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MOBiNET: Architecture and experience from a marketplace for mobility services

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Abstract

The paper shows an innovative approach for a European-wide ITS service platform which addresses current barriers of cooperative system-enabled service deployments such as a lack of harmonised services, availability of communication means, inaccessibility and incompatibility of transport-related data, fragmentation of end user subscriptions and payment services, and proprietary technologies in user devices. The primary goal is the holistic simplification of the overall process by bringing together mobility service supply and demand in a common marketplace. In this paper we present an overview of the platform's architecture, the functionality available at the time of writing and an overview of future functionality requests.

Keywords: ITS PLATFORM, ITS SERVICES, E-MARKETPLACE

1 Introduction

MOBiNET is a collaborative project that aims at simplifying the Europe-wide deployment of transport and mobility services by creating an "Internet of Mobility". In this "Internet of Mobility", transport users' requests match service providers' offers and openness, harmonisation, interoperability and quality are being promoted. During the course of the project, MOBiNET develops, deploys and operates the technical and organisational foundations of an open, multi-vendor platform for European-wide transport and mobility services.

The key objective of the project is the simplification of the overall process of bringing together mobility services supply and demand in a common marketplace. The open platform is going to provide the required "glue" functionality to let service providers easily compose their services based on available data or other business-to-business (B2B) services and to

deliver their services to end users. End users will be enabled to easily discover and use these services.

Key MOBiNET innovations address the barriers of cooperative system-enabled service deployments, including the lack of harmonised service interfaces, availability of communication means, inaccessibility and incompatibility of transport-related data, fragmentation of end user subscription and payment services, and proprietary technologies in end user devices.

The selected development approach provides early, constant feedback on developed platform functionality, allows proper requirement adaption, and ensures overall quality of the platform. The third iteration of the platform has been released before the ITS World Congress 2015 in Bordeaux. During this event, a hackathon was organized by MOBiNET in order to provide access to the platform for users outside of the MOBiNET project itself and gain feedback on the usability of the platform at that time. From this feedback additional requirements were extracted which will be included in an improved platform version which is scheduled to be released in the summer of 2016.

This paper is structured as follows. First, we introduce the overall platform development approach after which we provide an updated description of the platform concept [1] including its platform components. Based on this background, we discuss the development status in more detail based on implemented requirements, first usage experiences and open feature requests.

2 Platform architecture overview

Figure 1 shows the conceptual architecture of the MOBiNET platform. The platform consists of two main components: the MOBiCENTRE, containing all central functionality to support service providers and other business stakeholders, and the MOBiAGENT, containing all functionality on end user devices. The MOBiCENTRE is designed as a modular and scalable distributed system. It provides commonly required infrastructure functionalities to support the service provider chain from service management to billing, communication, identity management, and data quality assessment. In this context, the MOBiCENTRE acts primarily as a mediation platform that provides the necessary infrastructure to allow service providers to make their services available to a broader audience without major changes.

Additionally, the MOBiCENTRE provides a dedicated service provider Web portal which essentially provides a B2B service marketplace. It allows service providers to maintain the whole lifecycle of their services and to monitor their usage. It enables them to create completely new, innovative services based on already published data and services of other service providers. In this context, the platform handles technical aspects of service composition as well as business and contract-relevant aspects like pricing or service level agreements.

