The transport congestion challenge
getting the most out of the UK’s road and rail networks

November 2015
The Royal Academy of Engineering has published this ‘challenge paper’ to highlight a topic of policy interest on which the Academy has not formed a formal policy position. Challenge papers, which are authored by Fellows of the Academy, aim to provide informed analysis of an important issue, with the objective of promoting further discussion with policymakers and the public about the opportunities and challenges for the future.
CONTENTS

Foreword ........................................................................................................................................................................... 3
Executive summary ..........................................................................................................................................................4

1. Introduction .................................................................................................................................................................. 6
  1.1 Focus and structure of the paper .......................................................................................................................... 8
  1.2 Defining the congestion problem ........................................................................................................................ 8
  1.3 Current policy measures ........................................................................................................................................ 9
  1.4 Presenting the critical sectors for congestion reduction ..................................................................................... 9
    1.4.1 Inter-urban and urban road passenger transport ......................................................................................... 9
    1.4.2 Inter-urban and urban rail passenger transport ......................................................................................... 10
    1.4.3 Inter-urban and urban freight transport ................................................................................................. 10
  1.5 An overview of the strategies and technologies that could reduce congestion .............................................. 10

2. The range of solutions that could reduce congestion in the period to 2030 ...................................................... 12
  2.1 Methodology and structure of the paper ............................................................................................................ 14

3. Congestion reduction measures .............................................................................................................................. 16
  3.1 Reducing congestion in the inter-urban and urban road market ......................................................................... 18
    3.1.1 Efficient pricing ............................................................................................................................................ 18
    3.1.2 Reform of bus services ............................................................................................................................... 19
    3.1.3 Parking control and enforcement ............................................................................................................... 20
    3.1.4 Car clubs ..................................................................................................................................................... 21
    3.1.5 Smart Motorways ........................................................................................................................................ 21
    3.1.6 The Connected Car ...................................................................................................................................... 22
    3.1.7 Bus rapid transit (BRT) ............................................................................................................................ 22
    3.1.8 Light rail and trams .................................................................................................................................... 23
  3.2 Reducing crowding in the urban and inter-urban rail market ............................................................................ 24
    3.2.1 Rolling stock reform ..................................................................................................................................... 24
    3.2.2 Driver advisory systems ............................................................................................................................. 24
    3.2.3 Control, command and communication (CCC) systems ........................................................................... 25
  3.3 Reducing congestion in the inter-urban and urban freight markets ................................................................. 25
    3.3.1 Home delivery and ‘last mile’ solutions ....................................................................................................... 26
    3.3.2 Retiming deliveries ...................................................................................................................................... 27
    3.3.3 Improved logistics systems: urban consolidation centres (UCCs) ............................................................ 27
    3.3.4 Horizontal collaboration between operators .............................................................................................. 27
    3.3.5 Higher capacity urban delivery vehicles .................................................................................................. 28
    3.3.6 Higher capacity vehicles: long-haul operations ....................................................................................... 28
    3.3.7 Restructuring of logistics networks ........................................................................................................... 29

4. The potential contribution of a package of measures by sector ........................................................................... 30

Acknowledgements ....................................................................................................................................................... 33

Appendix 1. Other measures considered as part of the study ................................................................................. 34
Appendix 2. References and endnotes ..................................................................................................................... 35
Our transport networks bring life to our country. They connect businesses together, join people with jobs, deliver all the goods those people and businesses need and enable all the myriad other journeys that people choose to make. Congestion is what happens when is there is an imbalance between demand and capacity.

Through the last three centuries the transport network has kept pace with, indeed made possible, the country’s growth with the creation of, successively, the waterway, rail, then road and air networks on which we depend. We now see a drive by government to create new transport infrastructure to meet the needs of this century with investment in both modernising and developing completely new roads, conventional and high speed rail, and urban passenger train lines.

Welcome as the major schemes such as Crossrail, HS2, city light rail and trunk roads are in creating essential long-term new capacity, they are huge undertakings that will take many years to realise and challenge our available resources, particularly finance and skills. We simply cannot rely on new-build alone to provide the whole answer, especially in our major cities.

This is a major challenge for the UK that this paper seeks to examine, by considering the transport networks we already have and assessing the technical practicality of ways of getting more out of them, either to buy time before new infrastructure can be delivered or as the most effective means of achieving improvements. It is the work of a number of Fellows of the Royal Academy of Engineering with experience in the transport sector. The focus is on the short and medium term, with assessment of the realistic likely benefits against the costs and effort involved. ‘Frontrunners’ considered to offer the greatest potential to reduce congestion before 2030 are identified.

The paper also considers ways of managing and smoothing demand as well as increasing capacity.

Rather than present a formal policy position of the Royal Academy of Engineering, this paper aims to provide informed analysis of the potential of the various engineering solutions available, with the objective of promoting further discussion with policymakers and the public about the opportunities and challenges for the future.

Professor Andrew McNaughton FREng
Chair of the Academy’s Transport CoP
THE CONGESTION PROBLEM

In the period from now to 2030, congestion throughout the UK’s transport system is set to become substantially worse. A combination of population growth and per capita increases in GDP is likely to increase the demand for travel and generate more traffic.

The latest predictions from the Department for Transport (DfT) estimate that, on the English road network, this growth in traffic is likely to translate to a 55% increase in road congestion in the period to 2040.

Of even more concern, congestion on the Strategic Road Network – the portion of the network that carries a third of all road traffic and two thirds of freight traffic – is predicted to climb by 60% over the same period. On the rail network, total passenger miles are expected to increase by between 15% and 50% on 2020 levels by 2033. Growth will be broad-based, across each of the major rail markets, although London and the South East will continue to experience the most widespread crowding.

The UK already suffers some of the worst congestion in Europe, with various business data demonstrating that the state of the country’s road and rail infrastructure is a relative disincentive for inward investment. In a more competitive global economy, where future economic growth is likely to continue to be linked closely with greater demand for physical travel, the quality of a country’s transport infrastructure becomes an increasingly important determinant of economic success. Congestion in road traffic also increases the levels of emissions of both carbon dioxide and pollutants that will impact on the UK’s ability to meet climate change and air quality targets. This makes reducing congestion a growing concern for policymakers.

EXECUTIVE SUMMARY

In the context of this problem, the working group conducted a study on the available technologies and policy measures that are capable of reducing congestion in the most critical transport sectors by 2030. The scope was limited to domestic, land-based passenger and freight transport as these are the sectors that account for the bulk of domestic transport. However, it is recognised that aviation and shipping are both vital components of the national transport system and the economy, and should be included in any future transport strategy. The study ranged from capacity-maximising technologies designed to make the most of the available infrastructure, through to demand-side measures designed to reduce congestion, especially at peak times.

This is not to discount the government’s major programme of capital investment in new infrastructure. Significant investment will certainly add to capacity. This includes £15 billion on the strategic road network and £38 billion on rail over the next five years. Nevertheless, this existing supply pipeline is unlikely to meet the task of keeping pace with demand growth and, because of the length of time it takes to build new infrastructure, cannot be expected to offer the sole solution to congestion problems in 2030. This is compounded by the fact that, in the case of rail, investments plans are taking longer and costing more than expected.

Demand-side measures are also vital as they provide additional policy levers that are capable of more quickly responding to and reducing excessive congestion. It is therefore important that supply-side measures should be coupled with demand management and that any new infrastructure should be built with both capacity-enhancing and demand-side measures in mind.

MEASURES TO TACKLE CONGESTION

Yet within the context of this problem, the working group conducted a study on the available technologies and policy measures that are capable of reducing congestion in the most critical transport sectors by 2030. The scope was limited to domestic, land-based passenger and freight transport as these are the sectors that account for the bulk of domestic transport. However, it is recognised that aviation and shipping are both vital components of the national transport system and the economy, and should be included in any future transport strategy. The study ranged from capacity-maximising technologies designed to make the most of the available infrastructure, through to demand-side measures designed to reduce congestion, especially at peak times.

This is not to discount the government’s major programme of capital investment in new infrastructure. Significant investment will certainly add to capacity. This includes £15 billion on the strategic road network and £38 billion on rail over the next five years. Nevertheless, this existing supply pipeline is unlikely to meet the task of keeping pace with demand growth and, because of the length of time it takes to build new infrastructure, cannot be expected to offer the sole solution to congestion problems in 2030. This is compounded by the fact that, in the case of rail, investments plans are taking longer and costing more than expected.

Demand-side measures are also vital as they provide additional policy levers that are capable of more quickly responding to and reducing excessive congestion. It is therefore important that supply-side measures should be coupled with demand management and that any new infrastructure should be built with both capacity-enhancing and demand-side measures in mind.

ASSESSMENT OF INDIVIDUAL TECHNOLOGIES AND POLICY MEASURES

The full range of potential technologies and policy measures were considered by the working group and assessed in terms of their cost, congestion reduction potential and overall value for money. Of these, 18 frontrunners were identified across the road, rail and freight sectors.

Figure 1 shows how each of the frontrunners was graded in each of the parameters (see Section 2 for details).

CONGESTION IN THE URBAN AND INTER-URBAN ROAD PASSENGER MARKETS

Efficient pricing offers the best value for money and strongest congestion reduction potential of any measure, across both the inter-urban and urban road passenger markets. In an inter-urban context, the only other measure that offers significant potential is smart motorways (controlling speeds and using the hard shoulder).

In an urban road context, the following measures offer value for money in reducing congestion, in order of descending value for money: parking controls, car clubs, reformed bus services, bus rapid transit, light rail and the ‘connected car’ (vehicles that use radio traffic information systems and dynamic navigation to reduce delays). They can all support congestion reduction at a national level. While fully automated vehicles are now being developed more intensively, we do not see them making a significant contribution to congestion reduction in the next 15 years.

18 frontrunners were identified across the road, rail and freight sectors. In an inter-urban context, the only other measure that offers significant potential is smart motorways (controlling speeds and using the hard shoulder).

In an urban road context, the following measures offer value for money in reducing congestion, in order of descending value for money: parking controls, car clubs, reformed bus services, bus rapid transit, light rail and the ‘connected car’ (vehicles that use radio traffic information systems and dynamic navigation to reduce delays). They can all support congestion reduction at a national level. While fully automated vehicles are now being developed more intensively, we do not see them making a significant contribution to congestion reduction in the next 15 years.
CONGESTION IN THE URBAN AND INTER-URBAN RAIL PASSENGER MARKETS

On the rail network, control, command and communication (CCC) technologies – encompassing the use of communications-based train controls to locate trains on the network more efficiently and enable advanced traffic management – could offer significant increases in capacity. However, while offering a viable solution to congestion reduction, these technologies require complementary investment in stations and other infrastructure, and the scope for network-wide roll-out before 2030 is limited.

