Deliverable D7.3

Demonstrators

WP 7

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Project Summary

The objective was to establish an IT environment for the integration and analytics of data streams coming from high volume (mass) products with cyber physical features, as well from Open Data Sources, aiming to offer new cross sectorial services and focusing on the commercial confidentiality, privacy and IPR and ethical issues using a context sensitive approach. The project addresses cross-stream analysis of large data volumes from mass cyber physical products (CPP) from various industrial sectors such as automotive, and home automation. The business objective of the research was to allow for analyses of such data streams in combination to other (non-industrial, open) data streams and for the establishment of diverse enhanced sectorial and cross-sectorial services. The project has developed: (i) New models for integration and analytics of data streams coming from multi-sectorial CPP, including shared systems of entity identifiers applicable to multi-sectorial CPP (as well as the definition of agreed data models for data streams from multiple CPP aiming at defacto standard; (ii) Ecosystem, including a common Marketplace, and methodology to use such models to build multi-sectorial cloud based services, (iii) Toolbox for real-time and predictive cross-stream analytics, context modelling and extraction, and dynamically changing security policy, privacy and IPR conditions/rules and (iv) set of services such as services based on a combination of data streams from home automation and (electrical) vehicles to provide enhanced local weather forecast and predict and optimise energy consumptions in households. The project outcome build upon the results from past and current projects, where results from the project AutoMat, addressing services developed based on data streams from vehicles, will be used as a basis for further development aiming to extend it to integrated, cross-sectorial data streams analytics.

Project Consortium

- Institut für angewandte Systemtechnik Bremen GmbH (ATB), Germany
- Volkswagen AG (VW), Germany
- Siemens SRO (SIM), Czech Republic
- Meteologix AG (ML), Switzerland
- ATOS Spain SA (ATOS), Spain
- X/Open Company Limited (TOG), United Kingdom
- Universidad Politecnica de Madrid (UPM), Spain
- Vysoke Uceni Technicke V BRNE (BUT), Czech Republic

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Dissemination Level

PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Change History

Version	Notes	Date
01	Creation of the document	05.01.2021
02-09	Integration of partner inputs	-/-
100	Final version	12.03.2021

Document Summary

This deliverable comprises an overview on the implemented three industrial demonstrators of the Cross-CPP Ecosystem and cross sectorial services. The deliverable will also include the report with three cases studies presenting the use of the Cross-CPP Ecosystem at three industrial partners.

Abbreviations

API	Application Programming Interface
App	Software Application
B2B	Business-to-Business
CPP	Cyber Physical Products
D	Deliverable
dBZ	decibel relative to Z
e.g.	exempli gratia = for example
Etc.	et cetera
GPS	Global Positioning System
GUI	graphical user interface
h	Hour
HD	High Definition
i.e.	id est = that is to say
KM	Kilometre
LES	Large Eddy Simulations
SDK	Service Development Kit
UC	Use Case
UTC	Coordinated Universal Time
WP	Work Package

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1 Overview on Demonstrators

This document provides an overview of all Cross-CPP Demonstrators available to the Public. The following sub-chapters provide reference links to all material provided. All the demonstrator videos can be found on:

YouTube https://www.youtube.com/channel/UCAz0TKBcV9_o10XSR0Ypuxg

CROSS-CPP https://www.cross-cpp.eu/demonstrators

The figure below gives an overview of the whole Cross-CPP ecosystem developed and its several components being part of the Cross-CPP value-chain. For most of the component a demonstration is made available which are shortly described below.

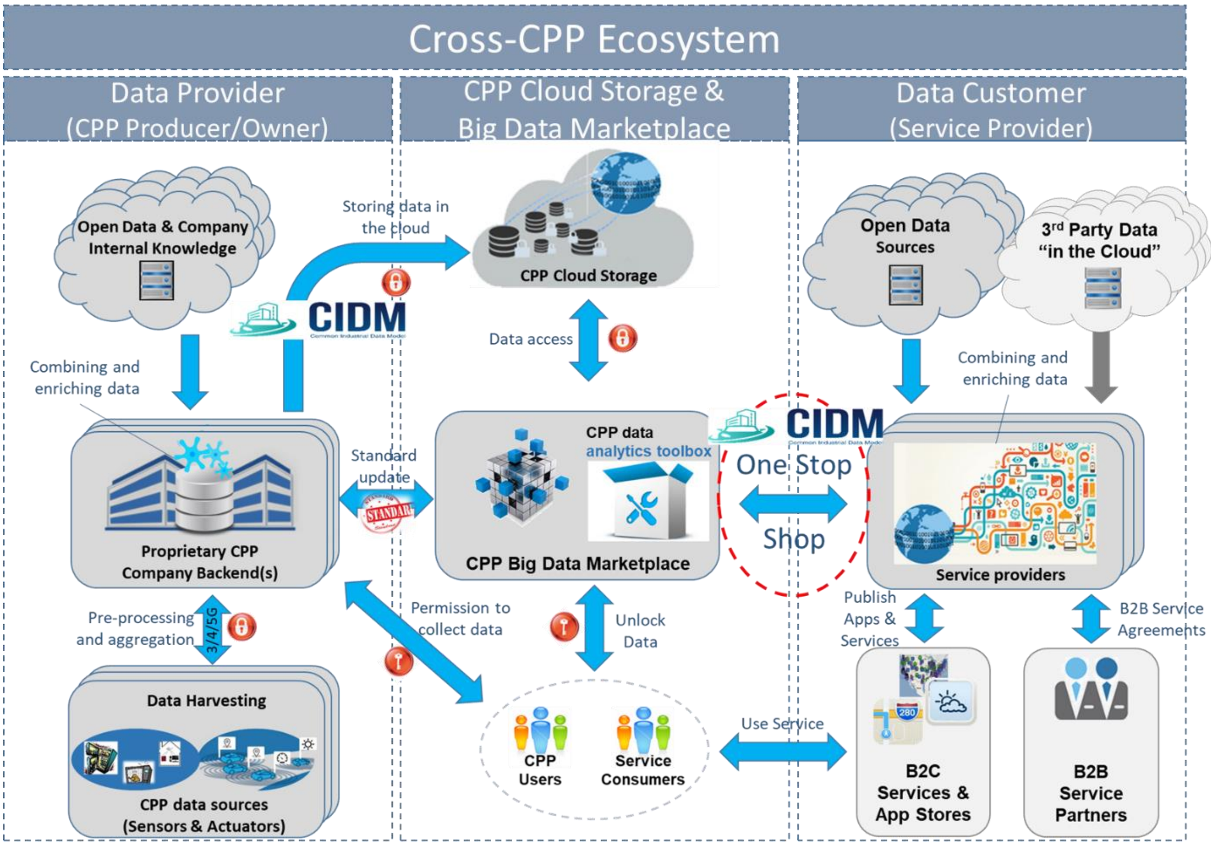
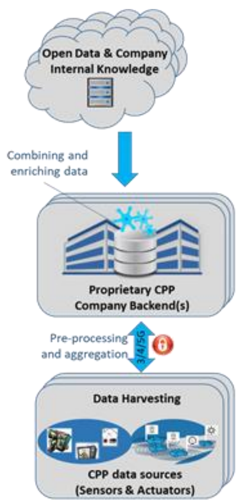


