disappear, and we think it did. • The information system we have is a solution from many different suppliers. It´s a well working solution but in case something goes wrong there are many suppliers to manage. As we are buying the system from suppliers, we are in the hands of them, both when it comes to support and in the fact that we have 3 parts agreement with Geosignage regarding the commercials. • When producing movies about happenings in the local areas we must be careful not doing commercial, there is a thin line between commercial and information about the society, markets etc, some of them is business driven from an organizer with commercial goals and some are not. • Do your own content – it will affect the result in a positive way. • All and all we are satisfied with our information system and with this system we have a well working communication channel speaking direct to our customers.

No.4a	Organisation	
	INNOBALTICA	
1	Title/Name of the method/service/product	
	OPEN MOBILITY PLATFORM - INTEGRATING AND STANDARDISING PUBLIC TRANSPORTATION DATA	
2	Geographical area of application	
	Two transport corridors: Karlskrona – Gdynia – Słupsk and Karlskrona – Gdynia – Starogard Gdanski using Stena Line ferries and feeding transportation lines in Pomorskie	
3	Phase of implementation	
	○ Designed	⊗ Implemented
	○ In the implementation	○ Tested
4	Main challenges addressed by this method/service/product	
	Main challenges - One of the challenges we see in relation to public transport is data integration and synchronization. Hardly anyone has transport data in the NeTEx format at the moment. The European Union requires its members to have data in this format. So far, there are few countries that have their files in this format, despite the guidelines on urgent preparation of files. This is another challenge to be faced. We want every operator who has entered his schedules to the portal to have them in the NeTEx format. Another challenge related to data is unification. Looking through GTFS files with data from several different organizers, one can conclude that there is a lack of compatibility between them. The mentioned format requires compulsory completion of some data columns. Unfortunately, data is entered differently. In addition, sometimes some data is not entered (usually because they are optional), and definitely should appear, e.g. facilities for disabled people in the vehicle or the presence of an elevator that helps to get to the bus stop. Another thing is that small organizers usually don't even have GTFS files, just for example they store them in a spreadsheet. Some also generate files with errors, so loading files to some website / application must be preceded by the elimination of mistakes.	
5	Description of the method/service/product	
	I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.	
	The goal of this stage of the project was to obtain as many timetables as possible from the regions covered by the project. The information obtained was used to fund the Passenger Portal and User Portal. The function of exporting data from the organizer's systems to the organizer's portal via the API has been opened. A module for periodic data import from the online service into the organizer's portal database was also put into use. Thanks to this, the organizer will have current data on timetables. Another activity that has been implemented as part of the project is the ability to export transport data to the NeTEx format. A module processing dynamic transport data in the SIRI standard has also been prepared. An implemented module and user interface on the website (Organizer / Administrator Portal) enabling displaying information about the current positions of vehicles and information displayed on information boards located at stops has also been given. The organizer on the website can find out if vehicle delays are expected on a line belonging to his network at a given moment. Those who have their own schedules but are in a condition that prevents data from being imported to the site have an alternative solution. The organizer will be able to manually enter the data. It is possible to add and edit lines, courses, calendars and stops. Such distributions can also be exported to the NeTEx format. As part of integration, we combine data from organizers with Pomorskie voivodeship, Blekinge Region and Stena Line.	
6	Lessons learned – positive and negative aspects	
	Aspects - In connection with our work on integration, we have gained various positive and negative experiences. We noticed that smaller organizers were much more eager to approach data integration. Besides, they volunteered to use the proposed solutions, which is why they did not have to be long persuaded to share their schedules. Qualitative data was difficult to get. Usually, small organizers had primitive data that was hard to integrate. It happened that you had to enter the data manually. As this is a new solution, this task was usually on our side. Dynamic data is another issue. Unlike static data, dynamic	

	data has often changed. To receive actual data in the organizer's portal about the location of the vehicle, it is necessary to update the data frequently. Usually, such data is refreshed every 30-60 seconds. Despite such frequent refreshing, it is impossible on the organizer's website to see the exact location in the subway. Tasks related to the NeTEx format were a difficult matter. The difficulty was that hardly anyone knew this standard and we did not have guidelines for choosing the version. As for the process of obtaining timetables for integration, it is quite a long task. It is associated with consultations with the organizers, waiting for an answer, signing various contracts, etc. These are necessary steps, so we recommend taking care of this task well in advance.

No.4b	Organisation	
	INNOBALTICA	
1	Title/Name of the method/service/product	
	OPEN MOBILITY PLATFORM - PORTAL FOR PT ORGANISERS: SET OF PLANNING AND ANALYTICAL TOOLS (AS A SERVICE)	
2	Geographical area of application	
	Two transport corridors: Karlskrona – Gdynia – Słupsk and Karlskrona – Gdynia – Starogard Gdanski using Stena Line ferries and feeding transportation lines in Pomorskie	
3	Phase of implementation	
	◯ Designed	⊗ Implemented
	◯ In the implementation	◯ Tested
4	Main challenges addressed by this method/service/product	
	Transport organizers in small towns usually have a rather primitive or outdated solution due to their modest budget. New, advanced software, services or portals are simply very expensive and buying such solutions for a locality with several lines is unprofitable. If such small organizers received a professional and modern solution, they could significantly improve the functioning of local transport. We also want to address our solution to organizers from large cities, which, unlike organizers from small cities, have modern solutions or can buy them because they can afford them. We want to offer them a product that would complement the solutions they have. First of all, they will get the chance to synchronize timetables with other transport organizers. Such a solution, which the organizers supply with their data schedules, would have even more positives (Passenger Portal). The most important thing we had to face was to hit the needs of the organizers. We would like as many organizers as possible to use our solution. For this reason, we have prepared such a solution so that it has functionalities that are useful, while the portal will not be too complicated.	
5	Description of the method/service/product	
	I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.	
	Another product under the project is the Organizer's Portal, which is to help organize the transport. It is a user interface in the form of a website, enabling the update of transport data by importing files. This solution is to facilitate the work of administrators and employees of the organization. People responsible for transport will receive a portal that will allow them to update or add new data about stops, lines and timetables. This will primarily help transport organizers who do not store transport data in digital form. On the other hand, organizers with their own system for storing transport data and enabling the export of data on lines, stops, timetables in the GTFS and NeTEx format can import their data to the organizer's portal. The option of downloading a file in the NeTEx format containing transport data for given lines and validity periods has also been added. Thanks to the synchronization function you can optimize the times of departures and arrivals of vehicles. The portal also allows you to observe how the area is covered with stops. With this function you can find out if there is any stop within a selected radius from a given point. This feature will help eliminate areas that, despite the population, do not have stops. By using the vehicle location, it is also possible to see where the means of transport is currently located. The transport	

	organizer using the portal can simulate the impact of changes in the timetable for a selected line ("A") for the time of transfers to other selected lines along the line "A". It is possible to check the change in departure time from the start stop and see the calculated times of transfers to other selected lines, in a selected hour. The portal can automatically set departure times from the initial stop (within a given range of hours) so that the total change time is minimized, assuming that the transfers cannot be shorter than the set time and that the travel rates cannot be more frequent than the set time interval. As part of the organizer's portal, a statistics tab is available, through which you can find out how much and what data has been entered into the portal. The user on the website will be able to register, log in or reset the password. In addition, a module was created whose purpose is authentication and authorization of access to the Organizer / Administrator portal. It is so that unauthorized persons do not have access to or even the possibility of modifying data on the portal. Thanks to appropriate solutions, people who will have access to the Organizer's portal will be assigned roles (system administrator, organization administrator, organization employee, technician) who have appropriate functionalities.
6	**Lessons learned – positive and negative aspects**
	When it comes to positive / negative aspects when implementing solutions, they are similar to those related to data integration. First of all, a lot of data that could be fed into the portal does not exist (e.g. Only some regions can benefit from observing the location of vehicles on the map, because other such data do not have) or is not available (organizers cannot provide it for various reasons). We also noticed the interest of transport organizers. We have received assurances that this product is needed and organizers will be happy to use it. We received questions about the possibility of presenting a solution that was being created at that time. In addition, interest was manifested in questions addressed to us and suggestions related to the portal. We were often asked about the presence of a function on our site. The suggestions were related to the functionalities that could be introduced. These proposals were very important to us. Thanks to them we have several ideas on how to expand the functionalities in the next stage so that they best meet the needs of transport organizers. From the topic of the portal functions themselves, we also see that the introduction of such software is not easy. It was necessary to carefully review each function so that everything was useful.

No.4c	Organisation	
	INNOBALTICA	
1	**Title/Name of the method/service/product**	
	OPEN MOBILITY PLATFORM - PORTAL FOR PASSENGERS: SET OF TRIP PLANNING TOOLS (AS A SERVICE)	
2	**Geographical area of application**	
	Two transport corridors: Karlskrona – Gdynia – Słupsk and Karlskrona – Gdynia – Starogard Gdanski using Stena Line ferries and feeding transportation lines in Pomorskie	
3	**Phase of implementation**	
	○ Designed	⊗ Implemented
	○ In the implementation	○ Tested
4	**Main challenges addressed by this method/service/product**	
	Traveling through Karlskrona – Gdynia – Słupsk and Karlskrona – Gdynia – Starogard Gdański transport corridors by public transport, contrary to appearances, was not such a simple task. Choosing the most suitable route so as to reduce interruptions related to transfers was the task of the traveller. As a result, a large proportion of people decided to resign in public transport for their own vehicles. This situation causes more congestion on the roads. Anyway, that's just one reason why people don't choose public transport. For example, another problem, if you travel a certain route for the first time, often travellers may have a problem finding the stop. We want to help solve these problems and offer travellers a travel planner who will include searched for a route from one city to another. The main challenge related to this is the introduction of such additional functions to make our application stand out from other travel-related	

	applications. There are regions that have or want to own tourist cards. Usually it happens that if someone has a tourist card, it is an ordinary, plastic card that you have to carry with you to use it. The best (most convenient) solution for a tourist would be to give the possibility of using an electronic "card" so that the tourist would not have to carry another card with him, but that he could prove using the smartphone application that he has the right to use / enter the given attraction.
5	Description of the method/service/product
	I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.
	Passenger Portal - A travel planner was created as part of the project, which aims to facilitate the movement of travellers (mapping a route from one point to another). The passenger using the portal can find out about the possible connections between points A and B located in the province or region for the selected day and range of hours, including information on the total travel time, number of transfers, departure times of subsequent connections, types of transport. You will also be able to see the suggested routes on the map. The portal includes, among others, a module integrating the Open Trip Planner software with a database of stops, communication lines, timetables, etc. A smartphone application (for IOS and Android) that performs the travel planner's information functions has also been put into use. In addition, you can purchase a ticket for such a route by entering the link to an external sales service. The application also has the option of planning a route in advance, and then saving it in the phone's application memory. This route can then also be made available to the selected person via e-mail or application from a mobile device. The passenger has the option of showing the code with information about the right to travel to the controller in public collective transport, while the controller can verify the AZTEC code presented by the passenger on the display by scanning or manually entering (if the code cannot be scanned) in order to check whether the passenger is entitled to travel. We gave the opportunity to integrate the planner with the tourist card, which allows you to use the services offered under the tourist card, such as, for example, admission to the museum. We will also be ready for a situation in which another region / regions would decide to implement their own card. Having installed the application you will be able to receive the signal of beacons sending transport information.
6	Lessons learned – positive and negative aspects
	We have noticed some aspects of the tourist card. On the one hand, we believe that this idea will interest regions that will ensure willingness to cooperate. On the other hand, you may come across a problem with the fact that some can very slowly get to work, despite the desire to have the card as soon as possible. The Open Trip Planner implementation was also a big challenge. OTP's main advantage was that it is open source. In addition, it is a commonly used solution. Despite previous problems, Open Trip Planner was implemented. We believe that this solution, although probably not the easiest to implement, is effective and gives a satisfactory effect. We also tackled the issue of buying tickets. As we did not have tickets in our plans, we at least wanted to indicate the place where the ticket could be purchased. We decided that the description of the route will have a link that after clicking will transfer to an external sales service. Contrary to appearances, preparing such an application is not an easy task. There are quite a few applications on the market to help with traveling. In this situation, the application must stand out to convince users. We believe that thanks to all these elements that make up the passenger portal, we have a product that is more than just an ordinary planner.

No.4d	Organisation	
	INNOBALTICA	
1	Title/Name of the method/service/product	
	OPEN MOBILITY PLATFORM – BEACONS: APPLICATION AND IOT DEVICES WORKING FOR DEDICATED PASSENGER INFORMATION (AS A SERVICE)	
2	Geographical area of application	
	Two transport corridors: Karlskrona – Gdynia – Słupsk and Karlskrona – Gdynia – Starogard Gdanski using Stena Line ferries and feeding transportation lines in Pomorskie	

3	Phase of implementation	
	○ Designed	○ Implemented
	○ In the implementation	⊗ Tested
4	Main challenges addressed by this method/service/product	
	Main challenges - We also see the potential in beacons, which can certainly help in traveling. Beacons can help you find a stop. For example, suppose you find yourself in a place that is within reach of a beacon. Let's assume that we have an application (Interconnect app) in our smartphone that could receive the signal sent by this beacon. You can install such a beacon at the bus stop and send a signal to the smartphone user who has the application receiving the beacon signal and has agreed to receive signals that it is near the "A" stop, in the near future the following public transport buses leave, nearby individual tourist attractions etc. In connection with this functionality, we see some challenges. We treat this product as a kind of trial. If the solution works, we plan to introduce more beacons. For this reason, the challenge is to properly select the first prototypes (with appropriate signal strength, durability, price, quality, etc.). No less important is the choice of mounting location. All this so that there is no problem with connectivity. In addition, a good installation location will reduce theft and vandalism.	
5	Description of the method/service/product	
	I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.	
	Beacons - The project also involved the introduction of specially programmed beacons that help passengers travel. It is a project of small energy-saving hardware modules enabling the location of a passenger near a stop using Bluetooth technology. They will be available in both rechargeable and battery-operated form. In the future, they could be mounted at different types of stops and using different data sources. The designed prototypes were subjected to various types of tests (optimization, endurance, etc.) in order to prepare in the future for their implementation at more stops. In addition, a housing design for such a beacon was also prepared to make it resistant to adverse weather conditions. As part of this part of the project, two beacons were installed in two locations. They send information to the passenger on the phone when the passenger with the installed application (Interconnect app) is in the area of operation of the beacon. Thanks to this, the passenger will find out what stop is nearby, what lines are running and what are the nearest departures of vehicles. The technician operating the beacons, thanks to a specially created application (only authorized persons will have access to it), has the ability to view the beacon, in addition, he is able to adjust the signal strength or check the power supply (Functions available when the technician is within the range of operating beacons). The technical application works on smartphones that have access to the network and running Bluetooth.	
6	Lessons learned – positive and negative aspects	
	When it comes to beacons, we find that they can support a lot of applications that could work in transport. On the other hand, we also see some restrictions. One of them is coverage. Under favourable conditions, beacons send a signal over a long distance. It is different mounting them in a city where obstacles reduce range. Mounting a beacon to vehicles is another matter. We assumed that it would be possible to send vehicle information about vehicle locations with the help of beacons. The vehicle moves at a certain speed and the range of the beacons is limited. Because of this, the traveller would have problems with catching, even for a moment, the signal from the vehicle. In addition, while assembly would be trouble-free on buses, it is troublesome on trains as it would involve a lot of formalities related to train testing. Choosing beacons is also associated with some dilemmas. The majority of phones have Bluetooth Low Energy 4.0, while phones with BLE 5.0 are slowly entering the market. Beacons using BLE 5.0 have a better range, but smartphones with BLE 4.0 do not receive its signal. Therefore, you have to choose between more modern and more popular technology.	

