59 A COLLABORATIVE NETWORK CASE STUDY: THE EXTENDED "ViaVerde" TOLL PAYMENT SYSTEM

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The extended ViaVerde business model is presented and discussed as a case study of an enterprise collaborative network in the domain of toll payment systems. In order to offer ViaVerde clients the possibility to use the installed RFID transponder to automatically pay services in car parking areas and gas stations, a complex collaborative enterprise network comprising a diversity of business models, was established. Besides banks and clearing house, there are other players involved. The car parking area owners, co-located shops, and companies offering employees parking facilities are examples of such players. The life cycle management of the underlying distributed business process requires a new framework able to deal with the distribution of contributing actors and the need to guarantee interoperability among the various heterogeneous systems. The paper focuses on the requirements for a technological platform to deal with such complex enterprise network. A service oriented infrastructure developed for toll management systems is taken as the baseline for supporting the new enterprise collaborative processes.

1. INTRODUCTION

The collaborative networks paradigm (Camarinha-Matos, 2004), represents an appropriate approach to a new business scenario where a group or companies contribute to offer car drivers a transparent and smooth payment of services involving a wide number of companies. The considered services include toll payment in highways (ViaVerde system) as well as payment in car parking areas and in gas stations using a uniform payment system based on DSRC technology (Jordan, 2001), a kind of car RFID. Car drivers do not need to have any direct relationship with the involved companies; but rather a unique contract with a single entity. For the customers these companies are "invisible"; in fact they only see an integrated payment system presented to them under the ViaVerde brand.

The enterprise collaborative network paradigm or networked organizations (Bacquet, 2004) is emerging in different contexts and it corresponds to a strategy to model collaborative systems involving a number of companies that appear to customers or service consumers as a single (apparent) unit. Such units offer services

or products making transparent the complex interactions performed in the background.

The ViaVerde tolling system is based on the free-flow of cars equipped with an RF identifier. When cars cross a ViaVerde toll, without stopping, a transaction is automatically generated and processed. The ViaVerde system uses a technology similar to the emergent RFID. In fact the DSRC is a kind of RFID where an active tag (transponder) installed in the car, communicates with a toll antenna through a 5.8 GHz wireless link (the road side equipment reads and writes information to the tag). Recently, the ViaVerde automatic payment system has been extended by BRISA to offer car drivers the possibility to access car parking and gas station areas equipped with DSRC system. With this extension, the car drivers receive on their billing report a list of transactions from different places that are controlled by different companies operating under different business models. The car drivers establish a contract with the ViaVerde Portugal company (VVP), which is a physical enterprise but with a trend to move towards a more agile organization focussed on the management of cross enterprise business processes.

This paper analyses the underlying business model associated to this virtual toll and fee payment system and discusses it in the context of the enterprise collaborative networks paradigm (Camarinha-Matos, 2003). The first objective of this work is to establish the technological infrastructure requirements taking as reference the ITSIBus project (Gomes et. al. 2003) (Osorio, et. al. 2004) and a set of basic conceptual constructs contributing to establish such distributed business model targeting the enterprise collaborative network (Camarinha-Matos, 2004). In the proposed enterprise network there are two coordinating companies. One is BAER (BRISA Access Electrónica Rodoviária), a company from the BRISA group responsible to manage the technological infrastructure. The BAER company is facing a complex challenge considering the number of technological business agreements it has to manage. The other company is ViaVerde Portugal, also a company from the BRISA group responsible to manage the ViaVerde payment related services, and as mentioned above, it is responsible to make transparent to clients (ViaVerde clients) fee payments in a number of contexts (motorway toll, parking areas, gas stations, etc.).

