Study on Public Transport Smartcards – Final Report

The EC Smartcards Study Consortium

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Study on Public Transport Smartcards

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Executive Summary

The report summarises the results of a study undertaken on behalf of the European Commission by the EC Smartcards Study consortium including AECOM, the lead consultant, The Transport Operations Group (TORG) of Newcastle University, PJohnson Associates, AustriaTech and NEA.

It presents recommendations regarding possible actions at the EU level to encourage and support interoperability between current and future public transport schemes, through the use of Smartcards.

Recommended actions have been assessed, in terms of their possible costs to the EC and the possible benefits that might accrue to scheme owners, public transport operators, public transport users and the public in general, through the bringing forward of more schemes and in a more integrated way than might otherwise be the case.

In addition to consultations with selected scheme owners, worldwide, a Practitioners Panel including 40+ members, representative of key players in the Smart Ticketing value chain has been established to review and comment on the merit of the actions proposed.

State of the Art Review

The review presented of the current situation has considered the development of smart card fare payment systems across Europe and the rest of the world and has looked specifically at the benefits these bring to regular travellers and also perceived and actual barriers to irregular travel, which smartcards can address.

A number of existing and soon to be deployed schemes have been reviewed. Each existing system's review has considered the benefits to accessibility that the system has brought and reasons why the system may or may not be more widely used.

Subsequent tasks have looked into the likely future trends in the development of smart cards and other smart ticketing technologies and their possible future application

The state of the art review has shown that the delivery of smart-ticketing schemes has been achieved through a variety of ways, including one central scheme provider, a network of stakeholders (operators, authorities, technical etc.), partnerships between PT operators and relevant Local Authority, and where an overarching private company took primarily responsibility.

The number of operators within a single scheme tends to be in the region of no more than 10, but it is possible for more established schemes to accommodate upwards of 40 individual operators. Funding for implementation of schemes has come from a variety of sources, from individual PT operators, local/regional government authorities, private shareholders, PFI arrangements and even from national and international development funds through pilot scheme research

The parties involved in the development, implementation and operation of integrated smart ticketing can be broadly categorised according to the following headings:

- Transport Authorities;
- Transport Operators;
- Standards Bodies;
- Equipment Suppliers;
- Service Suppliers; and
- Public transport users.

However, the exact nature of the stakeholders involved, the role they play and how they collaborate between each other varies significantly between schemes. This generalisation of the parties involved also belies the sophisticated nature of the value chain within the integrated smart ticketing arena

The main reasons for scheme owners and operators introducing smart-ticketing relate to improving the efficiency of existing systems (faster transactions, reducing the uncertainty of fares through automated calculation etc.) particularly where existing paper-based ticketing was becoming untrustworthy and fraudulent use of such tickets was on the increase.

From the end users' perspective, there is a clear desire for a ticketing system that is simple to use and can cover all modes of public transport, whether that be smart cards or otherwise.

Smartcards are still the most common form of smart-media currently being used, with cards being used from a variety

of suppliers. A diverse range of front-end and back-office systems are in use, each scheme having its own specific set-up. Smart-ticketing is perceived to be a lot more reliable, convenient, faster and easier to use than conventional ticketing, which delivers a better overall product allowing users to travel with more liberty.

Smart-ticking can undoubtedly remove some of the barriers to travel for the irregular and unfamiliar traveller. However, Smart Cards technology is necessary but not sufficient for the realisation of many of the potential benefits desired. Operational as well as technology change is required; data from cards need to be turned into intelligence to improve operational efficiencies etc.

Future View

The review of trends has considered how the market is developing, the impact of new and emerging media on the market place and how Government actions within EU member states and elsewhere can help in influencing the payment systems landscape.

The review has also considered the value chain for businesses involved with a mind to considering what actions the EU should take if they want to positively influence development of the marketplace. Associated with this is a review of the standardisation activities in the field undertaken to date and their impact.

The study concluded that while some existing schemes have already installed some components that conform to international norms, and have adopted operating models that comply with best practice; these are generally insufficient to support interoperation between schemes or across national or international boundaries.

The extent to which schemes might offer a range of non transport applications in the future has been informed by a review and analysis of schemes responding to the initial state of the art review. A limiting factor for introducing a range of applications and for future interoperability will be the extent to which schemes have and will be developing according to established specifications and standards. This limitation has been recognised by the IFM Forum and a possible way forward has been proposed.

Beyond technical considerations affecting the future development and roll out of smart ticketing, there are two main fields in particular where legal issues in implementing smart card solutions in public transport often cause concern and which will potentially limit their future development.

Firstly, the implications for transport companies and smart card schemes in transport of the legal framework with regard to e-money. Here the problem is to what extent public transport smart card schemes will have to meet the requirements and restrictions applied to e-money institutions and/or credit institutions. The second main area relates to privacy and data protection problems, in particular with regard to reconciling these with the various uses that transport operators would like to make of the data.

Based on this analysis, end user surveys such as those reported upon and other secondary research undertaken on reported trends in the uptake of different media, it is considered that conventional smartcards will remain as the dominant media for the time being (the next 5 years at least).

Near Field Communication (NFC) media, including suitably enabled mobile phones will become more prevalent over subsequent years with recent forecasts of the market penetration of such devices (ABI Research, 2008) indicating that the number of NFC phones will grow to be around 20% of the total phones in operation over the next 5 years.

Recommended Actions

The final stage of the study has been to draw together the results of the state of the art review and assessment of future trends to develop and assesses the likely merit of recommendations for EU level actions, designed to encourage greater interoperability within Public Transport ticketing, using smartcards.

Based on the preceding assessment of options and in consideration of the results of the analysis undertaken to date, it is considered that the EC might reasonably implement a programme of measures, along the lines of those set out within the Do-minimum scenario, to encourage greater adoption of smart ticketing within public transport.

These actions are designed to provide strategic leadership in the development and roll out of smart ticketing. The nature of the actions that might be undertaken include:

- Conducting detailed assessments of schemes, identifying and facilitating the sharing of best practice;
- Setting out ‘model’ scheme designs, business cases and model agreements between partners;
- Engaging with key stakeholders, and supporting relevant research into new technologies, seeking / supporting technological convergence;
- Providing incentives to stimulate further public and private investment and delivery;
- Ensuring the right ‘tools’ are available (scheme architecture, standards and specifications) and encouraging their use.

The approach taken and the effectiveness of the funds directed towards these actions should however be reviewed, after a period of say 3 years to confirm the appropriateness of this approach.

Subject to the results of this later review, the EC might wish to reassess / reconsider the merits of the additional (Do-something) actions set out within the report. The nature of the additional actions that might be taken include

- Providing additional funding for schemes that conform with the Vision and Plan to speed up the development of integrated smart ticketing schemes, in particular schemes which include the delivery of relevant, enhanced user data / information
- Developing model Framework agreements for the supply of services and equipment
- Including smart ticketing requirements in all newly let franchises

1. Introduction

1 Introduction

1.1 This Report

This Report summarises the work undertaken within the European Commission's "Study on Public Transport Smartcards".

The European Commission (EC) wishes to identify what steps if any it should take to encourage interoperability between smart ticketing systems, with the aim of reducing barriers to the use of public transport and in particular the use of multiple modes of travel within the same journey.

Interoperability can be considered at a number of different levels:

- Interoperability of media is the very essence of smart-ticketing (how this functions should be irrelevant to the customer);
- Interoperability of application (should be transparent to the customers with no need for knowledge of the application)
- Interoperability of products is having a product that can be used in more than one country on a single media.

Together they should lead to a significantly improved travelling experience for the passenger and increasing usage being made of public transport

More journeys being made by public transport instead of by private car has the potential to contribute towards a wide range of transport and other goals:

- Reducing the number of private car journeys can help to reduce congestion, making networks more efficient and reliable;
- Modal shift away from private cars can also reduce vehicle emissions, including carbon dioxide resulting in a significant contribution to a lower carbon footprint;
- Less congestion can also improve the quality of life of those living near main roads, through improved air quality, reduced noise pollution and road safety;
- Economic benefits are derived from likely improvements in the transport system operating efficiency and reductions in ticket fraud, in comparison with a more conventional paper based ticketing system;
- Improved public transport can also promote equality of opportunity and social inclusion, especially amongst those without access to private cars.

Smart ticketing, through the media of Smartcards, can improve the public transport offer and provide clear benefits to both the public sector and transport operators. Local and central government can benefit from the modal shift towards public transport. Increased passenger numbers and increased revenue provide a commercial benefit to Operators.

Better data from smartcards increases the efficiency of use of existing resources and opens up new commercial opportunities.

Although the plastic Smartcard is a well established media, there are other technologies such as contactless banking cards and mobile phones, which can potentially be used as a Smartcard, which have the potential to significantly influence the future of ticketing within Public Transport.

1.2 The Study

With these issues and potential opportunities to increase public transport usage in mind the specific purpose of the Smartcards study is to:

1. review the current situation with regards to public transport ticketing, payment and verification systems (Smartcards) across Europe and globally;
2. review trends in ticketing and fare payment and technological development in this area, considering the value chain and the business drivers associated with such technology and synergies with other potential applications;
3. review current and emerging standards for such ticketing and fare payment systems; then
4. Suggest the approach the EU should take in encouraging interoperability of such ticketing systems, with the aim of reducing barriers to use of public transport and in particular use of multiple modes of travel within the same journey.

The study has been undertaken by a consortium including AECOM, the lead consultant, The Transport Operations Group (TORG) of Newcastle University, PJ Associates, AustriaTech and NEA.

The outputs of this study are designed to respond to the Commission's green paper, "Towards a new culture for urban mobility".

1.3 The Study in Outline

The initial stages of the study are designed to establish the current state of the art in the use of Smartcards.

The review of the current situation has considered the development of smartcard fare payment systems across Europe and has looked specifically at the benefits these bring to regular travellers and also perceived and actual barriers to irregular travel. Each system's review has considered the benefits to accessibility that system has brought and reasons why this system may or may not be more widely used.

Subsequent tasks have looked into the likely future trends in the development of smartcards and other smart ticketing technologies and their possible future application

The review of trends has considered how the market is developing, the impact of major credit card and mobile phone companies on the market place and how Government actions within EU member states and elsewhere is altering the payment systems landscape. The review has looked at possible future developments in different types of fare payment systems including those using Near Field Communications, as well as pre-payment systems using mobile phones etc. Alternative systems to smartcards have been reviewed considering issues such as availability of point of sale terminals, accessibility for the elderly and disabled, interoperability for payment for other services, security levels etc.

The review has also considered the value chain for businesses involved with a mind to considering what actions member states and the EC should take if they want to positively influence development of the marketplace. Associated with this has been a review of the standardisation activities in the field undertaken to date and their impact.

The final stages of the project draw together the results of the study and develop recommendations for any actions at the EU.

Any proposed actions would aim to encourage and not restrict innovation, taking into account the economic, social and environmental impact associated with taking and not taking them.

1.4 Project Outreach

An outreach strategy has been developed to ensure the outcomes from the study are founded upon a consensus view of the current state of the art and of the likely future developments in the field and that the conclusions and recommendations from the study are generally endorsed by those within the value chain.

At the EU level this has involved consultations with scheme operators within the UK, Ireland, Norway, Netherlands, France, Germany, Italy and Spain. The study has also established links with the IFM Project / DG-INFO and a wide range of European Organisations, through the IFM Forum and the study's own Practitioners Panel

The Practitioners Panel includes 40+ members, world wide, representative of key players in the Smart Ticketing value chain. At an international level, the study has also consulted with scheme owners in Hong Kong, Japan, Singapore, Australia, Canada, North and South America

1.5 Study Tasks

The achievement of the study aims is predicated on the undertaking of the following tasks:

- Task 1: Documentation and assessment of current urban and suburban tarification systems worldwide, focusing on innovative smartcard ticketing systems
- Task 2: Analysis of functional requirements, including forward looking view of developments in ICT and future new functionalities
- Task 3: Consideration of the scope for harmonisation of rules and technical standards to facilitate interoperability, enhancing accessibility for those outside of the local scheme area
- Task 4: Survey of public acceptance of currently existing systems and views on future developments, taking account of changing demographic trends
- Task 5: Assessment of the scope for extended functionalities and services,
- Task 6: Analysis of value chain (stakeholders) associated with smart payment systems and analysis of future trends regarding service providers
- Task 7; Assessment of legal liability issues
- Task 8; Assessment of robustness of alternative systems especially in respect of security, misuse and fraud
- Task 9; Assessment of any recommended actions at EU level
- Task 10; Impact assessment and recommendations for EU level actions on smart transport tarification systems

The project tasks can be categorised according to the following broad headings, reflecting the specific purpose of the study:

- Initial tasks that **establish the state of the art**, tasks 1, 2, 4 and 7
- Subsequent tasks which **look to the future of smart ticketing**, tasks 3, 5, 6 and 8
- And those which draw together the results of the study and develop **recommendations for EU actions**, if any, tasks 9 and 10

There is a further task to report on the findings of the study, task 11.

The work undertaken and the conclusions drawn are presented within the following Chapters.

1.6 Report Structure

The remainder of this Report is structured as follows:

- Section 2 summarises the current State of the Art regarding smart ticketing
- Section3 presents a forward look, assessing the potential for new developments to increase interoperability between system
- Section 4 presents conclusions and recommendations for actions at the EU level
- Section 5 summarises the assessment of potential impacts of proposed actions.

Supporting information is presented within the Appendices to the Report

2. State of the Art Review

2 State of the Art Review

The state of the art review has encompassed an assessment of existing and soon to be deployed smartcard schemes, in consultation with scheme owners, plus consultations with practitioners in the field. It has also included a review of public perceptions of the technology associated with smart ticketing and of the value chain for the development, implementation and operation of schemes. Together they have established a base line scenario, from which the potential for future enhancements has been assessed.

2.1 Review of existing and soon to be implemented Systems

Consultations with scheme owners

An initial list of Smartcard schemes to be reviewed was identified using the recently published DfT consultation paper "Developing a strategy for smart and integrated ticketing" (DfT, August 2009) which gave a list of current and planned smart-ticketing schemes. Schemes were initially chosen in such a way as to encompass a range of smart card/ticketing schemes including those which were a) well established, b) relatively new in their operations and c) still being planned or in very early (pilot) stages of operation. This would ensure that a wider breadth of issues surrounding the planning, implementation and operation of smart-ticketing schemes should be covered.

To gather information for this task, an engagement strategy was developed, the details of which are in the project Inception Report (14th January 2010). Contact details were sourced through existing contacts, an internet search and also through various contacts sourced via the IFM project. These searches accounted for a number of the schemes originally identified, but there were a couple of omissions as a suitable contact could not be sourced. From this, an account was established on the professional contact network 'LinkedIn', where a number of related smart-ticketing groups exist. The study was promoted through these channels and further contacts were made both from the original list of schemes and in some additional schemes. Finally, the study was promoted at the ITT conference as part of a presentation on the IFM project, which led to further contacts registering their interest through the project website (www.ecsmartcards.co.uk) and a number of these were followed up to establish contact with any outstanding schemes.

A questionnaire was developed based on the key issues identified during the project Inception Phase and set out in the project Inception report. Two versions were prepared, one for current schemes and one for planned schemes, however the questions were virtually identical in both, except for a slight change of wording in places to reflect the different status of each category. Copies of the questionnaire, in both forms are included in the Appendix (Sub section A1).

The questionnaire was divided into four broad categories:

- Administrative Issues
- Drivers for Implementation
- Technical Aspects
- User Benefits

All questions were open questions, intended to allow respondents to go into as much detail as they desired. A supplementary questionnaire was sent to current scheme owners to determine the standards and specifications that have been used and applied. This has assisted in determining the ease with which schemes might be integrated in the future. A copy of the supplementary questionnaire is also included in the Appendix (Sub section A2).

Table 2.1 shows the schemes which were eventually contacted with the questionnaire and those who have since responded (updated at the time of writing). The schemes are a representative sample of those in operation or planned in the near future.

