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MK 2050: Innovative Mobility Roadmap

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Executive Summary

The Milton Keynes Futures 2050 Commission report *Making a Great City Greater* placed emphasis on early investment in 'Smart, Shared, Sustainable Mobility' for all as one of Six Big Projects for supporting Milton Keynes' (MK) population growth to 400,000 people without gridlocking the city's road network. While some aspects of this are within touching distance, others are expected to take longer to realise.

Future predictions suggest that Connected and Autonomous Vehicles (CAV), cleaner and more efficient propulsion systems, demand responsive travel and Mobility as a Service (MaaS) are poised to disrupt and transform the way people and goods move around. This paper reviewed the readiness of these smart mobility technologies to consider the extent to which MK might need to change in future to benefit from them. We concluded that the city's unique nature and the flexibility of its grid system, presents specific opportunities, and some challenges, for successful adoption and implementation of new ways of moving people and goods.

Taking into account the other MK 2050 Big Projects - notably those relating to spatial and economic growth - we have set out a roadmap for accelerating the delivery of innovative mobility services in the city over the next 30 years. Identified near-term actions include:

- Planning MK grid expansion and regeneration for mixed-uses in parallel with the growth of MK's urban area along a select set of more densely developed, high frequency transit priority and direct cycle corridors. These should link key trip generators, national transport nodes, Renaissance:CMK areas, Centre:MK and new/existing residential areas.
- Supporting Renaissance:MKC, and the delivery of MK:U through co-location of student accommodation and night-time economy facilities, while linking the university's delivery to innovative R&D on autonomous mobility, smart & connected cities, and sharing economies.
- Installing and maintaining smart data gathering mechanisms that cover MKC roads and parking assets to build a real-time open dataset of traffic flows and parking demand. By collaborating with local transit and bikeshare operators this will form the basis of a shared, open transport data network for richer understanding of local patterns of human movement and deeper, more seamless, integration across all travel modes.
- Investing in ultra-low emission modes (e.g. EVs) and associated charging infrastructure, while collaborating with private sector specialists and government innovation bodies to position MK as the go-to UK location for 'here-first' CAV testing and implementation.
- Working to attract/develop an integrated journey planning tool as the foundation for local mobility service aggregation (e.g. Citymapper / Whim). in parallel with setting up a smart integrated ticketing and car park payment system with local transit/bikeshare operators, so as to establish a platform for MK's future Mobility-as-a-Service offer.

1. Introduction

1.1 The Milton Keynes (MK) Futures 2050 Commission report[1] emphasised the importance of early investment in '**Smart, Shared, Sustainable Mobility**' as one of Six Big Projects for supporting population growth to 400,000 people without gridlocking the city's road network. Its overarching vision suggested a dedicated MK mobility service could offer a flexible range of transport options – combining EV car clubs, bike share and driverless shared taxi services – to facilitate local door-to-door journeys. These would seamlessly integrate with local electric bus and national rail services, through smart ticketing and booking systems that would underpin the city's on-demand integrated transport offer.

1.2 The extent to which Smart, Shared, Sustainable Mobility is achieved in MK by 2050 is expected to critically enable, or inhibit, the success of the five other 'Big Projects' in 'Making a Great City Greater':

- Anchoring MK as a key **hub of the Cambridge–MK–Oxford growth corridor**
- Establishing a university in Central Milton Keynes: **MK:U**
- **Learning 2050** to ensure learners have the skills needed for the future of work
- Attracting private and public sector investment to support **Renaissance: CMK**
- Promoting **Milton Keynes – The Creative and Cultured City**

Purpose and structure of this paper

1.3 While some aspects of this future vision are within touching distance, others will take longer to realise. This paper follows-up the MK Futures 2050 Commission's initial work to review smart mobility technologies and their state of readiness. It explores potential impacts on other Big Projects, notably those relating to spatial and economic growth.

1.4 The following sections review the projections of future mobility industry commentators to identify where the smart mobility market may be leading MK. By comparing anticipated smart mobility impacts with the MK Futures 2050 Commission's objectives, ITP has identified the opportunities, challenges, enablers, disablers and unknowns currently facing delivery of Smart, Shared, Sustainable Mobility. The paper concludes by setting out a roadmap of measures that Milton Keynes Council (MKC) could implement to achieve its aims for 2050.

[1] Milton Keynes Futures 2050 Commission (2016), *Making a Great City Greater*. Available at: http://www.mkfutures2050.com/read-our-report, last accessed: 07/09/17.

2. Smart, Shared, Sustainable Mobility - the vision for MK

2.1 The vision for future mobility in MK has already been set out in the Milton Keynes Futures 2050 Commission's report on *Making a Great City Greater*[2]. The section on smart, shared, and sustainable mobility (pp46-47) examines why Milton Keynes is uniquely positioned to capitalise on improvements in transport and infrastructure technology, while meeting specific challenges such as decreasing car ownership levels.

The vision

2.2 The report articulates MKC's vision for making a range of new transport options widely available. They include driverless EVs and electric taxis, accessible through a service provider's booking system that supports both timetabled and more flexible, on-demand services. The introduction of innovative mass transit services, such as a proposed Very Rapid Shuttle, would operate on priority express routes to further ensure traffic congestion is minimised by capitalising on the MK grid network's strength and flexibility.

2.3 Under the banner of Smart, Shared Sustainable Mobility, the report also summarises its vision for sustainable mobility in Milton Keynes. This is framed around the following investment priorities:

- Citywide travel integration systems
- Low-emission shared transport provision
- Transformative new mobility systems

Existing future mobility initiatives

2.4 The report briefly outlines the opportunities and challenges likely to be experienced in Milton Keynes in each case. The headings in this section of the report reflect the fact that the city is already working innovatively across many of the investment priority areas. Examples include:

- The MK:SMART programme's transport thread[3], which is in the process of rolling out a large-scale deployment of 'busyness sensors' across the city's extensive urban

[2] Milton Keynes Futures 2050 Commission (2016) *Making a Great City Greater*. Available at: http://bit.ly/2xfiwgC, last accessed: 07/09/17.
[3] MK:Smart (2017) *Transport*. Available at: http://www.mksmart.org/transport/, last accessed: 07/09/17.

road network and parking assets, together with passenger transport feeds, to power a Motion Map live information system.