Figure 1: Cross-CPP Ecosystem Components

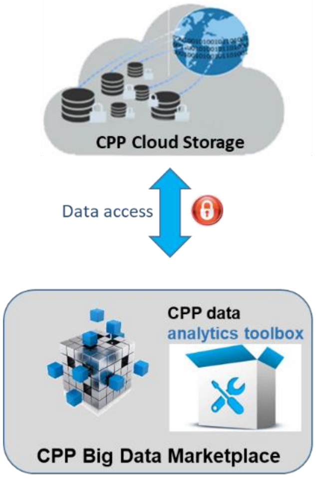
1.1 CPP data capturing



The CPP data capturing is done by VW for vehicles and Siemens for building data, both partners maintain their own backends. For both OEM's individual demonstrators are available, which are part of their Service demonstrators. The stories for VW and Siemens can be found here:

- Check here and see VW data capturing story: https://www.cross-cpp.eu/demonstrators
- Check here and see Siemens data capturing story: https://www.cross-cpp.eu/demonstrators

1.2 Cloud Storage, Market Place and Toolbox



The CPP Cloud Storage is a cloud-based data storage infrastructure that offers secure and private data vaults to data providers, to store their devices data packages in the Common Industrial Data Model format.

The CPP data marketplace is an Open Connected Vehicle Platform and Home Building that handles the brokering of brand-independent data from the different IoT devices allowing Data Consumers to create new B2B and B2C data-based products and services.

The Analytics Toolbox simplifies the extraction of the latter, by providing a set of libraries and modules designed to satisfy most data-related needs, and based on the most recent concepts and algorithms developed by the scientific community.

Described as the "New Oil" of the 21st century, data has the potential to shape economies around the world. The European Commission is building a European data economy for a fully Digital Single Market, where people and companies can enhance their positioning, by gradually removing the barriers and legislative constraints when using or re-using specific data. Especially machine-generated and machine- to-machine data in a B2B context.

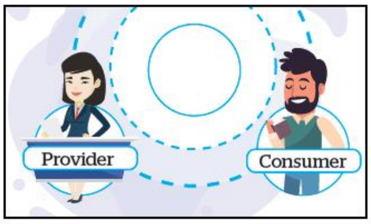
Smart Vehicles and Smart Buildings are two industries that have increasingly grown in the last decade. However, due to privacy and usage concerns, the data generated by the different devices are only used for specific cases, throwing away the potential for re-using it for the creation of novel services.

The large amount of continuously gathered data on these industries, represents major big data business potentials. Also, for cross-sectorial industries with interdisciplinary applications such as: insurance services, machine learning models to improve maintenance of roads in the cities or the quality resolution of local weather forecasting services, among others.

Within this context, Cross-CPP data marketplace (AGORA) is a cross-industries data marketplace that handles the brokering of brand-independent data, for allowing cross-sectorial creation of new B2B and B2C data-based products and services in the area of Data Economy.

Through a seamless and secure experience for exchanging and monetizing datasets, Cross-CPP data marketplace (AGORA) connects cross-sectorial Data Providers and Data Consumers for selling and acquiring harmonized datasets under the standardized data model (CIDM).

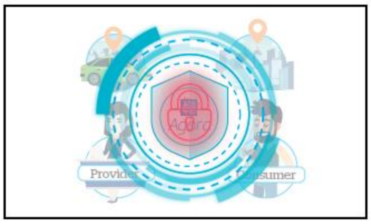
Cross-CPP data marketplace (AGORA) provides multiple benefits for both Data Providers and Data Consumers like the example of Emma and Tom in the figure.



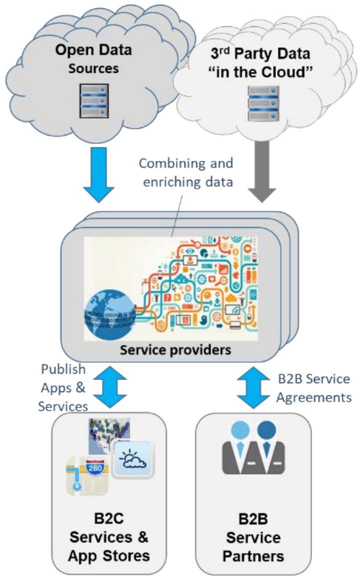
Emma is a Data Consumer leading an international insurance company. Tom is a Data Provider managing a vehicle rental company

Based on the vehicle data, Emma could create tailored "Pay How You Drive" insurance services for Tom's customers

- Normally, to access this data the two parties would have to sign an individual and closed data-sharing agreement, which implies a complex process: definition of infrastructure and service requirements, negotiations, waiting for resources to be provisioned until the middleware and databases are configured, and a series of steps until the release of the data is done.
- Under this time-consuming model, the "Data Journey" for the creation of data based B2B services using isolated and restricted data from only one Provider.
- Using AGORA Data Marketplace, Emma could explore multiple datasets in a faster way, and Tom can securely monetise the data among multiple cross-sectorial users.
- By registering and signing in as Data Provider or Data Consumer, they could sell and/or acquire various datasets and access a set of features on an end-to-end data platform.



1.2.1 How can AGORA help you on discovering new valuable services based on data?



- **B2B data marketplace** connects data providers and data consumers to facilitate the access, acquisition & monetization of cross-industries. Currently, vehicles and home building data are available but in the future other industries will be available.
- **Privacy and Security preserving:** Have full control over data shared, to whom and for which purposes, with personalized consent for data collection
- **Use of the Common Industrial Data Model (CIDM)**: uses open source Common Industrial Data Model to harmonize data catalogue of signals from cross-industries responding to data interoperability.
- **Open API and SDK** Search for more than 400 sensor signals, display advance visualization representations and retrieve datasets in a seamless experience.

Check here and see the promotional video of Cross-CPP data marketplace (AGORA) video here: https://www.cross-cpp.eu/demonstrators

1.2.2 Analytics Toolbox - Find the right data for You!

The Analytics Toolbox simplifies the extraction of the latter, by providing a set of libraries and modules designed to satisfy most data-related needs, and based on the most recent concepts and algorithms developed by the scientific community. It is buttressed by a modular structure, in which new analytics services can be added to fulfil new requirements; and in which multiple algorithms can be chained together, to give answer to even more complex questions.