A further number of other scheme owners were invited to provide inputs to the review, through the medium of the Practitioner Panel (including those involved in schemes within Sweden, Belgium and France)

Capabilities on project:
Transportation

Table 2.1 Schemes Contacted

Location	Scheme	Response
London	Oyster	Yes
Nottingham	Various	Yes (Nottinghamshire)
Dublin	LUAS + National ITS	Yes (x2)
Toulouse	Pastel	Yes
Paris	Navigo	Awaiting
Netherlands (Translink)	OV Chipkaart	Yes
Germany - Hohenlohekreis	Kolibricard	Yes
Rome	ATAC Metrebus	Yes
Hong Kong	Octopus	Yes
Japan – Various (Kansai)	PiTaPa (Suica/Pasimo)	Yes
Sao Paulo	Bilhete Unico	Awaiting
Chicago	Chicago Card/I-Go	Yes
Toronto	Presto	Yes
Melbourne	Myki	Awaiting
Nexus/Tyne & Wear	NESTI	Yes
Basque Area	EuskoTren Barik	Awaiting
Singapore PTE	EZ Link	Yes
Singapore – Local Trans Auth	EZ Link	N/A – covered by PTE
Norway - Various	Skyss	Yes (Bergen and VKT)

The key points arising from each section of the questionnaire are summarised as follows

Administrative Issues

Delivery of smart-ticketing schemes has been achieved through a variety of ways, including one central scheme provider, a network of stakeholders (operators, authorities, technical etc.), partnerships between PT operators and relevant Local Authority, and one example where an overarching private company took primarily responsibility.

The number of operators within a single scheme tends to be in the region of no more than 10, but it is possible for more established schemes to accommodate upwards of 40 individual operators (or more, depending on the regulatory environment). Some schemes include services provided by large national or multi-national transport organisations, whilst others have focussed on one or more individual local providers. There seems to be a relationship between the number of operators and the number of individual cards issued within a single scheme, some of the largest schemes have issued upwards of 20-30 million cards, whilst smaller schemes have issued between 12,000 and 600,000 cards.

Funding for implementation of schemes has come from a variety of sources, from individual PT operators, local/regional government authorities, private shareholders, PFI arrangements and even from national and international development funds through pilot scheme research. Costs could not be disclosed by some respondents for legal/contractual reasons, but figures received from those who could were again variable, starting from €200k (~£170k) to ~€182million (£150 million). These figures covered a range of required financial outlays and were dependent on the number of different stakeholders involved, and the scale of the scheme in question.

Direct input from Government into smart-ticketing did occur for some schemes, primarily at the county/regional/local authority level, although one scheme did mention that national / regional Government involvement was needed. 'Municipal transport authority' was also mentioned, implying an autonomous national body was in place to oversee the provision of funding allocation. For some schemes, funding could only be sought once the relevant Local Authority approval procedures had been completed.

With the exception of one scheme, all respondents thought that the current level of Government input was appropriate, which implies that the local/regional level on the Government hierarchy is possibly the best tier to make schemes successful. However, it was also identified that working between different tiers of the Government hierarchy was not an easy task and required significant efforts to co-ordinate all parties, especially when independent systems were involved.

Drivers for Implementation

The current smart-ticketing schemes were introduced from around 1997/8 up until 2008, some schemes identifying that a timeframe of around three-four years was required to go from pilot testing through to full implementation of a working system.

The main reasons for introducing smart-ticketing were related to improving the efficiency of existing systems (faster transactions, reducing the uncertainty of fares through automated calculation etc.) particularly where existing paper-based ticketing was becoming untrustworthy and fraudulent use of such tickets was on the increase. The paper systems needed to be modernised / replaced and the opportunity to include smart-ticketing strengthened future business cases for these replacements. Where an overall transport system was undergoing modernisation/expansion, this was also seen as an opportunity to introduce new smart-ticketing as a modern advancement to paper-based ticketing.

Smart-ticketing also provided opportunities to understand existing passenger flows and travel patterns in more detail, allowing for transport services to be tailored to better meet demands. Smart-ticketing was also seen as an opportunity to provide full integration and interoperability through one ticket across different modes and networks, opening up new opportunities for innovative fare products.

All drivers were leading towards meeting the (technological) expectations of the 21st Century passenger, by making Public Transport easier to use on a regular basis and, ultimately, a more attractive option. Some schemes also reported on wider applications of smartcards, and how the introduction of smart technologies opened up new markets beyond transport ticketing.

Positive experiences of implementing smart-ticketing included:

- Higher than expected uptake rates, and a more modern, efficient Public Transport system, leading to improved business cases
- Reduction in the level of fraud through direct fare evasion or misuse of the wrong ticket, leading to improved business cases and efficiencies
- A chance to reassess existing fare structures, and more efficient management of concessionary fare schemes

- Faster ticketing processes for the passenger, who favoured the new technologies and found the smart-ticketing easy to comprehend and use
    - Particularly for those schemes which adopted auto-reload functionality (where the user's balance automatically tops-up when the credit level drops below a pre-specified limit)

Negative experiences of implementing smart-ticketing included:

- Dealing with a vast network of PT operators, stakeholders, technology suppliers, funding bodies, legislative procedures etc., just to get the smart-ticketing scheme off the ground
- The timeframes required to deliver complex, technological products, particularly when third-party suppliers were involved and technological delays pushed back full implementation
- The financial investment and human resources required from the outset, plus identifying suitable funding sources to provide enough capital and ongoing revenue to make the scheme a success
- Dealing with expectations of the traveller when schemes became part of their everyday life, or when other schemes in a region offered different services not available to them
- Integration of a scheme across different modes or multiple PT operators, particularly where transport services were not under direct Government control
- Initial marketing of smart-ticketing to establish its identity with the passengers, including those who would not be regular or familiar users of the system (especially tourists)
- The publicised security breach of the Mifare encryption meant that schemes using cards of this type had to mitigate against any possible security concerns in their own systems

It was identified that to overcome potential barriers, a smart-ticketing scheme requires a strong network of stakeholders, all with common goals or aspirations to deliver an integrated product from the outset of the project. Good management was essential in keeping all partners round the discussion table, but quite often a large amount of time and resource was needed in order to resolve significant disagreements or other issues between partners. New technologies have a cost (production and distribution) and a robust strategy for managing the cost and deployment has been identified as a critical issue within some existing systems.

It was also important to bear in mind that there would be a substantial customer base for the smart-ticketing end product, and their needs must be considered during the process otherwise take up rates and acceptance of the scheme may be low. After sales issues and data security are also important attributes to consider, as this ensures the customer will feel confident when using the smart-ticketing.

Technical Aspects

Smartcards are still the most common form of smart-media currently being used, with cards being used from a variety of suppliers (Sony, Mifare, Desfire, FeliCa, Infineon). A couple of schemes also referred to the use of m-ticketing (SMS, NFC) technologies, and how they are trialling these, but they are still in their infancy. (M-tickets are sent to a mobile device containing text with event and ticket data and a unique, scanable, 2D barcode). There are a number of different fare/tarification structures/ payment methods/technology approaches currently in place:

- Touch-on Touch-off / Check-in Check-out / Scan-on Scan-off
- Touch-on (often used when a flat fare scheme is in operation)
- Zonal based system
- Time based system (e.g. single journey made within 90 minutes)
- Distance based system
- Post-pay credit system

One key advantage is that smart-ticketing can be used to automatically provide the user with the most suitable fare for their travel, including fare-capping, where after a certain number of single transactions, the fare is capped at the relevant day rate.

A diverse range of front-end and back-office systems are in use, each scheme having its own specific set-up. Most systems have a central system under their own control, although some have outsourced the management and maintenance of this to major ICT suppliers. Funding for the equipment needed for these systems has primarily come from Government sources, at various levels of the hierarchy, although there are examples of partnership agreements between the PT operators and the relevant Local/Regional authority.

Security measures are in place, although it was noticeable that some schemes did not understand some of the terminology used, which may prove to be a barrier for future interoperability. This is also one area where some schemes were not willing to share details, which may be necessary in the future should interoperability require them to do so. Particular terms/features mentioned pertaining to security issues include:

- Full audit trail
- Secure data stores
- Cryptographic keys
- KMF SAM encryption keys
- Standards, including ISO24014 and National Security Standards
- Data privacy and protection
- Credit-card style protection

User Benefits

All respondents were of the opinion that smart-ticketing brings a number of benefits to the user that traditional paper-based ticketing cannot necessarily deliver. Smart-ticketing was perceived to be a lot more reliable, convenient, faster and easier to use, which delivered a better overall product allowing users to travel with more liberty.

Tarification structures such as 'Pay As You Go' delivered greater flexibility for all users, not just those who used Public Transport on an irregular basis. Operational benefits included a decrease in dwell times at the bus stop, faster transactions and less cash-handling increased the safety for bus drivers and other on-board staff. Overall, smart-ticketing could have the benefit of influencing peoples' perceptions on Public Transport for the better.

Not all schemes offered additional benefits to smart-ticket holders. In some areas, smart-ticketing exists alongside traditional paper-based ticketing, offering identical products with the assumption that the paper-based system would eventually be phased out in favour of the smart-ticketing. It was identified that smart-ticketing could be used as a marketing initiative to offer travel discounts over cash transactions (two schemes reported the level of discount as 17% and 20%) which increased customer usage levels.

The flexibility provided by smart-ticketing could be used to personalise travel costs by providing user-specific zonal based fares, tailored to their most frequent journeys, removing the need for pre-defined zonal systems. Again, reducing the level of cash-handling improved the personal safety of the individual when travelling on Public Transport.

The opportunity to provide additional non-transport functionality and services through an individual smart-ticketing scheme has been taken up by some schemes, who offer parking payments, micropayments for shopping, payment for access to leisure and community facilities. Some schemes would like to consider offering such services, particularly through/on existing smartcard based systems (e.g. identity smartcards for company staff or university students), which could also be used to promote individualised travel information and ticketing options.

All respondents stated that smart-ticking can remove barriers to travel for the irregular and unfamiliar traveller, a couple of schemes commenting on how existing paper-based systems were complex even for the regular user. Automatic fare calculation and auto-reload functionalities provide greater flexibility to fare policies, which means that irregular and regular users would not have to worry about finding information on the appropriate fare, nor having the right money available to pay their fare.

2.2 Consultations with the Practitioner Panel

In addition to consultation with selected scheme operators, consultations were also held with an International panel of practitioners, including representatives of European Associations (encompassing Authorities, Operators and Users), Government Bodies and others within the overall Smart Cards Value Chain (including card producers, system designers and suppliers) plus consultants and advisors on transport policy. A list of the invited panel members is presented as an Appendix (Sub section A3).

Panel members were invited to complete two on-line questionnaires, exploring a range of issues associated with existing smart cards systems. In addition, members of the Panel were invited to comment on how schemes might develop in the future. (The research also explored the role that the EC might take in steering future developments).

The on-line questionnaires which panel members were invited to complete are included in the Appendix (Sub section A4). A total of 29 responses were received, covering both questionnaires (15 for questionnaire 1 and 14 for questionnaire 2).

The following summarises the conclusions drawn from the analysis of responses received from the panel surveys (for details of the actual questions please refer to the survey forms within the Appendix).

The consensus view of panel members is that If asked, the majority of users would say they were unaware of what a smart card is and how it works. While this was thought to be most prevalent amongst members of the older generation, there are many examples where smart cards are used for the delivery of concessionary tickets for senior citizens.

There is a perception of confusion amongst end users as to what the term 'smart card' actually stands for; although where there has been widespread adoption

of different types of smart card, end users are generally aware of the name of that particular ‘brand’ (e.g. Oyster) even if they do not necessarily call them a smart card. This underlines a need to focus, within the marketing strategy for a scheme, on the services delivered rather than the technology employed,

The panel members endorsed the view that the EC holds that Smart technologies will help increase the flexibility and ease of payment options, allowing a wider range of ticket options that can cover multiple modes. Public transport usage could be further incentivised through loyalty schemes for using the cards.

Smart technologies of the future will be driven by Near Field Communication (NFC) mobile phones, whilst ticketless payment systems will become more prevalent. The consensus of panel members was that the development of smart ticketing should be led by national government bodies in partnership with public transport providers in each country. An overall set of standards endorsed and promoted at the EU level would help to ensure interoperability Europe-wide, though there should not be a European smart card introduced for the sake of it. There is a view that Visa and MasterCard (Maestro) need to be involved as they already provide a set of contactless payment standards that allow European banks to issue contactless debit and credit cards to customers in all 27 member states, which can be used Europe-wide.

The main barriers to future interoperability are expected to be the difficulties in agreeing standards that all parties can agree on (especially in those areas which have already pursued smart cards which are unlikely to be compatible with these standards). In addition, it may be difficult to get agreement between government bodies and public transport operators as to how to fund the implementation and ongoing costs of smart cards.

As the adoption of a smart card system by a public transport operator will increase the number of ticketing methods they will have to be able to accommodate, there will be high costs to them from this approach. This will discourage them from pursuing a design with a more comprehensive set of standards

Integrated cards catering for public transport and civic services will become more prevalent in the coming years as this will save on cost and cut down on the amount of different items required to be carried. However, the key issue will be how to keep sensitive information about one service private from the other parties signed up to the card and getting agreements between parties; determining how this is achieved will slow the implementation of such cards.

The consensus view was that the costs of implementing the cards should be borne by all service providers benefiting from the integrated cards. Any extra costs could be passed on to tax payers (especially in the area where the implementation is taking place). However, it is envisaged that in many cases there should not be any extra costs incurred in the long run, when new systems such as these have bedded in.

It is recognised that it is very difficult for smaller cities and regions to invest in smart cards due to the costs involved and such systems take a long time to come to fruition. This supports a view that it would be better for smaller cities to develop complementary schemes or become part of a larger regional scheme. Those areas considering investment in smart cards can find out more information by consulting cities and regions which have developed systems via forums and site visits. Various bodies have been set up in different countries to promote and support the adoption of smart cards within public transport and EU level documentation has been written to advise on best practice in this area, although these need to be better promoted to maximise their take up.

The consensus view is that allowing the market to solely dictate the development of smart ticketing will lead to a large number of incompatible systems, where the costs of integration at a later date will be prohibitive. With regards to the specific actions which might therefore be taken at an EU level to help focus the future development of smart ticketing, the consensus view of the panel members was that the EC can aid development of smart card systems by getting a set of Europe-wide standards agreed at the highest level (and possibly paying a percentage of the implementation costs for the first projects compatible with these standards). Once higher level parameters ensuring compatibility between systems across Europe have been established, it would be appropriate to leave the exact make-up of individual systems to those at a local or regional level, as they will have the capacity to identify best what the local issues are and be able to decide, for example, which services to include and how the cards are paid for.

2.3 Public Acceptance of the Technology

A key to understanding the potential for smart ticketing to encourage additional usage of public transport and the role that smart cards and other

media might play in this is an appreciation of end users' perceptions of the technology involved.

Passenger Focus surveys of passengers' perceptions regarding Smart card technologies, undertaken in association with the planning and operation of existing schemes, but also as part of more general consultations on the subject, indicate the user benefits of integrated smart ticketing to be a lowering of queuing times when accessing public transport and of the time taken to otherwise purchase conventional tickets, better value products (supporting a wider range of tariffs, without increasing the complication of ticketing for individuals and the passing on of operator benefits through reduced fares) and a general enhancement of the convenience of public transport for end users is reported.

As a result of the enhanced information available from the technology to transport authorities and to operators, related to actual usage of public transport services, passengers perceive that they also benefit from enhanced information on local ticketing opportunities and through the availability of real time service information (particularly when mobile phones are used to receive such information).

There is also a perception amongst some users that the provision of integrated smart ticketing reduces the lock in between users and a single operator, allowing a wider range of services to be more easily accessed, with integration also making fares easier and simpler to display and leading to increasing standardisation of fare structures within and across operator services

Overall, integrated smart ticketing is seen by transport authorities and public transport operators to help in addressing public concerns that Ticketing is fragmented and overly complicated – with a stated desire from the Public for greater integration of tickets, particularly across local networks and better use of the technology, including pay-as-you go style ticketing.

The recent Ipsos MORI / Leeds ITS survey into smart and integrated ticketing has revealed that modern ticketing options, of which Smart cards are one, are seen as a 'natural progression' in the provision of public transport. As such they are, or should be, seen as part of the basic offer. The following summarises the relevant conclusions from the survey related to public acceptance of the technology.

The basic Smart card option is of greatest interest to the younger age group and frequent users of public transport. It also appeals to a proportion of non public transport users, for its simplicity of use.

Overall, whilst there is clear interest in both integrated and smart tickets as a means of reducing perceived barriers to the use of public transport, the appeal of different ticketing options varies in response to differing transport 'landscapes' and in consequence the impact of introducing integrated or Smart ticketing will vary in response to local circumstances. Importantly, the research found a strong resistance to the idea of paying more for either Integrated or smart ticketing options, not being seen as added value products.

