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Personal security barriers to implementing automation in public transport: Workshop 3 Report

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Workshop 3 Personal security barriers to implementing automation in public transport

Introduction

The workshop reported on in this Workshop Package 3 Interim Report is part of the project "Enhancing transport technologies to support personal security in travel by public transport: Scenarios for 2040", funded by the EPSRC.

About the Project

This project is focused on the role of technology and its interaction with user needs and perceptions in supporting personal security in travel on public transport. The aim is to develop fundamental understandings relating to this interaction and as a consequence to enable transport technologies to better support personal security (both perceived and actual) in travel by public transport.

Objectives

1 Assess the extent to which personal security issues are currently effectively addressed in a set of five specific application areas.
2 Identify potential future personal security issues and assess how they might be effectively addressed in a set of five specific application areas.
3 Examine how spatial, temporal and demographic factors influence the nature of both current and potential future personal security issues.
4 Develop policy recommendations to support decision makers regarding the application of transport technologies to support travel by public transport.

The Five Application Areas

1 Provision for public transport traveller information
2 Provision for contingency planning to support travel by public transport
3 Automated public transport services
4 Flexible transport services
5 Secondary, unintended effects of security (anti-terror, crime and antisocial behaviour prevention) technologies in the travel environment

Project Work Programme

The research programme is structured into 6 individual work packages, one for each of the five application areas, undertaken in sequence. The sixth work package will collate the individual reports from WPs 1-5 into a final project report, including policy recommendations and overall conclusions which will be presented at a Key Findings seminar.

Workshop context: the relationship between automation in public transport and personal security

Workshop 3 is focused on understanding whether passenger perceptions about personal security are a barrier to the introduction of automated services in public

transport. The workshop is the third in a series of five that are using a scenarios approach to explore issues and key drivers that influence how to enhance technologies to support personal security in travel by public transport. Each workshop is focused on a different application area. Participation in each workshop is intentionally diverse to ensure a wide range of perspectives are covered – bringing users, operators and service providers together to draw out new insights.

It is widely anticipated that automated public transport serviceswill have an increasing part to play in future travel. However, negative perceptions of the impact of automation on personal security may act as a significant barrier to the implementation of services. Alternatively, some forms of automation could enhance a sense of personal security. The purpose of the workshop is to investigate the views of the participants regarding the degree to which personal security issues are effectively considered and accounted for in the design and implementation of automated services. Automation can be defined in three main ways:1: the technique of making an apparatus, a process, or a system operate automatically; 2: the state of being operated automatically; and 3. automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that take the place of human labour (Merriam-Webster on-line dictionary[1]). All three variants are relevant to the focus of the workshop. Therefore we are taking a broad view of automation, from existing driver-less systems (e.g. Docklands Light Railway) as well as emerging systems and services such as personal and group rapid transit (e.g. the Heathrow Pod), the role of automation in enabling new transport services such as car clubs and bike hire schemes, to automated problem reporting services (e.g. Fix my Transport), automated information services (e.g. Traintracker voice recognition service), Smartcards offering greater automation of ticketing and fare collection, and help-points and security monitoring of unmanned transport locations such as stations. Some personal security concerns will centre on attitudes to cyber-security and identity theft. In other instances, particularly in relation to the more mature public transport services, user resistance to automated services is often predicated on the belief that they are designed simply to replace staff. The relationship between automation and staffing in terms of both roles and provision will also be explored.

Report of the workshop

Workshop Programme

In the first part of the day participants explored how far personal security, safety and confidence are considered in the current provision of automated services, both to draw out problems and highlight good examples. The need for reassurance that staff are able to help in the event of things going wrong in a journey can contribute to low acceptability of some automated transport services. A key question is to understand how far user-centred design and better information can overcome negative perceptions about automation in the transport environment.

In the second part of the day, participants considered the key driving forces that are influencing the future introduction of different types of automation in public transport.

[1] http://www.merriam-webster.com/dictionary/automation accessed 20 February 2013

Finally, example future possibilities for the application area will be narrated within the framework of a set of pre-defined scenarios. A final report from the day will be developed with the help of expert interviewees and workshop participants.

The timetable for the programme and the list of participants are found in Annex 1 and 2 respectively. Five intended participants were unable to attend on the day and will be invited to participate through the expert interview part of the overall project.

Findings from the workshop

In this section we present the material more by theme than by the chronology of the workshop. The first thing the participants were asked was to scope out the nature of automation in the public transport environment. As the later SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) questions used the same thematic headings, we have presented the thematic SWOT tables with the material on the range of automation in public transport. We then present the participants views of the reasons why various types of automation are introduced and the relationship of automation and personal security in different temporal, spatial and demographic contexts, along with our expansion of this material. Throughout we use bold text to highlight examples mentioned by participants, and have done desk research around these examples to inform our interpretation of the implications of the technologies.

We then consider the data generated that can be fitted into in an overarching SWOT analysis for the near term (i.e. over a time horizon up to 5 years ahead). The raw data collected by the Innovation Space software can be found in Annexes, highlighted in the relevant section.

Q1What forms of automation exist in public/shared transport at the moment?

We asked this introductory question in order elicit the participants' knowledge regarding existing automation in the public/shared transport sector. As an opening question it also helps to make all participants aware of the range of automation that we are interested in, as in the future automation and technological development will make the definition of 'public transport' quite different, introducing new possibilities.The raw data for this is found in Annex 3. Specific terms used by the participants are shown in **bold** in the text below to show how we have interpreted the significance of the item mentioned. Prior to the workshop we had scoped out that automation relevant to the project theme of personal security is likely to cover journey information before and during travel, booking and purchase, automated operations where humans are replaced or supplemented by mechanical or digital technologies, and security and crime prevention.

Information about travel services

There is great diversity in automation in the provision of information, drawing on key **databases** of schedules and services. This basic data is made available through the internet and automated **telephone services**. On-line passenger information consists of **websites** and portals (e.g. **TravelDirect**) for scheduling, **journey planning** and links to ticket sellers, as well as information about planned disruption. Increasing sophistication has resulted in greater expectations from passengers leading to a demand for more dynamic information.

Real-time information (RTI) was originally limited to essential operations, but new technologies are increasingly enabling RTI to be provided direct to the public. This is

increasingly supplemented with real-time sources of information that can be used in back-room operations, to help front-line staff, and to assist and assure passengers both before and during journeys (real-time passenger information or RTPI).Channels for automated RTPI include:

- **RTI boards** at termini, stations and bus stops and shopping centres or office buildings
- **On-vehicle informationscreens, withRTI/disruption, 'next stop', 'points of interest'**
- Telephone information services
- Websites and mobile websites for schedules and journey planning
- **Mobile apps**

Back room information includes **automatic re-routing during disruption**.

For some items listed by participants it is not clear whether these are desirable and possible with current technology, or whether they have actually been introduced anywhere.

SWOT analysis of automation in information provision

Strengths	**Weaknesses**
• Apps and mobile web sites allow personalisation • Accurate and timely RTI -Enhances feelings of safety • Allows more passengers to access more detailed timely information, and reduces pressure on staff resources • Automated sources of information have enabled passengers to have greater flexibility and control over journey making • Mobile technologies enable passenger to make most efficient use of their time	• Apps such as Network Rail app get information before the RTI boards in stations, and before staff know, and there can also be discrepancies between website and station information. • Information is only as good as the base data. A lot of data is reliant on human data entry which can lead to keying errors. Without data cleaning and correction there will be errors in the resulting information provided to users • Mobile information dependent on robust mobile coverage and capacity which is patchy in the UK. • When mobile networks are congested, voice calls are prioritised over data requests, so people trying to check RTI using mobiles when there are a lot of voice calls being made will not be able to access information. This is a problem during delay and disruption. • Relies on people having access to and being able to use the technology, as services are not always designed for people with specific needs. • Sufficient resource is need to manage information technology effectively. • Passengers increasingly want prediction, not just real time information.
Opportunities	**Threats**
• Improved communications solutions providing 'always connected' capability (apps etc.). NFC providing access to information in a user friendly and tailored manner (e.g. automatic language recognition and provision). Smart Wi-Fi can provide crowds with valuable information on every type of mobile phone.	▪ Data security and resilience to cyber crime and malicious attack - staying ahead of the bad guys ▪ Mobile communication solutions do not improve sufficiently quickly - high investment needed? ▪ Lack of funding due to world-wide economic

Not just smart devices. • Amount of technology already in development • Increase methods to report crime and anti-social behaviour. Social media can be used to photo and tweet ASB issues. That way evidence can be gathered with relatively low risks. • More personalised pre-journey planning and through journey updates, including answering specific geo-queries, such as 'where am I and where do I get off?' or accessibility information. • Reduced provision of infrastructure may drive technology based solutions to deliver capacity and improve customer service in a competitive environment. • Technology savvy population becoming older – opportunities to deliver age or disability specific services to a growing market.	downturn makes it harder to make business cases for investment in new technology services. ▪ Poor base data continuing to be the norm ▪ Changes to the underlying technologies or to market availability of technologies that transport sector has invested in (e.g. iPhone 5 doesn't have NFC) ▪ Those intentionally or unintentionally without devices are socially excluded

Booking and buying travel services

There is a great deal of automation involved in purchasing travel tickets. The internet has enabled **buying travel tickets online**, through links between online journey planners, other sources of schedule information and ticket vendors (including the transport operating companies' own websites). **Smartcards** also represent a new form of automation in ticketing, such as **Oyster** (in London) and **Walrus** (Merseytravel).

In principal smartcards can be pre-loaded with specific tickets, or pay as you go credits, either on-line, by telephone or in person at passenger-operated machines, as well as through a traditional face to face transaction at a booking office. A key advantage of smartcards for operators is the speed with which passengers can pass through gated stations. In practice, scheme designs vary, such as **Southern Rail**'s The Key (using the **ITSO** standard[2]), which at present is only for Monthly and Weekly Season tickets on part of its network (including Gatwick Airport). The extract from Southern Rail's website illustrates the promise of greater 'seamlessness' achievable with Smartcards:

> *"The smartcards will evolve over time with many possibilities for the future. For example, they could be used in the future to hold car park tickets or indeed to hold 'cash' which could be used at station or train retail outlets making the overall journey more straightforward for the passenger."*(http://www.southernrailway.com/smart-card/faq/what-is-the-key/10/ accessed 21 February 2013)

Metrobus(also in Sussex) is also using its own version of The Key for several types of bus ticket on the Gatwick part of its service network.The Key can be loaded with multiple ticket types in advance, though it is limited to the Metrorider or Multitrip tickets for Crawley, Horsham, Redhill&Reigate, Metrovoyager tickets, Horsham Park and Ride tickets, and Travelcards for Gatwick Airport workers.

[2]The ITSO government specification was highlighted by a participant during the refreshment break

The purpose of using smartcards that meet the ITSO standard is ultimately to allow customers to use the same ITSOstandard smartcard across different operators and regions. At present, anyone with a geographical spread of travel requirements would need a smartcard specific for each operational area required. In promoting smartcards to customers, the primary 'personal security' aspect that is highlighted is the protection against financial loss if the smartcard itself is lost, as they are (or can be) registered to individual customers, 'blocked' immediately if lost, and replaced.

All ticket purchase for the **Croydon Tram**is automated as stops are unstaffed. To ensure passenger comfort and assurance, each stop has disabled access, raised paving, CCTV, a Passenger Help Point, a Passenger Information Display (PID), litter bins, an automated ticket machine, a noticeboard and lighting. Most also have seating and a shelter. The PIDs display the destinations and expected arrival times of the next two trams (though it isn't clear whether this is Real-Time or timetable data), but can display any text-based message the operator wants to display, such as information about delays or cautionary notices.

Participants also mentioned the recent emergence and rapid development of **mobile and contactless payment systems**, and new apps for booking taxis such as **Hailo** and **Get Taxi**. These types of automation are fundamentally changing the offering for some transport types. **Wave and pay contactless payment** was viewed with some ambivalence by the participants. For example, whilst it is **presumed to be more efficient**, it wasn't clear to participants **who benefits from efficiency gains** – transport operators, passengers or banks? Some of the current wave and pay systems are very **open to hacking**, For example, one participant felt that limiting roll out to **London** makes it a target for criminals to **refine their hacking techniques.** Although payments are limited to a **maximum of ten £20 transactions per day**, thus limiting potential loss to customers, each individual transaction establishes a connection to the **customer's bank account**. In terms of efficiency, this is rapid, but also potentially a personal security weakness. The existing banking sector may not be keen to innovate rapidly as they are not the drivers of the new technology, which is being promoted by **mobile companies** and **MNCs** (who are seeking to diversify into banking),.

Hailo is a smartphone app for ordering and paying for taxis, available in nine world cities. For the London app (iPhone and Android), one of the selling points is focused on safety: "Be Safe. Hailo works with London's 23,000 trusted black cab drivers."(https://hailocab.com/ accessed 21 February 2013). App users can also pay with their credit cards and receive an e-mailed receipt. Hailo has a 'matching app' for cab drivers, which offers a number of business management features as well as a social media element to create a sense of community between black cab drivers.**Get Taxi** was founded in 2010 and has a similar offering to Hailo, but is also web-based, as well as having apps for iPhone, Android and Blackberry, with a Windows (Nokia) phone app coming soon (http://www.gettaxi.co.uk/ accessed 21 February 2013). It operates in 15 cities across 4 countries, and also offers payment from your smartphone.

There are a number of other similar taxi booking systems, such as TaxiMagic (in the US and Canada), MyTaxi and CabApp (www.cabapp.net accessed 21 February 2013). This service is also free, available for iPhone/iPad, Android, Blackberry and Nokia. Its USP is that it is the only taxi app available across the whole of UK and Ireland, rather than being limited to certain cities. The range of services includes "Hail Now, Pre-book and Fixed Price fares" as well as card payment. Assurance of safety and accessibility are highlighted by the company:

"All cab:app drivers are licensed and on confirmation of your booking you will receive the driver name, badge number, vehicle colour/registration and you can track your driver on the map as they drive to your location. You can also keep in direct contact with your driver through the in-app message board or by calling on their mobile phone."
"It's also about safe travel at night, perfect for women travelling alone. You can hail a cab from wherever you are without having to walk to the nearest rank or stand on a street corner. It's about accessibility for everyone. cab:app works in partnership with WheelPower to help highlight the need for and improve access to transport for many disabled people. Whether you are visually impaired or physically disabled, or just need a helping hand, you can communicate this in advance via the app as licensed taxis have the flexibility to meet your needs."