In the immediate future, capacity-enhancement on the rail network could be offered through a package of measures including reforms to increase the supply of rolling stock and the utilisation of driver advisory systems (DAS). This would help relieve pressure until CCC technologies can be delivered at scale.

In an urban road passenger market, the home delivery of goods bought via the internet is likely to stimulate the greatest gains in reducing congestion. In this context, it is also important to recognise that the greatest impact on congestion will be when technologies and other measures are packaged together as part of a coherent whole. Firstly, packaging can produce synergistic gains, meaning that the effect of a number of measures combined together is greater than the sum of their individual contributions. Secondly, packaging of measures can allow the barriers to one measure to be compensated for by another, which is important in making them publicly acceptable. The greatest potential for packaging of measures appears to be in the urban road passenger market.

CONGESTION IN THE URBAN AND INTER-URBAN FREIGHT MARKETS

In an urban freight context, the home delivery of goods bought via the internet is likely to stimulate the greatest gains in reducing congestion, is relatively inexpensive to administer and offers excellent value for money. It could be supported by robust measures such as re-timing deliveries to the off-peak, horizontal collaboration between operators (combining deliveries to reduce ‘empty running’) and the use of urban consolidation centres (UCCs).

In an inter-urban context, horizontal collaboration is also applicable. In addition, the adoption of high-capacity long-haul vehicles and restructuring logistics (for example port centric logistics, whereby cargo is unloaded, stored and distributed from the port itself) may offer some congestion reduction potential but both are likely to be quite expensive to implement.

CONCLUSIONS AND RECOMMENDATIONS

The working group agreed the following conclusions and recommendations which are presented for discussion.

- Government should develop an integrated strategy for tackling road and rail congestion over the next 15 years and beyond. Such a strategy must include continued infrastructure investment in conjunction with capacity-maximising technologies and demand-side policy levers aimed at managing less time critical trips away from peak periods.
- It is important to recognise that the greatest impact on congestion will be when technologies and other measures are packaged together as part of a coherent whole. Firstly, packaging can produce synergistic gains, meaning that the effect of a number of measures combined together is greater than the sum of their individual contributions. Secondly, packaging of measures can allow the barriers to one measure to be compensated for by another, which is important in making them publicly acceptable. The greatest potential for packaging of measures appears to be in the urban road passenger market.
- Of all the available interventions considered, efficient pricing on the road network offers the single best way of tackling congestion. It represents excellent value for money and is technically viable now. The main barriers to implementation relate to public and political concerns that it restricts people’s ability to travel and adversely affects low income groups; however, empirical evidence shows that well-designed pricing schemes can attract popular support and achieve substantial reduction in levels of congestion with only small decreases in the volume of traffic.

Of the individual technologies and measures available, those that offer the best value for money in reducing congestion are listed in Table 2 and considered in more detail in the paper.
1. Introduction
The transport congestion challenge
1. INTRODUCTION

1.1 FOCUS AND STRUCTURE OF THE PAPER

The Academy’s Engineering Policy Committee invited Fellows from within the Academy’s Transport Community of Practice (TCoP), a group of transport experts from industry and academia, to consider the potential of a range of technologies and policy measures that are capable of reducing congestion in the most critical transport sectors by 2030:

- capacity-maximising measures designed to make the most of the available infrastructure
- regulation and management of passengers and transport companies (often by government)
- demand-side measures designed to reduce congestion, especially at peak times, by displacing traffic to other times of the day or less congested parts of the transport network.

The brief was to publish this analysis in a ‘challenge paper’, designed to promote informed discussion on the issues, rather than setting out a formal policy position of the Academy. The paper considers solutions within the context of currently planned infrastructure provision. But, as discussed further in this paper, it was accepted that the newly planned infrastructure would not be sufficient, on its own, to achieve significant reductions in congestion.

It was decided that the scope of the analysis should be domestic, land-based passenger and freight transport – road and rail – given that these sectors make up the bulk of the domestic market. However, as the Academy argued in its 2005 report Transport 2050, a systems approach is needed for the management of all the nation’s transport infrastructure, leading to a strategy that integrates all modes of transport, and the omission of aviation and shipping from this paper should not be considered as questioning that conclusion. This paper focuses on reducing congestion in the near term, in those areas of the transport system that are most immediately jeopardising this country’s economic competitiveness.

1.2 DEFINING THE CONGESTION PROBLEM

Congestion is most often associated with road transport and occurs when the volume of traffic approaches the available capacity. This leads to queuing, resulting in journey times becoming longer and more unpredictable. Congestion also exists on the rail network with overcrowding arising when the demand for a service approaches its capacity. The main impact is on journey quality rather than delay, but this still exerts an adverse impact on the economy.

Congestion varies according to time of day, tending to be at its most pronounced during the morning and afternoon peaks as a result of travel to and from work or school. It is most severe in larger urban areas and on the strategic long distance routes connecting them.

Road congestion is a complex phenomenon and is difficult to define and measure precisely. The working group preferred the marginal cost approach to measuring congestion, which compares the cost imposed by a journey with the benefit gained. The cost of congestion is the difference between the two, and would in theory be zero when all journeys made had benefits that at least equalled the costs which they imposed. As can be seen in Section 3, the working group proposes a system of marginal social cost pricing for the road network, with prices set to reflect the costs imposed in terms of delay and disruption to other road users. Such a pricing regime should encourage those who benefit least from travelling in congested conditions to find alternatives. As a result, delays would fall, but speeds would still be lower than in free-flow traffic.

Different approaches to measuring road congestion result in different projections of its economic costs. Earlier attempts to measure the cost of congestion by comparing it with free flow travel came up with a figure in the region of £20bn a year. More recently, the DfT’s Road User Pricing Feasibility study (2004), which used marginal social cost pricing, suggested that a national system of charging had the potential to save around £10–12 billion a year. The independent Case for Action report (2006), conducted by Sir Rod Eddington, also used the marginal social cost approach to congestion to find that the direct GDP benefits of a system of pricing would be worth around £15 billion a year by 2025. These studies have differed in the detail of their calculations, but provide a realistic indication of the scale of the problem and of the potential benefits resulting from reduced congestion.

The purpose of this study is not to conduct an investigation into the relative merits of different approaches to costing congestion. Nor is it within its remit to precisely quantify the amount of congestion that could be reduced from the network by a range of policy interventions. However, one must acknowledge the presence of congestion now, note that it undoubtedly imposes a cost on the economy and observe that, by all sensible interpretation of the available evidence, this cost is likely to increase significantly in the period to 2030.
1.3 CURRENT POLICY MEASURES

The working group recognises the significant amount of capital investment that has been committed by the government to improve the national road and particularly the rail infrastructure. This commitment includes continued and new rail investment including Crossrail (1 & 2) and the Thameslink upgrade, High Speed 2 (HS2), the Northern Rail Hub, Great Western Electrification and a commitment to invest over £15 billion in the strategic roads infrastructure by 2021. Yet this supply pipeline, even if fully operational by 2030, would still be inadequate to the task of keeping pace with demand growth. Such is the length of time it typically takes for sizeable new infrastructure to be built that it is now too late to supplement this pipeline with additional schemes that are capable of exerting a significant impact within the next 15 years, although such schemes should be progressed vigorously to provide longer-term congestion relief. This leads to the conclusion that the supply-focused approach to congestion relief in the government’s National Policy Statement for National Networks is insufficient, and that constraining policy in this way risks escalating the country’s congestion problem significantly by 2030.

In terms of a demand-side response, the National Policy Statement has explicitly ruled out the potential for pricing, or the management of demand growth, to help reduce congestion in the near term. Not only does this remove from the equation a policy lever that could generate an impact within this study’s time horizon, it also ignores a measure that is capable of preserving the economic gains accruing from building new infrastructure in the long term – thus risking some of these gains being eroded by the effects of excess generated traffic. It remains important that any new supply that does get built for the long term is planned and designed with demand-side measures in mind.

1.4 PRESENTING THE CRITICAL SECTORS FOR CONGESTION REDUCTION

This paper identifies three critical sectors for congestion reduction: road passenger transport (both urban and inter-urban), rail passenger transport (again, urban and inter-urban) and freight transport (comprising urban and inter-urban road and rail sectors). Congestion in other sectors, such as the need for new aviation capacity in the South East, is not addressed, but its omission from the study should not be seen as an attempt to disregard the problem. Rather, the objective is to present targeted solutions to the sectors that play the most significant role in the domestic transport system, and to use that as a springboard from which to achieve further progress.

1.4.1 Inter-urban and urban road passenger transport

Road transport remains by far the most dominant mode of travel in the UK. Road transport carries 90% of passenger journeys and two thirds of freight movements. As can be seen from Figure 2, much of the continued rise in total passenger travel over the last 60 years results from the increase in distance travelled in cars, vans and taxis, with 68% of all commuter trips undertaken as either a driver or passenger in a car.

The DfT’s central forecasts anticipate that road traffic in England will increase by 30% in the period to 2030. Under these forecasts, traffic growth would translate to a 40% growth in congestion across all roads by 2030 and a 72% growth in congestion on the Strategic Road Network specifically.

The working group acknowledges wider concerns that the DfT has historically overestimated traffic growth. There is also some evidence that travel by car may have peaked in some socio-economic groups, perhaps in response to changing social behaviour brought about by growing virtual connectedness. However, the working group sees no evidence that such social trends will reduce the problem of congestion by themselves.

There has been a decline in the rate at which road traffic has grown over the last 20 years and the period between 2007 and 2010 was unprecedented in yielding consecutive...
annual falls in the total volume of traffic on the roads. Yet traffic levels have been growing since the beginning of 2013, in the wake of economic recovery, and appear to reinforce the DfT’s position that, following historical trends, a restoration of per capita growth in GDP and increases in population will combine to generate more traffic. The DfT accepts that there may be a saturation point in car ownership in some markets in the future, but maintains that there are plenty of other markets capable of facilitating continued demand for private, motorised travel. Meanwhile, a separate study into the occurrence of ‘peak car’ found that, while it may have affected pockets of the country’s population, as much as 70% remain unaffected by it.