- Driverless pods[4], the development of which the city has collaborated on with the UK Autodrive consortium[5] to lead international research into this possible new form of urban mobility. Consequently, MKC is poised to exploit the results to address specific local challenges (the so-called 'last mile' problem).
- The demonstration of autonomous saloon cars, highlighting the potential capabilities on MK's highway network via several open road trials.
- Santander Cycles[6], the Milton Keynes public bikeshare service, and Ecar Electric Vehicle (EV) Car Club service form the basis for local shared transport networks. In conjunction with the city's Redway network they offer world-class low-emission and active mobility provision.
- Electrification of transport through the city's Go Ultra Low status – promoting both all-electric bus services, and supporting the uptake of electric cars through targeted infrastructure and promotional activities via the UKs first EV experience centre.

Developing a plan for achieving the vision

2.5 The MK Futures 2050 Commission report set out some next steps that it believed MKC should take to wholly adopt Smart, Shared, Sustainable Mobility *"as a cornerstone of the city's long-term strategy"*. It particularly called on stakeholders to recognise that MKC is not now, and unlikely to be in future, the sole provider of mobility services – highlighting a need to embrace opportunities for collaborative working between public and private sector organisations to deliver new forms of mobility service.

2.6 The report also recognised that evolving transport and infrastructure technology, in parallel with wider social change, could have a significant impact on the successful future delivery of mobility services in Milton Keynes. As such, planning for future implementation was identified as being paramount to delivery.

2.7 This report picks up the baton from the MK Futures 2050 Commission's initial work in order to highlight some of the major expected mobility and infrastructure developments that are predicted to occur in coming years. It does so by considering their likely impact in a Milton Keynes context, and in view of the emerging priorities for MK 2050.

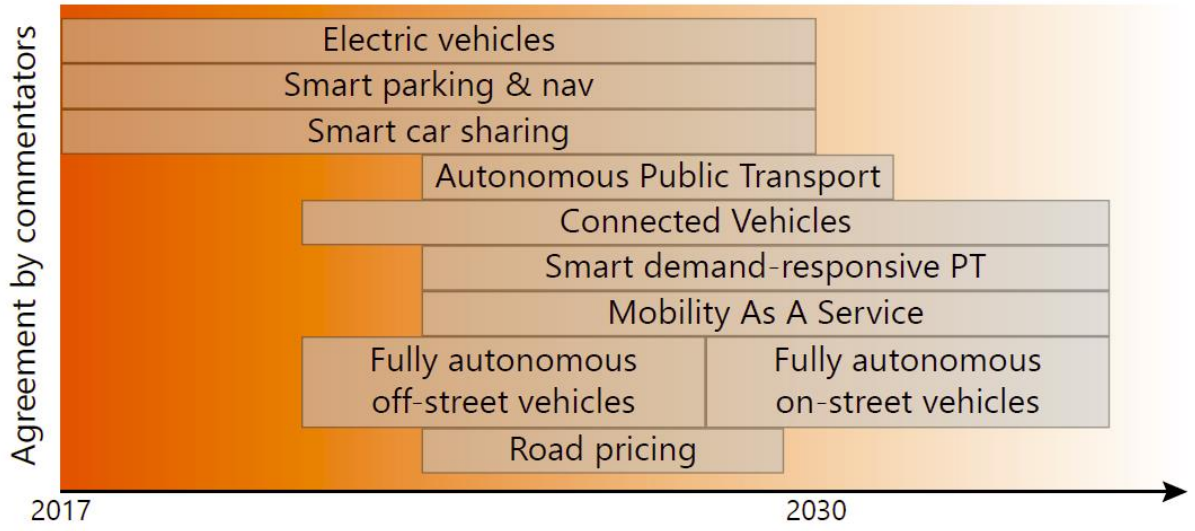
[4] Transport Systems Catapult (2016) *Driverless pods*. Available at: http://bit.ly/2ypuFgz, last accessed: 07/09/17.
[5] UK Autodrive (2017) *About UK Autodrive*. Available at: http://bit.ly/2gpGjEj, last accessed: 17/10/17.
[6] Santander Cycles MK (2017) *Santander Cycles MK*. Available at:, last accessed: http://bit.ly/1UmEPnu, last accessed: 05/09/17.

3. Where is the market taking us?

3.1 Developments in communications and computing technology in the past two decades are already exerting significant changes to people's mobility expectations and options. The biggest advances over the next 20-30 years are expected to arise from increasing autonomy and digital connectivity across all existing modes of transport. While driverless cars have captured most of the headlines to-date, innovation in these domains and the emergence of what has been dubbed the 'sharing economy' is also driving innovation in the fields of service timetabling, booking and payment infrastructure. If joined together seamlessly, these could transform the way that less-integrated mobility services we currently rely upon are delivered in the future.

3.2 This section picks out some of the most important advances relevant to Milton Keynes, examining what is expected by industry experts to happen before 2050 (Figure 3-1). This summary draws upon ITP's analysis of emerging technologies in the mobility marketplace and 'horizon scanning' reports prepared by industry commentators like Deloitte, PWC, Atkins, Gartner, McKinsey, KPMG, Allianz, Ernst & Young and Airbus.

Figure 3-1: Summary of smart mobility industry commentator projections



Source: ITP analysis of major industry commentator's future mobility predictions.

3.3 The range of estimated timeframes within which these new technologies are predicted to come to market/become widely adopted is strikingly wide. This serves to illustrate the high degree of uncertainty over the more transformational innovations, and may also reflect biases such as industry optimism/pessimism regarding developing technologies.

Connected and autonomous vehicles (CAV)

3.4 Perhaps the greatest expected change in mobility technology over the coming decades is the increasing connectivity and autonomy of vehicles of all types; including off-street and on-street, and for public and private usage. MK has been at the forefront of off-street driverless vehicle trials with the LUTZ Pathfinder project[4], and the UK Autodrive L-SATS project[5] - demonstrator platforms using UK-developed technologies to driverlessly move people around CMK.