To increase the acceptability of the technology to the public and maximise the uptake of integrated smart ticketing, the research indicated that the ideal technical solution would include the following essential features

- A plastic card
- Can be used across all operators and modes
- Option of zones/ modes
- Option of registration to minimise misuse
- Convenient top-up venues (e.g. newsagent, online, pay point, mobile phone (text), ticket office, cash points)
- Transaction records
- Reader to show remaining balance
- Flexible (both pay as you go and season tickets)
- No expiry of card

Other, nice to have features would be

- Loyalty reward programme – e.g. travel discounts, family excursion, supermarket points
- Option of additional modes – e.g. bicycle-hire, taxi credits
- Overdraft facility – emergency credit
- Ability to pay for other people's tickets – such as paying for children's tickets on the same card

Whilst the general preference appears to be delivery of integrated smart ticketing through cards, reflecting current perceptions of how such ticketing operates and actual experience of using such a medium, participants in group discussions were given additional options of payment embedded into their bank cards or mobile phones. The survey concluded that whilst Initial and spontaneous reactions tended to range from quite positive to slightly sceptical, serious concerns were expressed by some concerning the practical use and potential security risks of alternative technologies.

One of the primary issues raised by the participants is the need to publicly display a valuable possession (i.e. wallet or mobile phone) on public transport. Some also felt that a bank card or a mobile phone has a well defined purpose and that it should not be extended to

being a smart card and frequent users of public transport, in particular, were wary of exposure to financial risk as combining bank and travel card is perceived as increasing the risk of theft and loss. Others, who voiced that they liked the idea of a smart card as it provided them the ability to give their children their own smart card for occasional use, would not be able to do so, as it would be linked to their bank account.

The issues identified by the secondary research are echoed by the results of the study team's own primary research into public acceptance of the technology, through consultations with scheme owners and the practitioners panel .Key issues revealed by the team's own research include:

- A latent public support for smart cards, especially amongst those who have travelled to areas where they are in use;
- A desire for a ticketing system that is simple to use and can cover all modes of public transport, whether that be smart cards or otherwise;
- Those most likely to want or use smart cards are regular users of public transport and those who may not be familiar with all the types of tickets available to them for different modes (e.g. tourists and those making the switch from driving);
- Those most comfortable with technology are keen adopters, however, the use of smart cards within concessionary fares schemes for the over 60s shows that, if the system is simple and intuitive to use, technological awareness is largely irrelevant;
- The appeal of smart ticketing can be increased with the young through making these systems compatible with technology they already use;
- The older generation may not be as keen at first to adopt smart cards, however, if their use can be shown to be easier than current ticketing options (and comparable to using a credit card) they can soon become enthusiastic; and
- Whilst, in the main there will always be a percentage preferring more human interaction, smart card acceptance with the elderly can be enhanced through incorporating entrance fees to particular attractions within the services provided by the cards.

In terms of how public acceptance of alternative technologies and the impact of changing demographics is reflected within the strategic planning of future integrated smart ticketing systems, the consensus from the research is that customers will continue to want a choice of ticketing media available to them – smart cards, bank cards or mobile phones. The range of options available to travellers will also include the use of paper tickets, particularly for the 'unbanked'.

It is also felt that the enhanced data from integrated smart ticketing, delivered primarily through the medium of cards, rather than being an infringement of civil liberties, can be used to the advantage of the public transport user, enhancing passenger information and improving public transport planning and operations. However, it is accepted that it is vitally important to guarantee security of data, privacy and ensure customers' peace of mind to ensure the potential benefits of integrated smart ticketing are to be realised.

To support this, the UK Government, for example, is to produce a Privacy Impact Assessment and guidance to assist current and future scheme promoters to address this potential concern amongst the general public.

A Privacy Impact Assessment (PIA) is a process which enables organisations to anticipate and address the likely privacy impacts of new initiatives, foresee problems, and negotiate solutions to ensure data protection compliance. Risks can be managed through the gathering and sharing of information with stakeholders. Systems can be designed to avoid unnecessary privacy intrusion, and features can be built in from the outset, that reduces privacy intrusion.

Experience from those scheme operators consulted during the Smart cards Study, shows that with such concerns as data security being adequately and transparently addressed within the design and operation of the scheme, the public acceptance of the technology, whatever media are used, is greatly enhanced.

Experience also shows that once the technology has been experienced and is shown to be above all intuitive and simple to use, the focus soon turns away from the technology employed to the service and resultant benefits being delivered, which typically include ease of use (less need to carry cash, more certain budgeting), more flexible journey and choice of mode, route and timing and easier interchange within and between modes.

The review of responses received from members of the practitioner panel revealed similar sentiments concerning public acceptance of smart cards. The panel members were also invited to comment on the impact of changing demographics The following summarises the conclusions drawn from the analysis of responses received (for details of the actual questions asked please refer to the survey forms within the Appendix).

The consensus view is that there is latent public support for smart cards, especially amongst those who have travelled to areas where they are in use and acceptance tends to increase in areas where they have been adopted.

Those that are most comfortable with technology are also keen adopters. Where a system has been implemented for a particular section of the community (e.g. the concessionary fares schemes for the over 60s in the UK), this pattern is obviously distorted.

It is felt that while smart ticketing can produce modest changes in travel behaviour (where passengers feel better informed and get a better impression of public transport), the real change is likely to be driven by incentives offered to passengers as part of the deal. It is also possible that as more information is gathered about the travel habits of people, improved routing options can be provided to cater better to these needs, which will help encourage modal change.

The appeal of smart ticketing can be increased with the young through making these systems compatible with technology they already use (for example, NFC phones) and by increasing awareness through publicising in schools, although this group tend to be early adopters of such systems anyway.

The older generation may not be as keen at first to adopt smart cards, however, if their use can be shown to be easier than current ticketing options (and comparable to using a credit card) they can soon become enthusiastic in the main (though there will always be a percentage preferring more human interaction).

Future ticketing initiatives should focus on targeting those commuters not using public transport at present, those under 25 (with a view of transforming behaviour long-term) but also large employers, who generate lots of journeys and could help encourage workers to adopt smart cards.

With reference to their own schemes, for those answering the question, current schemes are being marketed on the basis of the multiple services incorporated within them. There are a large variety of methods used, such as static advertising on buses/trains or in stations, leaflet drops, advertisements in local newspapers, web promotions and media interviews. Little specific advertising targeted mainly at non-user public transport users has been attempted, although there has in some cases been general advertising at major civic events.

Marketing of smart ticketing across a wide area should focus on the ease of use for making journeys incorporating multiple modes. Marketing should be coordinated by the public transport operator in partnership with the public sector bodies involved in the scheme, with the cost of marketing should be borne from the public sector (by regional organisations, or national government in the case of national schemes).

The consensus view is that people are starting to embrace new media payment options, such as mobile phone based applications, in areas where they have been introduced. However, these still form a very small percentage of overall sales. Smart cards, at least in the short and medium term, offer the most possibilities in terms of linking together different services at one common point. Phone-based payment options are still in their infancy and therefore not expected to become the dominant payment option for most smart ticketing systems for at least 10 years (and probably much longer than that in most cases).

There should be more of a focus on phone-based applications, however these will not be the only method of payment used in the future and will not appeal to all. Phone companies are making advances in this area already and their input would be essential at an early stage for such options to become successful. Phone-based payment options offer new opportunities for interoperability; however, these would have to be governed by a similarly rigorous set of standards as smart cards.

2.4 The Value Chain

Also key to understanding the future potential for smart ticketing is an understanding of the value chain which underpins the market for such products, the role of various parties in the delivery of smart ticketing and their likely response to potential changes which might be encouraged by actions at an EU level.

The review of current scheme operations, through both the primary and secondary research strands, indicates that the parties involved in the development, implementation and operation of integrated smart ticketing can be broadly categorised according to the following headings:

- Transport Authorities;
- Transport Operators;
- Standards Bodies;
- Equipment Suppliers;
- Service Suppliers; and
- Public transport users.

However, the exact nature of the stakeholders involved, the role they play and how they collaborate between each other varies significantly between schemes.

This generalisation of the parties involved also belies the sophisticated nature of the value chain within the integrated smart ticketing arena.

- **Transport authorities** may well host back office and other facilities on behalf of several other authorities, possibly involving a range of public transport operators
- **Transport operators** might, for example, also include operators of car clubs and cycle renting schemes who manage access to their service via an integrated card
- A wide range of **Consultants and Advisors** are employed by both transport operators and transport authorities to assist with system design, procurement and implementation
- **Developers of Standards and specifications** along with **software providers** are required to develop new functionalities and added features, for example to mobile phones, ticketing interoperability requires the establishment of a fares policy framework between operators and authorities
- **Equipment suppliers** provide readers (on bus, including those used by inspectors and at the station/ interchange), back office equipment, point of sale terminals, handsets (for mobile phone applications) etc are required
- **Ticket 'issuers'**, with the provision of top up facilities with rights to travel added to the card (at station / remote, via the internet, say) are required, along with **Customer Support** facilities, publicity and marketing departments.
- **Service suppliers** include those responsible for communications networks, those who actually issue and personalise cards, those who operate back office facilities, those who provide 'Transaction Store and Forward' clearing house facilities – for a range of authorities and or group of operators – handling own transactions / forwarding information / settlements to other scheme operators etc
- **Deal brokers** preparing commercial agreements, along with the services of the **financial / payments sector**
- Public transport **Customers** ultimately determine the operation of schemes, based on their revealed preferences / willingness to engage

Rationalising the Value Change

For the practical purposes of the study and for developing and assessing recommendations regarding actions which might be taken at the EU level (to promote and enhance the use of integrated smart ticketing), the Value Chain might be reviewed in terms of the **Position** of stakeholders within the overall Business Case for such schemes. It is possible within a generic Business Case for the introduction of integrated smart ticketing to identify those parties which would bear the costs involved in any proposed change and those which would receive the resultant benefits (please see Appendix, Sub section A5 for further details).

It is also possible to consider the Value Chain in terms of the specific **Role** that particular parties would need to play in implementing any proposed changes (please see example presented within the Appendix, in relation to delivery of integrated smart ticketing within the UK)

Both the position and role of stakeholders will have an influence on whether any proposed action at EU level finds favour amongst those parties which constitute the Value Chain for integrated smart ticketing

The context for the integration sought at the EU level is that schemes are implemented at different times, in different regions, using different card types and in contexts where there are many other transport investments being pursued in parallel. Also, benefits do not necessarily fall where the costs lie, making business cases difficult for individual operators or authorities to justify the actions required when implementing change

The emerging Role of Financial Service Providers

Consultations with the Practitioner Panel (section 2.2) indicated that financial service providers (FSPs), such as Visa, American Express and MasterCard, need to be involved in the smart-ticketing domain of the future. As noted, these organisations already provide a set of contactless payment standards that allow European banks to issue contactless debit and credit cards to customers in all 27 member states, which can be used Europe-wide.

The services provided by these organisations would therefore be a potential future platform for harmonised Public Transport ticketing services across Europe. Indeed in recent years, the financial card sector has been making progress towards the Public Transport ticketing market. Visa's *payWave* for Public Transport journey payments is listed on their website as a likely area of expansion for Visa's services, whilst American Express have noted that Public Transport ticketing could be a great help in driving forward the general acceptance of contactless smart-technologies, so there are benefits to be had by both sectors in working together (Smart Card Alliance Conference, February 2010).

There have been some pilot tests looking at the integration of financial cards and transport ticketing. These include MasterCard's *PayPass* product which was trialled on bus services in Liverpool at the end of 2008, and the full implementation (since September 2007) of Barclaycard's *OnePulse* credit card (which uses Visa's services), combining credit card functionality and a TfL Oyster card onto a single card. More recently, TfL has announced its intention for consumers to be able to use their contactless bank or credit cards for pay as you go travel on buses, in time for the 2012 London Olympics

In light of these developments, further stakeholder consultations were undertaken with representatives of companies from the financial services sector. These additional consultations were used to gain a better understanding about the views and aspirations of these non-transport organisations who are moving towards, or at least considering, the Public Transport smart-ticketing market as a future business option for their services. A separate questionnaire was designed for this part of the research, but the line of questioning followed a similar structure to that used for the Public Transport scheme owners (Appendix, sub-section A1), namely four separate sections covering the following issues:

- Administrative Issues
- The Public Transport Smart-Ticketing Market and Drivers for Implementation
- Service Provision Planning and Technical Aspects
- User and Provider Benefits

All questions were open questions, intended to allow respondents to go into as much detail as they desired. For commercial confidentially reasons, the direct views of each organisation are not disclosed here, but a summary of all responses received is given instead on a section-by-section basis, within Appendix A9.

Implications of the Research Findings

What emerges from the research is the clear challenge that the Commission will face when seeking to deliver change within an existing market place, whereby those who would incur the costs of change are not always those who would receive the immediate benefits. Similarly, those who would receive the benefits are not necessarily those who need to play the greatest role in engendering the changes which might be sought by the Commission.

Such considerations need to be borne in mind when formulating practical recommendations for the Commission at the conclusion of the Study and for this reason, many of the proposed actions would seek to engender partnership working between those within the value chain , including model agreements which may be used between stakeholders, indicative scheme architectures and outline business cases. Smart Cards technology is necessary but not sufficient for the realisation of many of the potential benefits desired. Operational as well as technology change is required; data from cards need to be turned into intelligence to improve operational efficiencies etc.

Before any change can be effected, a key question to be asked is whether the public transport world / existing governance procedures are geared up to introduce the innovation and business change required to deliver the potential benefits anticipated through the introduction of integrated smart ticketing.

De-regulation can free up innovation, but has not worked effectively in other respects. Where the introduction of integrated smart ticketing has proven to be a success it is important to understand why this has been the case.

This is an issue addressed within the primary research strand within the Study, through consultations with scheme owners. In some cases it may be because of the dominant role played the Transport Authority / Local Government / State. In others it may be as a result of the dominance of a particular operator or even system supplier forcing the pace of change. These will be amongst the key factors to be considered when formulating the recommendations from the study.

Of particular note is the view of Financial Service Providers (see Section 3.1 for detail) which perceive the current market to be highly fragmented, across international, national and regional scales. Whilst this could provide longer term opportunities for FSP (Financial Service Provider) services to be introduced into smart-ticketing, for the foreseeable future existing systems would remain largely as they are.

3. Future View

3 Future View

The state of the art review established a base line scenario for smart ticketing from which the potential for future enhancements has been assessed

Predicting the future of smart ticketing has been informed by a mixture of secondary research guided by input from the IFM project, which aims to promote seamless travel throughout Europe using interoperable smart media, plus work undertaken in other related studies and primary research through consultations with scheme owners, particularly those within the planning stage and representatives of the value chain, from within the practitioner panel.

The assessment has drawn upon the case studies identified at the initiation of the study to identify the common approaches adopted for rules and technical standards.

An evaluation has been made of those systems identified which have multi-application smart-media (for example, integration of transport with non-transport applications) and could therefore be developed to deliver a range of integrated services. The likelihood of such future developments has been informed by a review of 'Best Practices' identified in the secondary research strand, considering the functionalities which could promote easier, integrated travel across modes.

A particular output from this analysis is a matrix of actual and potential extended functionality, together with an assessment of the associated technical and institutional opportunities/barriers. The study team has also assessed the legal and liability issues along with the robustness of alternative media to Smart cards, which might constrain future developments.

Whilst the focus of the study is the use of Smartcards within the bus sector, it is also recognised that smart ticketing can potentially play a role in delivering public transport services, covering different modes as well as geographic / operational boundaries.

While ticketing is generally more regulated and more integrated on rail, with multi-operator (but single mode) integrated tickets being commonplace, there is an opportunity through the use of smart media applications for greater integration with local networks.

As a general theme multi-modal through ticketing is usually considered as being for local / urban journeys within one town/city and its conurbations or a series of urban centres in a regional ticketing scheme.

Integration will, by necessity need to operate on at least a Regional level, if the required economies of scale are to be achieved. In the UK, Nexus is to work together with bus operators across North East England to develop the region's first smart ticketing technology for public transport. The plans would see passengers able to travel anywhere from the Scottish border to the Tees Valley using a single 'intelligent' card in place of cash.

The system would charge a fare from a passenger's smart card as he or she boarded bus, Metro or train, and allow them to take advantage of any network travel arrangements that exist. It would also make it easier for people to purchase travel through the internet. Versions of the smart cards would also let passengers take advantage of special offers from individual operators. Some long distance rail companies offer combined rail + local bus / tram ticketing for certain routes and in some countries, such as in Holland, there are moves towards a national local transport ticket that can be used anywhere in the country.

National governments in particular, including the EC at the European level, can play a key role in encouraging cross-modal linkages between local and national public transport operations, by introducing franchise arrangements for regional / national schemes around the provision of appropriate ticketing infrastructure and better integration with local smart ticketing schemes. DfT Rail has, for example, made ITSO a requirement of three rail franchises which are currently being let.

