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The Governance of Smart Mobility

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The Governance of Smart Mobility

Abstract

There is an active contemporary debate about how emerging technologies such as autonomous vehicles, peer-to-peer sharing applications and the 'internet of things' will revolutionise individual and collective mobility. Indeed, it is argued that the so-called 'Smart Mobility' transition, in which these technologies combine to transform how the mobility system is organised and operates, has already begun. As with any socio-technical transition of such importance to both economic prosperity and societal wellbeing, there are critical questions to be posed in terms of how the transition is managed, and how both the benefits and any negative externalities of change will be governed. This is a critical time for such questions to be raised because technological change is clearly outpacing the capacity of systems and structures of governance to respond to the challenges already apparent. We argue that it is imperative that the state and other participants in the wider arena of public policy pro-actively plan for the era of Smart Mobility so that the innovations associated with the smart transition can be steered in order to ensure more societally-desirable outcomes. To achieve this, a new set of governance challenges – encompassing new networks of actors, new logics of consumption, and new norms of behaviour – will require to be successfully negotiated. The *Governance of Smart Mobility* will therefore require the *Smart Governance of Mobility* so that the conditions necessary to ensure that the smart transition is beneficial do in fact prevail, otherwise there is the real risk that the smart mobility system will develop in ways which fail to meet the societal goals which public agencies are there to promote.

Keywords

Governance, transition, smart technology, mobility, externalities, service

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1 Introduction

The mass adoption of motor vehicles (the 'automobility transition') was one of, if not *the*, major socio-economic transformations of the 20th century (Geels et al, 2012). Over the 80 years in which the car has "wound itself inextricably into a large part of our affairs" (Buchanan, 1963: 52), much research has been undertaken about the evolution of the socio-technical systems that have facilitated mass car ownership, and how the economy and society have been transformed by automobility (Urry, 2004; 2008), from the sheer distances travelled in everyday activities to the location of economic activity, the operation of the housing market, the structure of retailing and differential access to educational and health opportunities. Alongside these huge gains in prosperity and quality of life, however, came the well-known negative externalities of mass car use, such as congestion, crashes, poor air quality, physical severance, social exclusion and inactivity/obesity, which the state has often struggled to manage effectively.

Most contemporary imaginings of 'smart mobility' describe a transition of equivalent reach and significance to that of 'automobility', focusing on a range of positive changes to how we travel around. Proponents of the smart transition outline a vision of the future in which mobility will be framed as a 'service' available 'on demand', with individuals having instant access to a seamless system of clean, efficient and flexible transport to meet all of their needs (see Wocatz and Schartau, 2015). Accompanied by the widespread adoption of autonomous vehicles (AVs) (see Fagnant and Kockelman, 2015), it is argued that the smart transition will bring huge gains in safety,

and the costs of transport to the user will be lower because the capital stock of the mobility system, primarily infrastructure and vehicles, will be used much more efficiently. There will be much greater consumer choice as new models of shared ownership of mobility assets, real-time aggregation of data and peer-to-peer mobility matching reduces the grip of large monolithic providers on the supply of transport.

Given that the state took several decades to come to terms with the challenges of managing the car and the profound impacts of the automobility transition on the economy and society, there is no time to be lost in beginning the task of thinking through how state action and public policy will need to change to take account of the implications of the transition to a 'Smart Mobility' future. In this paper, we explore the key contention that the transition to Smart Mobility as currently envisaged will require an equally important and far-reaching transition, that is to a new form of 'Smart Governance' for mobility. Such a parallel transition in how the state frames and reconciles key choices in how mobility is organized and distributed across society and the economy is necessary because unless we fully understand how and why our current mobility system will change as a result of the smart technological transition, we will not be able to plan for and deliver the desired policy outcomes and benefits of smart mobility. This is particularly so given that the push towards a smart future is being led by the technology sector, which has a product – the sensors, vehicles and software etc that underpins smart mobility – to sell, and needs to create a market in which there is *more* mobility, not less, in order to maximise its returns. Only a naïve view would see the producer interests of a sector estimated as being worth 1.0 – 1.5 trillion US dollars by 2025 (Wocatz and Schartau, *op cit*) as inevitably aligned with the wider, more complex needs of society as a whole. Indeed, without a sufficiently rapid,

critical analysis of how smart technology is likely to change the mobility system over the medium term, the state risks entering another long period of difficulty in dealing with a new set of negative externalities presenting potentially highly significant challenges to social cohesion.