In this context different business models are being implemented to offer access to car parking areas, be them private or public, to ViaVerde customers. Situations exist where parking fee discounts are given to customers when they shop in some stores served by a car parking. In other situations credits are accumulated in association or not to some brand fidelity card and used to pay car parking. All these services result in different contractual situations that need to be properly structured and also require an integrated infrastructure able to manage such processes. In fact, there is a challenge on how to model such complex and evolving network relationships and on what would be the best information and communication infrastructure to cope with the involved companies.

A systematic approach is necessary to address business models management involving different companies under different contractual agreements and in this case offering ViaVerde clients a number of new services making transparent for them the underlying complexity. Another vector of this challenge is the need for a structured framework to represent and manage the collaborative business models and link them to the executing information and communication technology (ICT)

infrastructure. It shall be noted that in this domain there is a trend to a fast and unpredictable evolution of business models integrating additional services with the corresponding need for agility to better adapt to new business strategies. This evolution requires a structured approach to model the development and deployment of the virtual systems that support the collaborative business processes.

The proposed approach departs from the ITSIBus initiative, a service based architecture that is being defined to promote interoperability among diverse technological systems by defining a multi-technology platform where unification is achieved at the service definition level based on WSDL. The ITSIBus initiative is being extended to include a development framework able to address virtual systems development following a model driven approach.

2. DISCUSSION OF THE COLLABORATIVE NETWORK

The business model under discussion involves a number of players each one responsible for specific roles. The ViaVerde company plays a central role considering that it is the entity that manages the relations between car drivers (ViaVerde Clients) and the ViaVerde virtual business model. This business model aims to facilitate the life of customers by giving them access to various services without requiring them to stop to pay service fees. As an example, when DSRC/RFID is installed in a car parking gate, a car with an OBU (On Board Unit, according to TC 278 terminology) can enter without the need to get a ticket or present any card. When exiting the parking lot the exit gates will open when a ViaVerde client approaches the exit lane. This new payment mechanism on car parking areas "inherits" other business mechanisms used to promote other businesses like discounts when shopping in some co-located stores or agreements with other companies to offer car parking facilities to their employees or customers.

To clarify the collaborative network shown in Figure 1 let's identify the role of each one of the business and technological players. A central role is played by the motorway user that adhered to the ViaVerde toll payment system available in all the Portuguese motorways and in many other countries in Europe and outside Europe. The ViaVerde company manages the business model by maintaining contractual relationships with the Portuguese payment clearing company (SIBS), with the car parking owners, and other companies that need to offer car parking access to their customers or employees. As a matter of fact, there is no limit for the contractual relationships related to the fee payment being it car parking, gas station services, or access to city historical areas, a situation already managed by ViaVerde in the city of Lisbon.

In summary, the roles of each main player are the following:

- ViaVerde company – manages the integrated (virtual) business model, maintaining the relationships with clients, including billing, and the relationships with SIBS and any other company (parking, store, employer, municipality) to manage other related services when clients access car parking areas, gas stations, city historical areas or any other place which access requires DSRC/RFID technology.

