Business Models and Service Applications for Traffic Management

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Abstract: Managing traffic becomes more and more dependent on ICT – Information and Communication Technology, in general and particularly on ICT services support. Safety, pollution, congestion, and travel time are all important concerns that point to needs for improving traffic management and realizing this would concern the supportive services (including ICT services). Technology-independent functionality models are not only needed for better understanding the (used and/or desired) (IT) services and discussing them of full value with both developers and users but also for establishing appropriate traceability that would allow updating the underlying technology accordingly based on desired updates in the service support. That is why business models and service applications need to be considered together. Hence, in addressing service applications for traffic management, we would emphasize on the crucial role of business process analysis and technology-independent modeling. Further, service applications relate to corresponding ICT-based service platforms that provide relevant support – in the case of traffic management, it would be for example: localized monitoring and management of traffic and environmental information collected from various information sources such as sensors, surveillance cameras, and weather stations. Such information should be made available through the services in order to increase reusability, loose coupling and management of different information and their analysis. With regard to this, two significant challenges relate to service discovery and interoperability. This paper, reporting research in progress, emphasizes not only on service applications (particularly for traffic) and relations to business modeling, but also on the challenges mentioned above. In this way, we present some visions on how to better benefit from business models and IT services, for usefully improving traffic management, partially exemplifying this.

1 INTRODUCTION

The use of Information and Communication Technology (ICT) is increasingly proliferating in transport vehicles. It is applied to support the main functions like car management and supporting the driver to navigate the vehicle from A to B. We begin to see intelligent systems using sensors and actuators to prevent accidents, for example when the car is approaching other cars too closely. Other applications include information systems like navigators to guide the driver to their destination taking traffic information into account. Other ICT systems are there to entertain the travelers with music and/or video movies. The above mentioned functionalities have been developed independently of each other: car sensors, engine management, traffic information systems, entertainment, and telecommunications. A number of these developments are currently specific to the car manufacturer and therefore the brand of the car. In near future, cars (of different brands) will be able to exchange information (FIATS-M, 2012). Nevertheless, with more and more cars appearing in urban streets due to commuting and increasing transportation needs, we experience severe traffic jams, especially during peak hours resulting to: (i) increasing CO2 emissions; (ii) people spending more time in traffic jams; (iii) wasting of fuel; (iv) stress levels increasing with drivers. Managing traffic in a better way is thus crucially important currently.

Managing traffic itself becomes in turn more and more dependent on ICT services support. Safety, pollution, congestion, and travel time (as mentioned before in this section) are all important concerns that point to needs for improving traffic management and realizing this would concern the supportive services (including ICT services). Technology-independent functionality models are not only needed for better

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understanding the (used and/or desired) (IT) services and discussing them of full value with both developers and users but also for establishing appropriate traceability that would allow updating the underlying technology accordingly based on desired updates in the service support. That is why business models and service applications need to be considered together (Shishkov, 2011). Hence, in addressing service applications for traffic management, we would emphasize on the crucial role of business process analysis and technology-independent modeling. Further, service applications relate to corresponding ICT-based service platforms that provide relevant support – in the case of traffic management, it would be for example: localized monitoring and management of traffic and environmental information collected from various information sources such as sensors, surveillance cameras, and weather stations. Such information should be made available through the services in order to increase reusability, loose coupling and management of different information and their analysis. With regard to this, two significant challenges relate to service discovery and interoperability.

This paper, reporting research in progress, emphasizes not only on service applications (particularly for traffic) and relations to business modeling, but also on the challenges mentioned above. In this way, we present some visions on how to better benefit from business models and IT services, for usefully improving traffic management, partially exemplifying this.

The remaining of this paper is as follows: Section 2 discusses IT services and also their relation to business modeling. Section 3 discusses the challenges as mentioned already. Section 4 outlines some envisioned solution directions. Section 5 provides partial exemplification. Finally, Section 6 contains the Conclusions.

2 IT SERVICES

In this section, we consider IT services in general (broader) and web services, in particular (these are those IT services which are delivered particularly through Internet). Let's nevertheless start from the service concept: from an abstract point of view, a service represents a piece of well-defined functionality that is available at some network endpoint and is accessible via various transport protocols and specialization formats. The functionalities provided by services cover a vast spectrum reaching from low level features like offering storage capabilities, over simple application functions like changing a customer address, to complex business processes like hiring a new employee (Alonso, 2004).

