Enabling intermodal urban transport through complementary services: from Flexible Mobility Services to the Shared Use Mobility Agency

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ABSTRACT

This paper explores the intermodality of urban transport from the point of view of the integration of regular collective transport services with complementary flexible transport schemes and shared-use transport. The latest ICT developments offer new opportunities to enable a leap forward in the way collective and individual mobility services are organised and offered. In the evolving scenario of the service sharing economy we see this with a number of new mobility schemes – e.g. vehicle sharing and dynamic ride sharing schemes like Car2Go, DriveNow, BlaBlaCar, Uber, Lyft which have been stimulated in part by reduced family budgets as well as the emergence of suitable supporting technologies. We define a Flexible Transport and Shared Use Mobility Agency; a single co-ordination centre of different flexible services and shared mobility schemes, which requires coordination and cooperation among different service providers, the integration of data and platforms, technical services and systems. The fundamental enabling technologies and standards are illustrated and the supporting ICT architecture outlined. Finally, the organisational aspects related to the operation of the Agency are discussed.

1. Introduction

Cities in Europe continue to grow. Currently, over 74\% of EU-28 citizens live in urban areas, a proportion which is expected to exceed 80\% by 2030 (EEA, 2013). Recent statistics show that the transport sector is responsible for 23\% of total CO2 emissions in Europe. If this trend continues, transport is expected to contribute up to 50\% of CO2 emissions by 2050 (EU,
For over two decades, increasing efforts have been undertaken in EU countries, cities and towns, to improve local mobility and reduce the negative impacts of traffic, with a significant number of projects implemented under the CiViTAS and other transport-related programmes (including e.g. IEE, FP7 R&D ICT and Transport framework, Regional Cooperation, etc.) producing important outcomes ranging from concept exploration to pilot implementation and demonstration.

However, as stressed by the European Commission (EC, 2009; EC, 2011; EC, 2013a), new challenges continue to emerge. Among these, climate change, energy consumption, air quality, the difficulties of tackling congestion and accessibility, especially for disadvantaged citizens, are of paramount importance. For these reasons, the priority objective is now to enhance mobility and accessibility while, at the same time, reducing congestion, road accidents and pollution in European cities.

Such a complex set of problems can only be effectively tackled by adopting an integrated, multimodal and robust set of measures. More sustainable urban mobility, for people and goods, and significant benefits in terms of energy consumption, environmental impacts and quality of the urban environment requires an appropriate mix of interrelated policies and measures. Among these, for instance: integration between housing policies and transport planning (generally indicated as Transport Oriented Development-TOD); enhancement of public transport efficiency and equity (based on, e.g. more extended and frequent public transport, bus rapid corridors, flexible mobility schemes and feeder services, etc.); promotion of green modalities (including pedestrians and bikes) and of "clean" vehicles.

This paper will look at the intermodality of urban transport from the point of view of the integration of regular collective transport services with complementary flexible transport schemes and shared-use transport, both public and private, up to the definition of a Flexible Transport and Shared Use Mobility Agency.

2. Towards a new understanding of shared transport solutions

The experiences of most advanced cities and towns in the world highlight that we cannot achieve sustainable urban mobility without an efficient, extensive and accessible collective transport system.
In the 2011 White Paper (EC, 2011), the European Commission stressed the key role of the Public Transport sector as a crucial factor for tackling congestion and deteriorating living conditions in urban areas. Considering that bus services are the primary form of public transport both in Europe and globally\(^1\) it is evident that the adoption of any effective mobility solution must include this key component. Buses have a very high efficiency potential: in fact one single bus carries the equivalent of 60 cars, consumes 3 to 5 times less energy per passenger, creates 11 times less noise and reduces serious injuries and fatalities from 10 to 20 times. Furthermore buses are a cost-efficient transport means for passengers.