Passenger and driver security and safety are an issue in the taxi industry. Applications that use verifiable identities can address personal security issues very effectively, and may also enable regulated hackney cabs to compete more effectively with private hire vehicles where local enforcement is sub-standard (http://www.cabapp.net/media/news). There are automation based developments to improve service provision in the Private Hire market as well: http://bargainphv.com/default.php. The Private Hire part of the transport market can be afflicted by unlicensed operators, which poses a personal security risk for customers.

Another new development combining online/app based taxi booking with smartcard payment has just launched in the Rhine-Main area of Germany, the TaxMobil Card. This aims to improve the efficiency of taxi operations, as customers pay a single monthly fee for unlimited taxi travel on demand, with the trade off that they may be sharing part or all their journey with other users. The monthly fee is 48€ and anyone over the age of 8 yrs can hold a card. http://www.taxmobil.com/index.php?english and http://www.eltis.org/index.php?uid=ZGZkZwxX&ID1=5&id=60&news_id=4015 accessed 26 February 2013.

The increasing use of **2D barcode systems** on Smartphones (such as QR codes) are also part of the automation mix. These can make it quicker to access information for specific transport locations. A particular advantage, is once the code has been scanned by a phone, the weblink (e.g. to RTI for that stop) can be accessed from anywhere, even at home, reducing waiting time in isolated locations. Smartphones can also be used to access booking and payment systems alongside accessing timetable information. This can eliminate any personal security risks from using ticket machines in public. For example, Arriva and Uno offer mobile ticket purchase in Hertfordshire (http://www.intalink.org.uk/default.asp?contentID=726).

This increasing automation in the travel domain offers the promise for greater seamlessness between modes which could result in some blurring of the definitions of

transport types as we know them at present. For example, the charging system for the**London Congestion Charge**(LCC) is based on **Automatic Number Plate Recognition** (ANPR), which is unobtrusive at the point of use, and drivers don't even need to be registered to drive into the charging zone, as the LCC is able to use DVLA[3] data to enforce payment if customers don't pay either online or in person within the allowable time period. This type of automation makes it possible to offer concessions to certain types of traveller, such as low carbon vehicles, and car club vehicles. Car club vehicles in particular could become part of the public transport mix in future years.

SWOT analysis of automated booking and payment systems

Strengths	**Weaknesses**
• Contactless payment (direct from bank accounts) is theoretically more efficient • Automated booking systems can help advance planning of journeys • Mobile ticketing reduces barriers to using public transport • Allows people to avoid queuing unnecessarily	• Difficult to implement and the business case is often not clear. • Wave & Pay too open to hacking, though is alleged to be as secure as any current card payment system. • Contactless payments from bank accounts mean data requests will need to go to individual banks. Whilst this is usually fast (about a third of a second), it increases the number of stakeholders in each transaction. • The potential efficiency gains may not be shared equally amongst all stakeholders • Adoption may be slowed by public confusion about the range of different options, leading to lots of diverse innovations and no clear winner, though people do like choice • Mobile solutions rely on battery life, and on robust and reliable mobile communication (coverage and capacity) - can be limiting in the UK - e.g. Waterloo!
Opportunities	**Threats**
• Seamless multi-modal ticketing and more transparent ticketing structure, and automatically providing the most economic ticket for the traveller • Smartcards and mobile payment methods accelerate the cashless society and reduces need for bus drivers to handle cash (several benefits). • Apps for requesting autonomous vehicles	• Incompatible or inflexible ticketing systems - not always giving the lowest cost option (33) • Reliability of Wave and pay and the reputational damage that could result from targeting of customers for criminal intent: apps available that read data on cards nearby, though mobile phone contactless payment is more secure. • Standalone systems versus internet

[3]Driver and Vehicle Licensing Agency

• More wave & pay = eradication of expensive Oyster system (54) • Technology acceptability: people wanting to do more using technology - to make best use of their time	based ones. The first is hard to fix - the second is open to cyber-attack • People become more vulnerable to personal crime, as they have the cards and the mobile devices that criminals need • Regulatory issues: IR issues around Wave and pay and staff involved in revenue protection having to sign off Data Protection responsibilities • Some technologies also require legislative change - e.g. wave and pay - in terms of data accessibility to law enforcement

Automated transport services

There is currently considerable research and development going into the automatic operation of vehicles themselves, in part in a drive for greater safety by reducing human error, but also in the search for greater operational efficiency (**reduced staffing costs**, **greater fuel efficiency**, and greater network **carrying capacity** are all possible through automation).

Automation has been developing in rail-based services for a long time. Automatic Train Operation (ATO) and the continued existence of drivers on some train services is more for reassurance and manual over-ride in emergencies, rather than strictly necessary (though this is highly contested, as the varied comments submitted to an online BBC story about underground train automation: http://www.bbc.co.uk/blogs/mindthegap/2010/06/do_we_even_need_drivers_on_the.html accessed 26 February 2013). For trains, there are five grades of automation (GoA) as described by the International Association of Public Transport (UITP). GoA 0 and 1 are fully controlled by a driver. GoA 2 is semi-automatic, with some operations controlled automatically, but with a driver present to undertake certain tasks. This is a very common level of automation in trains around the world. GoA3 is driverless train operation, but with a train attendant who is able to drive in emergencies. GoA4 is fully automated and unattended. The first unattended railway in the UK is the Docklands Light Railway (**DLR**), though there is also a high level of computer control in the London Underground system, with the 'drivers' of the recently upgraded **Victoria Line** there for other reasons. The acceptability of driverlessness on British rail-based systems has been mixed: union pressure has coalesced with passenger anxiety over security to create the need for 'Train Captains' on all DLR services for example.

Fully automated vehicles on guideways are also feasible, and there are several examples around the world. The first was the Group Rapid Transit system (GRT) in **Morgantown**[4](USA) system that has been in operation for several decades, as well as more recent developments such as the **Heathrow PRT,** the world's first commercial Personal Rapid Transit (PRT) system. The Heathrow POD, started operation at Heathrow Airport in 2011, providing a service between Terminal 5 and its Business Car Park. The POD is an

[4]See cover picture

automated vehicle operating on a specially constructed guideway (and is thus separated from other types of traffic). The system has reduced bus journeys on the airport road network by 70,000 journeys annually, and has a close 100% reliability record. The operators of Heathrow airport now plan to introduce a further PRT service for Terminals 2 and 3 (http://www.ultraglobalprt.com/ accessed 26 February 2013). The first urban PRT system (also an Ultra system) is being constructed in Amritsar, India, under a private sector contract awarded by the Punjab Government and should be operational in 2014. The press release refers not only to congestion and emissions improvements, but to the 'privacy and comfort' that will be offered to passengers (Ultra Global, 2011). Masdar City in Abu Dhabi is developing **free-running Pods.** Although these do not require rails or a concrete guide channel, they do require magnetic guide strips and a fibre-optic cable. In Masdar City the battery-powered PRT system is being constructed under the pedestrian level, in dedicated corridors, which it will sharewith a freight rapid transit system (http://www.2getthere.eu/?page_id=10 accessed 26 February 2013).

What existing automated systems have in common is that they are closed systems, and require special infrastructure. The biggest change to our current transport system imaginable is to introduce greater automation into road vehicles that does not require expensive re-engineering of roads (though other types of infrastructure might be required). There are two principal schools of thought. One is to work on driverless road vehicles – so-called autonomous cars (e.g. **Google car** (using Google's mapping data, and immediate environment detection technologies combined with computerised vehicle control), The second is to introduce partial automation for long journeys that 'platoon' vehicles together in convoys on motorways controlled by a lead truck driver. There have been a number of large publicly funded research projects in this area (e.g. **SARTRE** (Safe Road Trains for the Environment, with a test track in Sweden, is a partnership between Idiada and Robotiker-Tecnalia of Spain, Institut for Kraftfahrwesen Aachen (IKA) of Germany, SP Technical Research Institute of Sweden, Volvo Car Corporation and Volvo Technology of Sweden http://www.sartre-project.eu/en/Sidor/default.aspx accessed 26 February 2013); **KONVOI** (a national German project); **CHAFFEUR** which is focused on truck platooning). In both cases there are a great many technological, regulatory and society issues to resolve, and the technologies, though well-advanced, with successful demonstrations of prototype vehicles, are not near-market at present though within 10 years is a forecast that is often made.

There are also myriad examples of more limited types of automation. Some are within vehicles, such as SatNav capabilities to offer **automatic re-routing** in a real-time response to congestion (e.g. **TomTom**). Other developments aimed at drivers of commercial and passenger vehicles include **on-board units** which indicate to the driver whether they are running early or late to schedule. Larger-scale automations have developed in road network traffic management, such as **MIDAS** loops on motorways and car counts (pre mobile phones), linked to Active Traffic Management. Participants also mentioned the **Campus car**. Post-workshop research revealed that Campus car is a prototype low-cost light-weight shared vehicle. Access to the vehicle is spread to non-drivers through a social media-type app that enables people to 'hitch' lifts on the campus car.

SWOT analysis of automated transport services

Strengths	Weaknesses
• Reduced potential for human error • Automated train services doubtless more efficient • Can allow for high level of data capture linked to performance • Increased efficiency - both network capacity and energy use	• Resistance from unions to automation of public transport driving services • Human costs in loss of jobs. Risk of industrial action by unions • No capable guardianship; no natural surveillance, no clear rule setting presence - basic crime prevention principles missing (though possibly less need for it. Automation may limit opportunities for criminal action) • Immature market: too few systems to generate awareness/ support wider implementation through good practice examples e.g. PRT/GRT • Most automated systems work only in very closed environments with no interaction with other transport systems • Break downs costly and complex to physically fix. Huge risks associated with allowing remote fixing. • Service disruption takes longer to rectify than non-automatic services
Opportunities	**Threats**
• Autonomous cars would be socially progressive by widening access to personal transport to groups who currently can't drive (e.g. blind/partially sighted) • Potential to enhance whole transport network appears almost limitless. • Massive revenue potential from personal autonomous car service, and would be able to select vehicle appropriate for journey (e.g. Smart car for commute; van for moving house etc.) • Demonstrable benefits from early systems e.g. ULTRA could stimulate transferability • Diverting driving staff to customer service? • Opportunities for jobs in customer services to compensate for loss of driving jobs.	• First autonomous vehicle road death will gain a disproportionate amount of attention and damage public acceptability • Infrastructure was never designed for cutting edge technologies and needs to catch up • Automobile Original Equipment Manufacturers may be resistant to development that may negate their market position • Potential to rely too heavily on the technology and not supported by sufficient number of staff • Greater reliance on automation technology increases vulnerability to technological failure, e.g. loss of power supply.

Security/crime

Automation is also occurring in the security and crime prevention side of public transport provision. For example, **ANPR** is in use for enforcement purposes on the roads. **CCTV** has been used for security surveillance instead of or in support of human guards for many years, both in transport and in the wider urban environment. Technological development to enable automated identification of security risks through CCTV video feeds is well advanced, and includes **gait recognition** (identifying individuals through the way they walk), **video analytics** (such as **behavioural detection**) and **facial recognition**. Fixed facial recognition systems are already in use (e.g. the real-time fixed camera facial recognition system supplied by Facing-It http://www.facing-it.com/resources/PLS-FRS.pdf accessed February 2013). **Covert surveillance** was also mentioned, but no specific technologies.

Automated technology is already used for **biometric passport authorisation**, and biometrics can, in principle, be utilised with smartcards. Other technologies are widespread in access control: **gating/ticket barriers** are widespread on the railway network (overground and underground) and prevent access by individuals without valid tickets. Those with cardboard tickets or smartcards can use the automated gates themselves, though passengers with 'print at home' tickets have to seek assistance from staff. **Hand-held smartcard readers** can also be used by transport staff (e.g. on **TfL buses andrail**). **Passenger counters** are also in use for loading and business data.

Access to certain areas can also be controlled using **Proximity Readers** (which utilise contactless technology, such as RFID), and in terms of infrastructure protection, **automated guarding** is possible through **fibre optic solutions**, which can be used with existing communications cables to provide a **virtual security perimeter** which raises an alarm if crossed. **Security patrol point readers** can also automate elements of staffed security provision. For high value items in the transport environment, **automated 'stock' systems**and **bar-code stock systems** with electronic reporting forms for staff improve control of resources. **Unmanned Air Vehicles** which are available on the market could be used for automated patrol (for example, patrolling inaccessible areas that are at risk from cable theft).

Automated audio **awareness announcements** are in widespread use across the transport network (for example "Please do not leave your luggage unattended at any time"). **Bluetooth messaging** has been used with limited success:

Bluetooth has been used for targeted advertising on 'Gold Route' London buses, which works by having standard advertising on vehicles alerting passengers to the presence of Bluetooth capability. Passengers can then choose to enable their devices, and either accept or deny one-time only advertising messages. (http://www.cbsoutdoor.co.uk/About-Us/News/CBS-Outdoor-UK-and-Blismobile-bring-Bluetooth-to-London-Buses/)

On Indian railways, Bluetooth is used at Bangalore City Station, by Bangalore Division, in collaboration with RailTel and Telibrahma. The 'BluFi' service combines Bluetooth application and Wi-Fi connectivity, and enables passengers to receive a mix of railway information and entertainment, like videos, downloadable games, and wallpapers just by switching on Bluetooth on their mobile phones (http://southasia.oneworld.net/archive/ictsfordevelopment/bangalore-railway-station-goes-blufi#.UTiw1CRFDcs).

This targeting method can also be used for police awareness messages. For example, in

Wales it has been used to deliver anti-bullying messages to the mobile phones of the target audience (children and teenagers). A major advantage of the method is it enables measurement of the numbers of people who have received the message (http://www.ourbobby.com/EN/news/details.aspx?n1=1520&n2=1525&nid=6991).
On the London Underground, Bluetooth has been used on the Piccadilly Line to deliver anti-pickpocket alerts (http://www.harringayonline.com/forum/topics/bluetooth-helps-fight-against). However, there are also some security risks from incautious use of Bluetooth, as an example from Bolton shows. Thieves are using their own Bluetooth devices in the railway station car park to locate switched on Bluetooth devices that have been left in parked vehicles. They can then target those specific vehicles, even if the device is not visible (http://www.theboltonnews.co.uk/news/4335046.Beware_the_Bluetooth_thieves__warn_police/).

Most security awareness messaging is not automated, being delivered via poster campaigns. **Reporting** of crime and security concerns has also seen the introduction of some automation for both staff and passengers. For example, the **See Something, Say Something** campaign has a text service and phone app for passengers to report anti-social behaviour and crime. **Crimestoppers** have an anonymous voice-mail telephone reporting line, Merseyside bus drivers have the **IRiS reporting system**. **Stop Hate UK** also have telephone reporting systems for hate crime on public transport (for example in Merseyside/West Midlands).

For passengers who need help in unstaffed locations, there is widespread provision of **Help Points**, with a speaker/microphone and button to press to 'call' the controllers, who will help them with their problem, whether that is journey related or security related. Many of the train operating company help points are contracted to NRE.