The ability to create new ICT applications from existing services, independently on who provides these services, where they are provided, and how they are implemented, would mean usefully utilizing the service perspective in application development (Van Sinderen, 2012). Such kind of application development is innovative not only because the application is not constructed from the scratch (actually, this is true also for component-based application development) but also because the development itself is fully centered around the desired end functionality to be consumed by users (this leads to service compositions and hence developers would no longer possess full control over all software components that play roles in delivering the application functionality). Hence, the application development task (as considered in general) might split into: (i) development of small software modules delivering generic adjustable services to whoever might be interested in using them, and (ii) composition of complex functionalities, by using available generic services. This all inspires new middleware developments also (Shishkov, 2011).

Furthermore, in order to be of actual use, such services would demand enabling technology standards and some recent views of Papazoglou (2008) appear to be actual in this respect. Transportation protocols are to be mentioned firstly because logically, web services' relying on a transportation protocol is crucial. Although not tied to any specific transportation protocol, web services build on ubiquitous Internet connectivity and infrastructure to ensure nearly universal reach and support. Hence, their mostly relying on HTTP (the connection protocol that is used by web services and browsers) and XML (a widely accepted format for all exchanging data and its corresponding semantics) looks logical. Having this as foundation, we have to briefly discuss three core web service standards, namely SOAP, WSDL, and UDDI: (i) SOAP (Simple Object Access Protocol) is a simple XML-based messaging protocol on which web services rely in exchanging among themselves information. SOAP implements a request/response model for communication between interacting web services. (ii) WSDL (Web Service Description Language) is a language that specifies the inter-face of a web service, providing to the requestors a description of the service in this way. (iii) UDDI (Universal

Description, Discovery, and Integration) represents a public directory that not only provides the publication of online services but also facilitates their eventual discovery. And finally, as part of the web services composition, we need to introduce some orchestration defining their control flows (Alonso, 2004), such as sequential, parallel, conditional, and so on, and to also determine complex processes that would usually span many parties. BPEL4WS (Business Process Execution Language for Web Services) can usefully support such composition activities. Finally, as the collaboration among many parties (through their web services) is concerned, a common observable behavior (choreography) would often need to be defined. CDL4WS (Choreography Description Language for Web Services) can usefully support such collaboration descriptions.

In SUMMARY: all those details related to IT (Web) services essentially point to business analysis and business modeling activities to be done as 'background'.

3 CHALLENGES

As mentioned, two essential challenges with regard to what has been discussed so far, are: (i) service discovery; (ii) interoperability.

SERVICE DISCOVERY is of crucial importance in identifying, composing, and delivering a service but still here some issues have not been convincingly resolved yet (Sapkota & Van Sinderen, 2011). In an open environment, it is difficult to support on-demand collaboration if the published service descriptions are outdated consequently providing incorrect information. This difficulty escalates when service descriptions contain limited information, i.e., some information may be relevant to the discovery of services but since this information depends on the runtime state, it cannot be included in the service descriptions (Van Sinderen, 2012). So, besides the "correctness" (or "outdated information") problem, we also have the "state-dependency" (or "dynamic information") problem that leads to poor discovery results. For more information on analyzing the service discovery challenge, interested readers are referred to (Sapkota & Van Sinderen, 2011).

SERVICE INTEROPERABILITY concerns the ability of a service to collaborate with other services (Van Sinderen, 2012). This requires that different service 'owners' have to devise their processes and agree on a shared universe of discourse, such that their respective collaboration goals can be fulfilled. Furthermore, it requires the ability of exchanging information and of using the information that has been exchanged in accordance to the collaboration goals. If the collaboration is to be supported by Information and Internet Technology, underlying automated systems send and receive messages containing user data to represent the information. Communication protocols and data formats are to be standardized to achieve syntactic interoperability (exchange of data), and ontology definitions and ontology languages have to be developed to facilitate semantic interoperability (interpretation of data). Hence, in order to achieve interoperability, business requirements and technology solutions have to be aligned.