Despite this, however, over the past fifty years the operating conditions for buses have deteriorated. As buses have become caught in congestion, the quality, reliability, ridership and image of the bus has also deteriorated. This lack of efficient public transport services (both in quality and in quantity) forces many European citizens to use private vehicles for their trips (even short-range in urban areas). As this demand for private vehicle travel grows, urban road networks are increasingly unable to handle increased traffic flows. Significant traffic congestion issues arise, both in space and time. This covers city centres, their approach roads, and increasingly also the suburbs and the hinterlands and hinders the efficiency of public transport services. This vicious circle must be broken, not only to improve urban mobility, but also to enhance overall city liveability, to reduce pollution and emissions and to promote social inclusion.

Across urban areas it is clear that robust and efficient mobility solutions, well integrated in the overall urban planning system and suitable to specific city characteristics that can help overcome the barriers described above and improve living conditions and environmental quality of towns are required. Implementing innovative measures to break the downward spiral, by increasing the quality of bus services and strengthening the efficiency of newly emerging mobility schemes, cannot be delayed further.

Over the last fifteen years with the support of European funding\(^2\) several flexible and demand responsive transport services applications have shown important advantages and benefits in several European cities. DRT services are complementary to the conventional, scheduled passenger transport (fixed lines and timetable), as they usually address dispersed mobility

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\(^1\) In EU cities of over 250,000 inhabitants around 50% of public transport vehicle-km are covered by bus, rising to 100% in small- and medium-sized towns.

\(^2\) European Research Framework Programme IV, V, VI projects (e.g. SAMPO, SAMPLUS, VIRGIL, SIPTS, INVETE, FAMS, CONNECT) and in the Inter-regional Co-operation Programme 2000-2006 projects (e.g. MEROPE and AGATA under INTERREG IIIB MEDOCC, SUNRISE and MASCARA under INTERREG IIIC Programmes).
needs, both during hours of low demand and in areas of low population or where target users are dispersed amongst the general population, e.g. disabled and elderly, tourists.

In particular, Flexible Transport Services (FTS) can be defined as a transport service which is adapted for meeting users needs, typically on a trip-by-trip basis with a certain level of flexibility on three operational dimensions (routing, timing of the service, vehicle used) in order to enhance service offer and minimize costs in response to demand. FTS include a larger range of services and schemes, such as: general use and feeder services, local and feeder services to trunk haul services, replacement of low-frequency conventional services, replacement of fixed routes in evenings, weekends and other low-demand periods, dedicated/special services restricted to specific users groups, services in low-density rural areas, efficiencies in social mobility resources, niche urban markets, fuzzy lines between small buses and big taxis, etc. These different operational schemes have been validated and evaluated from the feasibility and technology aspects to the organization and business models in several EU projects, with different levels of implementation and results. At a policy level the EC 2007 Green Paper (EC, 2007), states that customized (Public Transport) solutions could serve better suburban areas and enhance integration and accessibility and calling to the implementation of Sustainable Urban Transport Plans (SUTPs) as part of SUMP to support efficient urban planning.

From the operational point of view, FTS are organized around the concept of a TDC (Travel Dispatch Centre), as the key operational (and technological) resource supporting the management of the main operation steps connected to service production workflow: the TDC manages users booking requests, journey planning and resource optimization (vehicles and drivers) communicating to the driver the new journey or the variations to the already planned one.

Complementary to these trends, the traditional contrast between collective and individual transport solutions is gradually blurring. In a service-sharing economy where the concept of Mobility as a Service is becoming a concrete market option, alongside established schemes like bike and car sharing, collective taxi and demand responsive bus services, new alternatives to public supplied schemes and car ownership are emerging. Dynamic car-sharing schemes (such as Car2Go, DriveNow and Zipcar), dynamic ridesharing services (like BlaBlaCar and Flinc), peer-to-peer transport arrangement schemes (such as Uber, UberPop and Lyft), and brand new forms of "institutionalized hitchhiking" (i.e. RezoPouce) are all examples of this new offer of flexible mobility schemes, complementary to regular (fixed routes and timetable) as well as flexible collective/public transport (Nelson and Wright, 2016).
We can identify the following significant trend: *from merely being the final recipients of transport services, users themselves have gradually become, in recent years, potential mobility service providers.*

