Examining possible value system transitions: The case of smart mobility services

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Abstract

The application of Information and Communications Technologies (ICT) to mobility has produced a wide range of smart mobility services. These services have been deployed either as large, vertically integrated solutions driven by governments or as fragmented initiatives by competing companies and consortia. Lack of open approaches has restricted the diffusion of these services. In this paper we explore two possible paths for how the value systems around smart mobility services could transition from a closed model to an open model. We use a framework and two case examples from prior research [1] to study these transitions in either centralized or decentralized path. We aim to address the potential conflicts in the evolution of smart mobility services especially from the European perspective.

1. Introduction

The application of the ICT to mobility has produced a wide range of smart services promoting green, safe and efficient mobility for people and goods. These services range from ones used by government entities (e.g. related to safety and road tolling) to enterprises (e.g. fleet management), individual vehicle users (e.g. navigation) and pedestrians (e.g. journey planners).

Although many services have been deployed and are in use the services and the technologies have been largely deployed as vertically integrated closed solutions. This in turn has restricted the diffusion of the services and made it difficult to scale them across markets and in general limited market growth [2]. The emergence of a dominant design has not taken place and experimentation still continues [3]. Very large vertical solutions are often complicated to implement and therefore miss the market opportunity [4]. The impacts to the business environment and to organizations have also been limited [5].

Overall, there is a clear need to move towards more open and horizontal market structure and to produce smart mobility services over shared platforms and to utilize modular designs and business architectures. Various open models have already been proposed. For example in [6] an open in-vehicle platform architecture for the provision of Intelligent Transportation System (ITS) services is discussed. An open multi-service model has also been proposed in [7] which defines a high level conceptual technical architecture for a multi-service and multi-vendor environment. Furthermore collaborative models have been introduced by competing voluntary industry consortiums such Genivi Alliance, Car Connectivity Consortium, and Open Automotive Alliance[1].

On an international level development towards open models is currently progressing with large scale pilots e.g. with the European project MOBiNET[2] that aims to build a community of transport data and service providers with a Europe-wide service platform. Countries such as Finland are deploying a large scale pilot led by the ministry of transport and its agencies[3] where the goal is to move to an open model and stimulate market driven diffusion of smart mobility applications and services through public procurement. The traditional ICT industry and standardization forums are also investing in ITS including Machine to Machine technologies, with a special focus on smart mobility [8], [9]. The International Standards Organization ISO Technical Committee 204 has already been working in this area for decades[4].

The purpose of this paper is to examine two possible paths for how the value system around smart mobility services could develop from the current closed models to open models. We use a framework

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[1] https://www.genivi.org/, http://www.mirrorlink.com/ and http://www.openautoalliance.net/ (Accessed 28th of May, 2014).
[2] http://www.mobinet.eu/ (Accessed 28th of May, 2014).
[3] http://liikennelabra.fi/ (Accessed 28th of May, 2014).
[4] http://www.iso.org/iso/iso_technical_committee?commid=54706 (accessed 25th August 2014)

and two case examples from prior research [1] to study the possible transitions, based on the open GSM model depicting a more centralized path and the open wireless Internet model depicting a more decentralized path. Furthermore, we extend the scope to study the alignment and synchronization of ICT and smart mobility services. We aim to show the possibilities and need to significant market changes as well as to discuss issues in emergence of dominant designs in the converging value systems and technologies.

The rest of the paper is structured as follows. Section 2 introduces briefly the theoretical background. Section 3 describes the framework of dynamic state model used to examine the value systems. Section 4 describes the current value system states around smart mobility services by applying the framework and using examples from mostly European markets. Section 5 depicts the possible value system transitions for smart mobility services from a closed to an open model following the examples of section 4. Finally section 6 discusses the significance of the results and their implications.

2. Theoretical background

Value systems and their internal dynamics have been discussed extensively, inspired specifically by the research by Porter who used the term value system to refer to a large stream of inter firm activities [10]. Value system expands to cover all relevant actors needed for a network of firms to provide product or service to the end customer, including the expectations and actions. Value systems are often based on one or few platform companies which strongly influence the dynamics of the value system. Platform leaders use open or semi-open technology communities, like standardization to extend the relevance of the platform and also the particular value system [11]. The power of the platform leader is maximized or monopolized when a value system is divided into two or more isolated parts as is the case in the two-sided market [12]. Value systems seem to follow a cyclical change between vertical and horizontal business models while the technology architecture is at the same time integral or modular, respectively [4]. The value systems evolve often by technology innovations which can be incremental, modular, architectural or radical [13]. Drastic changes, which also impacts the dynamical behavior of the value system are driven by radical innovations [14]. Value systems may also experience radical changes based on other factors such as regulatory actions and political decisions [15].

