OXFORDSHIRE COUNTY COUNCIL

# Science Transit Strategy

June 2016

integrated transport planning

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## Glossary of Terms

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|---|---|
| **ATOC RJIS** | Association of Train Operating Companies' Rail Journey Information Service. The IT system used to provide the timetables, fares, route planning, ticketing and transaction services needed to buy rail tickets and complete travel enquiry requests in the UK. |
| **Autonomous vehicles (driverless vehicles)** | Vehicles able to sense the road environment around them and navigate themselves to destinations by negotiating other traffic and road hazards. Vehicles are being manufactured with increasing degrees of autonomy and are anticipated to become fully driverless within the next 10-15 years. |
| **Bleeding edge** | Technologies considered so new that they could have a high risk of being unreliable and require considerable investment in order to make use of them. A proportion of bleeding-edge technology will find its way into the mainstream (e.g. email). |
| **Crowd sourcing** | A distributed problem-solving and production process that involves outsourcing tasks to an undefined public ('crowd') rather than a specific entity. |
| **Data mining** | The computational process of discovering patterns in large data sets involving methods that combine artificial intelligence, machine learning, statistics, and database systems. |
| **Digital exhaust** | Virtual 'trails' of data that are generated by individuals and things through their electronic interactions and transactions with both private and public sector organisations. |
| **Disruptive innovation** | Innovations which help to create new markets or value chains, and eventually disrupt existing markets and value chains (over a period of years or decades), to the extent they displace earlier technologies. E.g: the DVD player was a disruptive innovation for VHS players. |
| **GNSS** | Global Navigation Satellite System (GNSS) receivers commonly-used for surveying and navigation. |
| **GPS** | A space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more global positioning satellites. |
| **Hackathon** | A hackathon (also known as a hack day, hackfest or codefest) is an event, typically lasting between a day and a week, in which computer programmers and others involved in software development come together to create usable software. Transport hackthons can focus on building exciting transport-related apps, visualisations, or conduct insightful data analysis. |
| **Innovate UK** | The organisation formerly known as the Technology Strategy Board, which is responsible for disbursing innovation funding, mentoring and networking in order to accelerate the uptake of innovative technologies and practices across UK industrial sectors. |
| **INRIX** | One of the major global providers of live traffic and road network incident data, which is also increasingly being made available for analysis and transport modelling. |
| **Intelligent Mobility** | More responsive and predictive transport systems that:<br>Better meet the needs of an inclusive society by efficiently and sustainably connecting goods, services, events and people;<br>Optimise the use of available infrastructure capacity to maximise the time, energy and resource efficiency of travel and transportation.<br>Are more readily connectable and flexible - promoting seamless intermodal journeys that can flex according to disruptions, changes in schedule or priority, and competing demands for seemingly unrelated services<br>Generate smaller environmental and social impacts than current transport systems |
| **Internet of things (IoT)** | The proliferation of devices and ICT applications connected to the internet (such as smart meters, smart grids, and smart transport services) based on sensor networks and machine-to-machine communication. The number of networked sensors and information generators is growing at over 30% per annum, creating a rapidly expanding 'Internet of Things' (IoT) that is projected to contain as many as 50 billion devices by 2020. |
| **Interoperability** | The ability of different networks or discrete, closed systems (e.g. bus, rail, coach) to integrate and work together in order to allow for the seamless transfer of information, people and things. Interoperable transport systems are expected to form the basis for future intelligent mobility systems. |
| **Knowledge Spine** | A linear corridor running North – South along the alignment of the A34 dual carriageway between the M40 and M4 motorways. It runs from Harwell and Culham in the south, to the life science Bio Escalator in Oxford, on to the advanced engineering hub at Begbroke, and through to Bicester in the north. |
| **Living Lab** | An experimental real-world environment being set-up in Oxfordshire that is intended to support the accelerated design, prototyping, and testing of new technologies and mobility systems. |
| **Mobility as a Service** | The concept through which the movement of people and things (e.g. goods and services) can be bought and sold on a pay-as-you-go basis, or through subscription models. These approaches have become increasingly common in the world of software and technology, and are anticipated to underpin the development of intelligent mobility services. ITS Europe defines Mobility as a Service (MaaS) as a mobility distribution model in which a customer's major transportation needs are met over one interface and are offered by a service provider. |
| **Open data** | Open data is information that is available for anyone to use, for any purpose, at no cost. |
| **OXybeles** | The development of a local "catapult" to provide a central point through which local authorities can develop partnerships with Universities and business to develop innovative transport led approaches and technology that enhance services, manage infrastructure more efficiently and provide a basis for local business to address problems thus reducing burden on public sector finances. |
| **Sentiment data** | Subjective information collected through social media and other sources that can be mined using natural language processing, text analysis and computational linguistics techniques. |
| **Transport Systems Catapult** | The organisation set up by InnovateUK to accelerate the UK's development of intelligent mobility systems and their export to other locations in the world. |
| **UTMC** | Urban Traffic Management Control systems are used to manage traffic lights, bus and light rail priority, and car parks in UK cities. |

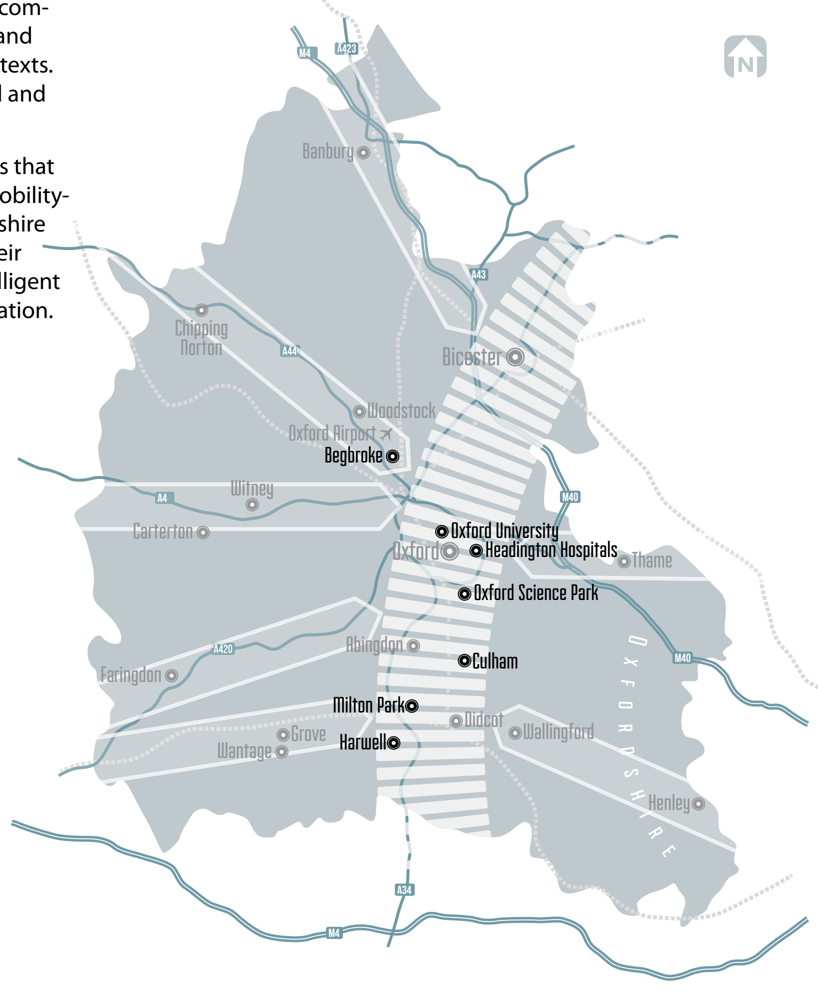
# 1 SCIENCE TRANSIT – FUTURE MOBILITY IN OXFORDSHIRE

1.1 A fresh approach to planning and delivering local transport is needed if we are to successfully, and sustainably, connect the places in Oxfordshire where the majority of people will live and work over the coming 20 years. This is particularly true for the Oxfordshire Knowledge Spine (Bicester - Oxford - Science Vale UK), which the Oxfordshire Local Enterprise Partnership's (LEP) Strategic Economic Plan (SEP) identifies as the key driver for local economic growth. Other parts of Oxfordshire will also be key contributors to the success of the county's growth strategy. Banbury in particular is a hub for employment in its own right. Banbury, Witney and Carterton each have individual area strategies which provide housing for significant numbers of people who work in the Knowledge Spine. **Science Transit relates to connectivity within, to and from the Knowledge Spine**.

1.2 A number of strategic challenges, which also present significant opportunity for purposefully directed growth and local improvement, emerge in relation to this area and its connectivity:

- The anticipated scale of housing and employment growth will place significant additional demands on the county's transport infrastructure:
  - With an integrated approach to transport and land use planning, major new developments can be located and designed to support new transport services, providing the catalyst for change and bringing benefits to existing communities
- Reducing carbon emissions to address climate change, requires a radical change in the way transport is provided and used:
  - Over the next 20 years, new, innovative products and systems will create a very different environment for mobility, with new ways of travelling and more efficient use of time, vehicles and space
- Travel from highly desirable and affluent areas, predominantly rural market towns and residential hinterlands, is contributing to rising traffic levels and road congestion. Predicted local economic and population growth is likely to increase demand for car travel in the absence of viable and equally attractive alternatives, placing greater strain on existing networks:
  - There are planned improvements to nationally important road, rail, and air connections that run through the County and serve local, regional and strategic national mobility needs. These will make it easier for people to travel through the county of Oxfordshire, as well as get to Heathrow and London. These improvements are likely to make the county an even more attractive location for businesses and people but may increase traffic volumes on local feeder roads.
- Continued rapid development of technology and communications will further accelerate the collection and transfer of data in both business and personal contexts. Much of the data in Oxfordshire is currently closed and not integrated:
  - More intelligent, data-driven transport systems that better integrate with personal and business mobility-needs are widely expected to emerge. Oxfordshire has an opportunity to be at the forefront of their emergence by acting as a live test bed for intelligent mobility system development and implementation.

The Oxfordshire Knowledge Spine



1.3 Science Transit is a direct response to these challenges. It defines a high-level vision, and outline roadmap, for the development of better-integrated, high quality mobility systems that both serve the Oxfordshire Knowledge Spine and connect it with the rest of the County. We envisage a future system made up of four main elements:

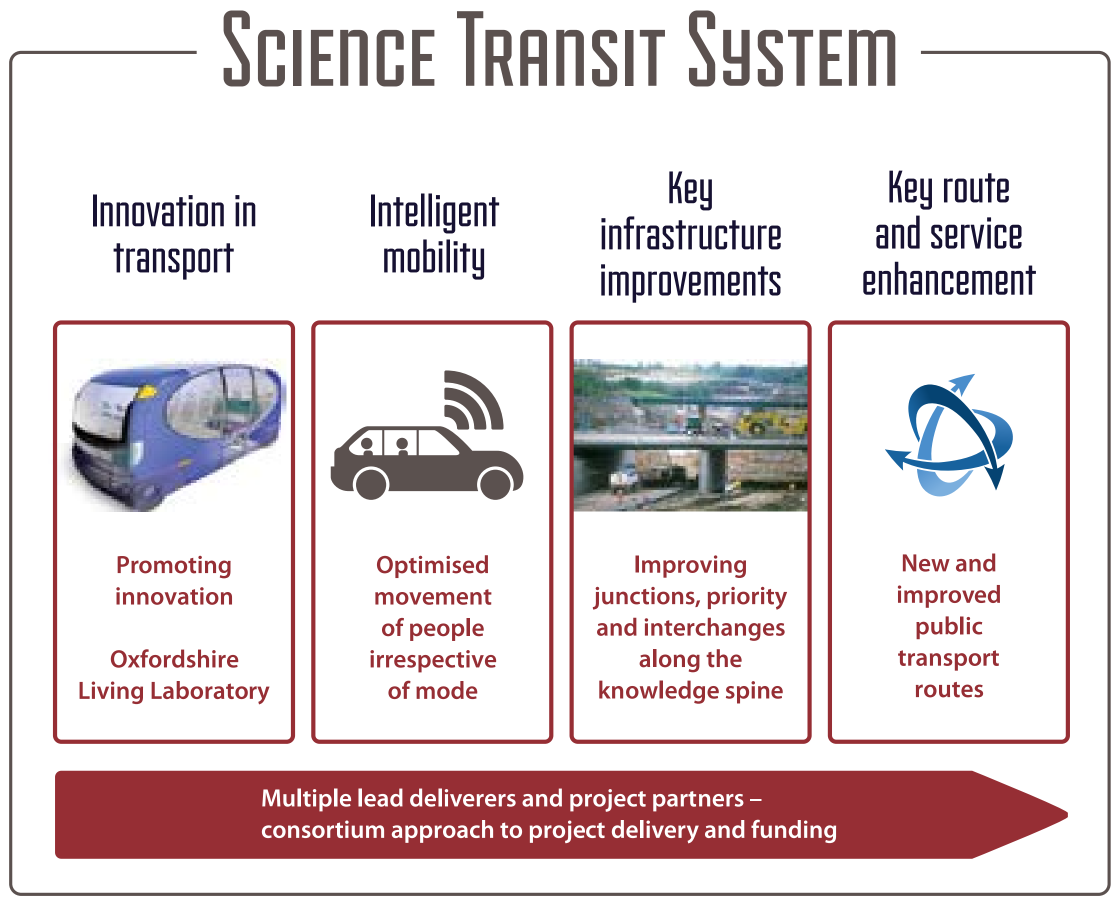
- Projects which **promote innovation** in mobility and integrated transport delivery.
- Projects which **encourage intelligent mobility** and opening Oxfordshire's data to promote research and enterprise.
- **Key infrastructure improvements** which will improve connections between key areas along the Knowledge Spine, for example, upgrading pinch-point junctions and constructing new rapid transit lanes. These infrastructure projects will sometimes be led by opportunities in funding streams.
- **Route enhancements** which will improve connections between key locations along the Knowledge Spine including new public transport routes and improved frequency of services on existing routes.

1.4 Science Transit is aligned with the County Council's practically-focused strategies for improving the county's transport networks: LTP4, accompanying area strategies, bus, rail and cycle strategies.

1.5 By implementing Science Transit alongside the strategies described above, we aim to:

- Embrace new technologies and data innovation to unlock intelligent mobility, presenting information to all users to allow them to make truly informed choices about the way they travel.
- Accelerate local growth through innovative R&D, providing opportunities for forward-looking business and research organisations and their highly skilled workforces to test and bring new products and technology to market.
- Improve connectivity between places where people live, work and spend their leisure time, ensuring all aspects of the door-to-door journey are fast, reliable, seamless and affordable.
- Integrate transport and land-use planning to improve non-car-based mobility, creating an environment where sustainable travel is the simplest and obvious choice.
- Deepen public and private sector partnership delivery for the mobility of people and goods, harnessing the respective skills of the different partners to fund, develop and implement new and improved transport systems.

The diagram below illustrates how the Science Transit System works together with interdependent elements.



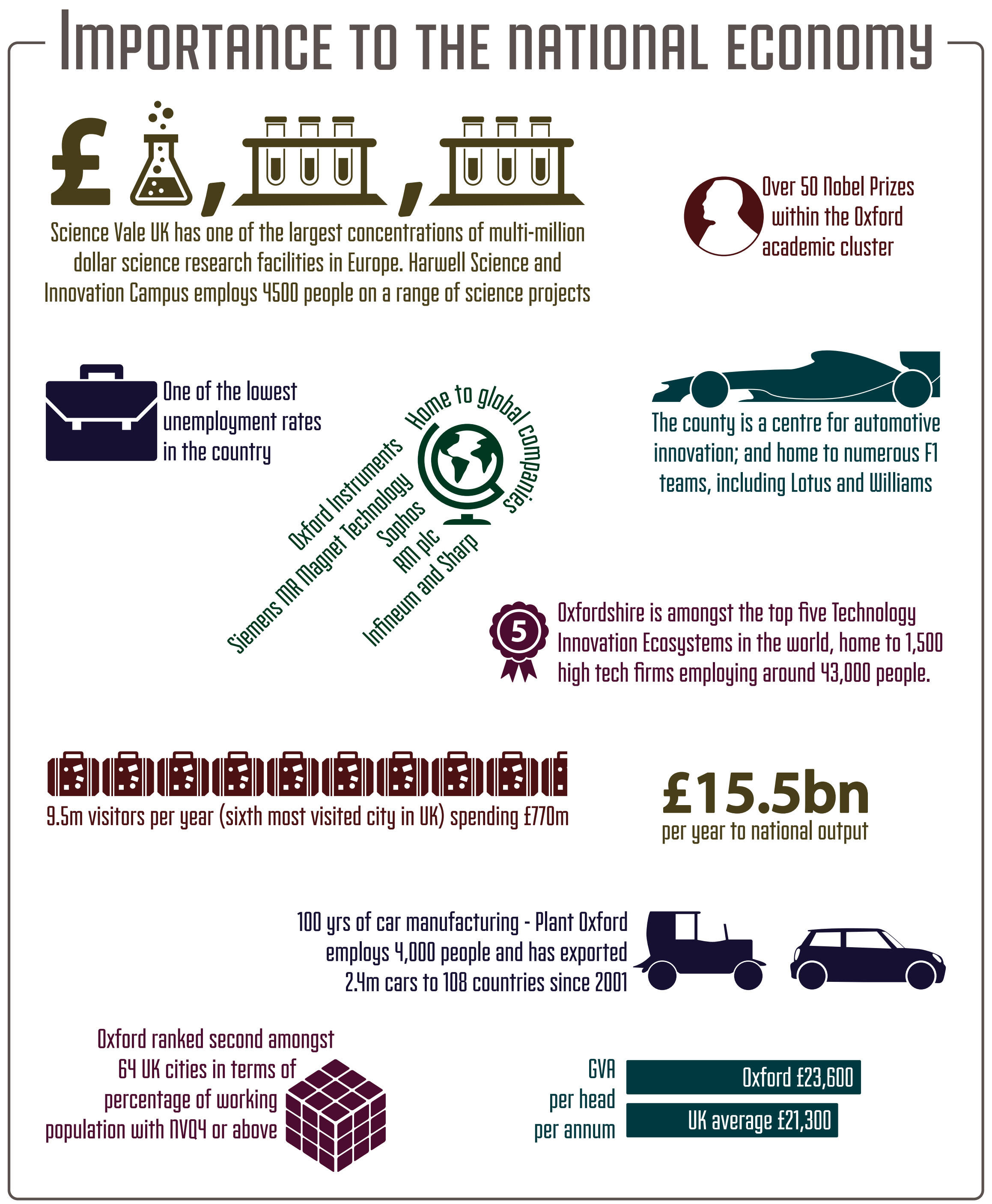



## 2 STRATEGIC CONTEXT

### Oxfordshire – a global centre for innovation

2.1 Oxfordshire is renowned across the globe for its academic excellence, innovative business culture and the quality of its built and natural environment. The county is home to Europe's largest concentration of multi-million pound science research facilities, underpinning our leading position in advanced engineering, manufacturing and life sciences, as well as sitting at the heart of the UK's growing international space cluster. We are therefore primed for investment with solid economic foundations and ambitious plans to support growth and the creation of sustainable jobs for local communities.