Stimulated by the current economic crisis (reducing for example the family budget for private cars/mobility but also the funds for public/collective transport), and despite some concerns related to acceptance from cities (as in the case of Uber, being limited or even banned in several cities in Europe and elsewhere\(^3\)), the continuous and growing success of such private and peer-to-peer ridesharing schemes in Europe and North America (Chan and Shaheen, 2012) shows that these can be considered as integral components of a truly intermodal urban mobility. Yet, at the same time, it is important to stress that if these solutions are not duly embraced by the overall urban mobility system they may lose effectiveness and even damage the overall system organization. This important transport resource which is both collective and flexible, needs to be carefully designed and operated to boost integration with new concepts and solutions and conventional public transport, thus bringing a real added-value in terms of mobility, accessibility and environmental sustainability.

Policy-makers, urban and mobility planners and city stakeholders are called to undertake strong actions, by adopting a multimodal and integrated approach, customized to their specific local context, for addressing the challenges described, and by taking into account three key issues:

- conventional (bus-based) Public Transport systems need to be "requalified" (in terms of frequency, regularity and comfort) to be fully and efficiently exploited;
- new private mobility schemes based on ride-sharing schemes need to be "institutionalized", embedded in the overall mobility offer and integrated with Public Transport services;
- ICT platforms and ITS systems should be planned within a "city approach", unitary managed and based on specific local requirements.

This scenario requires strong coordination and interoperability among the different mobility services, cooperation among the different actors and stakeholders involved in the transport network, and the integration of information, systems and operations at various levels in a clear framework of policies and organisational measures. Such a move is also consistent

\(^3\) [http://www.policymic.com/articles/89153/10-000-london-taxi-drivers-are-going-on-strike-for-a-reason-young-techies-aren-t-happy-about](http://www.policymic.com/articles/89153/10-000-london-taxi-drivers-are-going-on-strike-for-a-reason-young-techies-aren-t-happy-about)
with a recent contribution by White (2014) with urges identifying the appropriate roles of improved 'conventional' public transport (interurban routes etc.) and demand responsive and similar services.

3. The Flexible and Shared Use Mobility Centre: Concept and approach

Almost all of the FTS applications in Europe have been - or still are - operated as a single mode, by a single operator, and as a single element of a potentially larger intermodal transport chain. Moreover, in urban and metropolitan areas, FTS have been often applied with little or no integration at all with other transport modes and mobility schemes. Starting from this context the Flexible Transport Agency has developed (mainly in the EU FAMS and FLIPPER projects\(^4\); Ambrosino et al, 2004, 2010; Nelson et al, 2010) based on the vision that all actors in the FTS service chain constitute a “Open Community” through an appropriate open web architecture and cloud connectivity\(^5\). The different “actors” of the community can be connected and can collaborate at different levels with respect to its specific role (i.e. transport operators can obtain several benefits including: integrated booking opportunities, data and computing services sharing, improved access to information and services, improved offer, enhanced management of the workflow among the transport service providers).

Despite the physical location of the operators, the different types of fleet/garage, booking systems, services provided, etc., the Agency manages the entire service chain - from customer booking to service planning, monitoring and control - operating as a unique “open” entity, as “one operator with one fleet and one booking system”, providing an effective response to the mobility needs of different users groups’ characteristics that are not covered by the conventional public transport services.

The approach proposed in this paper focuses on the need to reconcile and enhance the two parallel axes of urban mobility (collective transport and personal mobility) by testing and demonstrating different innovative mobility solutions to be integrated under the “umbrella” of the Flexible and Shared Use Mobility Centre (FSUM), a centre for planning and managing the different sustainable urban mobility services based on the ride sharing approach.

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4 FLIPPER project web site www.interreg4cflipper.eu.
5 Related work has proposed the creation of a virtual marketplace for FTS which utilizes a multi-agent system where intelligent agents support different roles in the system. The platform development is described in detail in Emele et al (2013).
The approach does not call for “new complex solutions” and heavy investments, but rather for cost-effective and results-oriented measures. The goal is to enhance the quality and efficiency of urban mobility systems, by promoting a “quality evolution” of the conventional public transport services, fully integrated with new (green) mobility solutions and sharing schemes, thus enabling efficient investments and implementation times, flexibility in service operation, positive impacts in energy efficiency, environment quality and urban regeneration possibilities.