No.5	Organisation	
	HIE-RO	
1	Title/Name of the method/service/product	
	MULTI-STAKEHOLDER PLANNING AND MONITORING TOOL FOR PUBLIC TRANSPORT SERVICES	
2	Geographical area of application	
	Can be used anywhere on any PC where recent Microsoft Excel versions are installed	
3	Phase of implementation	
	◯ Designed	◯ Implemented
	⊗ In the implementation	◯ Tested
4	Main challenges addressed by this method/service/product	
	The current public transport systems hardly meet the customer´s expectations as regards simplicity, quality, density, frequency and general attractiveness. Consequently, people often use the car instead of trains or buses. Urban and regional public transport planners and operators are facing tremendous dynamics and complexity in various fields and thus service provision is challenged from different angles, such as: Climate change and environmental debates, New vehicle technologies, Mobility-as-a-service (MaaS) and new forms of urban transport and mobility, Demographic change and changing demand towards new forms of transport, New planning systems, Need for new governance models and for (cross-border) cooperation to improve public Transport. Against these dynamic developments, it is difficult for transport planners to keep track of changes, new and emerging markets and transport solutions, and in particular to identify where a city or region can be positioned in this phase of transition. Therefore, this indicator-based self-evaluation tool shall represent an easy-to-use tool to support public transport planning in their areas by helping, first, to assess the current public transport performance based upon selected key transport indicators and, second, by monitoring the indicator performance over time as well as, third, by comparing the area/city with other areas and cities.	
5	Description of the method/service/product	
	I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.	
	This product can be described as an indicator-based self-evaluation tool to be used for assessing the current public transport performance based upon selected key transport indicators, for monitoring the indicator performance over time as well as for comparing the city with other cities and regions. The tool should also indicate the strengths and weaknesses of the transport system of the city, thereby helping decision makers to identify fields of intervention in the public transport domain. This tool is based on recent versions of Microsoft Excel running on both Windows and MacOS computers. The coding language used is Virtual Basic. Therefore, the MS Excel functionality for executing Macros needs to be enabled while using the tool. The tool will provide the following functionalities: • **Comparison** of the transport system performance based on selected key public transport indicators over time, across cities and regions in tabular form as well as in diagrams. The user shall be able to select the indicator he is interested in, as well as the cities or regions to compare with. • **Intervention fields**: The tool will also aggregate indicator performance to intervention fields. Intervention fields might be sustainability, social inclusion, traffic and safety, efficiency and others. The final list of intervention fields will be discussed and agreed with the the project partners during the testing phase. For each field of intervention, the tool will comprise approx. five key performance indicators. • **Upload mask**: Provide an upload mask allowing the user to enter new or update existing relevant data for his city in a convenient way, and options to add new cities. The idea being that each user	

	will enter the relevant data/indicators for his city. Data for selected comparison cities, however, will be compiled as part of this assignment. • **Print and Export**: Print and export tables and diagrams, so that comparison results can be copied into and used in other documents and software environments. Further features of the excel tool include: - the possibility to add and select (further) indicators and cities in an easy manner. - it will be possible to enter target or reference values for selected indicators - the tool will consist at least of four parts, which are the database table, the indicator table, the upload mask and the analysis and comparison part (Figure 2). The first two shall be hidden to the user, while the latter two shall be visible. - the analytical part will present the comparisons in different types of graphs and visualisations, such as line and spider charts and others
6	**Lessons learned – positive and negative aspects** Positive • With the help of the programming language Virtual Basic, various data operations and visualisations can be performed that go beyond the common use of macro-free Excel tables and data bases. At the same time, using the Virtual Basic code enabled the developer to provide an easy-to-use tool with a clear graphic representation and labelled buttons to make this tool as self-explanatory and intuitive as possible. • The speed of data operations including the simultaneous representation of the indicators in graphs is fast. Memory usage is minimised. • The feedback during the partner meeting, where this tool has been presented, was positive and some project partners requested a version for testing. Negative • The tool has been programmed on Microsoft Office Excel within a Windows operating-system-environment by applying the advanced ActiveX-Functionalities. Tests within MS Excel on a Mac Operating System revealed that certain adjustments needed to be made, since ActiveX-Functionalities were not compatible to both platforms. The partly reprogramming of the code has cost additional time and efforts.

No.6	**Organisation**	
	HANSEATIC CITY OF ROSTOCK	
1	**Title/Name of the method/service/product**	
	INTERCOMBITICKET PROMOTIONAL CAMPAIGN FOCUSING ON OLD AND NEW TARGET GROUPS	
2	**Geographical area of application**	
	Rostock City and Greater Rostock Area and Guldborgsund Municipality	
3	**Phase of implementation**	
	○ Designed	⊗ Implemented
	○ In the implementation	○ Tested
4	**Main challenges addressed by this method/service/product**	
	The main challenges that were addressed by the enhanced method are the following: - The number of Danes and Scandinavians visiting Rostock and surroundings is still relatively low compared to the numbers of Germans visiting Guldborgsund and DK.	

	- The ferry link Rostock-Gedser is traditionally dominated by travellers using the car as transport mean as well as by logistics transport carried out with accompanied trailers (trucks). The number of foot passengers respectively those travelling by public transport from and to the ports of Rostock / Gedser is still very low although much was done in the last years to improve the connection for this target group. - Moreover among the foot passengers using this ferry connection the diversity of the user groups is still very low. Apart from business commuters travelling mainly and Sunday to Denmark and back to Germany on Friday, most of the foot passengers using the public transport on the link are summer tourists from Rostock, who are making a day trip to Nykøbing F / Gedser. Many of them using the InterCombiTicket (valid for bus in Denmark, ferry and bus/ city train/ tram in Rostock), which was launched in 2011 in the framework of The INTERFACE project, which was co-financed by the Interreg IVA South Baltic Programme 2007-2013. Considering the above the main goal of the promotion campaign was on one hand to further enhance the number visitors using public transport respectively travelling as foot passengers on the link Rostock-Gedser-Nykøbing F and on the other hand to promote the connection to new target groups.
5	**Description of the method/service/product** I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc. A new comprehensive promotional campaign around the InterCombiTicket and the public transport connection between Guldborgsund and Rostock was carried out in 2019. The campaign started in May and was continued until end of the year. The campaign addressed foot passengers from different domains (business, education, culture, tourism) and it included many different tools and instruments: - The InterCombiTicket website and also the website of Scandlines was updated. Both websites show the new film that was produced in Interconnect to promote the connection especially towards young people. See: (https://www.intercombi-ticket.de as well as https://www.scandlines.de/tickets-und-tarife/special-tickets/intercombi-ticket). - 140 city light posters in Rostock were used for promoting the public transport connection Rostock-Gedser-Nykøbing. Target Group are local citizens and tourists. - To specifically address students a promotion of the public transport connection Rostock-Gedser-Nykøbing and the InterCombiTicket was carried out on the screens of the Mensa Rostock in summer 2019. A short teaser was produced that was shown on the screens for 6 weeks. Students had the opportunity to get cheaper prices for the ticket from July-December 2019. As a result, about 100 Tickets have been sold specially to students. - Different further cross-border exchange activities between school classes, sport clubs and artists were carried out. On these exchanges the public transport connection was promoted and the travel costs were partly co-financed by Interconnect. - A promotion of the connection towards German and Danish businesses was carried out at “Rostock Lieferantentag” in April 2019 and “Hansesail meets Business Forum” in August 2019. On the event the public transport connection Rostock-Gedser-Nykøbing and the InterCombiTicket were promoted on a roll-up as well as via the above mentioned Interconnect movie that was shown to participants inside shuttle busses that operated during the whole event to transport participants between the different venues (event halls, hotel, restaurant, port, station etc.). - Another new element that was introduced was that the promotion of the public transport connection Rostock-Gedser-Nykøbing and the InterCombiTicket was widened to the Greater Rostock area. The area around Rostock is a very rural area and therefore characterized by “disadvantaged community groups“. For preparing these promotion actions around Rostock the Regiopole Initiative, the Public Transport Association Warnow and the Regional Planning Association Region Rostock were deeply involved in the campaign. The updated InterCombiTicket folders were

	finally spread on 370 places (hotels, public places like libraries or museums, companies, tourism offices, etc.) in and around Rostock.
6	**Lessons learned – positive and negative aspects** The lessons learned can be divided into positive and negative aspects: Positive aspects: - The promotion of the connection and along with it the cross-border ticket could be widened to new target groups. Many people that were addressed during the different measures articulated an interest to use public transport / travel as foot passenger from Rostock to Guldborgsund or the other way around. Negative aspects and lessons learned: - In April 2019, Scandlines enhanced the ticket prices for foot passengers including the prices for the InterCombiTicket significantly. In spite of all promotional measures that were taken in Interconnect the number of sold InterCombiTickets decreased in 2019. This has never been the case before. In contrast, whenever the promotion of the ticket has been intensified the number of sold ticket increased significantly. - The promotion for the InterCombiTicket / PT transport connection Rostock-Gedser on the Danish side needs to be intensified. Still the proportion of German visitors traveling to Denmark is more than 90% in comparison to Danes visiting Rostock (below 10%). Accordingly there is still a lot potential unused. - The promotion of the connection should also include better explanation especially for new customers on how to use the public transport connection and what is to be observed (where to change trams or busses, where can tickets be purchased, etc.). - In addition to the local promotion, the PT connection, the InterCombiTicket and along with it the destination Rostock-Guldborgsund should be promoted directly in further potential source markets (e.g. Berlin, Kopenhagen, Malmö – places with public transport affine people and with many people who do not own a car).

No.7	Organisation	
	HANSEATIC CITY OF ROSTOCK	
1	**Title/Name of the method/service/product:** **CHANGE / UPDATE OF THE BOOKING SYSTEM/ PROCEDURE OF THE INTERCOMBITICKET INCLUDING WIDENING OF ITS VALIDITY TO A NEW BUS ROUTE BETWEEN GEDSER AND MARIELYST ON GULDBORGSUND SIDE.**	
2	**Geographical area of application** **Rostock City and Greater Rostock Area and Guldborgsund Municipality**	
3	**Phase of implementation**	
	○ Designed	⊗ Implemented
	○ In the implementation	○ Tested
4	**Main challenges addressed by this method/service/product** The main challenge that was addressed by the service: The InterCombiTicket (All-in-one ticket for the connection Rostock - Gedser - Nykøbing F including bus, tram city train and ferry) was introduced in the INTERFACE project in 2010. A separate booking system just for the ticket was launched in the INTERFACE PLUS project in 2011. The ticket was bookable on the InterCombiTicket website www.intercombi-ticket.de.	

	As a consequence of the introduction of the EU Directive on data protection in May 2018, this "old" booking system required an update as it did not consider the requirements of the new regulation accordingly. As the costs for an update of the existing system would have been too high, the Interconnect project was used to launch a new booking system / procedure or the ticket. The change of the booking system was also used to overcome another challenge that was connected with the old booking system, namely the high administrative efforts to maintain a separate booking system just for the InterCombiTicket (the system is operated and maintained by Public Transport Association Warnow).
5	**Description of the method/service/product** I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.
	The old booking system of the InterCombiTicket was switched off in April 2019. At the same time the ticket purchase function for the InterCombiTicket was integrated into the existing local / regional public transport booking system of Public Transport Association Warnow, which is used by the local transport operators in and around Rostock (especially Rostocker Straßenbahn AG and Rebus). The InterCombiTicket can now be booked as mobile ticket via the Verkehrsverbund Warnow App. Users have to register before using the mobile app and then can purchase the ticket by Credit or EC/ Maestro card. See also further information under: https://www.verkehrsverbund-warnow.de/tarif-tickets/ticketuebersicht.html#schueler Initial problems with the function to pre-book the InterCombiTickets on days before trip starts, were meanwhile solved. The daily ticket is now bookable 10 day before start of the trip. Along with the update of the booking system the validity of the InterCombiTicket has been enlarged to a new bus route on the Danish side, that was launched in summer season 2019 operating from Gedser Port to the well know cottage area of Marielyst (and back). This area is visited esp. by many Germans from Berlin area (where more than 60% of inhabitants do not own a car). This group is another very interesting target group for improved cross-border public transport services and foot passenger offers.
6	**Lessons learned – positive and negative aspects**
	The lessons learned can be divided into positive and negative aspects: Positive aspects: - The integration of the InterCombiTicket into the existing booking system of the Verkehrsverbund Warnow ensured the further availability of the ticket (also considering the stricter legal requirement resulting from the EU Directive on data protection). - As a consequence of integrating the ticket purchase into the existing running ticketing system of Public Transport Association Warnow the administrative efforts connected with maintaining a separate booking system just for the InterCombiTicket could be significantly reduced. - The mobile booking function (esp. by smartphone or tablet) made the ticket purchase more comfortable and easy especially for local citizens of Rostock, which are using the Public Transport Warnow App regularly. - Enhancing the validity of the InterCombiTicket to the new seasonal summer bus between Gedser and Marielyst is a very good example for improving the performance of the cross-border public transport service in Rostock-Guldborgsund area. As a consequence new potential target groups can be addressed and it further increases the attractiveness of the cross-border public transport connection as a whole. Negative aspects and lessons learned: - In April 2019, Scandlines enhanced the ticket prices for foot passengers including the InterCombiTicket significantly. In spite of all promotion measures that were taken and that the booking procedure was further updated in Interconnect the number of sold InterCombiTickets decreased. - The purchase of the InterCombiTcket is now only possible when being registered / using the mobile app of Pubic Transport Association Warnow. This is attractive especially for local Rostock citizens

	and all those people which know/ regularly use the app, but especially for tourists that do not (want to) use local mobile applications during their holiday the situation has rather deteriorated. The same applies for (mostly older) people, which are not used to book / purchase public transport tickets via mobile applications, which concerns especially in Germany still a huge number of potential customers - The purchase of the ticket by an alternative way (beyond the mobile app) is not possible anymore. Efforts to re-launch an alternative way / offer to book / purchase the ticket (e.g. by selling it in a customer's Center of Rostocker Straßenbahn AG or in the Tourist Office Rostock), like it was possible some years ago, were not successful so far. The main reason for keeping the ticket purchase via the mobile app as the only option, is, because offering further alternatives would in turn again increase the maintenance efforts and costs of the ticket administration. The number of additional tickets that could potentially be sold by an alternative way are not high enough to balance to costs for the additional administrative efforts. Considering the above, one conclusion is, that future promotion activities around the InterCombiTicket and the PT connection Rostock-Gedser-Nykøbing needs to be connected with a promotion of the mobile app as such (and how to use it).

No.8	Organisation	
	GULDBORGSUND MUNICIPALITY	
1	Title/Name of the method/service/product	
	BICYCLE FLOWER – BICYCLING ROUTES GULDBORGSUND – ROSTOCK	
2	Geographical area of application	
	Route Guldborgsund – Rostock	
3	Phase of implementation	
	◯ Designed	⊗ Implemented
	◯ In the implementation	◯ Tested
4	Main challenges addressed by this method/service/product	
	There is a need for more mobility options between Hanseatic City Rostock and Guldborgsund Municipality. There is a large and diverse public and private cooperation across the Baltic Sea between Guldborgsund Municipality and Hanseatic City Rostock and surroundings. There is also a large tourism cooperation, for one-day tourism and for tourists visiting for longer periods. Private cars are the main transport solution used by tourists. Public bus transport services are promoted by public authorities and ways of improving this service and attracting more passengers are ongoing activities. As alternatives to cars and bus service there is a need for strengthening the bicycling as a mobility option for tourists crossing the Baltic Sea and to provide more attractions for the tourists. Both in Guldborgsund Municipality and in Rostock area there are active bicycle associations working with bicycle routes in close cooperation with tourist organisations. There are already the Copenhagen – Berlin Bicycle Trail crossing the Baltic Sea, however, there are no framework to support local or regional cross-border bicycling.	
5	Description of the method/service/product	
	I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.	
	To improve the above described situation a catalogue of ten one-day bicycle routes have compiled of seven bicycle routes in Guldborgsund Municipality and three bicycle routes in the Rostock area.	

	The catalogue has the name the **Bicycle Flower.** The name arrives from how the routes drawn on a map looks like a flower. One Guldborgsund route is the flower stem, xix Guldborgsund routes are petal leaves, and the three Rostock-routes are leaves at the flower stem base. The 50 page-catalogue includes descriptions of each route and options for overnight stays, eating places, shopping, bicycle renting and attractions. All ten routes have connections to the Berlin-Copenhagen bicycle route and may act as local routes to this international route. The catalogue is also available on the homepage https://cykelblomsten.dk. It is two local bicycle associations on both sides of the Baltic Sea that has produced the Bicycle Flower: Sundgruppen in Guldborgsund Municipality and Allgemeiner Deutscher Fahrrad-Club (ADFC) Regionalgruppe Rostock in Rostock.
6	**Lessons learned – positive and negative aspects**
	It is expected that the Bicycle Flower will increase the cross-border bicycling tourism and bringing more tourist across the Baltic Sea without driving in cars. It will support more cooperation among the local partners involved, first of all ADFC-Rostock and Sundgruppen, but also among local and regional tourism actors in general. Tourism on bicycling will give the tourists much more in-depth knowledge about local places, attraction and nature, and increase cross-border understanding and supporting further cooperation. Local distribution of the catalogue was part of the joint activity. However, still there is a task of spreading the new bicycling opportunities and develop the tradition of bicycling tourism; for a one-day tours and for a longer stays.

No.9	**Organisation**	
	GULDBORGSUND MUNICIPALITY	
1	**Title/Name of the method/service/product**	
	CONNECTIVITY OF RURAL AREAS - RURAL HINTERLAND BETTER CONNECTED TO INTERCHANGE POINTS	
2	**Geographical area of application**	
	Rural area of Guldborgsund Municipality	
3	**Phase of implementation**	
	⊗ Designed	○ Implemented
	○ In the implementation	○ Tested
4	**Main challenges addressed by this method/service/product**	
	Guldborgsund Municipality is a typical rural municipality with 61.000 inhabitants, and where one third – 20.000 inhabitants – are living in the main city Nykøbing Falster. Five towns have populations between 1.000 and 5.000 inhabitants, and around 20.000 citizens live in rural areas, i.e. villages and settlements. For people living in Guldborgsund Municipality Nykøbing Falster is the main interchange point for travels in the north-south transport corridor; Scandinavia, Copenhagen, Rostock, Berlin. The transport corridor is used by local commuters working in the Copenhagen area, as well as by tourist traveling between Sweden, Denmark and Germany. However, for people living the rural areas of Guldborgsund Municipality there is a lack suitable mobility solutions to the interchange point matching the actual needs. The traditional public bus services are inadequate for the actual mobility needs, and are at the same time very expensive for the municipality. The fine grid of bus routes with frequent departures are matching the urban areas, but not the sparsely populated rural areas, where only a few daily bus departures have the required number of passengers for a sound service. On the other hand the lack of such reliable, affordable and frequent service – also for outer lying hours – are necessary if local people not should depend on the alternative of one or two cars at each household, resulting to a further shift from public transport towards private cars.	