2.2 Oxfordshire makes a disproportionately large contribution to UK economic performance in relation to its geographic size and population:



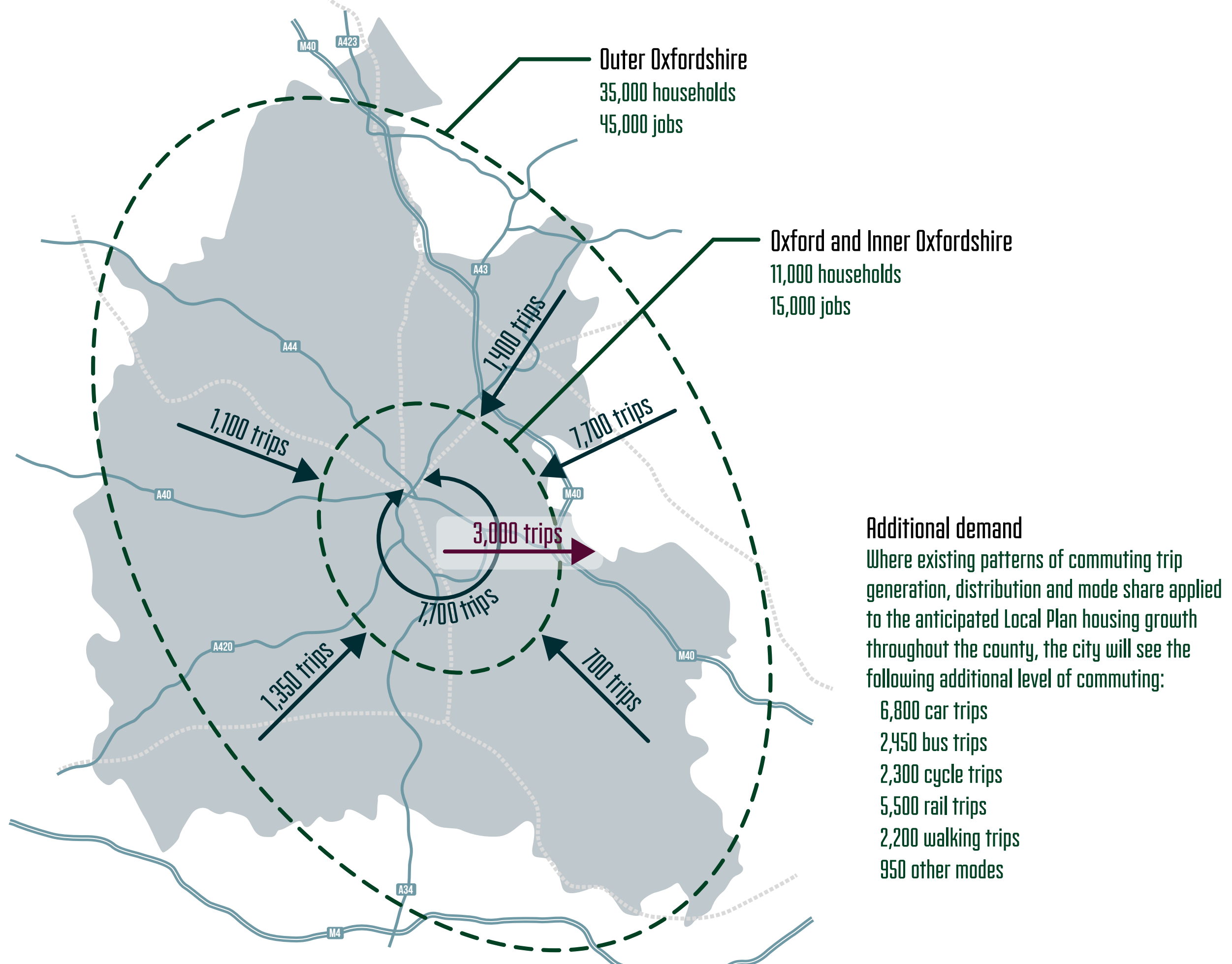
## A prosperous and growing county

2.3 Oxfordshire is currently one of the fastest growing, and most dynamic, areas in the UK. The City Deal, and Oxfordshire Local Enterprise Partnership's (LEP) Strategic Economic Plan (SEP), both set out a vision for accelerating economic growth to meet the needs of the area's science and knowledge-rich economy. Per Oxfordshire County Council's overarching growth plan, the aim is to place the county at the forefront of the UK's global growth ambitions to 2031 and beyond, through the delivery of:


Oxfordshire growth plans to 2031

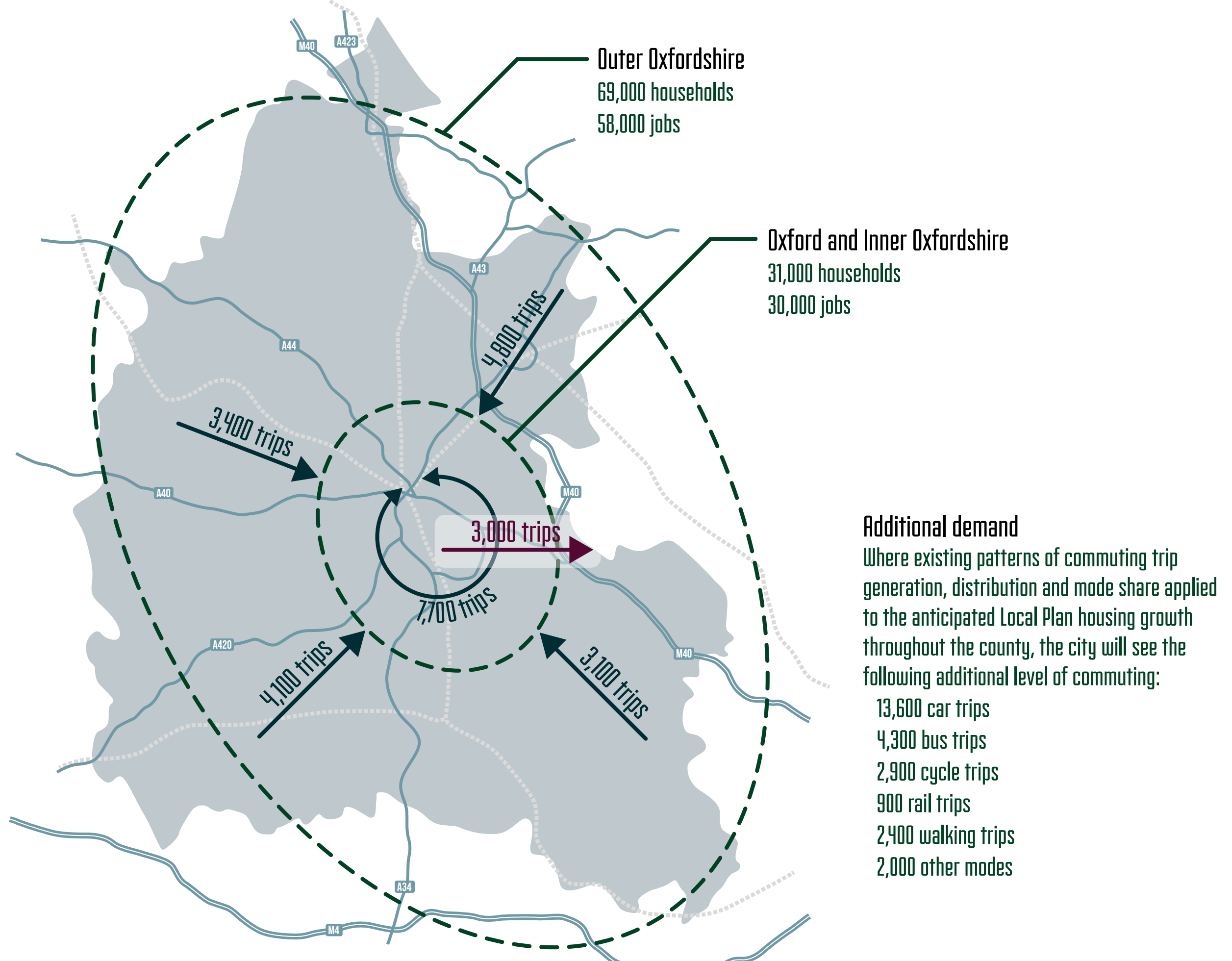
2.4 To date the various local planning authorities have progressed their Local Plans to different stages. The following diagrams summarise the main locations currently being envisaged as the focal points for future growth across Oxfordshire according to the Local Plans and the Strategic Housing Market Assessment (SHMA[1]):

### Scale of development and commuter trips to, from and within Oxfordshire 2031
(Local Plan growth)






### Scale of development and commuter trips to, from and within Oxfordshire 2031
(SHMA growth)




2.5 Government funding secured through the City Deal and SEP will be controlled locally to boost innovation and business growth, and create jobs in the technology and knowledge sectors in which Oxfordshire is already strong. This funding will also be used to unlock private sector investment, focusing on the following thematic objectives:

| | |
|---|---|
| Innovative Enterprise | Growth led by innovation, R&D and business collaboration |
| Innovative People | Specialised and flexibly skilled people across all sectors |
| Innovative Place | Quality of urban and rural environments and choice of homes |
| Innovative Connectivity | Freedom of movement and interconnectivity for people and things |

[1] Household growth levels taken from the SHMA and jobs forecast from Cambridge Econometrics study for Oxfordshire LEP. The SHMA is a technical study intended to help the Oxfordshire local planning authorities understand how many homes will be needed in the period 2011 – 2031. The Oxfordshire SHMA was commissioned jointly by all the Oxfordshire district councils supported by Oxfordshire County Council in 2013.

## The Knowledge Spine and Innovation Hubs

2.6 The creation of high value science-related jobs within the area defined as Oxfordshire's **Knowledge Spine** represents a cornerstone of the economic growth strategy enshrined in our City Deal and SEP. The Knowledge Spine cross-cuts the county; running from Harwell and Culham in the south, to the life science Bio Escalator in Oxford, on to the advanced engineering hub at Begbroke, and through to Bicester in the north.

2.7 Key innovation areas within the Knowledge Spine include those shown in the table.

2.8 Other parts of Oxfordshire will also be key contributors to the success of the county's growth strategy. Witney and Carterton are key commuter areas for the Knowledge Spine. Banbury, while a hub for employment in its own right, also provides housing for significant numbers of people who work in the Knowledge Spine. This emphasises the critical need for effective mobility links that connect locations situated within the Knowledge Spine to each other, as well as key residential and locations outside the Knowledge Spine into the area.

## Challenges of accommodating future growth

2.9 A key challenge moving forward is that our future growth plans are threatened by our current success. Existing patterns of development and high income levels have created an environment defined by high car ownership and high levels of car use – particularly outside of Oxford.

2.10 If our growth plans are to be achieved, we recognise the need to provide an effective mobility system that provides real alternatives to the private car and helps to reduce traffic congestion. This is a key aim of both this Science Transit vision, and Connecting Oxfordshire (LTP4). Importantly, the growth plans themselves provide an opportunity for changing travel patterns and making public transport more attractive and viable.

## Increasing demand for mobility

2.11 Unless public transport, walking and cycling can provide an equally or more attractive alternative, the predicted economic and housing growth will result in greater demand for private motor vehicle travel in the future – thereby increasing current levels of congestion and pollution.

| | |
|---|---|
| Science Vale Oxford | ▪ World class free-standing research establishments – at Harwell Enterprise Zone, Milton Park and Culham Science Centre.<br>▪ Growing settlements of, Didcot and Wantage / Grove and Abingdon-on-Thames provide a very attractive "town and country" lifestyle.<br>▪ Great Western Main Line, East-West Rail, A34 and M4 motorway also provide excellent links to Thames Valley, London and West of England. |
| Oxford | ▪ Thriving city of 150,000 people – combining a historic city centre, a wide range of cultural activities with world famous research-based universities.<br>▪ The area boasts major blue chip companies, business incubators and an existing industrial base around the Cowley motor manufacturing facility.<br>▪ The city is home to 40,000 students and attracts nine million visitors per year.<br>▪ Its dense urban bus / Park & Ride network and strong culture of cycling is the envy of many larger UK cities. |
| Bicester | ▪ A growing market town that is rapidly becoming one of the best connected places in the UK – thanks to excellent bus / coach services, expanding rail links to London / the Midlands and motorway connections.<br>▪ The availability of land for further housing and employment development will see the town grow in importance – especially for low carbon, sustainable living. |

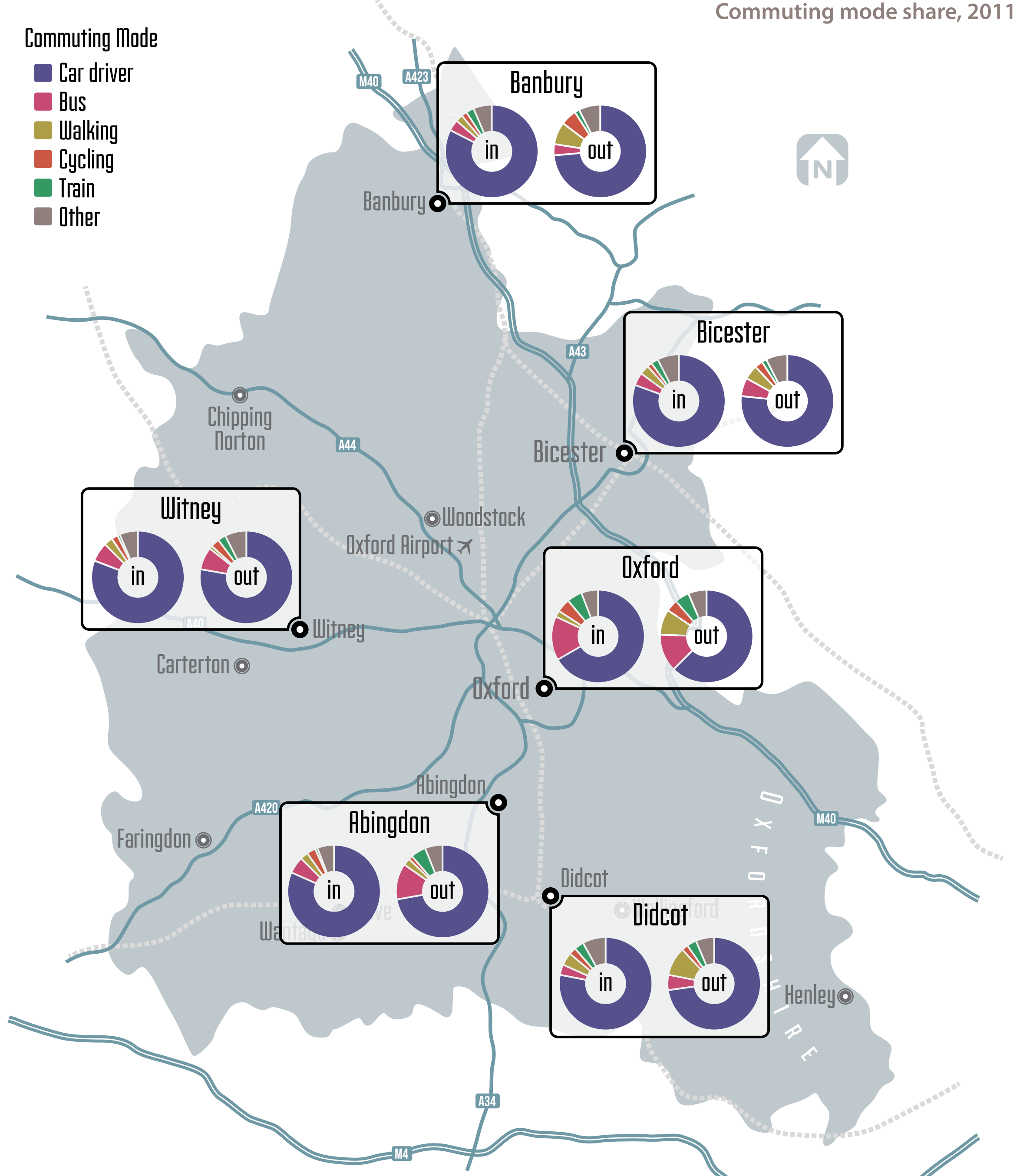


2.12 Car ownership in areas outside of Oxford is high, with, for example, 88% of households in South Oxfordshire owning a car, compared to the national average of 74%. Forecasts based on projected growth and residential development across the county predict the total number of cars owned will increase by approximately 70,000 vehicles (+19%) between 2013 and 2031 in Oxfordshire. This is higher than the growth of the number of households in Oxfordshire (16% between 2013 and 2031).

2.13 This high car ownership translates into high levels of car usage, including for commuting trips. Census data from 2011 reveals that around 80% of commuter trips to work from Banbury, Bicester, Witney, Abingdon and Didcot are made by car. Travel into Oxford is also predominantly by car, but 15% of trips into the city are by bus and 10% by bike and train.

2.14 All of the major settlements in Oxfordshire, and in particular Didcot and Oxford, see a greater proportion of people leaving by train each day to travel to work than the proportion arriving from nearby towns and villages. The higher proportions of commuter bus trips into Oxford, and emanating from Abingdon, demonstrate that where good public transport is provided, it can offer an attractive travel choice.