The data analytics toolbox, will provide easy to use big data analytic functionalities for Service Providers, supporting an easy access, search/detection and selection of required data.

Check here to learn more about the Analytics Toolbox:

https://www.cross-cpp.eu/demonstrators

1.3 CIDM - a Brand Independent Data Exchange Model

The Common Industrial Data Model (CIDM) is an open and highly scalable big data format, designed to harmonize IoT proprietary data into generic datasets. Therefore, the CIDM provides a brand-independent and transparent data model, which harmonizes proprietary data into generic datasets. However, the CIDM is not rigid, rather representing a living data structure, where in reference to the needs of the service provider community the amount of signals to be recorded as well as the type of measurement channels can be modified or extended.

Check here to learn more about Common Industrial Data Model (CIDM):

https://www.cross-cpp.eu/demonstrators

Services

A set of innovative services have been developed, all build upon cross-sectorial data streams provided by our CPP Data Marketplace.

The following five services have been developed by Meteologix, Volkswagen and Siemens:

- Service 1-3 by Meteologix:

  From 1x1km weather model to 100x100m city-scale weather model, Individualized weather forecast for smart buildings, and. virtual radar derived from CPP.
  https://www.cross-cpp.eu/demonstrators

- Service 4 by Volkswagen:
  Advanced Vehicle Service - Real time drivers warning and weather-based navigation.
  https://www.cross-cpp.eu/demonstrators
- Service 5 by Siemens:
  Smart city/building solutions: Mobility, E-Charging and Building energy management service solutions.
  https://www.cross-cpp.eu/demonstrators

A more detailed description of development cross sectorial services using CPP data flows from Cross-CPP Big Data Marketplace is giving in the following sections.

2 Meteologix Services Case Study

During the Cross-CPP project, Meteologix has built several prototypes for CPP based services that are designed to make use of CPP data from “foreign” sensors to fully exploit the possibilities of big data for meteorological applications.

For that, Meteologix has taken various perspectives on the provided data and envisioned several exploiting strategies for varying meteorological use cases. The main goal of Meteologix’ participation was to build a data environment within our meteorological infrastructure to assimilate sensor data from CPPs most efficiently as ordinary assimilation procedures expect high-quality measurement data from weather stations. However, the data derived from CPPs has several features that are different from classical observational data used in weather data processing contexts. For example, CPP data is potentially much denser (in regard to both time and location) and often less accurate as more measurement errors are to be expected due to e.g., car color, driving speed, placement of the sensor etc. Hence, it was necessary to conceptualize and subsequently develop innovative plausibility checks that validate the incoming CPP data, and also to develop a weather model that was able to handle the density and small-scale measurement differences in a way that would not lead to the rejection of most incoming signals.

UltraHD city model prototype

Meteologix has thus made great effort to build a full-physics extremely small-scale weather model prototype - called the UltraHD city model - that is able to resolve weather dynamics and improve the parameterisation of skin temperature and applied fluxes on a 100m grid. This resolution together with a newly invented plausibility check algorithm for CPP data allows efficient and enhanced data assimilation of CPP data, e.g., from cars or buildings or moving sensors like bicycle temperature sensors. The UltraHD is nested into the Meteologix’ 1x1km SuperHD, which was thus also enhanced for the purpose of this project as the UltraHD is dependent on high-quality boundary data as starting input for its own calculations.

To clarify, the UltraHD is not a classic downscaling model, but its own full-physics model that explicitly resolves larger turbulent motions in the atmospheric boundary layer (so called Eddies). These large Eddies are crucial to describe mass and energy transport in the boundary layer. Also, microphysical processes which describe phase transitions in the atmosphere, e.g., cloud/rain formation, freezing and sedimentation of snow and rain, are treated explicitly at the 100m scale by the two-moment microphysical parameterisation.

This UltraHD prototype currently provides output for the most important weather parameters (e.g., 2m temperature, 2m due point, total column condensate, 10wind, surface pressure, precipitation rain/snow), which enables it to assimilate sensor data for these parameters into the UltraHD to enhance its initializing fields and subsequently its predictions. Those predictions can be visualized for example as forecasting maps:

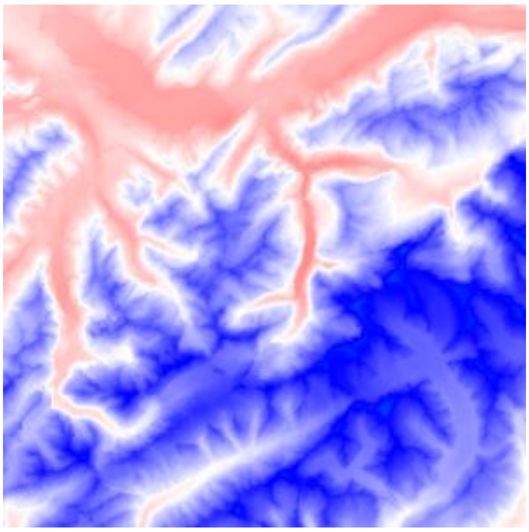


Figure 2: UltraHD model map of 2m temperature Interlaken (CH)

The difference in resolution and accuracy can be best demonstrated by model output comparison. Figure 3 shows the same map excerpt for the same time by two leading forecasting models (GFS and ECMWF), the third picture shows the corresponding model output of the UltraHD.