	This challenge of insufficient public transport service from rural areas to interchange points is probably a general challenge for the South Baltic Programme area.
5	**Description of the method/service/product** I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.

To solve the above described challenge Guldborgsund Municipality has started a comprehensive process for developing new and sustainable mobility solutions fitting the rural areas of the municipality. In this process three rural areas has been selected to serve as pilot areas: Guldborg village and surroundings, Horbelev village and surroundings and South Falster area.
New or enhanced mobility solutions were identified and selected in dialogue between the municipal administration, an expert consulting company and local citizens from the three rural areas through Facebook-dialogue, workshops and a questionnaire distributed to the entire municipality, but mainly to the three rural areas.
Identified mobility solutions were within three overall types:

1. Improved public bus service
2. Improved facilities for bicycling
3. Car sharing / car pooling

1 Improved public transport / bus service

- Free busses. This already exist for a specific route in the municipality, where a pilot concept reduces the cost significantly, and the lost bus fares are any way of minor size. The concept may be expanded.
- Improved bus stop sheds. This will provide shelter and make it more attractive and safer to wait for the bus. Timetables and lighting will add to the value. Bicycle parking close to the bus stop will make it easier to use the bus in combination with bicycles.
- Additional bus service during summer season. This will both serve the tourist and the locals (this service has already been realised).
- Event busses. Busses arranged for specific larger public events, typical for outer laying hours.
- Call busses / call taxi. These have been available for a few years subsidised by the municipality, and are much cheaper than a taxi, but more expensive than the bus.
- More options for bringing bicycles at the bus – allows for combination travels and expand the options for bicycling.

2 Improved facilities for bicycling

- More and better connected bicycling paths. The basic investment that can lead to more commuting and other daily transport on bicycle.
- Expanded lighting along biking paths / routes. Makes a more safety travel.
- Free testing of electrical bicycles. The municipal can provide electrical bicycle for free testing for a limited period to make citizens more familiar to this option and expand the use of bicycles, i.e. for longer distances.
- Better and unified sign boards – to support more safe travels for tourists and locals.

3 Car sharing opportunities

These mobility solutions may reduce the need for private cars in rural areas, and may involve combinations travels with e.g. bicycling.

- Joint driving / car pooling in private cars based on an online platform developed by the municipality with options for serving specific rural areas.
- Commuting parking places. Centrally located, e.g. close to a highway entrance, where you park your car or bicycle and drive together with others in private car. The municipality already has two such commuting park places.
- Village car. A car owned by the village community or by a private company that place a renting car in the village based on a village agreement.

6	**Lessons learned – positive and negative aspects**
	Guldborgsund Municipality has started a long journey for improved and sustainable mobility solutions for rural areas. The challenges are many. • The legal framework of municipalities and the state aid rules set limitations of to what extent a municipal is allowed to provide mobility options. • The public transport in Denmark is managed by regional public companies that set out specific rules that limits flexibility and cost efficiency of – mainly – bus service. • The comfort of private cars. • Traditions and lack of knowledge of alternative mobility solutions. • Many solutions require large initial investments. Guldborgsund Municipality has started the journey and some of the proposed mobility solutions have been implemented, most recently the summer bus Gedser – Marielyst – Nykøbing servicing particular the cross-border passengers at the Rostock – Gedser ferry.

No.10a	**Organisation**	
	GULDBORGSUND MUNICIPALITY	
1	**Title/Name of the method/service/product**	
	NEW AND ENHANCED BUS SERVICES (FEEDER LINES) - SUMMER BUS GEDSER – MARIELYST	
2	**Geographical area of application**	
	Southern part of Guldborgsund Municipality, Denmark	
3	**Phase of implementation**	
	○ Designed	⊗ Implemented
	○ In the implementation	○ Tested
4	**Main challenges addressed by this method/service/product**	
	The Marielyst Tourist Resort is a white beach area with a large number of summer cottages (more than 8.000) also used for rent-out to national and international tourists. More than half of the international tourists are from Germany, and especially Germans from Berlin area, where more than 60% of inhabitants do not own a car. Most Germans and other European tourists will travel to Marielyst via the Rostock-Gedser ferry connection. However, the normal bus connection from Gedser to Marielyst goes via Nykøbing and provide a long and time-consuming deviation. This situation may reduce the number of international visitors, it may make them choose to bring private car or it may reduce their holiday time with cumbersome travels.	
5	**Description of the method/service/product**	
	I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc.	
	Summer Bus from Gedser Ferry Port to Marielyst Tourist Resort; route 743 Based on local demands and specifically from the tourist organisation / office in Marielyst a dialogue and local meetings have been held to develop a summer bus for the Gedser – Marielyst route. The bus should particularly take care of the tourist arriving via the Rostock – Gedser ferry route. It should also provide better options for tourist in Marielyst to visit the Gedser area and the Gedser Tip, the southern-most point in Denmark. The route and time plan was decided in cooperation with local stakeholders and based on their knowledge of what the tourists need and want. As part of the local involvement it was agreed that local stakeholders should take part in the promotion of the summer bus, e.g. place the posters about the summer bus anywhere tourists (Danish, Germans, others) may pass by at Marielyst, Gedser and Nykøbing.	

	The bus line was launched in 2019 and was operating for six weeks in week no. 27 – 32; end-June and all of July. It had seven daily departures, and the timetable was uniform throughout the week. The timetable was matching the ferry arrival and departure in Gedser Ferry Harbour. The summer bus was operating as an ordinary Movia (regional public transport company) and Arriva bus (private operator) like all other busses in Guldborgsund Municipality. The municipality finance this bus service like any other local bus route, and bus fares follow the normal price setting. A special add-on is that the recent upgraded Intercombi-ticket covering the total travel between Rostock City and Nykøbing Falster also covers the summer bus route 743. The bus route 743 will also operate for six weeks in summer 2020. Based on the passenger numbers during 2020, a decision will be taken autumn 2020 whether it should be continued 2021. A passenger counting during one week in 2019 showed that for all six weeks 1.032 passengers entered the bus. This equals to 3.5 passenger per round trip. Hopefully, more passengers will use it during summer 2020; because, as the bon mot says: "use it or lose it". The summer bus was promoted in the tourism catalogue Visit Lolland-Falster, on posters along roads and in town and in the local newspaper. The new summer bus between Gedser and Marielyst is a very good example for improving the performance of total the cross-border public transport service in Rostock-Guldborgsund area. As a consequence new potential target groups can be addressed and it further increases the attractiveness of the cross-border public transport connection as a whole.
6	**Lessons learned – positive and negative aspects**
	The Marielyst tourism organisations and the visiting tourists did receive the new public transport service very well, and complimented this new mobility opportunity, that made them save travel time and providing more options for their visits around in the summer land. However, the number of passengers was not very high; though still resembling the passenger number of many other bus lines servicing Guldborgsund Municipality rural areas. The challenges of introducing new public transport service include clear and comprehensive marketing so that potential passengers know about the new service. Tourists are planning their holiday on traditions and experience from last years. Therefore, the service also requires regularity so that passengers can plan new holidays and daily activities based on the service.

No.10b	**Organisation**	
	KLAIPEDA PT AUTHORITY	
1	**Title/Name of the method/service/product**	
	NEW AND ENHANCED BUS SERVICES (FEEDER LINES) – CICO: CHECK IN/CHECK OUT SCHEMA FOR A REGIONAL E-TICKET SYSTEM	
2	**Geographical area of application**	
	Klaipeda region – Klaipeda City and district municipalities, Kretinga district municipality	
3	**Phase of implementation**	
	○ Designed	⊗ Implemented
	○ In the implementation	○ Tested
4	**Main challenges addressed by this method/service/product**	
	Technical implementation in vehicles, preparation of each route prices matrixes and dissemination to user.	

5	**Description of the method/service/product** I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc. Regional PT e-ticket, based on CICO (Check in / check out), is a new product for daily commuters on regional (feeder) bus lines. Prices depends on distance. Advantages comparing to traditional paper ticket from bus driver cashier: 1) time saving (validation takes 0.5 sec vs up to 1 min via cashier); 2) no need to have cash; 3) due time saving more reliable timetable.
6	**Lessons learned – positive and negative aspects** Negative – need to train customer skill validate e-ticket card more than one time. Positive – cost benefit analysis allows provide best price to customer .

No.11		
	Organisation	
	BLEKINGE INSTITUTE OF TECHNOLOGY	
1	**Title/Name of the method/service/product**	
	MULTI-STAKEHOLDER PLANNING MODELS FOR X-BORDER AND REGIONAL PUBLIC TRANSPORT	
2	**Geographical area of application**	
	South Baltic Region	
3	**Phase of implementation**	
	○ Designed	○ Implemented
	○ In the implementation	⊗ Tested
4	**Main challenges addressed by this method/service/product**	
	To enhance planning for a sustainable development of regional and x-border public transport that includes all aspects of sustainability and allows for a transition that would be fast enough to prevent unsustainable societal development (e.g. global warming, resource depletion, and distrust in society).	
5	**Description of the method/service/product** I.e. functionality, (technical) elements/components, aspects, desired impact, implementation process, stakeholders involved, etc. The two theoretical models both use the Framework for Strategic Sustainable Development – FSSD as guidance, which, for example, incorporates eight principles that defines a sustainable future. The first model enhance the creation of; (A) a vision for, and a common understanding of, sustainable x-border and regional public transport; (B) analyses of the current reality with regards to the vision; (C) solutions towards the vision; (D) a plan of compelling measures for how to get to the vision. The second model enhance the adoption of a bright idea for sustainable development into existing plans for sustainable x-border and regional public transport. The models are intended to be used by stakeholders that plan for x-border and regional public transport and will hopefully contribute to a sustainable development of x-border and regional public transport, firstly within the South Baltic Region, but can also be used in other regions globally.	
6	**Lessons learned – positive and negative aspects** One important aspect is that workshops/discussion deployed within the models would preferably be conducted in a language that participants are confident with in order to have as fruitful discussions as possible. It is also important that stakeholders can represent different competence areas with x-border and regional public transport i.e. resources, spatial planning, technical aspects, and governance, as well as different means of transport.	

	Using these two methods increases awareness about strategic sustainable development, about the need of a holistic perspective when working with solutions for sustainability, and also about the urgency to take actions for sustainability.

For more specific or detailed information on new and enhanced methods (set of new/enhanced methods, services and products for no-car passengers designed and tested in regional and cross-border travels both in and between the SB partner areas) reader might reach the following additional project documents:
4.1 Quality analysis of the public transport systems;
4.2 Benchmarks for the current public transport systems;
4.3 Feasibility study for the two pilot PT lines in the regional system;
4.5 Mobility in rural areas; Guldborg, Horbelev and Sydfalster;
4.6 Study visits for public transport system stakeholders in the partner areas;
4.7 Research publications summary.

INTER CONNECT

One ticket to the future

ACADEMIC RESEARCH

SUMMARY

Summary of A process and a Catalogue of Solutions for Sustainable Cross-Border and Regional Public Transport

The current public transport offers in the South Baltic region seldom meet customer expectations for easiness and attractivity of cross-border/regional journeys and rarely include integrated tickets for multimodal rides. To address that, stakeholders from six regions around the southern Baltic Sea developed the INTERCONNECT project that was guided by a holistic perspective on sustainability. Informed by that, this paper's objective was to propose a tool/method containing a planning process with a comprehensive and on-line open-access catalogue of solutions for sustainable cross-border/regional public transport services to inspire and guide planning and decision-making. The tool/method that was developed in this paper include a 7-step process and a catalogue of 42 solutions that were developed through several workshops and discussions among the authors and other experts in the field. The findings were compared and integrated with literature findings, practical experiences, then assessed against a principled definition of sustainability, and finally scrutinized and reviewed by project partners and external experts.

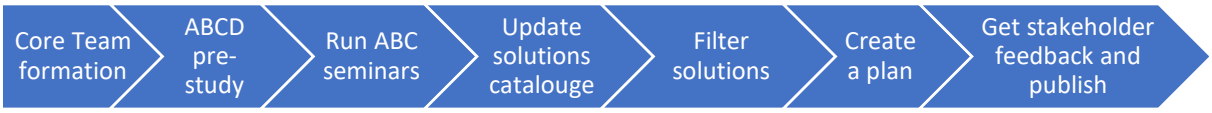


Figure: Summary of the 7-step process for planning towards sustainable cross-border/regional PT.

Table: List of solutions in the area of productivity/reliability for sustainable cross-border/regional PT (violations within parentheses can be avoided if improvements are made)

Solutions related to productivity/reliability	Sustainability		Conditions and limitations
	Violation	Improvement	
Create measures for PT to become faster or equally fast compared to car travelling.			High investment - requires national/EU funding.
Create a mobile app to inform passengers about position and estimated arrival time.	1, 2, 4, (5-8)	Make sure electricity for server comes from renewable sources.	
Create measures to increase reliability of PT by train, e.g. more tracks or meeting points, planned maintenance, rail security.	-		Collaboration with PTAs, operators and co-funding from national authorities.

The authors expect the results to sufficiently cover possible solutions for strategic sustainable development of cross-border/regional public transport and to inspire further development in other regions with similar infrastructure and financial means. The process and the catalogue of solutions are further described in the scientific paper by Borén, Ny, Tenart, and Mazouzi that was accepted for publication in July 2020, presented at the CSTFM 2020 conference in October, and then expected to be published in the conference proceedings 3-5 months after that conference.

Summary of A Process Model for Cross-border and Regional Public Transport Planning towards Sustainability

Achieving sustainability is not a quick fix, but rather requires long-term planning and well-anchored visions and goals that includes several aspects of the society. This is especially important for the transport sector that currently embraces measures to reduce emissions of Greenhouse gases, but often forget about other important aspects of sustainable development. In 2017, Robèrt et al. presented an iterative multi-stakeholder planning process model that embedded a strategic approach to sustainability, which proved helpful by giving diverse stakeholders a common, robust, and easy-to-understand goal and a way of working that was adequate for each of their contexts. Region Blekinge and project partners started in 2017 the INTERCONNECT project that had a focus on curbing car reliance by enhancing the use of cross-border and regional PT in the South Baltic Sea Region (SBSR). One research activity within that project was to test and further develop the iterative multi-stakeholder planning process for the sake of the project, so several workshops, seminars and discussion forums with project partners and external experts were organized. This resulted in a process-oriented model which comprises four main phases where the 'ABCD'-phase is chosen if a new plan has to be made (or an existing revised), and the 'Solution'-phase if plans for cross-border/regional PT do not have to be created or changed.

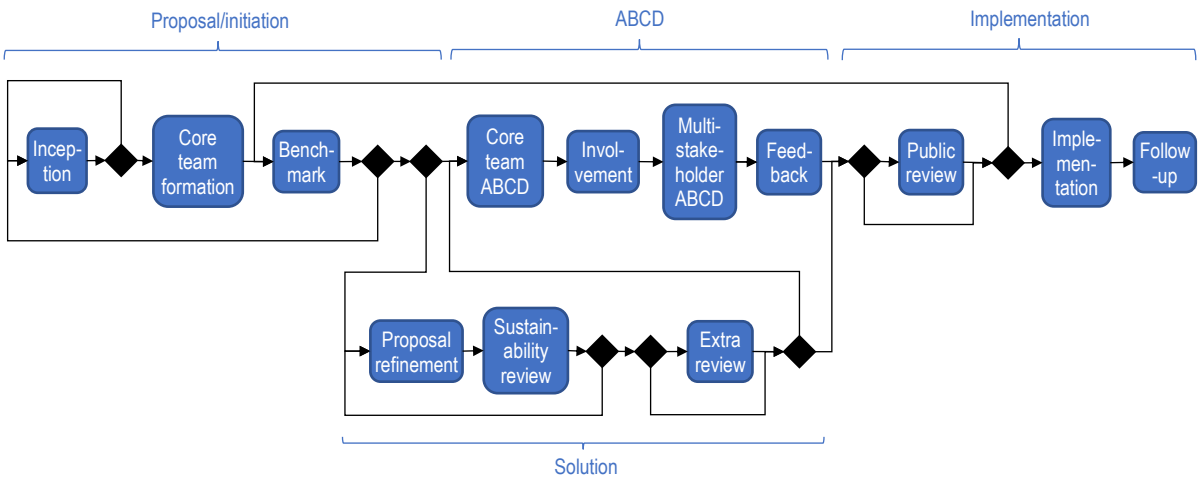


Figure: Overview of the process model for cross-border/regional PT planning towards sustainability.

The results are expected to be submitted by Borén, Ny, Nikulina, and Tenart to a scientific journal at the end of 2020 and then published during 2021.