Road congestion is worst in large urban areas and some busy inter-urban corridors with figures showing that average traffic flows on urban roads are significantly higher than those on rural roads.

### 1.4.2 Inter-urban and urban rail passenger transport

In the period since privatisation in the mid-1990s, the number of journeys on the rail network has more than doubled. During this period, rail transport has enjoyed the largest modal share of all journeys. Government forecasts anticipate that each of the three main rail markets (London and the south east, long distance and regional rail) will continue to grow in the period to 2030, expecting that total passenger miles on the rail network will increase by between 36 and 45% above 2011 levels — see Table 1.

Congestion on the rail network is experienced as overcrowding, describing a situation in which the demand for rail services exceeds the capacity of available trains.

This is the product of carriage capacity, number of carriages in a train and the frequency of train services. The DfT captures overcrowding mainly through a measure known as passengers in excess of capacity (PiXC). This represents the number of standard class passengers on a service at the critical load point. Overcrowding on the rail network does not produce delays in the same way that congestion does on the road network. Rail operators can control the number of vehicles on the network and deliberately operate below maximum capacity because of the reduced reliability that full utilisation would create. Trains therefore become overcrowded rather than the network becoming congested.

### 1.4.3 Inter-urban and urban freight transport

Most freight transport operations have to work alongside and in conjunction with road and rail passenger transport. Roads that become congested with cars restrict the flow of lorries and vans; the movement of freight traffic from road to rail in order to free up road passenger transport potentially restricts the capacity of the rail network for passenger travel. Any strategy to improve freight transport, and reduce congestion, must be seen within the context of what it would do to passenger transport, and vice versa.

Lorries account for approximately 5% of all road traffic, by vehicle miles, while vans account for approximately 14%. This compares with the roughly 80% of road traffic which is made up by cars and taxis. Road freight makes up by far the largest proportion of domestic freight movements, at approximately 68% of tonne-km. By contrast, rail takes a 9% market share, with waterborne (mainly coastal) freight movements at 19% and pipeline at 5%.

The trend in road freight traffic has differed between vans and lorries. In 2013, the number of lorries on the roads was smaller than 2006, as was lorries’ share of total road traffic. Van traffic grew, on both measures, over the same period: increasing its share of total road traffic from 12% to 14%. Despite this, government forecasts still expect both van and lorry traffic to increase, with vans expected to experience the fastest rate of growth of all road vehicles.

It is important to note that, just because lorry traffic is declining as a proportion of total road traffic, this does not necessarily mean that congestion is becoming a lesser problem for the freight industry. On the Strategic Road Network, for example, where congestion is forecast to be increasing strongly, lorries still make up a disproportionately large part of the traffic (at a 10% share, this is more than double lorries’ share of all traffic).

### 1.5 An overview of the strategies and technologies that could reduce congestion

Policymakers have available to them a range of policy levers that can be used to reduce transport congestion and crowding. These include adding to infrastructure, managing the way that existing infrastructure is used, regulating the operation and use of the

#### Table 1: growth in rail passenger miles from 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>2020</th>
<th>2026</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>London and South East</td>
<td>17–21%</td>
<td>28–34%</td>
<td>34–42%</td>
</tr>
<tr>
<td>Long distance</td>
<td>22–28%</td>
<td>39–49%</td>
<td>50–63%</td>
</tr>
<tr>
<td>Regional</td>
<td>8–10%</td>
<td>16–20%</td>
<td>19–24%</td>
</tr>
<tr>
<td>Total (average)</td>
<td>17–21%</td>
<td>29–36%</td>
<td>36–46%</td>
</tr>
</tbody>
</table>

Source: Network Modelling Framework (NMF) — estimates based on model runs conducted in October 2011
transport system, pricing its use, promoting behaviour change, and introducing new technologies that offer new forms of travel or, by extension, alternatives to travel. Digital systems can contribute in different ways to each of these types of policy lever and also provide a vital platform in integrating and enabling them. They can also help reduce congestion by improving the performance, and users’ perceptions, of less congesting modes of transport.

Between them, these policy levers can be applied to influence congestion and crowding through strategies that reduce the need to travel, especially during peak periods; reduce the use of the car, which makes less efficient use of road space; improve the performance of the road network; improve public transport in its own right and as an alternative to private transport; and directly improve the operation of freight transport.

The following paragraphs illustrate how these types of policy lever might be applied in each of the different transport markets.

To improve urban and inter-urban road transport, supply-side measures would include new road building and road widening schemes. However, there are other ways in which the capacity of the road network can be enhanced. For example, management of road space can include schemes such as smart motorways, which increase capacity and reliability. Regulation is applied principally to the ways in which roads can be used (such as speed limits) but also to the operation of freight vehicles and, particularly, public transport. In public transport, pricing and regulation are closely linked, with bus use being affected by service patterns and fare levels and by the ability of local authorities to influence them. Pricing, as a policy tool, is much less developed for private transport. In urban areas, some parking is charged for but, with a few exceptions, the use of road space itself is not.

These policy levers are best applied as a package; many will complement each other. For example, pricing the roads to discourage private car use in favour of less congesting modes is best combined with measures that bolster the supply of public transport, such as light rail or an efficient bus network, in order to improve their attractiveness as a viable alternative to car travel.

In terms of urban and inter-urban rail transport, conventional supply-side measures involve building new lines and stations and adding additional tracks and reconfiguring junctions with signalling upgrades, lengthening trains and increasing service frequency. While several such projects are underway at present, the plans for HS2 demonstrate clearly that it will take a substantial time for such measures to have a significant impact on overall capacity. In urban areas, improvements from Crossrail, the Thameslink upgrade and extensions to Manchester Metrolink will enhance capacity, but it is questionable whether they will be at sufficient scale. The other more immediate response is to lengthen trains and stations to increase the capacity of each train movement.

Among management measures, the most significant developments are control, command and communication (CCC) technologies, incorporating communication-based train control technology to locate trains more accurately on the network and enable the available track capacity to be used more intensively. These technologies will begin to have an impact before 2030 but will not be fully operational until around 2040.

Regulation and pricing are already widely applied in the rail sector, but there are opportunities for more extensive use of integrated ticketing and smart cards, ideally combined with those for road-based modes of transport.

Freight transport is directly influenced by the changes made to the supply, management and pricing of road and rail. Increases in capacity, through new supply or better management, will benefit road freight; new rail lines will potentially add to freight capacity, and pricing of road use will affect the costs of road freight. Some measures could act differentially on freight, such as the provision of specific regulations on lorry size or emission standards. More importantly, freight operators will respond differently from private travellers, since they typically have fewer alternatives, and their decisions are strongly influenced by the place of transportation in the wider production and distribution chain.

The main freight-specific policy levers relate to vehicle size and design, the use of consolidation centres, the impact of tele-shopping and the use of distribution centres.

Although the major focus of this project was to consider transport measures that can reduce congestion, it is important to recognise that there is a wider range of policies that can be employed to reduce congestion that do not exclusively apply to the transport sector. For example, reforms to land use planning, such as ensuring that new housing developments are designed from the outset with an integrated transport system, could reduce congestion simply by improving people’s proximity to facilities. With four million new homes needed by 2030, transport requirements should be a key consideration in the location, density and layout of new residential and associated retail and employment developments.
2. The range of solutions that could reduce congestion in the period to 2030
2. THE RANGE OF SOLUTIONS THAT COULD REDUCE CONGESTION IN THE PERIOD TO 2030

This section sets out a list of the ‘frontrunner’ technologies and policies that are considered to have the best potential to reduce congestion before 2030. They are drawn from a longer list of measures that were considered by the working group. Three measures – autonomous vehicles, telecommuting and diverting more freight to the rail network – were considered to have potential to reduce congestion but not at sufficient scale in the timescale being considered and, as such, not given frontrunner status. Further details on these can be found in Appendix 1.

2.1 METHODOLOGY AND STRUCTURE OF THE PAPER

Each measure was assessed independently on the basis of cost of implementation (using a scale from very expensive to very inexpensive/revenue neutral) and on its potential to reduce congestion (using a scale from limited to excellent). The overall value for money of each measure was then assessed in the range from limited to excellent by comparing its congestion reduction potential and cost of implementation. Figure 1 on page 5 gives details of how each of the frontrunner measures was graded. It should be noted that the grading was the subjective assessment of the working group based on their experience and expertise. It is necessarily broad as a strict, objective comparison of measures would be difficult given the different characteristics of each measure, for example variations in capital versus operating costs, passenger or freight or technology versus logistical restructuring. Table 2 lists each of the frontrunners in order of value for money grouped by road passenger, rail passenger and freight. The table also lists what the working group considers to be the main barriers to implementation for each measure. Possible barriers include those that would make it harder to implement a measure effectively – legal, political, institutional, public and technical, and those that reflect a potential weakness in the measure in terms of transport system goals – environmental, safety and equity. The barriers are given a traffic light rating to indicate how important they are thought to be.

