Multimodality for people and goods in urban areas

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WP4 – D4.8 Mobile Payment enablers specifications - iteration 1

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Instant Mobility WP4

D4.8 Mobile Payment enablers specifications - iteration 1

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Abstract

This document contains a draft description of the mobile payment enablers, which is addressing Scenario 3. This document is divided into four sections.

The first section is the introduction, setting the context of the deliverable. The second section describes the use cases functional decomposition (based on the work of WP3) and explains the formalisms used in the use case diagram. The third section provides the enablers description; it is the inside view of the platform and presents a description of the application in terms of systems and components. This section is also focused on the description of each component. The last section describes the public interface and the interaction with external services; it defines the environment in which the platform will be deployed and the requirements of these external actors to interact and take advantage of the platform. It is the outside view of the platform.

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1. Introduction

1.1 WP4 objectives in Instant Mobility

The objective of the "Future Internet Enablers" work package is to derive from the use case scenarios analysis and the Future Internet technologies roadmap produced by WP3, the detailed technical specifications of the components necessary to implement these scenarios. These components can be the proposed Future Internet enablers (either generic or domain-specific) or services build on top of these enablers.

1.2 Objectives of Deliverable D4.8

The purpose of D4.8 "Mobile Payment enablers specifications - Iteration 1" is to identify and describe both the generic enablers and the domain specific enablers necessary to implement some functionalities of Instant Mobility scenarios.

A second iteration, in which the set of requirements definition will be refined, is expected by month 15 (June 2012) and will be finalized in D4.15.

This document will serve as input to the prototype implementation in WP5 and the second iteration of the WP2 "Program collaboration" deliverable, which provides input to the FI-WARE project.

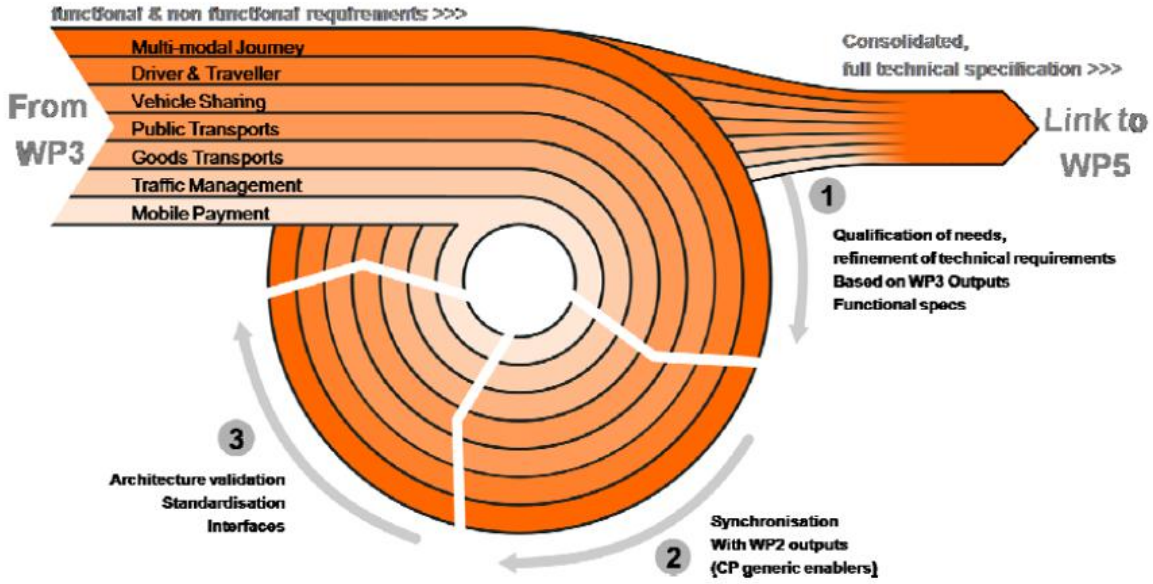

Figure 1: Iterative specifications of enablers in WP4

As all WP4 first iteration deliverable this is derived from WP3 activities. Since this deliverable and D3.3 are due at the same time we prefer to start working mainly from D3.1 and collaborate with WP3 to contribute to D3.3. Further integration of D3.3 results will be done in the second iteration of Mobile Payment enablers due in June. The workflow we intend to follow is depicted in Figure 2.