The value system transitions require time to evolve. Technologies experience a time period of fermentation after which the successful technologies will gain the position of dominant design [16]. Technology evolution is often unpredictable and especially from markets perspective experiences rapid growth periods instead of single S-shaped curve [17].

The diffusion of innovations in general have been observed to be dependent on factors related to the innovation itself, like what benefits it provides, how complicated it is to use and especially relevant for this study, how compatible the innovation is to the existing environment, broadly speaking to the value system, including the expectations of the end-users [18]. Diffusion speed naturally depends on how forcefully the new innovations are imposed over the links of the value system, where each diffusion link or interface may be different.

Keeping the control in such a complicated and complex value system is a very challenging task as can be observed e.g. in the Android value system, originally based on fully open Linux software, which later on developed to the Google sponsored Android semi-open mobile device operating system. Subsequently it has evolved further to a managed developer oriented application business and has finally experienced limited openness, dominating market power and behavior leading to partial fragmentation and confrontation [19].

More generally, complex systems include actors that are connected to each other by links creating a network of actions and reactions through feedback loops. Complex systems are modelled extensively by computer simulations [20]. Motions of complex systems have been studied to analyze the interplay between different types of subsystems [21]. Dynamical systems in general can be characterized by an attractor, whose type can roughly be divided into three groups: fixed point, limit cycle and strange attractor. For the sake of the completeness also the case without any attractor needs to be taken into account. Depending on the type of feedback loops the complex system behavior follows the four above mentioned categories.

3. Framework of value systems

In [1] a framework for value system modeling is introduced. The framework combines many of the concepts discussed above and describes four value system states, as four models, shown in Figure 1. The four models follow the three attractor models in [21] complemented by the fourth model without any attractor. The observed openness and level of centralized control define the dimensions of the modelling. In [1] the framework is used to model complex system behavior based on the strength of the feedback loops and power of the actors to show the observed dynamics of two different communications systems, Wi-Fi and Cellular. The simulation model has also been extended to showcase possible evolution paths of radio communications value system under different conditions [22]. In this paper the qualitative framework is applied to smart mobility services, observing the current state of the services, related industry activities, regulatory initiatives and technology capabilities.

3.1. Four value system states

Value systems in this paper are categorized into four different types following the centralized/ decentralized and open/closed dimensions aligned with the four models used in [1].

First of the states is a fully centralized and closed state where the value system is dominated by one actor and integrated technical components, henceforth the *monopoly model.* In this state one actor controls the tools of service production and distribution in the value system. The value system is centrally optimized and thus has strong centralized control and is slow to adapt to changes coming from outside.

Second model is a still centralized but quite open state with few tightly coupled market actors and technical components. Such a subsystem features a limited set of market actors co-operating and competing e.g. oligopolistic competition between large mobile operators, henceforth we call this state the *GSM (Global system for Mobile communications) model.* Since harmonized technologies are utilized users can rather easily switch between service providers and thus induce some competition between the market actors.

Third model is a partly decentralized and open state with many loosely coupled market actors and technical components, as we observe is used in the Internet and World Wide Web (WWW), henceforth the *Internet model.* Tools of service production and distribution are democratized and used by all for all. There exists a great heterogeneity of technologies and services with plenty of local innovation and competition. However, actors also collaborate and services and technologies are made interoperable so that valuable services that have high demand are able to flexibly scale bottom-up. End-users can freely switch and roam between services with low switching costs.

Fourth model is a fully decentralized and closed state with many isolated market actors and proprietary incompatible technical systems, henceforth the *fragmented model*. Here the actors are fiercely competing against each other and in practice no co-ordination exists. Isolation and intense competition leads to the erosion of resources where nobody is able to scale their services bottom-up. For end-users such systems are not usable due to limited functionality and high switching costs.

3.2. Four by Four value system transitions

The value systems often seem stable but under certain conditions they will experience state transitions. Theoretically four by four i.e. sixteen