There was no specific heading for a SWOT analysis of automation in security and crime. Items included here have been transferred from other headings or reflect the security/crime prevention issues that are raised under other headings.

Strengths	**Weaknesses**
• Many railway stations have Help points which automatically connect user with central call centre • Crime prevention and safety awareness and reporting campaigns	• Facial recognition software for CCTV still unreliable and reducing belief in its future for investment purposes • Identity theft resulting in wrongly being charged for travel. This issue needs to be tackled with more seriousness • Basic crime prevention principles are missing from unstaffed locations • Unmanned automated transport services have no reactive presence – i.e. First Aiders on scene, de-fib etc. • Mobile communications cut two ways: can be and are used to organise crime (e.g. football casuals; Bluetooth targeting) • Technology and data is sometimes being stretched beyond its usability (for example, the London Underground

	CCTV was installed for safety and crowd monitoring, and isn't a high enough specification for crime detection)
Opportunities	**Threats**
• Personalised and discreet messaging via proximity readers (Bluetooth or NFC) • Biometrics • Video-analytics • Improve delivery of existing information that would really help disabled people • "Over The Air" transmission of real-time bus data, wireless and automatic download of data/images on re-entry to depot	• Continued austerity tends to increase crime levels and lawlessness - human factors key to effective responses in some circumstances. A downward spiral in personal security would affect confidence to travel for any but most pressing reasons. • Dependence on technology - makes technological infrastructure a high value target for malicious attack. • Resistance to change by operators is a key barrier, as private companies are understandably cost averse. This means that legislation may be the only way to ensure that certain small steps are taken that would more equally support everybody to use public transport

SWOT analysis of cross-cutting issues with automated technology in public transport

Strengths	**Weaknesses**
• Technologies seem to be pretty mature; much is feasible and usable	• Travel information can be better than paper but relies on accurate base data • The business case for innovative automation can be hard to develop (impossible based on today's rules). The investor is never going to receive full return. Hangers-on have no incentive to participate • Institutional barriers and inertia, conservative thinking - do the minimum • Incompatibility of different technological systems and can be problems when technology is superseded by a new incompatible technology • Dependence on user having (or having the ability to use) the required technology • Customers like the personal touch and a well informed and pleasant member of staff is worth a lot more than automated systems

	• Citizen education - a more connected world means we have responsibilities to uphold on the use of our data. This is not understood
Opportunities	**Threats**
• Transport still in silos. Move to mobility and this would remove the silo • 4G Communications - 'always connected' coming closer? • There is great capability for innovation, system improvements and enhanced customer experience and technical/techno advances are ever faster • iOS and Android becoming dominant mobile OS – at present just need to develop app for two platforms (though Microsoft/Windows 8 may have a resurgence, and others not yet known may emerge within the decade)	• Funding for development • Downward spiral in sense of diminished sense of personal security affecting confidence to travel for any but most essential reasons? • Lack of an 'always connected' mobile communications solution(s) • Incomplete coverage of mobile signals • Implementation barriers endure - legal/regulatory, etc. can't keep pace with innovation • Risk that some users might invest in the 'wrong' technology (though trend towards greater interoperability?) • Franchising system mess - reducing length of franchises downwards from 15 year to 7 and 2 year • Short-term views of commercial companies

Q2 What are the main reasons why automation is introduced?

We asked this question in order to explore how differences in expectations/objectives in introducing automation might influence decision-making. Whilst there were not many participants who might be regarded as good proxies for specific user groups what others say they think are user benefits is illuminating. Whilst different stakeholders have different reasons for introducing automation, there is likely to be synergy or convergence between technologies that strengthens business cases for introduction. If there are personal security benefits from this synergy, we are seeking to identify and highlight those benefits.

For users

Given the sheer variety of forms of automation in the transport environment, the potential user benefits are similarly varied. **Increased safety** was mentioned as a user-focused benefit for introducing automation (though not necessarily one that is *driven* by users): majority (90%) of road accidents have human error as a contributory factor - automation may provide an opportunity to reduce accidents caused by driver error.

Customer service was perceived as delivering a lot of user benefits.Participants mentioned better customer **interaction with transport company**as a user benefit. Social media approaches offering two-way immediacy seem particularly promising, particularly as operators can **respond to complaints** transparently. However, it was also noted that the flow of information might need to be **controlled for operational and safety** reasons. It was also noted that the same techniques offer user benefits in enabling them to report **crime and anti-social behaviour** more easily.

Increased efficiency was also mentioned as a user benefit for introducing automation. However, efficiency benefits are quite general and not user driven. The examples given were (1) the near/mid-term development of **platooning** for more efficient (and safer) use of road space (see above); (2) Automatic Traffic Management, which acts to modify behaviour through speed smoothing, enabling small increases in network capacity and reduced fuel use; (3) **more frequent reliable services.**

Easier access to more up to date information, was considered to **improve passengers' journey experience** by allowing then to plan and re-plan their journey. However, it is not clear that this assumed benefit has been fully evaluated, except in the aviation environment, where it forms part of an **extensive quality service monitoring** to evaluate the customer experience before and after travel. One participant said that they did evaluate this, and assumed that others did as well. In part the need to increase the flow of information, once technology exists to provide it, becomes internally driven as the societal **thirst for information, accessibility and choice** gains momentum. Participants were sceptical about whether this is always a good use of automation and hinted that clear understanding of the **boundary** was needed. One suggestion was that the argument for provision lies **where it helps the majority of travellers** (i.e. where it has the maximum utility, rather than helping minorities). It was also pointed out that **the same information can be used for more than one purpose**. For example, better access to RTI also has operational benefits by enabling more control over events as there is a **better understanding** of what is happening.

Mobile communication technologies have delivered the **ability to do other things whilst travelling**, which encourages **modal shift** (this is not purely a user benefit) andthis is also one of the promises of autonomous personal vehicles (see above), as well as making new types of service viable, such as **car-sharing.**

For operators

Safety through automation also features as an operator benefit because it delivers s**afer operation.** It also reduces **mundane tasks**, and **human error**, which can also directly and indirectly improve safety. Automation can increase **capacity** and improve **efficiency, reliability**and **service frequency** were also perceived as operator benefits from improved performance. **Cost savings** were also mentioned, part of which can come from **reducing reliance of staff** and this was perceived as increasing **resilience**. Participants did not state which particular aspect of resilience was enhanced, but it might relate to reduced impact of strike action as well as reduction in opportunities for human error to cause disruption. These operator benefits are clearly desirable for **commercial reasons** in a competitive marketplace.

Other operator benefits from the introduction of automation included developing the ability to understand and control **crowd dynamics**, which is emerging as a key issue; **reducing fraud by staff** and the public (e.g. **protection of income** through ticket gates at stations), and as with users, to enable staff to **report crime and antisocial behaviour** more easily. The improvements to the data flow also enable operators to **undertake more detailed analysis, to identify and solve problems** (such as **perturbation recovery from incidents**), and to improve **matching of supply of service to demand on the service.**There is scope for the wider transport industry to learn from the **use of customer data** in the aviation sector.

For information providers

Real-time information and customer data both have a value for **planning and marketing**, and information providers can exploit this. Automation of travel information has made it **easier, faster and cheaper to disseminate**, but has also created a market in **sophisticated systems** for providing information in particular ways, particularly in relation to **complex multi-modal journeys**. Participants highlighted that data protection issues remain live and questioned whether some parts of the transport industry were making the best use of customer and journey data. For example, **outdoor advertisers pay to advertise on bus shelters**, and have a method to identify footfall **hotspots**. However, if they had more information about the demographics of those hotspots, locational advertising could become more sophisticated.

For security authorities

For the security authorizes, automated systems are a key **preventative** and **investigative tool**. Whilst CCTV more widely in the urban environment has been shown to have little preventative capability (Lorenc *et al* 2013), though helping with post-incident investigation, in the railway environment, the participants' view was that CCTV is perceived to have a preventative quality, as crime in this surveilled environment is extremely low. The **detection capability** raises the chance of **sanctioned detections** (i.e. resulting in court action, a caution/warning or reprimand). Automated systems also enable fraud patterns and incidents to be detected, whether by **staff**, or by passengers (as with **Transport Scotland's** detection of **smartcard fraud**).

Automation also enables **usage monitoring**, **threat monitoring**, **control or denial of service**, and **back-up recording** of incidences for **enforcement**. Security operatives can also have **remote access to security systems** (improving efficiency and coverage), though this also raises the possibility of **cyber-crime**. It was also perceived by participants that electronic monitoring **'sees'** more than a team of humans (for example, auto-detection in CCTV can identify **queuing traffic**, **intruder alarms**, **over-crowding**), and help to mitigate human error. However, the automatic **interpretation of observed actions** is not so well-developed.

Intelligence gathering that develops databases of crime and antisocial behaviour incidents can assist with analysis and hence **predictions of seasonal** and other **patterns** in criminal (or problem) behaviour. The benefits to operators in improving **perturbation recovery** also applies to the security authorities, who are likely to be first responders in emergency situations. However, participants raised a questi on about where (or if) data about automated services is held, and when/how designated authorities can access it.

Q3 What is good and bad about existing automated services?

Chronologically participants were asked to think more explicitly about the strengths and weaknesses of existing automated services after thinking about the range of automation and the reasons for introduction. The raw data is in Annex 3, and our summary of the Strengths and Weaknesses, drawing on answers to Q3 ordered by specific applications as well as on other answers given across the range of Q1,2,4 and 5 have been presented above under each application. A discussion of the SWOT analyses is given below.

Q4 What are the personal security issues with automated services in different circumstances?

Understanding the temporal, spatial and demographic factors that are implicated in personal security issues is a key objective of the project. We asked participants to give their views and examples of when any of these factors influence whether personal security is a particular issue for certain types of automation. Following on from the findings of Workshop 2 (see Pangbourne and Beecroft, 2012b) we added a fourth category of 'during disruption', as an example of occasions when different forms of automation might fail or assist in providing assurance or solutions to passengers affected by disruption.

Time of day/year

Most of the comments regarding the impact of automation on personal security under this heading relate to reductions in staffing overall or at certain times of day. Participants perceived that personal security becomes an issue when it's dark or in the later evening in summer, even if it isn't dark. It was noted by participants that the growth in the 'night-time economy' has left some parts of the transport network without **capable guardianship** at key times, creating personal security risks. It was also noted that the modal thinking of the fixed public transport network is not easily adapted to serving transport needs outside the identifiable peaks, with new thinking required.

The effect of introducing gated (ticket only) access to stations has reduced staffing on trains, except for the driver. This creates an uncomfortable and threatening environment for other passengers when drunks are travelling. Unstaffed stations also increase feelings of vulnerability, and staffed, well lit transport locations can become oases for the vulnerable at night. Several of the comments made by participants are used here as illustrative quotes:

> *Gating on stations has meant removal of staff on trains except for driver - not pleasant on trains in evening when the drunken element are travelling home and you are returning from evening meeting (comment number 13)*

> *A purely automated service - e.g. a driverless train into a staffless station late at night has big public confidence barriers. Doesn't matter how good the CCTV is (comment number 14)*

> *Automation does not make you feel safer. A caring friendly member of staff in the right place at the right time makes all the difference. (comment number 30)*

> *Different transport offerings on the time of day - based on frequency/cost - why not have a train provider put you in a taxi if that was the best mode for you at that time? (comment number 39)*

Time of day has other impacts on transport operations that can have indirect effects for passengers. For example, at peak times, the transport technologies are at greater risk of breaking down, due to system congestion. Time of year also has an impact – certain weather conditions can create considerable disruption for transport, with wider impacts rippling out from the epicentre of problems. Automated systems for passenger

information need to be adaptable, in order to avoid journey information leading passengers into less secure situations.

Type of area (e.g. rural/urban)

The geographical characteristics of areas can affect the degree of automation that is currently available. Rural areas are more likely to have **patchy coverage** for RTI and any of the more advanced automated systems using mobile technology can also be unreliable, due to **bandwidth** and signal constraints, something which can also affect some urban/suburban areas. There is also less public transport coverage, with rural areas having much less likelihood of a more or **less door-to-door service**, fewer **safe places to wait** and **lower service frequencies**. Journey planning is potentially made more complex by having less time flexibility, and passengers still need services to join these up and provide assurance and certainty in journey making.

> *One size fits all is not a viable approach. 3 distinct journey types to be catered for: 1) Inner City/urban - 2) Intercity/urban 3) rural to urban - each needs its own solution*(unnumbered comment)

A more direct impact on personal security could be having automated information that sends unwitting passengers on journeys through **'unwelcome' areas** that they would have chosen to avoid. One experience like this would be sufficient to reduce confidence in automated information sources. At present there do not seem to be any apps that integrate **crime-mapping data** with travel information data.

Demographic (e.g. age/gender) and personal context

It is more probable that the **older generation** will be technophobic or not have access to smartphones. In younger cohorts a **digital divide** has emerged between **Natives** and **Adopters** (also known as digital immigrants: Prensky, 2001), and it is inevitable that there will be differentiated take up of new technologies across the population, either by choice/preference or due to income disparity. This can lead to automation becoming a source of uncertainty amongst certain people, and in some local authority areas the majority of passengers still seek out **paper-based information**. However, older age groups that do adapt to automation are likely to experience some life enhancement through **better access** to social activities and health services (for example). However, the diverse impairments that affect older age groups, and the aging demographic suggest that automated services will have be carefully designed for **usability**:

> *Designing services for different needs, one size doesn't fit all, e.g. mobility impaired, sight impaired, hearing impaired, people with learning disabilities, all have travel needs.*

Gender is another dividing line for personal security that automation is not fully addressing or even exacerbating. For example,

> *Lack of staff presence during the hours of darkness likely to make some people, e.g. women, think twice about travelling. This might limit travel horizons.* (comment number 19)

This is also likely to impact on older or disabled people. The growing tendency to rely on smartphones for accessing information on the move potentially makes every passenger more vulnerable to crime, particularly if they look 'lost':

> *Necessity to carry high value goods makes pickings richer for opportunistic criminals* (comment number 43)

Participants also perceived **foreign visitors** as preferring assistance from staff due to language problems and lack of familiarity with UK online sources of information and apps. Whilst there is system that can recognise the home language of a browser and translate information, it remains too expensive for widespread uptake.

During disruption

Key personal security concerns during disruption include the risk of **missing the last connection**. Qualitative and quantitative evidence about the impact on individuals of disruption is in its infancy. It is difficult to know how decision-making about journeys is affected, either starting them earlier, or not making them, or deciding to drive instead. However, Hildebrand (2003) finds that some segments of the elderly have a much smaller travel horizon than others and this could be related to their perceptions of the risks involved with longer journeys, which would include delay and discomfort. That there is a 'common sense' understanding that disruption has an impact on personal security (and also wider safety) is evidenced by the use of websites to deliver geographically specific information about expected disruption, and associated advice, from road works and weather, such as from the Highways Agency and Traffic England.