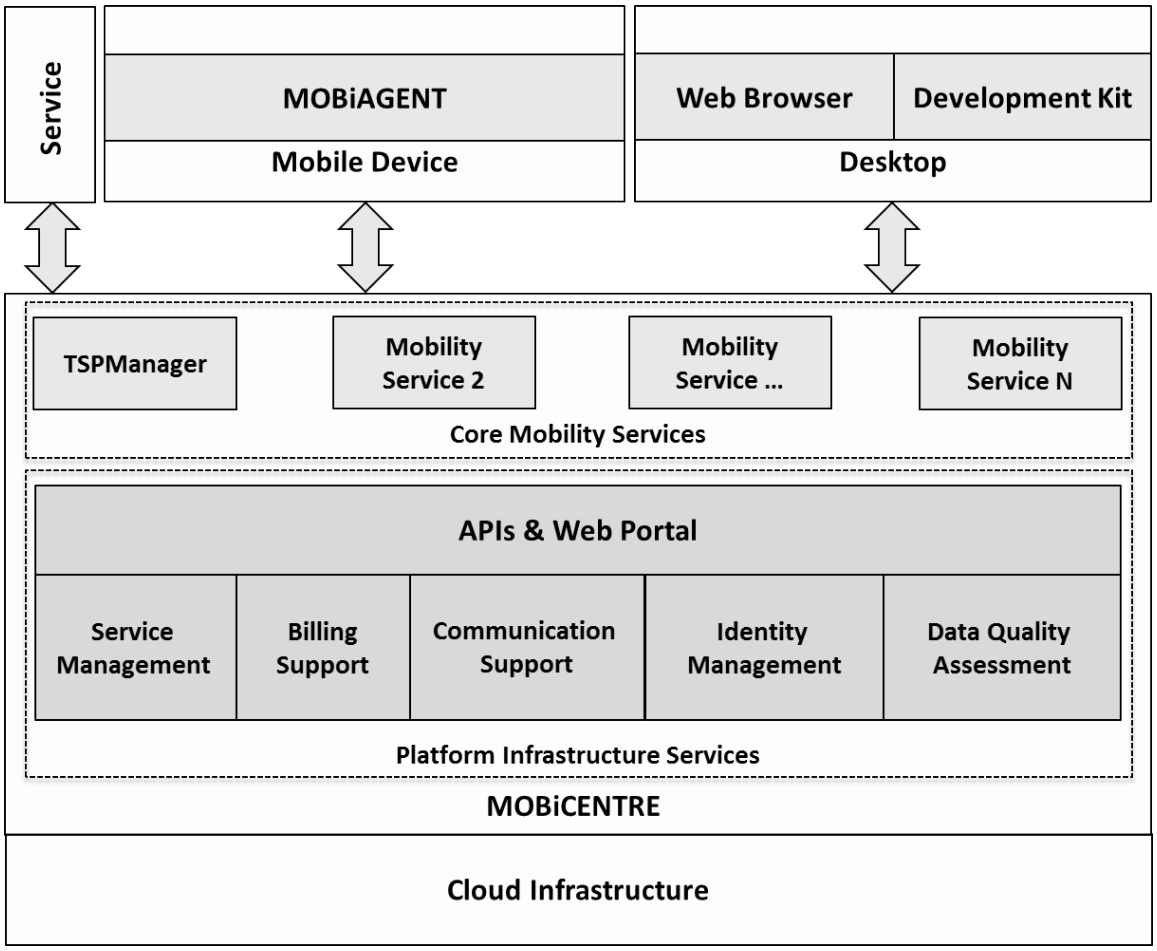

Figure 1: Conceptual architecture of MOBiNET

The infrastructure functionalities can be integrated with existing services via dedicated APIs. To ease migration of existing services and to build new ones, service developer support is provided (e.g. in terms of development tools, tutorials and test infrastructure).

In addition, it is planned to host core mobility services in the MOBiCENTRE in case these services are either useful in the context of a wide range of use cases or are completely missing. Such services are directly integrated with the infrastructure functionalities and are provided with the same quality of service. An example is the TSPManager module which provides access to telematics service providers (TSPs), see also section 2.6.

In addition to this MOBiCENTRE platform, an end user application, the MOBiAGENT, has been developed. The MOBiAGENT provides APIs to enable applications on the end user device to use the MOBiNET functionality as provided by MOBiCENTRE. In this context, it transparently enables access to multiple communication services (including Vehicle-to-Vehicle/Infrastructure (V2X) communication) and provides access to the MOBiNET end user marketplace to let end users discover and use mobility services. In principal, the MOBiAGENT is designed to support a wide range of mobile devices and application technologies (e.g., Web applications, OSGi-based applications) to simplify the

integration of existing applications. However, the current focus is on Android-based devices.
The next sections describe the individual components that are provided by the MOBiNET platform.