3.1 The role of ICT in enabling innovative service concepts

Starting with the premise that ICT technologies are making it possible to implement innovative services that can improve the cost-effectiveness of Demand Responsive Transport (DRT) systems, the role of ICT can be seen as one of the main aspects for improving not only the cost-effectiveness of DRT services but also for enforcing DRTs contribution to social inclusion. The role of ICT, including most recent enhancements (from open data and cloud solutions to mobile connections and social media) offers much for existing DRT architecture and schemes. Yet, knowledge of past DRT experiences and applications (especially in Europe and US) shows that technology is often used for simplifying the complexity of the problems (i.e. the needs of citizens and resources) and tends to be considered as the overall solution. Therefore it is important to analyze and define not only the contribution that the ICT can provide to DRT service management, but also to identify the support conditions (i.e. organization and management) for successfully implementing the appropriate ICT tools.

One of the common issues emerging is the importance of keeping the role of ICT in the overall DRT system management and service provision simple. For the system architecture this means a consolidated central software platform that is able to support all relevant DRT system functions (from booking and trip planning/assignment to the reporting and accountability) but also to co-ordinate the different actors involved in the DRT service provision. In this context, recent ICT innovations (mobile device, open data, large connectivity capacity, cloud architecture, etc.) could play a relevant role in increasing the overall information and accessibility of the user with respect to the single DRT service and also other public transport service options. ICT also facilitates the integration of a DRT system with other external systems (ticketing, transport fleet control service data bases, etc). Finally, a strong move towards the use of low-cost devices (i.e. tablets as on board
terminals) has emerged as one of the requirements, with the awareness of the background costs in terms of maintenance and data/operation level.

As technology becomes more integral to the future evolution of DRT systems, particularly those using Mobility Management concepts involving multiple organizations and their (often different) software applications in a common scheme for providing transportation services to a diverse set of organizations and individuals, the issue of what is included in the core technology infrastructure becomes increasingly important. System architectures, technology platforms, and data standards increasingly determine what is possible to accomplish with DRT schemes designed to serve multiple entities and their riders. Only if the technology foundations are sufficient is it possible to implement innovations that improve the reach and cost-effectiveness of DRT services. It is clear that common data standards and robust technology-based service platforms and architectures are needed for technology’s benefits to proliferate rapidly in the DRT sector.

A key aspect that emerges is the awareness that ICT could also have a crucial role in (re)positioning DRT services as one of the key components of the public transport service offer whilst also incorporating personal mobility solutions, in particular in:

- overtaking the holistic approach of many implemented DRT services;
- the co-ordination among the different services and actors both from the operation side and from citizens accessibility point of view;
- the integration and interoperability with other public transport service services and systems (at minimum AVL and ticketing systems) and the newly emerging privately organized shared transport;
- the provision of high-level user accessibility by social media and web facilities;
- the constant service promotion by focused campaigns and by using social media and existing data bases.

This approach is discussed below.

3.2 The FSUM concept

The FSUM concept addresses the two main levels of urban mobility in a coordinated way, where both public (collective) and private components interact with each other: major transport axes and corridors, on the one hand, and diffuse patterns and short trips on the other. Fostering the interaction between public and private mobility through various
connected mobility schemes (parking, P+R, interchange facilities with shared vehicles schemes, integrated payment, etc.) is pivotal for improving urban mobility as a whole.

To achieve seamless integration between collective and private sustainable mobility the FSUM will work on three interrelated levels (collective transport, personal mobility and connected systems) based on the concept of the FSUM centre. The FSUM centre will offer integrated access to several “on demand and shared” individual and collective services, by coordinated management of the various actors and services through an ad-hoc organization framework, technology-enabled services and soft measures.

Enabling technological component for the Agency is an ICT infrastructure, based on the emerging paradigm of the Internet of Services, provide several core facilities including: (1) services for transport users (Business-to-Consumer (B2C) services) enabling access to information, search for transport options, travel planning, booking, ticketing; (2) services for the co-ordination of different transport and mobility schemes and the interaction with the relevant operators (Business-to-Business (B2B) services); (3) services supporting the interactions among different authorities and entities involved in the control of transport services (Business-to-Administration (B2A) services).