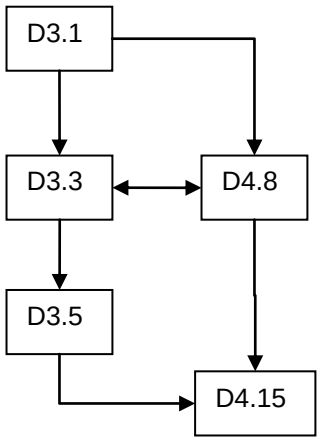

Figure 2: T4.8 and WP3 workflow. D4.8 is derived from D3.1 and work together D3.3. Final results will be depicted in D4.15

1.3 Contents

The content of this deliverable is mainly derived from scenario 1, "Personal Traveller Companion", since at the moment it's the most related one to mobile payments; for this reason this deliverable will focus on several topics that are related to other tasks, in particular tasks related to Personal Traveller Companion. Iteration 2 due in June may expand the content of the deliverable and adapt to other scenarios if necessary.

Payment is a key topic in multimodal travel and will be mostly based on use of mobile phones. The enablers will provide basic means to:

- Pricing. When different multimodal travels are proposed to users the correct price for every trip and the final price have to be provided.
- Billing. This implies all the means to monitor the traveller's trip in order to determine the trip price on-the-fly. This includes for instance check-in and check-out mechanism to implement pay-as-you-go policies.
- Virtual Ticketing. Electronic proofs of payment must be loaded into mobile phone and accessed on-the-fly by the transport operator infrastructure.

This set of enablers will be built on different components that include:

- Mobile phones and proximity technologies such as NFC.
- Infrastructure components like on board NFC devices and Point Of Sales (POS) physical infrastructure.
- Platform based components.

Payments in Instant Mobility may be related to different situations including not only public transport but also other transport means, including car and bike sharing, limited traffic area access, parking. In some cases the mechanism envisaged for payments, in particular proximity technologies, can be used for other scopes that don't imply money exchange like green point usage, access with special permission to limited areas.

Of course a relevant aspect related to payment is the financial transaction and in general the mobile wallet management; however this is out of the scope of this deliverable and the project in general. The solution here proposed assumes that services to process the financial transactions are somehow available.

2. Use case decomposition

2.1 Introduction

One of the most interesting innovations that Mobile Payment enablers will foster is the possibility to make a single payment for a multimodal travel.

Nowadays multimodal ticketing, that is better known as integrated ticketing, is based on the idea that every transport operator should make an agreement with any other transport operator possibly involved in the multimodal journey; this is very difficult to carry out and for this reason integrated ticketing is seldom implemented.

To overcome this trouble, the Instant Mobility multimodal ticketing service will relieve transport operators from the burden of reciprocally interfacing because it will act as an intermediate actor between them and the traveller.

When the traveller has found the optimal route with the help of the Multimodal Traveller Companion service, he/she will make a single payment to the Mobile Payment service to buy the full set of tickets needed for the journey; the Mobile Payment service will buy the virtual tickets from the various transport operators and will send them to the traveller's mobile terminal.

In this way the traveller's user experience is easier and greatly simplified.

2.2 Use case diagram

The Mobile Payment use case decomposition is derived from the activities carried on in WP3, particularly deliverable D3.1 as explained in Figure 2.

This decomposition is a first step towards the definition of the set of functionalities offered by the enablers; further steps will be devoted to integrate this decomposition in the overall picture of Personal Traveller Companion enablers. Nevertheless this first decomposition is a valid starting point to set up a first architecture design that will be depicted in chapter 3.