Commuting mode share, 2011 Census

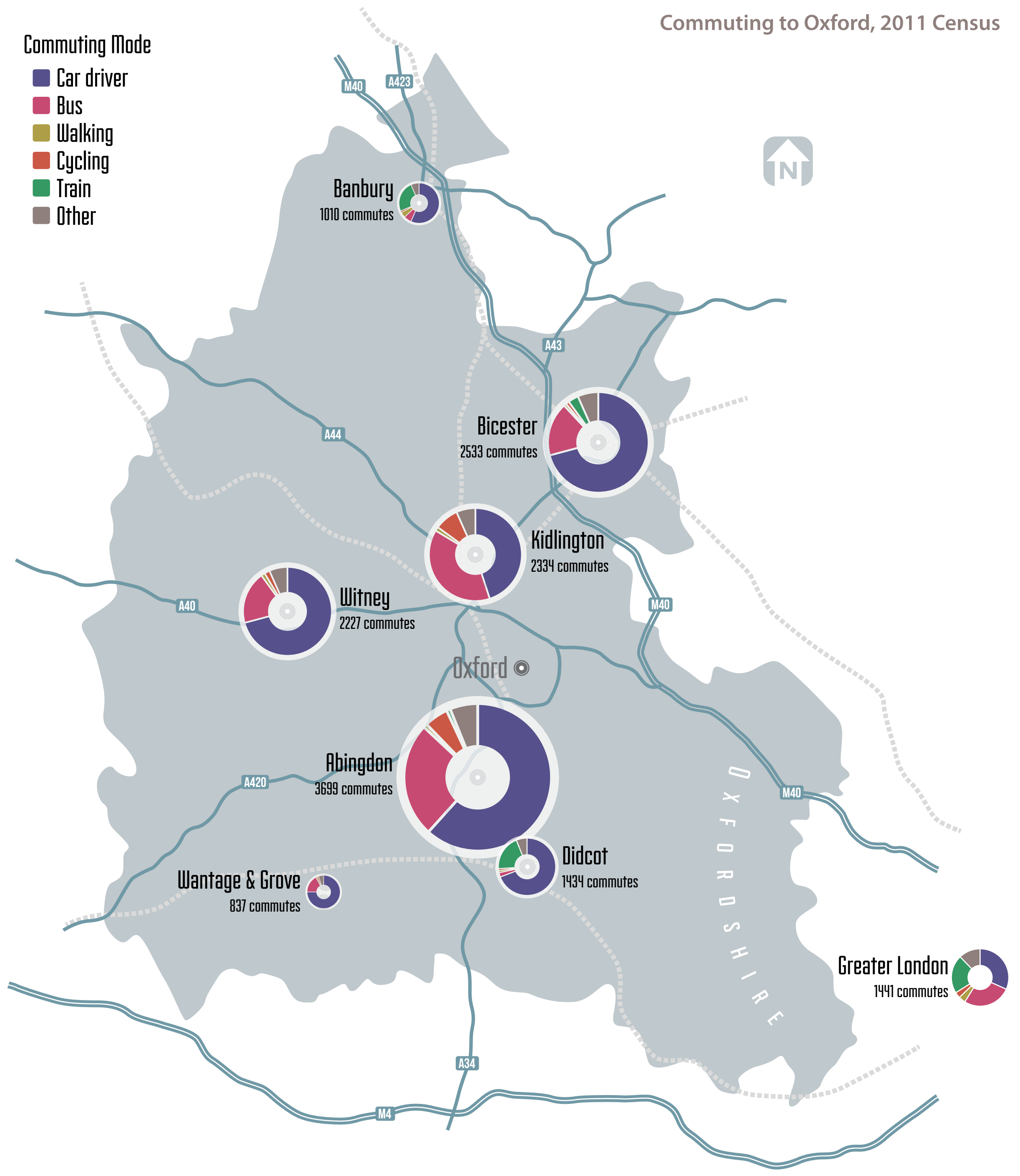


2.15 It is considered that high incomes and poor public transport accessibility are key reasons behind this trend, and improvements to public transport are essential if the growth in car use is to be reduced.

## Complex travel patterns

2.16 Although Oxford city centre is the largest urban area in the county, Oxfordshire presents a challenge to serve dispersed "polycentric" employment sites and housing development that have traditionally resulted in high levels of private car use because of difficulties in providing commercially viable public transport.

2.17 Reflecting its size, geographically central position in the county, and the range of employment opportunities available in the city, Oxford itself attracts workers from a wide geographic area. It is the main commuter trip attractor in the county, accounting for around 13,000 passenger car movements each weekday peak hour morning. As well as commuters, Oxford attracts tourists from all over the world. It was the seventh most visited town or city in Britain in 2013; attracting around nine million visitors per annum in total.

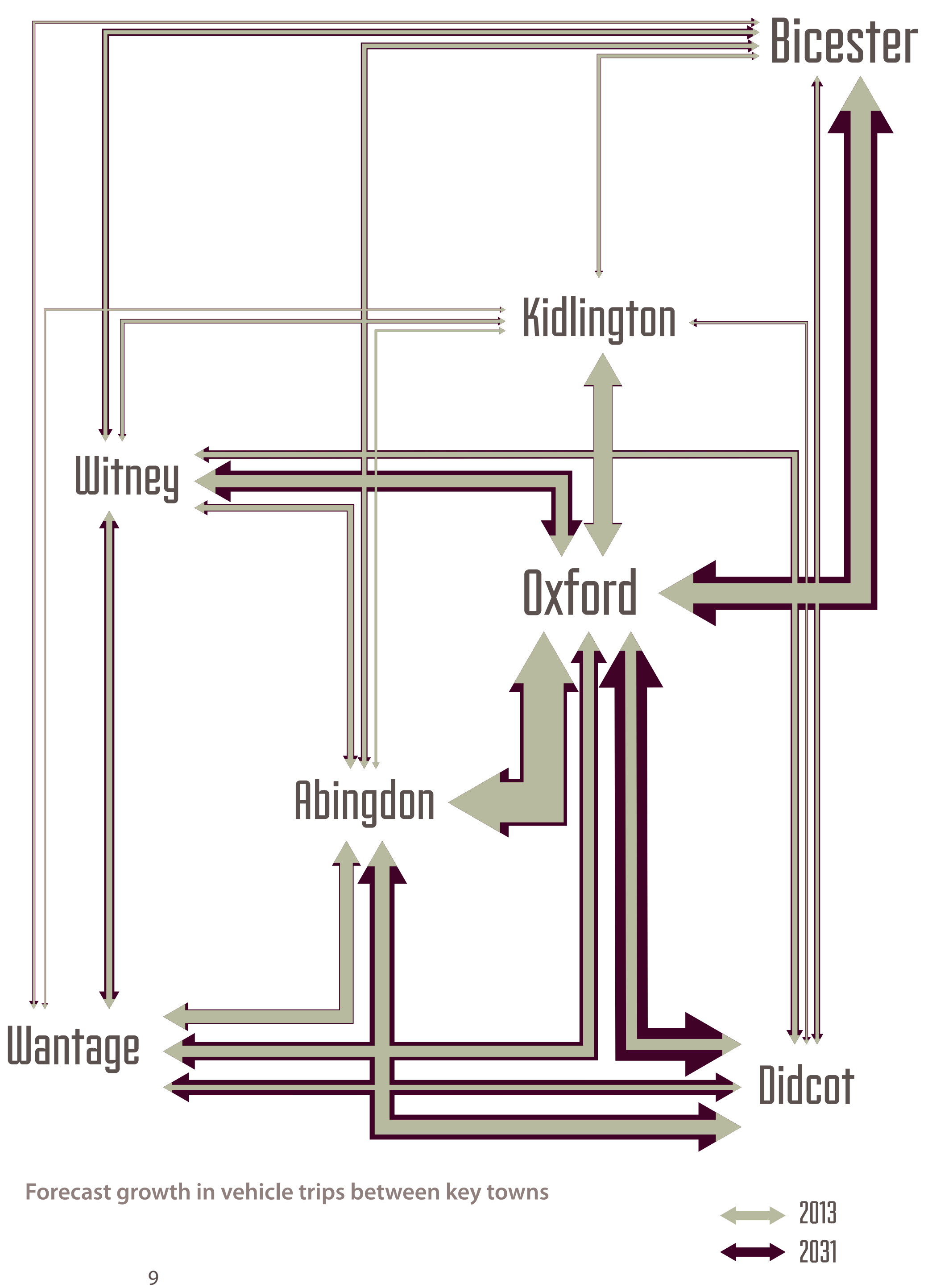



Commuting to Oxford, 2011 Census



2.18 The Oxfordshire Strategic Transport Model reveals that a large number of trips are currently made in the morning peak period on weekdays between key towns and Oxford. Although movements between these locations are greatest in the direction of Oxford; Bicester, Abingdon, Wantage, and Didcot are also significant trip attractors in their own right.

2.19 The projected future growth of local settlements is forecast to result in a strengthening of these movements during peak hours - particularly those emanating from Didcot, Abingdon, and Bicester.




Forecast growth in vehicle trips between key towns

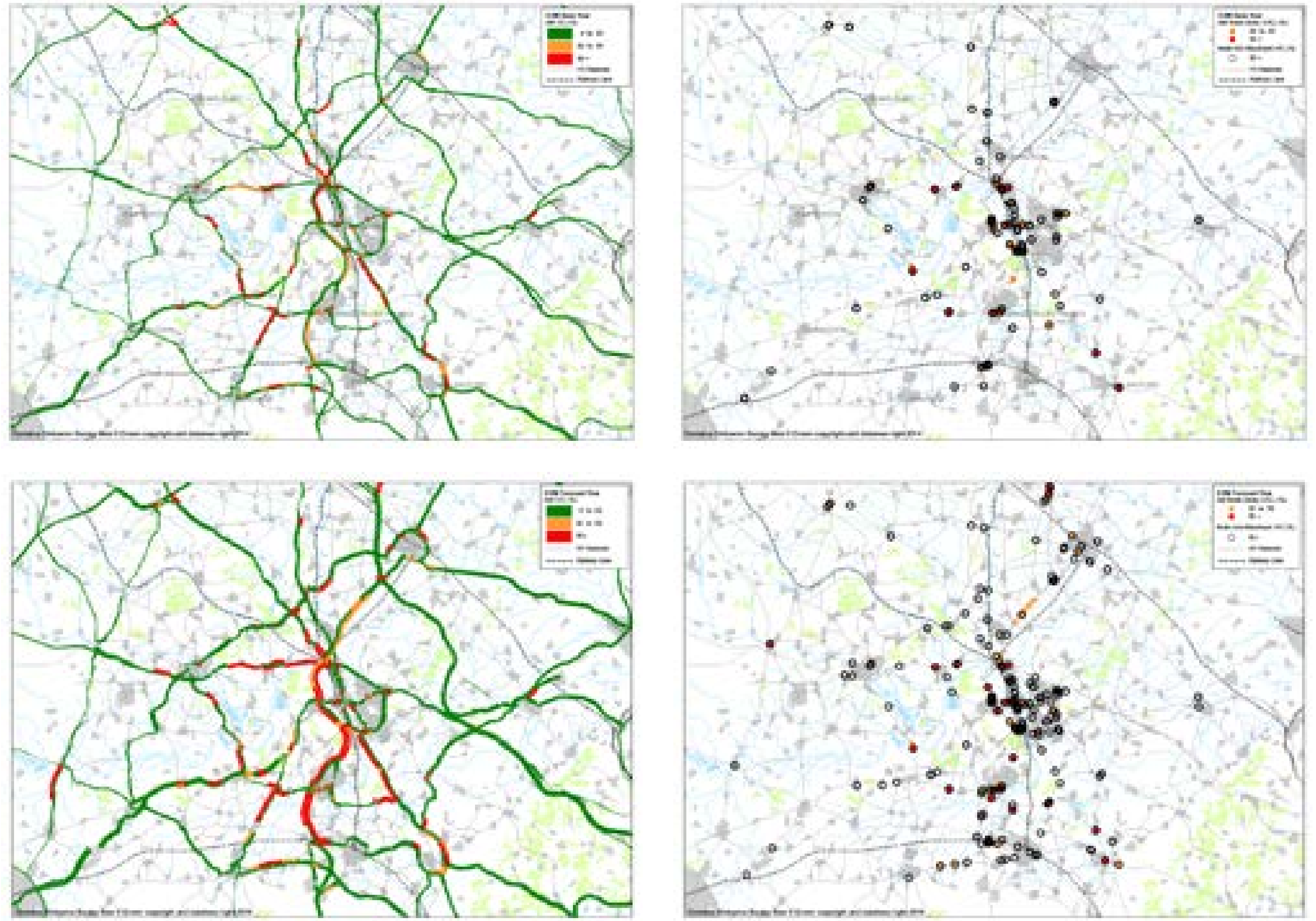
## Traffic congestion and its impacts

2.20 Perhaps unsurprisingly, the key characteristics of Oxfordshire's dispersed population and employment centres, complex movement patterns, and high levels of car ownership and usage have resulted in a highly congested road network.

2.21 The A34 and A40 already experience high levels of traffic congestion and delay. Most notably, sections along the western boundary of Oxford and towards Didcot frequently operate over capacity during extended morning peak hours and near to capacity for much of the day. As a result the A34 and A40 are not resilient to minor incidents and disruptions, which often result in major congestion events. Elsewhere in the county key junctions serving strategic routes like the A34, A40, and A44 operate at or beyond capacity during the morning peak hours. Stretches of the A420, A4074, A417, and A415 that link key residential areas and employment locations all experience high volumes of vehicles in relation to available highway capacity.

2.22 Future growth in jobs, population and car ownership levels will have a significant impact on the highway network's ability to cope with rising traffic volumes. During the morning peak hours there are projected to be more areas of stress on the network, particularly on the A34 between Oxford and Bicester, on sections of the Bicester ring road; and between Abingdon, Kidlington, and Didcot.

2.23 These levels of congestion on strategic and supporting road networks also create challenging operating conditions for local bus services. Buses rely on the same roads to operate, and only tend to benefit from bus lane segregation and signal priority on approach to/within Oxford. As a result, journey times can be slow from key towns to Oxford - up to 50 minutes to travel nine miles.



2013 and 2031 Forecast congestion



## Transport opportunities arising from projected growth

2.24 Although the challenges presented by Oxfordshire's projected growth over the next 20 years may seem overwhelming, many of the new residential and employment developments being envisaged will unlock funding and create opportunities to deliver improvements to the county's transport system.

### Intelligent Mobility for Oxfordshire

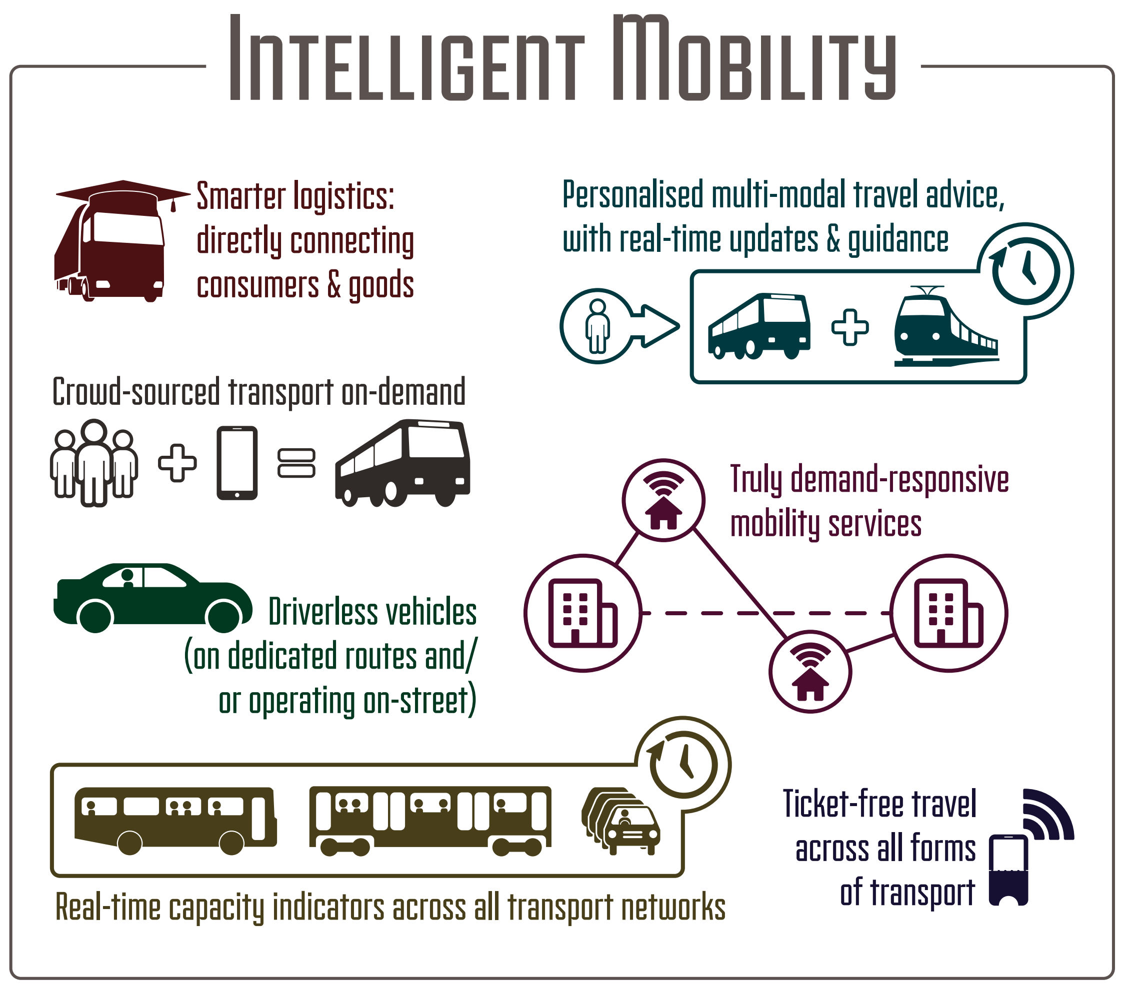
2.25 The emerging concept of Intelligent Mobility refers to significantly more responsive and predictive 'data-driven' transport systems that:

- More efficiently and sustainably connect goods, services, events, and people.
- Optimise available infrastructure capacity to maximise the time, energy and resource efficiency of travel and transportation.
- Are more readily connectable and flexible - promoting seamless journeys across all transport modes that can flex according to disruptions, changes in schedule or priority, and competing demands for other seemingly unrelated services.
- Generate lesser environmental and social impacts than current transport systems.