The FSUM will be able to support various tasks, including:
- connecting different mobility services with each other (conventional, ride-sharing services, etc.) and to the main regular public transport network/axes, and integrating these with other public transport modes (mainly railway and extra-urban services);
- providing real-time quality information and services enabling users to plan their trips, adapt travel choices in case of need (e.g. service changes, disruptions, etc.), provide feedback messages and information to the FSUM (on e.g. perceived quality of service, delay or disruptions, etc.) that will help improving service management and provision;
- enhancing users accessibility to interchange nodes and feeder services (i.e. parking areas, bike-sharing stations, etc.);
- serving a niche market of mobility demand (night period, week-end, special user groups, etc.);
- integrating other city mobility services (taxis, logistics services, special services to, i.e., leisure destinations, etc);
- supporting real co-operation with other operators (not only on transport services but also on B2A services or back-office services, shared software, etc.);
- integrating the overall FTS and shared mobility system with local mobility policies and operation schemes.
Figure 1 offers a first outline of the conceptual architecture for the Flexible and Shared Use Mobility Centre.

In proposed work the core role of the FSUM, that will be designed, adapted and tested in real environments is to support different mobility services, from high capacity/quality Public Transport schemes (like Buses with a High Level of Service - BHLS), regular and flexible collective services, to open, emerging forms of personal ride sharing mobility services (e.g. “institutionalized hitch-hiking”) as last mile services.

The core concept of the FSUM will be investigated and adapted to local policy objectives, stakeholder requirements, users needs and mobility market opportunities, leading to local implementations coordinating a range of different measures.

**Figure 1. Conceptual architecture of the Flexible and Shared Use Mobility Centre (FSUM)**

4. Discussion and Conclusions
In this paper we have described a scenario for urban and metropolitan areas where the role of FTS and the large-scale Agency can play a fundamental role with respect to the expansion of public transport services and the integration and co-ordination of the different modalities and operators, as recommended by the EU through the promotion of co-modality policies.

In particular we have analyzed some core issues underlying the concept of FTS Agency and its evolution into a Flexible and Shared Use Mobility Service Centre (FSUM). We have addressed the impacts of this mainly on the two dimensions of the service: operation and technology (i.e. role of FTS, service schemes, TDC operation, Agency concept, enabling ICT architecture and technologies, etc.). It must be emphasized, in addition, that a good understanding of the third dimension, “organization and regulation”, is essential and it is still very different among the 28 EU countries.

Concerning the FTS Agency concept and its evolution into a “shared mobility” Service Centre, some work is still necessary on several core issues. In the following we provide a list, without setting any priority order and highlighting the fundamental role of the Public Transport Authority (local or regional, depending on the individual country legislation) to enable the implementation of the concept:

- recognize the Agency as an “added value” service for the area and a social cohesion tool to address the city/towns problems;
- support the development of intermediate transport services for the different specific areas and citizens groups;
- define the concept of a unique Agency for the city / urban area and town;
- define conditions for public tendering of Agency operation’s activities;
- promote the definition of Public-Private Partnership for Agency operation;
- support possible interaction/synergy among TDC and Taxi Dispatch Centres and/or with other “Paratransit” services;
- integrate ride sharing schemes as last mile services with the public transport offer;
- issue public subsidies for the needed investment, especially for TDC management;
- analyze and define “specific” fare schemes and the relevant implementation conditions;
- push the real collaboration among Transport Operators and Citizens’ Associations;
- define a specific set of indicators measuring the quality and quantitative of service that are different from those of the conventional transport service.

In conclusion, taking into account the above considerations and the policy and concept of co-modality, as well as the fundamental role of ICT tools and technologies for the
implementation and operation of the concepts we have introduced, we believe the FTS Agency and its evolution into a FTS and Shared Use Mobility Service Centre can become a key player in the enhancement and strengthening of the role of passenger transport in towns and urban areas.

References