INTER CONNECT

One ticket to the future

TECHNICAL APPENDIX

- COMPLEMENTARY ISSUES

PART A: TECHNICAL REPORT ON RECOMMENDED PRODUCTION METHOD OF SENSORS' CASES

(WP 4 Technical Report; 30Nov2020)

Subject of analysis:

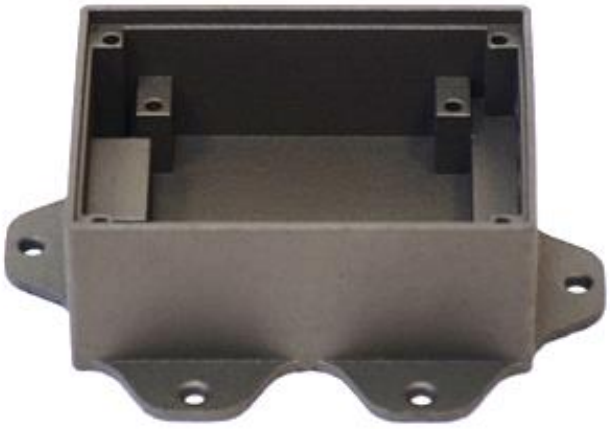
- **Quality verification of the powder method: MJF / Polyjet for use in the final production of the housing of sensors created as part of the Interconnect project,**
- **Verification of the strength of 3D printouts in technology for small series,**
- **Verification of print parameters in various technologies.**

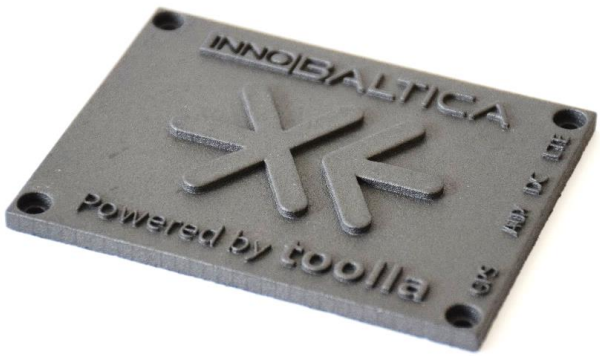
As part of the project, InnoBaltica built a special module of the Passenger Portal software and created a sensor activating functionalities for visually impaired or blind people.
In the end of the process of designing the sensor, it was necessary to verify and select the technology for producing the appropriate housing, ensuring the safety of the system and passengers.

The research was conducted at the end of the project, as soon as InnoBaltica got the final project of housings' construction. The results of the study of two separate 3D printing technologies are presented below: sintered powder printing and printing from thermoplastic materials.

MJF / POLYJET POWDER METHOD

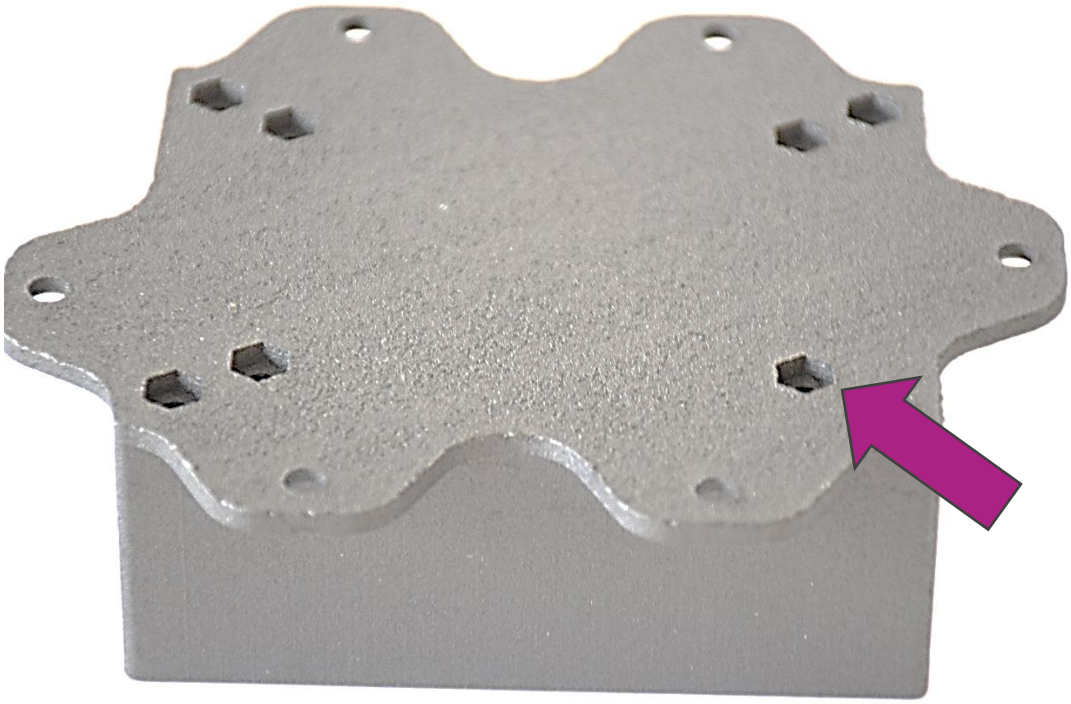
It is a method of printing from powdered plastics, selectively glued and welded.
The method consists in 3D printing from powdered plastics (polyamides) by selective spraying of binder on them, which sticks together the individual layers of the model and welding them at high temperature, which causes their permanent bonding.
For the production of the housing, it is necessary to produce the body and cover separately.





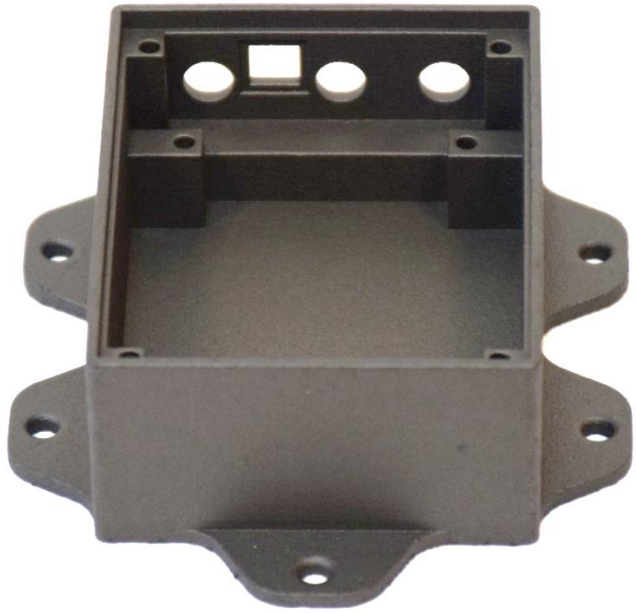
The printing must be precise enough to enable obtaining the grooves well adjacent to the nut.

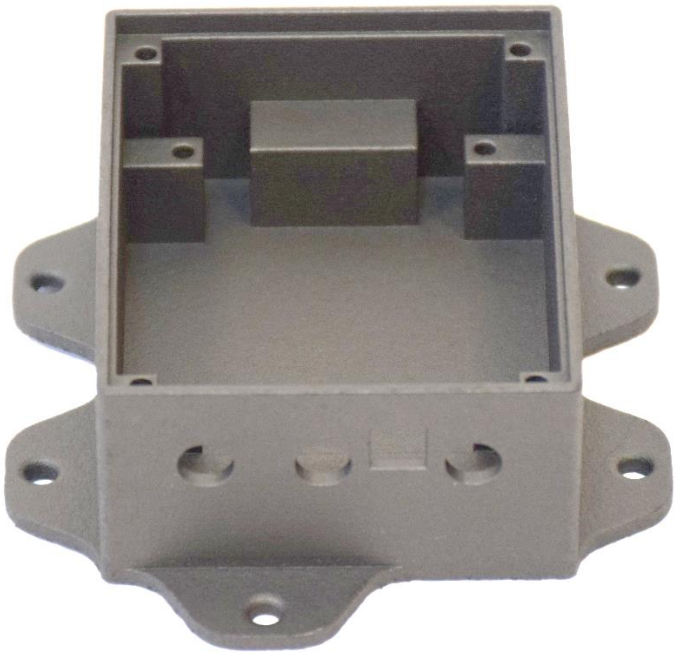
The design of the housing should prevent access to the device by unauthorized persons who do not have atypical mounting keys (for screws with hexagonal heads, torches, etc.).



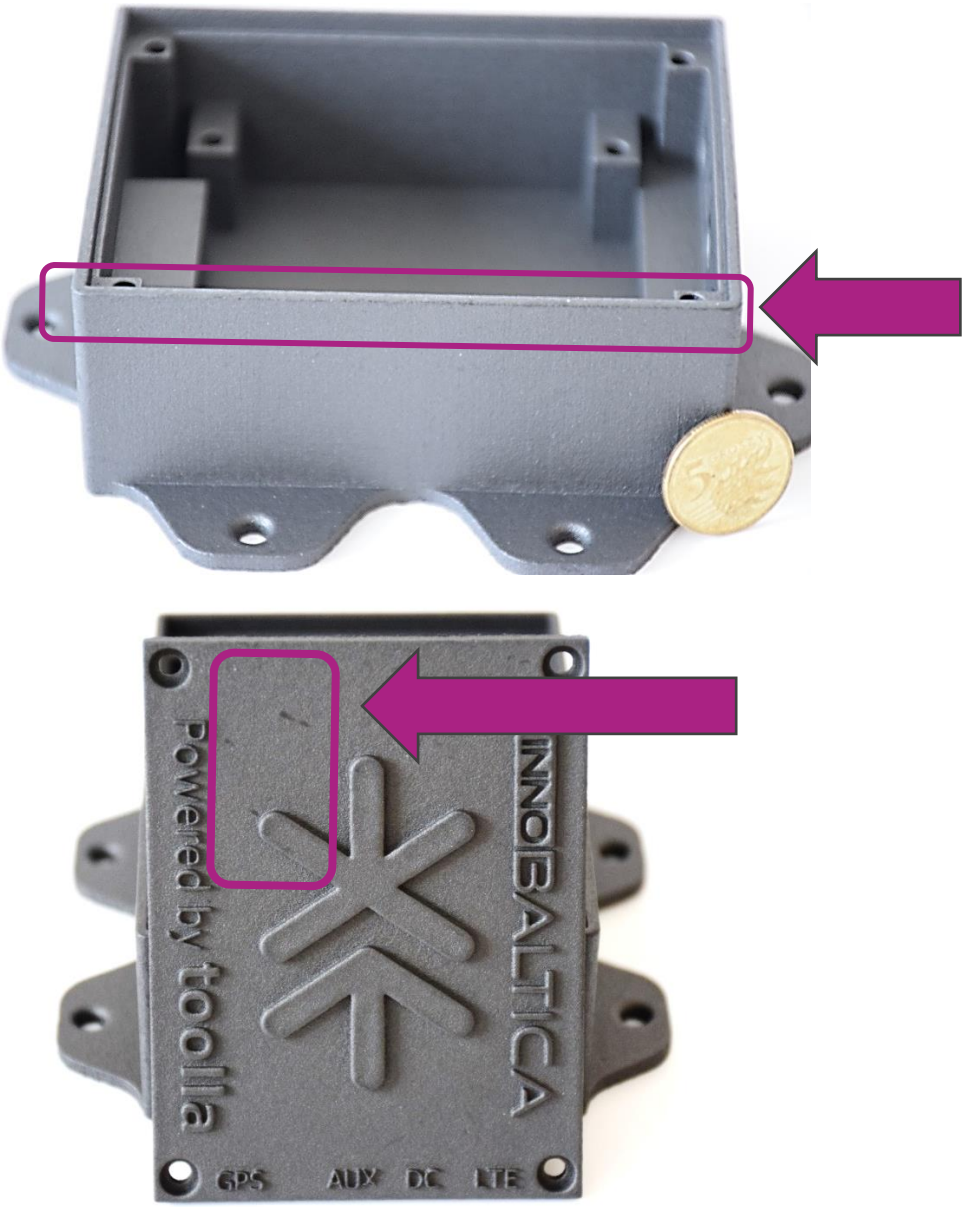
The printout in this method maintains all parameters. Unfortunately the material structure and roughness are visible.

The mounting holes are very well preserved, regardless of their shape and location. This is certainly one of the advantages of this printing method.





However, the printout shows minor blemishes, burrs and scratches. They do not affect the functionality of the housing. When the unit is to be mounted in a passenger's sight, consider manufacturing injection molded enclosures with a metal mold. This will certainly increase the aesthetics of the housing.



It is quite troublesome to create a short sample printout in order to verify the parameters and quality of the housings. Short series in this technology usually consist of about 200-250 elements simultaneously printed and sintered. InnoBaltica has completed a minimum order of 180 copies. On the other hand, such a quantity made it possible to check whether the production was homogeneous and maintained the quality of the whole lot. Such verification allows to avoid in-depth assessment of each individual piece of housing at the stage of final preparation of sensors for introduction in a given area.

A significant benefit of choosing this printing method is also saving time. Target print lots of thousands of such housings can be realized in a very short time. Printing of the target series of enclosures will take approximately 1-2 weeks with delivery.

METHOD OF 3D PRINTING FROM THERMOPLASTS IN THE LINE

It is a method that involves printing from thermoplastics (i.e. plastic) by heating the plastic supplied to the 3D printer in the form of a string in the print head and making it semi-liquid.

The plastic is squeezed out and spread layer by layer on the build plate. Layers are applied first in the XY axes, and when the 3D printer finishes stacking them, the head either rises up or the heat-bed lowers down a layer height and another layer is applied. The semi-liquid plastic bonds under the influence of high temperature and solidifies quickly, creating a (almost) uniform structure.

The applied layers of material are joined with the previous ones by cooling and then solidifying. In some cases, the solidification process of the molten material layers is accelerated thanks to the use of additional fans inside the working chamber of the device. Attaching the print head to the 3-axis system allows it to move, and thus build elements in the X, Y and Z directions.

To carry out this part of the study, 33 spools of thermoplastic material were used.

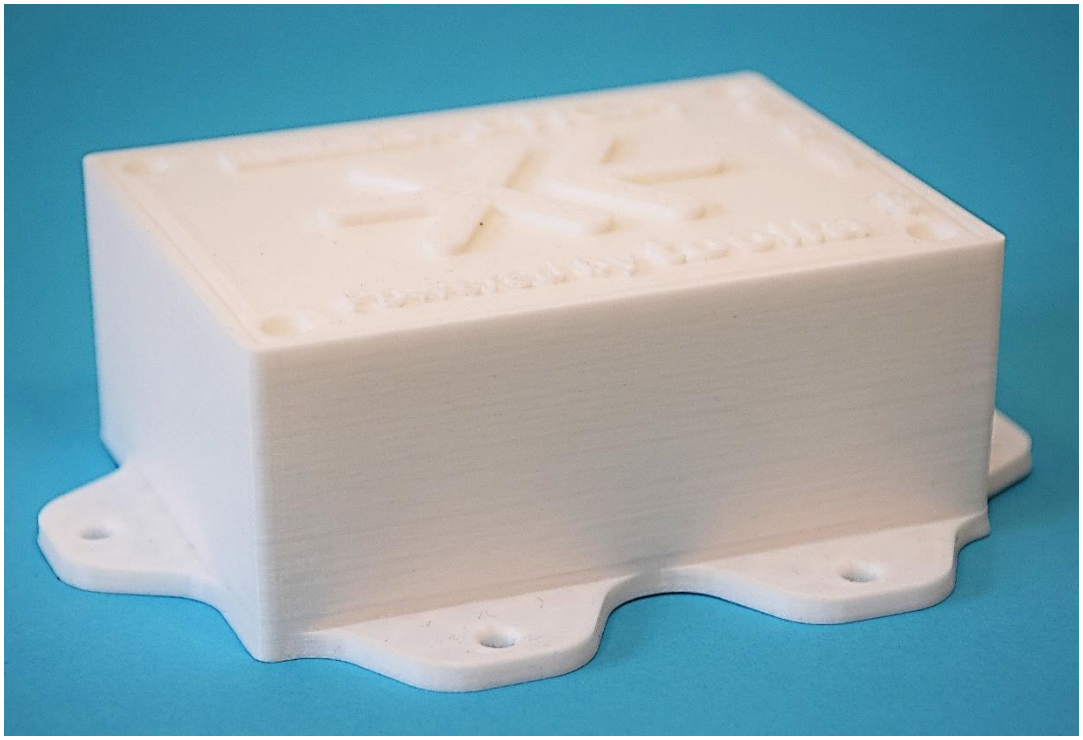
When printing in this technology, the following steps occurred to be the most important:

- Choosing the temperature of the heat-bed (different for different filament types),
- Choosing the right method of attaching the printout to the heat-bed (glue stick, spray glue, fixing stickers),
- Adjusting the print density (higher density provides a better finish to the housing, but requires more filament),
- Choosing the desired thickness of the external walls (thicker walls increase the weight of the housing and improve its strength, but you need more filament for this and the printing time is significantly longer).