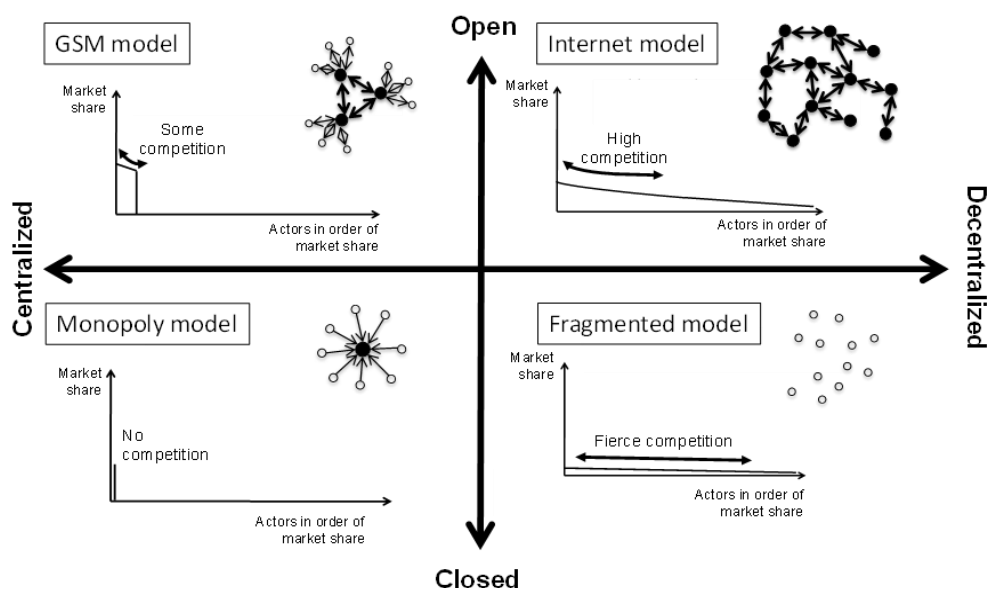

Figure 1. Modelling the four value system states (Adapted from [1]).

state transitions are possible.

The state transitions may be initiated e.g. by regulatory actions but also the introduction of a new, advanced technology may cause significant changes to the dynamics of a value system. Regulatory changes are often very visible while technology driven changes become visible only after large scale service adoption has already taken place. De jure and de facto characterizations of industry alignment used in standardization follow a similar division. During such transitions the value systems are typically only partially using the same system model. The transition may start in one subsystem layer only and the other layers will follow later. Full synchronization is a complex process and may take a long time to happen as discussed by Strogatz in [21].

3.3. Value system elements, drivers and constraints

Mobile communications and computing value systems are today very complex and it is not obvious to see any generic structure. On very high level, however, the value systems may be simplified and clustered to four major layers or subsystems:

Content. Consisting of any "user plane" data. The content may be stored in different parts of the business or technical architecture.

Network. Consisting of all the transport network mechanisms. The control functions of the transport network are part of the network layer.

End-user device. As long as the people are not directly connected to the network, some device is needed. Today "smart phones" are typical end-user devices, but a vehicle could also be the end-user device in smart mobility.

Identity. All users and their data will need an identification mechanism for service provisioning.

The subsystems, include both the technology elements as well as operational roles of the actors, e.g. the Network layer includes network infrastructure, network operators and their equipment suppliers. Furthermore, each subsystem may include several nested subsystems. Value adding service providers, application developers and application platforms may be mapped to one or more of the subsystems mentioned above depending on their primary focus subsystem. Operational and functional interconnections and roles of the subsystem are especially important in this study while the implementation aspects, like software and hardware are not.

The factors driving and constraining the value systems are even more complicated. In this paper we focus only on one important driver and two constraints.

Innovation. Innovation as a concept refers to the behavior and the ways the innovations are managed in the value system. In a fully open value system anybody has the possibility to create innovations and also gain the benefits while in the closed systems the possibilities to innovate are limited.

Ownership. Ownership and therefore the control of the subsystems will limit the use of the subsystem capabilities and resources and therefore is a non-technical constraint of interoperability and dependency.

Scarce resources. The most limiting factors are typically based on laws of physics. All value system actors have to take these into account. Radio spectrum, roads, real estate and energy are examples of limited natural resources.

Based on the previous work in [1] it can be observed that a fully synchronized and aligned system state is achieved when all the layers, including all of the actors on those layers behave under the same system state constraints.

Example 1: Transition From monopoly to GSM model

As it relates to the transition from a centralized and closed model to a centralized and open model the transition that has occurred in mobile communications can be used as an example [1].

Originally mobile communications services were provided with a monopoly model where the government was in control of infrastructure and services. End-users and other actors (e.g. suppliers) remained in a passive role and each country had a dedicated system for mobile communications that was not interoperable with systems in other countries.

In Europe, along with the deregulation of telecommunications markets and the introduction of digital mobile communications, a new model was introduced where governments gave radio spectrum licenses to market driven GSM network operators. Governments were still able to regulate the markets and the GSM model made it possible for operators to provide basic services (e.g. Mobile Voice and Short Message Service) with guaranteed quality of service. In the GSM model, standardized interfaces were used which meant that operators were able to source modular multi-vendor solutions, mobile operator networks were interoperable, and end-users were able to switch between operators and roam between countries using the same handset.

