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An Integrated Information and Payment Platform for urban transport

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This report is a summary of ideas collected and developed by the author Anders Gullberg over many years of research on urban transport in general, and ICT and urban transport in particular, in the Vinnova-financed project "TRACS – Travel planners for sustainable cities, a multidisciplinary project at CESC 2010–2015"[1]

Keywords: Urban transport, ICT, Institutional innovations, Service, Accessibility, Sustainability

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Abstract

Transport in growing cities suffers from congestion and huge investment costs. It also degrades the environment. For the first time in history, advances in information and communication technology – ubiquitous mobile computing – now allow us to harness the vast transport overcapacity found in many cities throughout the world, and to optimise the use of transport infrastructure and public transport. This can be achieved by creating an Integrated Information and Payment Platform in Urban Transport (I^2P^2UT), open for all types of conveyance. The potential consumer, environmental and financial benefits of such a platform are as great as the institutional obstacles that stand in its way.

Introduction

Unreliability makes urban transport a particularly poor service. ‘When will I arrive?’ ‘Will I be affected by overcrowding and/or congestion?’ When embarking on a journey, these are among the most pressing questions. Managers of public transport or roads give no firm answer and take no responsibility. When delays, cancellations or congestion occur, the transport users and conveyors themselves bear the brunt of the consequences. Urban transport infrastructure and public transport are provided without advantage being taken of the emerging possibilities of the mature stage of Third Industrial Revolution – ubiquitous mobile computing.

Across the world, growing cities struggle to expand their built infrastructure to deal with increasing traffic congestion and to reduce its environmental damage. Yet despite enormous investments, the problems tend to remain. Lead time for new projects usually extends to several decades. The task to which politicians, transport administrators and consultants devote themselves is paradoxical.

Although peak car use – shorter distances per individual and vehicle, later driving age and a plateau in relative car ownership – can be seen in some of the richer parts of the world, global car expansion continues with unrelenting speed. According to some forecasts, the global car fleet will double between 2015 and 2050, reaching more than two billion vehicles.

Increased capacity will not solve urban-transport problems. Instead, a solution would be to use the enormous overcapacity that already exists, for the benefit of all urban-transport users and providers. Thanks to advances in information technology this is now entirely feasible, and can, from a technical point of view, be achieved within the space of roughly a decade. However, to do so requires great institutional change.

Urban transport can be defined as the *service* that moves people and goods within a city region, its main goal being to create *accessibility*. This is achieved in various ways. Space may be provided in a vehicle of some kind, often according to a timetable, especially in the case of passenger traffic: public transport. Alternatively, roads and pavements are used by the road user/conveyor for walking or for transporting themselves and/or their goods by vehicle: self-service transport. Another option is ordered transport where, for example, a taxi service moves people or their goods on demand.

Urban transport, in common with most services, is *fixed in time and space* (Jansson 2006, p. 72f). It cannot be moved to another city. Nor can it be ‘stored’ for any length of time. In terms of transporting people, consumers are always co-producers, taking part with their bodies. Moreover, extra involvement is often needed, such as driving. Public transport too is based on active involvement – passengers taking themselves to and from stops and stations. In terms of goods transport, the recipient’s involvement is not obligatory.

Transport users, the various modes of transport, and transport companies are *highly dependent* on one another. Transport users are greatly affected by when and how others choose to travel. Consequences may include congestion and cancellations. The various modes of transport complement one another, many journeys combining different types. Yet these also compete with each other for customers, urban space and economic resources.

Providers and consumers alike endure a considerable *lack of information*. Not only the latter group remains in the dark about service quality, as mentioned in the first paragraph – urban-transport providers too, both highways departments and public-transport companies, know all too little about road-user demands and travel intentions. Not even when a passenger's journey has begun does the provider know where it will end. Both parties would benefit greatly from better-quality information.