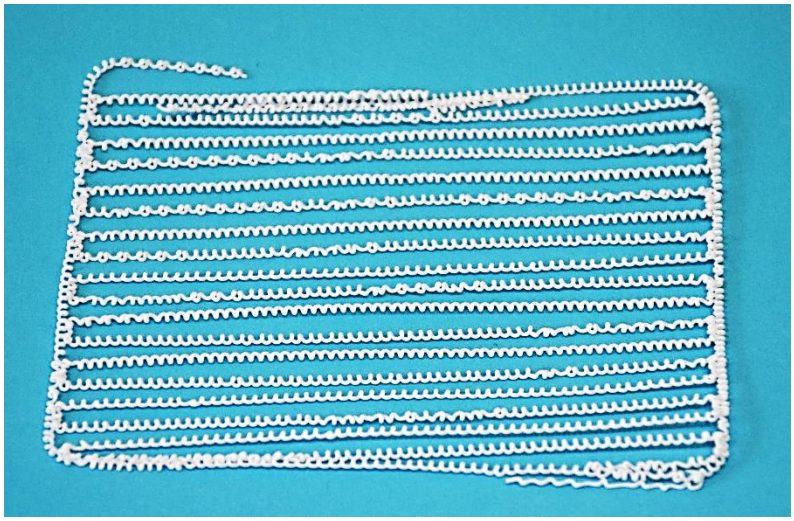
The printed housing can have any shape and colour we design. Additionally, a water-soluble support material is used to print elements containing arched structures.

After printing, the housing looks very nice. It is smooth and has delicate layers of synthetic material.


BALTICA
Powered by toolla



Below is the first layer of the printout. It was created as a result of incorrect calibration of the heat-bed.



Sample elements printed with incorrect calibration of the heat-bed and too low print density.

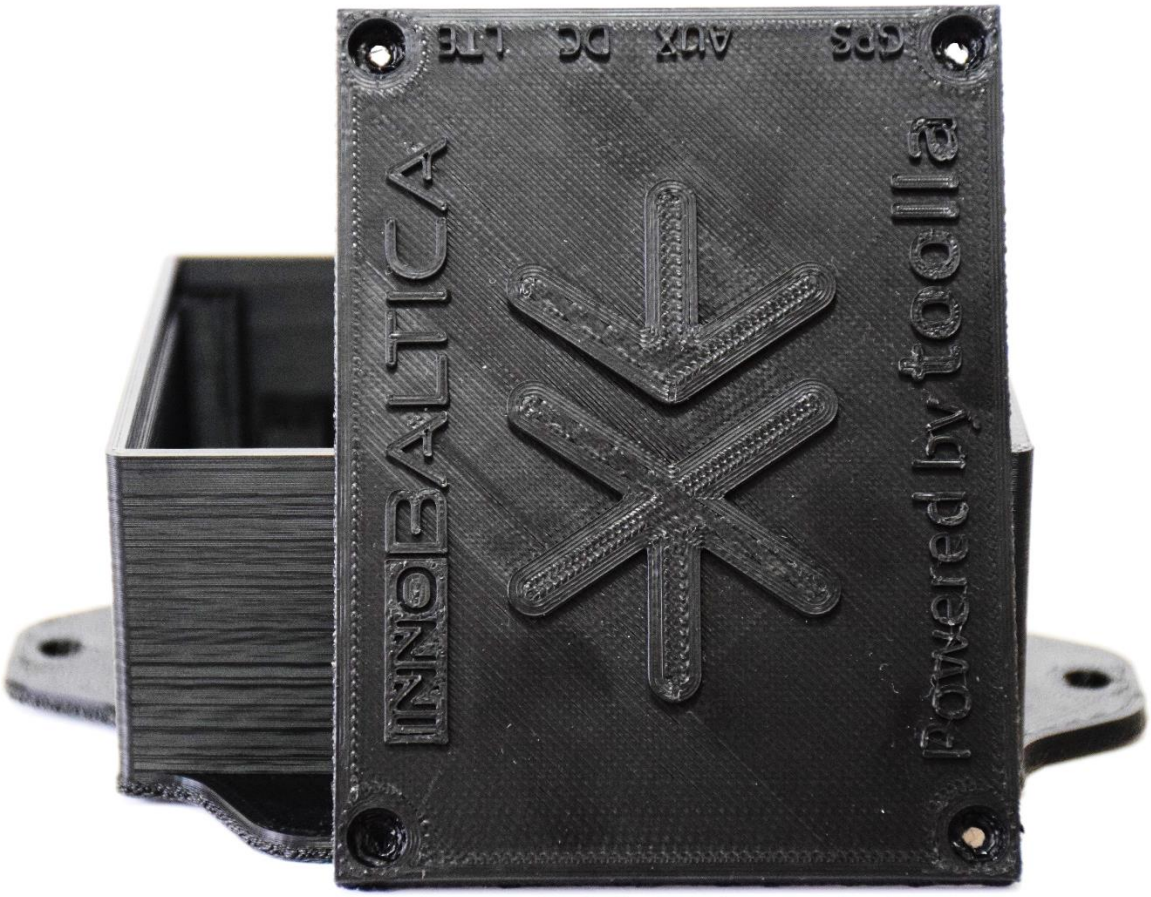
A more economical print with thinner walls builds the internal honeycomb structure of the housing. The housing cover is partially transparent when facing the light.

Despite its delicate internal structure, damaging the casing was very difficult. To break the cover, it was necessary to use great force and a lever.

The cover broke, but still some of the fibres were not damaged and held the two broken parts together. Only multiple bending of the housing at the point of the fracture made it possible to finally tear the element into two separate parts.

In the case of the production of the housing for use inside the vehicle, in a place inaccessible to the passenger, not exposed to acts of vandalism, it is not necessary to print the housings in a compact structure. Printing the housing in the full print structure presented below (cream-coloured element) will take up to twice as long as in a partially empty structure, which, as we have proven, has very good mechanical properties.

Small holes in this printing method may contain imperfections, which may reduce the comfort of mounting the sensor. Putting the screws in the holes and screwing the housing together will then require more force by the fitter, and in extreme cases it will be necessary to correct the hole with an electric screwdriver with a small metal drill bit.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SUMMARY OF PART A

The conducted technical analysis draw the following conclusions.

ADVANTAGES OF 3D PRINTING are as follows:

- It is the fastest production method,
- It is the is the cheapest production method,
- It gives the ability to create the most complex geometries.

DISADVANTAGES OF 3D PRINTING are as follows:

- It is poor in terms of surface quality,
- It is ineffective in high-volume production (hundreds of thousands - millions of pieces of details).

ADVANTAGES OF 3D PRINTING FROM POWDERED POLYAMIDES:

- the ability to print objects from very durable and resilient or flexible materials,
- much higher precision and accuracy than in the FDM / FFF technology,
- technology dedicated to serial production (possibility of stacking prints),
- the possibility of printing objects with complex geometries - due to the fact that it is a powder technology, the powder that is not sintered creates a natural support structure, which is easily removed after printing (although there are situations where supports are still indicated),
- full colour print is possible (but see disadvantages).

DISADVANTAGES OF 3D PRINTING FROM POWDERED POLYAMIDES:

- full colour prints are very expensive; default colour is graphite,
- to the production time, a second amount for post-processing should be added,
- the specificity of the technological process makes the technology profitable, first of all, with lower production series or large objects with complex geometry; small and simple things are more profitable to print in other additive techniques.

ADVANTAGES OF 3D PRINTING FROM THERMOPLASTICS IN THE FORM OF A LINE:

- the ability to print from a wide range of plastics, including the same materials used in injection molding technology; the possibility of 3D printing from composite materials doped with e.g. carbon or glass fibre,
- cheap consumables and operation of 3D printers; easy and quick service, which is important in low-volume production,
- speed of work - small details with simple geometry are printed in even several minutes; medium-sized details, not exceeding a dozen centimetres in XYZ axes, are printed within a dozen or so hours, so often during one working day,
- post-processing - apart from complicated geometries, where a lot of support structures must be generated, post-processing is simple, and sometimes even on 3D printers it is possible to immediately produce a ready-to-use detail.

DISADVANTAGES OF 3D PRINTING FROM THERMOPLASTICS IN THE FORM OF A LINE:

- not very high accuracy compared to other production methods - the height of the printed layer in the FDM / FFF technology is standard 0.1 - 0.3 mm (of course, you can try to print on a lower or much

higher layer depending on your needs); the standard diameter of the print head is 0.4 mm (i.e. the opening from which semi-liquid plastic is extruded),
- material shrinkage problems,
- post-processed complex geometries - some geometries will require the generation of such complex internal support structures that their removal after printing will be either very complicated or impossible.

To sum up, there are several pros and cons for each of verified methods. The major fact is that this methods are very easy to achieve, quick and ensure a very good elasticity of the production process.

Therefore, both presented 3D printing methods can be treated as a reference point for further local implementations in other regions of Europe, but each time a system developer should compare and assess presented advantages and disadvantages of compared methods and take the final choice.

PART B: TECHNICAL REPORT ON SYSTEM SIMULATION TEST

Subject of analysis:

- **programming the device to work with functionalities for the visually impaired and the blind,**
- **wireless programming to be used on the ferry and passenger terminal of the Stena Line carrier,**
- **electronic ticket functionality test - for integration with Stena Line,**
- **test of system parameters in various voltage settings,**
- **simulation test of the beacon management platform (technical logs).**

The simulation test was carried out at the end of the project and concerned the tools of integration with Stena Line and tools supporting the journey of visually impaired or blind people.

Intelligent devices were used to conduct the test - electronic printed circuits enabling their use to test the functionality of the system based on the Internet of Things (IoT) technology, i.e. sensors transmitting messages and sensors acquiring data from microsensors, e.g. accelerometer, gyroscope.

Simulation devices are electronic boards that can be programmed with their own software in any way, because they do not contain the electronics manufacturer's lock. Such devices are used to verify the functionality of the software, confirm that the code has been opened by the Software Contractor and check the implementation procedure of this embedded software on the target electronic devices.
During the system test, the following functionalities were tested:

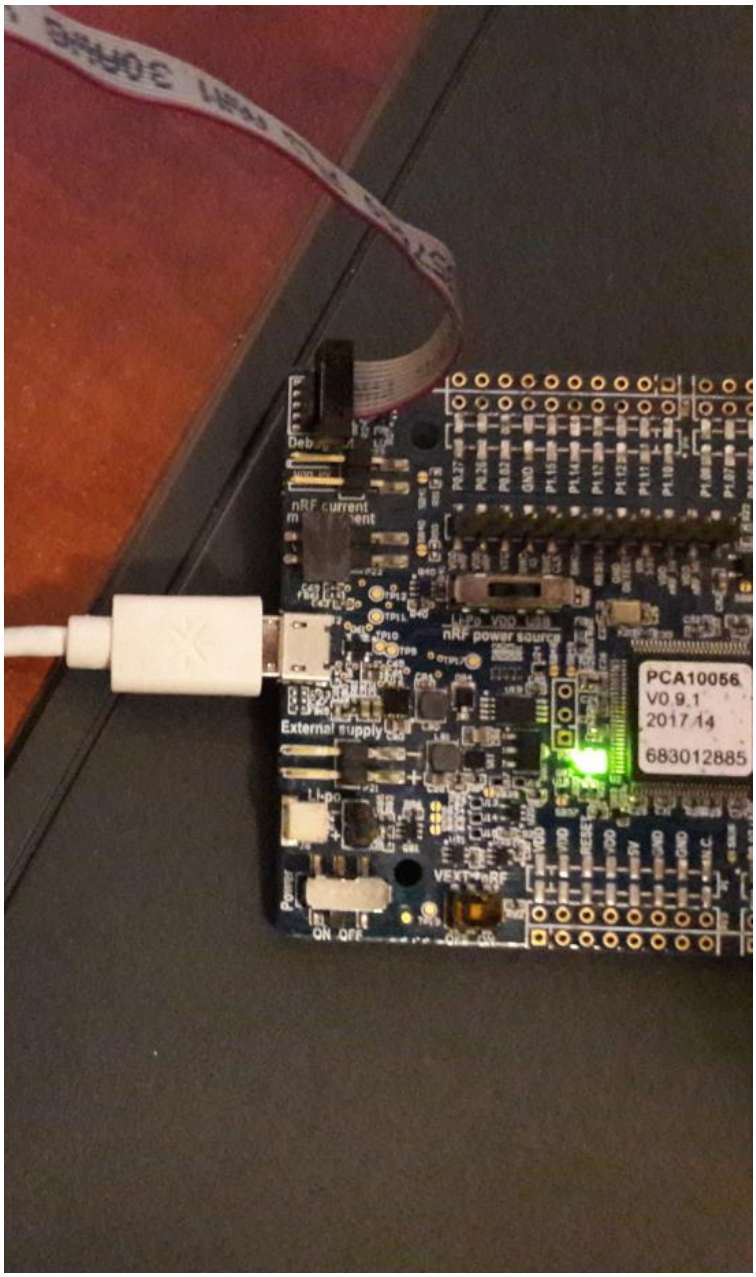
- programming the device to work with functionalities for the disabled,
- wireless programming to be used on the Stena Line ferry (functionality is still not very popular and easy to achieve be app developers),
- electronic ticket functionality test - for integration with Stena Line,
- test of system parameters in various voltage settings,
- simulation test of the beacon management platform (technical logs).

The test was carried out on November 26-30, 2020, i.e. after the main system and all its functionalities had been produced, which was necessary for the final test. The simulation test is always necessary to achieve the TRL6-7 level of the pilot solutions and prepare them for testing compliance with the EMC Directive before being fully implemented on the market (Directive 2014/30 / EU of the European Parliament and of the Council of February 26, 2014 on harmonization of the laws of the Member States relating to electromagnetic compatibility).

PREPARING FOR THE TEST - CONNECTING THE MODULE

The simulation device should be connected to a 5V power supply, for example to a standard wall charger for mobile phones.

Then attach the cable for programming the integrated circuit with the firmware.



SIMULATION TEST: PART 1 - PROGRAMMING THE MODULE

The nRF Command Line Tools were downloaded and installed for the task.

SoftDevice and program image for Beacon were implemented.

Then the next steps were taken using:
• compiled image of the program for Beacon,
• compiled bootloader image for Beacon,
• SoftDevice,
• the key with which we want to sign the software.

The test was carried out in groups: 4 times ten devices.

SIMULATION TEST RESULT for the development module:

1. **All attempts were successful. In two cases, there was a slowdown in the installation due to internet lag. However, this did not matter for the test result.**
2. **The software has an open code that can be implemented on printed circuit boards.**
3. **The programming procedure is properly developed.**
4. **The programming code of the central system is properly developed and enables simultaneous registration of many devices, e.g. when deployed in partner regions at the same time.**

SIMULATION TEST: PART 2 - WIRELESS PROGRAMMING TO BE USED ON THE FERRY AND PASSENGER TERMINAL OF THE STENA LINE CARRIER

Over-the-Air programming

Testers opened the nRF Connect application on the mobile device, ran the scans and connected to the selected simulation device:

Testers downloaded the list of available services.
Testers launched the DFU.
Testers chose the prepared program image.
Finally, Testers confirmed in the INTERCONNECT-S application that the software version had been changed.