Automation has a role in disrupted situations, as it can increase recovery times, but for passenger-facing tasks, **humans are best. Trained staff** are also on scene quickly when passengers require first aid, and are more flexible for finding solutions for passengers needing special consideration when journeys go wrong (for example, finding step-free access from the platform to the street at an unintended location).

> *Kindness and humour can make all the difference in a difficult situation.* (comment number 16)

Whilst some participants felt that technology was less effective at supporting people in crowded situations, for example, when information is only conveyed in announcements, excluding the hearing impaired, others felt that automation can be utilised to detect and prevent dangerous overcrowding, though it should not be relied upon to replace experienced staff, but should complement their skills and support them to **prevent disruption escalating**. For example, automated re-routing such as **SatNav diverts** can case **secondary incidents** by creating **new congestion points**. Similarly, **unpredictable** human factors mean that in a low-information crisis people will seize on any available crumb of information without necessarily evaluating its quality. It is key to **follow the right herd**.

Q5 What are the opportunities and threats to the development of automated services that support secure and confident journeys in next 3-5 years?

The final question in this part of the workshop programme asked participants to focus on the opportunities and threats to developing automated services that support personal security in the near term. In this exercise participants were encouraged to

state what could be done differently (i.e. opportunities), how automatic technology might support users to be and feel more personally secure while travelling. For threats, we asked participants to identify the key current and near-term barriers to developing automation. The raw data can found in Annex 3, and our synthesis of this material was included above with strengths and weaknesses under individual applications.

We discuss the SWOT analyses here, before going on to the STEEP(L) analysis.

Discussion of SWOT analyses

Strengths and weaknesses: The personal security aspects of the different areas of application for automation are different, but from the user perspective, information is clearly pivotal. In relation to automated information provision, particular strengths that were identified by participants related information brokering via the web and other channels (e.g. TfL, Transport Direct, National Rail Enquiries), making good use of base data to provide for journey planning, booking/purchase and RTI via multiple channelsfor the main forms of public transport as currently defined.

High quality **journey planning**:

- Websites
- Apps
- Telephone

Regular **RTI** via a variety of automated channels

- Websites
- Apps
- Telephone
- Passenger information boards

However, participants agreed that RTI capable of supporting passengers during service deviation and disruption is less well developed, and this group's views are consistent with those who took part in Workshop 2 which focused explicitly on disruption.Participants also felt that there are still some weaknesses in the automated information sources, that arises from inaccuracies in the databases. Bus information was singled out for criticism, as the information from bus companies is not all supplied to the same standard, and not all of it is supplied in machine-readable form, creating opportunities for keying errors to occur.

Automated audio messages are a strength in the sense that they are in widespread use, used for both RTI and security/safety messages, at stations and on vehicles. However, though not explicitly mentioned by participants, they are not always truly audible. Security and safety messages in particular may not be that effective, and could even be counter-productive by creating anxiety. However, no academic literature could be found that has evaluated the effectiveness of security and safety messages in the public transport environment. Audio messages should never be the only source of information (during disruption for example) – while very helpful for the sight-impaired, they are no use at all for the hearing-impaired for example.

Whilst the emergence of many apps to support travel, which is perceived as a strength, there are still some issues with **apps** as a weakness: evaluation, usefulness, mismatches between information acquired via apps and information on the ground (e.g. station PIDs and front-line staff). This last difficulty must be an artifact of the datasources that are scraped (used) by apps – why are they apparently able to provide information earlier than 'official' PIDs and staff at railway stations for example.

Mismatches between available sources of information can reduce general passenger trust in the information environment. Many apps appear to be very powerful (the participants mentioned the Plane Finder app which combines Augmented Reality with its base software and a phone's geo-location facility to 'point and identify' planes in the sky). Participants suggested that the evident power of such an app might be useful in the bus environment, as *"the required information is there as it is necessary for operations"*.

Smartcards are perceived as a strength in supporting convenience where they are used, but not integrated between different regions. The lack of integration can be seen as a weakness in this area.

Fleet management software is seen as a strength, as there has been a business case to support development in this area. Fleet management software provides many useful features for car and goods vehicle fleet managers, including routing, speed management and driver information.

Opportunities and threats: Whilst high quality examples of automation exist, there are definitely improvements that can be made which would support personal security. Firstly, for journey planning, the format of the base data needs to be carefully thought through, accurately entered (as often there is a human element in this process) and in agreement across different data sources (included frontline staff). It was remarked that most of the information required does exist but that there is resistance or inertia in the industry. Both rail and bus travel examples were highlighted by participants.

Another general weakness that was perceived by participants was the *"tendency to believe that technology is a panacea"*, leading to uncritical support for its introduction in certain settings. This is in contrast, however, to the perception that management are unwilling to equipstaff with the same portable technologies that are available to passengers, as they are either not trusted, or the operational changes that are required are too difficult to contemplate. One effect of this is that staff cannot rapidly counter the negative or inaccurate messages that are quickly propagated peer-to-peer via social media during disruption or about the quality or reliability of services. A second area of weakness is the widespread perception (amongst staff and the public) that automation is a mechanism for cutting staffing.

STEEP(L) analysis

In this exercise participants were asked to identify key driving forces that will affect the development of automation in public transport services beyond a 5 year time horizon. The raw data collected from the software can be found in Annex 4. Here we have collated and summarized the data into two tables, Table 1 for Social, Technological and Environmental driving forces, and Table 2 for Economic, Political and Legislative/Regulatory driving forces.

Social	Technological	Economic
• Aging population • On-street crime rates continue to fall against a background of austerity measures. At home technology takes youth away from the street corners. However, fear of crime remains, particularly the association of crime with transport locations, because the 'landmark' nature of such places means they are often used as geographic tags in reporting of nearby crime. • Successful automation technology becomes more trusted allowing further use e.g. autonomous vehicle, but user technological expectations (sometimes unrealistic) will only increase - faster, better, easier, etc. However, there will also be profound concerns for data and personal security, and society will be better informed about digital footprints, learning when to trade-off giving away personal data in exchange for enhanced services. Certain trusted brands will have an advantage. Criminal targeting of technology may influence choices for its use as technology becomes more ubiquitous. • Pervasive social media driving behaviour change by peer pressure amongst certain groups, whether pro/anti-environmental and technological (e.g. take up of Star Trak amongst Leicester students). • Successful development of autonomous vehicles improve social inclusion for those who are currently barred from driving for any reason (though cost might exclude those on lower incomes) • Complex trip and living patterns, although 'work anywhere' is the technological reality, more people may travel further to work, and live away from home during week • Establish new trust in travel information providers. How the public changes behaviour depending on the information provided will be key to success. (64) • Work-life balance debates will increase because 'always on' changes the relationship with employers. • What place for compassion?	• Developments such as internet of things, cloud computing and ambient intelligence offer potential to make travel easier through 'Always connected' communications solutions, such as micro mobile cells. (i.e. each lamppost is a base station), more NFC, more and better Wi-Fi in vehicles and buildings and better coverage from 4 G services • Cost of hardware reducing and software will be OS agnostic • Greater use of video analytics i.e. Smart CCTV for crowd management and security but data security and personal security challenges increase as technological capabilities increase. There will be a real need to build crime and disorder considerations into new technologies at the development stage, thinking not just about what is possible, but what is reasonable, proportionate, cost effective with safety in mind. • Trip purpose categories become blurred as ubiquitous technology enables people to mix and match office vs. working from home – a 'work anywhere' concept. This development facilitated by a greater ability to turn off work info and turn on 'play' information on devices. • Email disappears and social media drives communications	• Operators and authorities place service resilience before casualty/victim reduction. The cost of disruption will be a key issue. However, consumers will value the 'personal touch'. • There will be demand for easy-to-use seamless and personalised systems and services, and service integration could reduce costs [to operator?]. • New service providers and new business models based on journey provision will emerge. Competition amongst operators and modes increases and drives new standards of efficiency and service - greater product differentiation. Consumers will value the 'personal touch' and operators will have to equip staff with soft skills. Customers will value journeys against their personal preferences (e.g. time, cost, comfort), but service resilience will be placed before further reductions in casualty/victim rates. Staying competitive will require operators to develop business metrics (and better travel information), using the new, more accurate data available through automated ticketing, etc. • Cost reduction will be a major issue, both in the private and public sectors. Further cuts by government will limit what transport authorities afford to deliver or invest in; the value of staff time will increase, and employers will expect staff to be 'productive' during travel rather than driving - hence preference for vehicle autonomy [or trains]; staffing levels will be a significant factor in the cost base for transport operators. • Affordability of personal mobile devices will challenge the monolithic corporate IT system model, fuelling a drive towards 'bring/buy your own device', with staff taking ownership of their equipment but creating security issues as they use it for work and play (Gatwick already do this). • Increasing foreign MNOs owning UK-based assets and new franchisees in transport, supported by present Government. • Autonomous services will drive the 24/7 society, as they can operate for longer and more effectively than a human.

Environmental (and Health)	Political	Legislative/Regulatory
• Carbon reduction in all aspects of transport services/systems so will influence continued growth in rail freight, as well as further automation as journey making decisions will be made on both environmental and economic grounds. Further, autonomous vehicles reduce the need for car ownership, making the overall fleet more efficient, and reducing the need for on-street parking, substantially changing city and townscapes. • Climate change: more adverse weather incidents will drive better disruption information and people will be used to impacts and pre-predict these. • Land-use conflict could see a resurgence of direct-action environmental protests over large-scale transport infrastructure projects cutting through rural areas such as HS2 and roads – (a 21st century Swampy). • Resource pressures will drive reduction in the use of paper in travel information (timetable leaflets, wayside posters), and also drive the reduction in journey-making to distribution information in this form. • Environmental /health factors may influence the siting of mobile communications masts though smaller mobile cells with less power would cause fewer health issues. • Increased feelings of safety and security may encourage people to use public transport.	• Union influence over public transport will be weakened. • Change in government though a continued right-wing ethos promoting privatisation and cost reduction/profit maximisation (staff are a major over-head and this provide an impetus for automation).This ethos, and continued austerity maintains pressure to reduce government subsidies • Shift to a more integrated transport view - multi modal & inclusive leads to collaboration across boundaries - public to private - train - bus - all work together for common aim = shifting people & goods more efficiently • UK could leave the EU or substantially change its relationship with it. The UK itself could also unravel if Scotland goes independent. • Localism leading to enhanced 'local' systems and services • Continued short term approach of granting short term rail franchises that restrict long term investment in the rail industry • Power to the people from Tweets and Facebook (accountability by social media). Calling politicians to account and shaming poor company performance as people will know their rights regarding poor service. Global punctuality figures, even at 90% will not be good enough, focus will be on punctuality of particular journeys (as technology enables customers to monitor it). • Pressure to reduce road deaths (~6 per day in UK)	• UK removes itself from the EU in the hope of having more money to solve its own problems. However, this could cause the market to falter. • Mandatory requirements on transport operators to serve all sections of the community • Legislation needs to catch up with technology. • Legislation and regulation needs to allow for collaboration without assuming that it is anti-competitive and collusive. • Legislative to protect citizens from misuse of data • Willingness of Government to be a key enabler (instead of subsidy) - e.g. electronic service schedule data entry in the bus industry - 2013 only 20% of bus schedules are provided in the TransEXchange format - primarily by one bus operator - by 2010 it was targeted to be 100% • Autonomous vehicles will need a legislative change (the Vienna convention states all vehicles for use on public road must have a driver). US states (Nevada, California) already passed laws permitting autonomously driven vehicle use. • EU likely to seek some form of legislative security base level for rail industry across member states. • Possible EU move to single approach to data protection requirements to remove current cross border issues around sharing of information. • Police training has neglected soft skills - will they come back? • Potential impact of new Crime Commissioners with local agendas against rail transport companies as cross border operators

The Scenarios Exercise

Participants were given the framework for the scenarios exercise, which is based on those produced by Berkhout and Hertin (2002). The full rationale for the choice of this framework can be found in Work Package 1 report (Pangbourne and Beecroft, 2012a). The over-arching framework is illustrated below.

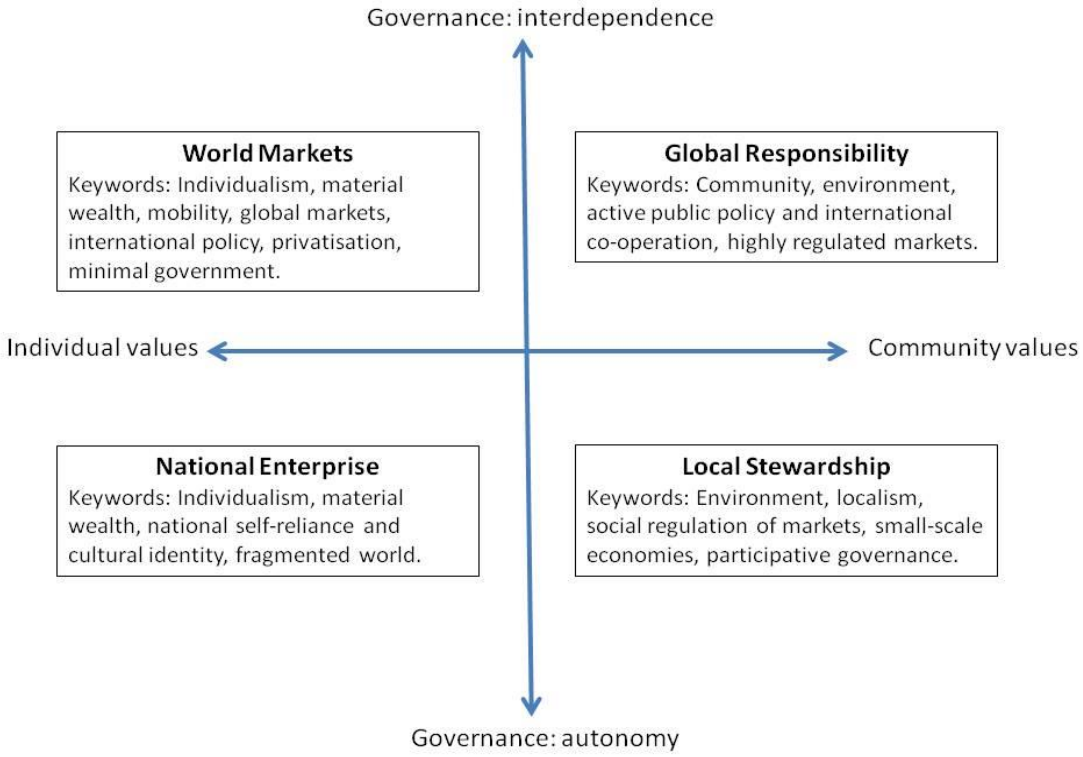

Figure 1 Scenarios Exercise Framework (Source: Summarised from Berkhout and Hertin, 2002)

As with workshop 2 (see Pangbourne and Beecroft, 2012b), the participants were given the scenario narratives about four plausible futures that were developed in the first workshop, which had sketched out quite fully the general features of the public transport landscape for each quadrant. These longer narratives are included in Annex 5. As with the first two workshops, the participants were divided into two groups, and each group considered a diagonally opposite pair of scenarios. Group 1 considered World Markets and Local Stewardship, and Group 2 considered Global Responsibility and National Enterprise. Mark Beecroft facilitated World Markets and National Enterprise and Kate Pangbourne facilitated Global Responsibility and Local Stewardship (i.e. swapping groups at the mid-point of the session). The perspective of the participants was captured on whiteboards, and photographed for subsequent analysis.