The paper proceeds as follows. First, we review the state of the art in thinking about the 'mobility system', that is the wider socio-technical system that generates the desire for mobility and in turn the practices through which that mobility is expressed today as a baseline for considering how this might change in future. We then go on to set out some key elements of the Smart Mobility transition as currently postulated. Next we review why the state has traditionally intervened in the mobility system and the changing way in which it has done so. Together, these sections set the context for discussion of a number of questions that the state will need to think through quickly before smart technology (and the producer interests championing its adoption) overtakes public policy and limit the state's scope to govern the smart transition for the public good.

2 The 'Mobility System'

Frank Geels' work on the notion of the Socio-Technical System (STS) is a useful starting point for exploring how systems of provision such as the mobility system emerge, and how innovations such as smart technology break into such systems once they are well-established (Geels, 2005; 2012). Important to the STS concept is the notion of an extant and dominant *regime* which comprises technology (e.g. cars and traffic lights), infrastructure (tracks, roads, filling stations and paths), knowledge,

markets and user practices, cultural and symbolic meaning, policy and institutions, and the industries involved in production and operation. Such a conception allows for the multiple factors that affect the setting of something like a speed limit to be considered in the round, and importantly illuminates why change might be difficult. It is not simply a matter of engineering know how, road design nor policy preference, but also a matter of negotiating social norms, customs and practices.

Watson (2012) grapples with how to extend STS theory in the transport domain to develop an explanation of how the regimes at the heart of socio-technical systems are themselves directly influenced by fundamental changes in 'patterns of demand', such as those implicit with any move to smart mobility. With reference to Giddens' longstanding notion of structuration, Watson suggests that:

> "practices (and therefore what people do) are partly constituted by the socio-technical systems of which they are a part; and those socio-technical systems are constituted and sustained by the continued performance of the practices which comprise them. Consequently, changes in socio-technical systems only happen if the practices which embed those systems in the routines and rhythms of life change; and if those practices change, then so will the socio-technical system." (Watson, 2012: 488).

There is no doubt that in the 20 years since the mass adoption of the worldwide web, and the decade or so since the emergence the smartphone, Watson's condition that the practices, routines and rhythms of life must change profoundly in order to reformulate the socio-technical system has been clearly met. A substantial research

literature has built up documenting how these technologies are changing socio-economic practices, how changing practices are driving further technological innovation (see, for example, (Castells et al, 2014; Wang et al, 2016). These developments have transformed many aspects of everyday life in less than a generation, leading to a situation in which the ways we communicate with each other, how we organise patterns of work, shopping, and socializing, as well as the information we have available whilst physically mobile are unrecognisable from only a few years previously. Crucially, the social contexts supporting these behaviours have changed just as quickly, with new norms surrounding how things are done, who communicates with whom and how, and what skills and competencies are expected of both individual consumers and suppliers in the marketplace of groups in the system and the wider resources within households, workplaces or communities within which the who and how of activities are, in part, determined.

Like any other complex socio-economic system, the mobility system can be described as such a “set of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behaviour, culture, ecology and belief systems” (Rotmans, Kemp and van Asselt, 2001: 16). Thus the automobility system is comprised not only the “manufactured object” of the car, but a set of diverse factors ranging from the cultural importance of the car as an icon of “individual consumption”; to the belief system that shopping mall and suburban quarter-acre house plot represented the “good life” and so on (from Urry, 2004:25-26).

Just, therefore, as the real importance of the automobility transition lies is in the ways in which it altered established ways of conducting everyday activities – and then in

turn changed the kinds of activities people undertook – so the same is true for the smart mobility transition. As Wadud et al (2016) point out, the potential of autonomous vehicles to reduce end-to-end travel times for a complex array of possible journeys will have much more profound impacts on society and the economy than simply some time savings for existing activities however important these might be in themselves: as the smart mobility system evolves, the new mobility opportunities it presents will lead to a reconfiguration of the systemic elements that produce different mobility outcomes in the first place, such as land use patterns, employment and housing locations, and so on (see, for example, Kim et al, 2015).

It is therefore immediately apparent that 'smart' change – such as the rapid and widespread adoption of autonomous vehicles – will in fact be deep and disruptive, turning out to be less about the visible replacement of human drivers with big data and sophisticated guidance electronics, and more about facilitating fundamental alterations at systems level to how we organise the economy and society across space and time. Contemporary imaginings of smart mobility – which, as we noted above, are often highly producer-led – offer optimistic visions of a society in which technological advances have delivered a benign mobility system that all users can access seamlessly and on-demand, avoiding much of the waste and pollution of today's conditions. However, there is no guarantee that such a vision will come to pass; indeed, given there has now been several decades' effort to ameliorate the negative externalities of the automobility era (see Marsden and Docherty, 2013), we should at the outset recognise that none of the technological innovations in car-based mobility to date[1] have unlocked such a positive outcome, and so we should be wary of claims

[1] Indeed, the notion of a 'smart' future implies a 'non-smart' today. The transition to an increasingly intelligent and interlinked mobility system has been underway for decades.

that the ‘next big thing’ – in this case smart mobility – will automatically be more successful. In fact, because mobility is a *system*, many *different* potential smart mobility futures exist, even for any given package of technological innovations; the key question that policy makers need to address is therefore that of how the state manages to keep a sufficient hand on the tiller to be able to steer the transition in ways which satisfy the often competing range of economic, environmental and social objectives that we mediate through our democratic processes.