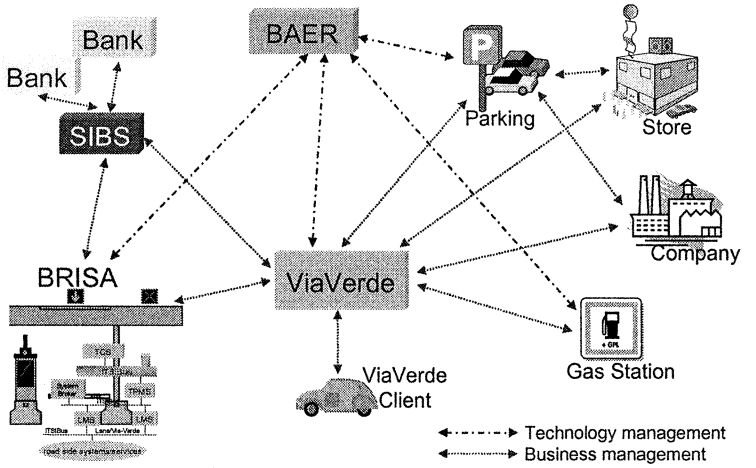

Figure 1 – Extended ViaVerde business scenario actors

- BAER, Brisa Access Electrónica Rodoviária – manages the underlying technological infrastructure to support the ViaVerde business model, including its extended form (parks, gas stations and city access beyond motorways);
- SIBS company – it is the Portuguese bank clearing company responsible to manage the Multibanco payment network involving ATM and POS systems. All the electronic payments flow is processed via SIBS that guarantees the bridge between card holders and banks;
- Car parking companies – companies that manage car parking areas with DSRC/RFID access installed. The ViaVerde clients are automatically recognized in this parking areas and the payment is done through ViaVerde. The ViaVerde company has to manage payments under some special business models like those involving the relations between ViaVerde clients and store discounts or employers;
- Gas stations – the ViaVerde client fills the car tank after it is automatically detected by the DSRC/RFID system and as soon as a PIN is introduced the payment is automatically processed by ViaVerde;
- Store companies – some stores offer discounts on neighbour car parking areas in order to attract or facilitate the access to clients. For clients holding the DSRC/RFID system the discounts have to be processed on an agreement basis between the shop owner and ViaVerde;
- Company – there are companies that make agreements with car parking areas to facilitate access to their employees. When they hold the DSRC/RFID system the access can be facilitated without the need for any other mechanism and it is managed automatically by the ViaVerde company;
- BRISA – the motorway management company that offers non-stop toll infrastructures based on the DSRC/RFID technology. The ViaVerde brand was initially associated to toll payment.

The challenge created by this scenario is complex considering that the involved companies are different, possess heterogeneous information systems, have different communication infrastructures and above all, there is some lack of trust regarding the introduction of new technological solutions. This lack of trust is understandable considering that the business model involves a huge number of transactions, involves a critical set of processes and it requires the trustiness also from ViaVerde clients, those that are the users of the virtual payment system. It is mandatory for the technological infrastructure to be failure free and also in the case some exception occurs the recovery mechanism must allow a clear and efficient resolution. Another important requirement is security considering that the business model deals with payments and even if small amounts per transaction are the majority of the cases, any security flaw would compromise the business model.

In order to better deal with this business scenario two main management domains were considered: business management, and technology management domains. The business management domain is related to the ViaVerde business model and deals with service related issues like contractual relationships with the ViaVerde clients and contractual relationships between ViaVerde and companies that are associated to the DSRC/RFID facility. The technology management domain is related to the supporting infrastructure and involves the BAER company. In order to materialize this system, there is a need to install new systems like DSRC/RFID antennas and their integration with the existing technological systems (systems integration). To some extent, the BAER company is responsible for the operational aspects of the collaborative network and beyond the mentioned partners, this company has to collaborate with the ICT development and services provider companies.

There is an extended scenario related to the interoperation of the ViaVerde business model with similar solutions implemented in other European countries. By contributing to the Pan-European ETC network, BRISA expects to offer ViaVerde clients the possibility to pay toll, car parking and other services in other European countries using the same DSRC/RFID technology (Figure 2).