The transition did not cover all areas of the earlier closed value system and some specific services maintained their earlier closed behavior. One example of those is the governmental radio networks for authority use, like the Terrestrial Trunked Radio (TETRA) networks in Europe which remained in the monopoly value system state even when the technology was standardization in an open fashion.

After the original synchronized growth period, the state transition in mobile communications has further developed by exploiting the existing mobile communications value system. For example Over The Top (OTT) internet services are tunneled through the GSM model oriented mobile networks forcing the service level agreements to follow the Internet paradigm, like best effort and flat rate national data tariffs. Such miss alignment has impacted negatively the service adoption as has been the case with digital mobile services in the European Union (EU) [23].

Example 2: Transition From fragmented to wireless Internet model

As it relates to the transition from a decentralized and closed model to a decentralized and open model the transition that has occurred in the evolution of wireless access to the Internet can be used as an example.

Wireless access techniques were all uncoordinated originally. With the introduction of the ALOHA technique and regulatory decision by the Federal Communications Committee (FCC) in the USA a vast number of different access technologies were introduced. In order to gain some interoperability work in different standardization organizations was started. The 802.11 group in IEEE together with Internet Engineering Task Force (IETF) started to work on voluntary specifications for wireless access to the Internet. The joint IEEE and IETF collaboration gained strongest support over other parallel activities especially within the computer industry. Larger and larger local networks were built using the evolving 802.11 generations. Wi-Fi Alliance was established to bring voluntary marketing and certification elements additionally to the technology effort. The local islands of interoperability were only loosely coupled, based on the same basic technology but limited by the uncoordinated access rights. The wireless Internet brought order to the originally fully fragmented business where all the devices and services were proprietary and vertically integrated. The new model led to a wide range of heterogeneous interconnected actors, services and technologies where users and providers were able to pick and mix devices and services in a modular manner. Local networks were connected on international level using light weight standards (e.g. IETF driven TCP/IP) with a narrow waist principle ensuring minimum interoperability only. Subsequently services developed over the top of the Internet and Wi-Fi were able to scale on a global level. On the other hand the light weight standards were not able to secure quality of service and therefore the networks still operate mainly using best effort approach.

In the wireless Internet access value systems there are also areas which have not yet converged with the Wi-Fi evolution. For example the Bluetooth community has only recently started to develop all IP profile while the IETF is co-developing the Constrained Application Protocol (CoAP) to extend the Internet model further.

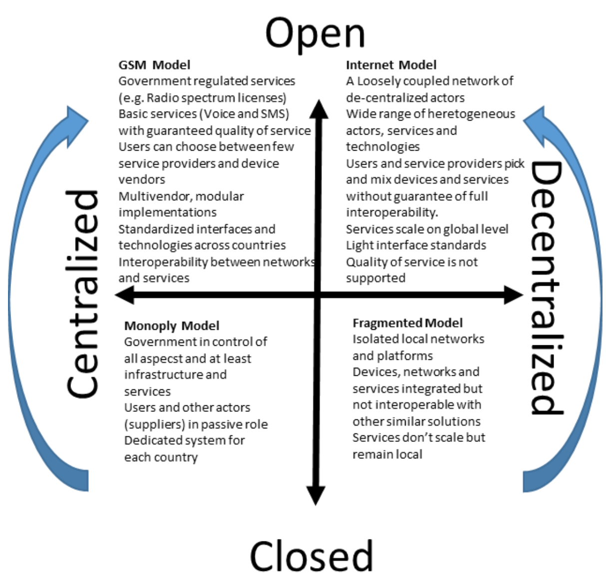

Figure 2. GSM mobile networks and wireless Internet as examples of transitions from closed to and open model.

4. Current state of the value system around smart mobility services

Smart mobility systems have significant similarities with mobile communications systems, where the principal value system layers, content, network, end-user device and identity are visible, but where the value system development is still in its early stage. Also the roles of value adding service providers, application developers and application platforms are significantly underdeveloped. Furthermore, the network effects that have been absolutely critical in the success of the mobile communications business [24] are still largely missing in smart mobility services.

4.1. Monopoly model in Smart Mobility

Although it varies between countries most government driven smart mobility services such as maintaining fixed infrastructure for traffic monitoring and road tolling follow the centralized and closed monopoly model. Overall, it can be argued that many smart mobility services have so far been very government driven with rather stagnated and inefficient processes.

Example services include government controlled ITS infrastructure, e.g. intelligent traffic lights and variable road signs that adapt to local conditions. These services have been implemented with a rather vertically integrated architecture that can be centrally controlled with high aims to guaranteed service and security. Other services include real time traffic information of road congestion and weather (provided by fixed measuring stations, fixed weather stations and cameras) that public authorities can use for traffic demand management with some open data access to all citizens e.g. in Finland Also the upcoming pan-European eCall service[5] that enables automatic emergency calls if motorists are involved in a collision will follow the same model and be mandated to all new vehicles.