2.1 Service management

The platform provides support for B2B (e.g., Web Services) and Business-to-Consumer (B2C) services (e.g., mobile apps). In this context, the Service Directory (SD) provides a common service description structure to describe B2B as well as B2C services, supports management of those descriptions, and provides search and discovery mechanisms. The functionalities of the SD are available via dedicated APIs, and through user interfaces in the form of a Web portal and the MOBiAGENT.
The discovery functionality supports service discovery during runtime from other services or applications. Discovery of services is based on key parameters such as service coverage area, service category, and input/output data format. The data format is indicated via an identifier that can be looked up in the corresponding Data Format Catalog (DFC). The DFC manages descriptions of data formats both technical and textual or references them via an URL.

2.2 Identity management

The Identity Management (IdM) framework establishes a common identity for MOBiNET actors (e.g., platform administrator, party administrator, developer, end user). This approach offers end users a single subscription to all MOBiNET services and enables service providers to offer services to end users who have no prior affiliation but are accredited through MOBiNET.
To solve related interoperability issues on the information and technology levels, the IdM defines an identity management ontology and provides corresponding components to manage identities and related identity attributes. In this context the IdM also handles privacy related aspects to ensure that corresponding actors have full control over their personal data. On this basis the IdM framework establishes support for single sign-on, authentication (e.g., OpenID [2]), and authorisation mechanisms (e.g., OAuth [3]).

2.3 Billing support

The Billing Support modules provide utilities to handle aspects of financial transactions in the background of a service, including membership fees and business fees. This is done by providing the bridge to enable end users (B2C) and service providers (B2B) to pay for the use of an app or service. The billing component allows monitoring of financial transactions of registered services and supports the completion of financial transactions by providing receipt

documents to involved actors. In this context, a basic infrastructure is provided which can be used to integrate ticket issuing services via the SD. The basis for transactions provides the service descriptions stored in the SD. A service provider can therefore rely on these utilities to consistently handle end user payments and compensation from other service providers.

2.4 Communication support

To support real-time and location-based ITS services, the MOBiNET platform provides the components Communication Agent (CA) and Communication Manager (CM). The CA is a centralized component that resides in the MOBiCENTRE. It is responsible for periodically receiving and processing anonymized location information from end user devices (e.g., on-board units, smartphones, tablets) equipped with the CM. This CM is part of the MOBiAGENT and provides periodic updates that can contain information about the current location of the device, its CM equipped neighbours and its communication capabilities. The CA has an interface towards roadside unit operators and mobile network operators and maintains information about coverage and service availability in a geographical area. Because of its centralized nature, the CA can provide advanced features, for example, geo-fencing and real-time statistics.
The CM ensures that periodic updates are sent to the CA. Applications can deliver their messages for further distribution with the CA while the CA decides on the optimum way to communicate them towards CM's.

2.5 Data Quality Assessment

Data Quality Assessment (DQA) addresses the problem of extracting quality indicators from traffic data. Fixed sensors and probe vehicles are considered as data sources. DQA serves data and service providers to evaluate the quality of such data collections in terms of the embedded information. Its output can be used to evaluate support service level agreements. Such evaluation indicators assess the quality of incoming data on its accuracy and value.

2.6 TSPManager

The TSPManager is a broker component which provides a platform for telematics service providers (TSP) granting data interoperability. It allows TSPs to offer telematics data to service providers (e.g., insurance companies, roadside assistance companies, repair workshops). In this way an end-user can grant a service provider access to his vehicle's telematics data operated by a TSP. Typically this data is collected by a device which is installed in the vehicle.
The TSPManager maintains a directory of relationships between TSPs and service providers

for each user, provides a standard format for data exchange, as well as corresponding APIs and user interfaces. Vehicle telematics data is an important source for several interesting use cases like vehicle maintenance, fleet management or usage based insurance. Thus, we consider the TSPManager as an essential component of the MOBiNET ecosystem and offer it as part of the platform.