3 What is ‘Smart Mobility’?

In order to begin the task of thinking through the implications of smart mobility that actors and institutions of governance will be confronted with, it is helpful to identify some key building blocks that are common to different views of the future as they are being debated today, especially those changes that are either already emerging or which are the subject of the most intense R&D effort, e.g.:

- The shift towards ‘mobility as a service’, where individuals’ ownership of vehicles is increasingly replaced by “usership”, that is the ability to purchase access rights to an interoperable package of mobility services (car, taxi, bus, rail, bike share) owned by others. This is facilitated by integrated aggregation and payment platforms, with intensive processing of ‘big data’ to match provision to demand in real time;

- Autonomous vehicles that do not require ‘driving’ by any of the passengers, and which enable all occupants of the vehicle to focus on other tasks whilst they are in motion;

- New user-generated and user-centred information which is context specific and integrates mobility and non-mobility options, which draws upon;

- Increasingly ‘intelligent’ infrastructure which derives operational information from users and provides feedback in real-time to influence of traveller behaviour and optimise system performance;

- The electrification of the vehicle fleet using battery power, plug-in hybrid and/or other new technologies. Combined with a smart energy distribution grid, electric vehicles could be both emission free at the point of use (thus satisfying consumer desire for ‘sustainable’ mobility, see Bakker et al, 2014) and also be part of the electricity storage solution for the widespread adoption of renewables more generally.

The list is not comprehensive of today’s opportunities (we do not, for example, address changes in the movement of goods in this paper, which are equally dynamic) and new ideas will surely emerge. Nonetheless, we can pick out from these core building blocks some key elements of the socio-technical transition that appear in the more technology-led imaginings of smart mobility futures. First, there is the transition from ownership to “usership” identified as a critical innovation by advocates of smart mobility (Wocartz and Schartau, 2015). This transition is already apparent: car share clubs had almost 5 million members and 92,000 vehicles worldwide in 2014, an increase of more than ten fold over a decade previously (Le Vine et al, 2014). Given that the average car today is parked for 96% of the time (RAC Foundation, 2012) there

is very significant potential to unlock efficiencies by reducing the amount of time expensive assets are not actually mobile or under occupied. Furthermore, apps such as Uber also work on the principle of better matching user demand and vehicle supply in space and time increasing the utilisation of drivers and reducing wait times for passengers. Combining these attributes provides the most optimistic (corporate) vision of the smart mobility future, as promoted by Google's CEO Sergey Brin:

> "… if cars could drive themselves, there would be no need for most people to own them. A fleet of vehicles could operate as a personalized public-transportation system, picking people up and dropping them off independently, waiting at parking lots between calls. … Streets would clear, highways shrink, parking lots turn to parkland." (from Bilger, B (2013), in Adams, J. (2015).

Second is a transition in the definition of the marketplace that is 'mobility'. Today this market is dominated by private vehicle ownership, roads funded by the state (usually through general taxation) and a public transport system which, to varying degrees in different places, has some form of state direction and support. The transition to a new smart model of mobility therefore implies that this traditional business model for the public-private allocation of tasks across the mobility system will evolve. As one recent study into the market for intelligent mobility put it "value in mobility is derived from traveller spend, whether this means spend on travel tickets, vehicle ownership, or services and apps." (Wocartz and Schartau, 2015: 8). Fundamentally, the commoditisation of individual journeys and the journey time of users is what makes 'smart mobility' pay for itself, and represents a continuation of the longstanding trend towards the neo-liberalisation of the transport system (Gössling and Cohen, 2014).

Whilst these innovations may also create public value for society and the state (Blanes et al, 2015) these are usually treated as secondary or residual impacts by the technology sector pushing the smart transition. More important for smart mobility proponents is the potential to grow the market by more effectively "address(ing) significant unmet lifestyle needs across a range of traveller types" (Wocartz and Schartau, 2015: 1): thus neatly revealing the essential paradox of much smart mobility rhetoric at present, i.e. that the smart transition will simultaneously create the promise of a system that can reduce demand, whilst at the same time fulfilling previously unmet demand. As we note in Section 2, it is equally important to consider how demand itself will be reshaped by these innovations rather just re-directed across modes.