According to D4.1 specifications the use case diagram reported in Figure 3 groups the various use cases in four layers:

- User application processes
- Long running processes
- Human activities
- Short running processes

At user application level processes involve usage of Mobile Phones; some use cases, like "Turn On Proximity Interface" and "Check In Tapping Mobile terminal" involve usage of proximity technologies. Other use cases, like "View Tickets, fares and terms of use" and "Get end-of-travel report" use applications running on the phone.

The majority of use cases at user application processes layer is monitored by the "Maintain tickets" process that is responsible of managing the traveller's tickets and the events generated by the interaction between travellers and the transport physical infrastructure like gates and ticket machines. "Maintain tickets" is a long running process because it tracks the traveller along all the journey.

Some transport services will cost proportionally to the time of travel or distance according to pay-as-you-go paradigm. In such cases the “Continuously update pay-as-you-go fare” process will interface with the pay-as-you-go transport operator that will provide the dynamic data regarding the current price for the usage of the transport mean.

The two main long-running processes use several short-running processes that are most likely running at network and cloud level; these use cases may be referred to as platform components. There are no human activities since most of the processes are automatic.

The use case diagram also includes two external actors that are financial operators and transport operator.

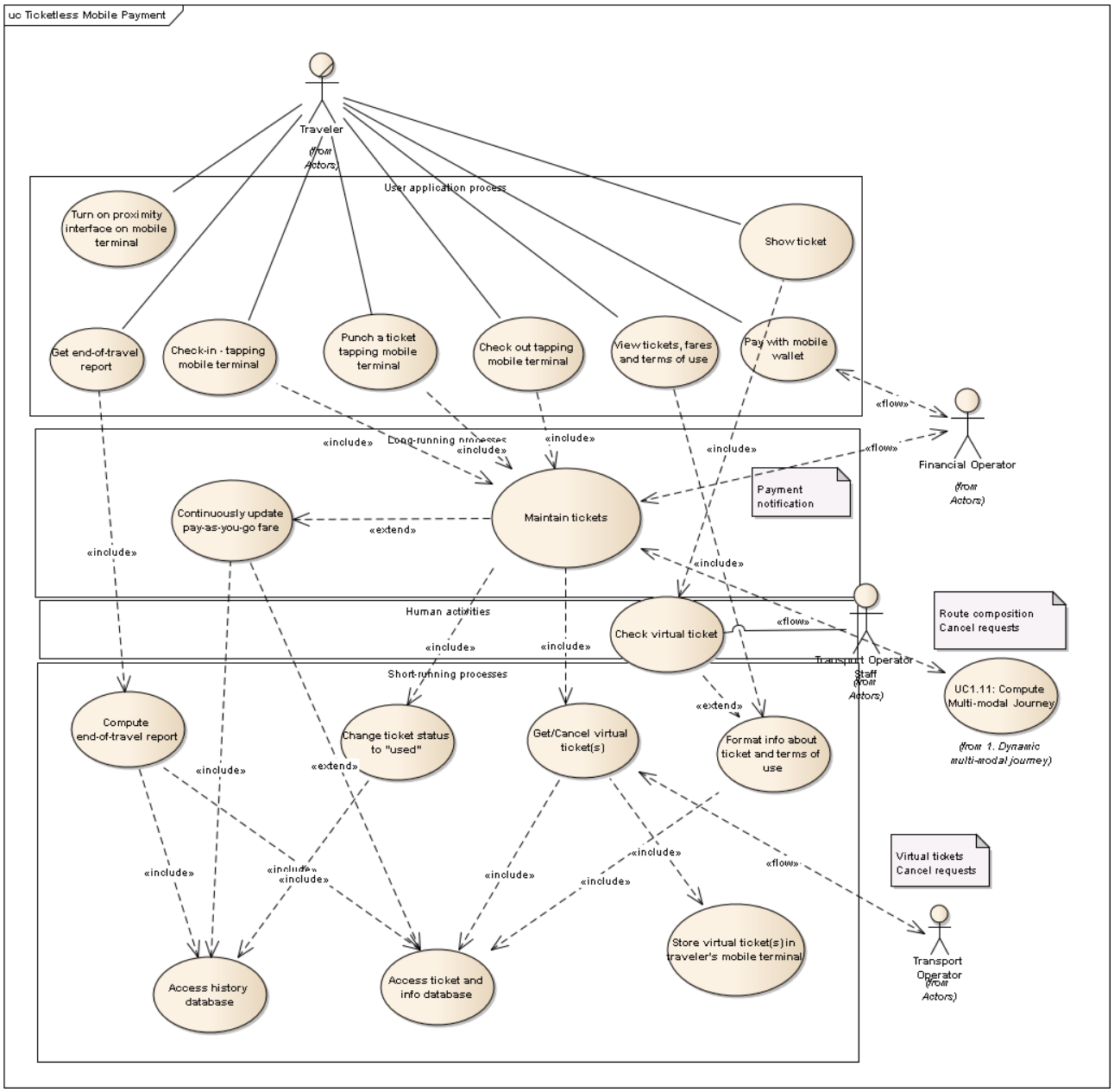

Figure 3: Iterative specifications of enablers in WP4

3. Enablers overall description

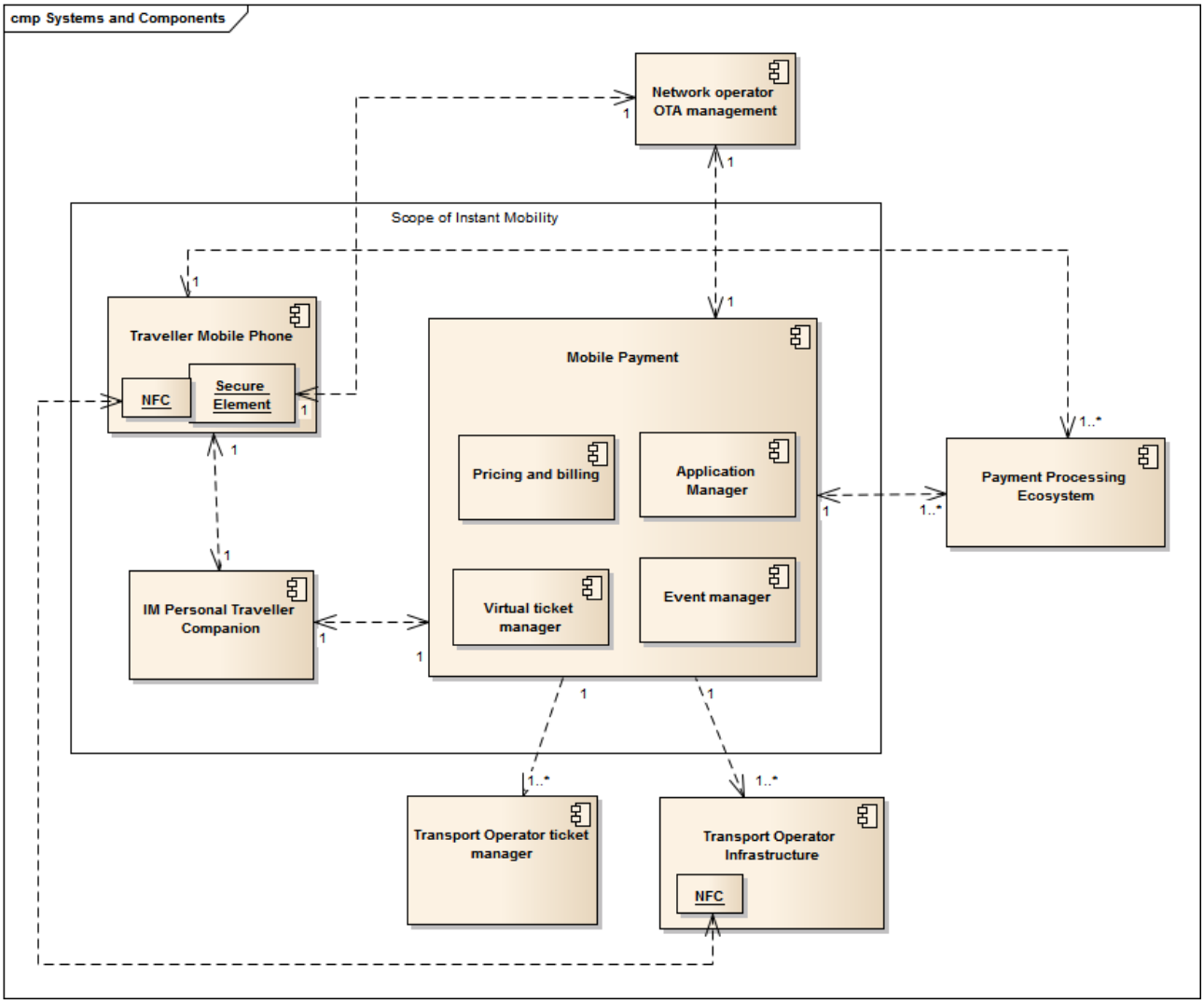

Figure 4: Components Diagram