3.5 For on-road transport, CAV are expected to have huge impacts over the coming years. This is primarily because they are expected to remove the human time cost of driving, improve safety through collision avoidance, and optimise traffic conditions at busy times through digitally-connected platooning. Former New York Mayor Michael Bloomberg estimates there will be 100,000 CAV in service by 2023, and that by 2025 as many as 42% of vehicles will be fully or partially autonomous[7].

3.6 There are also major implications for safety of road travel. CAV are expected to be able to operate distraction-free for far longer periods than humans, with 360° vision and radar that far surpasses a human's abilities[8]. Lane-keeping systems and other 'semi-autonomous' features already available in modern vehicles have resulted in 10-20% reductions in accident rates in real-world driving[9]. The Society of Automotive Engineers (SAE) have developed a widely accepted set of standards describing different 'levels' of operation for driverless vehicles, ranging from 1 (single-feature autonomy) to 5 (fully driverless for a whole journey)[10].

3.7 Removing the need for a human driver is likely to have a fundamental impact on the design of both private and public service vehicles. It is also expected to change vehicle ownership patterns as private owners need no longer maintain an asset that is unused for 96% of its life[8] and are instead able to use driverless taxis or other forms of shared mobility services (expected to become far more cost-competitive without the cost of a driver). What is not clear is the extent to which fewer autonomous vehicles may be shared within 'bounded' communities (e.g. families, workplaces) and/or publicly as a service.

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[7] Bloomberg Philantophies (2017) *Taming the Autonomous Vehicle: A Primer for Cities*. Available at: http://bit.ly/2qgcvZq, last accessed: 18/09/17.
[8] The Economist (2017) *Difference Engine: The Long, Winding Road for Driverless Cars*. Available at: http://econ.st/2wGiM3Q. last accessed 30/05/17.
[9] J. Cicchino/Insurance Institute for Highway Safety (2017) *Effects of Lane-Departure Warning on Police Reported Crash Rates*. Available at: http://bit.ly/2irKhwa, last accessed: 14/09/17
[10] Society of Automotive Engineers (2014) *SAE standard J3016: Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems*. Available at: http://bit.ly/2nqxjO1, last accessed 18/06/17.

3.8 For cities like MK, the increase in autonomy may mean less need for allocation of private and public parking and more requirement for taxi drop-off space. However, as the next section of this paper reveals, there are also likely to be significant implications for traffic flow and highway capacity - both through the steady transition to autonomy (on which MKC is involved in European research to explore highway design implications for the beneficial coexistence of CAV and non-CAV vehicles) and the unlocking of suppressed travel demand among groups that are currently unable to travel independently by car.

Cleaner and more efficient propulsion systems

3.9 Whilst increasing autonomy and digital connectivity offers huge impacts in almost all fields of human business and leisure in coming decades, urgent work is needed to reduce the effects of transportation upon the environment. Carbon emitted by internal combustion engines is contributing to climate change, and particulate emissions are proven to contribute to tens of thousands of premature deaths in the UK annually[11].

3.10 Efforts to tackle this issue have centred on electric vehicles (EVs). In recent years development of affordable plug-in cars by manufacturers such as Renault, Nissan and Tesla have resulted in growing interest amongst the general public; meanwhile electric buses have been successfully introduced in several UK cities – including using a wireless induction charging scheme in MK[12] [13]. Vehicles with electric propulsion systems at present represent a small share of the UK market, in part due to range anxiety[14], but as battery technology is expected to continue improving the relative simplicity and reduced running and maintenance cost of EVs is likely to make them attractive to more people[15].

3.11 For MK (already supporting an extensive charging network) this development is likely to mean greater requirement for customer-focused charging infrastructure to support use, and national consideration of issues associated with grid-level electricity generation and policy responses to lower taxation revenues associated with petrol and diesel fuelled vehicles. Other propulsion systems – like hydrogen powered vehicle technologies – remain in development and are being supported by the Department for Transport

[11] BBC News (2016) *UK air pollution linked to 40,000 early deaths a year.* Available at: http://bbc.in/21mdDs1, last accessed: 19/09/17.
[12] Go Ultra Low Nottingham (2016), *New electric buses power Nottingham's clean air ambitions.* Available at: http://bit.ly/2hhjyi9, last accessed: 20/09/17.
[13] CBI (2017) *Milton Keynes: Wirelessly charged electric buses*. Available at: http://bit.ly/2xmfJBu, last accessed: 20/09/17.
[14] WhatCar (2014) *The Nissan Leaf, a popular modern EV, has a full-charge range of approximately 100-120 miles*. Available at: http://bit.ly/2hg25KH, last accessed: 20/09/17.
[15] CNBC (2016) *Electric Vehicles will soon be cheaper because maintenance costs are lower, says Tony Seba*. Available at: http://cnb.cx/2jJHyPo, last accessed: 20/09/17.

(DfT)[16]. Technological breakthroughs in this field may further yield disruptive changes that improve mobility options for people and air quality in cities.

Demand responsive travel and mobility as a service

3.12 Digital technologies (in particular the internet[17] and rising smartphone penetration[18]) have altered and accelerated the responsiveness of mechanisms for researching, booking, paying for, and amending personal mobility requirements. Consequently, it is now easier than ever before for people to understand the range of options they have for travelling within and between cities. Digital tools like Citymapper and Google Maps have been able to capitalise on increasingly open data feeds from local and national sources[19] in order to virtually integrate disparate transport networks to improve users' awareness of the options they have.