2.26 Intelligent Mobility services are not currently very well defined, since many are yet to come to market. Those already in development, or are technologically feasible, are shown in the diagram.

2.27 The international market for Intelligent Mobility services is estimated to be worth £900bn[2] by the Transport Systems Catapult[3]. As a global centre for research and development, the Innovation Hubs that make-up the Oxfordshire Knowledge Spine are perfectly positioned to capture a share of this market.

2.28 Science Transit seeks to develop the concept of Intelligent Mobility and apply it to real world transport systems within Oxfordshire – with particular emphasis on influencing and changing the way people think about mobility. We envisage the planned transport improvements to the Knowledge Spine area will act as a live test-bed and proving ground for Intelligent Mobility systems, techniques, and services. In doing so we will work in partnership with local research industries and commercial providers to develop and integrate this expertise.



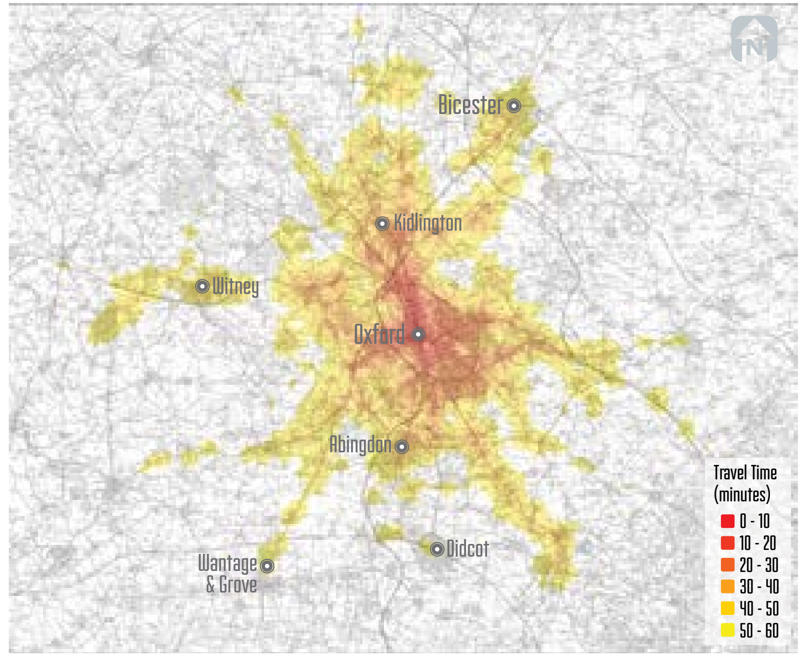

[2] Transport Systems Catapult (2013) Five-Year Delivery Plan to March 2018. Available online here, last accessed on 28/04/14.
[3] The Transport Systems Catapult (TSC) is the UK's technology and innovation centre for Intelligent Mobility, harnessing emerging technologies to improve the movement of people and goods around the world. The TSC forms part of an elite network of seven technology and innovation centres established and overseen by the UK's innovation agency, Innovate UK. Together, they represent a £1bn public and private sector investment up to 2018.

## Attractive public transport alternatives

2.29 The consolidation of people in the main existing settlements like Oxford, Banbury, Carterton, Bicester, Witney, Didcot[4] and Abingdon will help to strengthen the viability of enhanced public transport investment linking these towns to employment hubs. Anticipated investment to create new jobs across the county's Knowledge Spine, focused on the county's Innovation Hubs, will also help to define principal employment locations that can feasibly be connected to each other, and to local towns, by public transport.

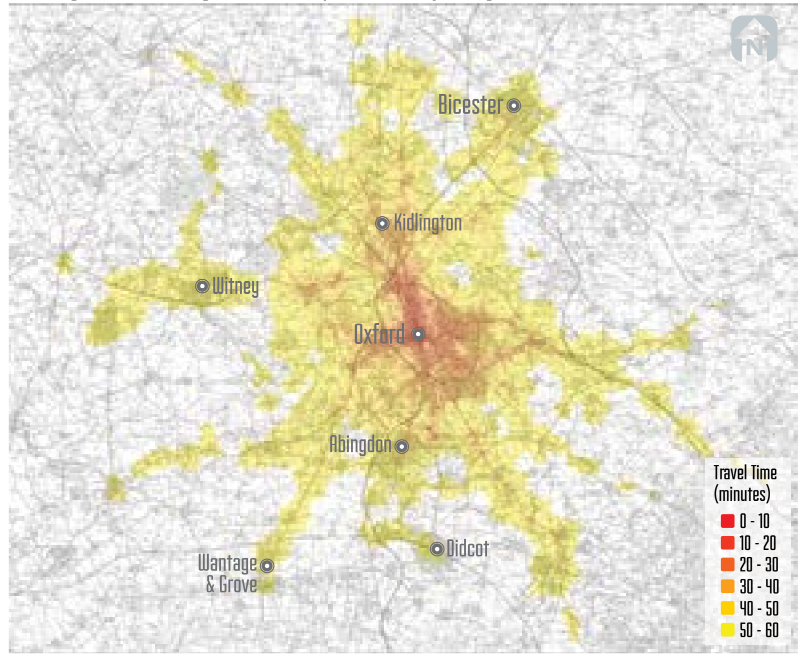
2.30 Projects highlighted in the Science Transit Strategy aim to achieve improved connectivity to new and existing development locations by public transport alongside service quality, passenger experience, and journey time/reliability improvements. For example, achieving a 10% reduction in door-to-door public transport journey times alone would increase by around 20% the proportion of Oxfordshire's current population that could access key employment areas in the Knowledge Spine within 20 minutes by public transport:

Existing situation




Journey times by public transport to Oxford City Centre

Existing situation with general 10% improvement in journey times




[4] Populations with > 20,000 inhabitants

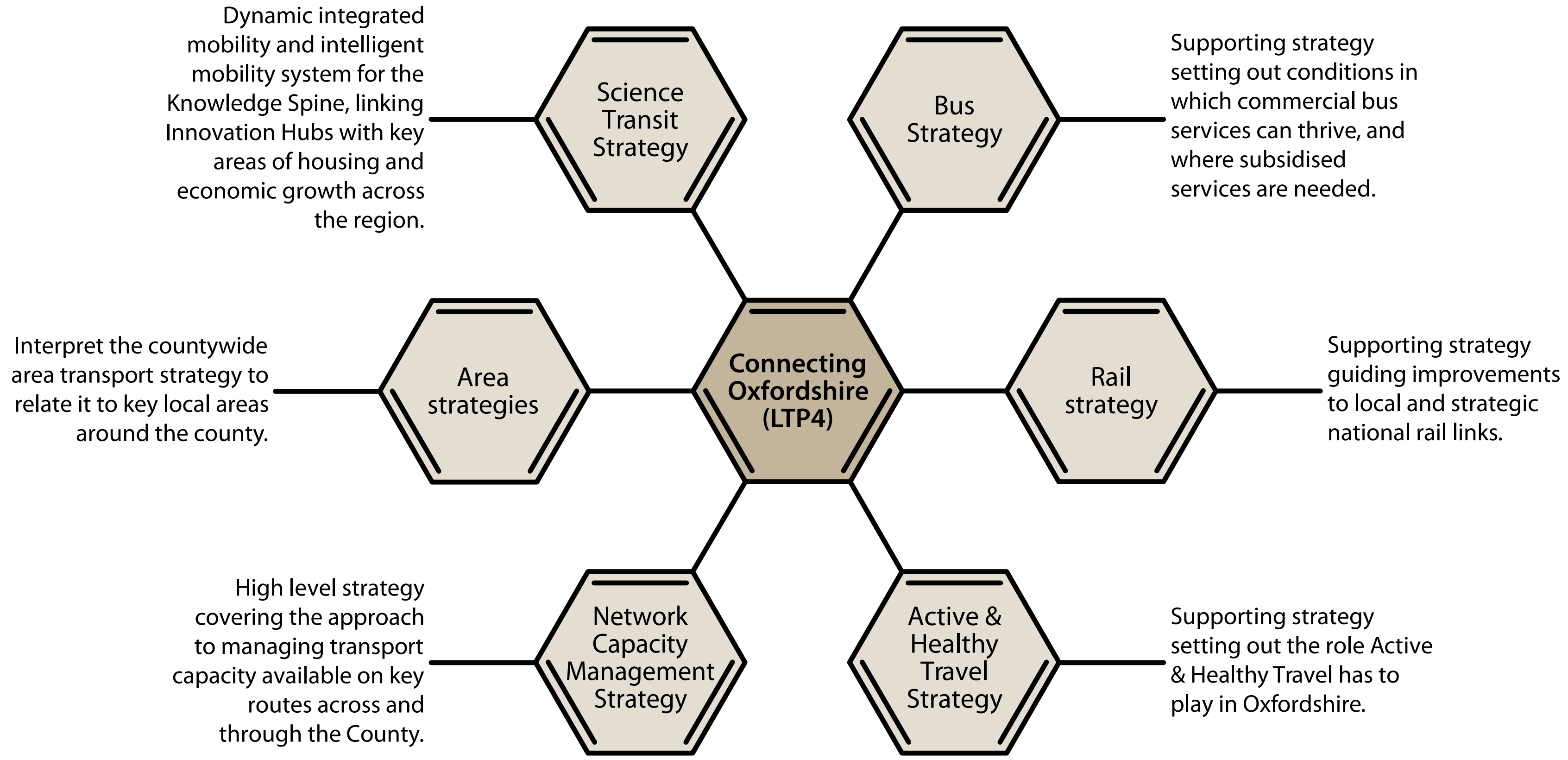


## Unlocking pinch-points on the highway network

2.31 Employment and residential growth will generate contributions from property developers and additional public revenues that can be invested in highway network improvements. Planned improvements to junctions on the A34 (at Hinskey, Kennington, Milton, Chilton, and around Harwell), on the A40 (Shores Green and Downs Road), within Oxford city centre; and new link roads at Grove, Wantage, and South West Bicester will help to improve traffic flows and public transport journey times alike.

## Strategic fit with existing transport policies and strategies

2.32 Science Transit is part of a suite of local transport plans and strategies that will combine to address existing and future traffic congestion challenges in Oxfordshire:



# 3 SCIENCE TRANSIT VISION & OBJECTIVES

## Our vision

3.1 **Science Transit** will realise a next-generation mobility and information system for the Oxfordshire Knowledge Spine across all modes of travel. It will link together our Innovation Hubs, and connect them to locations of identified housing and economic growth across the county. New developments will support Science Transit's delivery through strategic land-use planning to prioritise non car-based mobility, and create bi-directional demand for public transport services wherever possible. Science Transit will represent a credible and viable alternative to private car use by meeting people's basic mobility needs, as well as their expectations of speed, comfort, reliability, environmental sustainability, affordability, and journey experience.

3.2 This is about more than just improving bus services. The Science Transit vision is to ensure local transport links are deeply integrated with mainline rail and strategic highway connections to neighbouring towns, London, and Heathrow. New interchange locations will connect new and existing public transport services with walk, cycle, car-based, and air travel modes. Smart uses of real-time data generated through our effective coordination of mobility networks, and system users' movements, will increasingly enable people to seamlessly combine multiple travel modes to complete their door-to-door journeys.

3.3 To achieve this, Science Transit will actively seek to exploit:

- New and emerging technologies that improve the environmental efficiency and sustainability of conventional transport systems.
- Ticketless and cashless payment systems that are expected to enable seamless interchange across travel modes in the future.
- New and innovative uses of data that are being collected from local transport networks and vehicles in real-time.
- Entirely new modes of travel (e.g. autonomous vehicles) that are emerging from the intersection of technology, data, and transport system research & development.
- Partnerships with local transport operators, developers, and businesses to improve timetable coordination, service frequencies, and existing interchange and cycling infrastructure.

3.4 This ambition was outlined in Oxfordshire's feasibility bid to Innovate UK in 2014 to develop integrated transport solutions with Science Transit enabling the Knowledge Spine Area to be treated as a 'living laboratory' for the development and demonstration of 'Mobility as a Service'[5]. Its legacy will be a set of integrated mobility products that are end-user focused, seamlessly integrated with each other, and highly valued by time and money-conscious consumers.

## Strategic objectives

3.5 Five interrelated and interdependent objectives will underpin the development of the Science Transit system. They are to:

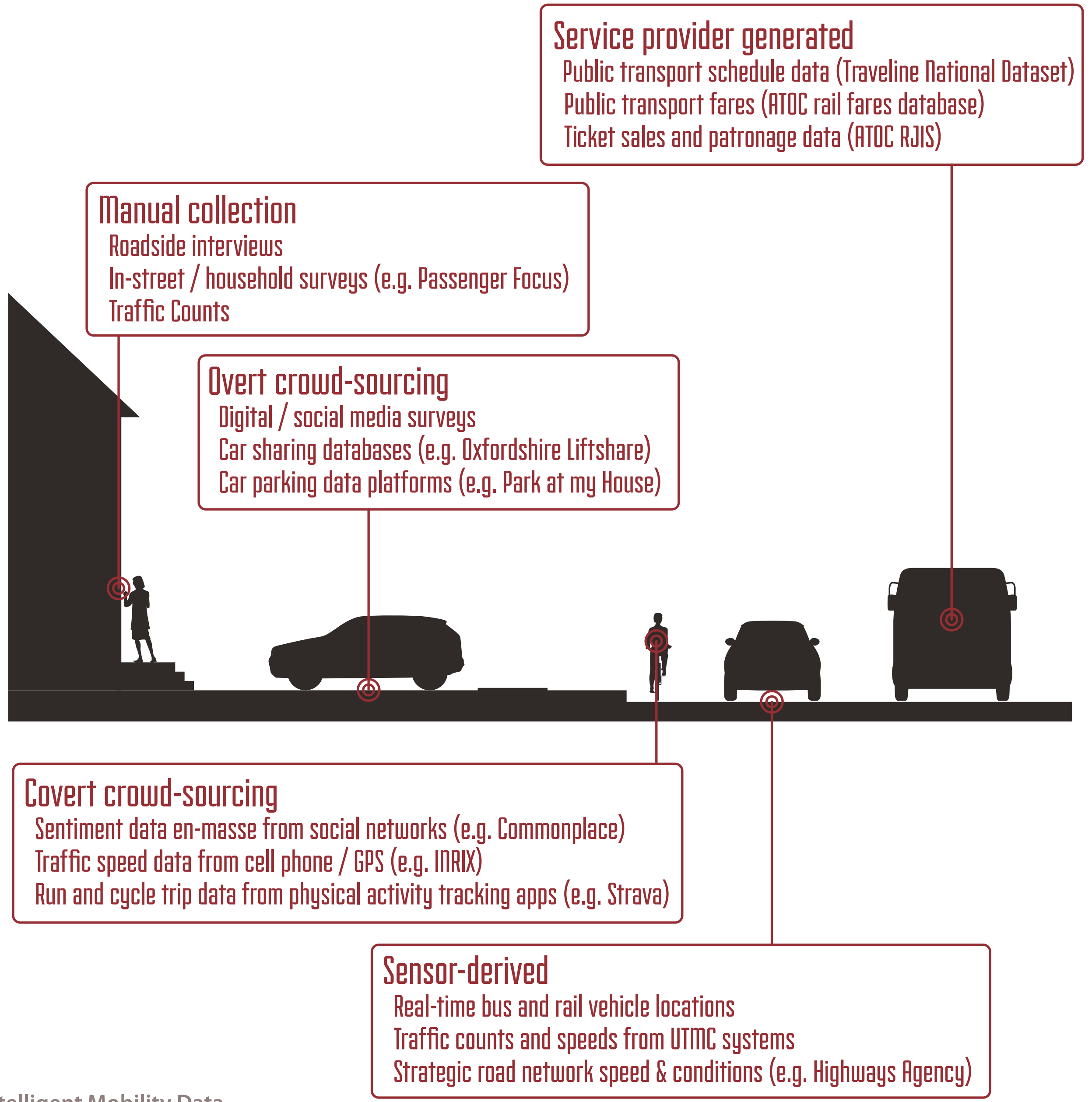
- **Embrace new technologies and data innovation to unlock intelligent mobility**
- **Accelerate local growth through innovative R&D**
- **Improve connectivity between places people live, work and spend their leisure time**
- **Integrate transport and land-use planning to improve non-car-based mobility**
- **Deepen public & private sector partnership**

3.6 The remainder of this section is structured around these objectives to explain each in more detail.

[5] ITS Europe defines Mobility as a Service (MaaS) as a mobility distribution model in which a customer's major transportation needs are met over one interface and are offered by a service provider

## 1) Embrace technology and data innovation to unlock intelligent mobility

3.7 Intelligent mobility services will be primarily, but not exclusively, driven by technological innovations and new analytical possibilities being created by accelerating flows of so-called 'digital exhaust' data. Such digital exhausts are a by-product of the online activities of Internet users and are created when people move around, purchase goods and services, or post updates to social networks. Such data is increasingly becoming available in real time:




Intelligent Mobility Data



3.8 Although it is impossible to be certain, given the emerging nature of many data processing and autonomous control systems at the time of preparing this strategy, we envisage the following possibilities will be unlocked by adopting a data-driven and proactive technology approach through Science Transit:

- **More timely, accurate, and insightful intelligence** for transport system managers in respect of what is happening across the county's transport and movement at any given time. This more proactive network management will draw on data from both public and private sector data owners, and Oxfordshire County Council's role will likely involve acting as an independent broker for this data.
- **Scope for autonomous mobility network** control and management systems that require less human intervention. These are likely to operate based on intelligent responses to data that are being collected and analysed in real-time, and simultaneously compared against historically collected and pattern-analysed datasets.
- **Deeper insight and intelligence for strategic transport planners**, enabling more efficient design and implementation of new mobility systems.
- **Personalised and context-specific multi-modal travel information** that can be delivered to individuals across multiple platforms. This will power digital tools that enable individuals to make more intelligent, data-driven, decisions about their personal mobility options in a range of scenarios – optimising their use of time, money, $CO_2$ and calories when moving around.