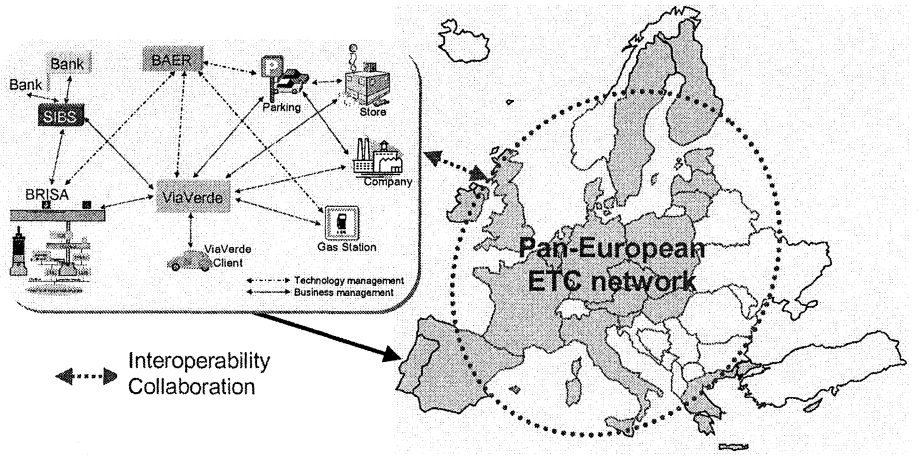

Figure 2 – Interoperability challenge for Pan-European ETC network

The objective is to offer a ViaVerde client the possibility to park in Madrid or Paris without the need to use another system than the DSRC/RFID tag installed in his/her car. This extended scenario towards a Pan-European ETC or electronic fee collection (EFC) network requires collaboration among European motorway companies to get true interoperability among their technological infrastructures. This European wide facility extends the enterprise collaborative network beyond country borders, what requires the establishment of an interoperability framework able to run the underlying enterprise collaborative business processes.

3. ITSIBUS TOWARDS A FEDERATION OF SERVICES

The electronic toll collection (ETC) infrastructure developed by BRISA follows a service based approach (Osório, 2004). The toll systems are built around standard services and implemented on a diversity of technologies (Osório, 2005). Nevertheless, there is already a strong file transfer pattern behind most of the collaborative processes. As an example, the list of valid DSRC/RFID identifiers is transferred in a file from the ViaVerde company to the BRISA toll management infrastructure. When a ViaVerde client changes the associated bank card or needs to perform a simple update operation the change requires some days to be effective. Even if the solution performs well, there is an extra effort that can be avoided if more operations are automated and if what today involves file transference evolves to service level interactions. Similarly to the IBM initiative named Autonomic Computing (Ganek, 2003), the suggested approach is based on the recognition for the need of an added intelligence associated to the management of the technological systems supporting the integrated or holistic enterprise. As a matter of fact a technological infrastructure to support enterprise collaborative processes will be developed around evolving autonomous heterogeneous systems responsible for specialized services. The execution of a number of distributed enterprise collaborative processes depends on the quality of the participating systems which range from storage, transaction management, security, fault tolerance, backup, to human interaction, to mention only a few of the panoply of systems underlying the services that contribute to the execution of the envisaged collaborative processes.

The ITSIBus infrastructure proposes for the Electronic Toll Collection (ETC) systems an architecture based on a set of autonomous systems implementing a set of core services aiming to contribute to infrastructure management and the specialized services targeted to implement specific functionalities (Osório, 2004). There is already a long way to run considering that the increasing "intelligence" associated to each system or enterprise technological component is contributing to an increased management complexity thus requiring advanced skills, not only during development but also during the operations phase. The adoption of open standards is contributing to facilitate the collaboration among heterogeneous systems. As an example, initiatives from the Distributed Management Task Force (DTMF) and Application Response Measurement (ARM) of Open Group, addressing software instrumentation of autonomous systems, are key contributions to an agile management of enterprise heterogeneous systems. In (Turner, 2002) the ARM standard is applied on a framework for identifying, monitoring and accessing to performance data of critical transactions implemented by web services. These

concerns are as well addressed by the ITSIBus through the monitoring and plug-and-play core services aiming at contributing to provide system's autonomy and manageability. The ITSIBus system as a container of a set of services, the core ones common to all the other systems and the specific services implementing specialized functionalities, constitute a federation of systems/services able to be organized according to the enterprise process needs (Figure 3).