Section 3 considers each of the frontrunner measures in more detail. Policy recommendations are included concerning their implementation and how the barriers might be overcome by policymakers. Finally, Section 4 considers how combinations of the measures could be packaged together in such a way as to maximise congestion relief, find synergies between measures and help overcome barriers.
### The transport congestion challenge

The range of solutions that could reduce congestion in the period to 2030

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value for money</th>
<th>Main barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficient pricing</td>
<td>Excellent</td>
<td>Legal, political public and stakeholder acceptability</td>
</tr>
<tr>
<td>Reform of bus services</td>
<td>Excellent</td>
<td>Political acceptability and institutional</td>
</tr>
<tr>
<td>Parking control</td>
<td>Very good</td>
<td>Political, public and stakeholder acceptability</td>
</tr>
<tr>
<td>Car clubs</td>
<td>Good</td>
<td>Legal, regulatory and institutional</td>
</tr>
<tr>
<td>Smart motorways</td>
<td>Good</td>
<td>Institutional and public and stakeholder acceptability</td>
</tr>
<tr>
<td>Connected car</td>
<td>Good</td>
<td>Legal, regulatory and institutional</td>
</tr>
<tr>
<td>Bus rapid transit</td>
<td>Moderate</td>
<td>Legal, regulatory and institutional</td>
</tr>
<tr>
<td>Light rail</td>
<td>Moderate</td>
<td>Legal, regulatory and institutional</td>
</tr>
<tr>
<td>Rolling stock reform</td>
<td>Good</td>
<td>Institutional and political acceptability</td>
</tr>
<tr>
<td>Driver advisory systems</td>
<td>Good</td>
<td>Legal, regulatory and institutional</td>
</tr>
<tr>
<td>Control, command and communication technologies</td>
<td>Moderate</td>
<td>Institutional, technical feasibility and risk</td>
</tr>
<tr>
<td>Home deliveries</td>
<td>Excellent</td>
<td>Legal, regulatory and public and stakeholder acceptability</td>
</tr>
<tr>
<td>Retiming deliveries</td>
<td>Very good</td>
<td>Political, public and stakeholder acceptability</td>
</tr>
<tr>
<td>Urban consolidation centres</td>
<td>Moderate</td>
<td>Institutional</td>
</tr>
<tr>
<td>Horizontal collaboration</td>
<td>Moderate</td>
<td>Institutional, technical feasibility and risk</td>
</tr>
<tr>
<td>High-capacity urban delivery vehicles</td>
<td>Moderate</td>
<td>Institutional, public and stakeholder acceptability</td>
</tr>
<tr>
<td>Higher capacity vehicles: long-haul operations</td>
<td>Limited</td>
<td>Legal, regulatory and political acceptability</td>
</tr>
<tr>
<td>Restructuring the logistic network</td>
<td>Limited</td>
<td>Institutional and technical feasibility and risk</td>
</tr>
</tbody>
</table>

Table 2: Frontrunner congestion reduction measures
3. Congestion reduction measures
3. CONGESTION REDUCTION MEASURES

3.1 REDUCING CONGESTION IN THE INTER-URBAN AND URBAN ROAD MARKET

3.1.1 Efficient pricing

| Value for money: | excellent |
| Costs:          | revenue neutral |
| Congestion reduction potential: | excellent |

The potential of road pricing applies equally to the inter-urban and urban road market.

This analysis concludes that efficient pricing of the road network is technically the best instrument at the disposal of policymakers in order to reduce congestion. By introducing a charge to reflect the marginal cost imposed by an additional journey on the road network, it encourages those whose benefits from travelling are less than this cost to find alternatives. These charges would vary considerably by time and place, with many roads being free of charge. The annualised operating costs would be high, but more than offset by the revenue generated; hence the assessment that this measure is largely revenue neutral. Value for money is therefore excellent.

Efficient pricing should reduce the need for, and the scale of, new road building, and should help new roads avoid becoming congested. The primary purpose of charging road users is not to impede people’s ability to travel; nor is it designed to produce dramatic reductions in overall levels of road usage. Rather, its purpose is to promote an efficient level of road use: where the benefits derived from each individual journey are at least equal to the costs they impose, and a charging mechanism encourages drivers whose journeys do not meet this criterion to choose alternatives.

Only small overall reductions in the level of overall traffic need to be generated by a pricing scheme in order to produce disproportionately large effects in terms of reducing congestion.

Road pricing would stimulate a variety of responses from road users other than simply not travelling. It would encourage some motorists to pick alternative modes of transport: some would be discouraged from undertaking less important journeys, removing demand from the system altogether; some would replace longer journeys by shorter ones; some would either retimed their journeys to the off-peak period or use less congested areas of the road network in order to avoid charges; and there would be some consolidation of journeys and more vehicle sharing.

The effect of this targeted measure would be to make substantial cuts in levels of congestion while limiting the inconvenience to consumers: a particularly important point given that the major barriers to its implementation are seen as being public and political resistance. Efficient pricing should reduce the need for, and the scale of, new road building, and should help avoid new roads becoming congested.

Political antipathy to the measure is typically based on the perception that the public and the business community see road pricing as imposing an extra cost on the road user, and as having unfair impacts on businesses and lower income motorists in charged areas. Yet international evidence indicates that a properly communicated and constructed road pricing strategy has the potential to overcome such resistance and tends to mobilise support for pricing among host populations in the medium term. Road pricing has been characterised as a monolithic policy instrument that affects transport users indiscriminately. However, it can be flexed to suit local conditions and the application of discounts and exemptions, funded by the revenues it accrues, and packaging with alternative forms of transport, can ensure that it does not disproportionately affect low income groups. Indeed, in its most efficient form road pricing could come with a radical reduction in other road taxes including fuel duty.

Improvements to digital systems over the last 10 years call for an update to the government’s position, as contained in its Road Feasibility Study (2004), that a system of national pricing is technically feasible but potentially costly and hindered by the inadequacies of available technology. Case studies from overseas should be used to help determine the best delivery system for applying charging in the UK. It is important that this decision encompasses assessment of the risks of each of the choices, including the implications of the introduction of pricing on safety.

It is important to recognise that pricing would also apply to freight traffic, although its impact on this sector would be likely to be more limited, since operators are less flexible and driven, in part at least, by clients’ demands. The application of pricing to freight would probably limit congestion principally by reducing the occurrence of ‘empty running’ (see Section 3.1.iv). But goods traffic would receive substantial benefits from the reduction in congestion resulting from changes in car traffic levels.

Critical issues for implementation

- Surplus revenues should be used initially to reduce or replace current vehicle ownership and fuel taxes, thus addressing the perceived unfairness of current tax regimes. Where appropriate, remaining revenues should be spent on wider enhancements to the transport system.
- Government should take account of international evidence that suggests
broad business and public acceptance of well-designed pricing regimes which are seen to be transparent, fair and designed to avoid undue impacts on disadvantaged groups. Political resistance to road pricing is the single biggest barrier to implementation, and needs a careful planning, communication and marketing effort.

- Any inter-urban charging regime should be introduced nationally, and should apply to all areas and times where there is significant congestion and in ways which avoid transfer of problems to local roads.
- National government and local authorities should reassess their investment policies to reflect the impacts of such pricing regimes on travel patterns, and hence on the need for new capacity.
- The government should update the review of technologies included in the Road Pricing Feasibility Study of 2004, and promote the further development of those technologies which offer the greatest potential for cost-effective charging, payment and enforcement systems.
- Within the national context, local authorities should consider introducing urban pricing regimes, where additional congestion reduction is needed, with any additional revenue accruing to their urban transport system. However, care will be needed to ensure that any local schemes are fully compatible with the national scheme.

### 3.1.2 Reform of bus services

**Value for money:** excellent  
**Costs:** inexpensive  
**Congestion reduction potential:** very good

Good quality and affordable bus services can help limit congestion by encouraging people away from their cars.

Evidence suggests that where these services form part of an integrated transport network, ridership figures will increase; whether through coordinated, multi-operator ticketing schemes or fully specified (potentially franchised) services, a planned network can make bus travel more flexible and convenient for passengers. Its principal benefit, however, is that it allows a local transport authority to deploy resources to match demand, satisfy unmet access needs, and contribute to congestion reduction on key corridors.

The best example of the benefits of a closely specified, more integrated bus network is London, where, between 1986/87 and 2014/15, bus journeys more than doubled, alongside a more than doubling in Underground use, in stark contrast to the rest of England where bus journeys decreased by a third. Some small cities have managed to generate substantial investment in their bus services, and increased levels of bus use through effective partnership with a single dominant bus operator.

The regulated nature of the market helps maintain a high level of service, with the provision of integrated ticketing, real-time passenger information and frequent, good quality vehicles bolstering the perception of buses as an attractive alternative to car and Underground use. The government has recently recognised this by offering franchising powers to Greater Manchester and, potentially, to other conurbations, as well as to Cornwall.

In the largely deregulated market outside London, there have been different attempts to introduce more integrated bus services. For example, there are cases where competing operators have coordinated their activity through multi-operator and multi-modal tickets. Some small cities have managed to generate substantial investment in their bus services, and increased levels of bus use through effective partnership with a single dominant bus operator.

The development of more integrated networks, whatever the model and wherever they occur, should be encouraged where they are better able to match demand, serve unmet needs and contribute to relief of congestion. However, in areas where greater integration is not possible because independent operators anticipate profit in competing with one another rather than coordinating their services, the local transport authority should be given powers to plan and specify the network in line with the guiding principles of providing for unmet needs and contribution to congestion reduction.
The regulatory environment for change is complicated. Though there are already powers in existence for local authorities to let services to private operators, through Quality Contracts, the legislative requirements for these contracts are demanding, as are restrictions imposed by the Competition and Markets Authority. Understandably, commercial operators also have reservations about restrictions on their commercial flexibility. The government’s current route of providing franchising powers to local authorities offers a much more effective solution.

**Critical issues for implementation**

- The development of more integrated bus networks should be encouraged where they are better able to match demand, serve unmet needs and contribute to relief of congestion. Service performance should be reviewed against these requirements, in order to assess the appropriateness of alternative approaches to bus service management.

- The government should extend the application of franchising powers to those authorities that would benefit from them, as a marked improvement to the current procedures for Quality Contracts.

- Local authorities should monitor the impacts of the application of such measures to identify lessons for other authorities that might wish to pursue a similar approach.

### 3.1.3 Parking control and enforcement

<table>
<thead>
<tr>
<th>Value for money</th>
<th>very good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>revenue neutral</td>
</tr>
<tr>
<td>Congestion reduction potential</td>
<td>moderate</td>
</tr>
</tbody>
</table>

Parking is an important service for motorists and should not be discouraged indiscriminately. However, in congested conditions in urban areas, controlling the availability and use of parking spaces can contribute to congestion relief in three principal ways. Restricting on-street parking at critical points in an urban network (such as near road junctions or schools) can increase the capacity of that network. Charging and restrictions on parking duration can ensure that there is always spare parking space available and so reduce the amount of traffic searching for parking spaces. More generally, controls on supply, usage and price can reduce the attractiveness of accessing a city centre by car, and therefore help reduce congestion on roads in the vicinity and encourage a switch to less congesting modes. Park and ride facilities on city fringes can reinforce such city centre controls.

Parking controls, both on- and off-street, can be implemented in a number of ways. Overall supply can be reduced, restrictions can be placed on opening times, durations and permitted users, and users can be charged to park. Charging is likely to be the most effective of these but needs, as with road pricing, to relate to the costs imposed by the user. For example, evidence from Nottingham suggests that the Workplace Parking Levy there operates principally as a source of revenue, rather than as a means of reducing car use.

All forms of control are only likely to work effectively if they are appropriately enforced.