3.9 In line with Oxford's emerging Smart City Strategy, Science Transit will be both a key contributor to, and consumer of, data from Oxford's envisaged Open Data hub.

**Successful delivery against this objective will involve embedding the latest mobility technologies and data analytics so that digital exhaust data collected from operational transit systems and the region's road networks bind the county's disparate transport network components into an integrated system.**

## 2) Accelerate local growth through innovative R&D

3.10 Driving economic growth through innovation is a key future theme for the county, and our delivery of the Science Transit Strategy will create opportunities for precisely this. Its commitment to embracing emerging environmental sustainability and intelligent mobility technologies in transport and other areas deliberately seeks to create significant research and development opportunity for local industries. Our aim is for the following business segments to benefit from future investment in the local transport system through innovative Research & Development (R&D) in:

- Vehicle manufacturing
- Communications technologies
- Electronic sensors and controls
- Logistics and distribution
- Traveller information systems
- Predictive modelling
- Infrastructure management
- Real-time data exploitation

3.11 Each of these are fast-moving, independent business sectors that have historically operated with little formal connection to each other. As such, existing intelligent mobility initiatives often appear fragmented, with the concept's full potential yet to be realised.

3.12 Science Transit will help overcome this lack of integration by establishing R&D projects that enable all forms of transport to participate in continuous, intelligent vehicle-to-infrastructure and vehicle-to-vehicle interactions. These offer unexplored potential to tackle global problems of congestion, poor traveller experience, fuel consumption, environmental pollution, and road safety.

**If successful, working in coalition with businesses and University partners, Oxfordshire's transport system will become a 'living-lab' for internationally significant, bleeding edge[6] mobility technologies that benefit our county whilst also being scalable for export to other regions around the world.**

[6] Bleeding edge technologies are considered so new that they could have a high risk of being unreliable and require considerable investment in order to make use of them. A proportion of bleeding-edge technology will find its way into the mainstream (e.g. email).

## 3) Improve connectivity between places people live and work

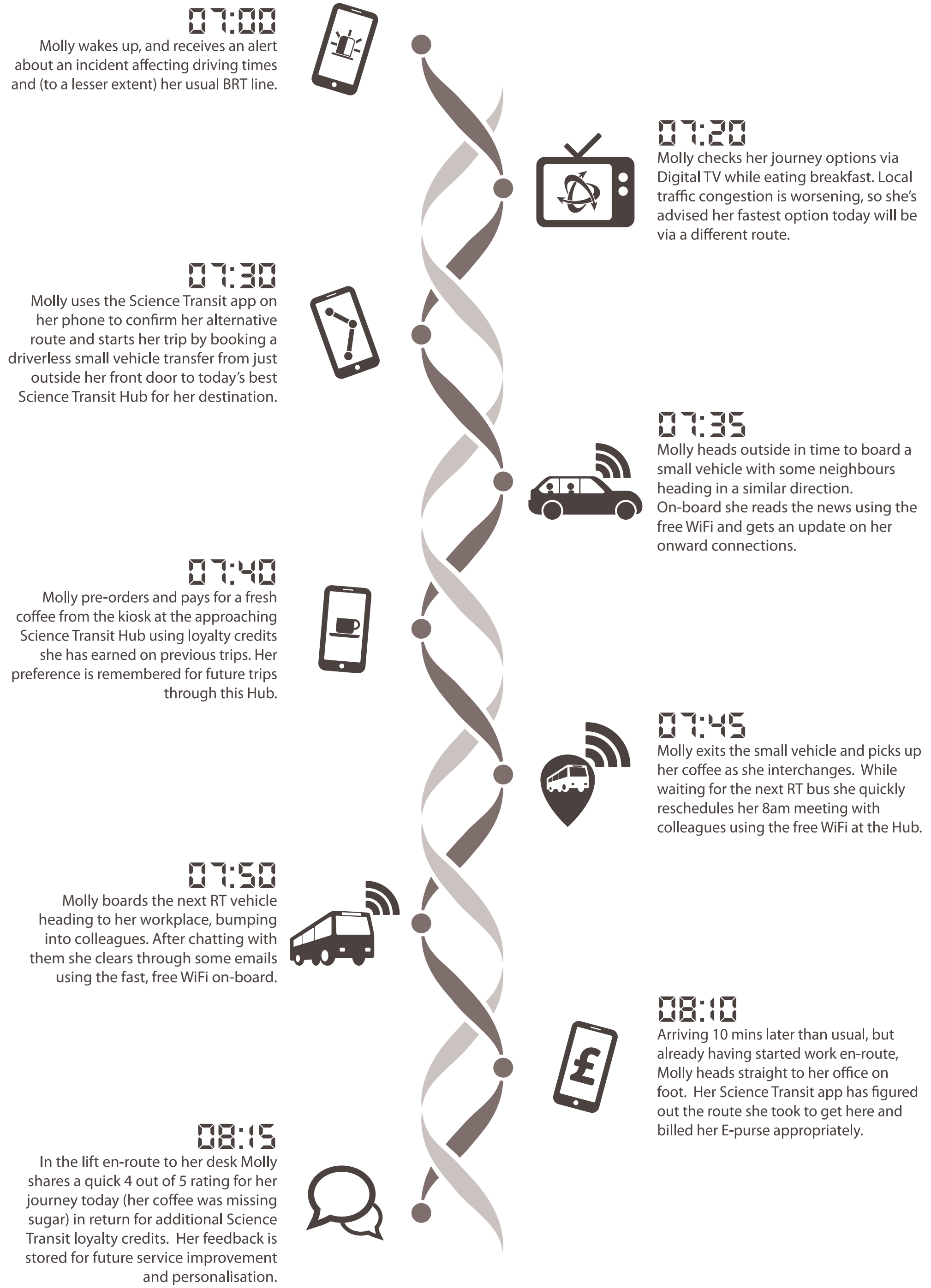
3.13 Science Transit's ultimate objective is to provide mobility as a consumer service that people in Oxfordshire can purchase easily, as and when they need it, for their trips to/from, and within the county. In this context the system will aim to be:

- **User-focused** – It will integrate with modern lifestyles, and align with evolving demands and expectations for personalised mobility options (both for people and goods). It will allow for informed decisions, be simple to use, and allow people to combine whatever modes of travel they want to use in order to get where they are going. Information and communication will be the key interface between the user and transport service.
- **Seamless** – Physical and virtual integration will ensure coordinated transfer between modes and create a 'zero wait state', whereby delay to users of the transport system is minimised before/during/after their journeys. Science Transit Hubs Interchanges and services will make space for people to work or relax whilst they are in-transit, and will be inclusive and accessible to all by design. Cashless payment and ticketless travel will aid seamless transfer between travel modes and ensure the system is easy to use.
- **Valued** – Trusted services, in which users perceive value for themselves, will be delivered. A transparent value proposition will be accompanied by simple and flexible payment systems. Science Transit will be recognised by its users as safe, reliable, comfortable, fast, environmentally sustainable, and good value. The clear use of Science Transit branding will create a common identity across integrated travel modes.

3.14 We foresee a combination of tangible improvements to existing public transport routes (as set out in the Bus and Area Strategies), the construction of new mass rapid transit capacity, and the creation of Science Transit Interchanges (described in more detail in section 4) for seamless interchange between modes of travel, as the basis for achieving this objective. The illustration provides an example of how Science Transit journeys between home and work are likely to take place in 2035, once the vision for the system has been fully realised.

**The closer we are in 2031 to providing mobility services that are as seamless as the example above, the more successful we will consider our delivery of Science Transit to have been.**

### A future journey to work






## 4) Integrate transport and land-use planning

3.15 Another key objective for our successful delivery of Science Transit is for the strategy to become fully embedded within the future growth aspirations, development proposals, and urban design features of the areas it serves.

3.16 The National Planning Policy Framework (NPPF) provides the policy requirement to locate major developments where the need to travel can be minimised and the use of sustainable travel modes can be maximised. However, there is also scope through future Local Plans and Reviews to deepen the integration between development proposals and the Science Transit system. For example, encouraging developers and local planning authorities to focus growth in locations adjacent to high frequency transport corridors can help to further boost demand for services, and reduce forecast future growth of private car trips. New developments can be designed with 'nudge' factors to make people more likely to choose sustainable transport, for example by providing parking in secure garaging areas a short distance away from homes or offices rather than directly outside and in view. This reduces the likelihood that a traveller will consider a private car journey as the default option when they begin their trip.

3.17 Through Science Transit our aim is for transport and personal mobility planning considerations to become significant factors in local planning decisions for residential, commercial, and employment developments.

**If successful we will create a virtuous cycle that enables growth and development to both support, and be supported by, commercially viable sustainable connectivity.**

## 5) Deepen public and private sector partnerships

3.18 The aims of the Science Transit Strategy cannot be achieved through Oxfordshire County Council working in isolation. Instead the success of the strategy will critically depend on effective partnership working, and joined-up project delivery, with:

- Private sector mobility providers - bus and rail companies, bike hire providers.
- Secondary service providers - car parks, public WiFi, ticket sellers.
- Research and development partners - Universities, technology providers.
- The local business community and our Local Enterprise Partnership.
- Local Planning Authorities
- Central government departments.

3.19 To this end our aim is to use the Science Transit brand and funding allocated for Science Transit projects to unlock involvement, in-kind support, and investment from private sector and research delivery partners.

3.20 An example already in development, is the OXybeles concept[7] being established in partnership between Oxfordshire County Council and local Universities. It will act as a vector for intelligent mobility research and live-testing. Innovative SME business development, new Intellectual Property for both local businesses and the OXybeles partnership, and wider economic benefits through efficiency savings are anticipated outcomes. The partnership will build on existing work being led by Oxfordshire County Council around digital traffic monitoring, responsive journey planning tools, traffic management and smart transaction hackathons[8].

**Successful achievement of this objective will involve the majority of Science Transit projects being delivered in collaboration with private sector and/or other research partners, and include shared investment, by 2035.**

[7] Oxfordshire LEP (2014) Strategic Economic Plan: Driving Economic Growth Through Innovation, pg 68, Available online at: http://www.oxfordshirelep.org.uk/cms/sites/lep/files/folders/Strategic%20Economic%20Plan/Oxford_Strategic_Economic_Plan.pdf, last accessed 28/10/14.
[8] A hackathon (also known as a hack day, hackfest or codefest) is an event, typically lasting between a day and a week, in which computer programmers and others involved in software development come together to create usable software. Transport hackthons can focus on building exciting transport-related apps, visualisations, or conduct insightful data analysis.

# 4 OUR APPROACH TO DELIVERING SCIENCE TRANSIT

## General approach

4.1 The ultimate vision for Science Transit is of establishing an integrated mobility system that is very different to existing ways of providing public transport. The approach we adopt to achieve this will need to recognise the strengths of the networks we have today and evolve each different component of the system appropriately.

4.2 The Science Transit Strategy will evolve over the next 20 years as funding, growth, development, investment, partnering, and intelligent mobility opportunities arise. Our long-term vision means the foundations on which Science Transit will be built are unlikely to fall into place overnight. Instead individual components of the Strategy are expected to materialise at different times, and in different locations, across the county.

4.3 For example, widely anticipated advances in technology and data-analytics are expected to dramatically change the landscape within which mobility services are delivered. Greater personalisation of services, and fluidity in response to changing patterns of travel demand, are expected to become common features of both urban and rural mobility systems. We don't know what some of these technologies will be but the Science Transit Strategy needs to be flexible enough to take them on board and exploit their benefits. As such our approach to delivering Science Transit will draw on four over-riding principles:

| | |
|---|---|
| Flexibility | To respond to rapidly changing technologies and analytical possibilities that emerge through the maturation of the current 'digital revolution' |
| Quality | Throughout our approach to planning, designing, and delivering Science Transit services, supporting infrastructure, and policies. |
| User-centred | Ensuring the infrastructure and services we plan truly meet the mobility needs and aspirations of local commuters, business and leisure travellers alike. |
| Intelligent | To purposively and patiently create a mobility system that is data-driven, truly multi-modal, and resilient to changing mobility patterns. |

## Key features and principles of the future system

4.4 It will be vital for Science Transit to get the basics of mobility right to satisfy the demands of both users and non-users. Science Transit must be accessible, affordable, reliable, and frequent. It must offer a rapid journey time, with seamless interchange, and serve desired origins and destinations. To additionally attract non-users to the system, and therefore generate modal shift, other aspects of the system also need to be high quality and appeal to people that would not usually consider using non car-based forms of mobility.

4.5 In designing and developing the system we will use the following hierarchical series of questions that users, or potential users, might ask themselves when considering whether Science Transit's mobility options are relevant to them:

- Does it do the job I need?
- If it suits my travel needs, is it usable?
- Does it diminish me as a person to use it?
- Am I willing to pay for this service quality?
- Do I consider this a quality product, and is it ethical?

4.6 Critically therefore, Science Transit must do a core job of meeting individuals' mobility requirements, and everything else is secondary. To achieve this, the main effort behind Science Transit will involve:

- Investing in sound product design for linkages, frequency, speed, and reliability.
- Holistic system design based on an accurate understanding of actual travel needs.
- Recognising no amount of added value or marketing can overcome core product deficiencies, but that they are a key part of the mix - particularly for generating mode-shift.

4.7 On this basis, the key design features of our fully-realised Science Transit vision are shown in the table to the right.

4.8 Deeply embedded intelligent, and data-driven, mobility technologies will cut across all four of these key design features; and is considered a critical enabler to achieving our long-term vision for Science Transit.

**Smooth interchange**

- Transport interchanges and vehicles that are truly accessible for all
- High quality audio-visual information
- Free WiFi at Transport interchanges
- Linked to local walk and cycle networks
- Seamless transition between different modes of travel
- Retail and service activities to enable productive use of time

**High quality services**

- Fast and efficient bus, rail, and autonomous small vehicle connections.
- Reliable journey times achieved via priority use of road networks.
- Safety and security paramount
- Free WiFi connectivity on-board.
- Easy to access vehicles for all users
- Responsive to demand based on data-driven operational management and adaptive learning from user's feedback.

**An easy to use mobility system**

- Cashless payment systems using smartcards, bank cards and smartphones.
- Identifiable branding across multiple modes of travel.
- Rewards and incentives for repeated use of the Science Transit network and off-peak travel[9].

**Joined-up smart mobility information**

- Relevant to different user contexts and journey purposes at all journey stages.
- Available via multiple digital sources (web, smartphone app, digital TV).
- Updated in real-time, to provide the latest insights and intelligence.
- Comparative travel time and cost information for an individual's options.

[9] Incentives such as those provided in Singapore might be considered: http://www.lta.gov.sg/content/ltaweb/en/public-transport/mrt-and-lrt-trains/travel-smart/for-commuters.html

## Evolving Oxfordshire's existing transport networks

4.9 Our starting point for the delivery of Science Transit is the county's existing transport networks. The following assets provide the basis on which our strategy will be implemented:

- **Park and Ride** sites that are already well-used, and have potential to act as strategic multimodal interchange facilities for trips through and within the Knowledge Spine.
- **Modern hybrid or emission-free buses with high levels of service** between key residential areas and Oxford city centre, and recently introduced services between Knowledge Spine Innovation Hubs and local residential areas.
- **Strategic rail connections** direct to London, Birmingham, Manchester, Newcastle, and Reading, with planned improvements through East-West rail.
- **Direct, high quality coach services** to Heathrow, Gatwick and Luton airports, and central London with free WiFi on-board.
- **Smart cards** that enable cashless payments, faster loading at stops, and create an integrated ticketing zone within Oxford and surrounding residential areas.
- **Real Time Information** systems covering most buses operating in and around Oxford city centre, with satellite tracking of bus vehicles powering underlying operational data systems and countdown departure displays at stops in the city.

4.10 These assets are currently focused around Oxford, as the county's largest urban area and primary generator and attractor of trips.

4.11 In practical delivery terms, Science Transit, alongside other related transport strategies and policies, will bring these disparate transport network components together over time and mould them into a cohesive system. It will deliberately broaden the range of mobility options beyond the main corridors into Oxford, to better connect residential areas across the county with the Knowledge Spine and its key employment locations. In doing so we will seek to address the following weaknesses currently present in local transport networks:

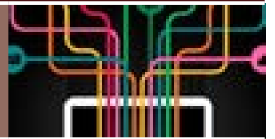
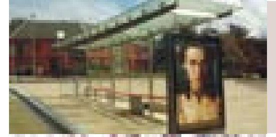
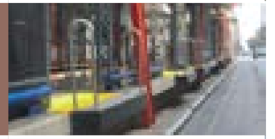
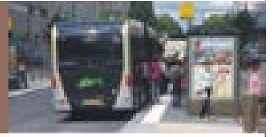
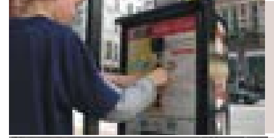
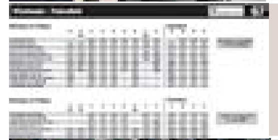
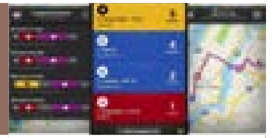
- **Comparatively long bus journey times** to Innovation Hubs across the Knowledge Spine, and service frequencies that do not allow for spontaneous travel.
- **Regular traffic congestion** on a highway network that is vulnerable to disruptions and extreme weather, and on which local public transport services also critically rely.
- **Fragmented and occasionally inaccurate local travel information** across multiple formats, making it hard for people to intelligently plan local trips.
- **Little multi-operator ticketing outside of Oxford city**, and disjointed rail and parking payment systems.
- **Lack of fast, direct rail connections to Heathrow and Gatwick**; and infrequent buses to London Oxford airport.
- **High carbon footprint of transport in Oxfordshire**, with air quality in Oxford exceeding EU and World Health Organisation limits.