The mobile payment enablers may be grouped in two main domains: platform enablers and mobile terminal enablers.

Platform enablers include tools that allow to:

- Determine the ticket price for the multimodal journey
- Distribute tickets to travellers on mobile phones
- Monitor ticket events in order to define correct fares (e.g. check in, check out and localization)

Mobile terminal enablers include:

- Mobile applications to access remote services
- NFC related enablers
- Trusted environment to manage NFC communication data.

Moreover, other important enablers are necessary. A proximity NFC infrastructure from Transport Operators is required for ticketing events. Over-the-Air (OTA) management for access to Secure Element in the traveller's mobile terminal shall be provided by Network Operators.

Finally, processing of payments done from mobile terminals shall be provided by financial operators.

The platform enablers may be grouped in a single entity that works along the MMT platform that is defined in D4.2. This is depicted in Figure 4, whose components and sub-components are described in detail in the following.

3.1 Pricing and Billing

This sub-component is responsible of the following processes:

- During the setup of a multimodal travel, it supports the Instant Mobility Personal Travel Companion service collecting pricing information from a plurality of Transport Operators.
- During the journey, it supports the "Event Manager" sub-component for all those events that have impact on monetary costs; its role is particularly relevant in case of "pay-as-you-go" transport means (e.g. ride sharing), whose cost is a function of time, distance and other parameters.
- After the journey (or at the end of each leg of the journey), it makes all the necessary computations and delivers billing information to the traveller.