Parking controls offer a largely demand-side application in terms of reducing congestion, though they can also increase the supply of road space by freeing up capacity previously used for on-street parking. The costs attached to their implementation are very low: because parking controls are already in place, the main costs are in intensifying such measures and enhancing enforcement of them, costs for both of which should be covered by the revenues they generate. The resulting value for money is excellent.

The most severe barriers for more intensive parking controls relate to the lack of political and public and stakeholder acceptability. Political resistance is based on a perception that the public and the business community will see parking controls as an unnecessary and aggressive imposition on the road user, and as having unfair impacts on businesses in controlled areas. The recent government decision to prohibit local authorities from using CCTV to enforce parking controls reflects these perceptions. In practice, evidence indicates that well-designed town centre parking controls, with charges set to discourage searching, improve access for those with greatest need to park and make the centre more attractive.

**Critical issues for implementation**

- Parking control is a local issue so local authorities need freedom to implement local solutions. Government should not unduly constrain its ability to use effective and efficient means of parking control and enforcement.

- Government needs to encourage the application of parking controls to all public and private off-street spaces, including new measures to control private parking.
• Local authorities should make use of parking controls to reduce congestion, including the use of new parking guidance and location technologies.
• Local authorities should ensure, through charging, that at least one in every seven on-street and one in every 20 off-street spaces is available at peak times to reduce searching.
• Parking controls should be enforced in ways that achieve a combination of chance of detection and penalty sufficient to deter illegal parking. At the same time enforcement actions need to avoid appearing unduly confrontational and to be cost-effective in their use of resources. In particular, suitable technology should be used to reduce the resource costs of enforcement.

### 3.1.4 Car clubs

**Value for money:** good  
**Costs:** very inexpensive  
**Congestion reduction potential:** limited

Car clubs – where several people have access to a commonly used and commonly owned or rented vehicle – provide an alternative to the conventional model of private ownership of automobiles. There are a variety of models, from Zip Car, where club members can reserve a car for a short period from dedicated on- or off-street facilities in the club’s domain, to peer-to-peer rental schemes in which a central brokerage matches private owners’ vehicles with users needing transportation.

Car clubs help reduce congestion by encouraging motorists to use automobiles more sparingly than if they owned the vehicle themselves.

Evidence suggests that membership of a car club reduces car ownership and mileage. In one of the best-documented schemes, in Bremen, 50% of users owned cars, and of these, 74% replaced a car by car sharing. In this way it is estimated that each car club car removed eleven privately owned cars.xxii

Car clubs offer a good impact in reducing congestion. Despite solid growth of about 10% per year in the UK market, the concentration of members in London suggests niche application so far.xxiii

However, the low costs and few barriers attached to their implementation and expansion do point towards the good value for money offered by this intervention. Evidence in Europe suggests that cities can actively encourage their development, and that there may therefore be potential for them to grow in the UK outside the capital. Local authorities may have a role in promoting their use, not least as a measure by which to reduce pressure on residential parking spaces.

### Critical issues for implementation

- The development of car clubs in the UK and internationally should be monitored on the basis of their impact to traffic and congestion.
- Local authorities should encourage the development of operational models for car clubs that best support local policy objectives.

### 3.1.5 Smart motorways

**Value for money:** good  
**Costs:** expensive  
**Congestion reduction potential:** very good

Smart (or managed) motorways increase the supply of road space by making the hard shoulder available for traffic when needed, and by using variable speed control to reduce the likelihood of disruption. As the name indicates, this is a largely inter-urban solution that provides very good congestion reduction potential but is not universally applicable in the way that efficient pricing (an urban and inter-urban solution) is. The capital costs associated with smart motorways are substantial, limiting its overall value for money.

There are various levels of operation; dynamic use of the hard shoulder involves requisitioning that part of the carriageway intermittently and only when use of variable speed limits is no longer able to maintain the smooth and reliable flow of traffic. ‘All-lane running’, on the other hand, operates the hard shoulder like a conventional running lane unless it is needed for emergency or maintenance purposes.

It is possible to install the necessary enhancements without having to close motorways but the roadside infrastructure still needs careful re-engineering in order to provide emergency refuge areas, which drivers still require.

Existing evidence indicates that the deployment of smart motorways has reduced congestion, improved journey time reliability and reduced fuel consumption, emissions and the rate of personal injury accidents on the roads. The latest statistics also indicate that they are able to deliver much of the benefits of road widening at substantially lower costs.xxv
Another benefit of smart motorways is that they take less time to implement than road-widening schemes as they require no land acquisition and are likely to be able to deliver more benefit before 2030 than conventional supply-side alternatives.xxxix

However, any in-principle decision to adopt all-lane running, as opposed to ‘dynamic use of the hard shoulder’ when introducing smart motorways, should not be taken without a thorough assessment of all the risks, including the intelligibility and compliance by motorists, as well as the balance of the benefits and costs.

Critical issues for implementation

• The programme to introduce further smart motorways should be continued and accelerated and, where possible, extended to expressways.

3.1.6 Connected car

Value for money: good
Costs: inexpensive
Congestion reduction potential: moderate

The ‘connected car’ involves electronic in-vehicle communications. Developments in internet connectivity, smartphone technology, electronic tagging and satellite navigation mean that the range of types and uses of communications is expanding rapidly and becoming ever more sophisticated.

Congestion reduction is principally achieved by radio traffic information systems, dynamic navigation and parking information systems that can increase drivers’ ability to avoid delays and therefore reduce congestion.

But as these facilities become more common, unless networks are adapted to suit, the spare capacity they access will diminish: their effect is therefore likely to be positive but limited.

This mix of technologies offers the potential for rich vehicle-to-vehicle and vehicle-to-infrastructure communications, which opens up the possibility for progression from information to advice, to various stages of regulating and ultimately controlling vehicle operations (such as autonomous cars).

The barriers to adoption are not small. In order to achieve system-wide connectivity, significant investment will be needed in vehicle, infrastructure and servicing capabilities and, given the large number of disparate actors in the field, it is not clear where responsibility for this investment will lie. Replacing the existing fleet of vehicles with more sophisticated connected cars, which would achieve the maximum benefit in driver performance, is also a long-term aspiration; this limits the congestion reduction potential of this intervention within the next 15 years.

Critical issues for implementation

• More rapid take-up of connected car technologies in new vehicles would bring benefits.

• Policies for active traffic management, road safety and congestion management should keep abreast of developments in communication in the vehicle fleet, and help stimulate further development.

• Standardisation of communication protocols for key functions in connected cars should be progressed.

• Local authorities should ensure that policies for active traffic management, road safety and congestion management keep abreast of developments in communication in the vehicle fleet, and help stimulate further development.

3.1.7 Bus rapid transit (BRT)

Value for money: moderate
Costs: moderate cost
Congestion reduction potential: moderate

Bus rapid transit (BRT) is a generic term for a bus-based mass transit system designed to provide reliable, frequent, fast and high-quality services. BRT is normally presented as a distinct ‘brand’ with a separate image from conventional bus services and may be considered to be a distinct transport mode. The physical design of BRT services varies widely but is distinguished by the fact that vehicles operating on BRT routes tend to spend a significant portion of their journey within a fully dedicated right of way, also known as a bus way. Their objective is to combine the capacity, speed and reliability of a light rail system with the flexibility and lower costs of a bus system and BRT has proved popular, and effective, across cities in the emerging and developed world.

The principal objectives of BRT are to improve accessibility and to replace more congesting car trips with a viable public transport alternative. It is the latter which contributes to congestion reduction. Impacts on car use vary. On the Cambridgeshire Busway, 24% of users are reported as being former car drivers but, given the scale of this scheme, this is probably at the upper limit of what BRT can achieve.

BRT is not a nationwide urban solution; in some corridors, light rail may be more suitable. Nonetheless, BRT tends to be a relatively quick public transport mode to install. Costs of implementation will vary, depending on the complexity of the system being proposed.

There are three key barriers to the implementation of BRT: institutional arrangements, use of road space and BRT identity. Institutional arrangements require cooperation between the local authority and the private companies operating commercial bus services. Motorists will resist reallocation of road space, but evidence of a cooperative approach between highway authorities and operators, and the demonstrated benefits of the scheme can help reduce this. A further potential barrier to BRT is a lack of clarity as to the identity of BRT as a mode, unlike light rail (LRT) which is a relatively well-understood concept. This can make it difficult to ‘sell’ BRT proposals to stakeholders, especially where measures such as road space reallocation are required.

The available evidence points towards BRT systems having been successful – the Cambridgeshire Busway carried 2.5m passengers in its first year of operation, some 43% above forecast – which suggests that these barriers should be navigable.xxxviii

Critical issues for implementation

These are combined with the light rail recommendations in the following section.

3.1.8 Light rail and trams

Value for money: moderate
Costs: expensive
Congestion reduction potential: good

Light rail and trams comprise a family of technologies enabling railway operations that can range from vehicles on separate rights of way to on-street operation where road space is shared with conventional traffic. These technologies combine to provide a high capacity and rapid form of urban transportation. Off-street operations
enable maximum speeds of up to 50mph between stops, while on-street running provides passengers with lower speeds but convenient city-centre boarding/alighting points.

Similarly to BRT, the ability of light rail to reduce congestion rests on encouraging modal shift away from more congesting car journeys. It is more expensive than BRT, but also offers greater capacity and attractiveness to car users, so achieves greater reduction in congestion. Value for money is therefore similar to that for BRT.

Existing evidence is broadly positive; in the cities that do operate light rail in the UK, the results suggest a significant increase in patronage over time – with total journeys on this mode more than doubling between 1997/98 and 2009/10. However, this increase is largely driven by system extensions, and patronage related to system length grew by around 25% over the same period. Research also points towards approximately 20% of peak hour passengers on UK tram schemes having previously travelled by car, demonstrating the net reduction in traffic that trams stimulate.

The main barriers to implementation of light rail in the UK are cost and physical space. In many UK contexts, relatively low residential density results in corridor patronage demands that do not justify the costs of light rail and are better suited to BRT. Physical space is also a barrier, particularly in historic urban centres where narrow streets would prevent operation of modern light rail vehicles without significant changes to the urban fabric which, in turn, carries significant costs.

There is some evidence that the UK design requirements make light rail more expensive to implement than in continental Europe. Principal reasons include the requirement to relocate utilities from below the tracks, more intensive measures to separate trams from other road users, an absence of common standards and the lack of a steady investment pipeline.