3.1 Scope for Future Enhancements

The assessment has drawn upon the case studies identified in the state of the art review to identify the common approaches adopted for business rules, International standards, National standards, Industry or scheme standards. Where possible, rules within schemes have also been addressed. The objective has been to determine if schemes have adopted a common set of technical standards that could provide a solid foundation for harmonisation and facilitate interoperability.

In the case of current media standards and levels of interoperation the findings are reinforced by the EU-IFM project. Here they identify the key standards required to support multiple applications on a common medium allowing the possibility of interoperation.

The EU-IFM vision expects that smart cards will migrate to a Secure Element hosted on portable devices, such as a mobile phone, PDA or USB device, allowing rapid expansion of a multi-application environment that can accept IFM applications across many transport networks.

There is already tangible evidence that their multi-application model can provide a first step towards a fully integrated and interoperable system and their proposals are summarised in the section 'Towards Harmonisation' in this report

The EU-IFM project as part of their "Inventory of functions, organisational models and economic issues of existing IFMSystems" identified five significant systems that support multi-applications:

- INTERCODE on for example Calypso BMS (Billettique Monetique Service) contains an e-purse and can host other applications. NFC, USB and Global Platform
- VDV-KA for example, GeldKarte with VDV-KA is already in use;
- TLS
- OTLIS
- ITSO

The EU-IFM suggest that the migration path will be a progressive introduction of multi-application media and of a separate common EU-IFM Application bringing progressive interoperable extra value to the most mobile customers. In current use cases where only one card type is issued, the application owner is likely to be the issuer and owner of the media. As multi-application media develop over the next five years to 2015 the Medium Owner and Medium Retailer become discrete functions within the IFM framework. Agreements will need to be established with the customer and the application owner in the case of the Medium Owner and between the customer and the Medium Owner in the case of the Medium Retailer.

Table 3.1 presenting information from the IFM project's deliverable 'State of the art on interoperable media and multi-application management' indicates some of the key features required to support multiple applications on a common medium and the possibility of interoperation, including:

- the communication protocol between the Customer Media and the terminal;
- the format of the data exchanged with the terminal;
- the security scheme used to protect those data and eventually authenticate the Customer Media to the terminal and
- the commands used to carry the exchanged data.

Table 3.1 Features Required to Support Multiple Applications

	Calypso	**ITSO**	**VDV Kern-Application**
Multi application	Yes	Yes	Yes
Data Model	Free (recommended building on EN1545)	Specified and built using EN1545	Specified and built using EN15320 & 1545
Data Integrity	Free	Digital Signature	Digital Signature
Data security	Number of symmetric key/app. Rest free	Messages sealed by ISAM	Integrated jkey management, mix symmetric and PKI
Commands	ISO 7816-4 + calypso specifc for contactless	Defined per customer media in Customer Media Definition	ISO7816-4 + Kernapplication specific
Communication	ISO 14443 A&B	Defined per customer media in Customer Media definition	ISO 14443 A&B
Card Types	Microprocessor native mask & Java applications	Customer media: Mifare, JCOP, DESFire, Calypso	Siemens JavaCard, Bank card
SAM	Calypso specific	ISAM contains product/media definitions	Only one supplier but open to more if needed

UITP Studies

In April 2007 the UITP published a Focus paper 'Everybody Local Everywhere' establishing their Policy Board's official position on interoperable electronic ticketing and fare management cooperation. A key recommendation was the importance of standardisation of media technologies and ticketing applications. An important outcome of the UITP's initiative was to lay the foundation of the EU-IFM project.

Triangle

In parallel to EU-IFM, another EU-funded programme, Triangle was set up by the Calypso Network to make a single Calypso card operate outside its normal operating area. It proposed using a small (200byte) sector on Calypso cards with a generic key that could hold a common product usable by each of the three Triangle partners (Paris, Brussels and London). Although some progress between Paris and Brussels took place, and the concept is being used today between the main operators in Belgium, it never worked in London because the gates there do not accept ISO14443 Type B cards. Whilst the aims of Triangle are the same as EU-IFM, they have adopted one specific technology (Calypso), rather than a generic multi-application that allows different products to co-exist which is a key step towards interoperation

Calypso Networks Association

The Calypso Networks Association (CNA) was established in 2003. The CNA has the overarching purpose of promoting the wider use of the Calypso specification and technologies, not only for Public Transport ticketing but also for enabling access to third-party (non-transport) services, utilising the same card within a multi-application scheme.

The development of the Calypso specification began in 1990 through a collaboration of Belgian, French, German, Italian and Portuguese transport operators, undergoing ten years of evolution and furthering the development of open technologies for secure Public Transport ticketing on portable devices. In 2000, the common ticketing data standard was given the Calypso name to help give the specification and underlying technologies a well-known recognition, followed by the founding of the CNA in 2003.

Currently, the Calypso specification can be found on Public Transport ticketing systems across 21 countries (in Europe, Africa, North and South America), in more than 80 cities accounting for more than 30 million contactless cards.

There are three key challenges outlined by the CNA for the future of Public Transport ticketing:

- *Interoperability* - the response to the need for mass transport networks to work together within countries, regions or cities ***at the European level***.
- *New technologies, new tools* - Transport operators should adapt their services to the increasing demand of travellers by enabling them to use Internet and mobile phones when buying tickets, downloading applications or accessing transport networks.
- *Multi-applicative context* - Local government, bank and university projects highlight the fact that there is an attractive possibility to share one medium with different service providers, among them transport operators.

The CNA have identified that future integration of different electronic 'on demand' services onto one single medium is a key opportunity for the smartcard/media markets: *"Different applications can be brought together into one single device for the citizens of tomorrow in Europe: The "Urban Pass", will have the ability to integrate mobility and banking applications, local authority and public administration service access."* To facilitate the wider adoption and interoperability of the Calypso specification, the CNA have established a Working Group (WG3) with the objective of *"promoting Calypso technology worldwide and participating in national and international standardization initiatives so that Calypso's good practices will spread throughout the community".*

From a technological standpoint, the Calypso security technology and memory storage are tailored to meet multi-functional requirements. The Calypso specification has a dedicated citizenship application and an e-Purse application (Stored Value), both of which can reside alongside a transport application on the same card chipset.

This multi-functionality can widen the field of applications provided on a single card to multi-service environments:

- *Mobility: parking, park & ride, car and bike rental.*
- *e-Government: access to on-line services from public multimedia kiosks.*

- *University: student cards, university canteens, entry access control.*
- *Leisure: library access, stadiums, museums, tourist attractions*
- *Commerce: private payments, loyalty schemes*

In June 2010, the CNA was part of a trio of smart ticketing organisations (CNA, ITSO and VDV) who demonstrated that a single smart card can be used for Public Transport across all three ticketing systems, as part of the IFM project. More information can be found in the corresponding section on the IFM project in this report.

EMV and IFM

EMV (VISA and Mastercard) have established a small 'Temporary Transit Area' (less than 250bytes) on their contactless cards, where the issuing bank permits use by a transport operator. For example a simple entry record can be recorded (such as happens on the New York Subway). However, this area is only temporary, not separately secured and can be over-written, and is unsuitable for interoperable ticketing. Further, these EMV contactless bankcards are not truly multi-application media and cannot hold other products unless a separate chip is added or unless the card issuers migrate to a more expensive multi-application smartcard.

In London, Transport for London (TfL) has investigated and is now adopting EMV contactless bankcards as a means for paying for bus services within London, but in their case it is simply to identify a user on entry. No ticketing is involved other than to read the card and any fare calculation will take place overnight in the back office and not involve the card itself, only the cardholder's issuing bank. This is a step forward in reducing the number of cards carried by a commuter and could lead to reduced issuing costs for TfL. Interoperability across other London transport networks is planned for the end of 2012. **Financial Service Providers (FSPs)** have been playing a role in the smart-ticketing market for around five years and have established positive working relationships with many scheme providers during this period. The realisation of contactless EMV payments in smart-ticketing pilot schemes shows that these working relationships are successful and have demonstrated that EMV technologies are now feasible for Public Transport ticketing. However, in a similar vein to the experiences of the scheme providers consulted previously, the main negative experiences have been related to the limitations of available budgets of transport providers to support the wider roll-out of new smart-ticketing technologies.

For FSPs, other negative aspects of attempting to enter the market have been the apparent lack of open data on global fare collection operations, as well as encountering some individuals who were 'ticketing traditionalists' entrenched in their existing systems and not open to the idea of new technologies.

In particular, one major barrier still hindering the development of this sector are the costs associated with scheme implementation. Financial institutions have to pay for the issuing of contactless cards and there are additional costs associated with promoting their services, convincing the transport industry about the security of EMV certification process for terminals. However, existing financial incentives for research and development intended to accelerate the adoption of smart-ticketing have been limited to transport-specific schemes and standards, with no consideration given to the acceptance of contactless banking cards and their standards. This lack of open competition is something FSPs feel needs to be addressed if future aspirations are to be realised.

Regarding the underlying technological systems, FSPs do not see their organisations as ones which would provide complete ticketing systems, from the front-end gates/barriers/terminals through to the back-offices. Instead, it is suggested that they are best positioned to provide various system components and services to support individual smart-ticketing systems. The main advantage the FSPs believe they can offer Public Transport providers is the provision of payment infrastructures with secure transactions, which will operate on a pan-global scale. However, any payment solution for smart ticketing would need to be compliant with specific financial card standards as well as international standards (for example ISO, EN, EMV). Unlike other examples of integrated service cards (such as Citizen and Transport cards), the use of FSP cards in Public Transport would not necessarily imply that a transport ticket (i.e. stored travel rights - STR) would be loaded onto a card, thus requiring a dedicated sector on a card's memory chip. This was also important as FSPs would not be in a position to influence tarification systems and structures for individual Public Transport networks; however the contactless technology would be particularly favourable for PAYG operations with appropriate fare capping.

European Payments Council Cards Standardisation Programme

The European Payments Council (EPC) is promoting, through its Card Standardisation Programme, true Multi-Application contactless bankcards where payment and transport applications can co-reside. Indeed the EPC proposals (published earlier this year under DGMOVE) are aligned with the EU-IFM and have established the need for a joint standard between SEPA (Single Euro Payments Area) and GSMA (GSM Association) to define the role of Trusted Service Manager for Mobile Contactless Payment (MCP). Further, their approach to card standardisation embraces Common Criteria to EAL4+ together with Global Platform, the Industry association for the development of standards for secure chip technology and Java, once again aligning themselves with EU-IFM and moving toward a standard that will allow secure payment using mobile devices, such as NFC enabled mobile phones.

E-inclusion and Inclusive eGovernment

An example of institutional standardisation is provided by the Italian Simpliciter project which reported, in March 2009, the definition of a new single, consistent legislative framework where digital technologies could be applied in the Italian public administration. The focus here is on the more efficient delivery of existing citizen services together with new e-citizen rights and opportunities.

As part of this initiative, in the Province of Trento, they are working towards inclusive eGovernment, by applying digital technologies to many services including:

- Treasury activities, for example, on-line payment for citizen services;
- eProcurement, where the management of their staff, including recruitment, is brought on line;
- Smart identity cards.

This work is leading to a decentralised governmental model, where the Regional and Local administrations are able to become better aligned with their citizens' needs.

3.2 Towards Harmonisation

The EU-IFM project has recently (June 2010) published the final version of their road map for long term development where the project recognises the need to update the existing EU-IFM standards and harmonise the current CEN standards to support EU-IFM.

They remark that: "Europe has adopted the International Standard ISO EN 24014 as the global model to define the systems and processes required to manage the distribution and use of fare products in an interoperable Public Transport environment".

At the system level, it is the aim of the EU-IFM to build on this standard developing a model that defines the generic components and interfaces as well as generic low level processes. The approach adopted and the proposed strategy do appear to be the most cohesive available, considering media interoperation, organisational roles, privacy, trust and security, together with the back office systems that will allow schemes to network and interoperate.

In the case of media interoperation key standards have been identified as being required to support multiple applications on a common medium and the possibility of interoperation. These are widely used open standards where they propose that:

Media must implement a microprocessor based multi-application Secure Element which hosts and executes the ticketing application;

Java Card as a secure multi application environment and Global Platform for application management interoperability are identified as mandatory technologies;

Several form factors can be used for contactless media, for example, smartcard, USB key, or NFC phones;

The Global Platform technology can be used for both Over-The-Air (OTA) or Over-The-Internet (OTI) remote application loading and personalisation;

It is clear that a cross industry certification process is essential to guarantee EU-IFM compliance and successful interoperability of both media and application.

No transport specific institutional barriers are expected that would prevent ticketing applications to be loaded onto non transport media (such as an NFC phone or a contactless bank card).

The project has also established a list of the main types of ticketing applications in Europe and has issued recommendations for a migration path to multi-application media (WP3 D3.3), recognising that:

The dominant smart ticketing media in Europe are VDV KA, Calypso and MIFARE Classic or DESfire. Most of the legacy applications using proprietary algorithms are now considering migrating to standard algorithms including 3DES, AES or RSA encryption algorithms.

Specific recommendations are that

- Ticketing application shall be available as a JAVA card applet which is possible for VDV KA and Calypso, but not for MIFARE Classic or DESfire which still require dedicated hardware for execution;
- Management of ticketing applications shall be achievable with Global Platform which is the case for Calypso, on going for VDV KA, but still an issue with MIFARE Classic and DESFire.

It is encouraging that the majority of the EU-IFM participants are already using or migrating towards ticketing applications compliant with the EU IFM media requirements, confirming that the approach of migrating existing local applications into multi applications is a realistic and pragmatic approach. This was demonstrated by the IFM-Forum held in Brussels in May 2010, where a French Calypso Application and a UK ITSO Application were hosted on a multi-application card issued by VDV in Germany. Transport Products from three IFM Schemes were loaded onto the card and successfully accessed on their respective ticket machines / validators. Each schemes' individual security was maintained throughout and without the need to share security keys.

This demonstration proved both the feasibility and practicality of the EU-IFM project's multi-application media approach as a first step towards interoperability.

It is expected that these findings will be further validated through a pilot as a logical next step for the EU IFM project.

In summary:

Existing schemes have already installed some components that conform to international norms, and have adopted operating models that comply with best practice; however, these are generally insufficient to support interoperation between schemes or across national or international boundaries.

This conformity across schemes could form a general basis for the development of a European organisation model that is capable of incorporating the existing national organisations that can fit, for example, the ISO EN 24014-1 role model.

In their final report it is clear that the leading IFM organisations have built a shared vision to:

- Create an EU-IFM network to provide direction, coordination, networking of best practices and implementation planning of pan- European IFMS initiatives.
- Promote further European Standards for transport smartcards including Security and Certification equipment.
- Develop a multi-application solution to interoperable ticketing that can be implemented by steps.

Ultimately, the leading IFM organisations expect a common smart media application to be the best way of ensuring interoperability; however the use of Multi-Application media provides a first step toward this goal, allowing customers to hold their transport applications and means of payment on one single convenient media. Local schemes may then implement the common application at their own pace with reasonable modification costs and minimum disruption to their operation

Scope to Enhance Interoperability

A limiting factor for future interoperability will be the extent to which schemes have and will be developing according to established specifications and standards. This has been recognised by the IFM Forum and a possible way forward has been proposed.

The degree of commonality between the schemes reviewed in the initial phase of the study therefore provides a useful pointer to the future as to how this might work in practice. This is summarised in the Appendix (sub-section A7).