Each mode of transport makes its own demands on *resources* such as energy and urban space, and operates according to its own capacity. Moreover, the impact of each mode of transport varies in terms of the local and global environment, transport equality, mortality rates and urban-expansion patterns. Capacity-related issues may be illustrated using three examples. Operating with normal loads and in mixed traffic, buses can transport seven times as many commuters as cars on urban roads and motorways (World Bank 1975). During a journey, a commuting motorist uses 60 times more space than an equivalent rail passenger. Allowing for the space required during the working day, including the area and time needed for parking, the ratio is 850:1 (Vuchic 1999, p. 57). A car in rush-hour traffic carries on average 1.2 occupants. In Stockholm, a city well-known for its comprehensive public transport, all commuters would be accommodated easily by the private cars on the road at peak times (Lundin and Gullberg 2011, p. 92).

To move about town, accessing public spaces and services is a *civil right*. We must therefore promote the kinds of transport available to people with limited economic resources: walking, affordable public transport, cycling, and facilities for the disabled.

There is *hardly a lack of capacity in urban transport*, especially in rich countries. But the service is produced and consumed partly at the wrong place, at the wrong time and in the wrong way to deliver a good-quality service. This stems from a lack of market mechanism and its coordinating capacity, which often results in sudden swings between congestion and over-availability.

Urban transport has changed radically over time. Thanks to the electric motor and internal-combustion engine, cheap energy, and an enormous infrastructure in what has been termed the Second Industrial Revolution, growing hordes of city dwellers are transported ever faster and ever further, by ever-more resource-hungry modes of transport, to ever-more widespread destinations (Cameron et al. 2004, Wegener 2012, Banister 2011). In past millennia, closeness was all that mattered in establishing accessibility. Muscle power was predominant; movement costly and laborious. Currently, in the age of the Third Industrial Revolution (Schön 2012), *information* plays a key role in many areas of life. But this does not yet fully extend to the urban fabric, where increased mobility continues to be the primary, often unsuccessful, means to create accessibility.

The information society: new possibilities

The microprocessor, computer systems, advanced data processing and forecasting models and, a little later, the Internet laid the foundations for the above-mentioned Third Industrial Revolution, which began in around 1970. Results elsewhere point to the possibilities for urban transport. The fields of manufacturing, transportation, stock-keeping and sales of consumer goods and durables have seen the development of global, integrated information systems, which have an enormous capacity for coordination. For instance, retail-sales information is immediately registered and relayed back down the chain. These systems have evolved gradually. When the information at each stage was rationalized, it was discovered that the various elements could very profitably be linked together (Cortade 2004 ch. 9). In highly complex systems involving many parties, only by such a gradual process can radical change occur. No single party can perform a metamorphosis of this type alone. It can happen only when parallel processes combine, with dedicated efforts by actors who seize the opportunities as they arise.

The rapid adoption of mobile devices and the ubiquity of two-way communications provide new opportunities to deliver information, and other services, at the exact time and place required, which also enhances the potential for coordination (Ng 2013).

Institutional science fiction

Creating an infrastructure, an Integrated Information and Payment Platform in Urban Transport has the potential to reduce the great information deficit, improve coordination, and harness unused capacity. The means have been developed, or have evolved, in various contexts. Some have come about recently, or will do so in the very near future: geo-spatial positioning as a condition for differentiated pricing; large-scale decentralization of digital intelligence, and continuous two-way communication; indoor navigation; and mobile-phone payment platforms.

Many applications can be incorporated and developed within the platform: multimodal journey planners; in-car navigation; real-time information on traffic density on roads and at car parks; advanced urban-traffic forecasting models; accident warning systems; control centres to constantly monitor traffic flow and security; regulated motorway slip roads to avoid congestion; differentiated, distance-based road charges using geo-spatial positioning; and numerous consumer-generated solutions to traffic-information problems. The building blocks of the integrated information and payment platform, which is required to resolve urban-transport problems, already exist. Many of them evolved alongside innovative business models made available by the new e-economy (Ng 2013). Thus, the question is one of institutional, not technical, science fiction.

Travel using the new platform

Two changes are urgently needed to improve services, harness dormant resources and enable positive interaction between supply and demand: a clearer agreement between provider and consumer for each journey, and two-way communication throughout the trip. These can be introduced as follows.