Critical issues for implementation

- Effective institutional models for the delivery of BRT and light rail should be established, taking account of the proposals for reform of bus services above.
- Government should commission a review of the relative costs of light rail construction in the UK and continental Europe and seek ways of reducing the unit costs of UK designs. In particular, the potential for avoiding utility diversions should be reviewed.
- Local authorities should monitor the impact of bus priorities, BRT and light rail systems and the effects of road space reallocation, and should provide evidence to improve the design, assessment and promotion of such measures.
- Local authorities should adopt a more holistic approach for urban design to ensure that BRT and light rail are integrated with the urban fabric and other transport modes.
3.2 REDUCING CROWDING IN THE URBAN AND INTER-URBAN RAIL MARKET

3.2.1 Rolling stock reform

Value for money: good
Costs: moderate cost
Congestion reduction potential: good

Overcrowding on the railway is not wholly the result of a lack of train paths but also of short services (trains with fewer carriages than required to meet demand).

Increasing the supply of rolling stock on the rail network to make trains longer is a supply-side measure that can bolster capacity in the short term.

New carriages can be added quickly and prior experience shows that small additions to the number of carriages can yield disproportionately positive effects in terms of servicing demand growth: between 1994 and 2013, there was a 106% increase in passenger miles despite the overall fleet growing by only 11%.xi

Assessing the costs of this measure is dependent upon the timeframe in which additional rolling stock would be distributed onto the network. Under the rail industry’s long-term plans – and present trajectory – to improve rolling stock, the costs could be evenly spread over the next 30 years.

However, if new rolling stock was fast-tracked over the next 15 years, as part of a national strategy designed to reduce congestion incorporating significant modal shift, these costs could well escalate.xi If fast-tracking of rolling stock proved not to be possible, an alternative option might be to extend the deadline by which domestic industry needs to comply with an EU directivexii on persons with reduced mobility (EU PRM-TSI) – pushing what is a voluntary rather than mandatory arrangement beyond its present 2020 deadline. This directive requires the replacement of old rolling stock that does not meet accessibility criteria for people with reduced mobility. The downside is that delaying replacement would have adverse implications on accessibility goals. However, it would boost capacity by enabling old stock to operate alongside its replacement stock, at least in the short-term.

Critical issues for implementation

- Measures should be employed to speed up the procurement and deployment of new rolling stock and boost capacity in the short-term. A business as usual approach to procurement is insufficient.

3.2.2 Driver advisory systems

Value for money: good
Costs: moderate cost
Congestion reduction potential: good

Driver advisory systems (DAS) are technologies that use a simple cab interface to transmit information to train drivers on the status of critical junctions or stations they are approaching, helping them to optimise their speeds to reduce congestion. They provide more information than is presently available through the observation of lineside signalling.

At their simplest, DAS enable the network controller to advise a driver to reduce speed to a specified value in order for a vehicle to arrive at a junction at a time when it is clear of conflicting movements; this prevents the need to break or halt severely, enabling better throughput and therefore better use of the theoretical junction capacity to be planned without reduction in service reliability.

Trains that mostly benefit from DAS are likely to be inter-urban fast services and, especially, freight services which currently take the most time to traverse a junction, and therefore use most capacity, if brought to a near or complete halt. It is also these trains that, once delayed, are likely to reduce
the practical capacity of subsequent pinch-points on the network.

A significant secondary benefit of DAS, which has underpinned plans for its future installation on major freight networks in the USA, is the consequent reduction in energy use through reduction in start-stop movement, along with reduced costs of operation and maintenance of, for example, train braking systems. The major beneficiaries are freight and higher speed inter-urban services.

To get the required benefits from DAS in high traffic areas the more complex CDAS (C for Connected) is perhaps needed requiring the installation of monitoring and decision support systems on the wayside communicating directly with the on-board DAS equipment. There is still some uncertainty around the exact configurations needed to support particular layouts and service patterns.

**Critical issues for implementation**

- Given the divergent professional judgement within the rail sector on the ease of delivery and subsequent impact of DAS in congestion alleviation, an early pilot scheme should be funded and implemented on a representative congested section of the network.

**3.2.3 Control, command and communication (CCC) systems**

*Value for money:* **moderate**

*Costs:* **very expensive**

*Congestion reduction potential:* **good**

Control, command and communication (CCC) systems comprise a mix of technologies that facilitate intelligent traffic management of trains and replace lineside infrastructure with communications based train control. They have a range of applications but ultimately, for the purpose of reducing congestion, enable trains to be placed closer together on the track and for network capacity to be therefore used more intensively.

CCC enables the position of vehicles to be continuously monitored and updated, rather than changes in position being reported only intermittently upon their entry into a 'fixed block' section of the track; the enhanced accuracy and removal of uncertainty that this provides on vehicles' relative positioning enables trains to be run with only the safe stopping distance between them and so improves capacity by allowing more trains to be run in a given period.

CCC also allows more accurate real-time control of trains approaching junctions and stations, combining to optimise the throughput of services.

CCC systems offer a transformative impact to capacity. Although more conventional capacity enhancers such as additional trains or new lines still offer considerable potential in the regions, the lack of space in London and the South East, where crowding is most acute, requires technological solutions that make better use of existing infrastructure.

However, CCC systems are complicated and costly to install. The process incorporates a high complexity of conversion: different operating principles for new technologies require that a whole network section of the railway needs to be adapted, as well as all the trains traversing it, before the system will function. The required investment in new or retrofitted train fleet, alteration of layout and the reconfiguration of key junctions produce considerable whole-life costs. A consequence of achieving higher throughput would be the need to invest in increased station capacity, both platform and overall passenger space. This would be most expensive at the locations where capacity is most needed, such as in London and the South East where additional land is at a premium.

Industry is focusing on potential intermediate steps for the roll-out of CCC in which some of its benefits, such as knowledge of train position, could be overlaid onto existing fixed-block systems without the need to replace all trains operating in the area concerned.

Despite the considerable costs attached to the introduction of this measure, it does appear to represent the best intervention in the rail industry for the long term. As network-wide deployment would take 15-30 years, there is a need for intermediate measures to supply much needed critical capacity in the short term.

It is important to recognise that CCC systems are not being developed in isolation. Although they stand out as offering the single-best potential for capacity on the rail network, they form only one component in a system of interrelated technologies on course to be installed on the rail network over the next 30 years.

**Critical issues for implementation**

- Government should work with the rail operational and rail supply industry to enhance plans for a first main line introduction of CCC to gain earlier knowledge of barriers and strategies to more wide-scale implementation.

- Lessons should be learned from countries such as Japan and China where these technologies are already more widely deployed.

### 3.3 REDUCING CONGESTION IN THE INTER-URBAN AND URBAN FREIGHT MARKETS

There are two main categories of intervention in freight transport that can have an impact traffic congestion for a given freight task. These are measures that result in use of higher-capacity vehicles requiring fewer journeys and measures that alter the logistics system and so result in fewer and/or shorter journeys. Those interventions that simply reduce the number of heavy vehicles or number of journeys have a relatively weak effect on overall traffic congestion. However, those interventions in the freight system that alter car traffic, particularly at congested times, can have a relatively strong effect. This latter category includes home delivery and ‘last mile’ solutions, urban consolidation centres and retiming of deliveries.

The promotion of higher-capacity vehicles enables more productive road freight vehicle trips, helping operators to minimise their costs at the same time as reducing the total number of freight vehicles on the road – but may attract some traffic from the railways.

There are three main opportunities for improved logistics systems to reduce traffic congestion: modifications to urban logistics systems, through use of urban consolidation centres (UCC); optimisation of the backbone distribution network; and retiming of deliveries (delivering out-of-hours).
3.3.1 Home delivery and ‘last mile’ solutions

Value for money: excellent  
Costs: inexpensive  
Congestion reduction potential: very good

The private car is the least efficient ‘freight vehicle’ in common use. It weighs approximately 1.5t, carries less than 50kg of freight on a typical shopping trip and uses substantial road space.

Almost any lorry running even partially loaded has a much higher ratio of payload to unladen weight and so is significantly more efficient than a private car.

The effectiveness of this measure rests on replacing private car trips to retail outlets with online shopping and home delivery solutions using freight vehicles that are larger and more efficient than the family car. The solution is particularly applicable to grocery shopping. As well as replacing multiple private shopping trips with one consolidated trip, a further benefit of this measure for traffic reduction is that home delivery can be done out of normal working hours.

A market-driven solution that is already in widespread operation, it requires no public subsidy and is cheap to implement; this results in a measure that provides excellent value for money.

There are significant barriers that limit wider adoption of home delivery. These are inadequacy of the online shopping experience, the problem of delivery failures, barriers to service consolidation resulting from competition law, and the need to orchestrate a change in consumer behaviour so that efficient last mile delivery becomes integrated and more pervasive.

Notably, the case for home delivery is weaker if the first-time delivery fails, requiring a repeat delivery or additional consumer journey to retrieve goods from a depot. Improved IT solutions and communication between the delivery service and the consumer are central to reducing failure rates of home deliveries. Local collection-and-delivery points (CDPs), where consumers can collect their failed home deliveries, are another potential solution.

Critical issues for implementation

- Supermarkets, logistics service providers and parcel delivery companies should collaborate more to build an integrated solution for home deliveries, enabling a compelling user experience.
- Research and development should be trained on finding new integrated home delivery systems.
- The aspects of competition law that may have an impact on integrated home delivery system should be investigated, clarified and, if necessary, updated.
3.3.2 Retiming deliveries

Value for money: very good
Costs: inexpensive
Congestion reduction potential: good

A significant reduction in traffic congestion can be obtained by widespread ‘retiming’ of deliveries and collections to less busy times of the day and, where appropriate, nights. This displaces freight traffic to outside the peak. This was done successfully in London during the 2012 Olympics. Retiming of deliveries can take large lorries out of congested areas at the worst times which also leads to less risk of collisions with cyclists and pedestrians, less fuel consumption and better air quality. However, it should also be noted that ‘convenience stores’ and other ‘just-in-time’ operations usually do not have large back-up storage. Consequently, the timing of deliveries is often critical to the availability of products on such businesses’ shelves, meaning out-of-hours deliveries are not an option in all cases.

Re-timing of deliveries is only likely to reduce by a small amount the total volume of journeys into city centres; they are being displaced mainly to other times of the day, rather than eliminated from the system altogether. The more significant gain is likely to arise from the removal of stationary freight vehicles on busy roads during the peak: significantly enhancing traffic flows and reducing urban congestion.