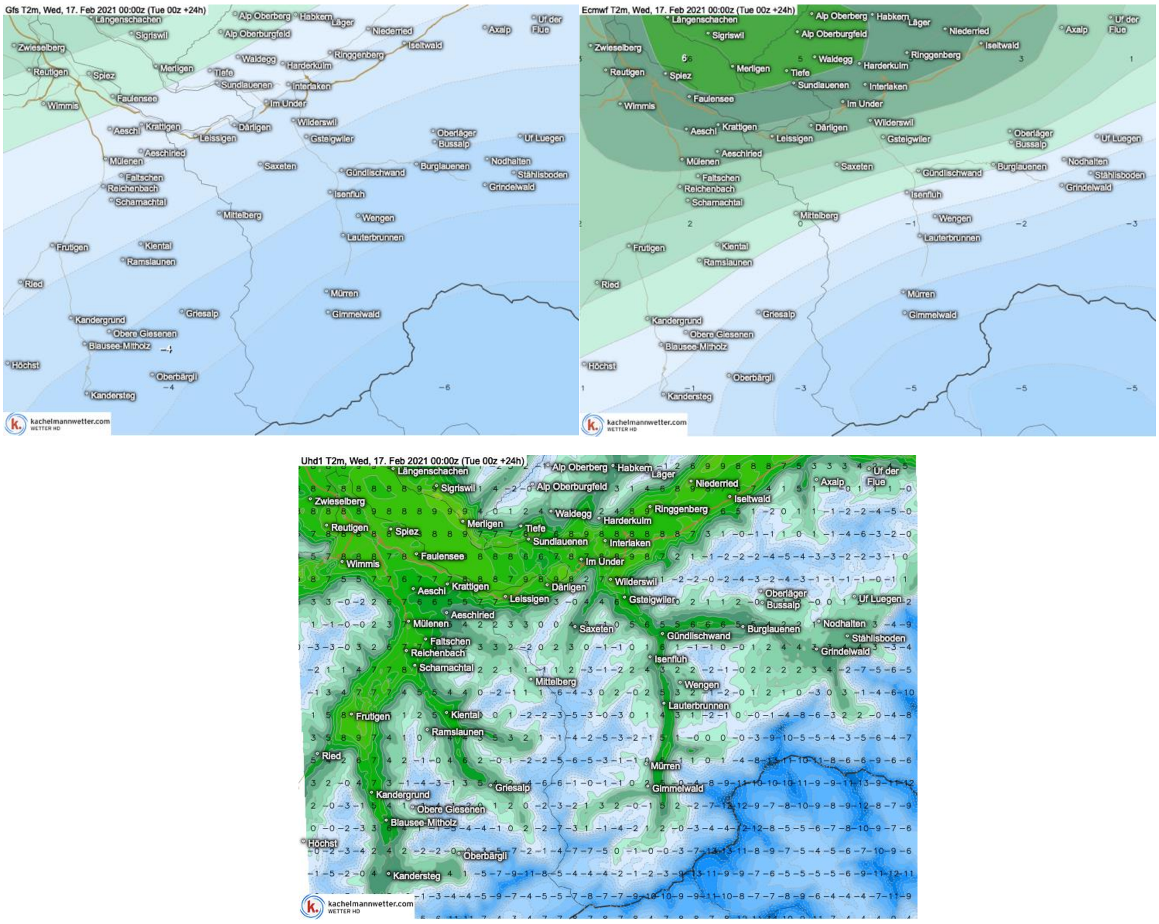


Figure 3: 2m temperature region Interlaken (CH), 17.2.21, 00z): GFS output (left), ECMWF output (right), UltraHD output (middle)

Beginnings of small-scale air quality forecasting:

The UltraHD model was also extended with a simple atmospheric chemistry model to model air quality including the following reactants: nitrous oxide, nitrous dioxide, nitric acid, ozone, hydroxyl radical, hydrogen peroxide, volatile organic compounds and organic peroxyradicals. Furthermore, a set of 22 additional equations was implemented including radiation dependent photolysis of ozone, reactions with atmospheric humidity and the formation of nitric acid. In addition, equations for the emission and deposition of passive atmospheric tracers like pm10 and pm2.5 were included.

Despite the additional variables and equations increased the memory and computational demand of the model significantly, it was possible to build a three-dimensional setup to simulate the lower troposphere for the region Tübingen/Stuttgart (GER) in real-time. A detailed analysis of infrastructure was necessary to parameterize emission of the NOx and PM compounds. This was done using OpenStreetMap data and identifying highways and certain urban structures as possible sources.

For validation of the UltraHD, we have nested it in several testing areas: Tübingen/Stuttgart (GER), Greater Basel (CH), Wolfsburg (GER), Berlin (GER), Leipzig (GER), and areas in the Swiss mountains: region around Interlaken (CH). A quantitative validation of the UltraHD is still ongoing as well as its further development.

Smart building ML-based weather forecasts

Besides the invention of a small-scale weather model for CPP data ingestion, we wanted to test the usage of CPP data for other meteorological applications that are more industrial user focussed, like the enhancement of already existing meteorological CPP data outputs of building or industrial sites. For this, we co-operated with consortium partner Siemens, accessed their building data via the Cross-CPP marketplace, and helped them to refine the weather predictions they received for their smart buildings by running machine learning models based on the historical data of their on-site weather stations, that are usually located at the roof of the building. These models learned by the historical measurement data and historical weather model output the building specific deviations and biases, and subsequently reduced them for new forecasts.

By applying these models, we were able to reduce the forecast errors for the Siemens buildings by ~40%, resulting in a remaining error of just ~1.49 °C between the so enhanced forecast for the building and the actual observation.

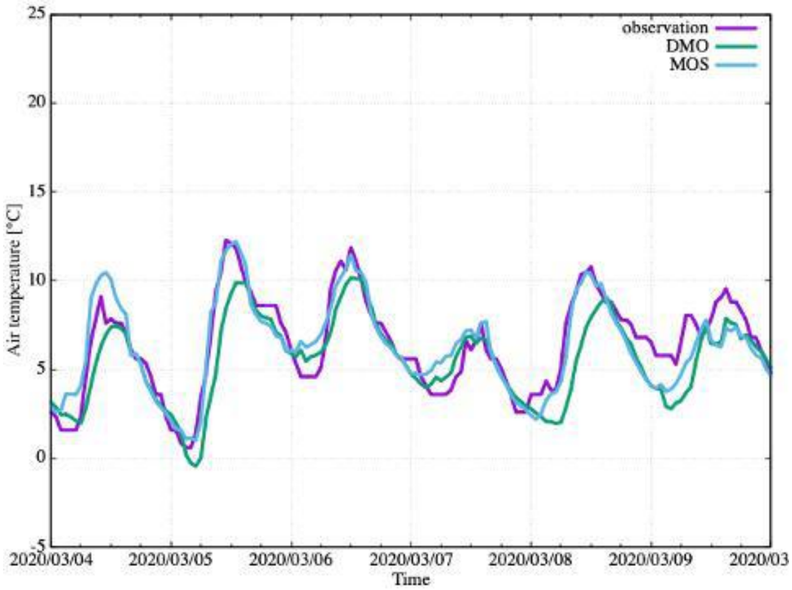


Figure 4: Exemplary time series of the observed air temperature (purple), air temperature from DMO (green) and the predicted air temperature (blue) for one week in March.

Virtual Radar

Another approach for using CPP data for meteorological purposes was to explore the possibilities of utilizing car rain sensor data and car wiper data. We conceptualized a “Virtual Radar” based on CPP sensor data instead of actual weather radar data that could be used to gain insights into real time rain events in regions that do not have expensive weather radars or where those are not publicly available.

We investigated which development steps would be necessary to build a service like that, and found that the output and measurement of car rain sensor data and wiper data is not standardized across all vehicles and vehicle types, thus effort is needed to account for those differences. Furthermore, the driving speed and the angle of the windshield needs to be considered when deriving precipitation data from windshield sensors as they play a crucial role on how much rain actually lands on the windshield.

Afterwards, the measured rain signals need to be calibrated regularly by using standard rain measurements (like weather radars) to gauge the output properly. And finally, the so collected precipitation data needs to be aggregated and visualized in almost real-time precipitation maps, which could then potentially used to issue warnings (e.g., flash flood warnings).