3.13 Coupled with contactless payments and account-based ticketing approaches, these technological advances have prompted several major trends that appear set to re-shape the way people travel over the next decade. They include:

- **Shared, flexible mobility services** such as Uber/Uber Pool/Lyft/Gett and Santander Cycles becoming more deeply integrated into a wider range of urban transport network contexts and UK locations. London, as the largest potential urban user-base in the UK, has been the initial focus for these.
- **Mobility-as-a-Service (MaaS)**, which is the concept of offering people multiple mobility service options through a central 'app' or online portal, and using that to book and pay for the services they use on a flexible basis. Live trials are due to take place in the West Midlands starting in autumn 2017 based on the early market leader, MAAS Global's, technology platform and Whim app[20]. Options available through this trial will include local buses, Midland Metro (tram), taxis, car and bike hire; with national rail integration being provided by SilverRail's national rail simplification technology. Early discussions have been held with the system providers who are searching for a number of launch cities for promoting/using this system in 2018. Milton Keynes is considered a possible medium-sized location.

[16] Transport Network (2017) *New £23m Govt fund to accelerate hydrogen vehicle take up*. Available at: http://bit.ly/2neF8br, last accessed: 20/09/17.
[17] Grieco and Urry (2011) *Mobilities: New Perspectives on Transport and Society*. Available at: http://bit.ly/2xvsGcL, last accessed: 20/09/17.
[18] CBR online (2016) *Smartphone penetration now more than 80% in UK*. Available at: http://bit.ly/2d90nZY, last accessed: 20/09/17.
[19] Techworld (2014) *London's Citymapper capitalises on decade of data*. Available at: http://bit.ly/2xgdXjx, last accessed 20/09/17.
[20] KPMG (2017) *Reimagine Places: Mobility as a Service*. Available at: http://bit.ly/2iAk9iy, last accessed: 20/09/17.

- **Data-driven/demand responsive public transport services**, which are tailored to specific traveller needs - potentially blurring the lines between conventional bus and taxi services. Citymapper's highly publicised weekend night bus service in East London is one UK example of user data being mined to inform service provision[21].

3.14 Together these innovations are expected to support 'seamless, intermodal travel' and providing flexibility that reduces reliance of cities on private vehicles[22].

How will people react to change?

3.15 Aside from uncertainty over the timescales for technological readiness and commercial willingness for mobility service integration among hitherto competing providers, one of the biggest unknowns is how people will react to predicted innovative mobility futures. Examples like the Sinclair C5 (now being reborn as an urban mobility tool[23]) and the Segway are useful reminders that not every technological innovation is fully embraced by a 'mass market' that is made up of people whose behavioural habits, attitudes, and lifestyle requirements underpin collective demand for travel.

3.16 One interesting observation, from EV researcher and proponent Tony Seba, notes that in recent years new consumer technologies have tended to arrive earlier than projected[24]. As such it is entirely possible that the 'best estimates' of different mobility technologies' arrival points, as shown in Figure 3-1, could be less optimistic than we might believe. Some of these – autonomous technologies in particular – will also require significant changes to personal and public liability insurance, and legislative/taxation frameworks, that have developed over the past 70 years to support the prevailing human-controlled, internal combustion-powered approach to mobility.

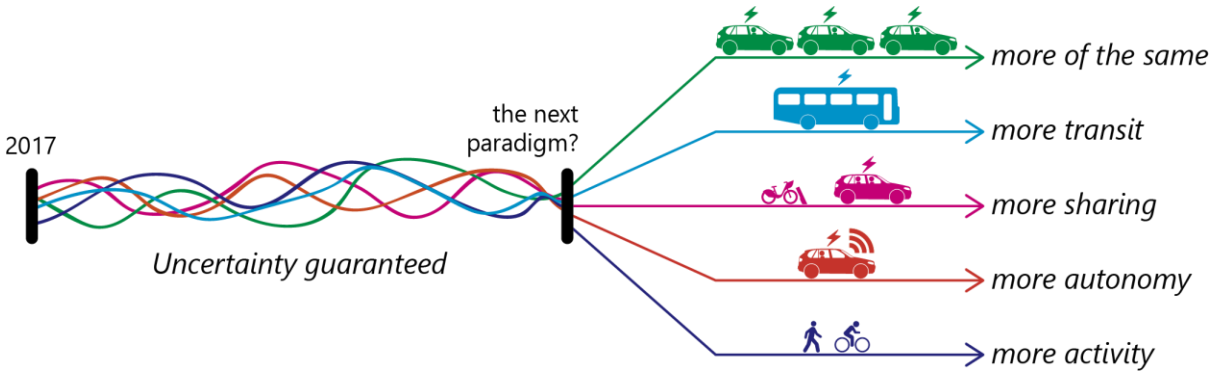
3.17 What most commentators do agree upon is that a true paradigm shift in the ways people travel, and the associated investment in new forms of mobility infrastructure - is likely to happen towards the middle of the 21st Century[25]. The following section examines ITP's take on the potential implications of such change for MK.

[21] Citymapper (2017) *CM2- Night Rider, our first ££ commercial bus route*. Available at: http://bit.ly/2gVgCL4, last accessed: 20/09/17.
[22] "The Rise of Mobility as a Service", Goodall/Deloitte, 2017.
[23] The Telegraph (2017) *The Sinclair C5 is reborn: 1980s electric tricycle gets 21st century update from inventor's nephew*. Available at: http://bit.ly/2l02tJc, last accessed: 20/09/17.
[24] Tony Seba (2017) *Clean Disruption of Energy and Transportation*. Available at: http://bit.ly/2wxZQZL, last accessed: 20/09/17.
[25] Rodrigue, Comtois and Slack (2017) *The Geography of Transport Systems*. Available at: https://people.hofstra.edu/geotrans/eng/ch2en/conc2en/ustrspgrowth.html, last accessed: 01/09/17

4. What are the implications for MK?

4.1 ITP's analysis of industry predictions for future mobility innovations suggests the only current guarantee is uncertainty. Depending on which smart mobility technologies and services shown in Figure 3-1 come to fruition, and when they become ubiquitous, a range of possible outcomes exist for how MK residents/workers/visitors are likely to choose to travel in the future.

Figure 4-1: Possible future mobility outcomes for MK



Potential impact on MK 2050 objectives

4.2 We first considered each of these five possible future implications individually, in the specific context of the MK 2050 themes around which MKC commissioned this and related strands of research in 2017.