3 Requirements, status and future plans

The MOBiNET platform is still under active development. For the development of the platform an iterative, use case driven development approach is applied. I.e., initial requirements have been gathered from pre-defined user stories. After each iteration, the list of requirements has been extended and refined. In total there have been three major iterations so far (Figure 2). Each iteration produces a major platform release and a corresponding minor release.

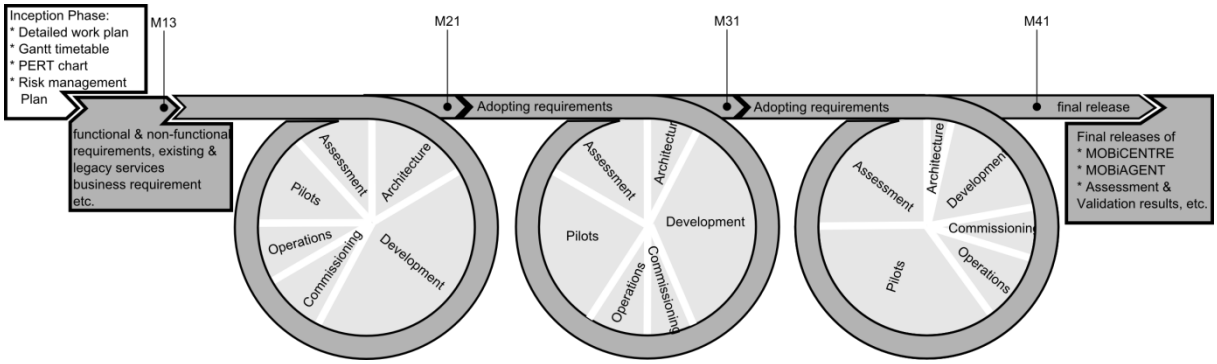

Figure 2: Development iterations

During each iteration, the basic activities of requirement gathering and refinement, architectural design and implementation as well as testing are closely aligned:

- **Requirement phase**: During this phase requirements and functionality for the platform is being gathered from multiple sources and discussed and re-defined with platform developers in order to have clearly described requirements.
- **Development phase:** During this phase the functionality for the newly gathered requirements is being developed whereby the development-related activities are organised in sub-iterations to ensure constant feedback and to handle requirement prioritisation.
- **Commissioning phase:** During this phase the developed platform functionalities are rolled out onto a pre-production environment in order to make sure that the newly developed functionality meets both non-functional and specific operational requirements.
- **Validation phase:** As soon as new versions of the platform components are available on the production environment, dedicated test sites validate the platform on the basis

of pre-defined use cases. The results of the validation are used to further adapt the platform requirements to better shape the platform scope.

During the beginning of the MOBiNET project, ten example services have been identified that can be enhanced by a MOBiNET like platform:

- **"Green Light Optimal Speed Advice (GLOSA):** This service provides drivers with advice on optimal driving speed to pass a traffic junction on green. […]
- **Usage Based Insurance (UBI):** This service calculates vehicle insurance cost based on real usage of a vehicle. […]
- **Multi Modal Travel Assistant (MMTA):** This service provides a multimodal journey planner and necessary information to a traveller during a journey. […]
- **Ad-hoc Priority Route:** This service plans and implements a fast and secure route through the network for ad-hoc use such as VIP vehicles and Emergency service vehicles. Vehicles involved can get priority at intersections (depending on the service level; e.g. fire brigade very high, visiting VIP moderate). […]
- **Non-stop Truck (NST):** This service transfers the weight information from a truck directly to the road administrator, while the truck is driving. When the vehicle passes a road-side ITS-Station, the in-vehicle ITS-Station broadcasts the weight of the vehicle together with an identifier to the road-side ITS-Station. […]
- **Parking Services:** This service gives information to drivers on available parking spaces and navigates the driver to find the space and use the service to automatically pay the parking cost. […]
- **B2B Traffic related services (B2BTS):** This service is focused on (1) Floating Vehicle Data - marketplace and value added services (data profiling and data quality); and (2) on the delivery of traffic maps & images to be included in B2C services and XFCD. […]
- **Demand Responsive Transit or Dial-A-Ride:** This service provides a booking system for door to door travel for people with disabilities. Users will receive automated alerts sent to them warning of imminent vehicle arrival. […]
- **Real-Time Traffic Information:** This service is to provide information on real time incident warning a driver who registers for the service. […]
- **VoiceInfo:** This service is a mobile, location-based social media service which uses audio messages to enable contextual voice communication between end users, location-based audio information distribution from 3rd party service providers, and crowdsourcing of mobility related data." [4]