4 SOLUTION DIRECTIONS

Taking all above in consideration, we can formulate a strategic GOAL as follows: to design and develop powerful and deployable service-oriented (road) traffic management system able to support individual mobility and network wide operations. Fulfilling this goal is claimed to be non-trivial and we have thus outlined several solution directions whose justification is left beyond the scope of this paper and whose further elaboration is considered as future work:

- considering technology-independent functionality models as 'bridges' between user demands and technological solutions;
- aligning technical solutions to the existing standards for service discovery and interoperability;
- balancing individual and group interests through sophisticated rules and regulations;
- aiming at solutions that are adequate with regard to observing privacy and security.

5 EXAMPLE

In the current exemplification section, we would consider a scenario presented at the FIATS-M'11 International Workshop (Sapkota, 2011):

Bob lives in the outskirt of Enschede with his wife and two children. He is scheduled to have a project meeting in Sofia at 11:00 PM on Friday. He *is occupied the entire day because of the kick-off meeting of his recently acquired project on Thursday. Because Bob is mostly busy with his work (delivering lectures, attending meetings, and doing research) during the weekdays, he spends his weekend with his family as much as possible. When his children know about his forthcoming trip to Sofia on Friday, they were sad that they will not see him during the weekend. So he promises his children that he will return to take them to the world-famous zoological garden in Emmen at the weekend.*

He decides to travel Friday morning to Schiphol where he will take an early flight to Sofia. Since taking a train would not leave him enough time to check in, he takes his car, which is equipped. with Intelligent Route Planning (IRP) agent, radio and Global Positioning System (GPS) devices.

He books the flight accordingly and downloads his e-ticket to his smart phone. When the e-ticket is downloaded, his smart phone recognizes it and wirelessly communicates with an IRP agent installed on his car. This agent communicates with the GPS device installed on the car and determines the required travel time to reach to Schiphol airport. The IRP agent knows that Bob normally wants to arrive at the airport 30 minutes before the normal time as suggested by the airlines and thus calculates the time Bob needs to start his journey. The IRP agent communicates this information to Bob's smart phone. Bob's mart phone then uses this information and sets its alarm accordingly.

When he follows the route shown on his GPS system, he suddenly encounters that the road is blocked because of construction works. He then ignores the advice that comes from the GPS system and drives on a different road that is thus NOT suggested by the GPS system. The GPS system apparently does not know about this situation and what Bob is doing because Bob is driving on a newly constructed road; the GPS system keeps advising Bob to take a U-turn if possible and Bob keeps ignoring the advice and keeps driving using his own instinct and sense of direction. After a while, the GPS system recognizes the stretch of road that Bob is driving and recalculates the route for Bob. The route Bob has taken based on his own sense of direction turns out to be a fast solution, especially in early morning travel time. The IRP agent on his car records this newly discovered route and updates the map and broadcasts the plan to the passerby cars.

While on his way, the IRP agent installed on a car coming from the opposite direction communicates information of long jam of cars 10 KM ahead because of a recent accident to the IRP agent installed on Bob's car. The IRP agent then communicates this information to the GPS system to re-calculate the route.

When he is driving on the re-calculated route, the IRP agent communicates with the Road-Side Infrastructure (RSI) and finds out that the traffic near the next junction where Bob has to turn right is congested (the RSI can determine such a situation by using information from loop detectors). The IRP agent informs Bob to change the lane well in advance. The IRP agent also predicts, based on the current weather conditions, total number of current road users and their average speed, that the joining road ahead of the next junction could have black ice. The IRP agent then informs Bob to drive at safe speed to avoid a possible slippery road condition.

When Bob drives some 100 KM, the IRP agent receives information from the RSI that there is a poor visibility 20 KM ahead of the road and schedules the light control system to brighten their light calculating the time required to reach that spot. When Bob passes the poor visibility area, the IRP agent identifies that the visibility is OK and resets the high to their original intensity through the light control system.

When at parking lot at the airport, Bob's car recognises that his friend Dave is also at the airport, and sends him an invitation for a coffee if he has time. Dave replies with a call and they meet at a nearby coffee shop. After having a chat with his friend, Bob goes to check-in his flight and leaves for Sofia.