4.3 Table 4-1 summarises our predictions and reveals that, although increasingly likely to be emission-free (at point of use), 'more of the same' does not sit comfortably alongside the transformative objectives for MK agreed as a result of the Milton Keynes Futures 2050 Commission's prior work. Continuing to pursue a car-centric approach to mobility is highly likely to limit the scope for MK's future growth; holding back its evolution as a great, pioneering city. There is a limited amount of developable land available in the existing MK urban area. The grid road network could be extended further, but doing so would limit scope for active travel and shared mobility services by extending origin-destination distances and intensifying traffic congestion on existing networks. Even so, we recognise that cars with internal combustion engines are likely to be around for some time, while a gradual evolution to cleaner alternatives takes place.

4.4 More transit and more sharing are highly compatible and could deliver broadly positive impacts in relation to the MK 2050 vision. They present scope to support economic

growth within existing/near-future boundaries of the city, while narrowing income inequalities for households without access to private cars and freeing-up space currently allocated to parking in and around CMK for other more productive land uses.

4.5 Even so, based on other current UK city trends the delivery of both 'more transit' and 'more sharing' outcomes are by no means certain to emerge readily in MK. More transit requires funding and leadership to reallocate roadspace for public transit priority, and investment in ticketing and data infrastructure to facilitate better integration between local bus and national rail services. Sharing could be challenging on the evidence of limited uptake to-date in car sharing and car club services in UK cities, relative to European comparators[26].

4.6 This in turn poses wider questions about social attitudes towards shared mobility services in general across the UK. Taking Uber and Lyft as examples; over 75% of their customer base is under the age of 45[27], and they appear motivated primarily by low pricing and ease of access and payment rather than any deep-rooted desire to share a mobility service.

4.7 The transport network and social impacts of ride hailing companies like these is also being scrutinised. Research focused on New York suggests they are responsible for 50,000 additional vehicles, carrying around 500,000 passengers per day and added 600 million driving miles in 2016 alone (more than the total Manhattan yellow cab mileage). This represents up to a 7% increase in driving miles in the most congested areas of New York (Manhattan, Brooklyn, Queens) worsening congestion and journey times, and leading to real-terms reductions in levels of metro and bus ridership[28] - reversing recent trends. These trends have been coupled with driver protests at the wages[29] and regulatory concern over the organisations corporate responsibility undertakings.

[26] Evening Standard (2016) *What's holding back London's car sharing services?* Available at: http://bit.ly/2w0WBFX, last accessed 01/09/17.
[27] Dogtiev,A (2017) *Uber revenue and usage statistics 2017.* Available at: http://bit.ly/2xpTyeb, last accessed 28/08/17.
[28] Schaller (2017) *Unsustainable? The growth of app-based ride services and traffic, travel and the future of New York city.* Available at: http://bit.ly/2gqeagc, last accessed: 17/10/17.
[29] Guardian (2016) *Uber drivers stage go-slow protest through central London.* Available at: http://bit.ly/2x9p7VC, last accessed 17/10/17.

Table 4-1: Summary of potential impacts for MK 2050 research themes

Theme	Potential impacts				
	More of the same	More transit	More sharing	More autonomy	More activity
Spatial growth	Low densities based around extended grid corridors	Higher-density corridors linked by more demand-responsive transit / rail services	Reduced parking requirement, scope to plan space in CMK differently	Transformational, if combined with other innovations/futures	Best supported by denser environments with shorter distances
Economic growth	Limited benefit from agglomeration	Attract/incubate/exploit public transport delivery innovators & new skills	Sharing economy could create new local capabilities	Autonomous vehicle tech / design / data / infra opportunities	Productivity gains from increased health of workforce
People & place	Sustainable? Urban dispersal limits scope for active travel and shared mobility	Supports more inclusive development and sustainable growth	Greater social interaction, lower travel costs, pay-as-you-go options	Space for cycling? Jobs? Favours more independent (auto) mobility	Public health & wellbeing, active places, better air quality/environment
Innovation culture	Swimming against the 'SMART' mobility tide, inhibits scope for revolution from car-dominated society	Demand-responsive services, coupled with deeper integration of existing travel options; low carbon benefits	Sharing economy opportunities related to smart mobility	Autonomy itself, Human Machine Interfaces, user research, testbed culture	Human performance measurement, smart bikeshare services, enhanced active + motorised integration
Innovative mobility	Modest optimisation, but sprawl means congestion is likely to worsen	More space-efficient growth with 'green' links to outlying settlement	Reduced car-dependence most likely in parallel with other 'futures'	Re-define roads, increase road utilisation, safety & in-trip productivity	Reinvigorate use of redways to mitigate potential risks from autonomous modes

4.8 Autonomy alone is unlikely to result in a dramatic transformation of the status quo in MK across most of the MK 2050 vision's themes. Its uptake could reduce the cost of local public transport services and taxis. However, the DfT's early work to model the impacts of Connected and Autonomous Vehicles (CAV) indicates the potential that they will result in a reduction in network performance due to the greater caution these vehicles are expected to demonstrate, and that substantial benefits are unlikely until higher levels of CAV penetration are achieved[30]. These results are in line with early results from the Autodrive study[5], the interim findings from which also suggest that additional capacity will only be realised if self-driving vehicles can operate in 'assertive' mode. The House of Lords Science and Technology Select Committee echoed these concerns[31], noting that

> *"it is possible to imagine a situation of total gridlock as CAV crawl around city centres. It is important that the right policy decisions relating to CAV are made in order to reduce the likelihood of this occurring"*
>
> House of Lords Science and Technology Select Committee, 2nd Report of Session 2016-17

4.9 Achieving 'more activity' is a current high-priority mobility policy ambition for the whole of the UK – as articulated in DfT's national Cycling and Walking Investment Strategy[32]. In MK the delivery challenges are the existing, car-dominated, urban form and the dispersed nature of origins and destinations inherently associated with the city's iconic grid road pattern and low-density environment. Widespread cycling uptake could yield local public health, congestion-reduction, air quality and productivity benefits[33].