Third is the greater convenience and comprehensiveness of inter-modality or "from the current 'modal-centric' to future 'user-centric' transport system" identified as an important benefit of this more marketised approach to accessing mobility services (Yianni, 2015: 3). Hietenan (2014: 3) sets out his view of future mobility as seeing "the whole transport sector as a co-operative, interconnected eco-system, providing services reflecting the needs of customers. The boundaries between different transport modes are blurred or disappear completely. The ecosystem consists of transport infrastructure, transportation services, transport information and payment services." Crucially, this transition requires the emergence of new integrated mobility aggregators, smart intermediaries that match mobility supply to demand in real time to tailor services to the needs of the travellers. The new role of aggregator, which is effectively a form of arbitrage for mobility, is one if not the most important change elements in the smart mobility system of the future. We return to the question of the implications of this role being played by the state or private firms below.

Fourth, there is a transition in the role of the citizen in the transport system. This is both as a source and recipient of information through mobile communication and through bringing their resources to the shared mobility platforms. This has so far manifested itself in people using their vehicles as part of ride-share systems, as vehicles on-demand for Uber and Lyft and by renting out driveways for other users (see www.justpark.com). This is part of a wider transition away from the state as the prime source of information to being one of many actors feeding information into the mobility system.

4 Why and how is mobility governed?

Before considering the new questions and issues which a transition to smart mobility futures pose for governance more fully it is necessary to revisit why the state is involved in governing the transport system today and why, therefore, it might remain involved. The reasons for state involvement vary according to the ideological lens through which the state is viewed. In the UK and US, for example, a neo-liberal approach (Peck, 2001) is adopted which suggests that transportation is treated as a market and that the system should evolve through market principles. By contrast, much of continental Europe adopts a 'welfare model' where the transportation system is owned or regulated by the state to promote a series of social policy goals (Ranci, 2011; Shaw et al., 2008). In reality a blended approach exists everywhere with an increasing focus being given to the approaches adopted to governing such a complex system. Before addressing the key facets of governance, we set out in Table 1 some of the reasons for state intervention.

Insert Table 1 about here

As the analysis in Table 1 suggests, under the developments for smart mobility set out in Section 2, all of these core reasons for state intervention remain important in any future mobility transition but the nature and relative importance of the different elements will change. This contributes to the narrative of the disruptive nature of transport innovations in that they directly challenge some of the long-held ways of doing things. However, it is not just what requires state intervention but also the means through which that intervention needs to be delivered (i.e. the governance of it) which is in transition.

Treib et al. (2007: 3) summarise governance as the "steering and co-ordination of interdependent (usually collective) actors based on institutionalized rule systems (Benz 2004: 25)." Whilst there is a prevailing view that change to entrenched socio-technical systems is slow due to the resistance of incumbent actors (Nykvist and Whitmarsh, 2008), we see some significant differences in a potential smart mobility transition. New aggregators of services and companies such as Uber are able to bring together existing resources and technology and generate new products which challenge the status quo very rapidly. They are doing so without recourse to state subsidy and, by virtue of generating significant numbers of users are able to challenge the incumbent providers' notions of their privileged position being in the 'public interest'. As well as the changes to the rule systems and issues from Table 1 there is evidently a significant on-going change to the network, competencies and power of the actors within the network of interests engaged in the mobility system and through which the transition will be negotiated (Dowling and Kent, 2015). The transition to 'smart mobility'

is also, therefore, going to require a transition to new forms of governance, a reality which is absent from the current technology-led visions.

Most visions of smart mobility are not blind to the role of the state, but instead see it as a relatively passive facilitator of innovation. In its review of the future market for intelligent mobility, the UK's transport innovation platform identified the role of the state in the transition as shown in Table 2.

Insert Table 2 about here

To us at least, this seems like a very hands-off view of the role of the state in smart mobility. As with other reports, the roles of the state are reduced to that of facilitator of the environment for service innovation, provider of data (often assumed to be at no cost, see Buscher et al, 2014) and provider of experimental lab in the first instance. These all seem like necessary conditions for the mobility transition to be accelerated but not sufficient to meet the overall obligations of the state. As Millard (2015: 9) suggests "government becomes just one actor amongst many… it still needs to fulfil roles which other actors normally cannot… Accountability for services and performance, and responsibility especially if things go wrong, is a critical issue".

More widely, we would argue that wider justifications for state intervention in mobility are resilient: the state will always have a role in trying to understand and shape the delivery of objectives for public good, such as correcting market failures, managing 'crowding out' effects and so on (Heibling, 2012). It is in this arena where potential conflicts between innovations such as smart mobility, their externalities and wider

public policy objectives such as better health, social inclusion, climate change mitigation and adaptation and reducing local environmental degredation need to be worked out. In short, under whatever future one imagines, the role of the state is still critical in deciding what we are planning for and, therefore, the extent to which developments to the mobility system might help or hinder the achievement of those objectives. This requires a pro-active approach to governance which is smart enough in itself to anticipate rather than merely react to the potential implications of a smart-mobility revolution. We now turn to some of the key challenges to be addressed in the next section.