Our project results indicate that the car sensors (at least in the VW cars in this project) are very sensitive even to small droplets. The maximum value of 10 is reached in a lot of weak rain events (low radar reflectivity <10 dBZ), suggesting that the sensors are triggered not (only) by intensity but instead (also) by droplet number. Rainfall intensity measured by traditional weather stations (in liter/m² water equivalent) is a function of drop size and number.

Despite the preliminary findings regarding the limitation of the intensity range, the car data sensors show potential in some applications. For example, the discrimination between radar echoes reaching the ground and those evaporating beforehand. Or for filling the remote sensing gap of drizzle, i.e., very fine/small droplets which are rarely detected by typical radar devices.

On the other hand, cars will likely not be able to replace a precipitation radar, at least not in the given configuration with a capped intensity value, because summer-time intensities are expected to be of intensity 10 (highest intensity in the testing vehicles) almost always.

During the Cross-CPP project, we investigated the development steps to create a CPP-based *virtual radar* and also developed the calibration procedure, and processing algorithms to extract a valid and reliable signal from some vehicle types, however, intense testing with more car rain sensor data, and subsequently further calibration periods are needed to fully develop a fully functional independent prototype service based on these theoretical proof-of-concept procedures. Nevertheless, based on our tests during Cross-CPP, Meteologix is confident that a service like that is possible and a valuable addition to conventional weather observation sources.

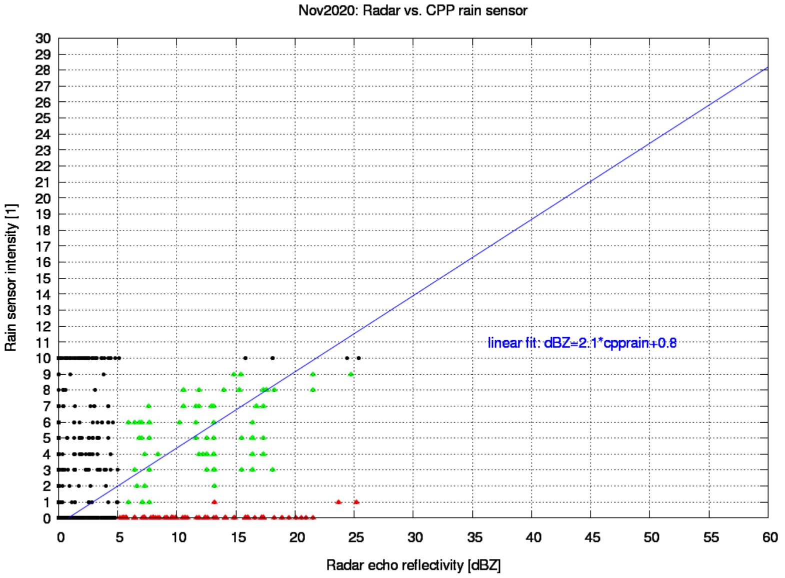


Figure 5: Scatter plot of cars' rain intensity sensor (y-axis) versus precipitation radar reflectivity (x). Red data points have been detected as implausible, black points have not been used during calibration because of low confidence in low-dBZ radar values.

Storm-cell intersection program

Lastly, Meteologix participated in the joint service project of a weather-based navigation for cars that warns the driver in advance of and during their trip of significant weather events. For this, we developed a real-time storm cell tracking to detect thunderstorms and track their pace and direction. This storm-cell tracking enables us to intersect the driver's route with the forecasted thunderstorm's path to issue warnings to the driver. Get more information on this service at the service description from VW.

In sum, Meteologix has come to the conclusion that CPP data can aid the expansion of meteorological solutions to new market sectors like smart technology as well as logistics and more user centred services despite the classical weather forecasting app. Meteologix has also shown that the quality of CPP data is diverse, but usually sufficient for meteorological purposes as its data quality deficiencies in comparison to classical meteorological observations can potentially be compensated by data density as CPP data usually is available in much larger amounts than professional measurements.

Meteologix has created a demonstrator video that shows you the rationale behind each prototype and its business use case. You can find the video here: URL

4 VW Service Case Study

New services around the car will be a main business case for upcoming vehicle generations and already in scope in the automotive industry. Volkswagen has within the built advanced innovative services for their vehicle customers, based on a cooperation with the weather expert Meteologix, which shows the possibilities with cross functional usage of data as prototype. Basis for the VW services are very precise local weather forecast information, which are firstly possible by using and combining data gathered from different CPP data sources (e.g. data from buildings and vehicles) with data from traditional weather stations, satellites, etc. This forecast information is offered as a service to VW, who has built by means of this B2B service own weather warning services (aqua planning, slippery road warning etc.) for their vehicle customers. Moreover, VW uses this high-precision and local weather forecast information to build a next generation navigation service, enabling a routing based on real time and forecasted weather information.

In this scenario, the driver is warned in real-time about weather-related dangerous road conditions in his near surroundings. In addition, a foresighted routing avoiding weather-related danger spots is offered to the vehicle customer.

Two data streams build the basis for this service:

- Real-time and forecasted weather-warning data from Meteologix company backend directly to the VW service backend.
- Raw slipperiness vehicle data from the Cross-CPP Big Data Marketplace.

The concept of this service not only offers enhanced comfort and safety to the driver, it also addresses a key challenge of autonomous driving – reliable environment information. Self-driving cars rely on real-time and forecasted weather and road condition information in order to anticipate the driving style, for example, drive particularly slowly when aquaplaning danger is ahead. The foundation of such a system consists of several car sensor data like outside temperature and rain intensity combined together with weather data from different CPP data sources and analyzed by a weather expert like Meteologix and is processed into real-time and forecasted weather-warning data.

Objectives and key functionalities

The service implemented by VW is a mobile application with two basic user options:

1. **Warnings in the user's proximity**. This option alerts the user in form of visual and/or sound signals displayed in the application about approximating dangerous road conditions such as slipperiness, aqua planning or bad weather conditions that could affect driving safety.
2. **Weather-based navigation**. This option gives the driver the possibility for re-planning his route before achieving the region where bad weather or dangerous road conditions like slipperiness or aquaplaning occur. Therefore, after entering the desired destination, the user has the option to choose between a safer guidance with no or less weather warnings and the regular guidance (shortest/fastest navigation). Real-time and forecasted weather-warnings from Meteologix build the basis for enablement of the navigation.

In order to ensure reliability of the service, it is crucial to determine above which level or threshold a weather warning is relevant to the driver. Basis for this evaluation are road safety, traffic regulations and likelihood of vehicle damages.