Strategic and spatial implications

4.10 In considering these potential impacts we recognise they are not mutually exclusive. In reality, we anticipate the five 'futures' are all likely to occur:

- to varying degrees
- at different times
- in different combinations
- … between now and 2050

[30] DfT (2016) *Research on the Impacts of Connected and Autonomous Vehicles (CAVs) on Traffic Flow.* Available at: http://bit.ly/2jbA6Hz, last accessed: 13/09/17.
[31] House of Lords Science and Technology Committee (2017) *Connected and Autonomous Vehicles: The Future?* Available at: http://bit.ly/2f1aBbK, last accessed: 01/08/17.
[32] DfT (2017) *Cycling & Walking Investment Strategy.* Available at: http://bit.ly/2qAw9zJ, last accessed 26/07/17.
[33] Public Health England (2016) *Working Together to Promote Active Travel: A briefing for local authorities.* Available at: http://bit.ly/29tuTY8, last accessed: 01/08/17.

4.11 Given the uncertainty documented earlier in this paper, MKC can make a local case for seeking to influence innovative future mobility options, and associated patterns of urban development, based on an understanding of potential impacts that best match the city's emerging vision for sustainable growth to 2050. The insights set out in this paper provide a basis on which to determine an innovative mobility roadmap that offers MKC the flexibility to respond to different future developments, while avoiding accidentally closing-off desirable future policy outcomes through near-term actions.

4.12 Questions over MK's future urban form and spatial growth also inform any innovative mobility roadmap. We worked with David Lock Associates (DLA) to consider the future mobility implications of three distinct spatial growth options they proposed through a related workstrand[34]. Summarised in Table 4-2, each one supports different combinations of the future mobility outcomes set out in Figure 4-1, and could themselves be delivered in parallel to facilitate significant growth of Milton Keynes and its economy.

Table 4-2: MK spatial options related to innovative mobility outcomes

Spatial option	Relationship to mobility outcomes
Grow the grid	'More of the same' mobility impacts in areas close to CMK, with some regeneration and infill development potentially supporting modest extra transit and physical activity journeys.
Rail-based transit oriented development	'More transit' and 'more activity' supported by targeting more intense development at existing rail stations, notably those receiving East-West rail investment. Scope for 'more sharing' and 'more autonomy' to help deliver seamlessly integrated first and last mile links in the longer-term.
New transit communities	'More transit and 'more activity' supported through prioritised routes to new settlements outside Milton Keynes' existing urban area. Mixed-use development patterns would support localised trips and maximise scope for walking and cycling. Shared autonomous vehicle services may replace bus/other rapid transit options as the primary mode of travel into MK.

[34] David Lock Associates (2017) *MK 2050 Evidence Paper: Directions and Scale of Growth*

5. Assumptions, enablers and pitfalls

5.1 Before drawing the salient insights from this paper together into an innovative mobility roadmap for MK 2050, it was necessary to document some standing assumptions we made about future mobility. We also reflected on which factors MKC might reasonably be able to influence over the next 30 years, and which near-term policy pathways could inadvertently close down desirable future options or outcomes.

Innovative mobility assumptions

5.2 In preparing the innovative mobility roadmap to 2050 we made a small number of key assumptions about the development of technologies and related policy issues that sit beyond MKC's direct influence. These are listed below and are considered to represent highly likely trends that happen irrespective of whether MKC takes a transformational near-term approach to setting mobility and spatial policies intended to shape the city's long-term sustainable growth trajectory:

- Ultra-low emission vehicle technologies become ubiquitous and cost-effectively available for most people in the UK, as part of a gradual transition away from petrol and diesel fuelled propulsion. Based on current technology trends, this is considered most likely to take the form of electric vehicles for land-based mobility. This transition will not address the external traffic congestion or inclusive mobility costs that are commonly associated with car-dominated urban environments.
- Grid corridors remain core to central MK urban form. This does not prevent the roads and verges, as currently present, from being re-imagined, but assumes the grid network laid down in the original MK masterplan remains part of the city's DNA.
- MKC continues to be a willing innovator and collaborator for trials of increasingly smart and intelligent proof-of-concept mobility services. This may strain public sector budgets and public opinion if specific investments (e.g. roadspace reallocation) are required or experimental services are perceived as unsuccessful. A willingness to act differently, and be perceived as a unique test-bed, is identified as a key element of the city's culture and development over the last 50 years.
- Legislative, liability and enforcement challenges associated with innovative mobility options that are currently in the early stages of testing and prototyping (e.g. autonomous vehicles and drones) are all surmountable within a 2050 timeframe. MKC may have a role to play, in influencing and lobbying government to accelerate change, but even without this activity external influences will ensure these changes are implemented across the UK.

5.3 All other aspects have been considered as possible measures for MKC to pursue as innovative mobility roadmap actions, which are described in section 6 of this paper.

Factors that MKC can influence

5.4 MKC owns, shares or influences a number of proactive local, sub-regional and national policy mechanisms that could be triggered to help deliver the city's innovative mobility roadmap. Other factors, such as the pace of development of fully autonomous vehicle technologies, are global trends that MKC will be reactive to over the next 30 years.

5.5 Table 5-1 links future mobility success factors that MKC could influence with one of the three spatial options, identified through DLA's work, to which they are *most closely* related. These are not mutually exclusive, so the innovative mobility options compatible with continued growth of MK's grid system could also be implemented to support the delivery of rail-based transit oriented development and new transit communities.