In those cases, where green incentive policies are to be applied, the "Pricing and Billing" sub-component is also responsible of green credits accounting and reporting to travellers and public authorities.

Traveller will use the Instant Mobility Personal Travel Companion Service to define the best route for the journey; once the route is chosen, the Pricing and Billing subsystem will issue an overall bill comprising the cost of all fixed prices for the needed transport means and will wait for the corresponding single payment (if the route makes also use of "pay-as-you-go" means, the traveller will provide authorization of charging a credit card or other similar financial instrument). When payment and charging notifications are received, "Pricing and Billing" will request tickets purchase to the "Virtual Ticket Manager" sub-component.

3.2 Virtual Ticket Manager

This sub-component performs all the processes related to ticket handling.

It receives ticket purchase requests from "Pricing and Billing", connects to each transport operator involved in the journey route and buys all the necessary virtual tickets. In cases where booking of places is originally handled by the IM Personal Travel Companion service, it sends the relative information to it.

The Virtual Ticket Manager sends the virtual tickets to the traveller's mobile phone and maintains a local copy of them stored in a service database. If IM Personal Travel Companion service notifies that the traveller decides to suspend or cancel the remaining part of the journey, this sub-component takes care of updating or cancelling the involved virtual tickets.

This overall concept implies the requirement to define a software format for virtual ticket that allows third parties (i.e. IM Mobile Payment) to handle them from transport operator, guaranteeing security, integrity and their customization according to the different needs of the different transport operators.