A travel planner answers how a journey can be made (transport type; journey time; uncertainties; car sharing; comfort; parking availability; hire car or cycle for any continued travel; price; and perhaps the suggestion of an alternative, equivalent destination, or of replacing the journey with a static service such as a video conference).

Prices, to minimize congestion, vary according to the time of day, route and mode of transport. Congestion can result from just a small percentage increase in traffic density, and once built up, can take hours to dissipate. Departure time influences the price given by the journey planner, and in the 'morning commute, only departure times from home have to be adjusted for queues to disappear. ... [I]f commuters retain their order of departure and their arrival times, everybody (except the very first and last driver) should depart later than in the unpriced equilibrium' according to the dynamic congestion model discussed by Small and Verhoef (2007, p. 130). The chosen travel alternative is booked in advance, creating a clear contract between consumer and provider.

Navigational help is available throughout the journey. This extends to pedestrians, cyclists and public-transport users.

Chaos caused by accidents and other unforeseen events can be countered by swiftly providing complementary transport. Other routes can be suggested too, but only to selected travellers to avoid congesting alternative roads.

In an electricity smart grid, consumers with surplus energy act as co-producers – prosumers, supplying power back to the grid (Lampropoulos et al. 2010). Similarly, urban travellers, especially motorists who nearly always have surplus capacity, can be invited to be urban-transport co-producers, by integrating vehicle- and journey-sharing within the information and payment platform. The platform also opens for communities of like-minded people to share experiences during the journey. Currently, car and lorry capacity is vastly underused, even at peak times. Just a small increase in car- and journey-sharing would improve traffic flow significantly.

On reaching the destination, the service is concluded and appraised. This information, stored by the service provider and customer alike, forms a bed of experience for both parties in future transactions. If the service has not been provided subject to agreement, the customer is compensated automatically. This creates an incentive for the provider to improve quality.

The platform should be open for other services too, supporting the merger of bottom-up and top-down initiatives. These might include services such as reserved seating and packed breakfasts on public transport; priority motorway lanes; and vehicle servicing by collection, coinciding with when a car is not in use. Many others are expected to develop once the platform is operational.

Not everyone can, or will want to, join an information and payment platform. It must therefore be fully possible to postpone membership or not join at all. However, the platform should yield positive results if only 20% of travellers participate, given the usability of the information generated when consumers enquire about alternative services and when they actually travel. Because differential pricing must also apply to non-members of the platform, there must always be a maximum charge, with all private vehicles registered in time and space.

The various branches of urban transport must be financially responsible for any damage they cause. In addition to the congestion of roads, car parks and public transport, this extends to local and global environmental impact, accidents, road noise and social equality. Where land availability is limited, area-effective means of travel such as public transport are prioritized. Transport distributes economic resources and accessibility between socio-economic groups unequally, so the transport needs of households with limited resources should be promoted.

Improved effectiveness almost always leads to increased consumption. Travel and transport become easier and perhaps cheaper too. Coordinated transport pricing across an entire urban region can counteract this latent demand or rebound effect (Hymel et al. 2010). Transport costs should not decrease in relation to goods and other services, as happened throughout much of the 20th century. On the contrary, costs, particularly those for transport types unavailable to all, can gradually be allowed to rise, thereby influencing the locations of different urban activities, with the ultimate aim of increasing accessibility as a whole, but over shorter distances.

Groundbreaking work to overcome institutional obstacles

Recent years have seen a massive uptake of ICT for data collection and (open-source) distribution, and traffic and transport control, at the same time as published research has increased many times over. Additionally, many on-going projects funded by the EU Seventh Framework Programme will produce huge numbers of reports, articles and prototypes over the next few years (European Commission 2013). All of this improves the chances of system change. Increasing forms of technology, including motor vehicles, are connected to the Internet – the Internet of Things (Min and Junping 2011), allowing their position and speed to be determined. A world of information, parallel to the physical transport world, is emerging. Despite this and other major innovations in information and traffic and transport control, only once the various functions become interconnected will the many benefits manifest themselves.