Table 5-1: Factors MKC can influence to deliver future spatial options

Spatial option	MKC owns	MKC shares	MKC influences
Grow the grid	• Highway / redway route planning • Definition of 'active places' • Real-time transport data • Spatial plan and public/workplace parking policy	• AV pod trials and EV charge network • Active travel promotion • Smart parking system • Transit network / hub development	• Developer contributions • EV charge/cycle parking in new developments • Car Club/AV take-up locally • Integrated journey planning/ticketing
Rail-based transit oriented development (TOD)	• Allocation of land near rail stations for more intensive land-use and interchanges • Define & prioritise TOD corridors through selective densification in urban area	• Real-time info to support seamless local interchange • Station investment funds and planning • Sustainable first / last mile options	• Rail + shared mobility R&D (e.g. MAAS) • Rail service frequency • Integration between rail and existing local public transport modes

Spatial option	MKC owns	MKC shares	MKC influences
New transit communities	• Allocation of land in spatial plan for new communities • Ambitious funding approaches (e.g. Workplace Parking Levy) • Local Cycling and Walking Infra Plan	• Income generation through new land-uses and under-utilised MKC parking resources • Sharing economy benefits and new mobility options	• Demand-responsive transit trials • Smart freight and logistic networks • Autonomous vehicle testing

Potential pitfalls

5.6 We identified a small number of near-term interventions and actions that may adversely impact successful long-term stimulation of innovative mobility services in MK:

- **Parking policy and strategy:** Continuing to provide a large quantity of low-cost parking spaces in CMK will do little to discourage unconstrained car use in the near-term future. It serves to undermine efforts to promote walking, cycling and public transport alternatives to car use.
- **Approach to utilising MKC land assets:** MKC's land assets within the urban area and how they are preserved or allocated for near-term development, could inhibit MK's innovative mobility potential. The road verges and vacant areas within the existing grid network offer scope for higher levels of development density at key locations (not everywhere). These will be required to support a limited number of transit oriented development corridors, both within the existing urban area and for linking to local rail stations and new transit communities. Development at lower densities could constrain scope for such mobility options in the future.
- **Design of new developments:** Planning ahead for anticipated uptake of smart, shared, sustainability mobility may require new developments to incorporate designated pick-up and drop-off areas, rather than high levels of car parking (the current norm). The anticipated introduction of Uber and other ride-hailing services could quicken demand for this kind of design in the near-term, potentially releasing a proportion of existing land allocated to car parking for mixed-use developments.
- **Autonomous vehicles:** Pursuing a highly autonomous future may now feel like an innovative approach to delivering mobility for all, but has uncertain consequences and impacts for urban environments. Delivering affordable autonomous on and off-street mobility services could significantly improve safety and increase access to opportunities for older and younger people, and non-drivers in MK. However, this

could also have a detrimental impact on any efforts to encourage widespread uptake in active travel modes and the significant associated positive health and environmental benefits. We anticipate that complementary, sustained efforts will be required to promote active travel modes and design healthier neighbourhoods.

- **Timing of major national infrastructure project delivery, and their integration with MK:** Both East-West Rail and the Oxford-Cambridge Expressway are proposed to pass close to MK. While they offer considerable scope to catalyse growth in MK and its surrounding area, the timing of their delivery and measures to link the city with these infrastructure projects are currently uncertain. This complicates local planning and policymaking, since it is unclear how MK's local roads and rail networks may accommodate expected increases in traffic levels and patronage to 2050.
- **Local public attitudes and leadership:** For many people Milton Keynes currently provides an ideal balance of easy access by car, low cost parking, and dispersed low-density living. Communicating the need for alternative policy pathways now so as to pursue a 30-year vision for innovative mobility and avoid negative economic, social and environmental outcomes will be challenging for MKC decision-makers.

6. MK innovative mobility roadmap

6.1 Drawing together the findings and observations from this paper, ITP has prepared an innovative mobility roadmap for MK. This charts a potential pathway for MKC, local innovators and private sector partners in respect of accelerating the delivery and uptake of smart, shared, sustainable mobility options that relate directly to the key themes and objectives defined in *Making a Great City Greater*.

6.2 Alongside the uncertainties and anticipated mobility innovations set out earlier in this paper, the roadmap takes into account the views and opinions of Council Officers, Members, and Consultants researching MKC's delivery of the other MK Futures 2050 Big Projects. These were captured through a series of workshops convened by MKC Officers during the course of our work.

6.3 In preparing the roadmap set out in Table 6-1 we have used three distinct timeframes as the basis for differentiating between actions, impacts and anticipated outcomes. These are explained below, and have been specifically chosen so as to align with the emerging Mobility Strategy that will underpin the next Local Plan for Milton Keynes. The timescales recognise that MKC also requires a high-level action plan for the near-term that is shaped by the impacts and outcomes in later years of the period to 2050:

- **Near term (by 2024):** These are predominantly actions that MKC and its delivery partners can take soon with a view to unlocking additional actions in the medium-term and interim impacts, as well as longer-term innovative mobility outcomes. They have been devised by 'back-casting' from the 2050 vision for smart, shared, sustainable mobility and identifying what can be done now to facilitate it.
- **Medium term (by 2031):** A combination of follow-up actions (some of which are enabled by near-term activities) and intermediate impacts that may be activated as a result of earlier work. The timeframe coincides with the next Local Plan period.
- **Longer-term (by 2050):** Beyond the current Local Plan period it is very difficult to define specific actions, on the basis that it will be 15 years from the time of preparing the roadmap. As such we have chiefly documented the longer-term innovative mobility outcomes that we envisage could be achieved as a result of the earlier actions.

6.4 In line with our earlier caution regarding future predictions, the roadmap reflects a 'best-estimate' of what could feasibly happen to MK in the future if early action is taken by MKC to influence the city's innovative mobility trajectory.

Table 6-1: MK 2050 innovative mobility roadmap

Related themes	Near-term (by 2024)	Medium term (by 2031)	Longer term (by 2050)
Spatial growth and expansion	**Action:** Deliver a new mobility strategy which appreciates the contribution that shared, smart sustainable mobility can make to support the MK 2050 vision. **Action**: Plan for future MK grid expansion and regeneration for mixed-uses in tandem with prioritised, at-grade transit and cycle routes. **Action**: Develop concept of transit orientated development that supports a fit-for-purpose MK mass transit option as it develops through the nationally important Cam-MK–Ox corridor. **Action**: Plan for some spatial expansion of MK urban area along a high frequency transit priority corridor(s) that links existing trip generators, MKC and Bletchley rail/coach stations, and CMK with new and existing residential areas. **Action**: Use planned transit priority corridor(s) as the basis for establishing dedicated on-street cycle routes that augment the redways and MK bikeshare service.	**Impact:** Increase in public transit use among local population and reduced car dependency, supporting further corridor-based growth and investment. **Action**: Extend established transit-oriented corridor(s) to serve spatial expansion of MK to outlying 'new transit communities' that are proximate to E-W Rail stations and Ox-Cam Expressway junctions. **Action**: Explore scope for extension of mass rapid transit (e.g. Micro Metro/Bus Rapid Transit) investment to complement and unlock new growth.	**Outcome**: Spatial growth of MK achieved along active travel and transit-oriented, rather than car-based, corridor(s). **Outcome**: MK population growth to 400,000 people achieved within a better-connected developable area with lower land requirement per capita. **Outcome**: Higher levels of inward investment are attracted to MK as it becomes an even better-connected place for people to live and work.