For each of the above ten services a service working group has been established. These groups significantly influence the platform requirements and components. In addition, the requirements are also extracted from user scenarios. These scenarios describe what kind of

functionality is expected from the platform. They form the basis of the development plan.
Besides the above mentioned services, there are in total eight pilot sites involved within the project. Each pilot site hosts one or multiple of the above mentioned services to validate the results of every iteration. This approach helps a lot to improve the overall quality of the platform and to further identify relevant requirements. The involved pilot sites with their hosted services are:

- **Aalborg, Denmark:** Parking Services
- **Helmond, Netherlands:** Green Light Optimal Speed Advice, Ad-hoc Priority Route and Real-Time Traffic Information
- **Helsinki, Finland:** Multi Modal Travel Assistant and VoiceInfo
- **London, Great-Britain:** Demand Responsive Transit or Dial-A-Ride
- **Torino, Italy:** Multi Modal Travel Assistant, Parking Services, B2B Traffic related services and Usage Based Insurance.
- **Trikala, Greece:** Multi Model Travel Assistant and Parking Services
- **Trondheim, Norway:** Multi Model Travel Assistant and Non-stop Truck
- **Vigo, Spain:** Green Light Optimal Speed Advice, Real-Time Traffic Information, Multi Model Travel Assistant and B2B Traffic related services

Besides gathering requirements from the service working groups, the project organised a hackathon during the ITS World Congress in Bordeaux (2015). The purpose was to improve the MOBiNET platform by providing external parties access to the platform and gather their feedback. An important result of this hackathon is that for using the service platform not only the platform itself is important, but it is also necessary to make many high quality services available.
After the third release, most features of the initial MOBiNET platform design are realised and available. As MOBiNET is a research project, the platform is considered a proof of concept. I.e., during the project not all gathered requirements are going to be realised. However, all requirements that have been identified by and from multiple sources are documented for future reference. As the traffic research aspects are the main focus of the project, for example usability aspects are considered secondary. The user interface is therefore rather functional. Furthermore, the project is preparing several scenarios to support further business use cases and monetary aspects [5] as it is currently not yet clear in which form the platform is continued after the end of the project. One possible option provides the European Mobility-as-a-Service (MaaS) Alliance which has been launched in October 2015 to push the mobility service paradigm as covered in MOBiNET with partners from several countries. As a perspective, these efforts offer an opportunity to pick up results from MOBiNET and carry them on.

4 Summary

First, we introduced the basic ideas of MOBiNET to create a platform for connected mobility services. An overview introduces the conceptual platform architecture which provides the required infrastructure functionality to let service providers easily compose their services based on available data or other B2B services, and to deliver their services to end users. This is provided by core components for service management, identity management, billing support, communication support, data quality assessment and the TSPManager. Next to the platform architecture, we presented the iterative, use case driven approach, which is applied for development. The requirement process is pushed by the service working groups and platform pilot sites.

With the third release of the platform, the MOBiNET platform has reached a level of maturity which allows granting access to external parties. Because of the research character of the project, MOBiNET focuses on mobility aspects and provides a proof of concept platform. Currently, the third platform release is validated. An update of the third release is going to be prepared for summer 2016.

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