Information systems related to public transportation, e.g. journey planners and payment systems, are also largely based on the closed and centralized model although some open Application Programming Interfaces (API), data formats and interoperability exists.

Overall, as it relates to these services, when each country has their own solutions and no common modular architecture and standards exist, multi-vendor solutions are not possible and the systems are locked in to a single vendor leading to a situation where the possibility to develop systems further is low. On a governmental level, harmonization attempts are ongoing e.g. related to eCall and road tolling in European Electronic Toll System. However without a critical mass of market actors supporting the standards, the standards will remain away from main stream operation.

[5] http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2011/c_2011_6269_en.pdf

4.2. Fragmented model in Smart Mobility

On the other hand the market driven smart mobility services are largely fragmented where each service provider works as an isolated silo thus corresponding to the fragmented model. For example information services like navigation and real time traffic (where information collected from government infrastructure is combined with floating car data received from private fleets) provided e.g. by actors like TomTom and Google do not offer the possibility for data portability, i.e. for an end-user to switch from one service to another and take her data with her while using the one single device.

Furthermore for example automotive manufacturers provide their own integrated and isolated in-vehicle platform solutions. They have developed services such as Volvo On Call, BMW Assist and GM Onstar that provide call center support and other value adding services. These services include market driven Third Party Services supported eCall, breakdown call (bCall), remote vehicle diagnostics for on demand repairs as well as infotainment services directly to the vehicles in a vertical and closed manner [25]. This approach creates a difficult environment for independent application developers who have limited resources to tailor their services to different platforms.

Several telematics services exist such as driver coaching for individual vehicle users, automatic travel reporting systems and driver diary for larger fleets e.g. for taxi's, and car sharing communities. Here, aftermarket modules are installed to the vehicles but typically these are not modular and the customers are locked into one solution. Fleet management information systems for logistics are common but are typically tailored for each case and integrated to enterprise resource planning systems resulting again a lock-in.

Some usage-based insurance (also known as pay as you drive) schemes exist where the insurance fee is dependent upon the driving behavior of the driver. Intelligent parking services are gaining momentum where the driver is automatically guided to a free parking spot and where the fee can be adjusted based on the time of day. All of such systems are largely fragmented.

Overall, the market is dominated by incompatible solutions where the end-users are locked-in to specific services providers with dedicated equipment. When switching costs are high and there is no support for data exchange between sources and "data roaming" between service providers the end-users have to stay loyal to their service provider regardless whether they are satisfied with the service [26].

5. Possible transitions of the value system around smart mobility services

In the following section two state transitions for smart mobility services are studied in detail using the framework of section 4 and summarized in Tables 1 and 2, respectively.

5.1. From Monopoly to GSM model in Smart Mobility

There are significant public needs to improve quality of service, energy efficiency, safety and environmental sustainability of traffic systems especially in services currently provided by government driven programs. These type of smart mobility services need a value system of large, market driven corporations, able to make long term investments and build large scale infrastructure. This is especially important for the EU, where the harmonization of services is a much more difficult task than in other large markets, such as the U.S. or China. The fragmented governance by partially competing member states calls for strong pan-European technical interoperability, even if full service harmonization is not desired.

Current European research programs are already set well to support new innovation model for this type of smart traffic technologies and services. The most efficient use of scarce resources like the radio spectrum requires also political coordination in fragmented European market. For service and technology development market driven ownership is needed to maximize the deployment speed as was the case in the early GSM market. For the scarce resource in smart mobility, i.e. the roads the smart mobility network operation licenses could be subject to auctions as the spectrum is auctioned in the telecom services. This is important particularly if significant new investments are needed to implement smart mobility systems. In this transition model, reasonable number of service providers will be needed in order to facilitate competition.

When applying the GSM logic further it is important to see smart mobility as set of commercial services rather than a set of governmental services financed by taxes. Service obligations like road priority service, tolling fees or eCall can be easily implemented also as part of the high quality commercial GSM type business model.

For smart mobility systems the content subsystem include critical information for navigation, maps, about road traffic, gas stations or toll charges of roads or bridges. The content may also refer to collected sensor data from the vehicles, covering almost unlimited sets of data on engine, transmission, location of the vehicle or more. The content subsystem in this context include also the metadata and other derived information that may become available for the benefit of the smart mobility users and service providers. Centralized control mechanisms may be needed to make the content relevant and available also for roaming smart mobility users outside of highly populated areas, service obligations for content, e.g. virtual roadsigns for autonomous driving.