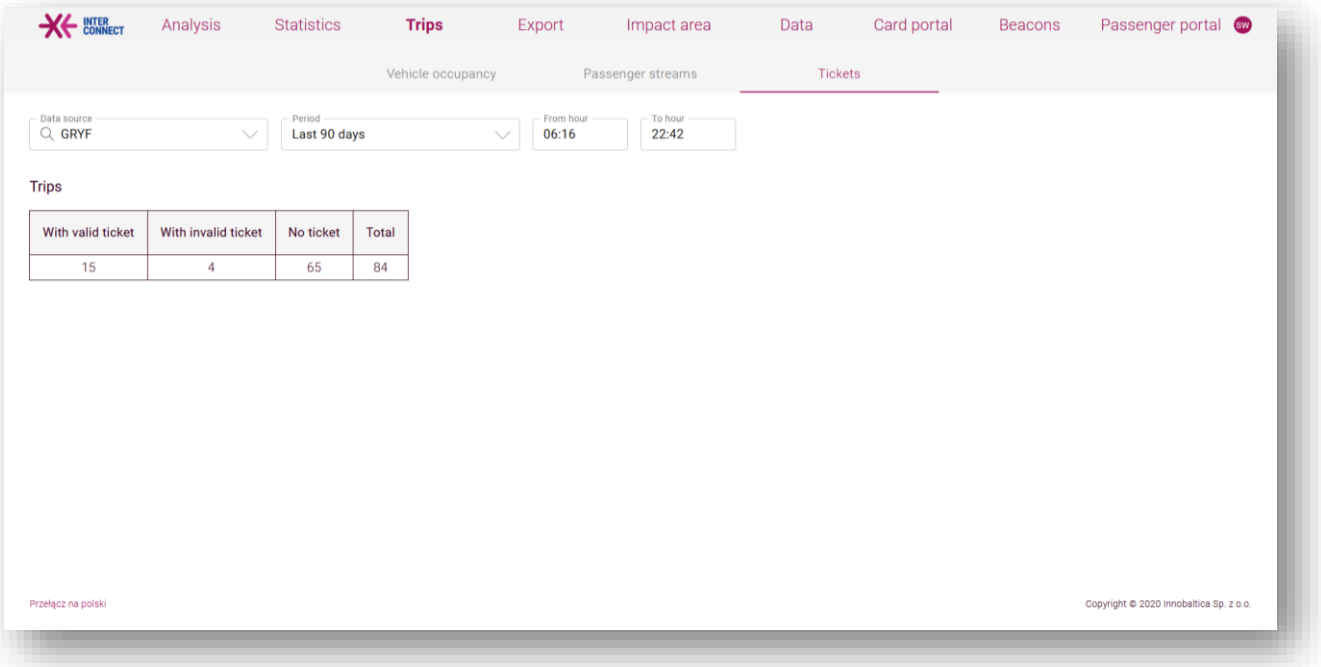
SIMULATION TEST RESULT for Over-the-Air programming:

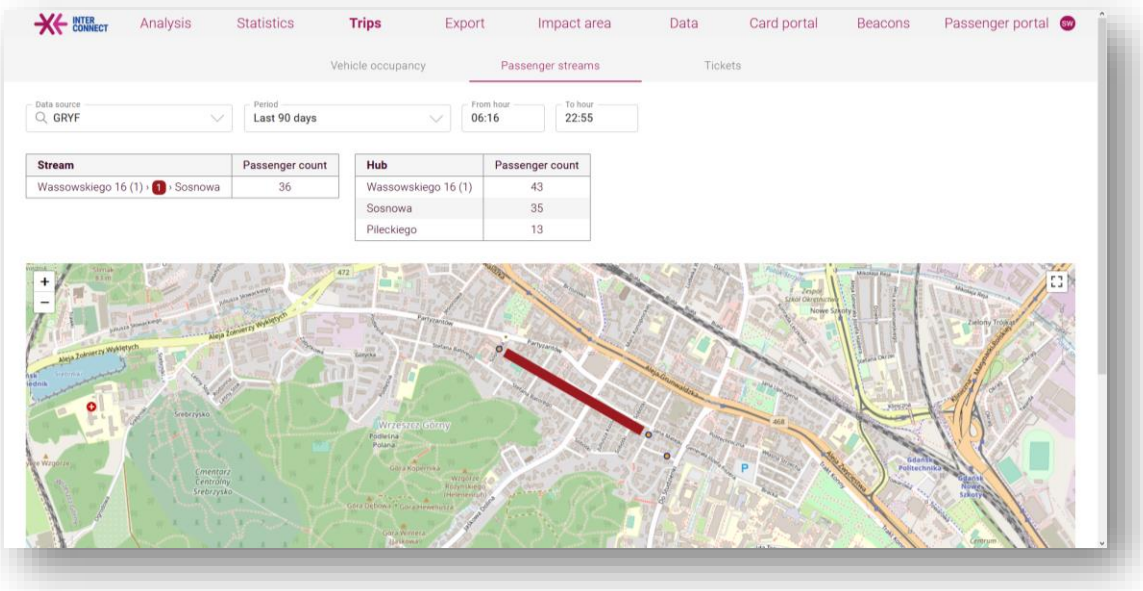
1. **All devices worked with the Interconnect service system and application.**
2. **In each case, it was possible to remotely program the device, which proves that the system administrator (InnoBaltica) can cooperate with service technicians from partner regions, for example in Blekingetrafiken or Stena Line.**
3. **At the same time, the devices being programmed in the system were queued up, which was assessed as the expected behaviour of the Interconnect system.**
4. **The remote programming procedure is described correctly.**

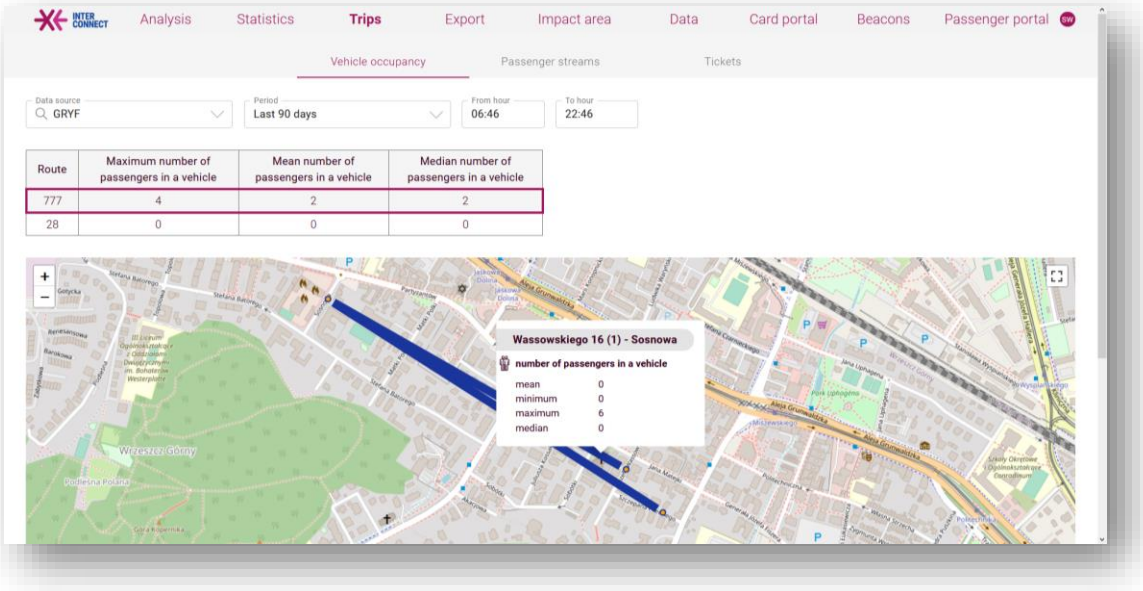
SIMULATION TEST: PART 3 - ELECTRONIC TICKET FUNCTIONALITY TEST - FOR INTEGRATION WITH STENA LINE

During the simulation test, the functionality of the electronic ticket assigned to the vehicle artificially assigned to the existing regional carrier providing services in the Interconnect transport corridors was verified.

Below are some examples of system messages.







SIMULATION TEST RESULT for electronic ticketing for Stena Line:

1. **System identified both valid and invalid tickets.**
2. **Simulation test proved that system is ready for implementation of joined ticketing in cross - border travelling – with the registration of passenger flows.**

SIMULATION TEST: PART 4 - SYSTEM PARAMETERS IN VARIOUS VOLTAGE SETTINGS

The system is able to cooperate in various voltage parameters.

These functionalities were verified with the use of a 5V mains charger, a 24V transport power supply and various batteries.

Measurements of voltage and other device parameters detected by the Interconnect central system are presented in the underneath tables. The test was carried twice for each intelligent testing device.

TX power = 8 dBm, default conf DCDC ON								
	b1	b2	b3	b4	b5	b6	b7	b8
custom_tx_power [dBm]	8	8	8	8	8	8	8	8
APP_CFG_ADV_DATA_LEN	31	31	31	31	31	31	31	31
CONNECTABLE_ADV_INTERVAL [ms]	100	100	100	100	100	100	100	100
Adv connectable	ON	ON	ON	ON	ON	ON	ON	ON
DCDC	ON	ON	ON	ON	ON	ON	ON	ON
Power source	Vext	Vext	Vext	Vext	Vext	Vext	Vext	Vext
Voltage In [V]	4,2	3,9	3,7	3,5	3,2	3	2,5	2,2
Vext	4,2	3,9	3,7	3,5	3,2	3	2,5	2,2
Current consumption								
Mean value (communication)	4571	4649	4835	5116	5440	6059	7109	8149
Mean value (idle)	250	232	215	208	170	275	366	280
Mean value (100ms) - con - multiple transmit+idle [uA]	449	434	426	433	411	541	697	647
Mean value (10s) [uA]	406	397	393	392	381	384	399	509
Max peak [mA]	12,25	13,72	13,61	14,73	15,82	17,18	22,71	22,74
Comments: the lowest possible power supply 2,2V to run RF								

TX power = 4 dBm, default conf DCDC ON								
	b9	b10	b11	b12	b13	b14	b15	b16
custom_tx_power [dBm]	4	4	4	4	4	4	4	4
APP_CFG_ADV_DATA_LEN	31	31	31	31	31	31	31	31
CONNECTABLE_ADV_INTERVAL [ms]	100	100	100	100	100	100	100	100
Adv connectable	ON	ON	ON	ON	ON	ON	ON	ON
DCDC	ON	ON	ON	ON	ON	ON	ON	ON
Power source	Vext	Vext	Vext	Vext	Vext	Vext	Vext	Vext
Voltage In [V]	4,2	3,9	3,7	3,5	3,2	3	2,5	2
Vext	4,2	3,9	3,7	3,5	3,2	3	2,5	2
Current consumption								
Mean value (communication)	3503	3616	3738	3856	4114	4228	5046	6357
Mean value (idle)	255	214	211	208	168	164	144	163
Mean value (100ms) - con - multiple transmit+idle [uA]	404	372	374	377	351	351	371	453
Mean value (10s) [uA]	386	350	344	330	321	308	305	398
Max peak [mA]	8,82	9,22	9,61	10,07	10,95	11,52	13,73	16,89
Comments: the lowest possible power supply 2V to run RF								

TX power = 0 dBm, default conf DCDC ON									
	b17	b18	b19	b20	b21	b22	b23	b24	b25
custom_tx_power [dBm]	0	0	0	0	0	0	0	0	0
APP_CFG_ADV_DATA_LEN	31	31	31	31	31	31	31	31	31
CONNECTABLE_ADV_INTERVAL [ms]	100	100	100	100	100	100	100	100	100
Adv connectable	ON	ON	ON	ON	ON	ON	ON	ON	ON
DCDC	ON	ON	ON	ON	ON	ON	ON	ON	ON
Power source	Vext	Vext	Vext	Vext	Vext	Vext	Vext	Vext	Vext
Voltage In [V]	4,2	3,9	3,7	3,5	3,2	3	2,5	2	1,9
Vext	4,2	3,9	3,7	3,5	3,2	3	2,5	2	1,9
Current consumption									
Mean value (communication)	2574	2551	2681	2770	2845	2973	3306	3811	4037
Mean value (idle)	219	198	197	176	142	149	121	113	87
Mean value (100ms) - con - multiple transmit+idle [uA]	327	309	311	296	267	279	268	288	274
Mean value (10s) [uA]	341	306	294	280	266	253	233	224	220
Max peak [mA]	5,28	5,33	5,63	5,82	6,14	6,52	7,42	9,36	8,94
Comments: the lowest possible power supply 1,9V to run RF									

TX power = -4 dBm, default conf DCDC ON									
	b26	b27	b28	b29	b30	b31	b32	b33	b34
custom_tx_power [dBm]	-4	-4	-4	-4	-4	-4	-4	-4	-4
APP_CFG_ADV_DATA_LEN	31	31	31	31	31	31	31	31	31
CONNECTABLE_ADV_INTERVAL [ms]	100	100	100	100	100	100	100	100	100
Adv connectable	ON	ON	ON	ON	ON	ON	ON	ON	ON
DCDC	ON	ON	ON	ON	ON	ON	ON	ON	ON
Power source	Vext	Vext	Vext	Vext	Vext	Vext	Vext	Vext	Vext
Voltage In [V]	4,2	3,9	3,7	3,5	3,2	3	2,5	2	1,8
Vext	4,2	3,9	3,7	3,5	3,2	3	2,5	2	1,8
Current consumption									
Mean value (communication)	2003	2111	2345	2378	2272	2512	2569	3412	3505
Mean value (idle)	222	194	183	185	145	162	109	113	120
Mean value (100ms) - con - multiple transmit+idle [uA]	319	293	285	292	255	276	237	268	288
Mean value (10s) [uA]	318	293	281	271	250	239	220	198	199
Max peak [mA]	4,48	4,58	4,84	4,39	4,86	5,39	5,92	7,39	7,57
Comments: the lowest possible power supply 1,8V to run RF									

TX power = -4 dBm, default conf DCDC ON						
	b35	b36	b37	b38	b39	b40
custom_tx_power [dBm]	-4	-4	-4	-4	-4	-4
APP_CFG_ADV_DATA_LEN	31	31	31	31	31	31
CONNECTABLE_ADV_INTERVAL [ms]	100	100	100	100	100	100
Adv connectable	ON	ON	ON	ON	ON	ON
DCDC	ON	ON	ON	ON	ON	ON
Power source	VBAT -> 3V3	VBAT -> 3V3	VBAT -> 3V3	VBAT -> 3V3	VBAT -> 3V3	VBAT -> 3V3
Voltage In [V]	4,2	3,9	3,7	3,5	3,2	3
Vext	4,2	3,9	3,7	3,5	3,2	3
Current consumption						
Mean value (communication)	2461	2645	2476	2345	2503	2645
Mean value (idle)	242	221	213	203	204	207
Mean value (100ms) - con - multiple transmit+idle [uA]	353	334	323	313	317	326
Mean value (10s) [uA]	432	398	337	359	366	348
Max peak [mA]	4,78	5,63	5,39	5,38	5,02	5,22
Comments: the lowest possible power supply 1,8V to run RF						

TX power = -4 dBm, default conf DCDC ON									
	b41	b42	b43	b44	b45	b46	b47	b48	b49
custom_tx_power [dBm]	-4	-4	-4	-4	-4	-4	-4	-4	-4
APP_CFG_ADV_DATA_LEN	31	31	31	31	31	31	31	31	31
CONNECTABLE_ADV_INTERVAL [ms]	100	100	100	100	100	100	100	100	100
Adv connectable	ON	ON	ON	ON	ON	ON	ON	ON	ON
DCDC	ON	ON	ON	ON	ON	ON	ON	ON	ON
Power source	VBAT -> 1V8	VBAT -> 1V8	VBAT -> 1V8	VBAT -> 1V8	VBAT -> 1V8	VBAT -> 1V8	VBAT -> 1V8	VBAT -> 1V8	VBAT -> 1V8
Voltage In [V]	4,2	3,9	3,7	3,5	3,2	3	2,5	2	1,9
Vext	4,2	3,9	3,7	3,5	3,2	3	2,5	2	1,9
Current consumption									
Mean value (communication)									
Mean value (idle)	220	211	188	181	169	179	139	118	123
Mean value (100ms) - con - multiple transmit+idle [uA]	383	374	352	346	332	342	302	281	287
Mean value (10s) [uA]	465	430	410	403	371	357	316	284	213
Max peak [mA]	9,17	9,18	9,12	9,13	9,24	9,27	9,31	9,31	8,49
Comments: the lowest possible power supply 1,8V to run RF									

TX power = -4 dBm, default conf DCDC ON											
	b50	b51	b52	b53	b54	b55	b56	b57	b58	b59	b60
custom_tx_power [dBm]	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4
APP_CFG_ADV_DATA_LEN	31	31	31	31	31	31	31	31	31	31	31
CONNECTABLE_ADV_INTERVAL [ms]	100	100	100	100	100	100	100	100	100	100	100
Adv connectable	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
DCDC	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Power source	Vext -> VDDH	Vext -> VDDH	Vext -> VDDH	Vext -> VDDH	Vext -> VDDH	Vext -> VDDH	Vext -> VDDH	Vext -> VDDH	Vext -> VDDH	Vext -> VDDH	Vext -> VDDH
Voltage In [V]	5	4,5	4,2	3,9	3,7	3,5	3,2	3	2,5	2,2	2
Vext	5	4,5	4,2	3,9	3,7	3,5	3,2	3	2,5	2,2	2
Current consumption											
Mean value (communication)											
Mean value (idle)	241	211	225	218	190	181	176	176	130	112	137
Mean value (100ms) - con - multiple transmit+idle [uA]	407	376	389	384	356	346	341	341	297	277	303
Mean value (10s) [uA]	481	428	387	356	349	329	306	287	252	226	227
Max peak [mA]	8,01	7,97	7,95	7,89	7,91	7,89	7,55	7,9	7,87	7,84	7,91
Comments: the lowest possible power supply 2V to run RF											

TX power = -4 dBm, default conf DCDC ON										
	b61	b62	b63	b64	b65	b66	b67	b68	b69	b70
custom_tx_power [dBm]	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4
APP_CFG_ADV_DATA_LEN	31	31	31	31	31	31	31	31	31	31
CONNECTABLE_ADV_INTERVAL [ms]	100	100	100	100	100	100	100	100	100	100
Adv connectable	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
DCDC	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Power source	Vext -> VDD + VDDH	Vext -> VDD + VDDH	Vext -> VDD + VDDH	Vext -> VDD + VDDH	Vext -> VDD + VDDH	Vext -> VDD + VDDH	Vext -> VDD + VDDH	Vext -> VDD + VDDH	Vext -> VDD + VDDH	Vext -> VDD + VDDH
Voltage In [V]	4,2	3,9	3,7	3,5	3,2	3	2,7	2,5	2,2	2
Vext	4,2	3,9	3,7	3,5	3,2	3	2,7	2,5	2,2	2
Current consumption										
Mean value (communication)										
Mean value (idle)	195	190	166	147	168	169	118	133	112	91
Mean value (100ms) - con - multiple transmit+idle [uA]	294	292	270	253	279	285	241	262	254	245
Mean value (10s) [uA]	328	302	291	275	252	237	225	216	207	204
Max peak [mA]	4,32	4,73	4,76	4,92	4,98	5,2	5,71	6,05	6,7	7,07
Comments: the lowest possible power supply 1,8V to run RF										

Interconnect										
	b71	b72	b73	b74	b75	b76	b77	b78	b79	b80
custom_tx_power [dBm]										
CONNECTABLE_ADV_INTERVAL [ms]	62,5	62,5	62,5	62,5	62,5	62,5	62,5	62,5	62,5	62,5
Adv connectable										
DCDC	ON	ON	ON	ON	ON	ON	ON	ON	OFF	OFF
Power source										
Voltage In [V]	4,2	3,9	3,7	3,5	3,2	3	2,7	2,5	4,2	3,9
Vext	4,2	3,9	3,7	3,5	3,2	3	2,7	2,5	4,2	3,9
Current consumption										
Mean value (communication)										
Mean value (idle)	180	150	135	139	112	110	89	95	173	141
Mean value (100ms) - con - multiple transmit+idle [uA]	348	323	314	345	302	314	305	323	512	476
Mean value (10s) [uA]	437	414	403	391	379	368	363	364	652	626
Max peak [mA]	5,16	5,64	5,52	5,8	6,12	6,64	7,18	7,65	10,38	9,14
Comments: the lowest possible power supply 1,8V to run RF										

SIMULATION TEST RESULT for voltage:

1. **All devices worked with different power sources and voltage.**
2. **The lowest possible power supply was 1,8V to have the testing devices corresponding with Interconnect system.**

SIMULATION TEST: PART 5 - BEACON MANAGEMENT PLATFORM (TECHNICAL LOGS)

As part of the test, the building of the technical file was verified - a service log informing about service activities undertaken by the service technician. Below are examples of the content of the service log.

