An Roinn Iompair
Department of Transport

Project Ireland 2040

National Investment Framework for Transport in Ireland

Background Paper 5: Technology

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Disclaimer

This Background Paper has been prepared as part of the supporting analysis for the National Investment Framework for Transport in Ireland. It reflects the latest data and information available to the author at the time of writing. The views presented in this paper do not represent the official views of the Department of Transport or the Minister for Transport.

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Summary

- The exact forms and extent of technological change that will occur in the period leading up to 2040 is uncertain.
- The pace of deployment of new technology will be influenced by legal and regulatory factors, as well as by innovation in the development of technology.
- Developments in shared mobility and autonomous vehicles can potentially deliver large beneficial impacts, particularly in urban areas and on highways respectively.
- Existing infrastructure will need to be retrofitted with the necessary technology to enable the full functionality of connected and autonomous vehicles.
- Land use and infrastructural planning should take a forward-looking but open-minded approach to prospective technological developments.

1. Introduction

As part of the National Investment Framework for Transport in Ireland (NIFTI), five major themes with the potential to substantially alter how and where transport takes place have been identified. These are:

1. The National Planning Framework;
2. Economic and Fiscal Context;
3. Climate Change;
4. Brexit; and,
5. Technology.

This paper considers the fifth and final theme, technology. Technological and organisational developments have the potential to transform the transportation of people and goods. The impacts of such developments must be considered as part of any strategic framework for investment and planning for Ireland's land transport network. The aim of this paper is to consider these possible developments in the context of Ireland's land transport network and its evolution up to the year 2040. The paper will firstly look at the potential impacts on land passenger transport of the provision of mobility as a service, before examining the prospects for autonomous vehicles in passenger transport, and finally consider developments in freight transport.

2. Mobility as a Service and Shared Mobility

The current model of private transport involving motor vehicles privately owned and driven by individuals is being challenged by technological developments. The introduction of several innovations in the provision of transport as a service, including app-enabled on-demand transport services, car- and bicycle-sharing, and ride-sharing platforms, have already made an impact on transport systems and promise to grow in importance as the enabling technology advances.

The provision of mobility as a service (MaaS) could have a sizeable effect on both public and private transport, particularly in urban areas. While traditional public transport provision with fixed routes and timetables could easily be maintained on high-capacity and high-frequency routes (ITF 2016), future urban public transport networks could consist largely of on-demand transport based on mobile app technology and a fleet of shared taxi-type vehicles, facilitating complete journeys and also acting as feeder services in conjunction with conventional public transport, particularly when operating in wider metropolitan areas (ITF 2017a).

Both the size of the total car fleet and the percentage of the fleet which is privately owned and driven could reduce drastically as people use MaaS as a main mode of transportation. This development would have a particular impact in built-up areas. As well as reducing congestion and emissions, the need for car-parking spaces in residential developments and both on- and off-street parking in urban centres would be substantially reduced, with shared vehicles remaining in motion for longer and requiring dynamic access to passenger pick-up points rather than parking spaces (ITF 2018). This evolution in the use of road space, while freeing up urban land space for other uses, may also require new traffic and demand management policies, e.g., limits on single-person use of shared vehicles or on urban access for private car drivers.

Tying these developments back to the Project Ireland 2040 National Policy Objectives (Government of Ireland, 2018), MaaS has the potential to assist with managing population growth (Objectives 2a, 3a/b/c) and making stronger urban places (Objectives 11, 13, 64, 68).

The *National Policy Framework on Alternative Fuels Infrastructure for Transport* plans for the majority of Ireland's future electric vehicle (EV) charging capacity to be provided by private charge points located at the residences of vehicle owners, given that Irish motorists currently have an unusually high level of access to driveways and private car parking spaces by international standards. In this context, future EV refuelling infrastructure policy should bear in mind the possible reduction in private vehicle ownership and private car parking space brought about by use of MaaS, and the potential requirement for charging points in the public space or at shared vehicle depots to cater for electricity demand.