When analyzing the critical network subsystem service needs, there are no requirements foreseen which in technical terms would be impossible for the current 4G and the future 5G mobile networks to provide. Exploiting the public mobile networks is likely to be the most effective way to provide high quality, full coverage and reliable connectivity to smart mobility assuming a fruitful synchronized co-development of smart mobility and ICT, both business and technologies. Some new network features will be needed, including device to device traffic and very low latencies.

Identity system for this type of smart mobility needs to be compliant with authority use in all member states of the EU. New multi-user/owner models are needed to separate the roles of drivers, passengers, car manufacturers and other possible stakeholders in quite a reliable way. Current solutions with multiple physical Subscriber Identity Module (SIM) cards in one vehicle are not practical and full remote provisioning of identities is needed. The importance of unbundling the roles of people, service provision and vehicles is critical for competitive market.

Currently there is no harmonized view on the business architectures for smart mobility in the EU. Taking into account the fragmented nature of the union the four main subsystems of the overall business and technology structure of the proposed smart mobility value system should stay unbundled but synchronized. Open operative interfaces with low interdependences between the subsystems enable competition and fast introduction of new technologies to happen.

Ownership of the content, network, user interface as well as the identity are important factors which define the value system dynamics. The end-users should feel motivated to move from the current monopoly business model to flexible commercial business model. Therefore it is obvious that end-users shall have a role of a subject rather than that of an object and therefore have the possibility to choose each subsystem components separately.

Leveraging the control points and dependences from the earlier telecommunications based research following list of changes is proposed in Table 1

Table 1. Value system state transition from Monopoly to GSM model.

Subsystem	Today (Monopoly)	Future (GSM model)
Smart mobility Content	Closed and proprietary content	Multi-vendor Content available, where a dynamic market for content is independently available from the other ITS subsystems
Network aspects, Operations and equipment manufacturing	Dedicated vendor(s) for government operator	Multi-vendor solutions, open competition between infra vendors in all elements of smart mobility system.
Device manufacturing **Device retailing**	Dedicated vendor(s) for government operator Government operator controlled	Open competition between independent device vendors, liberalized type approval for critical safety etc. requirements. Liberalized, Several different retail channels co-exist and compete.
Smart mobility service operation (covers identity and core network elements and registers)	Government operator controlled	National and international competition among the smart mobility service operators. End-users can choose freely what service provider they want to use as their home service provider. All the roaming will still work and there are only low additional roaming fees. Virtual smart mobility service operators are very common.
Process	**Today (Monopoly)**	**Future (GSM model)**
Technology creation (based on service requirements)	Created solely by government dedicated operator	Market driven standardization process with strong pan-European goal setting. Full interoperability between the smart mobility operators nationally and between the member states. Multivendor infra-structure and commercial consumer devices. Multivendor device market for pre-installed units for M2M segment
Device ownership and management	Government operator controlled, devices only leased to consumers	End-user controlled (note that there are different types of end users). End users are not bound to use any specific brand of devices related to their smart mobility vendor or e.g. transport infra vendor (like car company)
Scarce resource regulation	Government operator controlled	Harmonized regulation with strong national interest. Each member state may be in different economic situation and may prefer to use different mechanisms to manage the scarce resources (ie. roads and railroads etc., real estate related to those). This must however not be done with incompatible technical solutions.

There are many details which will need further definitions, like the role of value adding smart mobility services and application developers. The definition of the device should be very broad including ultimately virtual device which can be embedded to any hardware or software platform. Ultimately the smart mobility device is simply a standardized functionality with certain open interfaces. The key issue is the type and level of alignment of the dynamical behaviors throughout system layers and processes.

5.2. From Fragmentation to Internet model in Smart Mobility

Fragmentation in non-governmental services in smart mobility has taken place since there is a clear consumer need for products while there is very little top level guidance. The fragmented market facilitates innovative companies (especially small and medium size) ability to serve market niches. The growth and profit opportunities in such a fragmented business environment are limited, especially when also the service market is fragmented like in the EU. Therefore voluntary collaboration has emerged between companies and other actors.

The Internet model is likely to self-organize if suitable open collaboration and innovation is enabled. Already mentioned Genivi Alliance and Car Connectivity Consortium are examples of creating voluntary interoperability into the fragmentation but it is not clear whether such consortia follow truly the Internet paradigm in reality and how the collaboration between the separate forums is developing.

Unbundling of content from end-user devices, making the navigation information available on all device operating systems is fundamentally important. Similarly utilization of HTML5 and other web standards in smart mobility, instead of company specific data formats and APIs will facilitate the growth and new value generation. There are unlimited new data formats needed, including formats for smart mobility specific metadata which will make the services feature rich in the eyes of the consumers and other end users.