There are low costs attached to this measure, such as modifications to signage. The overall value for money is excellent – but there may be cost to retailers in having to employ staff outside normal working hours.

The main barriers to adoption of retimed deliveries are public antipathy to large heavy vehicles in cities during the night and incompatibility with restrictions currently imposed by local government. Curfews would need to be lifted in order to allow out-of-hours deliveries and recent innovations that enable much quieter operations should be promoted.

Critical issues for implementation

• Time restrictions should be lifted on out-of-hours deliveries in city centres.
• Local authorities should devise ways to promote best practice from operators, such as quiet operations, in order to make retiming more acceptable.

3.3.3 Improved logistics systems: urban consolidation centres (UCCs)

Value for money: moderate
Costs: expensive
Congestion reduction potential: good

The key purpose of urban consolidation centres (UCCs) is to avoid partially loaded goods vehicles from making deliveries in urban areas and thereby to reduce the total volume of goods vehicle traffic. This objective can be achieved by transshipping and consolidating goods at the UCC onto vehicles with high load factors for final delivery in the urban area.

This effectively means that a smaller number of higher-capacity vehicles can perform the same freight task as many partially-loaded, smaller vehicles.

There are a number of types of UCCs, although the greatest potential to reduce traffic appears to be where there are many business users. The involvement of the local authority can be useful and is usually justified on the basis of wanting to reduce traffic and environmental costs. The decision to make use of the UCC is typically a voluntary one and there is no single private body that is responsible for financing the UCC or enjoying its benefits. The financial costs tend to be shared unequally between the parties, with the local authority often taking on a disproportionate role. For reasons pertaining to finance, a substantial number of UCC trials operating the multi-user principle have been abandoned.

The measure offers good congestion reduction potential by reducing the number of small freight vehicles and vans entering shopping streets (by consolidating their loads at an out-of-town location) and by reducing traffic congestion caused by delivery vehicles parked in city streets.

One of the challenges of generating further use of UCCs is making them financially sustainable. A major factor is the extent to which the various participants (carriers, receivers and local authorities) are willing and able to meet the financial costs. This approach has been successful when linked to downtown restriction on large goods vehicles such as the low emission ‘Zone Verte’ in Paris.

Critical issues for implementation

• Incentives should be explored to encourage use of UCCs, including subsidies during their start-up phase.
• Other measures range from allowing UCC vehicles to use bus lanes, through to major restrictions such as the prohibition of all non-UCC vehicles from the specified delivery area; each of these should help to improve the efficiency of the UCC in question, enhancing the business case for investment.

3.3.4 Horizontal collaboration between operators

This measure is applicable to urban and inter-urban markets

Value for money: moderate
Costs: inexpensive
Congestion reduction potential: limited

If a freight vehicle returns to base empty, it does two journeys instead of one for a single freight task. Under some traffic conditions, this unnecessary additional journey can significantly add to congestion, as well as increasing fuel consumption by as much as 70%. Any measure designed to reduce empty running will reduce the number of freight vehicles on the road.

In the UK, empty running decreased steadily from the mid-1980s to a low of 25% in 2001. Since then it has increased again, for reasons that are not evident.

An effective way to reduce empty running is ‘horizontal’ collaboration between freight operators. There are various possible versions of this, but they all amount to two or more operators combining (part of) their vehicle fleets in order to improve the efficiency of the combined freight operation and reduce overall fuel consumption.

Because of operational constraints, it is difficult to find individual opportunities for one operator to provide a back load for another. Horizontal collaboration requires operational synergy between partners in terms of product characteristics, types of vehicles used and regions serviced.

In order to generate substantial savings through collaboration, it is necessary to synchronise overlapping freight flows.
of multiple independent shippers, as is proposed by the CO3 project (an EU-funded research project into collaboration in freight, entitled Collaboration Concepts for Co-modality). Information technology solutions are central to this so that participants can share information about daily flow volumes, plan loads, manage or coordinate delivery time windows between partners, and manage transport.

Urban consolidation centres, described in Section 3.3.3, are a special case of horizontal collaboration.

The ‘physical internet’ proposed by Montreuil (2011) has been suggested as an extreme version of horizontal collaboration that attempts to ‘transform the way physical objects are handled, moved, stored, realised, supplied and used; aiming towards global logistics efficiency and sustainability’. It achieves this by applying concepts from internet data transfer to real-world logistics processes.

Implementation of the measure would reduce empty running of vehicles and, by extension, the volume of vehicles on the road. As a market-led solution to congestion, it would come at little cost to the taxpayer while case studies already demonstrate the business case in which substantial cost savings (driver hours, fuel consumption) justify investment by industry.

The barriers to it are willingness of operators to collaborate, and lack of IT systems that coordinate collaboration activities. This intervention would have a stronger effect on fuel consumption and emissions than traffic congestion.

Critical issues for implementation

- Research and pilots are needed that trial the development, at scale, of working systems of multilateral collaboration. Business models that explain how costs and benefits of cooperation are shared equitably between competitors should be explored as part of this.
- The aspects of competition law that may hinder collaboration between operators should be investigated, clarified and, if necessary, updated.

3.3.5 Higher-capacity urban delivery vehicles

Value for money: moderate
Costs: expensive
Congestion reduction potential: moderate

Increasing the capacity of urban delivery vehicles decreases the volume of journeys that need to be undertaken and should reduce traffic in cities and town centres. Deliveries to convenience and department stores tend to originate from regional distribution centres and involve ‘multi-drop’ deliveries in which the vehicle delivers a partial load to a number of stores in succession. The types of vehicles performing this freight task are often restricted in length, height, parking and turning space in city centres, meaning that relatively small, rigid delivery vehicles are often used.

Use of short semi-trailers instead of rigid lorries can substantially increase vehicle capacity and reduce vehicle trips. Trailer capacity can be increased further by use of double-deck urban vehicle configurations, as implemented by Boots, and trailer length can be increased further through application of trailer axle steering technologies.

The main barriers to the implementation of higher-capacity, reduced frequency urban delivery journeys are physical space requirements in loading bays and parking space restrictions at convenience stores. This is a supply-side measure that offers good congestion reduction potential. The costs of providing better unloading facilities for operators in updating their fleets mean that this measure offers only quite good value for money.

Critical issues for implementation

- Local authorities can assist freight operators by providing adequate parking for lorry unloading at convenience stores.

INTER-URBAN SOLUTIONS

3.3.6 Higher-capacity vehicles: long-haul operations

Value for money: limited
Costs: expensive
Congestion reduction potential: limited

The use of higher-capacity vehicles for long-haul operations increases the productivity of individual journeys to reduce the volume of vehicles needed on the road, removing some traffic but with the primary application of lowering fuel consumption.

There are a variety of different approaches, from the use of longer semi-trailers to introducing modular long vehicle combinations.

Throughout Europe, the European Modular System (EMS) has become accepted as the norm for higher capacity long-haul vehicles. This system provides for a number of modular longer vehicle combinations, with two or more articulation joints, generally up to 25.25m in length. The principal benefit of EMS vehicles is their larger volume, rather than increased weight. Such vehicles operate freely in Scandinavian countries and the Netherlands, with an ongoing trial currently underway in Germany.

In the UK, such vehicles are prohibited on the grounds that they would exceed the legal maximum length. Instead, the government is currently conducting a 10-year trial on ‘longer semitrailers’, which are 2.05m longer than conventional 13.6m long semitrailers and have an additional 15% payload capacity. These vehicles operate trailer axle steering systems to enhance manoeuvrability and satisfy turning circle requirements.

Higher-capacity long haul vehicles are technically feasible now, with the main barrier to their implementation being public resistance to the notion of longer vehicles on UK roads. Australia has introduced programmes to monitor the use of designated routes by high-capacity vehicles. This has had the effect of reassuring the public on their performance and impact, although full road trains are reported as being less popular than ‘double bottom’ trucks (dump trucks with double trailers).

The costs attached to implementation of this measure include legislation and
enforcement costs and the need for additional parking infrastructure. The congestion reduction impact on trunk routes is likely to be moderate, resulting in a measure that offers some potential but is poor value for money.

**Critical issues for implementation**
- Legislation should be explored that allows higher-capacity vehicles to use the UK’s trunk road network.
- Government should consider implementing an ‘Intelligent Access Program’ (IAP), such as is used in Australia, to monitor use of designated routes by high-capacity vehicles. This would give politicians, road asset owners and the general public the confidence that these high-capacity vehicles are travelling on the correct routes at the correct times, with allowable loads and travelling below a set speed threshold.

### 3.3.7 Restructuring of logistics networks

**This measure is applicable to urban and inter-urban markets**

- **Value for money:** limited
- **Costs:** very expensive
- **Congestion reduction potential:** limited

There are various ways that logistics networks can be restructured to reduce the road freight intensity of the UK economy (measured by the ratio of road tonne-kms to GDP).

About 90% of goods imported to the UK arrive by sea, with some 75% containerised. The UK’s two major container ports handle more than seven million ‘20 foot equivalent units’ (a type of container) per annum.

Only 30% of this volume is transported inland by rail (a comparatively less congesting mode) and often the final movement of that volume is conducted by road: so the vast majority of container movements occur by road.

Port centric logistics (PCL) is a measure that manages demand more effectively to reduce the overall number of freight trips that need to be undertaken. PCL bases distribution centres at ports, with container loading and unloading in the port environment. This minimises the inland movement of containers by removing the need for journeys from ports to regional distribution centres and back again (otherwise known as ‘empty running’). It therefore reduces tonne-km moved (which also reduces energy costs and emissions) and the total number of road journeys being made.

A combination of widespread use of PCL (moving distribution centres (DCs) from the centre of the country to the ports) with coastal shipping used to transfer freight between DCs located at ports could potentially reduce road freight movements significantly.

At scale, it is likely to be market-led, at little cost to the taxpayer, but would take between 10–20 years to implement in light of the major coordinated modifications to logistics infrastructure that would be needed across the country. At best, therefore, the measure is likely to be able to deliver only limited benefit before 2030. In the longer-term, the business case would be made principally on the basis of substantial reductions in fuel consumption for operators rather than congestion reduction. Yet, it would still cause much disruption and require a great deal of upfront investment.

At an aggregate level, a limited amount of congestion is likely to be saved from the introduction of the measure; at a local level, particularly in and around ports, the effect might be greater.