Questions for scenario development

The scenario development exercise was structured by asking the following questions.

1. Under each scenario, what types of automation will be most prevalent, and over what scale will they develop?

2. From a passenger perspective – how comfortable will travellers be with these types of automation, and what will be their expectations of support in terms of information and services?
3. From the operator perspective – what kind of business models will operators of automated services develop (e.g. will there be system convergence or modal obsolescence?), and how will passenger confidence and customer service be prioritised?
4. From the local/transport authority perspective – what role will authorities have in governance and resourcing of automated services (e.g. data protection, infrastructure provision, social equity)?
5. What will be the threats to personal security in automated systems under this scenario?
6. What will be the solutions to these threats generated under this scenario?

Automation under World Markets

In this future automated services develop rapidly, though the largely deregulated market place leads to variability in access to and quality of services. At the high end there is a strong emphasis upon bespoke services characterised by automated, dynamic and seamless journey planning, booking, payment and feedback through dedicated and integrated brokering and journey support services. Automated services act as intelligent agents supported by rich historic and real time data on travel services, traffic conditions and user characteristics to provide an intuitive and smooth travel experience for travellers. These exclusive services are targeted towards specific customer groups such as long distance (domestic and international) business and leisure travellers. Automatic translation services to interpret international travel environments are an example of such services.

Automation plays a central role in the use of the car most obviously in terms of performing the driving task. This enables private cars to remain king for local travel and as a means of accessing rail and air services for long distance travel. Users are able to be productive throughout journeys, and complex journeys are easier to negotiate as difficult or stressful tasks like navigation or finding and paying for parking have become obsolete. There is automated integration of car services with dynamic booking and payment of parking at rail stations and airports. Infotainment services will be available so that 'your flight begins when you get in the car'. Car clubs and self service car rental services are popular, especially for those aspiring to car ownership with a range of services offering varying levels of secure access supported by biometric and PIN technologies. Automation in road transport will extend to intelligent motorway infrastructure supporting platooning of vehicles including private cars, road freight and long distance coach and bus services.

Passengers expect high levels of service from transport providers because they are paying for it, but there is significant differentiation by ability to pay. Willingness to pay is high because services are greatly valued as a key support to sustaining high levels of mobility in a secure manner. This valuation is related to very socially divisive nature of society in which crime and anti-social behaviour create anxiety.

From the operator perspective there is a strong commercial imperative to provide integrated services to provide customers with whole journey solutions. Here the role of automation in supporting bespoke services, brokerage and intelligent agents is critical. The deregulated market enables flexibility in the operation of such services, but the demands of integration lead to the consolidation of power in the hands of Multi National

Corporations (MNCs) who have the capacity and range of operations to provide many of the services under a single corporate banner. They also have the power and influence over franchisees or smaller independent service providers to determine the operational environment and control access to the market. Foreign ownership of transport systems, services and infrastructure is commonplace.

Revenue protection is the key concern of operators and drives technological developments underpinned by intelligent automation to provide airport-style securitization in other public transport environments. The increasing sophistication and ubiquitous presence of surveillance and access control technologies underpin these developments. They enable much more secure control of travel environments where mass movements of people are involved with limited impacts upon passenger flow and system throughput and the associated effects on passenger convenience. However, the degree of inconvenience incurred by users will vary according to their status and their willingness/ability to pay for premium access to systems and services which bypass/circumvent some of the obstacles.

Staff in the transport sector is radically different as a result of high automation. Driving skills and ticket office staff are no longer in demand, but there is an increasein customer service roles to support travellers and provide a reassuring staff presence. The role of government is very limited in this future with accelerated planning and consent processes for automated systems and services driven through by power of commercial operators.

The tension between people's desire to lead highly mobile, independent and energy intensive lifestyles and an energy-constrained world means issues of power supply and power costs are significant problems. Disruptive elements in society, given the high levels of social division render crime and anti-social behaviour a major issue at a variety of scales and levels. This includes targeted, politically motivated cyber and terrorist attacks on MNCs and their automated systems, infrastructures and services. Civil disobedience, strikes and rioting against the prevailing social and economic order offer constant if less dangerous threats. Lower-level crime (particularly theft) and anti-social behaviour is also prevalent and is motivated by high levels of social exclusion. The monopolistic nature of many systems and services increases both vulnerability to attack and the consequences of attack in terms of knock-on effects as disruption cascades down through the integrated and inter-dependent services.

It is a seemingly paradoxical feature of this world that staff play a key role in protecting systems and services against threats in terms of resolving problems and supporting travellers. However, the sophistication and intelligence of automated services are highly advanced and intuitive, providing a greater challenge to antagonists, however, the resourcefulness of criminals to meet these challenges increases in tandem. There is a greater role for private security services in providing bespoke services and securing key transport interchanges, and operators have invested in back-up systems and spare capacity (system redundancy) in transport operations to reduce the pay-off from successful attacks and thus their attractiveness as a potential target. This is sufficient to justify the cost and efficiency losses.

Automation under Global Responsibility

In this world, automation continues to develop and society accepts it rather like Japan does now. There are many ambient technologies in use (the Internet of Things ahs matured), with buildings equipped with smart WiFI, and cloud-based services

controlled by Multi-national Organisations (MNO) are in widespread use. The societal orientation of this world prioritises information sharing, with innovation driven by cost-saving.

For transport, innovation is driven by cost-saving, smart metering/pricing is introduced to try and smooth and spread congestion at peak times, capacity of road and rail networks is increased through signaling and platooning technologies. Access to mobility services is based on personal identity with widespread use of biometrics, but the experience is seamless and without barriers, using vicinity readers. This is all accepted by passengers, who have a high trust in national systems, and expect the seamlessness at point of use. Automated data collection has matured so that passengers are able to monitor the punctuality and reliability for *their* journeys, and this granularity of information drives improvement across all services, making the transport environment less stressful for both passengers and staff, who are highly trained in the softer skills required for high quality customer service, and treated with respect by passengers.

The high-tech nature of the transport environment means that most operators are MNOs, part of the global market place. However in this society the regulatory framework acts to encourage them to work in a collaborative manner. There is some convergence between sectors, particularly within the transport and telecommunications market, but perhaps also with energy providers. The importance of customer service means that operators will prioritise satisfying customer expectation, and the most successful companies will be those who retain customer trust – there is a high cost for loss of trust relating to personal data, lack of reliability or poor safety records. However, the regulatory system is more enlightened, with no fines for failures but an insistence on investment on solving the problem.

The global and interconnected nature of this society means that transport authorities are increasing operating across national boundaries, either with a common regulatory framework for emissions and service levels, or for control when there are cross-border services (e.g. aviation, marine, rail, and coach services). Regulation is extended to ensure passenger safety, security, environmental performance and performance management. Authorities also set the standards for the provision of information, and act as travel information brokers.

The importance of digital data for information and operations, combined with the prevalence of MNOs and cloud-computing creates an international legal and security mine-field, as national boundaries have become increasingly meaningless for the mobility of people, goods and knowledge, yet essential data has to be physically held in servers, which may be in other countries with different laws. Other security risks are posed by developing systems dependent on sharing data, which means that information is freely available to both *bona fide* users and those with subversive intent. More data tracking is required as a result. The probability of widespread system failure is slightly increased by governmental complacency about cyber-security and dependency on high-tech integrated systems, which leads to a loss of resilience. The collaborative approach to the provision of many society goods, like public transport, means that there can be a lot of inertia in adopting new technologies, as consensus has to be achieved for change. In this highly conformist society, unknown levels of risk are posed by individuals who are different – either deliberately or culturally non-conformist (including temporary residents and migrants).

Automation under Local Stewardship

This world is more fragmented than Global Responsibility, with many services, including transport, operating over a much smaller, local or regional, scale. Larger metropolitan regions will be more able to develop automated services such as ticketing with dynamic pricing as they will have critical mass. The societal orientation will ensure that this takes account of social need. However, in smaller areas, the technologies to achieve this will be less affordable, only diffusing across when infrastructure comes up for renewal. Local transport companies are largely responsible for automation at the local level, with little resource support from the authorities. Wealthy rural areas would have moved away from public transport services as we currently know them, as autonomous cars operating on a commercial or shared ownership model will provide a better and more equitable service. Commercial operators will also have pay as you go additional services available in autonomous vehicles, such as drink and snack dispensers. However, it would be sometime before less wealth off areas were able to benefit from the flexibility of this new kind of public transport.

Clearly, from a passenger perspective, crossing boundaries will become far from seamless as there will be no standardization. The customer base for transport services will be increasingly polarized, as lack of public resources reduces non-commercial services to the minimum. The community-oriented nature of society will emanate as 'self-help' in small groups, with grass-roots development to meet own needs based on common interests (e.g. DRT for the elderly or disabled, social transport for the poor, workplace and business park transport services commissioned by large employers or consortia. Information might be harder to obtain, but for those who can afford it (such as autonomous car service users), RTI will be available to enable best use of time.

Larger operators are likely to have fragmented into smaller units as the Local Stewardship society develops, as it becomes harder to maintain a consistent product across many different jurisdictions that might have different boundaries to the services provided. Transport businesses have to be reshaped, and economies of scale are lost, leading to more basic service provision. Urban centres will have a better business case for the co-operation between providers that is necessary for an integrated transport system, but it will not exist in other areas. The more localized scale of governance will reduce resources, and there will be less investment in automation, though energy pressures are likely to necessitate sharing the costs of investment in key new infrastructure like electric charging points.

Local authorities who can afford it will have some subsidy available to support social inclusion. It will be much harder to plan national infrastructure and networks such as High Speed Rail, intercity coach services, domestic and international airports, due to myriad local interests and the localised power of NIMBYs. Growth or contraction will depend on the influence on politics and planning of local and regional economic characteristics. Developer contribution will be a very important source of funding for all forms of mobility provision, including designing for active travel, which will be prevalent. In some areas, local authorities may succeed in building collaborative partnerships to achieve economies of scale to introduce better services.

At the local/regional level society is relatively cohesive, and specific security threats are hard to perceive in this world, though safety may be an issue with the greater numbers cycling and walking. Lower levels of travel information and fragmentation of provision creates uncertainty about travel, making some travellers more vulnerable to personal victimization. Other crime in the travel environment is likely to be focused on property such as bicycles [potentially also on infrastructure such as metals, as crime prevention and detection is similarly fragmented, potentially creating opportunities for

foreign organized crime gangs]. Uncertainty about travel limits travel horizons, and a vicious circle of uncertainty and limited mobility act together to undermine the travel environment. Furthermore, fewer people are travelling at predictable times, as many more people have switched to active travel modes and have adjusted daily lives accordingly, reducing commuting by public transport in many areas. This, combined with automation drives operators towards flexible service provision.

Authorities and operators respond to some issues, for example, in some areas the major effort involved in achieving policy alignment will have been perceived as worthwhile. Many mobility solutions are developed on an ad hoc basis by grass-roots community groups. Major efforts are made in situational awareness training for cyclists, to tackled safety, crime and behaviour.

Automation under National Enterprise

In this future 'homeland' security and protection of national assets are of central importance. Introspection and distrust in terms of international affairs permeates the attitudes and behaviour of people in everyday life and in the domestic sphere. Insularity, fear of others, of outsiders and of the unknown, means that boundaries and place matters. In the absence of economies of scale encouraged by international markets technological innovation in the transport sector is slow to develop. Small-scale, quick fix interventions are common, with few implementation barriers in a deregulated domestic market, but failure rates are high. These individualistic approaches mean lack of coherence and partnership working to provide consistent and sustainable solutions. Commercial success for service providers depends on finding and exploiting a niche in a highly segmented market where differentiation is based on willingness and ability to pay. A multi-tiered landscape of service provision means first class highly bespoke services for the rich, akin to the World Markets scenario, with automated, dynamic and seamless journey planning, booking, payment and feedback through dedicated and integrated brokering and journey support services at the high end. However, outside the elite there is a downward trajectory in gradations of service quality, falling sharply at the low end to onlyvery limited provision by the state to maintain a subsistenceservice level.

Automation is seen as a selling point in modal competition and in service provision within modes, particularly in terms of integration with non-transport services e.g. automated payment and delivery options for shopping to interchanges. The priority in enhancing quality and protecting key national assets concentrates investment and technological innovation in infrastructure, vehicles and services on nationally important transport networks and interchanges and major cities. In a future where road transport prevails, automation extends to intelligent motorway infrastructure, to ensure efficient operations. Slot booking to travel on the network is introduced leading to further innovation with access to premium lanes and roads offering faster connectivity fora price. Further management is provided by highly dynamic and automated road user charging, finely graded by time of day and/or road conditions. There is also automated intelligent monitoring and feedback on the condition of infrastructure assets and associated maintenance requirements. Indeed across the key transport infrastructure and the major cities automation is a key tool in protecting and managing key assets through surveillance and reporting. This surveillance extends to the integrated management and use of data on citizens by the state providing greater control of information and society in interests of 'homeland security'.

Travellers are highly conscious of their individual needs and desires, emphasizing their social status and peer group connections to distinguish themselves from others. Trust and security are important aspects here and this is reflected in the supporting services that are available. People value information to aid navigation between places, particularly if journeys cross boundaries or international borders. People are very concerned about entering marginal and peripheral places – consistency in service provision and quality information on travel environments are important and this information is provided at the high end by intelligent agents offering bespoke routing criteria based on rich data regarding local environments, building on the traditions of accessibility planning in combination with the prevailing surveillance culture. Value of time and concerns aboutdwell time are strong customer service concerns. Severance is a major issue in terms of gaining access to national networks and services. Individuals who live and travel outside the key national infrastructure are marginalised, with limited choices and poor quality, insecure services.