SIMULATION TEST RESULT for SERVICE LOG:

1. **The file formulated correctly in the central system.**
2. **The file formulated in the same way and at a similar time regardless of the power source, that is: with the power adapter or the battery.**

SUMMARY OF PART B

The simulation test verified functionalities of central system and parameters of its elements.
It verified technical assumptions and proved correctness of the prepared programming procedures.

Based on the test, it was concluded that the Interconnect tools can be recommended for further implementation in the SBR area.

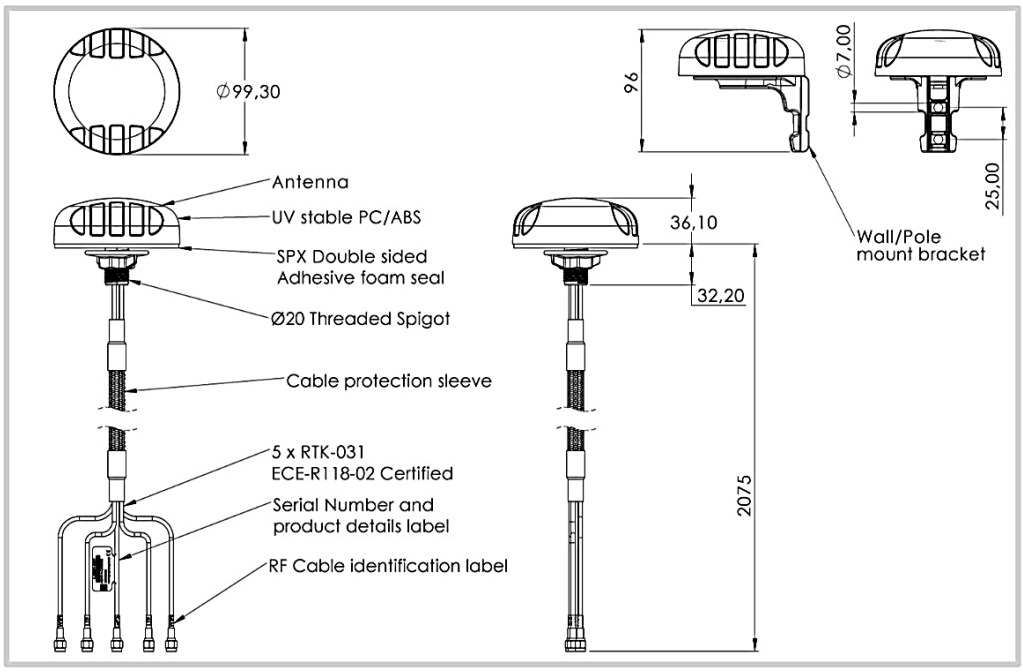
PART C: TECHNICAL REPORT ON ANTENNAS AND RADIO WAVES (WP 4 Technical Report; 30Nov2020)

Subject of analysis:

- **Global navigation and positioning systems (GPS or equivalent);**
- **Transmission apparatus for radiotelephony, radiotelegraphy, radio and television transmission;**
- **External bus antenna that allows data transmission using the infrastructure of cellular networks and locations.**

In the extended project implementation period, dedicated IT integration tools were developed to run a joint ticket with Stena Line and Blekingetrafiken. The scope of the task was to build algorithms for the determination of passenger flows in public transport vehicles but also for taking cars actual localisation. In order to develop and verify the prepared solution, it was necessary to purchase GPS antennas that could be easily installed / disassembled in designated vehicles and at points visited by passengers.
For this purpose, 135 low-profile PUCK-5-W omnidirectional Poynting antennas were purchased. Antennas were assigned to the vehicles participating in the study and stationary locations. The study, which took place on November 26-27, 2020, involved GRYF bus carrier vehicles, InnoBaltica employees with mobile and stationary sets. As a result of this work, the possibility of examining passenger flows was verified.

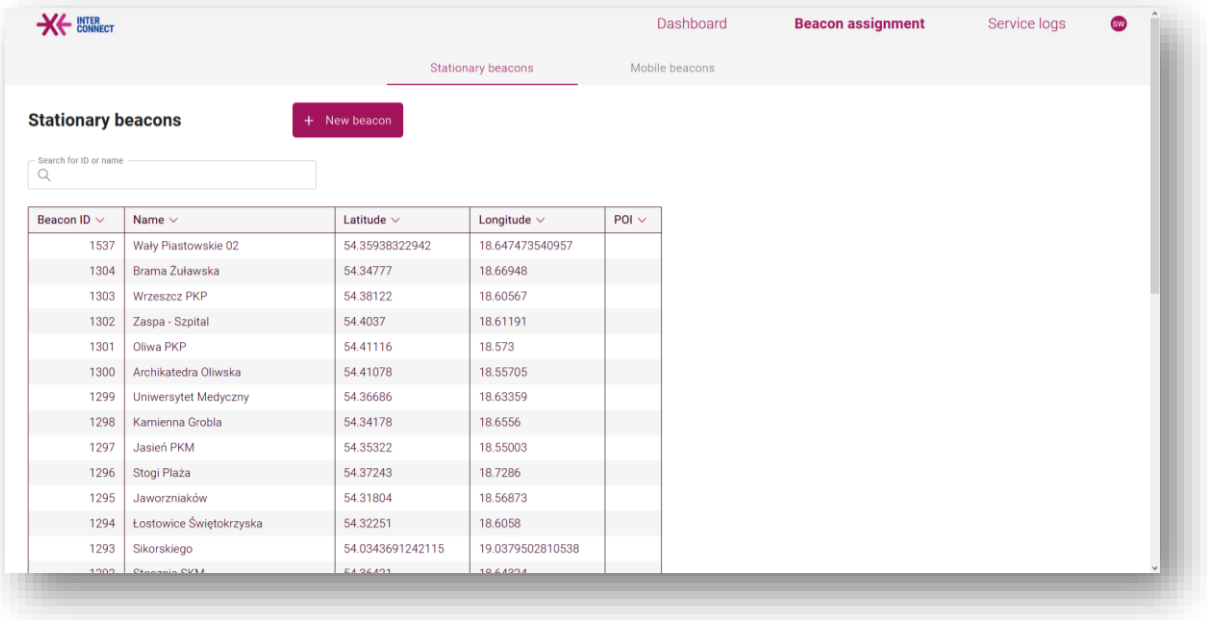
COMPONENTS, CONSTRUCTION
The antenna devices selected for the system have small dimensions with a diameter not exceeding 10 cm and are characterized by a low profile not exceeding 4 cm. Thanks to this, the device fits all buses and does not interfere with the daily care of the vehicle, including pressure washing.



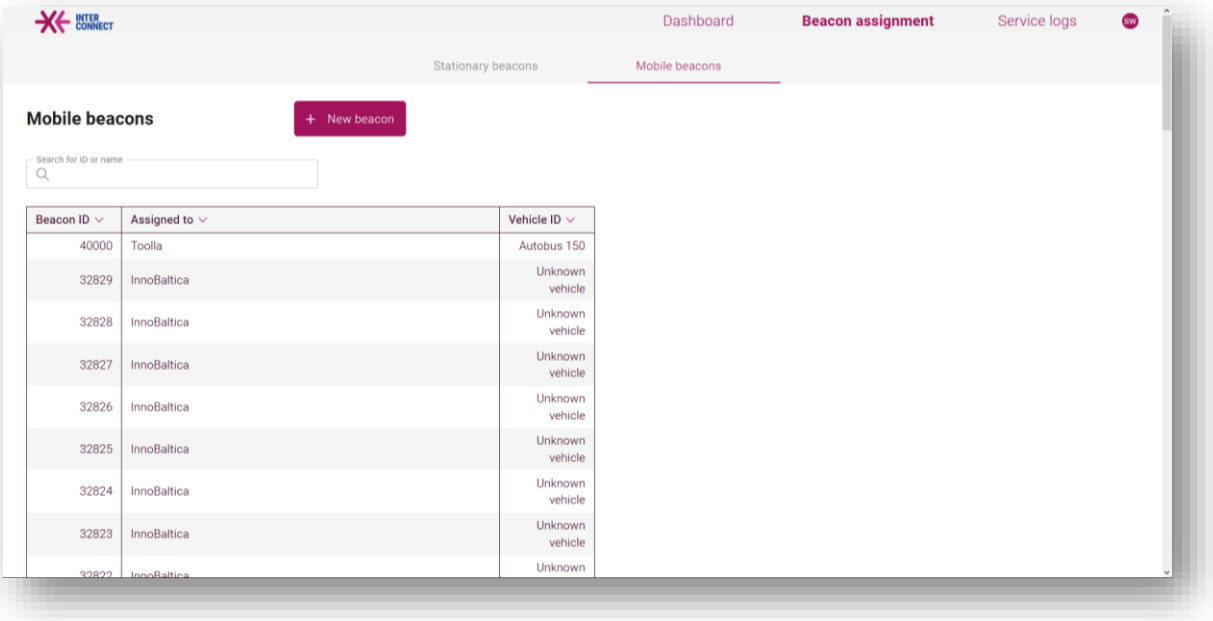
As we can see the chosen antenna is very easy in use, also when carriers change their cars to serve certain routes. Chosen model gives flexibility of Interconnect offer and guarantees full usage of system infrastructure.

ASSIGNMENT TO VEHICLES AND STATIONARY LOCATIONS

Antennas were assigned to the vehicles participating in the study and stationary locations.



Beacon ID	Name	Latitude	Longitude	POI
1537	Wały Piastowskie 02	54.35938322942	18.647473540957	
1304	Brama Żuławska	54.34777	18.66948	
1303	Wrzeszcz PKP	54.38122	18.60567	
1302	Zaspa - Szpital	54.4037	18.61191	
1301	Oliwa PKP	54.41116	18.573	
1300	Archikatedra Oliwska	54.41078	18.55705	
1299	Uniwersytet Medyczny	54.36686	18.63359	
1298	Kamienna Grobla	54.34178	18.6556	
1297	Jasień PKM	54.35322	18.55003	
1296	Stogi Plaża	54.37243	18.7286	
1295	Jaworzniaków	54.31804	18.56873	
1294	Łostowice Świętokrzyska	54.32251	18.6058	
1293	Sikorskiego	54.0343691242115	19.0379502810538	



Beacon ID	Assigned to	Vehicle ID
40000	Toolla	Autobus 150
32829	InnoBaltica	Unknown vehicle
32828	InnoBaltica	Unknown vehicle
32827	InnoBaltica	Unknown vehicle
32826	InnoBaltica	Unknown vehicle
32825	InnoBaltica	Unknown vehicle
32824	InnoBaltica	Unknown vehicle
32823	InnoBaltica	Unknown vehicle

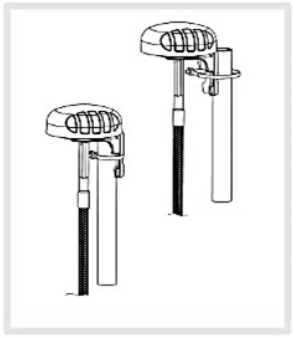
According to the principles of research in this field, the antennas were divided into 27 sets of 5 pieces. The results obtained in the groups were finally averaged.

ASSEMBLY

There are six possible assembly methods for the tested devices, that were tested by InnoBaltica:

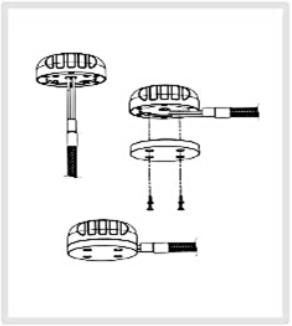
Spigot Mount

Removable 40mm & 80mm threaded spigot (included)



Vertical Pole Mount

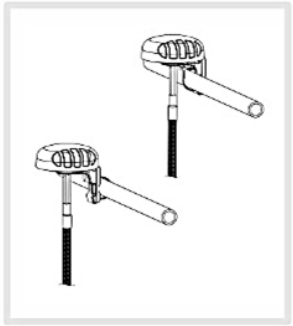
Pole/Wall Mounting bracket (included)



Magnetic Mount

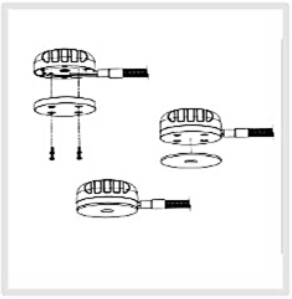
Magnetic Base (included)

For temporary and low mobility installations.



Horizontal Pole Mount

Pole/Wall Mounting bracket (included)



Surface Mount

Adhesive Surface Mounting (included) or can also be directly secured with longer M4 bolts (not included) to the female threaded inserts located in the antenna base

Wall Mount

Pole/Wall Mounting bracket (included)

The existing holes in the bus roof, the 3M fastening tape were helpful in quick assembly, and the sealing silicone was helpful for the stability of the antenna during the test.

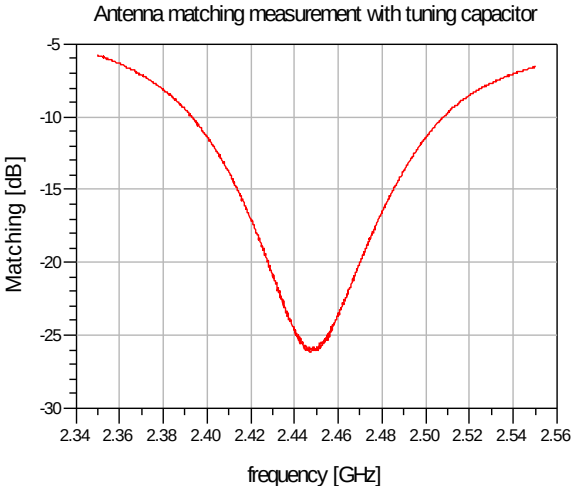

3M
9448A
Double Coated Tissue Tape

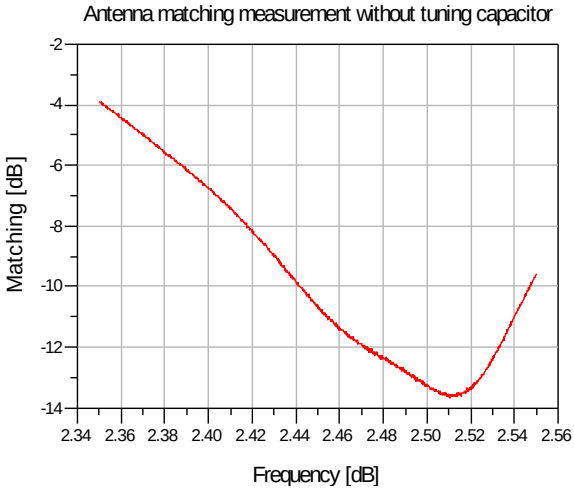

7518
INTEGRO

This silicone sealing was not esthetical but occurred to be very easy to remove after finishing research.

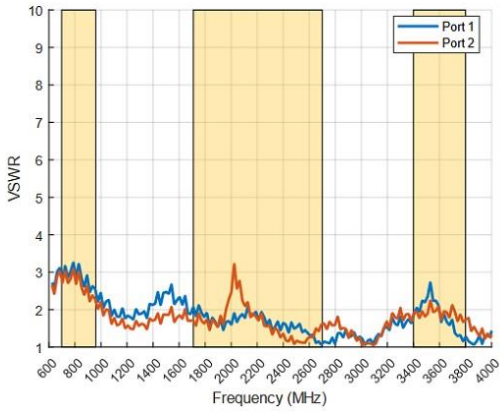
SIGNAL AND RADIATION

In the second part of the study, on November 25-30, 2020, the signal strength from the antennas and its impact on the signal frequency of electronic devices were analysed.