GUI examples

The user has two user options: the "warning mode" and the "navigation mode". Per default, the former is the displayed mode after opening the application. In this mode, the driver is being alerted about upcoming dangerous road conditions and severe weather warnings by showing a warning icon and a short warning message. By clicking "Navigation mode" the user can enter a desired destination to be navigated to (frame 3 Figure 6). In case of warnings on the route, these are displayed as warning icons on the map with a short text at the top side of the application (frame 6 in Figure 6). In addition to the fastest route an alternative route avoiding the bad weather region is visualized on the map. The user can now choose between the fastest route (normal navigation) or the alternative route (safer navigation) to be navigated to the desired destination.

The user has the option at any time to change modes, i.e. from navigation to warning mode and vice versa.

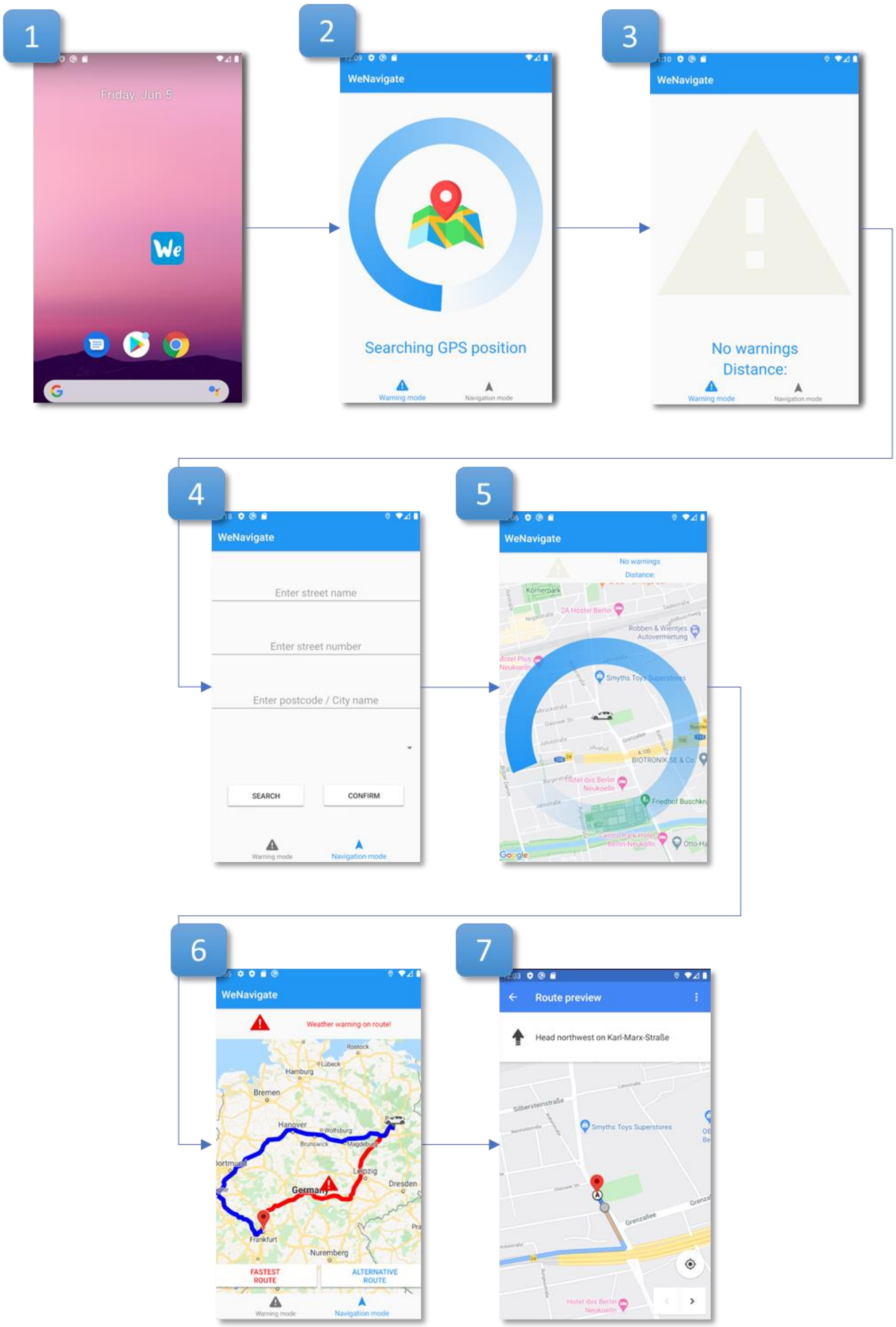


Figure 6: Application wireframe of Service 2.

This type of service allows Volkswagen to offer its customers an improved and, above all, safer driving experience. For example, the service shown here as a prototype in an app can also be integrated into the vehicle's native navigation system in the future.

5 Siemens Service Case Study

What makes a city smart? Smart city solutions contribute to the effective management of urban areas, improving connectivity, sustainability, and livability.

How can we improve city life? The quick answer is: data. Cities, in all their complexity, generate huge volumes of it, all the time. We can use these insights to optimize the systems that support our urban lives – from transportation and health, to energy consumption and safety. And these are real, tangible changes: by utilizing data, it's possible to improve emergency response times, reduce greenhouse gas emissions, and improve commutes. Dedicated solutions help leverage smart data to maximize city potential.

Mobility

For a sustainable mobility, managing the capacities of roads and traffic routes has to be holistic, predictive and focused on actual demand. Traffic managers need to reconcile multiple aspects such as cost-effectiveness, convenience, safety, and environmental protection. The prerequisite for this are data acquired from intelligent infrastructure systems, for example, from autonomous and connected vehicles.

The information gained from these data helps use roads and transportation routes to their optimum capacity and to create incentives for commuters that help improve traffic flows and mobility behavior – including solutions for safer and more convenient urban bicycle traffic. The result is an attractive city with excellent mobility options that is both green and livable.

E-Charging, car connectivity

The key to electromobility is energy. Through a new generation of charging infrastructure and advanced software, we provide the link between utilities, buildings and automotive to create one new dynamic digital space.

The increasing number of electric vehicles poses new challenges on distribution grid operators as well as fleets, gas station and other charging infrastructure operators. With our power system consulting offering we support in determining the effects on the power grid and recommend suitable measures. A well as providing business advisory for the planning, implementation and operation of eMobility charging infrastructures.

Building energy management

Every building starts at a different point on the sustainability journey – this creates unique sets of efficiency challenges and opportunities. From public entities to global enterprises, Siemens designs and implements building efficiency and sustainability improvement programs that are commensurate with the organization's own constraints and goals.

It's important to ensure that buildings remain fit for purpose for years to come, while managing resources and costs more effectively. This requires a holistic approach – and a partner that understands the technological opportunities for organizations that want to monitor, improve and report on the efficiency of their facilities. We combine the latest building technologies with advanced analytics and digital services capabilities that deliver new levels of building performance – for single buildings, campuses or geographically distributed facilities. In doing so, we help public, corporate and institutional investment real estate actors meet their strategic and operational goals.