Far-reaching institutional innovations have proved far more difficult to disseminate than their technical, vehicular counterparts. Both the electric tram and the car spread almost globally in just a few decades. Conversely, the congestion charge took far longer. As early as the 1840s, a French engineer devised such a system to deal with the congested bridges of Paris. Yet a scheme was only put into practice more than a century later in Singapore in 1975, with successors of any note emerging in 2003 in London and 2006 in Stockholm (Gullberg and Isaksson 2009).

Tax fatigue and fear of the surveillance society have proved effective arguments against road charges. Moreover, influential interest groups, such as the car, oil and construction industries, who oppose all radical change, can deploy huge resources to mobilize broad popular support against the very idea of paying to use the roads. Nevertheless, future change cannot be ruled out (Geels et al. 2012). There are roughly 450 conurbations of one million inhabitants or more in the world today, and every urban region functions as its own socio-economic niche, given that urban transport cannot be relocated (City Population 2015). Therefore, the proposed platform may feasibly be introduced in isolation, one city at a time, as with the congestion charge, and this time with the possibilities of the new e-economy to hand (Ng 2013). Sufficient support in just one or two cities would allow the platform to be adopted, and if the vast slumbering potential of urban transport were realized, successors would probably soon follow by a process of inter-city rivalry. Urban-transport problems impact the daily lives of vast numbers of people, certainly a majority of the four billion living in urban areas in 2015 (United Nations 2015).

Big Brother is both a real threat and an effective form of scaremongering. Although, at the risk of sounding despondent, Big Brother is already watching us, perhaps the common citizen can finally benefit from this worrying state of affairs in the form of first-class urban transport. According to Mimi Sheller there may be logics where 'security is more important than freedom, and control is more important than equity' that would transform the mobility system (Sheller et al. 2012 p. 302). In any case, the negative effects of surveillance must be minimized to ensure the legitimacy of an Integrated Information and Payment Platform in Urban Transport of the kind outlined in this report. This may include obtaining informed consent in order to use personal data.

Benefits

The proposed platform offers many benefits. Variable pricing allows increased opportunities to tailor choice and demand. Transport can be imposed with reasonable charges, and providers can obtain far better information. So can consumers, whose journeys and deliveries can be estimated more closely, and be a concern of the provider throughout the journey. Eliminated or greatly reduced congestion will provide massive time savings, with a concurrent pricing policy supporting social equality and the environment. In Stockholm, congestion is calculated to cost each commuting motorist SEK 4000 a year. The corresponding figure for the 498 urban areas in the USA is $818 (Gullberg 2015). Across the EU, the cost of congestion has been estimated at 0.5% of the gross domestic product (Papageorgiou et al. 2003), while calculations elsewhere normally vary between 1 and 2% (*Managing urban traffic congestion* 2006, p. 160). Utilizing unused capacity in urban transport and preventing urban sprawl will also allow large-scale, environmentally harmful, mobility-stimulating investment in new infrastructure to be postponed or cancelled. An ICT system for urban transport of the kind presented here can be used to implement pre-existing environmental and transport policy goals, and to help overcome the dichotomy between technology fix and behaviour change, which are all too often presented as mutually exclusive alternatives (Lyons 2012).

Almost all the above has been suggested before. The radical new feature is linking the elements together in an information and payment infrastructure. With public bodies providing most of the funding for roads, as well as underpinning the public-transport deficit (Saarikivi 2010, p. 17; Small and Verhoef 2007, p. 159), it is hard to see what other party could take the initiative for such a platform. Only an open platform of this kind, working in real time, in both directions between consumer and provider, can ensure the physical infrastructure and available vehicles are used effectively, finally allowing chaos to be avoided by coordinating transport providers and users, and influencing consumer-flow to the various modes of transport.

It is important to note that all citizens, and the vast majority of companies, can benefit greatly from the proposed platform. These include public-transport users; pedestrians; transport companies and those making or receiving deliveries; and of course motorists, who can save time and, if desired, money by more effective car-sharing, for example. For the future, the idea of further increasing the mobility of urban inhabitants seems to have reached a dead end. Despite increasing expansion, demand always outstrips capacity. Global and local environmental considerations do not support the idea of increased mobility. We must use the resources already available. The question of which cities or politicians will take the lead towards the new era remains wide open.

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