4.12 At the heart of Science Transit is the recognition it needs to be conceived, developed and implemented as an integrated system. It needs to allow users to make seamless door-to-door journeys more productively than if they were made by car, and within comparable journey times.

4.13 By taking the strengths and weaknesses listed above into account, and mapping them against the key components that will make up Science Transit, we can indicate where Oxfordshire's transport networks currently sit in relation to our desired level of development for each one. Each component can be developed at different rates across different areas of the network. The figure below illustrates the various stages of evolution that might be considered, and identifies where today's system sits within that framework:



### Possible evolution of Science Transit

| | | | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 | |
|---|---|---|---|---|---|---|---|---|
| Relevant to all | Intelligent data-driven mobility |  | Limited automatic data collection | Increased data collection and use by individual organisations | Some sharing of schedules and pricing data between different stakeholders | Open data sharing platform for real-time traffic and local public transport data | Data shared by all mobility services. Real-time & historic feeds power predictive models and autonomous systems |  |
| High Quality Services | Priority |  | Shared lanes in mixed traffic no priority | Shared lanes but with some preferential treatment | Designated lanes, heightened priority | Dedicated lanes and segregated facilities | Exclusive alignment with full grade separation |  |
| | Vehicles |  | Functional | Exterior aesthetic and ride/comfort features | Improved boarding accessibility and information features | Diversified vehicle sizes, materials, capacities, alternative fuels | Guidance, propulsion and demand responsive routing |  |
| Seamless Interchange | Stops/ interchanges |  | Basic flag, some shelters | Improved shelters, signage and amenities | Additional passenger information, safety and security amenities | Enhanced station services and fare collection | Enhanced berthing, loading and land use features |  |
| | Route structure |  | Basic regular service | Improved service frequency with transfer connections | Extended stop distances with skip-stop and express services | Regional coordination, high frequency and reliability | Flexible route options to increase one seat rides, on/off alignment operations and convenient transfers |  |
| Easy to use mobility system | Publicity/ branding |  | Limited | Marketing with minimal differentiation from other routes | Wider use of branding to differentiate services | Marketed and branded as a separate tier of service | Full branding and marketing as single service system |  |
| | Fare collection |  | On-board only | Increase pre paid fare sales | Proof of payment fare systems | Electronic fare collection using smart card systems | Multi modal multi operator ticketless travel and e-payment |  |
| Smart mobility information | Information |  | Basic timetable information at stops and public locations | Web-based information, improved distribution, some real time information | Wider roll out of real time information | Real time information at all key stops and public places | Personalised, context-aware information and alerts through multiple digital devices. |  |
| | Handling small demands |  | Car and taxi based | Car, bike, and taxi sharing schemes, bike hire service | Semi-flexible bus services, Car Club | Demand responsive small vehicles. E-bike hire system | Intelligent demand responsive transport |  |

4.14 The remainder of this section outlines how we will approach the implementation of the components which make-up the four key design features of Science Transit.

## Creating an easy to use mobility system

### Smarter fare collection

4.15 Alongside traveller information, fare collection is a business-critical support system that will respond to, and facilitate, the broader Science Transit system's operational design and business model.

4.16 Fare collection is considerably more than just a background technical system. It represents the 'front-end' of the most fundamental business and pricing decisions for local transport operators. Similarly the price being charged, and the mechanism for making payment, is a key point of interaction between system users and the mobility service.

4.17 Through our delivery of Science Transit we intend to evolve fare collection systems across all mobility services in the county. In the not-so-distant future we envisage county-wide cashless and ticketless travel, with integration into national rail, coach, and park and ride parking payment systems. To make this a reality the focus of our work will be on:

- Developing technical and data interoperability frameworks with transport operators to allow for multi-mode and multi-operator ticketing and cashless payments.
- Establishing branded Science Transit fare products that extend to connecting services, and allow for revenue sharing between different service operators.
- Simplifying pricing mechanisms so users can easily identify their best fares via Science Transit publicity materials and digital information channels.
- Developing online and interactive services via the web and smartphone apps that including on-the-fly payment for travel (while in motion or progress).
- Exploring and testing the potential for location-aware fare collection to facilitate automated payments.
- Opening-up anonymised fare revenue and patronage data to allow for predictive and pattern-analyses that could inform more intelligent transit route investment decision-making in the future.

4.18 Several of these activities present scope for collaborative R&D with local innovation partners in order to accelerate routes to market for locally-developed fare collection and payment systems.

### Consistent branding

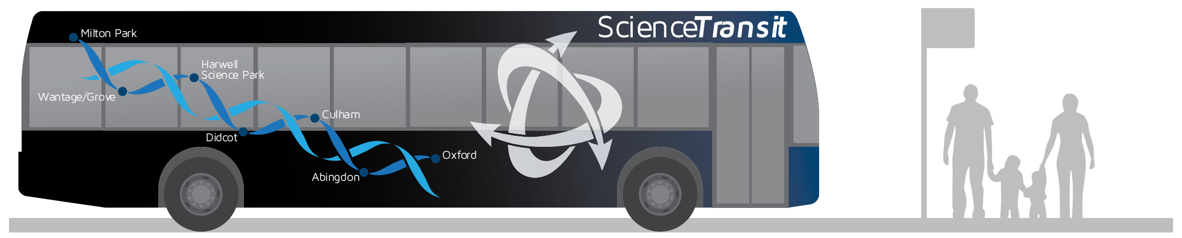
4.19 Developing a strong, coherent brand and identity for the Science Transit system is an important consideration of overall system design. Whether a sign, symbol, slogan or word, branding the system will ensure a constant message to the audience, aiding recognition and building awareness amongst the population. An engaging brand will help us to reach the general public and assist with achieving support and buy-in.

4.20 Our work to brand the system will consider concepts tapping into what people want, need, and require; as well as - ultimately - what they desire. The brand needs to create an image in the minds of users and non-users so as to clearly communicate a positive and accurate perception of the services on offer through Science Transit.

4.21 Through our development of this Science Transit Strategy document, we have created the following outline concepts which can be tested and developed with potential system users as we progress this component of the strategy.

4.22 There are already some very strong branded images for Oxfordshire and it is important that any new brand is minded of this to enhance customer experience rather than add uncertainty. We need to consider how the Science Transit Brand integrates with other brands while remaining inclusive.

Possible Science Transit Branding




ScienceTransit

ScienceTransit

ScienceTransit



## Joining-up smart mobility information

### More intelligent information for system users

4.23 Travel Information, like fare collection, has traditionally been a supporting system that should ideally be carefully tailored to the customer service and operational objectives and features of Science Transit. Reliable and accurate mobility information is central to empowering public transport users and non-users into making more intelligent decisions about their choice of travel modes. The world's most successful transit systems can be negotiated in relative comfort without the need to interact with anyone. These are often urban light rail and metro systems where every effort is made to reassure the user along the course of their journey. The same principles have been successfully applied to local bus-based systems (e.g. Trans-val-de-Marne busway in Paris and Zuidtangent in Holland).

4.24 Outside of London, Oxford has one of the most comprehensive real-time passenger information systems in the UK. This information has to date been delivered at-stop, via digital displays, but is increasingly becoming available through web-based feeds so that it can be embedded into various forms of digital media.

4.25 The growing availability of real-time transport data feeds (particularly in major cities) is rapidly changing our historic reliance on timetables and paper-based information distribution approaches. Personalised travel information is increasingly available from queryable online sources that allow prospective travellers to provide details of the origin, destination, and timing of their trip to receive relevant information in return. Widely used smartphone apps like CityMapper and MyCityWay are driving-up the quality and relevance of multi-modal travel information in large global cities. Their users are gaining deeper insight into the travel options available to them, enabling enhanced decision-making about the optimal route and mode combinations for the combinations of trips they need to make.

4.26 Our expectation is that similar personalised, context-specific, journey planning tools will trickle-down to smaller cities like Oxford as the multiple open real time data feeds they depend on become reliably available. Science Transit aims not to overlook user groups that will continue to need clear and concise paper-based and at-stop information, but provides a growing alternative. We envisage the bulk of work we do to deliver this strategy will involve:

- Working with local transport operators, highway network managers, and other mobility service providers (on and off-street car parking, bike hire systems, car clubs, and car share providers) to broker real-time open data feeds that can be shared publicly and used to power next generation information tools.
- Exploring the possibility of crowd-sourcing user feedback and sentiment in relation to their experiences of using the Science Transit system, to inform future service planning and identify which system components work well / require attention.
- Enhancing the quality of information on board Science Transit system vehicles, with better insights into the performance of connecting services and mobility options.
- Fully opening-up and exploiting all of the mobility-related data owned by local authorities in the region, including Urban Traffic Management Control centre datasets.
- Collaborating with local R&D partners to develop innovative, locally-relevant, mobility information tools that improve the efficiency with which people use the Science Transit system alongside the rest of the county's transport networks.
- Working with local property developers to ensure intelligent mobility information services are 'designed-in' to new residential developments and dwellings constructed over the course of the next 20 years.
- Engaging with other UK cities and transport groups to play an active role in the development of open global standards for sharing mobility-related data.

4.27 By implementing these initiatives, Oxfordshire's mobility data feeds will come to act as the glue that binds together disparate transport networks into a truly multi-modal, integrated Science Transit system. The mobility information products described above will likely become central to the way people choose how to travel, as well as providing the means to procure and pay for mobility 'as a service'.

### Handling small demands

4.28 The process of accommodating small demands (both short trips, and longer trips from locations where there is limited demand) is increasingly thought of as a data problem. 'Inefficient', and operationally inconvenient, taxi and car passenger trips are traditionally accommodated at major interchanges with limited provision elsewhere. Data-driven, location-aware mobility services like Uber, and automated bike sharing/car club services, mean it is becoming easier than ever before for people to plan and make multimodal trips with minimal interchange penalty. In the most densely populated urban areas these lifestyle oriented services are enabling growing numbers of people to reduce their dependency on the private car – and in some cases live totally car-free.

4.29 Our delivery of Science Transit will recognise that the semi-rural and rural nature of many of the county's residential areas currently places limitations on the viability of these kinds of 'next generation' services. In doing so our work to accommodate small travel demands across the system will combine the following activities:

- Working with local taxi and private hire companies to explore ways we can enhance integration and interchange at Strategic Science Transit Interchanges.
- Improving the provision of physical interchange facilities at Transit and Strategic Interchanges for private and hired vehicles, allowing for both pre-planned and on-the-fly connectivity with scheduled/high frequency public transport services.
- Working with local R&D partners to scope, design, test, and implement a family of scalable, and replicable location-aware vehicle hire and ride sharing technologies focused on bike hire, car share, car clubs and other on-demand vehicle services. By developing new products and technologies that are both relevant and financially viable for smaller cities like Oxford, we envisage scope for innovation-led growth and re-sale to other similarly sized cities around the world.
- Partnering with local Universities and automotive companies to create and test intelligent, driverless, demand-responsive mobility services. We envisage this scaling from existing local work to develop and trial the Robotcar vehicle into a viable product.

4.30 Implementing many of these initiatives will be a long-term undertaking that necessitates significant collaborations with industry and academic partners. We believe the long-term gain from investing time and resources – and being receptive to opening-up the county's highway networks to provide the living lab needed to test their real-world viability – presents genuine scope for us to establish new forms of mobility that are globally relevant and exportable.

## Embracing intelligent data-driven mobility

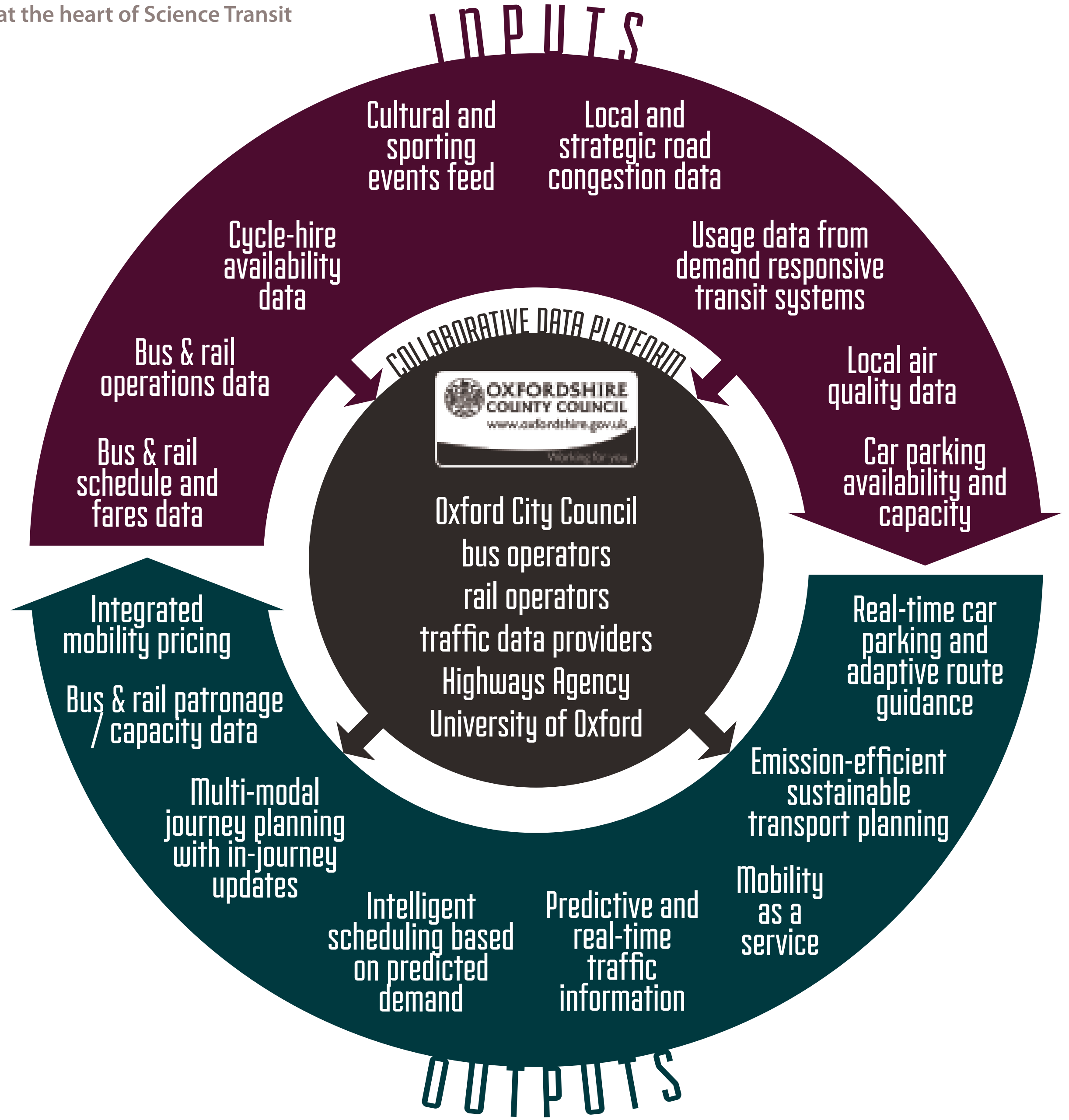
4.31 Our desire to embrace intelligent, data-driven, mobility is guided by our observation they are already disrupting[10] existing transport networks, and look set to pervade new forms of mobility for the foreseeable future. Our expectation is that intelligent mobility techniques and practices will cross-cut all of the Science Transit system's components. The Strategy sets out a plan that ensures Oxfordshire is at the forefront of influencing and embracing the new disrupting technologies.

4.32 While this is a long-term aspiration and is not something we can expect to achieve overnight, the intelligent mobility sector is gathering pace rapidly. To set the 20 year Science Transit time-horizon in context, technologies that were pure science fiction just 20-25 years ago are increasingly commonplace. As such it is very difficult to predict with any precision where our pursuit of Science Transit will take us, or how quickly current public transport providers will respond to the disruptive innovations on the horizon.

4.33 As a practical first step towards achieving more intelligent mobility, the collection and storage of transport-related data from a range of local and national data sources will underpin the development and design of Science Transit. Oxfordshire County Council will play a central role in coordinating this automated data collection effort, working in partnership with local transport providers (e.g. bus and rail companies, bike hire providers) and secondary service providers (parking providers, free public WiFi, ticket sellers). The diagram below shows how data generated through the process of providing these services can feed back in to the design and delivery of the better optimised Science Transit system.

[10] A disruptive innovation is an innovation that helps create a new market and value network, and eventually disrupts an existing market and value network (over a few years or decades), displacing an earlier technology. The term is used in business and technology literature to describe innovations that improve a product or service in ways that the market does not expect, typically first by designing for a different set of consumers in a new market and later by lowering prices in the existing market.

Data at the heart of Science Transit






4.34 Not all of the datasets required for intelligent mobility are currently freely and openly available, and some are unlikely to ever be made available in this way, but when collected and combined in real-time they offer scope for deeper understanding of the way transport systems interact with the world around them. Further integration with data flows from social media, restaurants, venues, shops and other trip-generating destinations is ultimately envisaged as critical to the development of mobility systems that are responsive to the changing aggregated travel demands of people.

4.35 Resolving the technical problems associated with collating and combining the data flows from the multiple sources described above is a common challenge across the established transport industry as a whole. From the perspective of the financial business case for Science Transit, any data costs associated with procuring or collecting missing datasets will need to be considered. Long-term, these costs may be integrated within the price of travelling in and around the Oxfordshire Knowledge Spine, or borne by new commercial models (e.g. through sales of seemingly unrelated products).

4.36 The table to the right summarises the key drivers and opportunities for Oxfordshire businesses and research industries in respect of the five strands for Intelligent Mobility identified by the Transport Systems Catapult.