5 Towards the Smart Governance of Mobility

There are a number of clear and present challenges for governance if it is to become sufficiently smart enough itself to manage the various aspects of the transition to smart mobility. Perhaps most important of all is the set of issues raised by the change of relationship between producers and consumers of mobility implied in the major shift from ownership to sharing. Notions of mobility as a service[2] are already being piloted by BMW with their i-Mobility initiative and of course by Uber (whose share price is predicated on it becoming much more than a taxi company, however smart). But there are fundamental decisions to be made about what exactly is the public good that mobility as a service will provide, and therefore the role of the state in governing it. Although the mobility as a service model is very carefully portrayed as both more responsive to consumers by virtue of its 'smart' matching of supply to demand, and more sustainable because it tackles the problem of the fixed costs of car ownership encouraging additional 'free' discretionary trips, it is essentially a *rentier* model where

[2] http://www.transdev.com/en/media/videos/jules-julie.htm

the clear incentive for the mobility service provider is to generate *as much mobility as possible* to maximise returns on capital. Even if the direct costs of more vehicular-based mobility are to some extent mitigated by greater efficiency of and less pollution from the vehicles themselves, the potential costs at the system level are huge. For example, what would be the impact on society if ubiquitous AVs eradicate 'traditional' public transport modes everywhere except in the very largest cities? How will intense local externalities such as the extreme physical severance and the almost complete erosion of the public realm implied by constant high density flows of autonomous vehicles on critical parts of existing infrastructure be managed? We return to these and other questions below.

The key unifying dynamic at play in all of these examples is the redefinition of the implicit bargain between the traveller as end-user and the state about how individual mobility demands are balanced against wider public goods and policy objectives, a question made more complex still the emergence of new players in the smart mobility future such as new service providers (Google, Uber, BMW etc) and the mobility management intermediaries that will facilitate the smart marketplace (which could be providers themselves or alternatively specialist firms[3], or a bank, or a supermarket). As Dowling and Kent (2015) identify, even an apparently simple 'smart' innovation such as organised car sharing requires renegotiation of the relationship between state and various private interests, with the state allocating public space for a commercial operator to run a business, leaving others to deal with the externalities and opportunity costs. Similarly, the state has been heavily subsidising the provision and management

[3] Skyscanner is a good contemporary example of such an intermediary that has quickly come to hold an important and powerful position in structuring a particular mobility marketplace, in this case aviation.

of public charge point networks for electric vehicles, locating them in prime high value locations (Strasser et al., 2015).

Although both of these examples may appear trivial, this is because few people are *currently* using them and their impact on behaviour at the aggregate level is modest (McGuirk and Dowling, 2009): they could in fact be clear signposts to the creeping privilege of certain mobility solutions over others through the differential allocation of public assets, most importantly road space and the wider public realm. This in turn raises wider first principles questions about what regulatory posture the state will want – or perhaps *be able to* – adopt in future (see Docherty et al, 2004; Cowie, 2010). We would argue that the two most important outcomes and therefore signposts of the smart transition to date are: first, that peer-to-peer sharing has most benefited those people who *already have* substantial capital assets (e.g. a spare vehicle available to use as an Uber taxi, or an apartment in a popular location for Airbnb) by quickly improving their ability to make a financial return on that capital; and second that the naked disregard for established structures of market regulation by the highly financed companies behind such apps provides a clear window to a future in which the power relationships between the state and smart providers is very different from today (see *The Guardian*, 2016).

Imagining how different smart futures might play out therefore requires difficult, uncomfortable thinking about how the state will approach the task of regulation when the mobility system is in (perhaps unprecedented) flux. It might be possible, at least in the early stages of the smart transition, for those state organisations that have retained enough power and expertise (e.g. Singapore LTA or Transport for London) to fulfil the

role of service aggregator (i.e. acting as the portal and contractual authority for the purchase of smart mobility services) themselves, such that access to and the pricing of mobility services is meaningfully regulated in a similar way to now. Such a situation would also make it possible for the state to take a robust view about the taxation of new forms of mobility, not only to raise revenue *per se* from the surpluses generated by smart mobility services, but also to crystallise the additional value released by the greater capacity potential of new uses of historic infrastructure such as roads that were built and maintained by the taxpayer. The urgent importance of thinking through how a smart mobility future will be taxed cannot be underestimated[4], since even non-smart electric vehicles,

> "are three times as energy efficient as internal combustion vehicles, (therefore) complete electrification will reduce the energy tax base to one-third. In addition, the tax on electricity use is only about one-tenth of the fossil fuel tax, as reckoned per energy unit. The loss in tax revenues from fossil fuel taxation in the EU is estimated at €800 billion as a consequence of the vehicles that could enter the car fleet by 2020. This calls for new market correction mechanisms for road transport in the future, if the external costs of transport in the form of road wear, congestion, local pollution and accidents are somehow to be internalised." (Lindberg and Fridstrøm, 2015: 8).