3.3 Application Manager

The Instant Mobility Mobile Payment objective is to relieve travellers from the burden of dealing with each single transport operator ticketing service. In order to achieve this objective, the traveller's mobile terminal will execute a Mobile Payment Application, which will interface with the Mobile Payment service and will ensure a unified and harmonized user experience to travellers when dealing with payment of any transport shift.

The Application Manager sub-component is responsible of all the processes needed for making this scenario possible, supporting the installation of the Mobile Payment Application on the traveller's mobile terminal and its subsequent update and maintenance.

Application Manager is also in charge of maintaining data and code stored in the Secure Element embedded in the traveller's mobile terminal (see chap. 3.5). Since it is not the owner of Secure Element, it does not perform this job directly but through an external service, here called "Network Operator OTA Manager", whose function is detailed in chap. 0.

3.4 Event Manager

Along the journey the traveller will access transport means like trains, subways, buses (but also cars or bikes) and the transport operator typically will want to check the existence of the necessary tickets. While in some cases this job may be executed by human personnel, the use case mostly envisaged in Instant Mobility is that the traveller has got a virtual ticket stored in his/her mobile terminal, which is equipped with an embedded NFC radio interface; the traveller then must only simply tap the mobile terminal against a local fixed NFC terminal, which reads the virtual tickets and execute the consequent actions, according to the possible various use cases, like opening a subway access gate or virtually "punching" a bus ticket.

Every time the traveller performs any kind of interaction with the transport infrastructure (i.e. not only on NFC accesses) a corresponding "event" message shall be sent to the "Event Manager" sub-component, which is in charge of storing the event and making all the necessary processing. Event Messages can be sent to the Event Manager from the traveller's mobile terminal application or from the transport operator infrastructure.

Payment related events may be:

- Virtual ticket punch event: it will result in a ticket status change to "used" in the Mobile Payment local ticket database.
- Traveller check-in or check-out event: in pay-as-you-go service this events will start/stop far accounting[1]. This event may also be communicated to IM Personal Companion Service to allow traveller's position update.

3.5 Traveller Mobile Terminal

The mobile terminal is an essential component of almost every Instant Mobility service scenario. Regarding payment, Instant Mobility assumes that by few years NFC proximity radio interface will be quite popular on mobile terminals, independently from any market segment.

Among the advantages brought by this technology, one of the most important (for payment) is that it works only at very short distances thus ensuring the willingness of the owner to use it and

[1] While it is likely that each transport operator will reserve to itself the critical task of bill accounting, the IM Mobile Payment will anyway also do this task on its own in order to be able to constantly provide an estimation of accumulated costs to the traveller.

also the impossibility of interfering or eavesdropping the radio link. In order to effectively exploit such security features, a Secure Element must be intimately connected to the NFC radio front-end hardware. The Secure Element is a piece of hardware capable of storing data and computing, whose content can be accessed only by an authorized entity, that owns the necessary software keys; nowadays, mobile terminals do already have such hardware facility in their SIM cards and some manufacturers recently started to sell mobile terminals with NFC radio directly connected to the SIM cards.

In order to allow the simplest and fastest user experience in mobility applications, virtual tickets shall be stored in the traveller's mobile terminal, thus enabling a quick access to them when the traveller taps the mobile terminal against the transport infrastructure NFC terminals.

Generally speaking, each time the traveller taps the mobile terminal against an NFC external terminal, the first task that has to be performed in a very short time is to check whether the mobile terminal contains any relevant information associated to that external terminal; in Instant Mobility this may consist, for instance, in checking whether the traveller's is authorized to pass an access gate because he/she has got the necessary ticket. The best way to execute this job in a very short time and with minimum software constraints is to commit it to the computing facilities available in the SIM, just because it is directly connected to the NFC radio. This leads to the requirement of being able to store in the SIM the minimum set of data that allow handling the events described in chap. 3.4; this does not mean that virtual tickets shall necessarily be stored in the SIM, they may be stored in the application memory as well.