Voluntary interoperability in Wi-Fi through standardization created a market for large number of compatible products, (access points, routers and others) that can be used in versatile manner to create larger networks and value systems. Similarly, especially for smart traffic applications, further standardization of open interfaces and APIs will be needed. Open access to on-board diagnostics (OBD) interface and to the controller area network (CAN) bus information will create significant new opportunities for new devices, services and applications. Powerful mechanism to bring desired interoperability without full mandated architectural control is to establish a voluntary certification program where the technology providers and users can meet to solve the common problems. Mission critical systems in the vehicles obviously need special protection against miss-use.

Each value system layer and process will need similar attention in this decentralized transition as discussed in section 4.1 for the centralized transition process. The control mechanisms however are systematically voluntary and decentralized. Proposed focused actions are summarized in the Table 2 below.

Table 2. Value system state transition from Fragmented to Internet model.

Subsystem	Today (Fragmented)	Future (Internet model)
Smart mobility Content	Proprietary, social network based content	Open hyperlinked content available for many different applications. Some additional quality improvement mechanisms to reduce the noise in the crowd sourced information
Network aspects, Operations and equipment manufacturing	Any vendor builds its own products, typically fully vertical solutions, tunneling used to by-pass non-co-operative layers.	Any vendor may build products, interoperability verified in plug fests and voluntary certificates. Critical mass needed to make the value system to self-organize.
Device manufacturing	Large number of car manufacturers, mixed with larger number of proprietary ITS equipment vendors. Very low likelihood of interoperability.	Open competition between device vendors but ITS services will work between the devices and even identities and consumer data may be portable from device to device.
Device retailing	Perfect competition in retail	Open distribution, ITS services are portable between devices.
Smart mobility operation (covers identity and core network elements and registers)	Fully proprietary services, bundled with proprietary devices and technologies.	Number of service providers utilizing standardized products and protocols. Services may still be non-interoperable due to limitations of full openness in all layers. Voluntary id federation may lead to significant growth of few service operators (Facebook's of ITS)
Process	**Today (Fragmented)**	**Future (Internet model)**
Technology creation (based on service requirements)	Large number of proprietary non-interoperable solutions	Voluntary interoperability based on minimum set of standardized interfaces between the major layers of the value system
Device ownership and management	Fully random. No control of device ownership, not any type of authentication either	End-user controlled. ITS service ownership separated from devices.
Scarce resource regulation	Government operator controlled. No regulation, not even a guidance for proper use.	Anybody may control the resource. All resources are available to any services which may lead to un controlled congestion from time to time.

Voluntary value system creation based on uncoordinated open interfaces does not easily lead to "carrier grade" quality of service. This is a notable limitation also in the smart traffic oriented open sources driven initiatives. Therefore voluntary interoperability concepts in the car environment will be limited to services in which also the driver or owner of the vehicle will fully voluntarily utilize the service. This can be observed e.g. in car sharing services such as Uber, Lyft and Sidecar[6] which provide an Internet based platform and facilitate demand and supply between end-users in need of transportation and drivers.

[6] www.uber.com, www.lyft.com, http://www.side.cr/ (Accessed 29th of August, 2014)

6. Discussion

Overall, smart mobility services will be fundamentally important for societies globally already in the near future. Using analogies of closely related similar industries with references to generic behaviors of complex systems can give guidance to what to expect under given pre-conditions. In this paper those preconditions are divided into four different system models, which will operate differently depending on the external and internal rules and dependences of the models. Each of the models exhibit behaviors that are in the equilibrium between the driving and constrained factors such as innovation and use of scarce resources and between the operational modes of collaboration, control and competition. There is no ultimate preference between the four models but rather all of the models can be foreseen to exist in the smart mobility services as is the case in the ICT business. Today smart mobility services can be observed to implement system dynamics of only the two closed models while the development towards the open models need both theoretical and empirical guidance.

The significance of these results is not to dictate the way the smart traffic services should be organized but rather to raise the discussion to find an optimum match between the needed services and most relevant system model. Special attention is needed to manage the expectations of all the stakeholders in a value system systematically to stay within the same system model. When radical transition from one model to another one is desired all of the factors need to be reconsidered also systematically. This paper aims at helping to address the issues such as how far the voluntary implemented systems can support governmental needs or how to enable independent applications to flourish in tightly controlled multiparty platforms. Further studies are needed to address the other possible transitions which are not discussed in this paper.

When considering how difficult it is to make new system models to emerge when there is a dominant monopolistic or fragmented business model already in place, it may be useful to consider holistic approach, addressing all the layers of the system at the same time and in a systemic manner. Only this way, the desired state transitions can really take place.