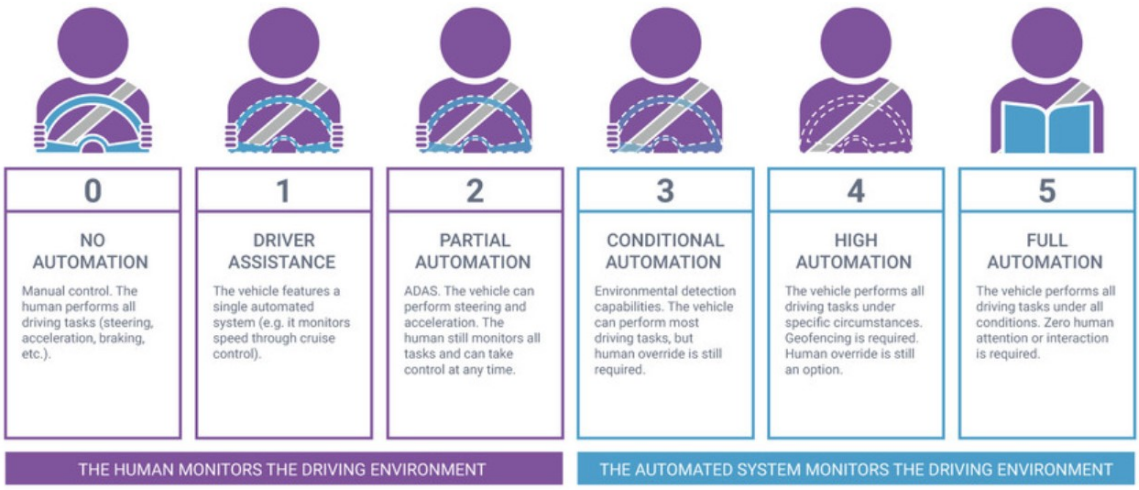
MaaS would also have impacts for travel outside built-up areas. Citizens living in urban and metropolitan areas will still need to travel outside their immediate surroundings (to other cities, towns and rural areas) for some portion of their journeys. If private car ownership falls as a result of MaaS innovation, demand for interurban and/or urban-rural public transport and MaaS services may see a corresponding increase to facilitate journeys which would previously have been undertaken by private car. The dynamic interaction between the spatial distribution of settlement patterns, private car ownership and transport service provision should be borne in mind by transport and land-use planners.

While the future evolution of shared mobility services is uncertain, transport and land use planning should remain alert to potential changes and be ready to take decisions on interventions to facilitate developments as appropriate. The physical and regulatory context will fundamentally determine how and at what speed a transition to greater use of shared mobility services unfolds, and the efficiency and accessibility benefits of these services are potentially transformative.

3. Connected and Autonomous Vehicles

Autonomous driving capability in passenger vehicles has been developing notably in recent years, and continues to evolve. A basic taxonomy of levels of automated driving in passenger vehicles has been developed by the Society of Automotive Engineers International (SAEI Standard J3016) which runs from Level 0 (cars with no automated driving functions) to Level 5 (cars with full automation of the dynamic driving task and the absence of pedals, steering wheel, etc.)[1]. Figure 3.1 provides a summary of the different levels of automation. Automated driving technology in passenger cars currently available on the market has not gone beyond Level 2 (Tomita 2017), although automotive manufacturers and public sector initiatives are competing to produce cars equipped to Levels 3 and 4 and eventually reach fully connected and autonomous vehicles (CAVs). Some forecasts suggest that 75% of traffic will be autonomous vehicles by 2040 (O'Keeffe & McCarthy, 2017). The level of technological advancement will not be the only factor determining how soon CAVs become commonplace on public roads, however; the legal, regulatory and broader policy environment must also adapt to account for and facilitate this change.

Figure 3.1: Level of Driving Automation



Source: synopsys.com

The impacts of CAV technology have the potential to be profound. Reductions in accidents and congestion as a result of autonomous driving will potentially yield large economic benefits as road capacity is used more efficiently, transport costs (in both money and time) are reduced, and productivity increases. An increase in vehicle kilometres travelled in CAVs by the elderly and mobility-impaired is a distinct possibility, particularly in rural areas with low public transport coverage. Developments in CAV technology such as those outlined could have an enabling role for National Policy Objectives (Government of Ireland, 2018) on making stronger urban places (Objectives 5, 6) and supporting people, homes and communities (Objectives 28, 30).

A persistent link emerges in the literature between MaaS and CAV developments. Gelauff (2016) outlines four possible scenarios based on a two-dimensional matrix of automation and sharing. Uncertainty remains, however, regarding the exact forms that the technology may take, the business models and market structures that may arise

[1] For a full table explaining the SAEI Standard levels, see Smith (2017).

for firms providing shared mobility services using CAV technology, and the type and scale of government intervention that may or may not be required to ensure beneficial outcomes for society.