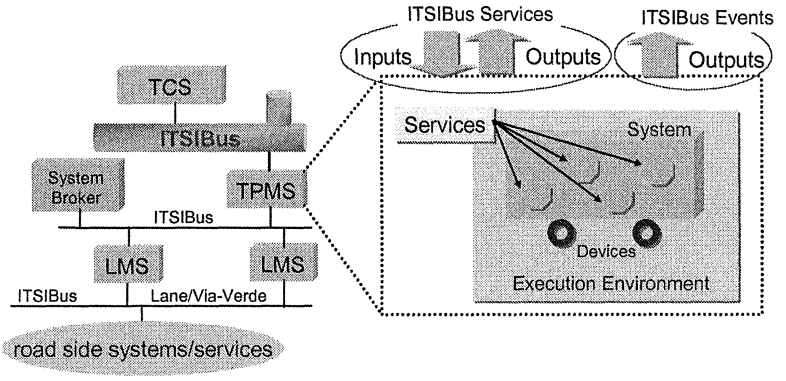

Figure 3 – Toll technological infrastructure based on a federation of services

Each system/set of services of the ETC infrastructure contributes to the execution of the ETC process which is responsible to manage toll information transactions and technology operations management. Each ETC system has an underlying process that is being transposed from a hard-coded approach to a model driven development and operations management approach (Osório, 2005). As shown in (Figure 4) the new generation of the ITC management system is based on a federation of services and the design and development of strategic services like the Toll Coordination Service (TCS), the Toll Plaza Management Service (TPMS) and the Lane Management Service (LMS) are being developed following a model driven approach through process definition in a procedural language (XPDL/BPEL) and its execution based on an orchestration engine.

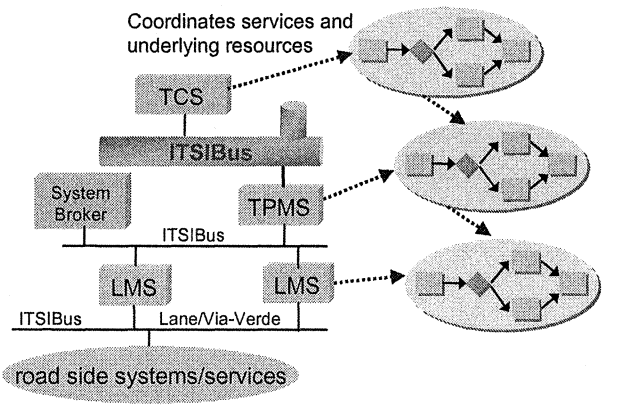

Figure 4 – The ETC management system/services based on service orchestration

Considering the challenges proposed by the extended ViaVerde business scenario, the strategy under evaluation is to extend ITSIBus to the enterprise collaborative space, following an initial proposal discussed in (Gomes, 2003). At the moment, collaboration is deeply grounded on ad hoc information exchange, which is difficult to develop, deploy and manage and not agile enough to cope with new business dynamics and unpredictability imposed by a fast evolution of the business models.

The adoption of the enterprise collaborative network paradigm is seen through a set of collaborative enterprise processes (CEP) designed to cope with specific collaborative business models. Considering the example of the extended ViaVerde business model, an underlying CEP needs to be defined as choreography of a number of services required to implement specific functionalities on each enterprise network member (Figure 5). The proposed approach requires a service definition framework able to deal with the enterprise systems requirements like:

- Distributed transaction management in order to guaranteeing system consistency against failures;
- Service location transparency and an efficient service discovery and advertisement mechanisms. Transposition of enterprise borders is a challenge considering security requirements;
- Distributed information management for high data volumes considering performance and availability;
- Security considering resource access policy management, user authentication, information privacy, integrity and non refutation are some of the related security issues;
- Integration with legacy enterprise systems.