Our service development is considering above mentioned main points related to Smart Cities.

Main thought of the service is to exchange information among data providers related to "E-Charging", meaning vehicles will be providing information about its battery status and other information relevant during the charging process, buildings about its e-chargers infrastructure – free charging locations and constraints.

Together with ML they are providing very precise weather forecast for our building based on the historical and current data, this serves as a base of building energy management performance regulation.

Furthermore, using real-time data in the communication online with the car / building about occupancy of e-charges placed outside of the building or inside (in the garages) in a way that the vehicle would send out its own information about its capacity of the battery. This together with its current position and speed could possibly calculate time of arrival and to reserve an e-charger for this specific car. Within the scope of the project, such a reservation will be done manually by the vehicle driver via application.

Based on information about battery capacity, the building will be able to calculate the time needed for full charge and then to reserve an e-charger for another interested parties.

With such data exchange, besides benefits for individuals, many other service providers could benefit:

- E-charger providers
- Facility managers
- Shopping malls, city centres
- Municipalities
- Fleet operators
- Payment for the e-charging service providers

To be able to charge the car with electricity, a big amount of energy is required. Such energy is not usually stored and has to be used ideally once it is available. Within the company backend, it will be evaluated how much energy is currently used and how much can be allocated for the charging. Especially when talking about Smart Building, energy efficiency and self-independence are core topics.

In a situation where the building is generating its own electrical energy from sources such as solar panels or wind turbines that cannot be controlled as needed and, moreover, the production is strongly depending on the weather, it would be helpful to have as precise weather prediction as possible.

With such information it could be estimated in what time there will be strong wind or sunshine and how much energy will be produced by the building. Based on an intelligent building management system it will be calculated how much energy the building will use for its own purposes and what amount could be used for e-charging stations. Knowing that, building owners then can offer its e-charging stations for a special price in order to not to lose generated energy.

Objectives and key functionalities

During the project duration and communication with consortium partners, development of the project is going to the direction that we are testing some of the possibilities that we thought previously only theoretically.

Especially the weather forecast that building could use for its own needs. That is described in the Meteologix use case in chapter. Based on the data provided by building, ML is able to provide precise weather forecast directly for the needs of that exact building. That strongly supports developing of the service because with such an information we can further evaluate and control energy management of the building, its dependency on the weather and eventually more possibilities of smart charging of e-vehicles.

Main objective is then to generate data by buildings in order to give information about availability of electric charger but also to get data from vehicles about its status and operational data.

All data is processed in a coordinated way between the partners.

The goal of the service is to increase awareness and show possibilities of use of big data which is essential part of the current and future Smart Cities. Since the service itself is very complex, after modification of its parts, it can be divided into several independent services and with those there will be new business opportunities for new service providers. Building owners, infrastructure providers, electricity distributors, owners of the households – all those can benefit with offering e-chargers and at the same time they can save money for the electricity, because it will be used wisely and where and when needed.

Of course, end-customer will benefit the most. Again, there will be significant saving of time, fuel and overall energy. The aim is to provide the driver with rather small number of free e-chargers that are ready to use.

By providing such possibilities to end-customers and other service providers, we expect increasing interest of installation of e-chargers on the site corporations, municipalities but also households. Typical providers could be shopping malls, airports, hospitals, current parking lots providers, city operators and more.

Bigger installed base of e-chargers will for sure attract new electricity vehicle users. Even though the impact of using electricity cars over the combustion and diesel engines on the environment is questionable. Increase of its used will boost production and support quicker development.

In general, with having this service in place in such or modified form, we expect positive consequences for the environment and "easier" life of involved parties which is not possible to measure but are in regards as follows:

- Less time needed for finding suitable spot
- Less pollution produced by vehicles
- Improvement of infrastructure, support of brownfields
- Emerge of new service providers
- Controlled energy consumption
- Effective usage of generated electrical energy
- Support of renewable energy sources

So beside economic and business impact there is also sustainability taking into the consideration.

App description

For accomplish the main goal of the application is necessary to run it online, therefore internet connection is needed. Also, another prerequisite is the location of mobile phone using its internal GPS module.

The GPS position is bringing different perspective to the problem at hand. In these days, the location is a very sensitive detail, so it is necessary to handle it in very protective way with the highest security policy. Data security is described further. With location are connected two other things which must be reconsidered – used technology for location determination and technology for evaluation and presentation aka maps application used for the service.

The map activities such as a:

- Showing user location
- Showing e-charger location
- Calculating the way
- Provide navigation ability

are provided by google maps application which is globally available. Thanks to this connection the main application is also extended by abilities e.g. road filtering (toll, highways, ferries), accidents reporting etc.

When all the prerequisites are met it is possible to successfully run the application. As the application is matched to the specific car and user, the registration/login function is necessary to have. The user must connect the application with the car he/she is driving so that the application can get the data about car from the server (e.g. battery capacity, charger interface and charger capabilities, car type and others). Thanks to the Marketplace is possible to skip the user input and get all needed data directly.