3.6 Other Components

The other components shown in Figure 4 are outside the scope of Instant Mobility services but deserve to be examined because there may be a reciprocal influence between those components and Instant Mobility components.

3.6.1 Transport Operator Infrastructure

Even if the IM Mobile Payment service may try to trace all the ticketing events just relaying on information from the traveller's mobile terminal, it would be much more preferable to get them directly from the various transport operators. Since there is a plurality of transport operators it comes out that events shall be communicated according to common rules and formats.

Events generated through NFC interfaces will necessarily come out from a first stage of processing carried out in the traveller's SIM; this means that each transport operator shall provide the Mobile Payment component with the proper configuration and processing capabilities to be stored in the SIM in order to enable the traveller's mobile terminal to correctly interface to each transport operator infrastructure.

3.6.2 Transport Operator Ticket Manager

Virtual Tickets are issued by each single transport operator; their content and format is closely related to the processes implemented by the various infrastructures when they communicate with the traveller's mobile terminal via NFC radio. While such content and format shall be enough general and flexible to allow every transport operator to implement its specific ticketing processes, it is also mandatory that transfer of virtual tickets through third parties (like the Mobile Payment component) must be possible. This requirement is one of the pillars that will allow the great user experience enhancement foreseen from Mobile Payment.

3.6.3 OTA Management

Over-the-Air Management of the content of Secure Element in traveller's mobile terminal is a mandatory function for Mobile Payment, which needs to store processing and configuration data in the traveller's SIM.

3.6.4 Payment Processing

Mobile payment financial processing is outside the scope of Instant Mobility, and is today available in various technical solutions. Here is simply assumed that travellers will be able to use their mobile terminals to pay the Mobile Payment service once for all the virtual tickets they need for a journey of whichever complexity and length.

4. Public interface and interaction with external services

The deployment diagram below, gives an overview of the system that realize the activities carried on in deliverable D3.1 as well as the various system interact among them.