For operators and service providers the key markets to engage relate to the national level infrastructure and the major cities. Geography is of central concern. High speed rail links proliferate, but only toconnect the major cities. Whilst there is a degree of integration in supporting national networks, this breaks down at other spatial levels. Whole journey solutions are at a premium as travel through peripheral domestic regions is difficult and international travel is constrained by enforced national boundaries which disrupttravel.

The government influences society and economy through national level planning and management of the key drivers of economic growth, the major cities and the communications links between them. Governmental support for infrastructure and information management assists the operators to develop the nationally-significant transport links, but neglects less strategically important linkages. The key social impact is urbanisation, andconcentratation in the largest cities, leading to a growth in the size and number of metropolitan areas. These areas are then able to support mass transit services which are highly managed and secure travel environments with extensive automated surveillance and intuitive feedback.

Unsurprisingly in a socially divisive society criminal activity is prevalent at a variety of levels. At the highest level in a world of independent and introspective nation states suspicion and hostility leads to international threats upon national infrastructure. At the lower level crime (particularly theft) and anti-social behaviour are prevalent, particularly at the margins between protected and unprotected spaces. Given the large amount of personal data held by Government and the role it plays in regulating access to goods and services cyber crime and particularly identity theft are major problems with sometimes devastating personal consequences.

Target hardening is the primary response to security and crime concerns. The major national assets, including transport infrastructure and services are well protected, underpinned by automated surveillance and data management. State-held data on citizens is key to tracking and profiling behaviour, regulating access to transport systems and services, utilising extensive databases and a national identity card system. Patterns of movement are monitored and domicile postcode is a key determinant of status. Whilst this target hardening makes travel relatively safe on the major networks crime is displaced to the margins and in the peripheral areas it is rife.

Greater protection of assets at the national level is also reflected at the personal level. People invest in technologies to ensure secure access and control of goods and vehicles. This can have severe unintended consequences as the person is then the most

vulnerable point in the chain and this increases risk of violence and intimidation as the method to access vehicles and goods.

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Annexes

Annex 1: Workshop Programme Timetable

0930 – 1000 Registration

1000 – 1015 Welcome and introduction to the day

1015 – 1020 Tour de Table

1020 – 1130 Scoping of current issues

1130 – 1145 Refreshments

1145 – 1215 Identification of future key driving forces

1215 – 1230 Introduction to scenario planning activity

1230 – 1315 Lunch

1315 – 1520 Scenario planning breakout groups (5 minute break at 1415)

1520 – 1550 Plenary feedback and discussion

1550 – 1600 Wrap up/next steps/thanks

Annex 2: Workshop Participants

Organisers: Dr Mark Beecroft and Dr Kate Pangbourne, Centre for Transport Research, University of Aberdeen

Facilitator: Jane Dowsett, Department for Business, Innovation and Skills

1.	Nikki Swanson	Merseytravel
2.	Chris Cooper	IBM
3.	Julia Gregory	Gatwick Airport
4.	Duncan Manners	British Transport Police
5.	Bob Gough	SERCO Docklands Light Railway
6.	Derek Greene	Track4Services
7.	John Strutton	Transport for London
8.	Ken Young	British Transport Police
9.	John Gill	John Gill Technology Ltd
10.	Nick Reed	Transport Research Laboratory
11.	Gary Umpleby	Hogia

Annex 3 Raw data used for SWOT analysis

What forms of automation exist in public/shared transport at the moment?
Information systems (e.g. RTI, websites)

- Apps
  - What kind of apps? Can we have some examples please?
    - Greater Anglia rail app, Network Rail App, National Express App, Airline and airport apps
  - How to judge which are actually useful?
  - Apps seem to be able to identify station platforms, yet staff on site don't know! Mismatch, why?
  - More we can do by designing in to databases at the outset - building business case sometimes dubious. All the information is already there, but the train companies are resistant to change.
  - Airplane spotter apps - seem very powerful. Why can't this work with trains and buses? The information must all be there to run the network. The staff should be 'armed' to the same level of information.
    - Managing people who have data/mobile phones is an operational nightmare - human factors! The perfect world doesn't exist! Though this doesn't mean we can't try to improve our systems, but 'we' don't fully trust our staff enough to hand them lots of portable technology.
- Rti
  - How many forms does this come in? - e.g. is it all Electronic boards or do we include on-line info via QR/mobile phones?
- Websites
  - How much diversity/coordination is there across websites?
  - Are they accessible and usable by people with disabilities?
- Journey planning (may cross-connect to Booking and Purchase?)
- Paper based info
- Staff
  - Good one! need reliable data at the front end
  - See comment above from discussion about mismatch with staff and apps!
- Service deviation and disruption -> more important than time to departure?
  - Disruption: difficult to both deal with the problem, and get the information out. e.g. signallers to driver to passenger etc. Olympics good info required massive increase in personnel, and a dedicated comms person. Our expectations may be too high - the technology beguiles us into thinking that we should know everything all the time. Also giving too much information about pinpoint location of trains may have Security implications.
  - \problems with passenger 'revolution' and trying to get off trains when no information about delays, etc.
- Social media
- Fleet management
  - Presumably this is fleet management software, includes routing and scheduling? (58)
- Timetable / schedule entry
  - Reliability of data needs to be focused on and checked. e.g. bus data, starts with operator on paper or electronically to certain standards. LA then has to enter that into another system which is fed to various other providers of information. Too much scope for error. (114)

- TfL website; Local "Bluetooth Spammers" (limited success); Public announcement regime; "Countdown" displays at bus shelters
- Info snacking is ideal on mobile phones.
  - Is this a Kit Kat?
- Transport Direct
- Traveline
- On vehicle information systems -> Next Stop, Points of Interest, Service disruption
- Automated planning systems which take into account any limitations
- Automatic rerouting in the event of service disruption
- Personalised travel information -> before, during and after
- Regular announcements as to service disruption
- Connection protection between modes and same mode
- School children specific information - service disruption linked to school closed
  - Needed!
- Communications limits usability
- Too much focus on 'Glitz & Glamour' and not on baseline data entry and ability to update in real time
- Bigger security risks from more information...

Booking and purchase systems (e.g. Taxi booking, tickets)

- National Rail Website
- Journey planning - cross connect to Information Systems?
- Oyster card
- Telephone
- London congestion charge
- On-Line Oyster purchase; Passenger-Operated Machines; "Wave and Pay"
- Multi-modal information systems which are easy to understand and use
- Other types of smart cards e.g. Southern Rail/Metro bus
- Pre-paid airport parking
- Hailo and Get Taxi are great for ordering a black taxi.
  - How does this work? Presumably it smartphone app based?
- 2D barcode systems on smart phones
- Coming soon - contactless payments. This could also feature in security
- Web based for travel for all modes e.g. rail/bus/coach/car rental/ taxi/airline
- Ticket desks with people
- Needed - linking to real-time information about current service adherence to schedule?
- Anyone care to comment about the current Swiss debacle on banning on train ticket sales (which I believe has resulted in someone being told a smart phone ticket purchase was invalid as the debit card payment went through 4 minutes after departure.
  - A case of not thinking possible scenarios through and not having a strategy to respond to it
- Walrus card
  - Not heard of this one - where is it in operation? - Merseytravelsmartcard

Automated transport services (e.g. driverless vehicles)

- Google car

- Campus car
- Heathrow PRT
- DLR

- All DLR services have a "Train Captain" aboard?
    - And the Victoria line - drivers by exception.

- Group Rapid Transit but mainly trials (except in US Morgantown)
- Croydon Tram
- Car platooning (trials)

- e.g. SARTRE; KONVOI; CHAFFEUR projects

- Driverless trains planes and automobiles
- How close to market are all of these.

- Driverless car - within a decade
- Technology is there now for all. UAV's can be bought over the internet

- On-board units indicating early / late to driver
- Free-running Pods - e.g. Masdar, Abu Dhabi
- Automatic re-routing by e.g. TomTom in response to congestion etc.
- MIDAS loops on motorways

- Car counts (pre mobile phones). Linked to ATM.

Security/crime

- Automatic Number Plate Recognition

- this is also part of the payment mix for road pricing

- CCTV
- Fibre optic solutions - example using existing communications cable to provide a virtual security perimeter which sends out exception alarms. Automated "guarding" (26)
- Gait recognition
- Biometric passport authorisation
- Unmanned Air Vehicles - can they be used to provide automated "patrol"
- Reporting forms for staff

- Automated "stock" systems for high value items

- Gating/ticket barriers
- Hand held oyster readers for TfL buses and rail modes

- Awareness announcements; Bluetooth messaging (limited success); Awareness poster campaigns (wallpaper?)

- Video analytics
- Proximity Reader access control
- See Something, Say Something - text service and App for passengers to report anti-social behaviour and crime
- Needs to be taken seriously by transport companies. They seem to react to situations rather than prevent them happening.
- Security patrol point readers
- crimestoppers reporting line
- Fixed facial recognition systems
- Facial recognition
- IRiS - reporting system for bus drivers in Merseyside
- Covert surveillance
- Behavioural detection - electronic or staff

- Sto Hate UK to report hate crime on public transport - Merseyside /West Midlands
- Identity theft resulting in wrongly being charged for travel
- Help points
- Whose perspective dominates in deciding what security is?

Other

- Bar coded stock control systems (83)
- Passenger counters (89)
- Ticket operated barrier gates (97)
- Information that would really help disabled people - it exists, but resistance to change from operators - cost averse, has to be legislated for that they must take steps that support everybody (the market will not provide for these small 'niches'). Smart meters investment with in-house displays - can these displays be joined up with other things like transport information. Caveat: don't follow the minitel example - everyone has a screen. (112)
- "Over The Air" transmission of real-time bus data; automatic download of data/images on re-entry to depot(117)

What are the main reasons why automation is introduced?

For users

- Increased safety (9)
  - In what specific ways? (21)
    - Majority (90%) of road accidents have human error as a contributory factor - automation may provide an opportunity to reduce accidents caused by driver error(54)
- Better interaction with transport company.(11)
  - Which kinds of automation lead to better interaction with the transport company?(30)
    - Twitter?!(63)
- Availability(12)
  - Does this mean that automation increase availability of transport for users, and/or increases information?(51)
- Increased efficiency(15)
  - Platooning can lead to more efficient road use(59)
    - Automatic Traffic Management?(68)
      - More efficient - as in more network capacity and reduced fuel use(83)
- Easier access to information(16)
- Improve passengers journey experience - allowing then to plan and re-plan(17)
  - Has this been evaluated, or is it an intuitive assumption(57)
    - Practical reality ...(69)
    - Yes at Airports we have extensive quality service monitoring which is used to evaluate passenger experience before and after(72)
    - Do it myself so imagine others do,(76)
- Ability to do other things whilst travelling (18)
- Control - can manage decisions (19)
- More frequent reliable services(20)
- Convenient and real time access to travel information (22)

- But needs to be controlled from an operational and safety aspect (75)
- better understanding of what is going on(23)
- Accessibility and choice(24)
- More up-to-date information(25)
- Respond to complaints(26)
- Meet the thirst for information(31)
- Should we actually do this? Where is the boundary?(65)
  - Where it helps the majority of travellers?(78)
- Ability to use the same information for more than purpose (52)
- Car-sharing more viable - door to door service(64)
- Encourage Modal Shift(73)
- Can provide feedback about services - good/bad(77)
- Can report crime and asb.(84)

For operators

- Safer operation(5)
- Cost savings(6)
- Reduce mundane tasks - > safety related?(7)
- Reliability - ability to run more frequent services(8)
- Reduce human error(13)
- Reduced reliability on staff and therefore resilience(33)
- 'reliance'(67)
- I am assuming that this means reducing reliance on staff increases resilience??? (70)
- Efficiency (36)
- Help understand developing issues such as crowd control dynamics etc.(82)
- reduce staff fraud (38)
- improve performance40)
- increase level of information to provide more detailed analysis and help identify and then solve problems,(46)
- Competition and commercial reasons(47)
- Reduce staffing(48)
- make better use of scarce capacity(53)
- Protection of income e.g. Gating at rail stations(61)
- More efficient and predictable matching of supply of service to demand on the service.(80)
- Can report crime and asb.(85)
- Better perturbation recovery from incidents(86)
- Airports do a lot with customer information.(89)

For information providers

- Real time information is valuable for planning and marketing(28)
- Are the marketers well integrated with the planners and information provision teams? Presumably there are many different models used by different operators. Probably lots of differences between modes too.(79)
- Easier and quicker / cheaper (?) to disseminate(32)
- More sales of sophisticated systems(37)
- Data protection issues(42)
- Easier handling of complex multi-modal journeys?(43)
- Customer data is valuable for market research(55)
- Is this data being mined effectively?(81)

- Improved marketing(58)
  - Outdoor advertisers are paying for bus shelters, and can identify hotspots, but might do more if they knew more about the passengers.(88)

For security authorities

- Investigative tool(10)
- Detection capability - more chance of sanctioned detections (14)
- Usage monitoring (27)
- Control/denial of service (29)
- back up (recording incidents) for enforcement (34)
- Potential for remote access to security systems (35)
- Risk of cyber-crime (39)
- Preventative - 'big brother' (41)
  - Research suggests that CCTV alone deters very little crime - if it did there would be no crime in town centres all over the UK(50)
    - crime on railway system is extremely low and CCTV or perception of CCTV is preventative in his environment (66)
- Improved monitoring of threats(44)
- Mitigate human error(45)
- Where data about automated services is held - how do you access this?(49)
- Electronic monitoring can 'see' more than a team of humans? E.g. CCTV->automatic detection (queuing traffic, intruder alarms, over-crowding etc.) (56)
  - Are such systems capable of interpreting observed actions? (74)
- reduce staff fraud (60)
- Enhance existing operational security measures.(62)
- Intelligence gathering of crime and asb. incidents = can assist with predictions of seasonal crime patterns (71)
- see comment on perturbation recovery (under operators) (87)
- Transport Scotland have uncovered a lot of fraud using smartcard (90)

What is good and bad about existing automated services?