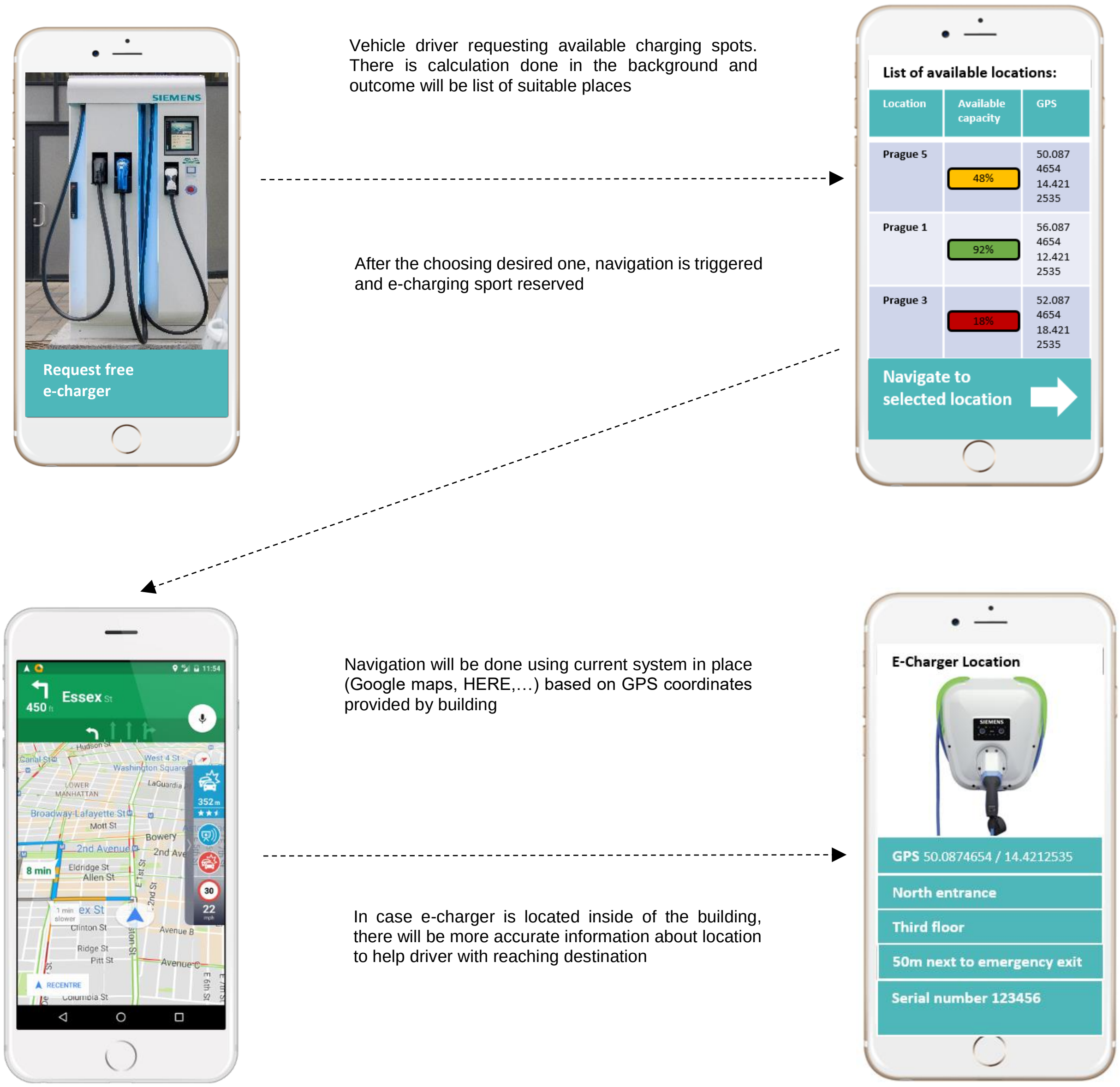
In first scenario when the driver is looking for suitable e-charger location the user's location is, as mentioned before, necessary. The prepared list of near available e-charger spots is obtained from Marketplace. The preparation process includes a multilevel filtering. Part of the filtering is processed in our company backend and its highly protected know-how of company. In short way the backend is providing all locations where the charging is possible with respect to building energy production and strategy, building reservation systems and to building manager decision.

The second scenario is supervision of charging vehicle. The data here is again obtained from the Marketplace thanks to all information provided by car manufacturer and its interface. The user can easily check the information about the charging process based on downloaded data.

GUI

End user will be using the application for finding available e-charging spots – choosing desired one – making reservation - being navigated to – confirmation of arrival / connecting to e-charger – follow the process – confirmation of finishing charging / departure.

Mobile application is the developed solution and an exemplary use is presented in Figure 7.



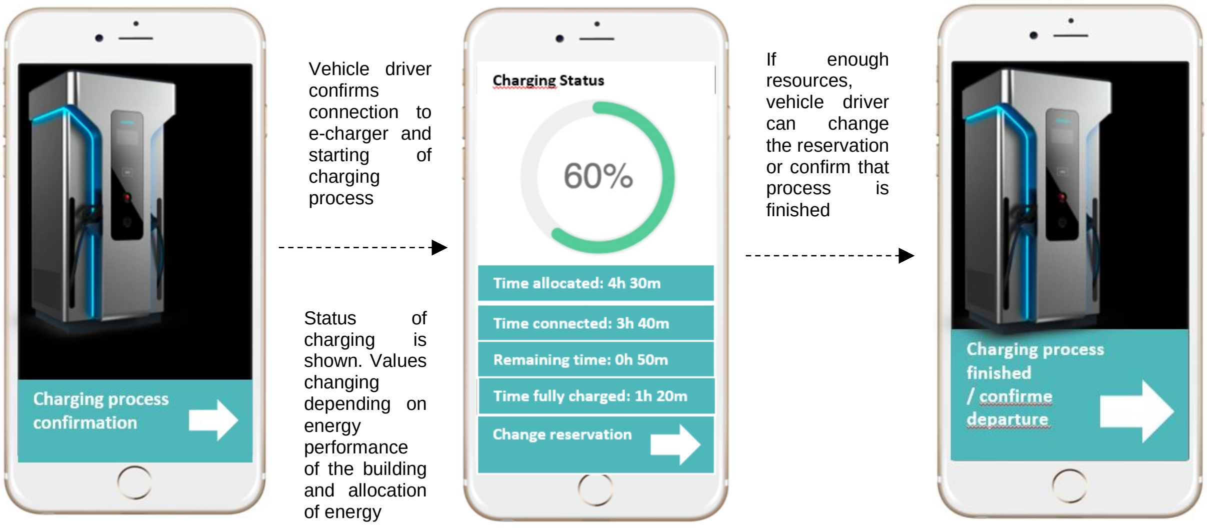


Figure 7: GUI of the E-Mobility Charging Service

6 Demonstrator links

As central link to all our Demonstrators you can use our:
Cross-CPP project web page: https://www.cross-cpp.eu/demonstrators
Cross-CPP YouTube channel: https://www.youtube.com/channel/UCAz0TKBcV9_o10XSR0Ypuxg

What	Description
CPP data capturing	Demonstrator of the VW and Siemens data capturing implementation, for gathering and transferring vehicles and building data into brand-independent data sets.
Cloud Storage & Market Place	The CPP Big Data Marketplace (AGORA), is a cross-industries data marketplace that handles the brokering of brand-independent data, for allowing cross-sectorial creation of new B2B and B2C data-based products and services in the area of Data Economy
Analytics Toolbox	Demonstrator of the Analytic Toolbox, data analytics toolbox, which provides easy to use big data analytic functionalities for Service Providers, supporting an easy access, search/detection and selection of required data.
Common Industrial Data Model (CIDM)	The Common Industrial Data Model (CIDM) is an open and highly scalable big data format, designed to harmonize IoT proprietary data into generic datasets.
Meteologix	UltraHD city model prototype Service: From 1x1km weather model to 100x100m city-scale weather model.
	Smart building ML-based weather forecasts: Individualized weather forecast for smart buildings
	Virtual Radar: Virtual rain Radar derived from car rain sensor data and car wiper data
Volkswagen	Advanced Vehicle Service: Real time drivers warning and weather-based navigation
Siemens	Smart city/building solutions: Mobility, E-Charging and Building energy management service solutions

CROSS-CPP