Multi-Application - Allowing Support for Non-Transport Applications

The extent to which schemes might offer a range of non transport applications in the future has been informed by a review and analysis of schemes responding to the initial state of the art review. This review is summarised in Table 3.2

Capabilities on project:
Transportation

Table 3.2 Review and Analysis of Schemes

Scheme name	Main function	Additional functions	Co-resident applications	Barriers-		Security
				Technical	Institutional	
HK Octopus (Hong Kong)	Public transport ticketing and fare payment.	Full scale micropayment scheme;	Access control; Loyalty System.	Close stakeholder scrutiny and regulatory oversight.	Close stakeholder scrutiny and regulatory oversight	Full audit trail; Multiple fit-for-purpose security measures (card + System).
EZ Link PTE (Singapore)	Public transport ticketing. e-Payment.	Auto top-ups; Smart card payment in retail - expanded merchant network;	Loyalty and reward programmes that are run by various stakeholders			No trust model
OV Chipkaart (NL)	Public transport ticketing.	Goal is electronic fare calculation and ticketing system;.	In a follow up stage, the acceptance of the OV-chipkaart for micro payments; Trials are going on for: Parking; Taxi rides; Bike rentals; Bike storage; Car rentals.	Unspecified	Unspecified	Trust model along ISO 24014 is in place.
ATAC Roma	Public transport ticketing.		Aspirations to pair public transportation to payment channels and mostly "non strictly linked to transport" services - Car sharing, Museums entry, Sports events		Little freedom to really target users' need.	KMF – key management facility
Chicago Plus/I-GO	Public transport ticketing and fare payment		Other functionalities could include social administrative services, like welfare payment, library card, identification, etc.	Funding.	Funding.	Hotlist and watchlist

Capabilities on project:
Transportation

Scheme name	Main function	Additional functions	Co-resident applications	Barriers-		Security
				Technical	**Institutional**	
LUAS Dublin	Tram ticketing & PAYG (pay-as-you-go) ePurse.			Take-up of the smart card proved far more difficult & expensive than anticipated.		Includes trust model.
Kolibricard	Check-In Check-Out payment. Autoload-prepaid System.		Car parking system can be used.	No active promotion of the standard (VDV-CA) by the suppliers.		VDC-Core Application plus relevant data-privacy regulations
Nottinghamshire CC	Concessionary Travel free passes and pre-paid (termly) season passes.	Future aspiration to create a network ticket across the County – including e-purse				ITSO specification
Skyss Oslo	Zone-to-zone fare-calculation & flat-fare.					Des-cryption
VKT Norway	Flat-fare & Automated Fare Calculation.			Internet interface and application planned for online product sales but the supplier has not been able to develop this module. Faster boarding on buses.		National standard (NSD) encrypted card/reader keys.

Capabilities on project:
Transportation

Scheme name	Main function	Additional functions	Co-resident applications	Barriers-		Security
				Technical	**Institutional**	
PiTaPa Japan	Post-pay service like credit card for train, tram, buses, taxis. Membership is necessary.	Retail (approx. 18,000 shops, 2,000 vending machines);	Access; Parking; Lockers.		Deregulation was necessary to allow post-pay scheme. For foreigners, it is difficult to get PiTaPa service.	Credit card system - extremely strong security measures
Planned						
PRESTO Toronto	Multi-modal ticketing, passes. Payment.	Loyalty Programs; University Pass; Co-fare	Potential for parking, municipal services, joint ventures.			Security measures are based on the requirements of the individual service providers
NESTI T&W	Transport ticketing. E-money.					ITSO specification
Greater Dublin Card (ITS)	Transport ticketing. E-purse.		Other uses of the smart card once it becomes established, e.g. car parking, road tolling, vending and low value retailing;	Lack of common end-to-end standards for smart card ticketing.		Not disclosed.

Of the 12 existing schemes that provided information as part of the state of the art review, 8 declared either that fare payment was realised with some form of stored value. Although no details about the nature of the stored value were given it was clear that in one or more cases e-money has been implemented. In other cases it is possible that tokens with monetary value are issued.

In the case of the PiTaPa Japan scheme where fare payment rather than ticketing has been implemented the card provides identity only and the system performs the functions of credit card post-payment with back office clearing and settlement. This scheme lends itself to extension to retail payments which PiTaPa has taken advantage of. However, by its nature, this scheme could, without strict safeguards at the human interface level, compromise privacy, as private businesses have access to transportation, financial, and even property data through the card.

Non-transport payment has been implemented by 3 schemes including one that has its card readers fitted in 2,000 vending machines.

Other applications include:

2 schemes with a loyalty scheme;

2 with access control;

2 with parking and;

1 with ‘lockers’.

Of the 3 planned schemes providing information, all intend to implement some form of stored value for fare payment and 2 have aspirations for their scheme to be extended to non-transport applications similar to those amongst the implemented schemes plus municipal services, joint ventures and road tolling.

As a scheme adds functions and applications so the threat of attack increases.

A few schemes sensibly declined to offer any information about their security; others had only scant knowledge of their scheme’s security measures, although appropriate measures were likely to be in place.

None of the correspondents mentioned protection of privacy as a major issue.

Card take-up

For some schemes the strategy or strategies for promoting the use of smart cards for transport ticketing and payment is to include the development of co-resident applications and additional functions.

However, as Table 3.3 suggests, this is not consistently the case and many other factors come into play to determine actual usage.

Table 3.3 Review of Scheme Functionalities and Scheme Usage

Scheme	Additional functions or applications	Number of cards	Population served	Cards/1000 head
HK Octopus	3	20,000,000 in circulation	7,000,000	2,860
EZ Link PTE (Singapore)	3	5,000,000	5,000,000	1,000
TfL Oyster	0	35,000,000	7,700,000 + large number of commuters	4,550
OV Chipkaart (NL)	5 trials	6,800,000 distributed since 2005	16,500,000	412
ATAC Roma	Aspirations	280,000 in use		Rome 220 Latium 35
Chicago Plus/I-GO	Aspirations	400 to 800 in use	2,900,000	0.28
LUAS Dublin	0	60,000 issued	1,200,000 to 1,700,000	35 to 50
Kolibricard	1	12,000 users	180,000	67
Nottinghamshire CC	0	145,000 in use	780,000	186
Skyss Oslo	0	80,000 regular users	1,300,000	62
VKT Norway	0	35,000 regular users		150
PiTaPa Japan	4	2,000,000 membership	24,000,000	3.3

Population figures for the region served, where provided by the correspondents, are used. Where no population figure is provided either the number of cards per head, where provided (ATAC Roma and VKT Norway), is used or population figures from the regions web site are used.

Whilst some of the highest numbers of cards per head are in use by schemes with additional functions and applications – Hong Kong Octopus and EZ Link PTE (Singapore), in both these cases the smartcard scheme was a replacement of a highly popular magnetic stripe card scheme where only transport ticketing and payment functionality was available. The TfL London figure for cards per head is not representative because a great many people from outside London have been issued with a card. Of the remaining schemes, OV Chipkaart (NL) has the next highest number of cards per head and has multi function/application trials ongoing. The rest of the schemes have only aspirations or no additional functions or applications and much lower card take-up. The PiTaPa Japan serves an apparently very large population but is limited by the need for cardholders to take up membership.

While the exact causal link is not clear, schemes with the highest take-up probably provide the highest utility for cards due to a relatively high demand for public transport services. Perhaps schemes where the demand is lower need multiple functions and applications in order to stimulate card take-up.

Multi-application possibilities

With one exception, none of the respondents to the initial review of schemes provided a window on their rationale for selecting non-transport applications and functions to be combined with transport other than cost sharing and economies of scale. The PiTaPa Japan scheme correspondent indicated their strategy as '*PiTaPa can be also used for shopping, because people's main purpose is not using public transport, but doing something enjoyable or beneficial at the destination.*' This seems to suit their post-payment approach. However, it would not be financially viable for retail merchants handling predominantly low value goods and services and few transport authorities or groups would find the regulatory burden of becoming a credit institution viable.

Alternative strategies for transport plus other applications are known to have been considered by smart card scheme planners and operators in the UK including:

'Commuter cards' - transport ticketing or fare payment could be combined with kiosk and vending machine payments (newspaper, drink, snack), access control/time recording (place of employment, room, computer), catering payment,

'Student cards' - could be for transport ticketing, pass or fare payment with access control/attendance recording, vending and catering payments, test result records, diet records,

'Social cards' - transport ticketing or fare payment with event ticket. Combining public transport ticketing with event ticketing (football match, concert venue, cinema, theme park etc.) with appropriate marketing of tickets could help to address congestion and parking difficulties when large numbers of people attempt to converge on a venue. Such a combination of functions and applications might also include payment for food, drink and souvenirs from kiosks and vending machines.

Additional functions

Ticketing functions with a particular purpose are known to have been pursued in connection with some UK schemes. These were functions involving a limited number of users at any time but with a potentially disproportionate impact.

Hospitals serving low income families in some cases offer to pay the fare of an outpatient with an appointment so that the appointment is not missed. The administration of providing a relatively small amount of money is costly and the benefit is sometimes abused. However, the cost of a missed appointment far outweighs that of administering a cash handout. Hospitals would like to be able to post a smartcard with the return fare encoded along with the appointment letter, or maybe add a ticket to the customer's existing card.

Police youth offender schemes suffer from non-attendance at appointments with probation officers. The oft used excuse is 'no money officer'. To counter this, police would like to be able to provide the youth with a smartcard with the return fare encoded with validity only on the day of the appointment. The objective is removal of excuses.

3.3 Legal Liability Issues

There are two main fields in particular where legal issues in implementing smart card solutions in public transport often cause concern and which will potentially limit their future development.

Firstly, the implications for transport companies and smart card schemes in transport of the legal framework with regard to e-money. Here the problem is to what extent public transport smart card schemes will have to meet the requirements and restrictions applied to e-money institutions and/or credit institutions.

The second main area relates to privacy and data protection problems, in particular with regard to reconciling these with the various uses that transport operators would like to make of the data.

The e-Money Directives

The First Directive (Directive 2000/28/EC) amended the definition of 'credit institution', as originally laid down in the First Banking Coordination Directive to include e-money institutions within its scope. The policy objective of this amendment was 'to allow institutions which are not willing to enter into full banking operations to issue electronic money under the fundamental rules governing all other credit institutions' and to avoid distortion of competition between institutions issuing e-money, whether banks or not.

The practical implication of that amendment is to permit an e-money institution which is authorised in its home Member State to benefit from a 'European Passport' – in common with other credit institutions following the adoption of the Second Banking Directive – according to which it may issue e-money throughout the EU, either on a cross border basis or by way of establishment in another Member State (or both).

The Second Directive (Directive 2000/46/EC) introduced the concept of e-money institutions as a special type of credit institution, subject to prudential supervision rules similar to those applicable to standard credit institutions under the recast Banking Directive and provided a Community law definition of e-money.

E-money is defined as a claim on the issuer that is:

(a) stored on an electronic device ;

(b) issued on receipt of funds of an amount not less in value than the monetary value issued;

(c) accepted as means of payment by undertakings other than the issuer.

In order to ensure the soundness and stability of e-money institutions, the rules set out in the Second Directive comprehensively addressed all aspects of their authorisation and supervision, including their licensing, initial and ongoing minimum capital requirements, limits on permissible investments, fit and proper management obligations etc.

Since e-money-institutions are not deemed to accept deposits and cannot grant credit the regulatory and supervisory rules prescribed by the Directive are less strict compared to those applicable to banks under the recast Banking Directive. Thus, in line with the Directive's objective to persuade non-bank credit institutions to enter the market as e-money issuers subject to a reduced prudential supervision regime – and having regard to the lower risks inherent in the issuance of e-money, e-money institutions were made subject only to some of the prudential supervision rules applicable to standard credit institutions. At the same time, some of the benefits of this lighter prudential supervision were offset by restrictions in connection with their business activities and investments which are more stringent than in the case of other credit institutions.

The prudential supervision guarantees built into the Second Directive might suggest that the Community legislature saw greater merit in protecting consumers than in opening up the market to the largest possible number of participants. Indeed several years following its adoption the Directives' success in encouraging the growth of new and innovative forms of e-payments (e.g. multi-merchant e-loyalty schemes with bonus points) or e-payment schemes making use of established media (e.g. fixed line and mobile phone telecommunication networks) has not been spectacular.

Therefore, on 10 October 2009 the new Electronic Money Directive 2009/110/EC ("the EMD"), was designed , which was published in the Official Journal, OJ L 267, 2009, p. 7.The new EMD will replace the Directive adopted in 2000, to encourage the further development of the electronic money industry.

In accordance with its Article 22(1), Member States will have to transpose the obligations of the new Directive in national law by 30 April 2011 (eighteen months after its entry into force). However, some Member States have indicated that they intend to speed up the transposition process in order to incorporate the obligations of the new EMD sooner.

A fundamental change in the new Directive concerns the introduction of proportionate prudential requirements facilitating market access to newcomers. While the new Directive facilitates market access for new service providers, at the same time it maintains a high level of consumer protection.

The new e-money Directive constitutes the legal framework in which smart ticketing schemes will have to be implemented in the EC in the future. There is however, still a possibility to opt-out of the Directive when the application of the use of the card is limited to public transport only.

Some public transport scheme providers (e.g. TLS in the Netherlands) make use of this opt-out (at least for the time being). This exemption is, however, in the longer term not an attractive solution, because as soon as the application of the smartcard is broadened (e.g. paying for the restaurant in railway stations or shops in the railway stations) one again has to meet the requirements of the e-money Directive (e-money

institutions etc.). In particular, the integrated multi-modal use of cards (e.g. also in taxi's and in car parks around railway stations) could already be problematic, which will depend of the precise definition of public transport in the Member State involved.

Furthermore, there may be problems with equity, e.g. the use of cards for certain disadvantaged groups (e.g. handicapped people) that will have to be transported by special transport to / from public transport entry points, which is not automatically possible with other public transport modes.

- ***Implications for scheme design:***

A key consideration for the future development of smart ticketing will therefore be the extent to which the same general liabilities under the e-money Directive will apply to integrated / interoperable ticketing in the future. Could scheme owners forego to some extent the requirements of the Directive, similar to the current opt out scheme, but extended across modes and other transport related services , given the constraints that they may otherwise impose?

Privacy and Data Protection

Legal issues related to protecting privacy and personal data will play an increasingly important role in determining the future development of integrated / interoperable smart ticketing schemes.

As smartcards are used in more locations and have increasing amounts of data stored on them, personal data are potentially becoming available to more people and organizations. The card-administering agency can now frequently monitor travel behaviour of individual users of a service. This information could be used to improve transit routes and schedules but can also potentially be used more generally for marketing purposes, if any personal identification is contained within the card. This transit data can also be used to track the whereabouts of individuals.

With such issues in mind, a number of technical and procedural measures are required from scheme owners to protect the privacy and personal data of customers. Furthermore, the use of individual personal data by scheme providers and / or public transport operators should also be controlled as much as possible.

Specific data privacy protection legislation is generally achieved by National legislation, and for a variety of social, cultural, economic and legal backgrounds, vary from country to country. In addition, most countries have also established a particular National organization which coordinates policies with regard to privacy and data protection and may also enforce privacy protection legislation.

However, the general principles are common, and due to provisions made by trading blocks such as the European Union, and APEC, in many cases, while there may be specific National aspects to data privacy and data protection, there are common aspects that are global. Common guidelines are provided by regulations such as the Data Protection Directive of the European Union, the APEC Privacy Framework and OECD's 1980 Guidelines on the Protection of Privacy and Trans-Border Flows of Personal Data.

A Working Party, the so called Article 29 Working Party has been established by Article 29 of Directive 95/46/EC.It is the independent EU Advisory Body on Data Protection and Privacy. Its tasks are laid down in Article 30 of Directive 95/46/EC and in Article 14 of Directive 97/66/EC. A specific group on e-ticketing in public transport has been set up within ARTICLE 29 Working Party and extracts from Working Paper about e-Ticketing in Public Transport adopted by the ARTICLE 29 working party at the 42nd meeting, 4-5 September 2007, Berlin are presented below.

The Working Group recommends that:

Privacy Impact Assessment

The information systems of transport companies should be designed and implemented by taking into account the customers' right to protection of their personal data; generally speaking, they should reconcile the right to free movement of individuals with the requirements of effective public transportation.

Anonymity

The Public Transport Authority (PTA) or transport company should provide alternative ways for customers to travel anonymously (without undue obstacles), e.g. cash or an anonymous e-ticket. Where anonymity cannot be offered for technical reasons, the following recommendations have to be observed:

Privacy Policy and Transparency

PTAs or transport companies using e-ticketing systems should provide data subjects with unambiguous information on the processing of personal data which they carry out. Data subjects should be in a position to easily understand all the specific purposes sought by the companies, what items of personal information concerning them are collected and stored, and how such information is used.

Data Minimization and Retention Period
As regards, in particular, to the processing of the data concerning users' movements, the information systems of transport companies should be designed and implemented by prioritizing the use of anonymous data. If (directly or indirectly) identifiable information is used, this information should be stored for the shortest possible period (and erased automatically thereafter), and account should be taken of the lawful purposes to be achieved via the processing – as a rule, the information in question should not be retained for longer than a few days after being stored.

Security
Security for accessing personal data should include an audit system to prohibit the misuse of information. Transport companies should ensure that the privacy of registered users is guaranteed when making their databases accessible to partners or even their own employees.

Marketing
A PTA or transport company should obtain the free and informed prior consent of customers for the use of personal data for its own marketing purposes or associated partner's usage of information for unsolicited marketing towards the traveller. This consent should be distinct from the acceptance of the general contractual obligations.

Proof of Payment
As far as proof of payment for individual journeys is required e.g. for refunds or tax allowances, privacy-friendly solutions should be offered.

Code of Conduct
The adoption of a privacy code of conduct should be encouraged. As regards, in particular, processing of the data concerning users' movements, the information systems of transportation companies should be designed and implemented by prioritising the use of anonymous data.

