ITS-IBus – JINI and Radio Identification Technologies underlying Interoperability through a Real Life Open Service Oriented Toll Management System for the Pan-European Motorway Network

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ABSTRACT

The ITS-IBus (Intelligent Transport Systems Interoperability Bus) architecture was developed in Portugal in a join research project involving ISEL (an academic and research Institute), BRISA (the biggest motorway management company in Portugal) and WhatEverSoft (the first Sun Authorized Java Center in Portugal). It aimed to develop an open, service oriented architecture for a toll management system in order to promote interoperability among systems from different vendors and to the Pan-European motorways network. The ITS-IBus architecture is a peer-to-peer service architecture where discovery and advertisement mechanisms and event registration and subscription are used to establish a community of peer services running on systems (execution containers). These services present standard interfaces and implement toll specialized functionalities like car identification, car classification, and license

plate recognition from others. The services run on systems that beyond the functional services, implement specialized system services (core services) like administration, configuration and security. The ITS-IBus was primarily motivated by the need for a "plug--and-work" infrastructure where systems from different vendors can be integrated in an open toll management system. Another challenge was established by the need to construct a Pan-European motorway toll infrastructure where cars can use the same payment facilities across all European countries. This talk presents and discusses a real life implementation of the ITS-IBus architecture using JINI and DSRC/RFID technology.

In Portugal there is an automatic payment system named Via-Verde based on a car active identifier using DSRC technology, a kind of RFID using a 5.8 GHz wireless link between the road side equipment (the antenna system) and an on board unit in the car (tag/identifier).

Nevertheless, other payment technologies are expected to be adopted what results in additional specialized systems requiring to be integrated. Interoperability among such technological systems is of paramount importance considering that, for car owner transparency when crossing different motorways in different countries, it is necessary a background ICT infrastructure promoting interoperability at different levels – technology and processes. The talk will go behind the scenes into the interoperability issues and how they are solved used using jinni services that create an abstraction layer from tags / antenna vendors.

Even if JINI is the underlying technology used by the first toll management system following ITS-IBus architecture, other technologies are being evaluated to implement its concepts. The JXTA, the Web Services and .NET are some of the technologies that are being used to consolidate ITS-IBus and to evaluate strategies to implement interoperability among services developed in different technologies.

CHALLENGE AND PROBLEM ROADMAP

A toll ICT infrastructure is made of panoply of systems some of them integrated by monolithic proprietary toll management systems. These systems evolve by their own and, in most of the cases, they follow a single vendor strategy what makes them far from an open innovation space. The Portuguese BRISA motorway company decided in 2002 to promote the development of a new strategy based on an open interoperability bus where multiple vendors of motorway toll systems were able to plug their systems. The main strategic goal was to create an open and competitive space where concurrent vendors were able to plug their systems. As a result, from the beginning of 2005, the ICT toll infrastructure evolved from a single

vendor for the DSRD/RFID system where only the Norwegian Q-free where able to supply this kind of system, to a multi vendor infrastructure where systems from both Q-free and Kapsch are now in operation. The alignment with an open service based architecture where specialized systems of a toll management infrastructure can be offered by more than one supplier has generated a significant cost reduction, not only on systems acquisition but also on system management and evolution. The work here presented is an innovative step from the early and innovative Via-Verde solution adopted in 1995 by BRISA. The Via-Verde tolling is based on the free-flow of cars equipped with an RF identifier. When cars cross a Via-Verde toll, without stop, a transaction is automatically generated and processed. The Via--Verde system is using a technology similar to the emergent RFID. In fact the DSRC is a kind of RFID where an active tag installed in the car, communicates with a toll antenna through a 5.8 GHz wireless link (the rode side equipment reads and writes information to the tag).

THE PROPOSED ITS-IBUS ARCHITECTURE

The ITS-IBus architecture is organized around executive systems made of a set of "*pluggable*" services. To achieve this goal, three concepts were defined. The system concept identifies an execution container holding a set of services (the second concept). These services are the implementation of functionalities grouped on a fine--grained based strategy. The third concept is related with the standardization of the execution container, the service definition and deployment framework. Beyond the "*plug-and-work*" service, a system (service execution container) holds also a monitoring and a security service. The monitoring service is an important piece to contribute to the management of the quality of the services (QoS) and also to contribute to coordinating decisions when fault tolerance is required to comply with critical processes. The security services are necessary considering that a toll infrastructure is a distributed system with Internet access for administrative and management tasks. The developed systems range from DSRC/RFID transaction coordinators, car classification and license plate recognition systems. All these systems hold services positioned on a peer-to-peer basis on the infrastructure. The services know each other through discovery and advertising mechanisms. Services can access other services following a synchronous or an asynchronous call; the asynchronous scenario are based on an event subscribe mechanism for managing call-backs. The ITS-IBus architecture for a toll management system is a hierarchical coordination system based on a lane management system (LMS) with a lane coordination service, a tool plaza management system (TPMS) holding a coordination service for a set of lanes and finally a toll

central coordination system holding a service to coordinate all the TPMS systems. The LMS system type can hold services to coordinate Via-Verde (DSRC/RFID like) lanes, manual lanes based on an operator (tollbooth) and the electronic lanes (eTOLL) based on bank card or other automatic payment mechanisms. All the services follow an open interface defined by ITS-IBus project and available for suppliers to incorporate into their systems.

AN ITS-IBUS ARCHITECTURE IMPLEMENTATION WITH JINI 2.0

Even if the ITS-IBus specification is technology independent the first implementation was made to the JINI 2.0 platform. Other technologies were considered to map ITS-IBus concepts like SOA/ Web Services, JXTA but Jini seemed like the most stable and reliable. A set of adapters were developed to integrate existing systems to the ITS-IBus infrastructure while it is expected that in the future toll system vendors might adopt ITS-IBus specification making their system ITS-IBus enabled..

The presentation will detail the technical architecture, describing the hierarchy of services on the LMS – Lane Management System (price management for the different vehicle types and origins and adapters to the RF Readers); the TPMS – Tool Plaza Management System and the CC – Central Coordination System. It will show how the same underlying architecture supports automatic and manual tool collection, depending on the services that are "plugged" into the lane.

From the point of the ITS-IBus architecture there is no limitation on the adopted technology; a broker concept is being developed to offer virtual access to ITS-IBus services from any service independently of its underlying technology. This is however a delicate issue considering that it is not an easy task to establish such a generalized mapping independent of the underlying technology.

ACCELERATING INTO THE FUTURE WITH MODEL DRIVEN DEVELOPMENT

Since the beginning of the ITS-IBus project a special concern was dedicated to the "leaning curve" required by adopting advanced systems and concepts like those proposed by ITS-IBus and associated to the underlying technologies. Even if JINI is not a complex platform it embeds a lot of new concepts and a huge framework requiring specialized knowledge do deal with. To facilitate service development, it is being developed a plug-in for the Eclipse platform specialized to guide toll management system developers to create systems, services and client applications. The client

application was established as a special service used to test ITS-IBus services to be used during developments. The main goal from developing such a kind of workshop to create new systems and services is to focuses developers on service business logic. The objective is to offer experts on toll management an advanced tool where services and services integration on complex systems can be developed from models, reducing to a minimal the code needed to be written. With ITS-IBus development workshop a developer does not need to be an expert on JINI or in any other underlying technology selected to support ITS-IBus concepts.