Related themes	Near-term (by 2024)	Medium term (by 2031)	Longer term (by 2050)
Renaissance: CMK	**Action**: Support MK:U through co-location of student accommodation and night-time economy – ensuring good sustainable transport links to CMK rail station and thecentre:MK. **Action**: Link MK:U delivery to innovative R&D on autonomous mobility, smart & connected cities, and sharing economies. **Action**: Ensure Renaissance: CMK areas benefit from enhanced inclusive connectivity by linking these re-imagined places with new mass transit services and priority cycle routes. **Action**: Combine work on mass transit and intelligent mobility themes with social research to understand the needs of low-income communities. Ensure the findings are fed-in to the design of smart, shared sustainable mobility services that serve the Renaissance:CMK areas.	**Impact**: Increase in transit use and active travel among local population through new student population in MK and a wider range of travel choices in Renaissance:CMK areas. **Impact:** Greater social inclusion, public health, and access to opportunity afforded to Renaissance:CMK locations through non-car dominated redevelopment. **Impact:** Scope for selective densification along mass transit corridors to demonstrate the concept within MK environment and to prime spatial growth and expansion in new transit communities. **Action**: Actively pursue spin-off ventures / local smart, shared, sustainable mobility services derived from MK:U learning. **Action**: Incentivise retention of post-MK:U study knowledge in local jobs.	**Outcome**: Economic growth of MK around next 'mobility paradigm' services and technologies. **Outcome**: Successful attraction and retention of younger demographics interested in lifelong learning – reflecting the pioneering spirit of MK's initial residents 50 years ago. **Outcome**: Successful regeneration of the oldest areas of CMK, updating the city's pioneering urban design and masterplanning principles.

Related themes	Near-term (by 2024)	Medium term (by 2031)	Longer term (by 2050)
Mobility innovation and technology	**Action**: Install a network of smart sensors covering MKC roads and parking assets to build a real-time open dataset of traffic flows and parking demand. **Action**: Collaborate with local transit and bikeshare operators to establish a shared, open transport data network for deeper understanding of local patterns of human movement across all travel modes. **Action**: Invest in/encourage tailpipe emission-free modes of travel (e.g. EVs) and associated charging infrastructure. **Action**: Collaborate with private sector specialists and government innovation bodies to position MK as the go-to UK location for on and off-street testing, and 'here-first' sustained implementation of CAV technologies. **Action**: Work to attract/develop an integrated journey planning tool as the foundation for local mobility service aggregation (e.g. Citymapper / Whim). **Action**: Work with local transit/bikeshare operators to establish a smart, integrated ticketing and car park payment system.	**Impact**: Rich local mobility datasets are freely shared, combined and exploited to optimise: mobility service delivery and traffic management, personal mobility planning and strategic spatial planning. **Impact**: Significant decarbonisation of local transport networks resulting from rapid exploitation of next-gen propulsion. **Impact**: A permissively-managed MaaS offer is available to MK residents and visitors allowing for integrated journey planning and payment across all modes operated by multiple providers. **Action**: Re-purpose parking spaces in MKC and residential areas as, and when, they become unnecessary based on emerging CAV technologies. **Action**: Apply market-leading status to influence central government thinking on mobility-related taxation, insurance and liability policies beyond the existing private car ownership mobility paradigm. **Action**: Participate in R&D of dynamic mobility service management and routing.	**Outcome**: One, or more, Smart, Shared, Sustainable mobility providers are established in MK to operate within a regulated MaaS market overseen by MKC on behalf of the MK City Region. **Outcome**: Mobility service innovations and technological developments emerge and are adopted as quickly in MK as they are in major world cities. **Outcome**: MK's innovative mobility services have contributed to an evolved 'new town' urban form that has accommodated significant population and economic growth while improving social, public health, and cultural outcomes for residents and visitors to the city.

7. Next steps

7.1 Through ITP's follow-up work to the Milton Keynes Futures 2050 Commission report on *Making a Great City Greater*, the disruptive potential of innovative future mobility services has been recognised as one of the most potentially transformational, but equally uncertain, components of successfully delivering MK's 2050 vision.

7.2 This paper has served to deepen MKC's understanding of the key challenges and uncertainties, and sets out a practically-focused roadmap for steering the city towards its aspiration of accelerating local delivery of **Smart, Shared, Sustainable Mobility**. We found that MK does not need to completely change and 'become like everywhere else' in order to accommodate future mobility possibilities. Its unique urban form (in a UK context) and the flexibility of the city's grid system are significant assets that can be redeployed, as and when required, to support the expected mobility paradigm shift.

7.3 Even so, selective densification at key locations along defined connectivity corridors in the near-term - serving existing and future growth poles, regeneration sites, and national transport network nodes – is expected to accelerate the potential for sustainable growth in MK. In this context our identified near-term actions are considered as key steps towards maintaining MK's vibrant economic and demographic growth. If achieved, they should help MKC succeed in establishing the conditions required for delivering a less car-dominated place in which opportunities for social inclusion, equal access to opportunity, active travel, and more efficient movement of people and goods, are maximised.

7.4 In delivering the roadmap, it will be important that MKC recognises the essential need to continue developing and strengthening partnerships with local and national public transport operators, data owners, neighbouring local authorities, and mobility service innovators. Continuing to scan the horizon for developments in the fields of Connected and Autonomous Vehicles, data driven mobility systems, and sharing economy trends should help to ensure that MKC's vision remains practically-focused and achievable.

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