But maintaining a strong regulatory posture will be difficult if not impossible in many contexts. State power in the transport domain is weak in many places, especially those such as North American cities where the private car is already the overwhelmingly

[4] It is instructive to note the peak or surge pricing being adopted by Uber and being accepted by users in stark contrast to the slow pace of deployment of congestion based charging led by the state.

dominant form of mobility and in which the state has little or no existing role in the 'belief system' about how mobility should be distributed beyond building as many roads as possible. It is therefore difficult to imagine how strong-enough new state regulatory frameworks will emerge to challenge the actions of Apple, BMW, Google and others for whom the smart mobility sector is an extension of corporate strategies designed to provide brand loyal consumers with a single integrated provider of as many of their needs as possible. Seemingly trivial and experimental decisions in the "relatively carefree" early phase of transition (Bakker et al., 2014; 52) could prove at best difficult to change and potentially irreversible given the rapid establishment of new norms of usage and powerful providers (consider still today the challenges of changing urban parking policy).

Some minimum level of regulation of the smart mobility marketplace will, however, be necessary. As Cowie (2010) notes, "qualitative regulation" in the form of legal and regulatory frameworks for basic standards of operation is required in order for users to know what to expect on the network such that their journeys can actually be undertaken safely. The development of a *Code de la Route* is synonymous with the need for pedestrians, cyclists, and drivers to know how to perform in the many different circumstances they will face on the highway network. Indeed, the need for such frameworks will become more, not less, important with the widespread adoption of autonomous vehicles, since the absence of a human being who is directly responsible for the impacts (literally) of her or his vehicle requires codifying of many things we currently take for granted. Indeed, the law is probably the domain in which inability of the state to keep pace with the technological transitions underpinning smart mobility

is brought into starkest relief, witness arguments about whether it is appropriate to "sue my car not me" (Gurney, 2013).[5]

Another assumption underpinning many visions of the smart future is that the system will be so good at matching supply to demand that an effectively perfect market for mobility services will be created. We are sceptical of this view both *per se* and for the reasons we have outlined above, and also because the smart transition to date has clear echoes of other transport markets through the decades which tend towards conditions of oligopoly or monopoly: without regulation, preventing anti-competitive behaviour such as a global-scale company providing mobility services from strangling new market entrants at birth through price attacks would be well nigh impossible.

The most important asset that the state needs to exert some form of control over in order to avoid anti-competitive practices and other negative externalities is therefore the data upon which the smart transition depends. Data is the most valuable commodity in the smart system, because it structures the matching of mobility to demand, and therefore both the price of mobility to the end user but also the size of the surplus generated by the mobility service transaction. In the smart future, data is the knowledge upon which the power to control the marketplace. Yet, in line with the wider neo-liberal framing of the smart transition to date, in which the role of

[5] Commentary on the thorny ethical problems that underpin how autonomous vehicles should behave in crash situations (literally, who they should kill and who they should not) is beyond the scope of this paper, but see, for example, Adams (2015) and Goodall (2014).

government has been set out as creating the conditions for technological innovation to occur (see above), the state is actively *giving away* this data to private interests:

> "A key enabler of the value chain for smart mobility services is a city's upfront investment in ITS and other intelligent infrastructure that generates key raw data… Public agencies, including city government, are seeing the economic value in making their data available at no cost… for private data owners, this raw material may be a saleable asset in its own right." (Buscher et al 2014: 30).

In time, the decision to cede control over the data underpinning smart mobility could turn out to be a strategic error of possibly seismic proportions. The state is already losing its position as the principal source of knowledge about travel patterns on the network relative to mobile phone operators, with this information asymmetry also set to grow further through e.g. better peer to peer sharing of location data. Whilst such developments in theory offer opportunities for more user-led and intelligent planning decisions to be made, the critical shift in knowledge and associated power as a result will make governing mobility much more difficult in future. In a system where autonomous vehicles are the norm and/or where the aggregation of mobility services across different forms of transport is the proviso of a small number of powerful private sector enterprises, the state will be interacting more with a frontline of fewer more powerful industrial stakeholders than is the case today. The power of the state to intervene to steer demand could become, we suggest, much more constrained and subject simultaneously to criticisms of interference and stymying of productivity should efforts to manage demand for whatever reason be brought forward.