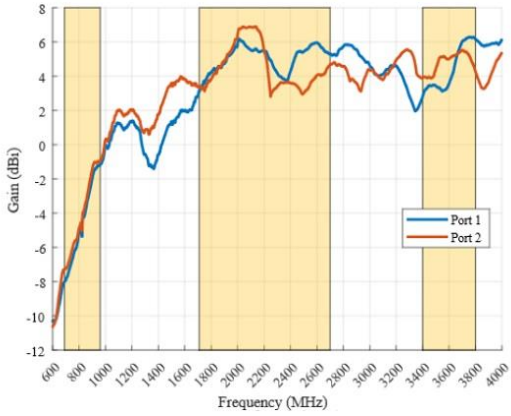




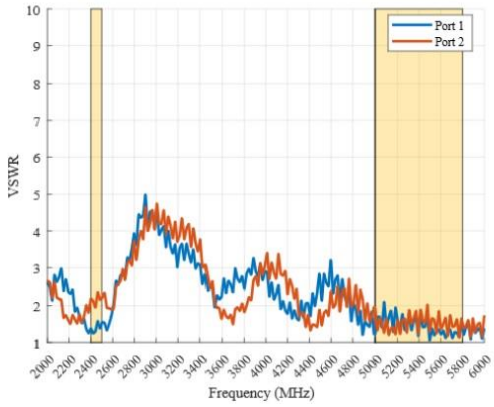
VSWR: Cellular Antenna



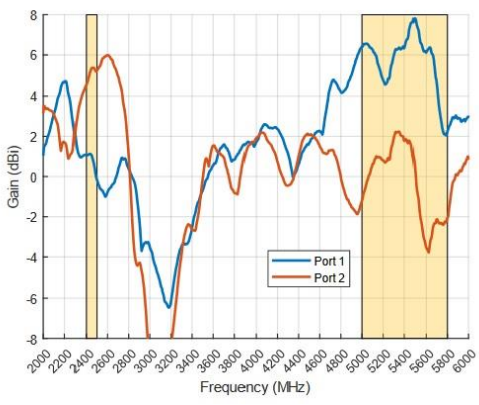
Gain: Cellular Antenna



VSWR: Wi-Fi Antenna



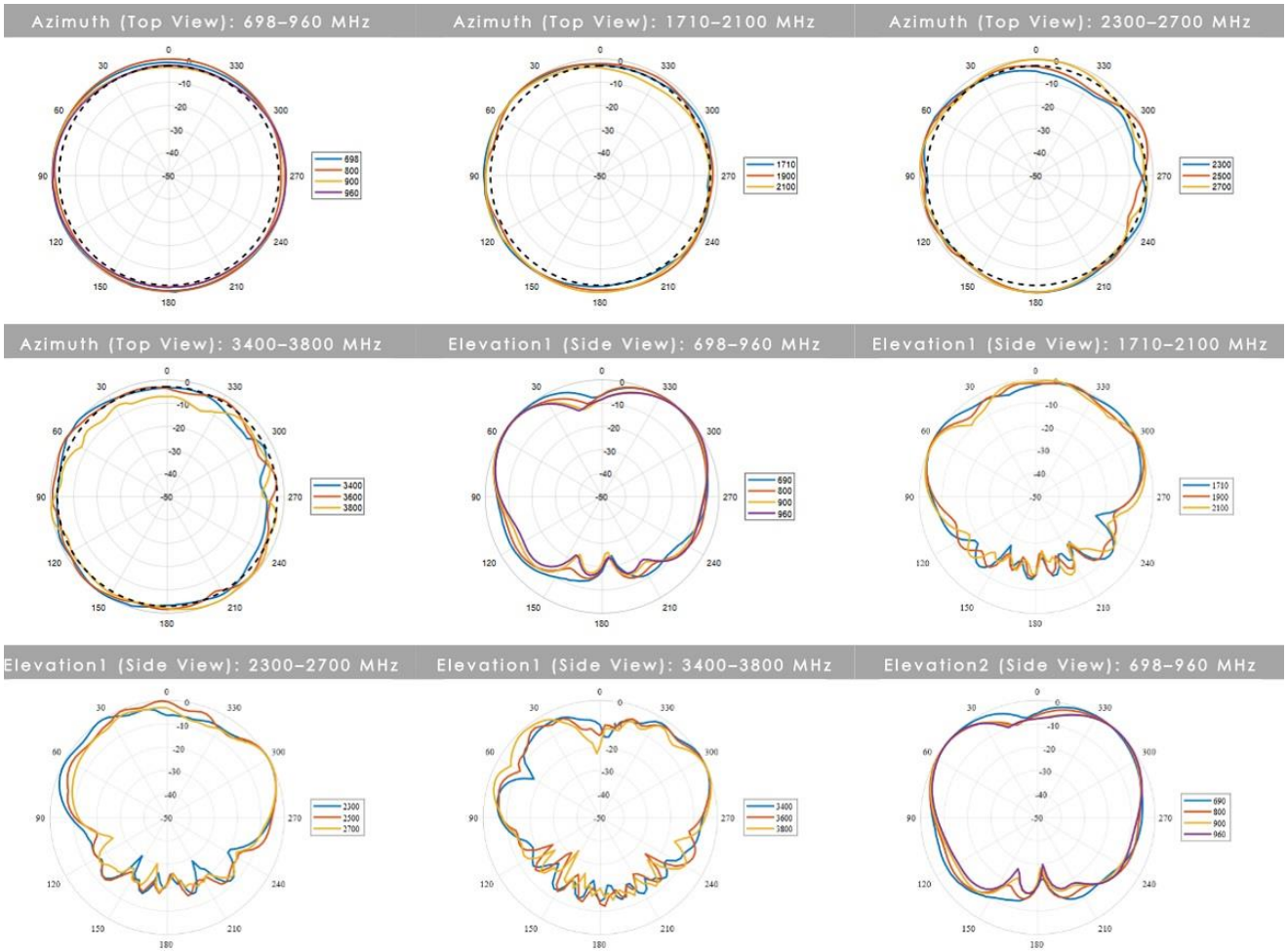
Gain: Wi-Fi Antenna



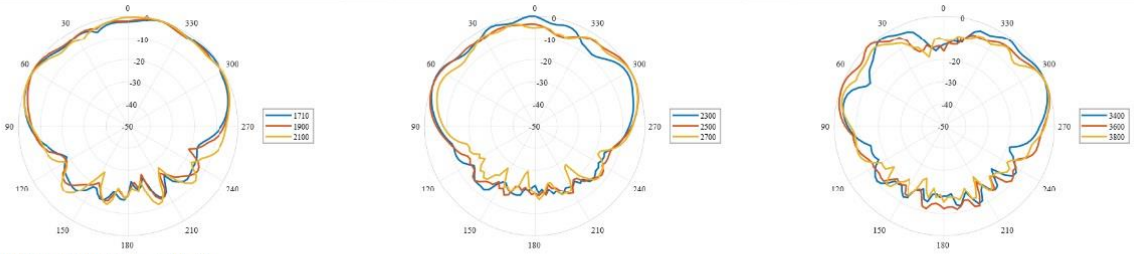
Antennas have gain in dBi. 6dBi is the peak gain in all bands from 698-960, 1710-2700 and 3400-3800 MHz, while 7.5dBi is the peak gain in all bands from 2400-2500, 5000-5800 MHz.

Additionally, the gain for other frequencies was confirmed:
- Gain at 698-960 MHz: -1 dBi
- Gain at 1710–2700 MHz: 6 dBi
- Gain at 3400–3800 MHz: 6 dBi
- Gain at 2400-2500 MHz: 5 dBi
- Gain at 5000-5800 MHz: 7.5 dBi.

The following radiation patterns have been identified for the devices:

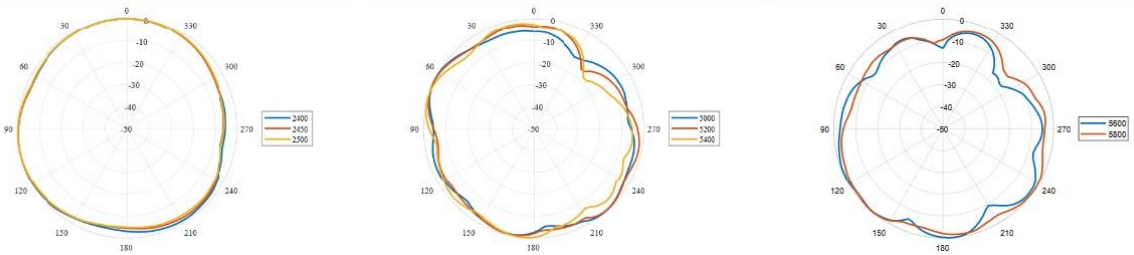


Elevation2 (Side View): 1710–2100 MHz | Elevation2 (Side View): 2300–2700 MHz | Elevation2 (Side View): 3400-3800 MHz

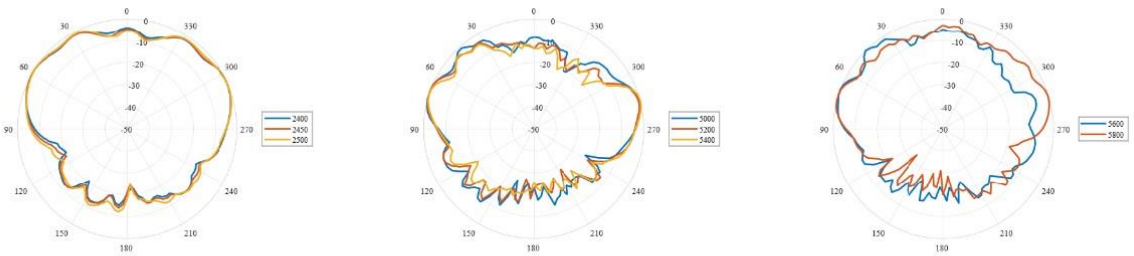


Radiation Patterns – Wi-Fi

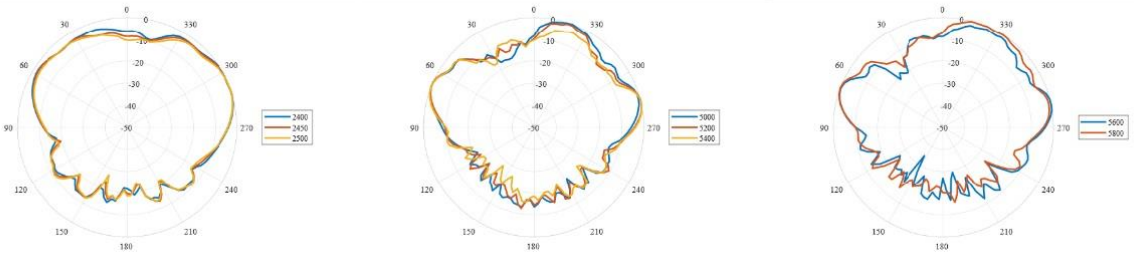
Azimuth (Top View): 2400–2500 MHz | Azimuth (Top View): 5000–5400 MHz | Azimuth (Top View): 5600–5800 MHz



Elevation1 (Side View): 2400–2500 MHz | Elevation1 (Side View): 5000-5400 MHz | Elevation (Side View): 5600–5800 MHz

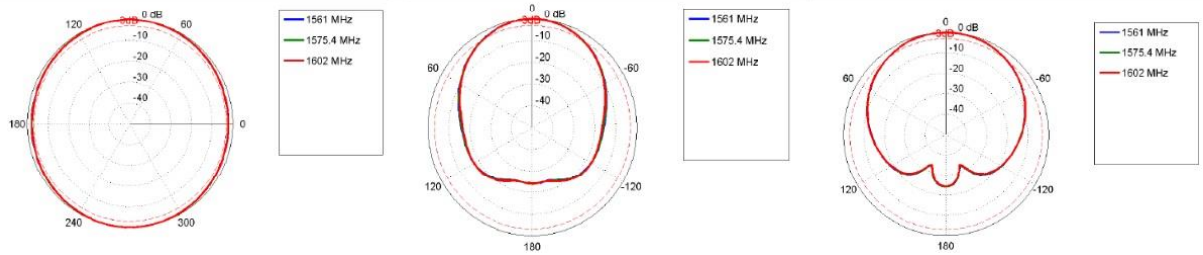


Elevation2 (Side View): 2400–2500 MHz | Elevation2 (Side View): 5000–5400 MHz | Elevation2 (Side View): 5600–5800 MHz



Radiation Patterns – GPS

XY Plane: 1561–1602 MHz | XZ Plane: 1561–1602 MHz | YZ Plane: 1561–1602 MHz



PWR constant

Channel	Frequency	Meas freq [GHz]
0	2,4	2,399965
5	2,405	2,404966
10	2,41	2,409966
15	2,415	2,414966
20	2,42	2,419966
25	2,425	2,424964
30	2,43	2,429964
35	2,435	2,434964
40	2,44	2,439964
45	2,445	2,444964
50	2,45	2,449964
55	2,455	2,454964
60	2,46	2,459964
65	2,465	2,464964
70	2,47	2,469964
75	2,475	2,474964
80	2,48	2,479964

Spectrum analyzer setup: freq +/- 100kHz BW 620 Hz Amplitude Ref level 20dBm

Cable losses included

Channel constant - 5		
	Meas PWR [dBm]	
Value [dBm]	Min	Max
8	7,06	7,08
4	3,57	3,6
0	-0,26	-0,22
-4	-4,42	-4,4
-8	-7,86	-7,81
-12	-11,74	-11,72
-16	-15,73	-15,71
-20	-20,08	-20,06
-30	-40,79	-40,76

Channel constant - 40		
	Meas PWR [dBm]	
Value [dBm]	Min	Max
8	6,79	6,8
4	3,32	3,34
0	-0,74	-0,73
-4	-4,97	-4,96
-8	-8,44	-8,42
-12	-12,37	-12,36
-16	-16,41	-16,39
-20	-20,74	-20,71
-30	-41,44	-41,38

Channel constant - 75		
	Meas PWR [dBm]	
Value [dBm]	Min	Max
8	6,58	6,59
4	3,06	3,07
0	-0,84	-0,82
-4	-5,13	-5,11
-8	-8,62	-8,61
-12	-12,57	-12,55
-16	-16,58	-16,55
-20	-20,94	-20,92
-30	-41,64	-41,6

The measured output power value and set power value slightly differs. This differences are mainly due to additional band pass filter (integrated with the matching circuit required for the nRF52840 RF pins) and probe connector.

Raw measurement

Channel constant - 5		
	Meas PWR [dBm]	
Value [dB	Min	Max
8	3,38	3,4
4	-0,11	-0,08
0	-3,94	-3,9
-4	-8,1	-8,08
-8	-11,54	-11,49
-12	-15,42	-15,4
-16	-19,41	-19,39
-20	-23,76	-23,74
-30	-44,47	-44,44

Channel constant - 40		
	Meas PWR [dBm]	
Value [dB	Min	Max
8	3,23	3,24
4	-0,24	-0,22
0	-4,3	-4,29
-4	-8,53	-8,52
-8	-12	-11,98
-12	-15,93	-15,92
-16	-19,97	-19,95
-20	-24,3	-24,27
-30	-45	-44,94

Channel constant - 75		
	Meas PWR [dBm]	
Value [dB	Min	Max
8	3,02	3,03
4	-0,5	-0,49
0	-4,4	-4,38
-4	-8,69	-8,67
-8	-12,18	-12,17
-12	-16,13	-16,11
-16	-20,14	-20,11
-20	-24,5	-24,48
-30	-45,2	-45,16

cable loss [dB]

@ 2.4GHz	@2.42-2.5GHz
3,68	3,56

SUMMARY OF PART C

The analysis of the possibility of using the Poynting PUCK 5 low-profile omnidirectional antenna (or relevant products) allowed to draw the following conclusions:

1. An element of the system can be the tested external bus antenna enabling data transmission using the infrastructure of cellular networks and locations.
2. The antenna for use in bus vehicles should be closed in a compact housing made of plastic, e.g. ABS, and free from protruding elements that are not resistant to automatic vehicle washing.
3. Each antenna operating within the Interconnect system should have integrated two antennas for the bands of working cellular networks, two Wi-Fi antennas (dual-band 2.4 GHz and 5 GHz) and one antenna for the navigation system.
4. The gain of the antenna for use in bus vehicles should be at least as follows:
   - 0.95dBi @ 410 - 470 MHz,
   - 3.4dBi @ 690 - 960 MHz,
   - 5.7dBi @ 1710 - 2700 MHz,
   - 3.9dBi @ 3400 - 3800 MHz.
5. Each antenna for the navigation system should have an integrated low-noise amplifier with a gain of at least 18 dBi and compatible with the power supplied by the main module of the test set.
6. Connection to the antenna should be provided by means of durable, twisted SMA connectors (SubMiniature version A coaxial connector), providing the output impedance of the ports equal to 50 Ohm.
7. The antenna should be resistant to external weather conditions, with a tightness class of IP68 or higher and a strength class not lower than IK10.
8. The length of the antenna cables should be at least 2m.
9. The antenna should be CE certified and compliant with the RoHS standard (i.e. the provisions of the Restriction of Hazardous Substances Directive).
10. The weight of the antenna should not exceed 0.7 kg, and its external dimensions should not exceed 200x130x100mm (length x width x height).
11. It should be possible to mount the antenna to the roof of the vehicle using mounting screws or a magnetic base.

All these requirements are met by the tested low-profile omnidirectional PUCK-5 antenna (or relevant products). Therefore, it can be treated as a reference point for further expansion of the system in other regions in Europe.