**Critical issues for implementation**
- Government should work with industry to assess the costs and benefits associated with moving to a ports-centric model for the UK and identify the most effective applications of this approach.
4. The potential contribution of a package of measures by sector
The transport congestion challenge
4. THE POTENTIAL CONTRIBUTION OF A PACKAGE OF MEASURES BY SECTOR

Packaging technologies and measures together can serve two purposes. Firstly, packaging can offer synergistic gains, meaning that the effect of a number of measures combined together is greater than the sum of their individual contributions. This applies to the reduction of congestion but can also relate to other public policy goals, such as reduction of carbon emissions or improvements to safety. Secondly, packaging measures can allow the barriers to one measure to be compensated for by another.

The use in London of congestion charging revenues to enhance the bus network provides a useful illustration of both of these principles. An improved bus network made the impact of congestion charging on reducing congestion more effective, because it became easier for more car drivers to switch to bus use. The availability of an enhanced bus network helped reduce the major barrier of public antipathy towards pricing. At the same time, the availability of charging revenue made it possible to overcome the financial barrier to enhancing the bus network.

These principles apply to all four of the sectors considered by the working group and, to a lesser extent, to packaging between the sectors.

Within the urban road sector, efficient road pricing and reformed bus services would support one another much as they did with congestion charging in London. The implementation of bus rapid transit and light rail would go further in reinforcing the congestion-relieving impacts of pricing, since they would provide high-quality alternatives to the car. The main barrier to them is finance, which can again be overcome using the revenues from efficient road pricing. The connected car and car clubs measures are less central to such a package. However, a road network in which the vehicles using it are ‘connected’ would enable the traffic which continued to use the network under efficient pricing to do so even more efficiently. Where efficient pricing encouraged marginal users to reconsider their ownership of a car, car clubs could offer an efficient alternative.

Within the inter-urban road sector, the most effective measures are efficient pricing, managed motorways and, to a lesser extent, the connected car. The main benefits of packaging are between the first two: managed motorways would increase the capacity of the most critical parts of the network; efficient pricing could then ensure that traffic is diverted from less efficient roads to use these enhanced routes, while avoiding the increase in overall demand which might otherwise occur. At the same time, the revenues from efficient pricing could help meet the costs of the managed motorway programme.

Within the rail sector, rolling stock reform and the application of CCC and DAS technologies are to some extent appropriate to different contexts. Rolling stock reform is the most appropriate solution in provincial settings where there is still scope to increase capacity, while CCC and DAS are principally needed in London and on inter-city routes where train capacity has already been maximised. Even so, there will be some parts of the network where the two approaches to capacity enhancement can reinforce one another.

Home delivery takes private car trips off the road during business (or peak) hours and replaces them with approximately 1/20 or 1/15 of the number of delivery vans. Such delivery trips tend to operate in residential areas during timed slots, often in the evening. The use of larger, more efficient urban vehicles to deliver freight to city stores and businesses would reduce lorry traffic and the retiming of deliveries would take these lorries off the road during business hours. The combined effect of these measures would reduce both the numbers of cars and lorries on the road during peak hours.

Between the road and rail sectors, the principal arguments for packaging are to ensure that rail offers an effective alternative to road use where the latter is most congested.

Efficient road pricing would send signals to drivers to encourage them to seek such alternatives; it can also provide the finance necessary to support many of the rail measures.

Between the passenger and freight sectors, the most important consideration is that freight, on both road and rail, can benefit significantly from congestion relief in passenger transport. Freight measures should thus be designed to ensure that they capitalise on these benefits. To a lesser extent, recommended freight measures such as home deliveries and freight consolidation would help relieve road congestion; these benefits should be taken into account in planning efficient pricing and enhancements to public transport.

Across all the sectors, digital systems technologies can provide an integrative framework. Perhaps the most important message is that the maximum benefits will only be gained if the solutions for the different sectors are planned together – between urban and interurban, between road and rail and between passenger and freight.
Acknowledgements

This paper was produced by the following members of the Academy’s Transport Community of Practice (CoP) at the request of the Academy’s Engineering Policy Committee. Given that the paper covers a wide range of technologies and policy measures, it should be noted that those listed do not necessarily concur with all the points made in the paper.

Lead authors
Professor Andrew McNaughton FREng
Chair of the Academy’s Transport CoP
Professor Tony May OBE FREng
Emeritus Professor of Transport Engineering, University of Leeds

Contributing Fellows
Professor David Anderson FREng
Emeritus Professor, University of Warwick
David Bayliss OBE FREng
Trustee, RAC Foundation
Clive Burrows FREng
Group Engineering Director, First Group Plc
Professor David Cebon FREng
Professor of Mechanical Engineering, University of Cambridge
Dr Chris Elliott MBE FREng
Director, Pitchill Consulting Ltd
Rod Muttram FREng
Director, Fourth Insight Ltd
Tony Roche FREng
Independent Railway and Engineering and Management Consultant
Derek Turner CBE FREng
Visiting Professor, University College London

The authors of the paper would also like to thank Professor Richard Allsop OBE FREng, Roger Ford, Professor Stephen Glaister CBE and Professor Rod Smith FREng for their helpful comments during the preparation of the paper.
Appendix 1. Other measures considered as part of the study

Though the chief focus of this paper is on ‘frontrunners’ considered to offer the greatest potential to reduce congestion before 2030, there were a range of other measures scrutinised in the evidence gathering stage. In this section the group provides a brief summary of some of these measures and explains why they were not given frontrunner status.

AUTONOMOUS VEHICLES

Autonomous vehicles have received much publicity recently, not least because of the government funding for formal trials in four UK cities\(^5\). But the concept of autonomy in a vehicle is not new and encompasses a spectrum of technological functionality; ‘low autonomy’ cars are already in wide commercial circulation and aid the driver by automating a range of tasks inside the vehicle while ‘high autonomy’ vehicles, where the car can drive its entire journey without any human involvement, are predicted for mass deployment in the next 15–20 years.

In so far as congestion reduction is concerned, the most promising application of the technology is the way it enables the platooning or convoying of a group of synchronised vehicles: this reduces the amount of space needed between successive cars and permits a more intensive use of the existing road capacity. This application is seen as particularly relevant to motorways and therefore an inter-urban context. There may also be benefits in an urban context but more evidence will be needed that the UK trials should provide.

However, autonomous vehicles are not likely to substantively reduce congestion in the period before 2030. In order for major benefits to be achieved on the motorway, and capacity to be used more intensively, large portions of the vehicle fleet would need to be platooned. Yet, in the short term, it seems far more likely that a mixed fleet, of mainly conventional and some autonomous vehicles, will endure. This would severely limit results. Furthermore, there are major infrastructural challenges attached to discharging platoons of autonomous vehicles from free-flowing traffic conditions (like motorways) on to the rest of the road network: as vehicles slow down on the approach towards intersections, bottlenecks would occur unless major road-widening schemes were undertaken. The scale of investment needed for this to happen at a national level is likely to take longer than the next 15 years to implement.

TELECOMMUTING

In the same way as the internet has the potential to reduce the volume of physical shopping trips (see Section 3.3.1v, home delivery solutions), so too can virtual conferencing and remote working replace some physical commuting trips and therefore lower congestion in the peak. This is an argument which has much wider implications and goes to the heart of the debate on future mobility, informing concepts such as ‘peak car’ which suggest that the motor car is offering diminishing value for consumers. On the one hand, there is evidence, not least from the 2012 Olympic Games in London, that telecommuting can have an impact on peak-time commuting. Yet, on the other hand, it is also worth pointing out that the introduction of smart technologies (smartphones, laptops and tablets) could potentially encourage workers to travel more: the opportunity cost of spending unproductive time travelling to the office can now be used meaningfully for work purposes.

DIVERTING FREIGHT TO THE RAIL NETWORK

Rail only accounts for about 9% of domestic freight movements. In theory, moving more road freight on to the rail network, which uses fewer, higher-capacity and energy-efficient vehicles to deliver the same volume of freight, would generate an overall reduction in congestion. The problem with this strategy, however, is that the parts of the rail network most suitable for the take-up of freight are also those parts of the network under most pressure from passenger transport. Given the need for the rail network to absorb more passenger traffic, not least because of the partial modal shift which efficient pricing would stimulate, this puts this measure in direct conflict with other recommendations in the paper.

One option would be to retimé rail freight delivery to the night time, so that it competes less with peak-time passenger traffic. Nevertheless, the scale of modal shift towards rail freight that would be needed to make a significant national contribution to congestion reduction would require substantial investment in infrastructure. Because freight tends to be moved by road for the last mile of its journey anyway, a national network of new multi-modal termini would still need to be built at railway stations in order to transfer pallettes on to lorries. Such a network would take a significant amount of time to build and probably run up against the same investment challenges as restructuring towards ports-centric logistics.

INCREASED MOBILITY

There is now considerable investment in improvements for walking and cycling, particularly in London. This should be encouraged when planning any urban environment but it will only help to reduce congestion if a significant shift away from private car use can be realised.
Appendix 2. References and endnotes


vii Network Rail, Delivering a better railway for a better Britain: our plans for 2014 to 2019. http://www.networkrail.co.uk/publications/better-railway/


See also Research Annexes (Vol 3) to the Eddington study – (December 2006) Transport Demand to 2025 and the Economic Case for Road Pricing and Investment, p. 118


x ibid


xvii ibid


xx Table TRA0302, Road statistics, Department for Transport. https://www.gov.uk/government/collections/road-traffic-statistics


xxiii Table TRA0104, Road traffic by vehicle type and road class 2014, Road statistics, Department for Transport (DT). https://www.gov.uk/government/statistical-data-sets/tra01-traffic-by-road-class-and-region-miles

The transport congestion challenge 35
Royal Academy of Engineering

As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering.

We have four strategic challenges:

**Make the UK the leading nation for engineering innovation**
Supporting the development of successful engineering innovation and businesses in the UK in order to create wealth, employment and benefit for the nation.

**Address the engineering skills crisis**
Meeting the UK's needs by inspiring a generation of young people from all backgrounds and equipping them with the high quality skills they need for a rewarding career in engineering.

**Position engineering at the heart of society**
Improving public awareness and recognition of the crucial role of engineers everywhere.

**Lead the profession**
Harnessing the expertise, energy and capacity of the profession to provide strategic direction for engineering and collaborate on solutions to engineering grand challenges.