But maintaining some kind of effective economic regulation is only one challenge the state will have to meet. Ensuring an appropriate degree of equity and non-discrimination in access to smart mobility services will also require careful intervention. We acknowledge that many visions of a smart mobility future in which user costs are lower have the potential to resolve some long-standing exclusion issues. However, the smart mobility transition will not occur at the same pace or to the same degree across different spatial areas and will not be uniformly accessible to all members of society. As intensive utilisation of vehicles is at the heart of the business model for usership rather than ownership, it is unsurprising to see these services predominantly located in central areas or in particularly dense nodes in bigger cities. Dowling and Kent (2015) found, for example, that almost half of the car club vehicles in Sydney were within or very close to the CBD, a pattern that can be seen with bike share schemes and coverage of taxis.

Whilst there is obvious potential for the 'sharing' economy to allow more bottom up solutions to emerge that work at times and in places that public transport has retreated from, there will be big differentials between urban, peri-urban and rural experiences of a 'smart-mobility' future. In order to address these inequities, the state will have to engage differently and think about how best to ensure that new mobility services have some kind of universality. At present, this 'safety net' function (where it exists) is expressed through subsidies for certain types of public transport service. But this model is already gravely threatened by the decline of so-called 'lifeline' public transport services due to car competition and increasing public sector austerity in many places. In a smart future, will the state need to consider supporting mobility subscriptions

rather than the transport services which underpin them or could a social contract form part of the right to operate, a new kind of 'Public Service Obligation' for smart mobility?

There is also a very real question as to whether the state will end up as, if not operator-, then guarantor of last resort for a system of autonomous vehicles. Government will have approved these vehicles and, as with rail accidents on private sector networks, it is the state that ultimately needs to answer the case when things go wrong and, potentially, invest to put right any identified deficiencies. But will government have the capacity to understand what risks it is really underwriting and where the vulnerabilities really lie?

These issues demonstrate how questions about the potential asymmetry of power between the state and global corporates acting as mobility providers and aggregators re-emerge in many analyses of the impacts of the smart mobility transition. We have already explored how control of the data underpinning the smart system is key to the pricing of mobility and the levels of surplus it generates for reinvestment through the taxation mechanism. But if the principal transaction in the smart future is between mobility companies and individuals, then this will in turn change the dynamic about who speaks for the consumer, and what the 'public interest' is in the first place.[6] Those firms acting as mobility service providers and aggregators – who, as we have seen, will have access to the crucial datasets underpinning the smart ecosystem – will be in a very powerful position to claim that they understand the preferences of their users better than anyone else, and so that it is for public authorities to respond to these

[6] The very public clash between Apple and US law enforcement agencies on the issue of data encryption is an important early example in how new understandings about the relationship between individual, service providers and state rights is highly problematic.

preferences. The risks of excluding the needs of those groups of people who engage with smart mobility service provision in some form of 'different' manner are obvious: those people with limited budgets who use very little or no service (e.g. people for whom cycling and walking will meet the majority of their mobility needs) will therefore have very little voice in such discussions. Who, therefore, will it be that leads calls to protect the public realm from a new wave of vehicularisation brought about by the ubiquity of autonomous vehicles?

Finally, there is the issue of the state's position as guarantor of agreed social norms and how these are reflected in the smart mobility future. Perniciously, some types of social aggregation services have *already* been shown to demonstrate selective approval processes – "Digital Discrimination" – on the grounds of race (Edelman and Luca, 2015; Edelman et al, 2016). Research has also demonstrated the unease with which many people approach the idea of sharing vehicles (see, for example, Neilsen et al, 2015). But without some form of regulatory control for social obligation, what kinds of digital discrimination will emerge in 'smart' mobility? Gender-segregated AVs? No services for areas deemed undesirable (or unprofitable) by mobility firms themselves? Premium costs to travel on a Saturday night for young people aged under 25? Or "better service in areas with more white people"? (*The Washington Post,* 2016).

In raising these crucial issues of public value and fairness, we do not, however, argue that state involvement will be a panacea. Nonetheless, we are attracted to Millard's writing about a future, smarter state which is more aware of the need for "openness" in its operation and activities so as to be alive to "wider developments in society and the manner in which other societal actors are changing their roles and ways of

operating." (Millard, 2015: 3). The smart mobility transition will be another mixed public-private technological transformation of the kind Mazzucato (2015) identifies, harnessing the innovation of private sector firms but with the kind of state support necessary to ensure that its full potential is captured. As Millard (op cit, 4) also notes, this will involve,

> "breaking down, or at least cooperation between, silos across different administrations, levels and locations, through pooling and sharing infrastructures, processes, data, assets, resources, content and tools. It implies forms of federation and coordination which balance centralisation and decentralisation as well as top-down and bottom up approaches. This involves huge challenges technically, politically, legally, organisationally and in terms of working cultures".