- ***Implications for scheme design:***

The Working Group recommendations have clear implications for the design of current and of future integrated / interoperable smart ticketing schemes. In general, systems need to be designed so as to separate the personal information from travel information (two component model). Central storage should be reserved for aggregate data and/or anonymous transactions. The Cardholder should also be able to control information concerning their use of the card.

Based on these considerations, the IFM project has proposed a privacy charter incorporating the points highlighted above. The project has also developed a European handbook on rules and regulations for privacy protection in fare devices and back-offices (IFM Deliverable 2.3). A summary of relevant Deliverables from the IFM Project is included in the Appendix (Sub section A6).

Looking at the privacy and data protection legislation in various Member States one could identify a few additional points which may have to be incorporated in the proposals and be reflected in future scheme design and operations:

- It seems that one has to distinguish between the use of data only for the purposes of payment/ clearing and settlements on the one hand and the use for other purposes (e.g. for marketing or improving services) on the other hand. In the first instance the use / protection requirements could just be the same as those of financial institutes, while the requirements for the second group seem to be comparable/ similar to those of air-mile schemes or frequent flyer arrangements;

- In addition to the explicit approval of the customer, the public transport operator could think of offering the customer benefits for using those data (e.g. data providers get an automatic fare reduction when there are delays in public transport). In other words, the use of data for marketing could be just another type of product on the smartcard.

- There is an increasing tendency to consider allowing (strictly limited) controls of personal data by third parties (e.g. controls by the police or parental control of the use of the smartcards by children e.g. in the latter case when the smartcard budgets could also be used beyond public transport). It is not clear how this should be included within the present framework of protection of personal data;

- As the functionalities increase in a smartcard, there is more emphasis on enhancing security e.g. using biometric identification techniques, such as fingerprint and iris pattern identification. But, biometrics is not without problems. If a fingerprint or other biometric source has been compromised, it is compromised for life, because users can never change these. It therefore seems that additional protection measures are required to reduce the risks involved with these identification techniques.

3.4 Systems Robustness

The potential future use of different media will have implications for the approach which might realistically be adopted by scheme owners to deliver smart ticketing in the future.

The following sections therefore consider the merits of smartcard payment and ticketing systems meeting different standards vis-à-vis other types of payment systems (on-board cash payment; mobile phone payment; magnetic stripe ticketing etc.).

Particular reference has been made to the DG INFSO's Interoperable Fare Management (IFM) project deliverables including the functional survey of existing sets of privacy protection rules applicable to transport IFM applications by national institutions and regulations in different contractors' European countries.'

The primary aim of Phase 1 of the EU Interoperable Fare Management Project (IFM Project) was to accomplish a European wide initiative dedicated to encouraging attractive access to public transportation with modern fare management that is safe, reliable and convenient for both users and operators. Once achieved, this would serve as a model for many further countries outside Europe faced with the need to strengthen the use of public transport.

An early output from the work conducted by the IFM Project in the 24 months between January 2008 and December 2009 was the road map reported by Work Package 7 in September 2008.

Here the project established that Trust and Privacy Models will be key to gaining customer and operator acceptance of IFM schemes and that this should be supported with a toolkit for national transport authorities to use when building Fare and Distribution agreements, including how their back offices will interact.

After analysing trust management within major European schemes under Work Package 1, Work Package 2 has focussed on how to maintain privacy within local and pan-EU schemes. This work has culminated in their most recent report (March 2010) in which they address how personalised services can be delivered to the passenger whilst maintaining their rights to privacy. Instead of issuing a new level of regulation, directive or law, they have provided a common ethical code of conduct in the form of a handbook: "European handbook on rules and regulations for privacy protection in fare devices and back-offices".

The EU-IFM Project was demonstrated to the EU Commission in Brussels during May 2010, where a UK ITSO Shell and a French Calypso Application were loaded onto a German VdV KA transport smartcard to show how all three IFM Applications can co-exist on the same media (in this case a Phillips SmartMX card).

In parallel with the issues affecting privacy, the IFM project has also considered how the various components within a fare management scheme can interoperate successfully. They looked at media support for multi-applications, possible migration paths from legacy media, functional, organisational and economic issues for fare management systems. WP3 studied the path for introducing interoperable media to provide access to networks that are part of different IFM schemes, replacing dedicated customer media with more flexible media supporting multi applications allowing products from different IFMs to co-reside and interoperate.

With this objective in mind, the Smartcards study team has assessed the robustness of each of the currently available media, in particular considering opportunities for misuse and fraud.

The results summarised in the following sections are also provided in tabular form giving a measured assessment of the different fare payment systems considered, highlighting their strengths and weaknesses.

Contactless Smartcard

Contactless smartcards conforming to ISO/IEC 14443 are now common place in public transport, used both to convey tickets and as a payment mechanism. Banking cards are now taking advantage of the same technology providing scope for interoperability.

The primary advantages and disadvantages of contactless smartcards include:

- Acceptability. Experience to date with the schemes implemented has shown that contactless smartcards are generally very well accepted both as a payment means and as a means of conveying entitlement to services, proving identity, and conveying tickets.
- Interoperability. Widely acceptable but only where compatible readers are provided. To date there has been little interoperability between the various schemes implemented, meaning that a smartcard issued in one country, is very unlikely to be acceptable in others.

- A contactless smartcard is not in itself Divisible, however, a store of value held within the smart card can be divided by a suitable reader.
- Stable, i.e. it conveys the same meaning over long periods of time
- Durability. A contactless smartcard contains electronic circuits entirely encapsulated within a plastic case. As such it is less robust than coins or bank notes, but more robust that magnetic stripe cards (in which the storage medium is exposed on the face of the card at risk of damage) or mobile phones which are significantly more complex.
- Recognisable. No special skills or intelligence should be required to understand how to identify and use money. Smartcards are well short of this so far as virtually none show what value is in them. A separate device is needed.
- Portable. A contactless smartcard can contain a high value in relation to its size.
- Anonymous. Clearly there is potential for tracking of card holders activities with a contactless smartcard system, however this can be overcome by measures such as anonymous smartcards and encryption of data records.

Cash

The most common application for smartcards in public transport is payment, in which they mainly compete with coins and bank notes. Coins must be one of the most successful products in the history of commerce, and the product lifetime of bank notes must also rank amongst the longest. Whilst neither fully satisfies all the modern needs of consumers, they do meet the most important criteria for recognition as money.

The advantages of cash are that coins and banknotes are:

- Widely acceptable and interoperable, The Euro provides for interoperability between states participating in monetary union. Even in non-participating countries such as the UK, ticket vending machines can easily be constructed to accept both Euro and local currency and some do.
- Divisible
- Stable, i.e. it conveys the same meaning over long periods of time
- Durable. Coins last much longer than bank notes, but the ageing is due to use in transactions
- Recognisable. No special skills or intelligence are required to understand how to identify and use money.
- Portable. It must have a high value in relation to its size.
- Anonymous. Under normal circumstances there is no record linking banknote serial numbers to the holder and no possibility of linking coins to their holder.

Some of the limitations of coins and bank notes when used to pay fares have been overcome by transport operators issuing tokens and stored ride cards of various technologies, each of which shifts the balance of advantages vs. disadvantages.

The disadvantages of using coins and banknotes in public transport are principally that they are expensive to handle. In metro, light rail and bus ticketing the costs of handing cash and change giving at the point of the transaction is significant and particularly so for buses where dwell time not only increases the operators' costs but increases passengers' journey times and can affect reliability. Further costs of cash transactions arise in counting, transporting and banking coins and banknotes, some of which could be avoided through the use of smartcards.

Counterfeit and fraudulent coins and banknotes can be a serious problem in ticketing vending machines leading to substantial losses to the operator unless avoiding action is taken swiftly.

Security is a further disadvantage with the use of cash for fare payment particularly on buses where the crew might be attacked for the cash on-board.

Contact smartcard

Smartcards that rely on electrical contact with a ticket issuing machine offer the possibility of not only providing payment but also of storing the ticket resulting from a transaction. With suitable and adequate security designed in the card and ticket machine some of the disadvantages of cash may be overcome. However, because the card needs to be inserted in a slot to be read, transaction times are much greater than for a contactless

card and in the case of the Mondex trial in the UK, transaction times on buses were greater than for cash transactions. Such smartcard types are therefore unsuited for use on buses, light rail and closed transit systems.

In considering the most common uses of contact smartcards, namely as identity for either credit or debit functions, privacy of the holder is potentially compromised in transactions.

In the case of the credit function the name and credit worthiness is at risk and where a debit transaction is conducted the holders name and bank account details are at risk.

Optical card

Optical memory cards which function in a similar way to CDs and DVDs provide a large memory capacity of several Mbytes and the capability of being used as an erasable store of value. The cards have been used widely in harsh environments and have not only withstood high temperatures but have been proven to retain integrity after having suffered significant physical damage. However, the card cost is probably similar to the cost of a smartcard and the cost of terminal equipment configured as a ticket issuing machine would be much higher than for a smartcard terminal device. Furthermore, the read/write device for an optical memory card has relatively delicate moving parts and would be less reliable, particularly on buses, than a smartcard reader.

Another type of optical card which has been used as a telephone card is printed with a fine line grating representing a store of value. The grating may be disrupted to change the angle of reflection of light and to represent cancellation of a unit of value. The science involved in the definition of the fine line structure gives the system another layer of security in addition to the high cost of the manufacturing tools. The card cost is relatively low and the effective memory size is small. There is no possibility of recharging the card and the read/write device is expensive. As with the CD type optical card the read/write device is also unsuitable for use on buses.

Mobile phone ticketing

Ticket delivery schemes using the mobile phone network to transmit either a text message description of a purchased ticket or a bar coded ticket typically involve a third party ticket coding organisation.

Depending on national interpretation of the e-money directive, payment may be either by deduction from the back office mobile phone pre-pay account, by direct debit or by a debit or credit card arrangement.

The advantages to the transport operator are a relatively fast transaction although inspection of the displayed ticket is probably slower than the automatic inspection of a ticket stored in a contactless smartcard. A further advantage is that the transport operator does not need to provide the ticket carrying artefact. This is supplied by the mobile phone owner.

Various approaches to security by the mobile phone ticketing service providers have so far seemed to be effective.

The technique is only suitable for certain types of ticket, typically tickets valid during a defined time period. It would not be suitable for a carnet of defined journeys as without an NFC interface, cancellation of a ticket cannot be carried out at the point of use. Interoperability is achievable at the commercial level but is unlikely to be viable across borders unless the mobile phone operators reduce their interchange charges. This is likely to remain an obstacle to effective multi-operator, multi-modal ticketing. Privacy of the passenger is at risk by virtue of the record of the ticket transaction being linked with the mobile phone contract.

Although the third party ticketing service provider would probably allow for a ticket to be re-transmitted to the purchaser's mobile phone in the event that 'low battery' prevents presentation of a ticket, the mobile phone user is most likely to be denied travel in this event.

An advantage of mobile phones is that the status of payment and ticketing products can be determined using the mobile phones display.

NFC on mobile phone

Adding NFC (Near Field Communication) capabilities to the near ubiquitous mobile phone has the potential to provide for the purchase of public transport and other types of ticket over the mobile phone network and to subsequently offer the ticket for travel at a smartcard reader. Mobile phone providers are intending that the NFC functionality of their handsets is compliant with ISO/IEC 14443.

The issues of interoperability should therefore be the same as for contactless smartcards compliant with ISO/IEC 14443. Security issues are likely to be broadly similar to those for contactless smartcards except that mobile phones are more vulnerable to being stolen. Privacy could be an issue where tickets are purchased via the mobile phone network as the travel transaction can be traceably linked to the mobile phone contract.

The combination of mobile phone and NFC technology has the following advantages:

- The public transport operator does not need to provide the ticketing/payment artefact;
- Tickets and stored value could be purchased over the mobile phone network for presentation to ticket machines via the NFC interface. However, the commercial viability of this depends on the charge made by the mobile phone network provider and who pays and also the widespread deployment of NFC in mobile phones;
- Potential for interoperability with contactless smartcards – tickets could be purchased and value added at any smartcard ticketing terminal in the system for which the NFC device has been configured.
- The effective personalisation of period pass ticket products. It is unlikely that the owner of a mobile phone will part with it to someone wishing to take a bus journey free of charge.
- Depending on the design of mobile phone with NFC interface, the mobile phone display could provide a window on the store of value and tickets available at the NFC interface.
- Recognisable – the status of payment and ticketing products can be determined using the mobile phones display.

Disadvantages include:

- Purchasing tickets over the mobile phone network depends on there being adequate signal strength at the place of purchase and the phone battery having sufficient charge for the transaction to take place. However, if the NFC interface is ISO/IEC 14443 compliant tickets and monetary value could be transferred directly to the phone's store via the NFC interface from a source other than the mobile phone network.
- Concern from the owner of the mobile phone that privacy could be compromised.

Contactless smartcard technology or NFC on a portable device

ISO/IEC 14443 compliant functionality has been added to watches and could, with advantage, be added to other types of portable device. Such combinations could provide all of the advantages and disadvantages of a contactless smartcard plus to following:

- The transport operator would not need to provide the ticket/stored value carrying artefact;
- Potential for interoperability with contactless smartcards – tickets could be purchased and value added at any smartcard ticketing terminal in the system for which the NFC device has been configured.
- A device with a display and some means if inputting commands could be designed to provide a display of remaining value and un-cancelled, un-expired tickets.

Magnetic stripe ticketing

Magnetic stripes on credit card size (ISO/IEC 7810) paper tickets have provided for automatic validation for closed mass transit networks and on buses and trams. The main advantages are low cost of the card and multiple use although wear out is much faster than for contactless smartcards.

The principle disadvantages have been the high cost of reader maintenance, and poor reliability, due to the need for fine adjustment and moving parts. Another disadvantage is that certain ticket types can be easily subjected to fraud.

The memory capacity is significantly less than smartcards are capable of providing, which further limits the complexity of ticket types that can be written to the card, but it does also mean that recording the identity of the holder is not usually practicable leading to protection of privacy.

Bar code

Other than mobile phone based bar coded tickets, printed bar codes are not renewable or re-chargable. Bar codes in 1 dimension contain a very limited amount of information limiting their utility to simple ticket types. 2-dimensional bar codes could provide for more complex ticket types.

The main advantages of printed bar coded tickets is the increased security provided where tickets are sold off-bus/tram combined with automatic scanning for validation. Disadvantages are a high cost reader and susceptibility of the ticket to physical damage.

Be in-be out payment

This is a technology for payment for travel by transactions conducted in a back office with the passenger's bank account. An identity artefact carried by the passenger is 'woken up' by detectors mounted in the vehicle doorways to register the card or mobile phone as it passes within the vicinity of the detector. The vicinity is up to 1.5m between the wake up detector antenna and the card device or mobile phone. The on-vehicle

ticketing system is able to both read and record the identity and to write ticket and payment information to the device.

Detectors mounted within the vehicle log the continued presence of registered devices within a range of up to 30 m but only those card identities still present after the vehicle moves away from a stop are recorded. This information provides a record of all device identities that have been detected and for each device identity the number of stops traversed by the vehicle whilst that device could be detected.

The card type device contains a chip, a battery, a display and an antenna operating at 868 MHz. It can also be supplied with one or more push buttons for the card holder to make selections and to confirm transactions. The battery enables writing to the card at the specified range of operation. The display can be scrolled by use of a push button mounted on the card.

The alternative to the card device is a mobile phone with “near field communication capability operating at the same frequency as the card.

The main advantage of the technology seems to be that ticketing transactions are entirely automatic not even requiring any action on the part of the passenger. However, unless the technology is incorporated in a mobile phone, the artefact, which is significantly more expensive than a smartcard, must be provided either by the transport operator or the passenger. The system records journeys together with the passengers’ identities which could lead to privacy being compromised.

The system cannot be ISO/IEC 14443 compliant so interoperability with smartcards is not possible. The system cannot be ISO/IEC 14443 compliant so interoperability with smartcards is not possible, with the ISO14443 operating frequency of 13.56MHz being much too low to penetrate to all corners and compartments of a passenger transport vehicle. Compatibility between systems, and therefore interoperability with smartcards, would only be achieved if a dual frequency artefact is developed.

Since the identity artefact does not carry a ticket, revenue protection through ticket inspection would appear to incur doubt about system reliability and could lead to fraud by over-travelling.

3.5 Comparative Analysis of Different Media

Table 3.4 presents a comparison between the technologies reviewed (the basis of comparison is the contactless ISO/IEC 14443 smartcard)

Based on this analysis, end user surveys such as those reported upon earlier and other secondary research undertaken on reported trends in the uptake of different media, it is considered that conventional smartcards will remain as the dominant media for the time being (the next 5 years at least).