Information systems (e.g. RTI, websites)

- **Strengths**
  - Apps and mobile web sites allow personalisation(31)
  - RTI -Enhances feelings of safety(36)
    - only if it is accurate and timely(50)
  - Allow more passengers to access information - improving amount of info available and less pressure on staff resources(53)
  - Allow greater flexibility for the passenger and control(61)
  - Prediction is now here. Real-time is no longer good enough(65)
  - Allow access to more detailed and up to date information(66)
  - Allows passenger to make most efficient use of their time(71)
- **Weaknesses**
  - Apps such as Network Rail app get information before the RTI boards in stations, and before staff know(28)
  - Even if good for original purpose, possibly poor for other requirements(33)
    - e.g. London Underground CCTV was not installed for crime, it was there for safety and crowd monitoring.(94)
  - Only as good as source information(35)

- disconnect between information on websites and information available at the station(38)
- Rely on base data being entered by humans - keying errors etc.(39)
- Lack of 'front-end' data cleaning and correction - errors manifest themselves in the information provided to users(52)
- Mobile information solutions rely heavily on robust mobile communications - coverage and capacity still restrict this in the UK(72)
- Relies upon people having access to and being able to use the technology(78)
- requires sufficient resource to be put in place to manage it effectively(79)
- Misuse of the data(86)
- Not always designed for people with specific needs?(90)
- Reliance on RTI information to mobile phones, if delay at stations for example, voice calls are prioritised over data, so people trying to check the data will just get the 'egg timer' as the network is clogged by voice calls 'I'm going to be late'....

Booking and purchase systems (e.g. Taxi booking, tickets)

Strengths

- Contactless payment (direct from bank accounts) - much more efficient in theory(29)
    - Efficiency for whom? Are the theoretical efficiency gains shared equally among stakeholders? Who might lose out?(56)
- Helps advance planning of journeys(49)
- Allows people to avoid queuing unnecessarily

Weaknesses

- Difficult to implement and often business case is not clear.(32)
- Wave & Pay wide open to hacking, and limited roll-out making transport in London the place where criminals will be most likely to find people using wave and pay technology - rich pickings(34)
    - Wave and pay is as secure as any normal card payment system.(48)
    - Payments are limited to a maximum of 10 x £20 per day.(82)
- Contactless payments from bank accounts mean data requests will need to go to individual banks.....(40)
    - This takes around a third of a second.(54)
    - Which sector is driving the contactless payment innovation? Is it the banks?(62)
        - The mobile sector, MNOs as they want to become banks.(75)
- May lack flexibility(43)
- Is adoption becoming an issue, as many people become confused by the range of different options, leading to lots of diverse innovations and no clear winner?(44)
    - People accept that they are increasingly give bewildering choices but they settle on what suits them. They like choice.(67)
- Need to have a fail-safe if the battery dies(74)
- Mobile solutions rely on robust and reliable mobile communications (coverage and capacity) - can be limiting in the UK - e.g. Waterloo!

Automated transport services (e.g. driverless vehicles)

Strengths

- Autonomous car - would enables disabled (e.g. blind) access to personal vehicle(37)
- Potential to reduce road accidents due to driver error(42)
    - Automated train services doubtless more efficient(51)
- Can allow for high level of data capture linked to performance(45)
- Increased efficiency - both network capacity and energy use

Weaknesses

- Resistance from unions to automation of public transport driving services(58)
- Human costs in loss of jobs. Risk of industrial action by unions(59)
    - Could these free up resources for more investment in customer-service related jobs?(70)
        - I there was a will(91)
- No capable guardianship; no natural surveillance, no clear rule setting presence - basic crime prevention principles missing(63)
    - But - possibly less need for it. Automation may limit opportunities for criminal action(87)
        - refer to London Buses experience(92)
- Potential to rely too heavily on the technology and not support with sufficient number of staff(64)
- There aren't enough systems around to generate awareness/ support wider implementation through good practice examples e.g. PRT/GRT(73)
- If we are over-reliant on technology, we are more vulnerable to technological failure, e.g. loss of power supply.(76)
- Most automated systems work only in very closed environments with no interaction with other transport systems(80)
- Very much "all your eggs in one basket". If an automated service fails - potentially you need someone who can physically fix the hardware. Huge risks associated with allowing remote fixing(81)
- Can be significant problems in event of service disruption which take longer to rectify than non-automatic services(83)
- No reactive presence - i.e. First Aiders on scene, de-fib etc.(84)

Other

- **Weaknesses**

- Can be problems when technology is superseded by a new incompatible technology(69)
- Citizen education - a more connected world means we have responsibilities to uphold on the use of our data. This is not understood(88)

Cross cutting

Strengths

- Technologies seem to be pretty mature; much is feasible and usable but...

Weaknesses

- Travel information can be better than paper but relies on accurate base data(30)
- Transport still in silos. Move to mobility and this would remove the silo(46)
- The business case can be hard to develop(47)

- Impossible based on today's rules. The investor is never going to receive full return. Hangers on have no incentive to participate(57)
- Institutional barriers and inertia, conservative thinking - do the minimum(55)
- Incompatibility of different technological systems(60)
- Dependence on user having (or having the ability to use) the required technology(68)
- I still believe customers like the personal touch and a well informed and pleasant member of staff is worth a lot more than automated systems(89)

What are the personal security issues with automated services in different circumstances?

Time of day/year

- Late evening travel(6)
- Late hours(7)
- Dark nights(8)
- Capable guardianship missing during key hours affected by "night time economy"(10)
- Gating on stations has meant removal of staff on trains except for driver - not pleasant on trains in evening when the drunken element are travelling home and you are returning from evening meeting(13)
- A purely automated service - e.g. a driverless train into a staff less station late at night - has big public confidence barriers. Doesn't matter how good the CCTV is(14)
- Automation does not make you feel safer. A caring friendly member of staff in the right place at the right time makes all the difference.(30)
- Late at night staffed stations have been seen as an oasis - an area to get help and assistance. Vulnerable people gravitate towards the well-lit and staffed station(32)
- Different transport offerings on the time of day - based on frequency/cost - why not have a train provider put you in a taxi if that was the best mode for you at that time?(39)
- Peak times generate stress on transport technologies as well as systems which can lead to breakdown(48)
- Automated systems need to allow for weather conditions restricting travel - system dumps you into snow!(50)
- Winter weather and darkness - greater risk of disruption, with wider impact.

Type of area (e.g. rural/urban)

- Lack of access to automated services across the entire network(12)
- Accessing RTI, indeed most advance/automated systems and services can be problematic - bandwidth/ patchy coverage(15)
- Particularly in rural and some suburban areas(21)
- The 'Last Mile' - public transport may not be available door-to-door in rural areas(17)
- Lack of regular bus service in rural areas(20)
- One size fits all is not a viable approach. 3 distinct journey types to be catered for: 1) Inner City/urban - 2) Intercity/urban 3) rural to urban - each needs its own solution(28)
- But they still need to be joined up!(37)

- An automated system may plan your journey through an 'unwelcome' area with high crime rates - although you don't this(35)
- There's no app for that! (the accessibility/crime mapping stuff is not integrated into this information)(54)
- System overload if too much 'noise' / (data) traffic(36)
- having smartphone out and about all the time could make you more vulnerable to theft(45)
- Safe places to wait in rural areas when buses are late or cancelled.

Demographic (e.g. age/gender)

- Digital divide between Natives v Adopters(9)
- Older generation may not have access to smartphones(11)
- Technophobia among some older people(18)
- But - may enhance life for older generation by enabling access to social activities, health services etc.(27)
- Lack of staff presence during the hours of darkness likely to make some people, e.g. women, think twice about travelling. This might limit travel horizons.(19)
- Population as a whole will has different levels of technology(23)
- Not everyone has a smart phone. Not everyone wants a smart phone(24)
- Paper-based information is still sought by the majority in some local authority areas(26)
- Usability/design standards - do they meet people's needs?(29)
- Foreign visitors - want assistance from a person and will not know about specific web sites and apps(33)
- There is a system that can recognise the home language of a browser (65 languages), but the cost is unpalatable at the moment.(55)
- Increased communications cuts two ways. Can be used to organise crime (e.g. football casuals)(38)
- Necessity to carry high value goods makes pickings richer for opportunistic criminals(43)
- Designing services for different needs, one size doesn't fit all, e.g. mobility impaired, sight impaired, hearing impaired, people with learning disabilities, all have travel needs.

During disruption

- Missing the last connection(5)
- Can we find any evidence that this has affected people's decisions about making journeys - either starting them earlier, or not making them, or deciding to drive instead?(25)
- suggest look at highways agency and traffic England as an example(42)
- Humans are best for dealing with unexpected situations. Kindness and humour can make all the difference in a difficult situation.(16)
- Technology - properly applied can decrease recovery times(22)
- Information provided unlikely to include special facilities needed by some travellers (e.g. step-free access from the platform to the street)(31)
- Technology cannot administer first aid to people that succumb during crowding caused by disruption - trained staff on hand quicker than emergency services(34)
- But technology should be better at predicting, detecting, preventing that overcrowding in the first place(46)

- Information may only be provided in one modality - e.g. audio announcement which may be of limited value to someone with a hearing impairment(40)
- Rely too heavily on information by technology and you risk serious safety incidents in relation to crowd control for instance.
- Trusted information is key. Following the right herd!
- Unless carefully controlled can cause 'secondary' incidents - e.g. SatNav diverts - everyone gets the same divert resulting in new congestion points / accidents
- Humans are very unpredictable and it is difficult to predict where the next ill person incident will occur. Lots of work done scanning the data already. We can predict the likelihood of the impact of disruption but it takes staff not announcements or information via other media to prevent disruption escalating.

What are the opportunities and threats to the development of automated services that support secure and confident journeys in next 3-5 years?

Information systems (e.g. RTI, websites)

- **Opportunities**
  - Improved communications solutions providing 'always connected' capability (apps etc.)
    - Near Field Communications gives the information in a user friendly manner. It can be automatically recognise a browser and provide the information in 200 languages easily and quickly.
      - But latest iPhones have removed NFC capability?
    - Smart Wi-Fi can provide crowds with valuable information on every type of mobile phone. Not just smart devices.
  - Amount of technology already in development
  - Increase methods to report crime and anti-social behaviour
    - Encourage people to photo and tweet ASB issues. That way evidence can be gathered without risk.
      - Unless you're spotted doing it
  - Personalised pre-journey planning and through journey updates
    - Passengers with impairments including heavy luggage can be given appropriate travel information. Lift not stairs etc.
  - Reduced provision of infrastructure may drive technology based solutions to deliver capacity
    - Drive for improved customer service as a result of competition
    - Concern that those without the personal devices will be left behind?
  - Technology savvy population becoming older
    - 60 m smart phones in UK.
    - May still be luddites...
  - 'Where am I', 'Where do I get off', 'How do I find that platform', where is the coach / rail station at the airport?

Threats

- Data security and resilience to malicious attack - staying ahead of the bad guys
- Mobile communication solutions do not improve sufficiently quickly - high investment needed?
- cybercrime - criminals are always one step ahead
- Lack of funding due to world-wide economic downturn

    - this is practical application
    - business cases do not stack up
- Poor base data continuing to be the norm
- Changes to the underlying technologies

Booking and purchase systems (e.g. Taxi booking, tickets)

- **Opportunities**

- Seamless multi-modal ticketing(24)
- Will reduce amount of cash handled by bus drivers(32)
- Call for autonomous vehicle through app(45)
- Accelerate a cashless society(48)
- Simplified ticketing structure that is more visible to the customer.(50)
- More wave & pay = eradication of expensive Oyster system(54)
- People wanting to do more using technology - to make best use of their time(65)
- Automatically provide the most economical ticket for the traveller(66)

- **Threats(12)**

- Incompatible or inflexible ticketing systems - not always giving the lowest cost option(33)
- Wave and pay. Need convincing.(34)
    - Targeting of customers for criminal intent(71)
    - Apps available that read data on cards nearby...(80)
- Wave and Pay may damage reputation to extent that becomes a barrier to accessing public transport(39)
    - Wave and Pay on phones is (should be) more secure than wave and pay cards, which are a temporary phase?(79)
- Standalone systems versus internet based ones. The first is hard to fix - the second is open to cyber-attack(58)
- People become more vulnerable to personal crime, as they have the cards and the mobile devices that criminals need?(63)
- IR issues around Wave and pay and staff involved in revenue protection having to sign off Data Protection responsibilities(67)
- Some technologies require legislative change - e.g. wave and pay - in terms of data accessibility to law enforcement

Automated transport services (e.g. driverless vehicles)

Opportunities

- Potential to enhance whose transport network appears almost limitless.(23)
- Personal autonomous car service - massive revenue potential(29)
    - Would be able to select vehicle appropriate for journey (e.g. Smart car for commute; van for moving house etc.)(51)
- Demonstrable benefits from systems e.g. ULTRA could stimulate transferability(75)
- Diverting drivers to customer service?

Threats

- First autonomous vehicle road death will gain a disproportionate amount of attention(20)
- public acceptability(22)
    - Infrastructure was never designed for cutting edge technologies and needs to catch up(42)

- Automobile OEMs may be resistant to development that may negate their market position(35)
    - 'Original Equipment Manufacturer'(84)

Other

Threats

- Franchising system mess - reducing length of franchises downwards from 15 year to 7 and 2 year(21)
- Short-term views of commercial companies(52)
- please do not revisit public \ private partnerships - what a disaster(62)

Cross cutting

Opportunities

- 4G Communications - 'always connected' coming closer?(36)
- There is great capability for innovation, system improvements and enhanced customer experience and technical/techno advances are ever faster(56)
- iOS and Android becoming dominant mobile OS - just need to develop app for two platforms(60)
    - What about Windows 8? Resurgence of Microsoft. Maybe others not yet known in five years time.(85)

Threats

- Funding for development(18)
- Continued austerity tends to increase crime levels and lawlessness - human factors key to effective responses in some circumstances(30)
    - Downward spiral in sense of personal security affecting confidence to travel for any but most essential reasons?(38)
- Lack of an 'always connected' mobile communications solution(s)(40)
- Incomplete coverage of mobile signals(44)
- Implementation barriers endure - legal/regulatory, etc. can't keep pace with innovation(64)
- Dependence on technology - makes technological infrastructure a high value target for malicious attack(70)
- Facial recognition software for CCTV still unreliable and reducing belief in its future for investment purposes(76)
- Some users might invest in the 'wrong' technology (though trend towards greater interoperability?)

Annex 4 Raw data for STEEP(L) analysis

What will be the key future driving forces influencing the development of automation and passenger experience beyond 5 years?