4.37 Projects that could be delivered in partnership with local R&D centres to exploit these opportunities include:

- Dynamic traffic and transport modelling.
- Fully interoperable payments systems across all locally present forms of transport.
- Next generation electric vehicle charging infrastructure.
- Ultra low emission vehicle propulsion technologies.
- Exploitation of free public WiFi connectivity for pedestrian footfall and vehicle tracking.
- Electric vehicle driver information.
- Intelligent two-way feedback between driver and vehicle, including crowd sourcing feedback on journey satisfaction and performance.
- Autonomous passenger and freight vehicle design, implementation and service delivery.

| Intelligent mobility strand | Drivers & opportunities for exploitation through Science Transit |
|---|---|
| Autonomous systems | ▪ Optimised performance and control of existing transport services<br>▪ Reduced operating costs and staffing requirements<br>▪ Better use of existing transport network capacity<br>▪ Reductions in fuel costs and transport emissions<br>▪ Driverless technologies and control systems |
| End-to-end journeys | ▪ Greater convenience for transport users<br>▪ Inclusive access for people with limited mobility<br>▪ Mobility as a service procured on-demand<br>▪ Reduce time and costs associated with moving people |
| Information exploitation and customer experience | ▪ Easier to use, more navigable transport networks<br>▪ Tailored, contextual assistance for travellers with particular needs<br>▪ Reduce time and costs associated with moving people and goods<br>▪ Add value by leading consumers to relevant goods and services |
| Resilience | ▪ Faster response to emergencies and incidents<br>▪ Better-informed strategic plans for winter readiness<br>▪ Dynamic switching between transport networks<br>▪ Reduced costs associated with service delays and cancellations |
| Smart infrastructure | ▪ Adaptive capacity to accommodate primary movement flows<br>▪ New sources of data from connected infrastructure<br>▪ Reduce/delay need for additional road/rail/air infrastructure<br>▪ Optimise maintenance and repair activities based on sensor data |

- Data mining, predictive analyses using historic datasets, and autonomous control systems for individual mobility services and system managers.
- Partnering with local mobility service operators to ensure real-time information feeds are converted into actionable real-time intelligence for system coordinators (and autonomous control systems), as well as being made available retrospectively for pattern analyses and predictive modelling.
- Exploitation of GNSS[11] and Internet of Things data flows from increasingly connected vehicles and infrastructure.

[11] GNSS - Global Navigation Satellite System (GNSS) receivers commonly-used for surveying and navigation.

## Delivering smooth interchange

4.38 All journeys involve some form of interchange, whether it is walking to the bus stop to get on a bus, transferring from bus to train, or parking the car and walking to the office. In the context of Science Transit, the ambition is to make all interchanges as smooth and seamless as possible.

4.39 To this end through the Science Transit, public transport and Area Strategies we will establish a network of stops and interchanges that serve key destinations across the Knowledge Spine, and act as interchange points between multiple modes of transport. These will differ in scale from one location to another, but as a general rule will:

- Accommodate high frequency services, and large flows of people, at peak times.
- Facilitate seamless, stress-free transfer across multiple modes of travel.
- Be situated in locations that are close to the strategic highway network, providing maximum opportunity for park and ride and mode-shift from private car use.
- Maintain safe walk and cycle access by keeping people segregated from public transport and vehicle movements.
- Become an integral part of the land-use mix to create vibrant centres of activity that reduce 'dead-time' commonly associated with interchange between travel modes.

4.40 The following hierarchy is envisaged for the future Interchanges:

- **Local** - a simple stop serving a limited number of routes, with safe and convenient access by walking and cycling, and perhaps some cycle parking
- **Transit** - an interchange served by a range of different services, perhaps with a number of stops/shelters, at the convergence of walking and cycling routes, with pick up/drop off facilities, and possibly some parking to facilitate park and ride
- **Strategic** - a major interchange potentially served by national and regional rail or bus services, many local bus services, and including existing and proposed Park and Ride sites.

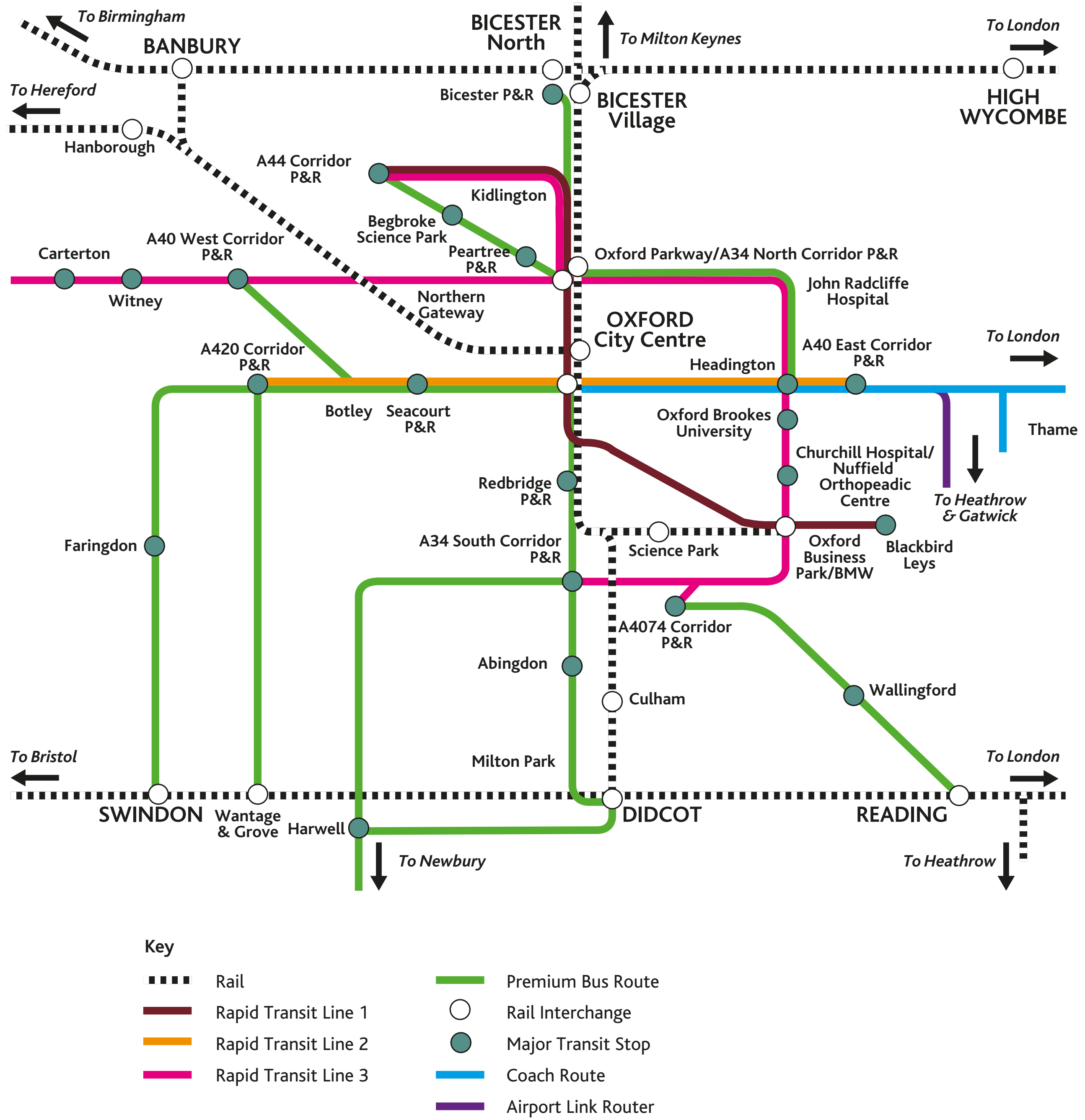
4.41 We envisage that many Strategic Interchanges will, over time, become connected to each other by rapid transit services designed to move large volumes of people at regular frequencies. Where passenger volumes do not support mass rapid transit, buses with high levels of service will operate at peak hour frequencies that are sufficient for users not to need a timetable (e.g. every 15 minutes). Key residential areas and smaller destinations, such as satellite campuses at each of the county's various science parks, will be connected by feeder bus or small vehicle services as well as secondary walk/cycle and demand responsive mobility services.

| Intercange type | Potential locations | Facilities | Transit Modes |
|---|---|---|---|
| Local | Less accessible parts of residential and employment areas | RTPI, information, shelter | Local bus, small vehicles, DRT, driverless "Pods" |
| Transit | Major residential develop-ments, innovation areas, town centres | RTPI, information, improved shelters, plus some retail and service activities | As above plus higher capac-ity/frequency services |
| Strategic | Railway stations, park and ride interchanges | RTPI, information, inter-change building offering wide range of retail and service opportunities | As above plus rail, regional and national coach, park and ride |

4.42 The existing network already has the benefit of some good quality stops and interchanges, particularly in and around Oxford. Moving forward, it will be necessary to identify the location of local, transit and strategic interchanges in conjunction with the connections between them. An impression of how Science Transit Interchanges could be connected to form a system is set out on the following page (indicative plan).



Illustrative Transit Network



4.43 The aim of the Science Transit system will be to provide the majority of people who work in Oxfordshire with journey options that involve no more than a single, logical, interchange through a Science Transit Interchange and minimise the need for private car use. In developing and improving the quality of local interchanges, some of the features that will need to be implemented include:

- Further roll out of Real Time Passenger Information.
- Relocation and increase in the number of Park and Ride sites, as proposed in the Oxford Transport Strategy; to serve more routes, increase interchange potential, and enhance facilities on-site (retail and other services).
- Improvements to existing/creation of new national rail stations to serve as Strategic Interchanges with a wide range of retail and other services to ensure productive interchange.
- Creation of Transit Interchanges in new developments and existing Innovation Areas, with improvements to existing town centre interchange facilities.
- Design for a wider range of vehicle-types to serve graduated demand across routes.

## Achieving high quality services

### Deploying appropriate transit vehicles

4.44 Travel demand between, within, to, and from the Knowledge Spine is highly varied. As such, an important consideration in the design of Science Transit system will be to provide for a range of movement patterns along different corridors. Using vehicles of appropriate capacity levels will allow for service frequencies that are attractive to users, and deliverable at an affordable price.

4.45 The Science Transit system will integrate a combination of walk/cycle, demand responsive small vehicles, conventional bus services with high levels of service, dedicated Rapid Transit, and Heavy Rail connections into a cohesive mobility network. The key service types, and the roles they are envisaged to play, are outlined to the right.

| Service type | Role in Science Transit |
|---|---|
| National Rail links | ▪ Fast connection between Banbury, Bicester, Didcot, and Oxford Strategic Interchanges.<br>▪ Fast connection to London, Heathrow and key destinations in neighbouring counties.<br>▪ High volume people movements at regular intervals. |
| Rapid Transit (RT) | ▪ High frequency links between Strategic Interchanges<br>▪ High degree of segregation and priority from road traffic delivering reliable journey times.<br>▪ High quality vehicles offering mass-transit system capacity, where needed.<br>▪ Deployed on high-demand corridors. |
| Premium Transit Routes - Buses with high levels of service | ▪ Regular services linking larger residential areas' Transit Interchanges with nearby Strategic Interchanges<br>▪ Act as a feeder service to RT and National Rail links. |
| Connector Transit - Smaller vehicles operating on scheduled and flexible demand-responsive routes | ▪ Minibus shuttle services operating at peak hours.<br>▪ Feeder services to connect Local Interchanges in residential / destination locations with lower levels of travel demand.<br>▪ Demand responsive services on semi-fixed routes to connect smaller residential areas with nearby Strategic Interchanges and destinations. |
| Premium/Super cycle routes & walking | ▪ Direct, segregated active travel links that connect destinations and residential areas to their nearest Science Transit Interchange (set out in Oxford Transport Strategy). |
| Private car travel | ▪ Frequent interchange opportunities with high quality public transport and demand-responsive services.<br>▪ Essential connection into Science Transit network for people living and working in rural parts of the county.<br>▪ Scope for driverless vehicle technologies to dramatically change demand for private car use. |



4.46 The service types described above represent a continuum. Lower cost services that are more flexible and can be implemented with little lead-time are ideal for areas where limited demand for non-car based travel exists. If through their introduction, or local development, the scale of passenger demand changes over time, these services can be scaled-up gradually through the provision of larger vehicles and improved network infrastructure.

4.47 An important feature of the Science Transit system will be its flexibility. Some aspects of network infrastructure (bus priority at junctions, RT running lane segregation, walk/cycle paths connecting Interchanges to places), and the services that use them, will be permanent fixtures. However, other components will be designed to operate on a flexible basis – reducing the need for expensive infrastructure that is only used for part of the day. Flexible components of the Science Transit network are anticipated to evolve over the 20 year delivery horizon to include:

- Small vehicle services operating on scheduled routes, which can be amended with minimal lead-time to respond to travel demand from new housing development or specific scenarios (e.g. University term start and end, annual festivals and cultural events). Data collected from the Science Transit system, and combined with local road traffic/event data feeds, will inform the scheduling of these services.
- Demand responsive mobility services that do not operate on a scheduled basis, but instead use computer algorithms to match requests for short distance travel from multiple users. Several such systems are currently in development in the UK (Simply Connect) and internationally (Bridj), and are anticipated to become increasingly common as intelligent mobility services become more commonplace. The Science Transit system roadmap will plan for the integration of these kinds of data-driven transport services alongside existing forms of mass rapid transit and public transport.

4.48 Over the timescale being considered by Science Transit, greater volumes of services will come directly to people - rather than necessarily requiring people to move to them. Early signs of these kinds of system are evident in the form of services like Click & Collect, which are changing people's movement patterns and mobility demands. The Science Transit Strategy will need to adapt to these technology-driven changes in order to ensure it remains relevant over the life of its 20 year delivery horizon.

### Improved priority and segregation

4.49 Science Transit's aim is for more rapid services to deliver travel time savings and more reliable journey times, particularly between Strategic Interchanges. Only high levels of segregation and priority will deliver this. Bus gates, bus lanes, grade separated lanes, or exclusive transit ways - such as disused rail corridors - will be implemented, as appropriate, across the Knowledge Spine and on interconnecting routes from neighbouring residential areas. These will all be explored as part of individual Area Strategies.

4.50 Just as railway tracks indicate where a train travels, treatments or markings to differentiate a running way can effectively convey where a dedicated bus service operates. Differentiating the appearance of bus running ways can be accommodated through a number of techniques including pavement markings, lane delineators, alternative pavement texture, alternative pavement colour, and separate rights-of-way. These are likely to be features of routes that connect Transit and Strategic Interchanges.

4.51 We anticipate investment in a guided system will also help promote a stronger image, and generate greater modal shift. However, this needs to be balanced against the lower costs and greater flexibility offered by high quality conventional bus-based systems. The lead-time, cost, and permanent nature of any form of segregated running way means they are only likely to be appropriate for high-demand links between Strategic Interchanges that also serve major employment sites (e.g. Innovation Hubs) and residential areas.

# 5 DELIVERY ROADMAP

## Context

5.1 As a long-term vision for improving mobility options and connectivity into, and within, the Oxfordshire Knowledge Spine, we envisage Science Transit will be delivered gradually over a 20 year timeframe.

5.2 This 'future-focused' time-horizon, and desire to proactively integrate intelligent mobility into the Science Transit system, means anticipated technological innovations and research-led development will introduce considerable variability over when specific components can feasibly be delivered. As identified in the previous section, future levels of public funding available, the actual scale and location of demand for movement created through settlement growth in Oxfordshire, and relative transport priorities all impact upon the accuracy with which we can plan and deliver our vision.

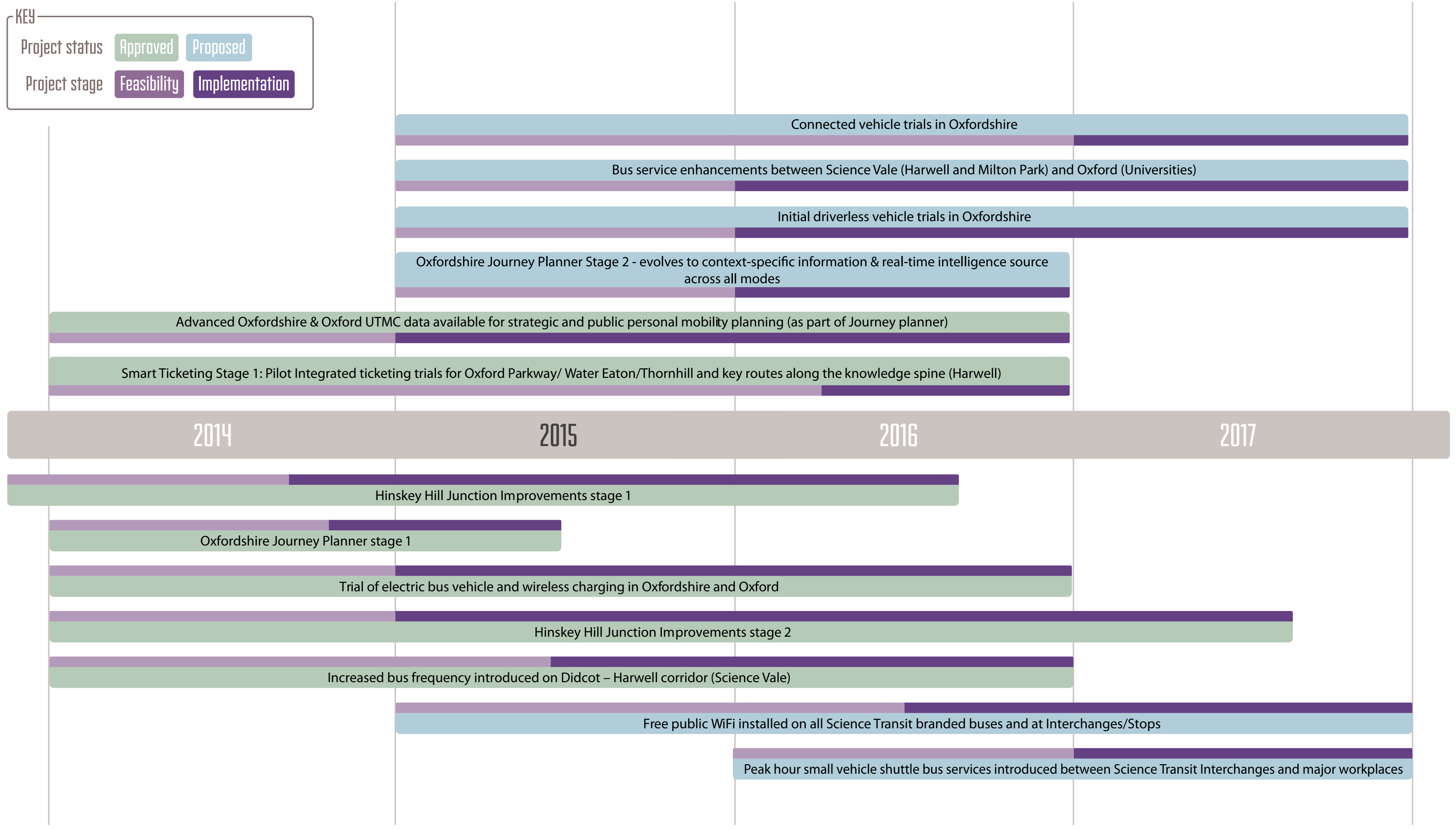
5.3 Our roadmap for delivering Science Transit needs to account for this inherent uncertainty, and to allow different components of the Science Transit system described in the previous section to move forward at different speeds – whenever demand, funding and private sector opportunities emerge. The timeline on the following page therefore constitutes an outline plan, with the near-term activities grounded in current and planned projects. The kinds of projects considered necessary to fully achieving all of the Science Transit objectives, but which may currently appear aspirational, are shown as medium and longer-term activities. We note these projects may not be delivered in the precise order they are described overleaf, but envisage they are likely to come to fruition over time in a manner that ensures the components of Science Transit are gradually assembled as part of an integrated system.