Near Field Communication (NFC) media, including suitably enabled mobile phones will become more prevalent over subsequent years with recent forecasts of the market penetration of such devices (ABI Research, 2008) indicating that the number of NFC phones will grow to be around 20% of the total phones in operation over the next 5 years.

Table 3.4 Comparative Analysis of Alternative Technologies			
Technology	**Utility**	**Advantages**	**Disadvantages**
On-board cash payment	All types of retail/ticket transaction	Anonymous. There is no risk to the privacy of cash users	Relatively high cost of handling both at the point of transactions and in the process of transfer to a bank. For buses; increased dwell time resulting in increased journey times and decreased reliability.
Pre-boarding cash payment	All types of retail/ticket transaction	Anonymous. There is no risk to the privacy of cash users	Relatively high cost of handling both at the point of transactions and in the process of transfer to a bank. Additional costs of third party retailing activity and ticket vending machine servicing.
Contact smartcard	Open network heavy rail ticketing. Third party ticket retailing	No change. No cash handling.	Total transaction time significantly greater than for contactless card partly due to the holder having to insert it in a slot.
Optical memory card (CD type)	Erasable store of value – potential to re-charge	Very large memory capacity. Very robust.	High card cost (similar to smartcards), high reader/writer cost and large size, poor intrinsic security, slow speed.
Optical card	Erasable store of value.	Low cost, high intrinsic security and a robust card construction.	Low memory capacity, high reader/canceller cost, slow speed, disposable functionality only.

Table 3.4 Comparative Analysis of Alternative Technologies			
Technology	**Utility**	**Advantages**	**Disadvantages**
Mobile phone ticketing	Tickets with time validity.	Ticket validation at the point of use faster than a cash transaction. Transport operator does not provide the ticket carrying artefact.	Ticket cancellation not practicable. Third party costs likely to arise for the transport operator. Mobile phone transmission costs will arise for the passenger. Some ticket types not practicable. Interoperability limited to commercial level. Effective multi-operator, multi-modal ticketing unlikely to be achieved. With no current standards pertaining to the use of mobile phones in this way for transport tickets Ticket type complexity limited by the size of mobile phone display screens.
NFC on mobile phone	Potentially any ticket type including non transport tickets. Assuming compatibility with ISO14443, an ticket type that a contactless smartcard could potentially handle.	In addition to the functionality of a contactless smartcard, purchase and transmission of tickets and stored value to the NFC interface over the mobile phone network. The transport operator does not need to provide a ticket carrying artefact. Remaining value and ticket validity could potentially be displayed by the mobile phone.	Privacy could potentially be compromised because the record of ticket purchase is linked to the mobile phone contract. 'Low battery' and/or 'no network availability' could inhibit the purchase of tickets via the mobile phone network. Bar coded tickets require a more costly and less robust reader than a smartcard reader.

Table 3.4 Comparative Analysis of Alternative Technologies			
Technology	**Utility**	**Advantages**	**Disadvantages**
NFC on a portable device	Potentially any ticket type including non transport tickets. Assuming compliance with ISO14443, a ticket type that a contactless smartcard could potentially handle Tickets could be purchased via an internet web site, and downloaded to the portable device remotely, for example, using the wireless interface of a mobile phone. However, this assumes a link from the mobile phone operating system to the NFC system (likely but not necessarily an obvious development).	The transport operator does not need to provide a ticket carrying artefact. Remaining value and ticket validity could potentially be displayed by the portable device.	
Magnetic stripe ticketing	Most relatively simple ticket types	Low cost card. Card can be printed on at the point of purchase and at subsequent validations/cancellations.	High cost of maintenance of readers. Some ticket types susceptible to fraud e.g. carnet of 1 day passes. Fast readers require a paper ticket which is more susceptible to damage than plastic.
Bar code	Simple ticket types with a short period of validity.	Enhances security of off-bus/tram ticket sales.	Bar coded tickets require a more costly and less robust reader than a smartcard reader. Ticket type complexity limited by the size of 1-dimensional barcode. Printed bar code cannot be renewed or re-charged and can be easily damaged.

Capabilities on project:
Transportation

Table 3.4 Comparative Analysis of Alternative Technologies			
Technology	**Utility**	**Advantages**	**Disadvantages**
Be in-be out payment	Payment for recorded journeys.	No action required by the passenger.	Costly identity artefact. Requires a back office administered payment arrangement – could compromise privacy. Complexity of revenue protection regime could lead to fraudulent travel. No interoperability with ISO/IEC 14443 smartcards is possible.

4. Recommendations

4 Recommendations

4.1 Recommendations on Actions at the EU Level

Determining recommendations for actions at the EU level regarding smart ticketing has been based on the study team's considered view of the current state of the art and what the future might hold in terms of interoperability, underpinned by the potential use of new media. Consideration has also been taken of legal / liability and robustness issues associated with particular options and the position and role that the EC plays within the value chain for smart ticketing. It has also involved consultations with existing scheme owners and those who anticipate implementing a scheme within the foreseeable future plus consultations with a panel of 'Practitioners' regarding the potential actions that might be taken.

The Panel includes:

- Representatives of European Associations (encompassing Authorities, Operators and Users);
- Representatives of Government Bodies associated with transport; and
- Other key actors within the overall Smartcards Value Chain, including:
    - card producers;
    - system designers and suppliers; plus
    - consultants; and
    - advisors on transport policy.

The study team has also looked in particular at the following research, to inform recommendations on particular actions:

- The results of the UK Department for Transport Consultation on Smartcards, as summarised within their report 'Smart and Integrated Ticketing Strategy';
- Recommendations from the LINK project, related to the regulation and facilitation of schemes; and
- Outputs from the IFM Project, related to future actions to promote integrated fares within public transport.

Draft conclusions and recommendations were peer reviewed through the study's Practitioner Panel and through opportunities arising from participation in the recent IFM Forum meeting.

Recommendations have also been subjected to an impact assessment. Recommendations have been value-judged in terms of the likely nature of impacts, in terms of incurring costs and delivering benefits. Based on this assessment proposals have been categorised / aggregated against three broad headings, with the impact of recommendations reviewed / valued at this aggregate level.

An overriding view from the Practitioners Panel, established by the Study Team, is that the EC will be unable to let the market alone dictate future development, if it is to achieve its own goals for interoperability. Seeking to increase the coverage of schemes and levels of integration, encouraging innovation whilst maintaining interoperability; resisting further pilots, but focusing on roll-out are all messages which have emerged from the consultations to date.

Specific actions proposed for the EC to aid the development of smartcard systems include more active promotion and encouragement for the use of existing standards, agreed at the highest level (and possibly paying a percentage of the implementation costs for projects compatible with these standards?). A possible generic system architecture could also be promoted based on a high level vision of shared functionality (for example, with respect to back office facilities), but with the precise detail of a scheme's architecture being decided locally. Adoption of this architectural approach should be encouraged; within the UK, the DfT is funding regional back offices to 'pump prime' smart ticketing schemes.

The architecture should, as far as possible, be technology neutral, in terms of the media by which smart tickets are delivered. It should support the roll out of smartcards, which are likely to be the principal means for the delivery of smart ticketing for at least the next 5 to 10 years, but also opening up greater use of EMV (Europay MasterCard VISA) chip and pin type technology and NFC (Near Field Communication) phone applications, which are being considered for future scheme implementation / integration across schemes / modes / service areas.

Once higher level parameters, seeking to ensure compatibility between systems across Europe, have been agreed at the EU level, it would be appropriate to leave the exact make-up of individual schemes to those at a local or regional level, as they will have the capacity to identify best what the local issues are and be able to decide, for example, which services to include and how the cards are paid for.

While it is tempting to seek to integrate across the delivery of many services, not just transport related, but also possibly involving sectors such as Sports and Recreation, Social Services and Education, a word of caution from consultations, particularly with scheme operators, is the almost 'exponential' increase in the complexity of the institutional and operational arrangements required as a consequence.

There is also evidence that the technology demands of the smart ticket for use on public transport can be different to those of other services. Public Transport tickets are replaced more frequently ('churn') and have shorter lives, so if integrated with other products on the same medium could escalate the re-issuing costs in the event of loss by the passenger.

Specifications should therefore be flexible and scalable, adaptable to the needs of different stakeholders, including smaller operators, with a primary focus on meeting the needs of public transport users.

Early engagement with those seeking to develop new technologies, which might potentially be facilitated by actions at the EU level, would minimise barriers for entry for potential buyers. Streamlining certification will be important for product development and competition; using existing standards minimises rollout costs, assuming these are shown to be delivering what is required.

It is recognised that those areas considering investment in smartcards can already find out more information by consulting cities and regions which have developed systems, via forums and site visits. Various bodies have been set up in different countries and on a European / international level to promote and support the development of Public Transport, within the overall context of enhancing urban mobility, for example, the VEKE in Hungary and the UITP working at an international level. EU documentation has also been written to advise on best practice in this area. Nevertheless, the consensus view from the study team's consultations is that i more should be done at the EU level to improve accessibility to best practice, potentially providing model agreements and frameworks which might be used for those seeking to implement such schemes.

What is clear from both the primary and secondary research undertaken to date is that it is difficult for individual organisations to make a stand alone business case for investment in integrated smart ticketing. Upfront investment and partnership working is needed to enable authorities and operators to realise the full potential of such schemes.

Making procurement easier through the provision of framework agreements and support with up front costs are areas where EU level actions might potentially be taken. Encouraging the introduction of integrated smart ticketing might also take the form of paying higher subsidies to operators who implement such schemes – to qualify, operators would accept a prescribed standard of payment mechanisms / media – linking to integrated ticket products (if subsidies are paid according to ridership levels, this would increase the need for auditable data from smart ticketing, reinforcing the trend towards the introduction of such schemes).

The introduction of smart ticketing might also feature within the process of franchising services (franchising of services is more common within the rail sector). Whether mechanisms and levers exist to provide such fiscal support should be considered by the Commission.

Overall, such moves would provide authorities with more scope to insist on integrated ticket schemes, although careful monitoring at an EU level should seek to ensure that smaller operators are not being squeezed out from the market.

Small operators will find the business case for investment more difficult compared with larger operators who benefit from economies of scale. It is considered by the UK Government at least that the initial focus of integrated smart ticketing should lie within major urban areas where the business case is strongest (economy of scale / links across a range of services), from which further expansion can occur.

4.2 Developing a Vision and Action Plan

It is clear from the research undertaken to date that a Vision and Action Plan helps in promoting the actions required of the various stakeholders involved in the development, implementation and operation of integrated smart ticketing.

The EU ITS Action Plan, recently published, with its focus on urban mobility can help in co-ordinating stakeholder actions in a way that will deliver the benefits envisaged by the Commission. Beyond the high level plan, actions need to be prescribed / agreed with key stakeholders to take forward the Vision.

Delivering public transport integrated across networks and modes will require actions which need to / can only be undertaken at the highest level. Such actions reflect the unique position of Governments and by extension the Commission to unblock barriers to delivery within the overall Value Chain for smart ticketing.

The UK Government has recently published its plans for smart and integrated ticketing and the nature of the actions they propose to undertake themselves are reflective of the conclusions / recommendations which have emanated from the

research undertaken for this study, in terms of actions which should be considered at an EU level.

In summary, they are related to:

Providing Strategic Leadership, through measures such as:

- Conducting detailed assessments of schemes, identifying and facilitating the sharing of best practice;
- Setting out 'model' scheme designs, business cases and model agreements between partners;
- Engaging with key stakeholders, including new technologist actors like EMV and NFC developers and supporting relevant research into new technologies, seeking / supporting technological convergence;
- Providing incentives to stimulate further public and private investment and delivery;
- Ensure the right 'tools' are available (scheme architecture, standards and specifications) and encourage their use.
- With respect to scheme Infrastructure:
- Providing additional funding for schemes that conform with the Vision and Plan to speed up the development of integrated smart ticketing schemes, in particular schemes which include the delivery of relevant, enhanced user data / information;
- Developing model Framework agreements for the supply of services and equipment;
- Including smart ticketing requirements in all newly let franchises;

In terms of encouraging integration between Tickets:

- Produce best practice guidelines for the implementation of smart and integrated products;
- Use existing levers and mechanisms – bus quality partnerships etc – to help shape the institutional and operational arrangements required to deliver integrated ticketing;
- Encourage integration between bus and rail local and national schemes (end to end journey ticketing, such as PlusBus in the UK);
- Closely monitor developments and check if additional levers and mechanisms (possibly involving legislation are warranted in the future.

Other Work Streams / Indirect Measures:

- Incentives provided for the provision of real time information (fed by data from smart ticketing schemes) within public transport;
- Produce a Privacy Impact Assessment approach and related guidance, as a 'seal of approval' for schemes which comply with appropriate standards.

4.3 LINK Project Recommendations

The LINK project, undertaken on behalf of the European Commission has developed several similar recommendations designed to foster passenger intermodality in Europe. Those of particular resonance to the conclusions and recommendations from the EC Smartcards Study are summarised as follows:

Related to Policy and funding:

- Introduce a new EU level funding programme - for long-distance, international Passenger Intermodality.

Directives and regulation:

- Establish obligatory delivery of data and information in the field of ticketing and information;
- Establish obligation to make standardised tariff and timetable information available on request to authorities responsible for passenger transport information provision;
- Make provision of door to door ticketing information mandatory for long-distance rail-ticket Distributors.

Standardisation and technology:

- Develop standard for long-distance electronic ticketing - to allow compatibility with local fare management systems;
- Create common standards for quality, user experience and technology at transport interchanges.

Assessment and planning;

- Establish passenger, operator, scheme owner and government acceptance criteria for smart ticketing technology;

4.4 The IFM Project Outcomes and Recommendations

The IFM Project has the primary aim to make public transport more user-friendly by facilitating seamless accessibility to different public transport networks across Europe using smart media. The objective is to provide travellers with common styles of contact-less media throughout Europe which can be used for loading multiple transport products in different geographic areas.

The final IFM Forum meeting, held in May 2010, provided details of the planned future road map 'Towards European Interoperability'. The Smartcards study team were represented at the Forum meeting, providing an opportunity to cross fertilise between the studies and the recommendations and conclusions arising.

It is apparent that Political and business decisions, best facilitated through actions at an EU level and therefore to be considered by the European Commission for support are required to deliver the project's vision. Broadly they relate to the establishment of common templates for products (supporting common multi-application processes) and a common set of rules to underpin the process of ensuring interoperability

In their final report it is clear that the leading IFM organisations have built a shared vision to:

- Create an EU-IFM network
- Promote further European Standards
- Develop a multi-application solution to interoperable ticketing;

Achievement of this Vision is based on a number of proposed actions. Two parallel tracks of action are recommended by the project.

Track 1, Priority Lane for quick wins, includes the following actions:

- Establish funding of an EU-IFM Alliance aiming at short term objectives
- Create Interoperability for customers through common multi-application processes on a single media in the customer's possession
- Create a Common Portal for customers to remotely load local applications together with the development of an "IFM Brand" to provide assurance and focus
- Update and harmonise current CEN Standards to support EU-IFM
- Create a Pilot operation in a number of Member States in preparation for wider rollout

Track 2, Long Haul towards Long Term Vision, includes the following actions:

- Establish funding of the EU-IFM Alliance aiming at its long term objectives
- Develop a Common EU-IFM Application and Common Product Templates supporting an extension of the "IFM Brand"
- Develop a commercial and technical framework for the sales and settlement of EU-IFM Products
- Extend functionalities to facilitate inter-modality between road and rail, and support for Demand Management for all transport modes (urban, suburban, regional and interurban)
- Engage and merge with existing IFM Systems and other transport modes (including private): e.g. road tolling, bicycle hire, parking, air, ferry
- Extend to non-transport applications and market external to EU

4.5 Peer Review - The Practitioner Panel Views

The draft recommendations and conclusions from the Smartcards study have been subjected to a Peer review by those within the Practitioners panel. An on line survey invited panel members to indicate the degree to which they agreed or disagreed with the draft recommendations.

Panel members were also invited express any other comments they wished to make regarding the nature if not the specifics of the suggested actions, based on their particular experience.

A copy of the survey is included in the Appendix (Sub section A8).