After the meetings in Sofia, Bob returns to The Netherlands. When he lands at the Schiphol airport, he turns his smart phone on. His smart phone then wirelessly communicates with the IRP Agent at his car. The agent then communicates with the GPS system and calculates the time required to reach his home and informs his wife Alice about his arrival time. Bob then continues his journey towards his home following the route displayed on his GPS system.

After driving 45KM, the road RSI communicates to the radio device installed on his car that the road further ahead is busy (which is expected because it is a Friday night). The RPI agent receives this information through the radio device installed on Bob's car and communicates with the GPS system to recalculate the new route and new time required to reach Bob's home. It appears that Bob will arrive home 30 minutes later than previously expected, the IRP agent then informs Alice that Bob will be late by 30 minutes because of busy traffic.

The new road that Bob is driving now is relatively empty ahead of him with just few cars behind him. When he approaches Enschede, the IRP agent communicates with the RSI and finds that an ambulance is coming on the joining road at the junction ahead and Bob will not be able to cross it safely. The IRP agent then informs Bob to slow down because the traffic light at the junction is going to turn red because of the high priority vehicle on the other road. When he starts decelerating, the IRP agent communicates with the IRP agent on the car behind Bob (which was out of the range of RSI communication) and informs that Bob is decelerating. The IRP agent on the car behind Bob then informs his driver Tim to start decelerating to avoid possible environmental pollution (noise, air) and a possible collision because the car in front is decelerating for some reason.

When the ambulance crosses the junction, RSI broadcasts the message that it is going to turn the traffic light to green because there are no other vehicles on the joining road. The IRP agent informs Bob to smoothly accelerate and move forward. Finally, when Bob arrives at home, Alice is waiting for him with a hot cup of coffee, he starts talking with Alice while drinking his coffee.

Hence, a service platform is necessary, for supporting communication between vehicles as well as between vehicles and road infrastructure through the concept of services orientation. The concept of service orientation is used to integrate various types of systems and services. It is also used for supporting interoperation between these services and systems. Furthermore, the service orientation allows us to deploy services in the cloud to achieve performance requirements such as scalability and efficiency.

Such a service platform needs to provide support for different communication protocols as well as service descriptions. To support this requirement, the service platform would provide a standard communication interface which bridges the protocol heterogeneity through the use of adapter. The heterogeneity between service descriptions can be handled by defining an intermediate description language which can allows us to define mappings without knowing the target description language. The back-end information system infrastructure is used to process the collected information and to derive useful information or the composition of services for the user.

In realizing all this, it is essential keeping full consistency between:

(i) what is desired (from user perspective) and
(ii) what is delivered (from system perspective).

We find this example and the follow up discussion as further justification of the claim that technology-independent functionality models are to adequately BRIDGE the gap between the two.

6 CONCLUSIONS

The contribution of this paper is two-fold:

(i) We establish and justify the role of technology-independent functionality models, especially with regard to the technical and technological facilitation of (road) traffic.
(ii) Analyzing strengths and challenges concerning IT services, we propose service-oriented solution directions and provide partial exemplification concerning our proposed visions.

We plan to develop further these views, elaborating them from a privacy/security perspective. The reason is that, as according to our view, without convincingly touching upon this, it would not be possible to implement and deploy such systems in at a larger scale.

REFERENCES

FIATS-M Home: http://www.fiats-m.org.

Shishkov, B.: Technology-Independent Functionality Models for Road Traffic Systems. Proc.: FIATS-M'11 (2011).

Alonso, G., Casati, F., Kuno, H., Machiraju, V.: Web Services, Concepts, Architectures and Applications. Springer-Verlag, Berlin-Heidelberg (2004).

Van Sinderen, M.: Modeling Internet-Based Goal-Oriented Enterprise Interoperability (Keynote Lecture). Proc.: BMSD'12 (2012).

Papazoglou, M. P.: Web Services: Principles and Technology. Pearson Pr. Hall (2008).

Sapkota, B. & M. Van Sinderen: Leveraging the Publish-Find-Use Paradigm of SOA, Supporting Enterprise Collaboration Across Organizational Boundaries. Proc.: BMSD'11 (2011).

Sapkota, B.: An Adaptive Service Platform for Traffic Management and Surveillance. Proc.: FIATS-M'11 (2011).