## The Roadmap

5.4 On this basis our indicative Science Transit delivery roadmap is set out overleaf. For each potential Science Transit project we have estimated the amount of time related to the three key stages of:

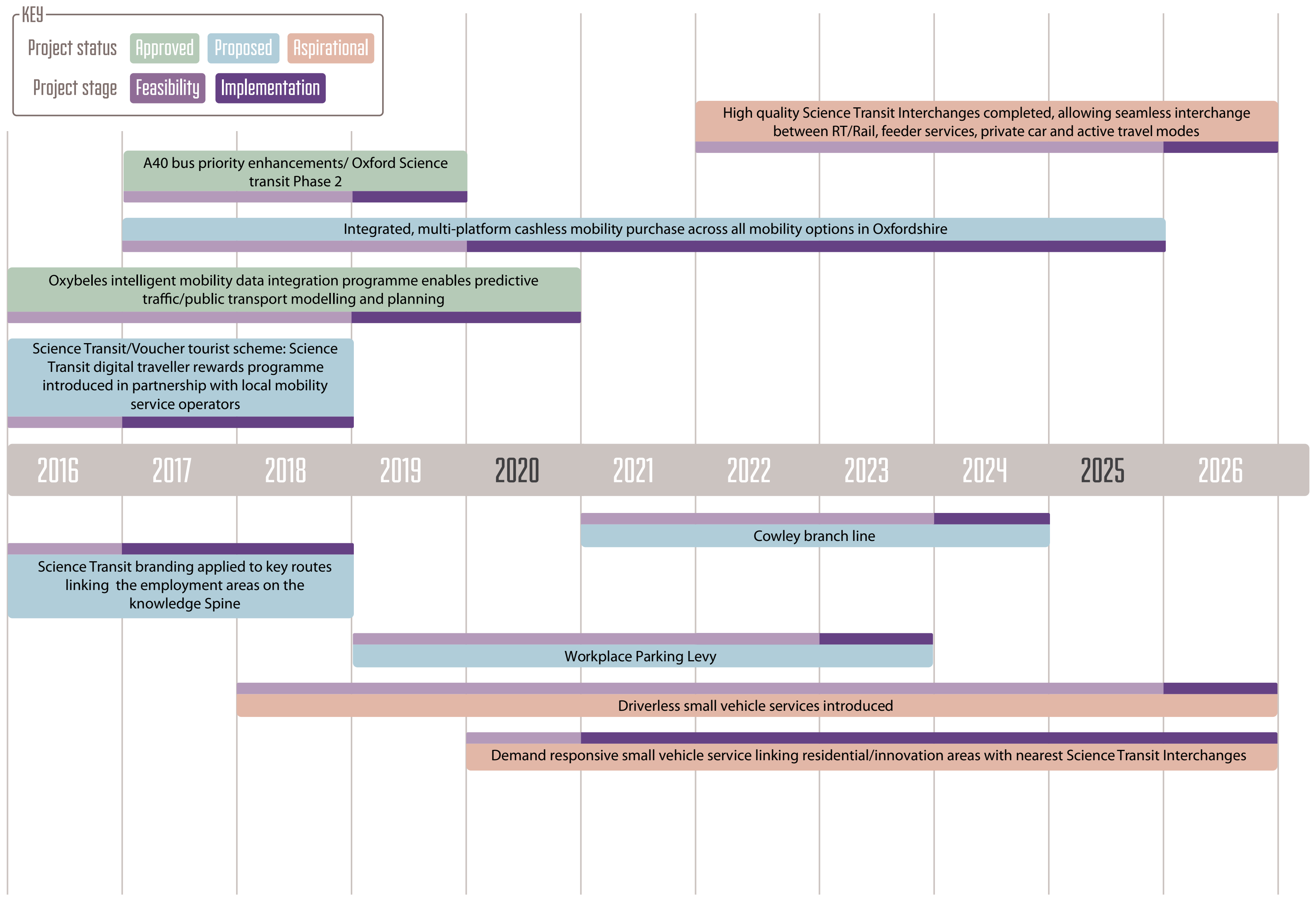
- **Aspiration**: Pre-feasibility work to appraise and prioritise new project ideas.
- **Feasibility**: Detailed appraisal to determine each idea's viability and deliverability.
- **Implementation**: Technical delivery of the project, resulting in improved mobility.

# Science Transit Roadmap - projects implemented by 2017






# Science Transit Roadmap - projects implemented beyond 2017



# 6 KEY SUCCESS FACTORS

6.1 The Science Transit Strategy cannot be delivered successfully in isolation. It needs to be supported by supportive transport and land use planning policies, by a robust funding strategy, by clear governance, and involve both the public and private sectors.

6.2 The figure below provides insight into how we envisage these different aspects will be delivered through Science Transit in order to ensure the necessary supporting policies and conditions are in place for the strategy to be a success.

## Supporting policies

### Managing car-based demand for travel

6.3 Successful transport strategies typically combine "carrots" to encourage a particular behaviour and "sticks" that discourage choices that have significant environmental, economic, or social impacts. Science Transit will offer a high quality door-to-door service to encourage passengers to use the system, but will require supportive measures to reduce growth in car use and lock-in the benefits of modal shift. This is not about being anti-car, it is about making the best possible use of existing and future infrastructure and services for the benefit of all residents, businesses and visitors to Oxfordshire.

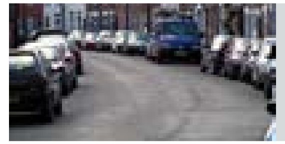
6.4 Controlling the supply, pricing, and location of car parking is an established policy that has been used to manage car-based demands in Oxfordshire, and in Oxford particularly, for many years. By restricting demand in the city centre and encouraging park and ride through supply measures and differential parking charges, the number of vehicles entering Oxford city centre has been strongly managed.

6.5 It is important that this continues and is extended in a way that is complementary and supportive to the Science Transit Strategy. Whilst existing policies influence the demand for public parking, a considerable proportion of spaces in Oxford city centre and virtually all of the spaces at the Innovation Area, are privately owned. Where appropriate, the potential for workplace parking charging should be explored in order to manage demand at these locations. Alternatively, congestion charging could be used in areas where there is high travel demand and very limited road space, as a way to influence behaviour and choice.

6.6 With the intelligent real time data available on congestion, parking availability, and public transport capacity, it is possible to envisage a dynamic approach to pricing for road usage, car parking and transit services that optimises the use of available parking and highway capacity. We envisage this will become technologically feasible in both urban centres and in more remote locations. It offers scope to simultaneously maximise revenue for further re-investment in Science Transit by encouraging the use of vacant spaces or seats that would otherwise remain empty. So, for example, during the parts of the day when travel demand is at its highest and pressure on the road network is at its most severe, the differential between the pricing of Science Transit services and driving/parking would be at its greatest. During quieter periods of the day, where spare road and parking capacity existed, the differential could be smaller. Re-investing revenue from any such user charges to develop improved public transport infrastructure and services would be essential from an acceptability perspective.

## Spatial Planning

6.7 There is a need for 100,000 homes or 5000 per annum to be built in Oxfordshire between 2011-2031. There is currently a large shortfall in provision with only 5,360 homes having been built in the three years 2011-2014. While there are many reasons for this shortfall, a clear commitment to delivering Science Transit, together with its integration within the spatial plans for the county, will help address concerns over the impact of growth on transport networks and infrastructure. To achieve this, Science Transit must become embedded within the future growth, development and urban design of the areas it serves.

| | | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 | |
|---|---|---|---|---|---|---|---|
| Land use integration |  | No integration | Ad hoc policies to encourage integration | Integrated transport and land use planning becoming embedded within Planning Policy | Policies on uses, densities and parking standards related directly to public transport accessibility | Hard and fast rules requiring transit oriented development |  |
| Demand management |  | No parking or other fiscal measures | Parking charges and some supply limitations | Differential charging according to location and purpose | Congestion charging/ workplace parking levy | Dynamic pricing of parking, road use and public transport |  |
| Funding |  | Government grants | Increased private sector funding, eg from developers | Private sector becomes responsible for the majority of investment | Innovative mechanisms to capture land value increases to allow borrowing and reinvestment in system | Self-sustaining system |  |

6.8 NPPF provides the policy requirement to locate major developments where the need to travel can be minimised and the use of sustainable modes of travel can be maximised, there is the opportunity through future Local Plans and to better integrate future development with Science Transit. Transit Oriented Development (TOD), which lies at the interface of land use planning, transport planning and urban design, will become part of future land use plans in Oxfordshire. In land use planning terms, TOD means clustering mixed use development around existing or proposed public transport interchanges and stops, with the highest density development closest to the public transport node. The short walk/cycle distances create a high demand for public transport services, with the mixed use characteristics helping to reduce motorised trips and generate the bi-directional demands that facilitate efficient public transport operation.

6.9 To support funding of Science Transit, the potential level of developer financial contribution to new infrastructure and services should be clearly based on proximity to the Science Transit network. Development sites located closer to stops or interchanges should pay a lower level of contribution (or in some cases nothing at all) compared with locations which are more remote and likely to be more car-dependent in nature.

## Land for parking

6.10 Over the time horizon for delivering Science Transit, there are likely to be many changes to the way in which we choose to travel, either because of global issues such as climate change and peak oil, national or local issues driven by political decisions, or behaviour change stimulated by Science Transit itself. One of the impacts of this might be that ownership and use of private vehicles is very different to today, with greater focus on the use of public vehicles (be they mass transit, demand responsive or autonomous) and therefore less demand for parking in city and town centres, and at innovation and business parks. This would create an opportunity for using land currently taken up by parking for more productive and valuable use, thereby increasing density, with positive impacts on the commerciality of transit services, and land values, creating additional revenue for re-investment in Science Transit.

## Funding

6.11 Science Transit will be developed and delivered over the next 20 years and whilst immediate funding from the Local Growth and City Deals is available for initial projects, a flexible and scalable strategy is required for the longer term. Both capital and revenue funding will be required and it is the very nature of political and economic cycles that the availability of grant funding from Government is unpredictable. Staying ahead of the game, and being able to demonstrate economic, environmental and social benefit from investment will, however, always remain the best approach to securing investment. The following sections set out some of the key principles of the funding strategy and discuss the potential sources of funding that will facilitate the delivery of Science Transit.

## Principles

6.12 **Self-sustaining.** The overriding aspiration is that over the long term, Science Transit should be self-sustaining, with a commercial network of services and the financial ability to invest in upgraded and new infrastructure and services. This will require all stakeholders to play and pay their part; and for new funding mechanisms to be developed, tested and employed.

6.13 **Advance preparation.** Oxfordshire has a strong recent track record in securing significant grant funding. To continue this success it is vital that new ideas are developed, appraised, and designed so they are "oven ready" for funding submissions; and powered by clear, positive business cases. Increasing involvement of private sector industry partners is envisaged.

## Sources of funding

6.14 **Government.** In the short term, Government is likely to continue to make the largest contributions to the funding of Science Transit. This might come through Government Departments, for example, DfT, DCLG and BIS, or through research and innovation bodies such as Innovate UK and similar EU funding such as Horizon 2020. Such funding, however, is unpredictable, and with current policies aimed at reducing national debt, competition for funding for transport-related schemes will only increase, therefore reinforcing the need for robust and positive businesses cases and the ability to leverage funds from other sources, including the private sector.

6.15 **Operators.** Oxfordshire's Growth strategy will attract close to a quarter of a million new residents and create 85,000 new jobs - effectively the size of a new city. This will generate significant demand for travel, and massive potential for mobility service operators to increase ridership and revenue. Existing and new operators must be encouraged to invest in new services and, potentially, infrastructure.

6.16 **Developers.** Contributions towards delivery of the Science Transit Strategy can be expected from developers through Section 106 agreements and the Community Infrastructure Levy. This will require a clear strategy that needs to be grounded in transparent and accessible planning policies so it is clear what is expected in respect of different types and sizes of development.

6.17 **Industry.** Oxfordshire's research, innovation and academic communities will have the opportunity to pilot and trial new technologies and systems in a "living lab" environment. With the scale of the global intelligent mobility market put at around £900bn, there is significant incentive for local industry partners to invest in Science Transit to test and prove their technology solutions with the longer term aim of securing reward through international sales. Close working with industry, and developing the living laboratory, will put Oxfordshire in a stronger position to successfully attract R&D investment and funding through channels such as Innovate UK and Horizon 2020.

6.18 **Users.** Science Transit users will pay for their use of the system through fares. Successful delivery of this strategy is expected to drive-up revenues from local mobility services over time, attracting trips that would usually be made by private car. Effective branding and promotion of new high quality services will help users from around the county to recognise the value of Science Transit services, and begin switching modes to benefit from it.

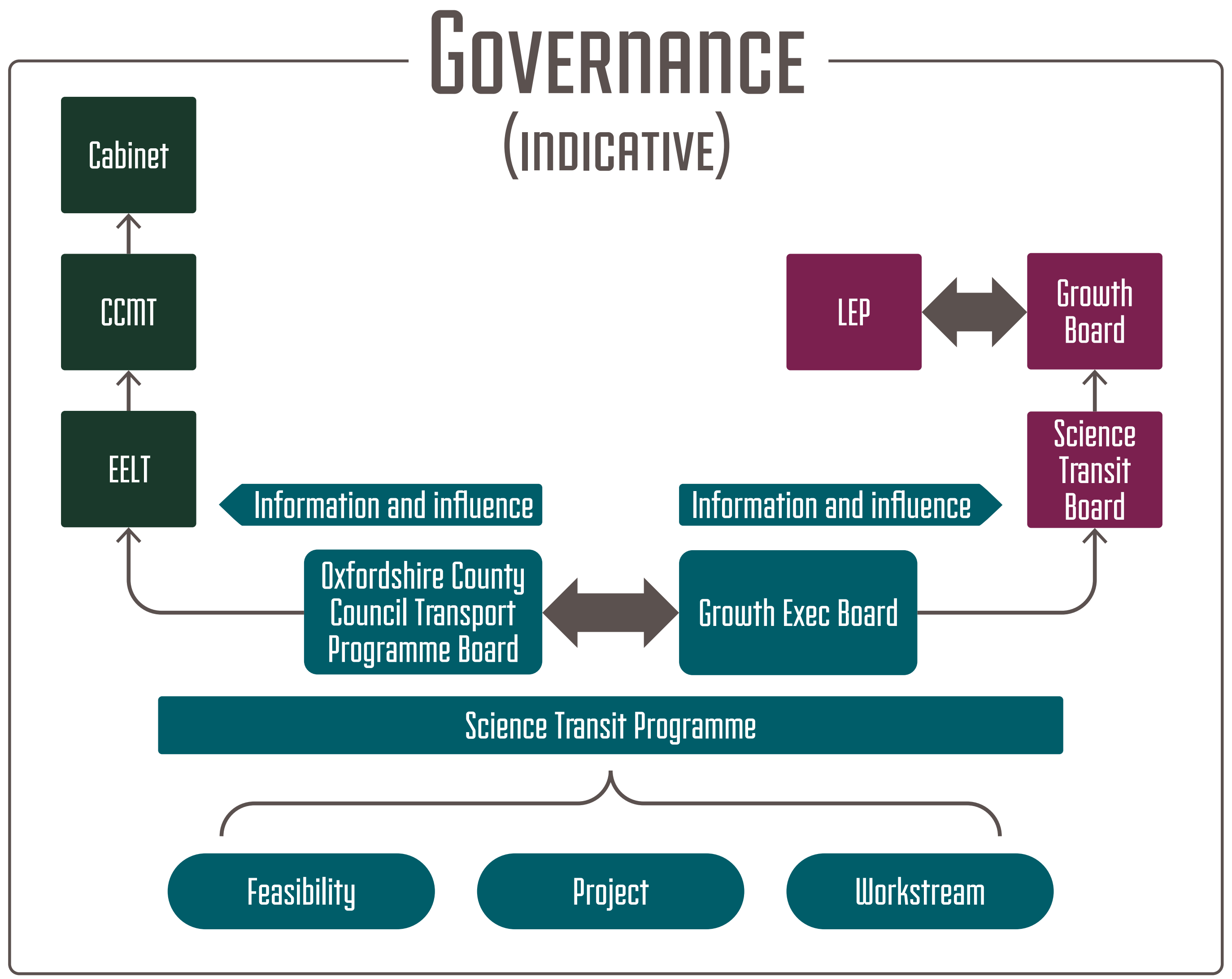
6.19 **Land value capture.** A potentially significant contribution to funding could be made through mechanisms such as land taxes, business rates and Tax Increment Financing (TIF) to capture increases in land value generated by new and improved transit services. Such mechanisms require investigation, detailing and buy-in from relevant stakeholders.



## Governance

6.20 A clear governance structure has been established to manage the development and delivery of the Science Transit Programme, as shown in the figure to the right.

6.21 The Science Transport programme will report to the Transport Programme Board and Growth Board Exec Group which will form the primary governance and decision making point for the project.

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