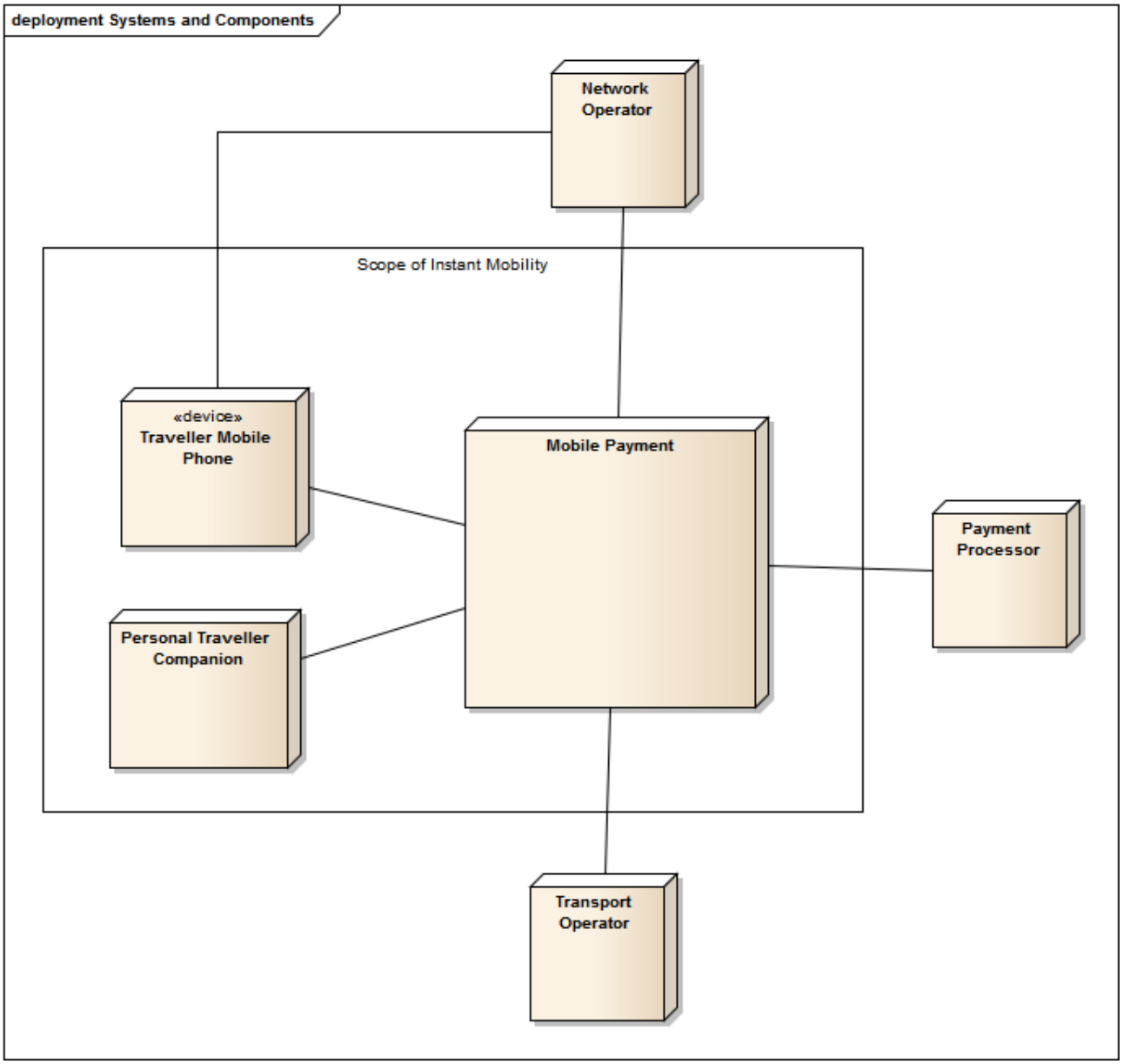

Figure 5: Deployment diagram

The deployment diagram has to show only the interactions among the macro element (each of which may contain many components), not focusing on interactions with the actors.

The first purpose of a deployment diagram is to show the interactions with external systems, if they exist.

In our case there are three external elements:

- *Transport operator*: it is composed of the ticket manager and the physical infrastructure.
- *Payment processor*: it consists in the payment ecosystem that will take care to manage the entire payment process.

- *Network operator*: this is mostly referred to the Over-the-air management that allow the operator to upload application in the user's SIM and configure them.

Now we will focus on the information exchanged among the various elements of the deployment diagram.

1) Between *Payment Processor* and *Mobile Payment* will flow the following information:
   - Generic travel info
   - Confirmation of travel's payment
   - Cash flow info when the mobile payment buy tickets (needed by the travel) from transport operators.
2) Between *Transport Operator* and *Mobile Payment* will flow the following information:
   - Pricing information needed by *Personal Traveller Companion* to compute multimodal travel partial or final price.
   - Virtual ticket (that will be delivered to the traveller)
   - Travel's event such as traveller's check-in/check-out, gate pass through, etc.
3) Between *Personal Traveller Companion* and *Mobile Payment* will flow the following information:
   - Pricing information to compute multimodal travel partial or final price.
   - Routing information.
   - Travel's event such as traveller's check-in/check-out, gate pass through, etc.
4) Between *Traveller Mobile Phone* and *Mobile Payment* will flow the following information:
   - Virtual ticket generated by *Transport Operator*
   - Travel's event such as traveller's check-in/check-out, gate pass through, etc.
   - Mobile terminal application that Mobile Payment may upload to traveller's mobile terminal.
5) Between *Network Operator* and *Traveller Mobile Phone* will flow the following information:
   - Mobile terminal application SIM-based like app that can manage NFC features to implements check-in/check-out functionality.
6) Between *Network Operator* and *Mobile Payment* will flow the following information:
   - Request to upload and configure application SIM-based.