Interaction from vehicle-to-vehicle (v2v), vehicle-to-cloud (v2c) and vehicle-to-infrastructure (v2i) is likely to be a key development of CAV technology in the near future. Infrastructural investment should aim to facilitate this interaction of Intelligent Transport Systems (ITS) between vehicles and their environment, both immediate and at the aggregate network level. As well as ensuring that new investments incorporate the emerging technological developments in their design, existing infrastructure will need to be retrofitted to enable the full functionality of CAVs along those routes. The following changes may be required to the road network in order to accommodate CAVs (O'Keeffe & McCarthy, 2017):

- Creation or use of smaller new roads for CAV usage as vehicles move closer together and required passing distances change;
- Integrated charge points across the road network;
- Redesign of physical elements such as crash barriers; and,
- Dedicated CAV lanes on interurban roads.

Given the level of uncertainty that still prevails over the rate of technological advance between now and 2040, a strategic approach to transport infrastructure demands both awareness of potential technological requirements and flexibility in planning for these developments. An example of this kind of approach would be the incorporation into the design of roadways of space for roadside beacons/cables for transmission of signals/information, without committing hastily to a particular form of technology which may become obsolete. Building potential technological capability into new infrastructure while remaining agnostic as to the ultimate form of that technology is not straightforward but should be made easier over time as technological advances crystallise and the corresponding requirements become clearer.

Level 5 technology would require a high degree of interaction with and accommodation from the immediate environment, particularly in urban areas with multi-modal traffic and complex traffic patterns (Gelauff 2016), but widespread use of this level of CAV technology is not currently expected before 2040. In the medium-term, ITS technology is more likely to be required where traffic patterns are relatively simple, specifically on highways, where Level 2/3/4 cars are able to operate automatically, and in transition zones between highways and urban environments, where the limits of the CAV technology are likely to require a human to regain control of the driving process.

4. Freight Transport

CAV technology is also anticipated to have an impact in the domain of road freight transport. Driverless technology is already successfully operational in trucks driving in controlled environments such as mines (ITF 2017c), and trials are being conducted on public roads in several regions, including the European Union and the United States. The need for human drivers of road freight vehicles could be markedly reduced—the International Transport Forum estimates that, with swift take-up of the technology, between 53% and 69% of projected demand for professional haulage drivers in Europe and the US in 2030 could be filled by driverless technology (ibid.).

The international compatibility of land transport technology and systems is of clear importance for freight transport. As a geographically peripheral and economically open state, Ireland's competitiveness would be at risk were our land transport network to move out of sync with those of our export and import markets, as coordinating freight movements between Ireland and those destinations would become more costly for road freight operators, both Irish and non-Irish. To avoid this, land transport planning must be informed by the development and implementation of new vehicle, network and communications technologies, and common operating standards and protocols across trading partner countries (e.g., the EU), particularly in light of the National Policy Objectives (Government of Ireland, 2018) on Ireland's main ports (Objective 40) and working with our neighbours (Objectives 43-46, 51). As with passenger transport, efforts to prepare road infrastructure for freight-enabling ITS should focus on routes where freight traffic travels most frequently, i.e., the main strategic routes offering connectivity between Ireland's main centres of population and commerce, and to international markets.

5. Conclusions

The impacts of technological developments on land transport in the period to 2040 are likely to be mostly beneficial, particularly in potentially bringing about more efficient use of road space, lower emissions and greater road safety. Shared mobility is likely to require fewer parking spaces for private cars, and may require changes to demand and traffic management policies in concentrated urban areas. Investment in technology to facilitate the use of connected autonomous vehicles should focus primarily on the routes where CAVs will see most use, likely to be highways and their link roads. Where these routes are not newly built, further public investment to retrofit the necessary technological infrastructure along the route will be required.

Less built-up areas may also be affected through the use of autonomous vehicles and greater use of public transport as a result of reduced private car ownership, which could in turn affect the optimal distribution between publicly and privately owned and situated refuelling sites for electric vehicles. Ensuring the viability of main trading routes and compatibility with international markets are key goals for road freight-related infrastructure policy.

Across all areas of future technological change, the approach of planning must be forward-looking but open-minded, to ensure both the interventions necessary to facilitate beneficial developments, and the avoidance of costly errors through premature commitment to regulatory or physical infrastructure which ultimately becomes inefficient or obsolete.

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