7. References

[1] T. Ali-Vehmas and T. R. Casey, "Evolution of wireless access provisioning: A systems thinking approach",

Competition and Regulation in Network Industries, vol. 13, no. 4, pp. 333-361, Dec. 2012.
[2] M. Denni, H. Gruber, “The diffusion of Broadband Telecommunications in the U.S.”, Communications & Strategies, no. 68, 4th Quarter 2007
[3] J. M. Utterback, “Mastering the Dynamics of Innovation”, Harvard Business School Press, Boston, 1994.
[4] C. Fine, “Clockspeed-based strategies for supply chain design”, Production and operations management, vol. 9, no. 3, pp. 213-221, fall 2000.
[5] M. L. Tushman and P. Anderson, “Technological Discontinuities and Organizational Environments”, Administrative Science Quarterly, vol. 31, No. 3, pp. 439-465, Sep. 1986.
[6] B. Oehry, C. van Driel, L. Haas, M. Wedlock, and K. Perrett, “ITS Action Plan: Adoption of an open in-vehicle platform architecture for the provision of ITS services and applications, including standard interfaces”, European Commission, Brussels, 2010.
[7] I. Heino, O. Pihlajamaa, and A. Vilkman, “Multi-Service Architecture for mobility services”, project report, 2013. Available at http://www.vtt.fi/inf/pdf/technology/2013/T142.pdf (accessed 28th of May, 2014).
[8] SBD, “2025 Every Car Connected: Forecasting the Growth and Opportunity GSMA Connected Living programme: mAutomotive”, A whitepaper written by SBD for the GSMA, Feb. 2012. Available at http://www.gsma.com/connectedliving/wp-content/uploads/2012/03/gsma2025everycarconnected.pdf (accessed in 26th May 2014).
[9] CEN&ETSI, “Final joint CEN/ETSI-Progress Report to the European Commission on Mandate M/453”, 2013. Available at http://www.etsi.org/images/files/technologies/Final_Joint_Mandate_M453_Report_2013-07-15.pdf (accessed 26th May 2014).
[10] M. Porter, “Competitive Advantage: Creating and Sustaining Superior Performance”, New York, NY: Free Press, 1985.
[11] A. Gawer, M. A. Cusumano, “How companies become platform leaders”, MIT Sloan Management Review, Vol. 49 No. 2, 2008.
[12] T. R. Eisenman, G. Parker, M. van Alstyne, ”Opening Platforms: How, When and Why?”, Harvard Business School, Working paper 09-030, 2008
[13] M.V.J. Henderson and K.B Clark, “Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms” Administrative Science Quarterly, 35(1): 9-30.
[14] C.M. Christensen, “The innovators dilemma: when new technologies cause great firms to fail”. Boston, MA: Harvard Business Press.
[15] P.H. Longstaff, “The puzzle of competition in the communications sector: Can complex systems be regulated or managed? Boston, MA, Harvard University Program on Information resources Policy Working Paper.
[16] P. Anderson, and M.L. Tushman, “Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change,” Administrative Science Quarterly, Vol. 35, No. 4, pp. 604-633, 1990.
[17] A. Sood and G. J. Tellis, “Technological evolution and Radical Innovation”, Journal of Marketing, Vol. 69, No. 3, 2005.
[18] E. M. Rogers, “Diffusion of Innovations”, Free Press, 5th edition, 2003
[19] D. Tilson, C. Soerensen, K. Lyytinen, “Change and Control Paradoxes in Mobile Infrastructure Innovation”, 45th Hawaii International Conference on System Sciences, IEEE, 2012.
[20] J.D. Sterman, “Business Dynamics: Systems thinking and modelling for a complex world”. New York, NY: McGraw-Hill. 2003
[21] S. Strogatz, ”Exploring complex networks”, Nature, vol. 410, no. 6825, pp. 268-276, 2001.
[22] T.R Casey and T. Ali-Vehmas, “Value System Evolution Towards a Cognitive Radio Era: Implications of Underlying Market Dynamics”, 2012 IEEE International Symposium on Dynamic Spectrum Access Networks
[23] REGULATION (EU) No 531/2012 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 June 2012 on roaming on public mobile communications networks within the Union http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0531&from=EN (accessed 25th August 2014)
[24] M. Katz and C. Shapiro, “Network Externalities, Competition and Compatibility”, The American Economic Review, vol. 75, no. 3, pp. 424-440, Jun. 1985.
[25] Lina Konstantinopoulou, Mobility Challenge “Mapping of Products and Services” 2013, Available at http://www.imobilitychallenge.eu/files/studies/D2.2_Mapping_of_products_and_services_Version_2.0.pdf (accessed 25th August 2014).
[26] J. Lee, J. Lee, L. Feick, "The impact of switching costs on the customer satisfaction-loyalty link: mobile phone service in France", Journal of Services Marketing, Vol. 15 Iss. 1, 2001