- **Social**
  - Consumer demand for seamless systems which are easy to use
  - Crime rates continue to fall against a background of austerity measures. One theory is because technology - within the home - is taking the youth away from the street corners.(23)
  - Fear of crime likely to continue to be an issue - association of crime with transport locations is often spurious or accidental. Media coverage has a role to play.(97)
  - Service resilience placed before casualty/victim reduction(27)
  - (If delivered successfully) Technology for automation will become more trusted allowing further use e.g. autonomous vehicle(29)
  - User expectations of technology will only increase - faster, better, easier, etc.(31)
  - Environmental 'peers pressure'?(37)
  - Social inclusion benefits if autonomous vehicles successfully developed.(49)
  - People travelling further to work - more living away from home during week(56)
  - Establish new trust in travel information providers. How the public changes behaviour depending on the information provided will be key to success.(64)
  - Demand for personalised services(68)
  - Personal touch is valued(69)
  - People trade-off their data for enhanced services - seem to be pretty willing - will this continue or will we become more risk averse?(74)
  - Trusted brands (like TFL) versus others.(99)
  - Personal responsibility to manage our own data, but most of us are lazy (or ignorant) about protecting our own digital footprint - knowledge gap.(100)
  - User expectations (possibly unrealistic) of what technology can deliver(75)
  - Increased concern about privacy of data(78)
  - Somebody will know where you have travelled - some people don't have oyster cards because they don't want to leave a trail.(98)
  - great ability to turn off work info and turn on 'play' information(81)
  - people able to select information they want to receive and when(86)
  - Work-life balance debates because 'always on' changes the relationship with employers.(83)
  - Targeting of technology for nefarious reasons may influence choices for its use as it becomes more extensive(87)
  - Email disappears and social media drives communications(89)
  - Peer pressure to use technology - e.g. StarTrak in Leicester - students liked using their mobilephones to access public transport data - became 'trendy'?(90)
  - Beware of social exclusion - new technology can be expensive?(93)
  - aging population(96)
  - What place for compassion?

- **Technological**
  - 'Always connected' communications solutions(8)
  - Micro mobile cells. I.e. each lamppost is a base station.(10)
  - More and better Wi-Fi in vehicles and buildings(19)

- better coverage from 4 G services(26)
- cost of hardware reducing(32)
- Greater use of video analytics i.e. Smart CCTV(33)
- software will be OS agnostic(40)
- more NFC(46)
- Misguided belief that technology is the panacea for all ills(47)
- Developments such as internet of things, cloud computing and ambient intelligence offer potential to make travel easier(53)
  - crowd-sourcing updates on travel conditions - e.g. crowded services or dirty vehicles (probably quicker to share the negative than the positive - human nature)(94)
- People mix and match office vs. working from home - work can be done anywhere concept(63)
- Data security and personal security challenges increase as technological capabilities increase(65)
- ePaper / 'sticky' electronic paper(67)
- Technology is here. How to take best advantage of this capability is the challenge(72)
- Real need to build Crime and disorder considerations into new technologies - at the development stage. Not just what can we do - as what should we do and how do we make it safe?(80)
  - But - need to compare the price of enforcement and penalty versus accepting low level fraud.

- **Economic**
  - New service providers - new business models based on journey provision(7)
  - Integrated systems could save money(12)
  - Value of time - companies will prefer staff to be 'productive' on journeys rather than driving - hence preference for vehicle autonomy(13)
  - Affordability of personal mobile devices(15)
  - Increasing foreign MNOs owning UK-based assets(17)
  - new franchisers for transport _ supported by present day Government(20)
  - Cost /Overhead reduction - staff major factor(41)
  - Further cuts by government - what can transport authorities afford to deliver or invest in(45)
  - Buy your own device. For work and play.(50)
    - Staff takes ownership, look after equipment better...(107)
    - Gatwick do this too.(108)
    - the opposite model is the corporate IT system, that has had its security compromised by installing their own stuff...(109)
  - Competition amongst operators and modes increases and drives new standards of efficiency and service - greater product differentiation(51)
  - Need for better business information / metrics to stay competitive - e.g. bus operators moving to Electronic Ticket Machines means data is entered more accurately ... which can also be used for improved travel information(82)
  - 24/7 society - autonomously driven services may operate for longer and more effectively than a human operator(84)
  - Focus will shift to measuring the quality of the journey against your preferences - time - quality - cost(88)

- Better understanding of the business importance of soft skills...(103)
- Cost of disruption - 'cheaper' to have a death than an injury (for example) - this will skew operator attitudes?(106)
- 60 minute target to clear a fatality. An injured person on tracks takes as long as it takes#(110)
- Shorter time to evaluate whether things are good or bad.

- **Environmental**
  - Sustainable journeys - making a decision to undertake a journey based on the environmental as well as economic impact(16)
  - Carbon reduction in all aspects of transport services/systems so will influence automation(21)
  - More adverse weather incidents driving better disruption information and people used to impacts and pre-predict these(24)
  - Need to reduce use of paper (timetables, waysides ...)?(25)
  - Need to reduce fuel consumption is distribution of hard-copy travel information(28)
  - Autonomous vehicles would reduce need for car ownership(36)
    - Would lead to more efficient vehicle fleet(39)
    - Would reduce need for provision of parking(43)
  - environmental /health factors for sitting of mobile data masts(44)
  - Increased feelings of safety and security may encourage people to use public transport(57)
  - Smaller mobile cells with less power and therefore fewer health issues.(60)
  - Resurgence of direct-action environmental protests over large-scale transport infrastructure projects cutting through rural areas such as HS2 and roads - 21st century Swampy...(77)
  - Continued growth in the rail goods sector.

- **Political**
  - Dismantling of RMT "stranglehold" on public transport
    - Two sides to this. By repeatedly coinciding industrial action to coincide with holidays - they are isolating themselves from the public. What would you rather have - a reliable driverless train or one where the driver strikes to coincide with your annual holiday?
  - Change in government(14)
  - Right-wing ethos - privatisation and cost reduction/profit maximisation
    - Staff are a major over-head.(101)
  - Shift to a more integrated transport view - multi modal & inclusive
  - UK not in EU
  - Collaboration across boundaries - public to private - train - bus - all work together for common aim..= shifting people & goods more efficiently
  - Localism leading to enhanced 'local' systems and services
  - UK fragments if Scotland goes independent
  - Pressure to reduce government subsidies
  - Continued short term approach of granting short term rail franchises that restrict long term investment in the rail industry

- Power to the people from Tweets and Facebook. Shaming poor company performance.
- Pressure to reduce road deaths (~6 per day in UK)
- People knowing their rights regarding poor service.
- 90% on time service will not be acceptable in the future.

- Once all the technology is in place, further reliability improvements come from your people (is one view).(102)

- Accountability by social media...

- **Legislative /Regulatory**
  - UK removes itself from the EU and has more money to solve its own problems

  - UK removes itself from EU and market falters

  - Mandatory requirements on transport operators to serve all sections of the community
  - Legislation needs to catch up with technology.
  - Need to embrace collaboration. This does not mean it is anti-competitive and collusion
  - Protect citizens from mis-use of data
  - Willingness of Government to 'make things happen' - e.g. electronic service schedule data entry in the bus industry - 2013 only 20% of bus schedules are provided in the TransEXchange format - primarily by one bus operator - by 2010 it was targeted to be 100%
  - Need to change Vienna convention - states all vehicles for use on public road must have a driver. US states (Nevada, California) already passed laws permitting autonomously driven vehicle use.
  - EU likely to seek some form of legislative security base level for rail industry across member states.
  - Possible EU move to single approach to data protection requirements to remove current cross border issues around sharing of information.
  - Police training has neglected soft skills - will they come back?
  - Potential impact of new Crime Commissioners with local agendas against rail transport companies as cross border operators

Annex 5 Scenario narratives from Workpackage 1

Scenario 1: World Markets

Individuals ignore national and regional barriers as they strive for material wealth and mobility. International and long distance domestic travel increases for those who can afford it. There is growth in demand for complex journey planning services. People value high quality services such as multi-lingual automatic translation for way-finding in unfamiliar environments. Innovation is initially spurred by the sharing of international best practice, but commercial imperatives lead to a small number of multi-national global corporations dominating provision of these services. The car is the mode of choice for local journeys, and to access long distance travel by PT, for those who can afford it. This leads to increasing emphasis on infrastructure, facilities and services, including traveller information, which support car access to PT interchanges. Quality information is only provided where there is clear commercial benefit, resulting in fragmented information provision.

Those wishing to travel beyond the locale depend on service providers to join-up this fragmented picture at a cost. For those who cannot afford such services there will be decreasing confidence in travel and narrower travel horizons as people place their faith in familiar environments and trusted services. As PT services reduce in scale and quality there is an increasing role for Demand Responsive Travel services to bridge the gap. These services are commercially driven, with trusted service providers facilitating access to key travel generators such as business parks, industrial estates, airports, or shopping malls. The desire to maintain independent travel drives growth in alternative models of car ownership and use such as car clubs, car sharing and on-street car hire. However, car clubs and car sharing are less 'open' than in the past, with membership oriented around rigorous profiling and/or pragmatic relationships between trusted peers with shared interests.

Target hardening is an issue of increasing concern. Cars and mobile phones are increasingly secure with access and use controlled by PIN systems and biometric data. Remote device shut down will deter theft, but this shifts the vulnerability from the technology to the owner, increasing violence and intimidation to access their biometric and PIN data. The bespoke information and journey planning services which emerge in this scenario require the collection of sensitive personal data. Secure data storage is also major concern and individuals are reluctant to share information reducing the role of open data. Social media is limited to closed communities of interest managed by trusted service providers, who tightly control access. The high monetary value of traveller information means that commercial imperatives prevail over open access to data, reflected in the role played by multi-national corporations in data ownership.

Scenario 2: Global Responsibility

Society is highly cohesive and conformist, with a bias towards achieving community-oriented consensus. The population is highly educated, feels secure and trusting of one another. Citizens and businesses are highly taxed, as the social value of public goods, including PT, is recognised and well-supported. The cost of providing services and information is shared between parties to give economies of scale.

Disruptive radicals are rare, but more dangerous due to lower levels of social 'alertness'. Extreme criminality or terrorist acts are deeply shocking to society, but the response is not to impose draconian security controls. The openness of society and its reliance on open data raises the threat from cyber attacks, and physical attacks on infrastructure, as there are few barriers to information for the determinedly disruptive. However, policing functions are highly computerised and ubiquitous, with technologies such as CCTV and facial recognition developing to a level at which the cost has reduced. Antisocial behaviour and crime is reported immediately using social media, enabling fast and accurate response and reporting, enabling accurate public perceptions about safety and security in the travel environment.

Public authorities and commercial data holders are committed to making their data available, and work collaboratively, utilising public feedback and government-sponsored standardisation. There is a high level of cooperation between universities and industry, and across sectors, in sharing intellectual property. The use of open data and the cooperative nature of society supports the development of shared travel services. The interests of minorities or groups who tend to feel more vulnerable at present are well-provided for in service and information provision, and they feel safe and confident in using PT. There is very little emphasis on the use of cars for local journeys because of community preferences for high air quality standards and low noise, healthy environments, with active travel and/or PT used for work and leisure travel. The well-integrated and multi-modal transport networks are very data heavy, to support operations and traveller information. Social openness leads to innovations in Augmented Reality Technology to find fellow passengers with common interests, to find empty seats on crowded trains, or find carriages that aren't deserted so people can gain comfort from not being alone. Direct information about the immediate travel environment is available through community-led social media, e.g. people at one end of a train use mobile devices to tell others where there are empty seats.

Scenario 3: National Enterprise

Society is motivated by national and individual self-reliance, with the operation of PT and related information services characterised by fragmentation. Infrastructure and service priorities are oriented around 'homeland' security. Major investment priorities are key national infrastructure such as the motorway and national rail networks and major interchanges, designed to link the major metropolitan centres as engines of economic growth. There is an emphasis on protecting borders and international gateways such as ports and airports. These priorities result in clear disparity in the level of investment and services between priority areas and peripheral places.

The technologies which underpin traveller information services are developed at the national level, an insular approach retarding innovation by ignoring international best practice. The absence of global players in the market means that competition does not drive forward innovation and economies of scale. In the absence of economies of scale, an alternative economic model emerges for information services. PT and related information services that are not economically viable decline and even disappear. Those that remain only provide information beyond minimal standards when there is clear commercial benefit e.g. to support ticketing or advertising. The fragmentation of service provision creates a market for systems and services that join-up and co-ordinate to support travellers. A high degree of differentiation in services is available, regulated by pricing and privilege passes to first class PT facilities are popular. Brokering systems and services play a key role in supporting travel and commercial DRT services fill gaps caused by the decline in PT provision. However, the private car remains the travel option of choice for those who can afford it. Infrastructure, services and information to support access to PT by car are investment priorities.

A stark digital divide contributes to wider social polarity. Access to information and services is unequal and the highly prioritised uneven investment in infrastructure and services leaves those at the geographical margins most vulnerable. De-regulated service provision affords very limited protection for the vulnerable. Information provides a critical role in supporting personal security, but quality information is costly because RTI has become valuable as services deploy dynamic fare systems to regulate access. The lack of community support makes information systems particularly important. Mobile technologies act as 'travel buddies' and systems and services become increasingly sophisticated and bespoke. Lack of trust in notions of community and data-sharing cause a decline in social media and open data. Trust is placed in national political and cultural institutions, reflected in the small number of official providers of traveller information. Citizens carry a National Identity SmartCard incorporating biometric and location tracking data as well as banking and ticketing functions. The high degree of surveillance is the main source of security in travel and in the urban public realm. Though predicated on the importance of maintaining homeland security, it also provides reassurance for local travel and day-to-day living.

Scenario 4: Local Stewardship

Most powers are devolved to local and regional authorities, leading to fragmentation of approaches across national space. Although there is a high level of environmental awareness, it is locally or regionally oriented. Most journeys are highly localised and active travel prevails for health and environmental reasons. This has changed the nature of PT provision, which adapts around a fitter, though older, general population, who have different journey patterns based on using a mix of owned and shared bikes. There is a growth in local bike hire schemes integrated with PT access points. Travel environments are more age-friendly, with better pedestrian routing and lighting, supporting confidence in independent travel. Information provision makes realistic allowances for the walking and cycling segments of journeys. The resultant network is simpler and easier to understand, making the provision of RTI easier. However, the model of a mix of commercial and subsidised services is much the same as in the present, though substantially based on contracts between the operator and the funder. The services are differentiated to cater for diversity of need, and information provision is similarly fragmented. The significant growth in the numbers of extremely aged increases the number of mobility-impaired citizens who cannot cycle or walk, and are disadvantaged by the shrinking of local bus networks, making them reliant on bespoke services to access healthcare. Similarly, distinct communities such as students are more dependent on PT for specific activities, such as accessing leisure and returning safely from nights out.

Technology is increasingly used to support home-working, reducing the need for face-to-face meetings, and for commuting. There is a reduction in longer, non-routine trips, but those that are undertaken are supported with good information provision that enables people to cross local and regional boundaries between services and standards with confidence. Local broadcast media increasingly provide real-time information about travel conditions in the locality, and DAB pushes localised travel information to geo-located mobile devices, enabling travellers to remain up to date and able to adapt journeys, regardless of mode. PT provision provides plenty of space for bicycles on vehicles, and better bike storage at interchanges. The local and community-oriented lifestyles reduce threats to personal security, though there is an increase in cycle theft.