The definition of such integrated view for the enterprise collaborative processes requires a number of consensuses, both regarding process definition and the distributed execution environment. The emergent grid initiative promoted by the Globus Alliance and its initiative on the Open Grid Services Architecture (OGSA) in collaboration with W3C, IETF and OASIS after adopting Web Services as the reference implementation technology are being analyzed as potential contributions to such required distributed service execution environment. OGSA addresses the creation (factory) of services global naming, Grid Service Handle (GSH) and references Grid Service Reference (GSR), lifetime management, registration and discovery, authorization, notification, concurrency and manageability (Foster, 2004).

Even if the OGSA initiative is important to the development of collaborative distributed computational environments, it shall be noted that the strategy adopted by ITSIBus is a multi-technology approach (Osório, 2005). The strategy is to develop a platform and a framework able to deal with complementary strategic and technological approaches. The first productized version of the ITSIBus was based on the JINI platform whilst the reference implementation has services bound to Web Services and JXTA technology. As a matter of fact enterprise systems evolve more than revolve; any framework has to deal with different cultures and systems at different development stages. This means that some companies of the collaborative network are not able to definitely adopt new system but rather accept a kind of adapters making the bridge between legated systems and the required facilities to integrate the new collaborative networks.

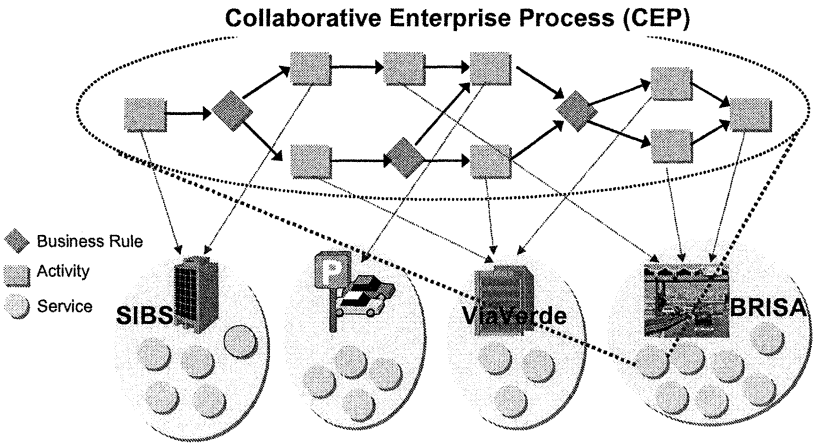

Figure 5 – Enterprise network based on a federation of collaborative services

Another line of the research under discussion is to contribute to the model driven development like it is proposed by MDA initiative of OMG considering a model-driven approach for process integration (Koehler, 2005). The adoption of a declarative approach through the process definition language BPEL and complementary UML graphical representation for activities and constraint rules like Object Constraint Language (OCL) is a way to offer process experts the right tools to generate complex enterprise collaborative systems. Developing at model level, the guidelines proposed by OMG through the MDA initiative can be more easily considered, in particular the Platform Independent Model (PIM) construction and its (semi)automatic mapping to different Platform Specific Models (PIM). This is however a complex research topic that requires further contributions in order to achieve an effective MDA approach, at least considering a completely automatic process to map PIM to PSM.

4. CONCLUSIONS

The presented case study aims at contributing to establish a technological framework for enterprise collaborative networks in the ITS industry. A new structured approach for the challenges faced by the BRISA company to extend its toll infrastructure to payments in car parking and in gas stations was presented. The discussion was centered on the requirements and a first approach was discussed considering two main aspects for the collaborative network. One important aspect addresses the management of the collaborative business processes. The other complementary aspect addresses the management of the technological infrastructure considering as a main concern the interoperability among technological systems of the network members. The discussion is grounded on the ITSIBus as a multi-technology infrastructure based on services to manage motorway toll systems. Furthermore there is a concern in the described work to promote a model-driven approach as a way to cope with the underlying complexity and to be able to map

(bind) models on different technological infrastructures. This approach aims to contribute to develop a new generation of technologies, methodologies and tools able to cope with the complexity associated to the life cycle management of these collaborative networks.

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