6 Conclusion

The transition to 'smart mobility' requires a similarly dramatic transition in 'smart governance' if the state is going to be able to harness the undoubted potential of many of these innovations to deliver key societal outcomes. Failure to do so risks the state being overtaken by events and moving to a responsive and piecemeal mode of governance, doing little more than plugging holes in the public policy dike before others open up.

Our analysis suggests that there are some unchanged fundamentals of governing mobility (smart or otherwise) which need to be debated as a matter of urgency in considering how the smart transition will play out. Number one is the need to provide a clear set of policy goals and a direction within which decisions can be taken. In short,

there is a need to be clear about what planning is for and, therefore, to establish a framework within which various smart mobility options might be privileged or otherwise in different contexts. Beyond this, it requires radical thinking about how we will pay for transport in the future, what the obligations are of those who will benefit from smart mobility most, and which notions of 'publicness' need to be reasserted in the face of various emergent forms of smart mobility option.

In this paper, we do not want to advocate a deterministic position about how the smart transition will inevitably develop; rather, it should be read as a cautionary tale about how taking small, incremental decisions that seem benign enough in themselves might in fact lead us into quite a different future to that which the glossy visions of smart portray, in which many of the safeguards governing how mobility is shared out across society, and how we define the purpose of supporting and developing mobility in the first place, no longer meet wider societal objectives. As Millard (2015: 9) notes,

> "Government is there to ensure public value is created by the most appropriate means in terms of what works best in a given context and for given needs… this may involve government having a major direct role or a minor one in creating public value, but even in the latter case government needs to be a facilitator and orchestrator to ensure that it does."

At a time where governments around the world are seeking to shrink the state and reduce administrative costs (simultaneously leaching expertise), it is difficult to be optimistic that government will pick up the baton to orchestrate the smart transition despite the need for, and benefits of, action identified here. Our hope in starting these

critical debates, some fifty three years on from Buchanan's visionary report about the risks inherent in the rise of automobility, is that society 50 years from now is not left similarly looking back at the mismanagement and missed opportunities from the next great mobility transition.

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Table 1: Core Reasons for State Involvement in Transport Governance

Need for intervention	Key Issues Today	Changes with Smart Mobility
Basic standards of operation and rules of movement	Interoperability between systems, standardization of laws and enforcement	Need for interoperability of payment, protocols for communication, charging infrastructure and operation of autonomous vehicles. Growing importance
Conditions for a free market do not exist	Managing monopoly infrastructure providers and limited service competition, preventing collusion	New players in the market increase competition for mobility provision and some, but not all, services; new aggregators of services overcome some collusion issues; new oligopolies emerge. Infrastructure monopoly conditions remain.
Environmental, economic and social externalities exist	Climate change, air quality, congestion, social exclusion and inequity	Challenges remain although different transition paths may impact on the relative importance of the problems
Problems of co-ordination between modes exist	Competition can exist between public transport operators within and between modes. Limited ticketing integration. Balancing of road space allocation.	Mobility as a service requires the integration issues to be resolved, perhaps through new aggregators rather than existing providers. The management of space remains an issue.
Innovations fail to reach market due to high initial costs	Stimulating the transition from fossil fuel to clean electricity powered transport has a cost premium. State support of bike share and car share through space allocation, initial costs and/or utilisation	Many information based services do not require state involvement. Requirements to create innovation environments for more advanced automation technologies likely to remain.
The state is an aggregator of risk	The state can borrow at lower rates than the private sector and is ultimately guarantor when private provision of public services fails	Will continue to be involved in major infrastructure and is likely to remain a key player in a more automated future.

Table 2: Role of the State in Smart Mobility Transition (Wocartz and Schartau, 2015:4)

State Level	Action
National Government	Fund research and development activities and skills development…
	Focus on filling the gaps in provision of reliable, fast, and ubiquitous connectivity.
	Establish a data exchange mechanism and mandate open data where appropriate (e.g. in rail franchises).
	Create a central ticketing platform and multi-modal marketplace and encourage multi-modal integration to support expected advancements in dynamic pricing and timetabling.
	Foster cross-industry collaboration to unlock value from Intelligent Mobility
Local Government	Encourage and support new business and participate in experimentation with new Intelligent Mobility solutions in private and public transport
	Shift focus towards procuring against challenges rather than procuring for solutions
	Push for integration and innovation in public transport (e.g. demand responsive services)

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