In general, those of the Panel who responded (around 50% of those invited, for which the proposed actions were most relevant i.e. those within the Europe) were in broad agreement with the recommendations proposed by the study team

Regarding the provision of strategic leadership, the panel were:

- in favour of the EC providing a vision or roadmap for how and when they would like to see integrated smart ticketing develop and evolve in the future *(36% strongly in favour, with a further 50% generally in favour).* One specific comment made was that the vision and roadmap should be sufficiently flexible so as to allow for gradual evolution towards system interoperability on a bottom-up basis.
- strongly in favour of the EC continuing to conduct detailed assessments of schemes, identifying and facilitating the sharing of best practice *(50% strongly in favour, with a further 43% generally in favour)*
- in favour of the EC providing a framework and methodology for benefits and costs, and establishing business cases for investment in new and integrated schemes *(29% strongly in favour, with a further 43% generally in favour and 7% generally against).*

- apparently ambivalent to the idea of the EC setting out model scheme designs, business cases and model agreements between partners, to be adjusted according to local circumstances *(14% strongly in favour, with a further 36% generally in favour, 21% generally against, 7% strongly against)* However, in presenting this conclusion, the study team is conscious of the relative levels of experience of those on the practitioners panel. It is anticipated that those of lesser experience, particularly those at the planning stage of a scheme, would be more strongly in favour of the EC providing such model agreements (experience borne out within the CIVITAS project).
- strongly in favour of the EC engaging with key stakeholders, including those developing new technologies to support relevant research *(57% strongly in favour, with a further 36% generally in favour)*
- in favour of the EC providing financial incentives to stimulate further public and private investment and delivery *(36% strongly in favour, a further 43% generally in favour and 7% generally against).* However, one respondent commented that the public transport industry should by now be able to see the benefits of smart cards and not be dependent on financial incentives to drive schemes forward.
- in favour of the EC ensuring the right 'tools' are available (for those of lesser experience) to develop and implement schemes (overall architecture, standards and specifications) and encouraging their use *(43% strongly in favour, with a further 43% generally in favour).*

Regarding the development of scheme infrastructure, the panel were:

- ambivalent to the idea of the EC providing additional funding for schemes that conform with best practice as advised by the EC, to speed up the development of integrated smart ticketing schemes *(29% strongly in favour, a further 14% generally in favour and 14% generally against).* One respondent felt that there was no obvious case for the EC to subsidise smart ticketing schemes in most cases, the exceptions being mainly for regions where concentrations of population span member state borders and European support might help justify an integrated cross-border scheme.

- ambivalent to the idea of the EC developing model Framework agreements for the supply of services and equipment to authorities and operators *(7% strongly in favour, with a further 36% generally in favour and 14% generally against).* One respondent felt that this would help those entering the smart ticketing arena to identify the key factors to take into account when setting up their scheme.
- in favour of the EC including smart ticketing requirements in all new let franchises *(36% strongly in favour, a further 21% generally in favour, with 14% generally against)*

Regarding the encouragement of integration between Tickets, the panel were:

- in favour of the EC producing a best practice guide for the implementation of smart and integrated products *(36% strongly in favour, 50% generally in favour, 7% generally against)*
- in favour of the EC using all existing policy, legal and financial levers and mechanisms to help shape the institutional and operational arrangements required to deliver integrated ticketing *(36% strongly in favour, 36% generally in favour and 7% generally against).* One specific comment made was that if common standards could be used across all implementations, this would make the market more competitive and help to drive down prices.
- in favour of the EC closely monitoring developments and see if additional levers and mechanisms (possibly involving legislation) are warranted in the future *(21% strongly in favour, with a further 64% generally in favour compared with only 7% strongly against)*
- mainly in favour of the idea for the EC to provide financial incentives to those operators who can show that the data collected through smart ticketing is utilised also for the provision of real time information, enhancing the quality provided and assisting with wider EC policies associated with an Informed Society *(29% strongly in favour, 21% generally in favour, 7% generally against, 7% strongly against)*
- in favour of the EC producing a 'seal of approval' for schemes which comply with appropriate data security / personal privacy standards *(21% strongly in favour, with a further 64% generally in favour).* One specific comment suggested that this seal of approval could be used in publicity for schemes to help assure customers that their personal data was safe.

General comments

Some general comments were also made by the panel. One respondent worried that much of what was being suggested for the EC to do would 'duplicate what is already happening in

cities and in member states already' and thus result in wasted effort or additional complexity.

Another warned that due to the high integration cost for ticketing, the main priority should be only on the most popular and therefore more tried and tested products and services, which form the core of the majority of smartcard schemes.

Others felt there was much that could be achieved through EC involvement in the smart ticketing arena. One respondent wanted the EC to be 'ambitious yet realistic' with how much influence it can have in this field. Another said it was 'essential that the EC takes leadership' in this area and did not leave it to private organisations.

4.6 Subjective Assessment of Recommendations

Each of the proposed recommendations / actions have been value-judged in terms of the relative level of the costs to implement and benefits which may arise as a consequence in comparison with a more conventional paper based ticketing system;

This subjective assessment is presented in Table 4.1. The more detailed assessment of recommendations is presented in Chapter 5.

Table 4.1 Subjective Assessment of Recommendations

Nature of Action that might be taken	Specific Recommendations presented within the Report	Anticipated level of Cost*level to Implement	Anticipated level of Benefit as a result of Action* taken
Providing Strategic Leadership,	Conducting detailed assessments of schemes, identifying and facilitating the sharing of best practice;	M	M
	Setting out 'model' scheme designs, business cases and model agreements between partners	L	H
	Engaging with key stakeholders, including new technologists like EMV and NFC developers and supporting relevant research into new technologies, seeking / supporting technological convergence;	M	M
	Providing incentives to stimulate further public and private investment and delivery;	M	M
	Ensure the right 'tools' are available (scheme architecture, standards and specifications) and encourage their use.	M	H
Supporting the Roll out of Schemes	Providing additional funding for schemes that conform with the Vision and Plan to speed up the development of integrated smart ticketing schemes, in particular schemes which include the delivery of relevant, enhanced user data / information	H	M
	Developing model Framework agreements for the supply of services and equipment ;	M	H
	Including smart ticketing requirements in all newly let franchises;	H	H
Encouraging Integration:	Produce best practice guidelines for the implementation of smart and integrated products;	L	M

Nature of Action that might be taken	Specific Recommendations presented within the Report	Anticipated level of Cost*level to Implement	Anticipated level of Benefit as a result of Action* taken
	Use existing levers and mechanisms to help shape the institutional and operational arrangements required to deliver integrated ticketing;	M	M
	Encourage integration between bus and rail local and national schemes (end to end journey ticketing)	M	M
	Closely monitor developments and check if additional levers and mechanisms (possibly involving legislation are warranted in the future.	L	M
Other Work Streams / Indirect Measures:	Incentives provided for the provision of real time information (fed by data from smart ticketing schemes) within public transport;	M	M
	Produce a Privacy Impact Assessment approach and related guidance, as a 'seal of approval' for schemes which comply with appropriate standards	M	L

*Anticipated Order of Magnitude – Low, Medium, High

4.7 Summary

In summary, it is felt that a Vision and Action Plan involving the EC with key stakeholders will provide the necessary strategic guidance and help secure the 'institutional' support required to underpin the development of integrated smart ticketing.

Putting the Plan into action will require continuing engagement by the EC with those designing, implementing and operating schemes. Enhanced networking between stakeholders and the sharing of best practice, demonstrated projects and proven cost / benefit analyses, should all help in making the Vision of integrated smart ticketing a reality. The development and application of model designs, institutional / operational frameworks and quality indicators should also help in bringing forward the process of integration, with a potential for a common 'brand', as suggested by the IFM project.

Overall, such actions are likely to deliver a net benefit to the European Community, although some 'rebalancing' of costs between partners within the value chain, including the EC providing additional funding / including some up front 'pump priming' monies to support the business case for change will most likely be required.

The Indicative Business case for Smart ticketing presented in this report provides an order of magnitude for the investments required to implement smart ticketing and the nature and levels of benefits that might be expected as a result.

Once schemes have been established, monies invested by the Commission would be recompensed by operational and environmental benefits resulting from increased use of public transport by those travellers who would otherwise use private cars, recognising that while costs will be borne short term, benefits will be realised long-term.

5. Impact Assessment

Capabilities on project:
Transportation

5 Impact Assessment

5.1 Introduction

The EC's Impact Assessment Guidelines (SEC (2009) 92) sets out a framework for the identification and evaluation of policy options.

A number of stages are identified, within the underlying process set out within the Guidelines, namely:

1. Identifying the problem
2. Defining the objectives
3. Developing main policy options
4. Analysing the impacts of options
5. Comparing options
6. Outlining indicators to monitor progress

Preceding chapters of this report have addressed Stages 1 through 3 above. The following sections address stages 4 through 6, in consideration of the recommendations (main policy options) summarised at the conclusion of Chapter 4.

For the purposes of analysing impacts (Stage 4), recommendations have been grouped according to three broad headings. These relate to a series of actions to progressively increase not only the number of smart ticketing schemes deployed but also the degree to which schemes are integrated. At the basic level, there are a number of actions related to the provision of strategic leadership (please see summary table at the conclusion of Section 4.6) which it is considered will help those authorities currently considering smart ticketing schemes take action.

Figure 5.1 illustrates how such actions would be intended to bring forward more schemes, quicker than would otherwise be expected. This is represented by the difference between the trajectories labelled do nothing and do minimum

Do minimum actions relate to providing Strategic Leadership, as summarised in Section 4.6, essentially pointing out why authorities, in particular those contemplating the implementation of schemes, should take steps now to bring them forward.

The direct actions the EC could take to support the implementation of schemes (labelled 'Do Something – Supporting Roll out' within the diagram) would be expected to further accelerate the deployment of schemes and lead to increasing integration between existing and newly deployed schemes. This is represented by the difference between this trajectory and that labelled Do-Minimum.

As shown in the diagram, these actions require progressively more investment, by the EC and others to achieve the desired aim of an increasing number of schemes being implemented and in a more integrated way. However, this increased investment should bring with it additional benefits which need to be taken account of when assessing the merit of such actions.

The following sections aim to quantify the likely costs and benefits associated with the measures that might be taken. For the purposes of analysis we have considered those areas of Europe which have been previously highlighted as showing the greatest potential for deployment / integration between schemes (reflected in the distribution of schemes whose owners were consulted with during the Study).

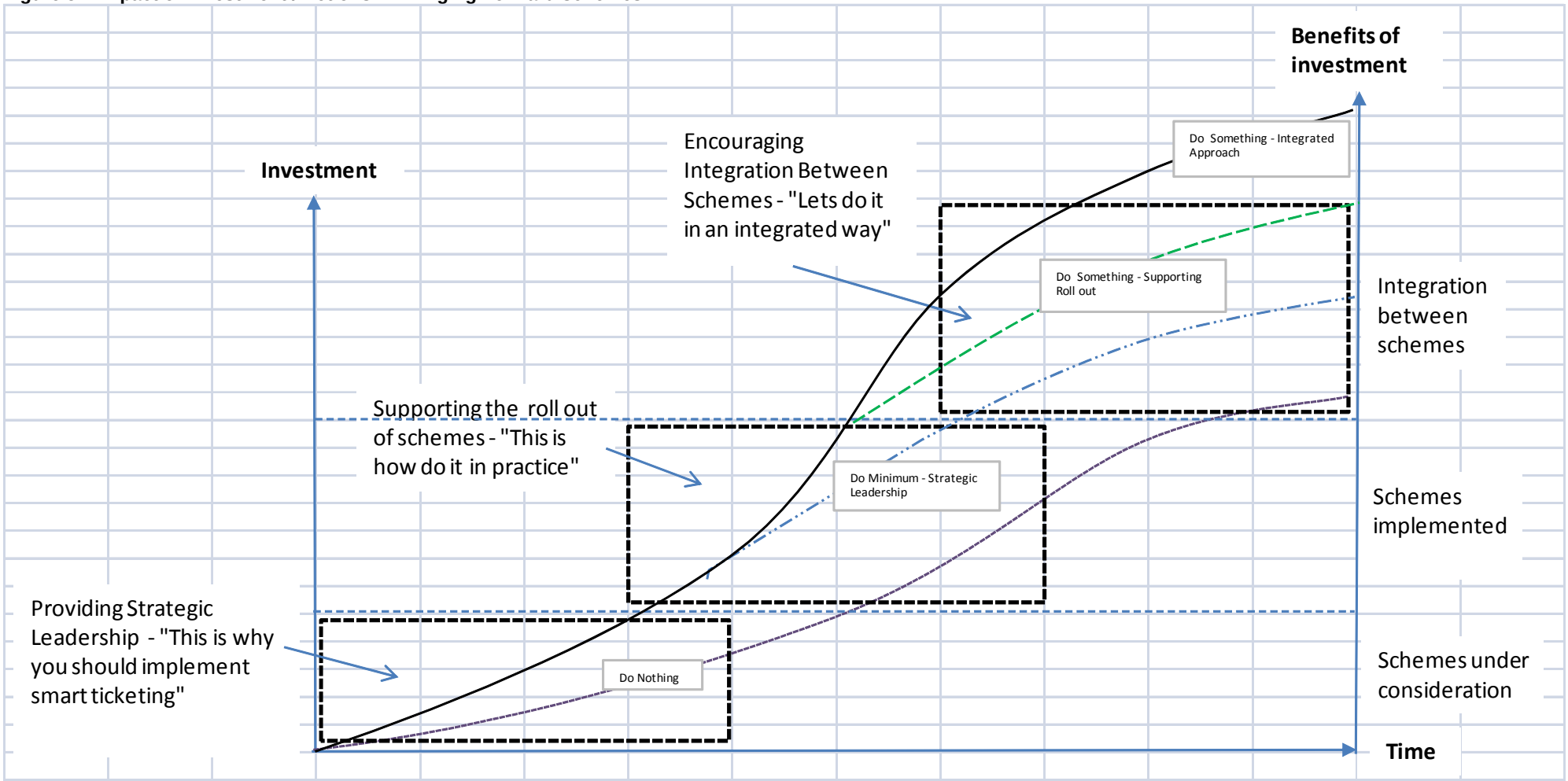
For the purpose of this analysis we took a nominal figure of 20 schemes as a base line figure (considered for deployment over a period of 10 years), of which four would are being considered for implementation on a regional-wide basis.

Without action (Do-Nothing scenario) we have assumed that only 50% of the schemes would come to fruition over that time horizon.

These (and other) estimates have been informed by the 'state of the art review' and 'future view analysis' set out in Chapters 2 and 3.

In the context of the following analysis, 'region-wide' implies a scheme involving services (essential bus / metro-based), co-ordinated over more than one town/city; essentially overseen by a single Public Transport Executive, on behalf of several authorities. 'Integrated' implies smart ticketing operations, including integrated fare regimes / payment mechanisms across several public transport operators and including other public services within the same 'region'.

Figure 5.1 Impact of Investment / Actions in Bringing Forward schemes



It should be noted that 'Investment' includes that made by all parties within the Value Chain. Some non EC investment is envisaged as part of the Do-Nothing scenario. Increasing Investment will tend to increase the Benefits of Investment delivered, however, this is a non linear relationship.

It has not been possible to establish a precise estimate of the number of schemes under consideration or those which might be brought forward as a result of actions taken. Consequently, some 'guess estimates' are made, where the value of the estimated incremental benefits compared with the incremental costs (in proportionate if not absolute terms) should, to a degree, be scalable so that the conclusions drawn are reasonably robust across a range of underlying assumptions.

An analysis has been made to identify the level of benefits required to warrant the EC investment implied by the recommended strategy. This is compared with the minimum number of additional schemes that would need to be brought forward, as a result of this strategy, to justify the investment made by the EC.

In reviewing the results of the analysis, it should also be borne in mind that a significant investment is required, by authorities and operators, to develop, implement and operate schemes. Whilst this has been taken into account, in part, within the assessment, insofar as the number of schemes likely to be brought forward has been constrained, there is no certainty (given, suggested or implied) that any additional schemes will result from the proposed measures. This should be taken into account when considering the report's conclusions and recommendations.

Costs and benefits are assessed on an incremental basis. It is also assumed that EC actions are a step wise process, with the provision of direct support for the deployment of schemes, being preceded by actions designed to provide strategic leadership. As a consequence, total costs and benefits must be considered at all times, when reviewing the merit of the various actions that might be taken by the EC.

The final set of actions shown on the diagram are aimed at encouraging greater integration between schemes than might otherwise occur, even if preceding actions to encourage and facilitate the implementation of schemes are undertaken. This is represented by the difference between the two Do-Something trajectories.

It is envisaged that the increasing investment implied by each set of actions will lead to further enhancement in the benefit delivered (the degree to which is explored within the following sections), as more schemes are delivered and integrated quicker and more cost effectively than might otherwise be the case.

Given the progressive nature of implementing the policies under consideration, Stage 5 of the assessment ('Comparing Options' within the EC's Impact Assessment Guidelines) focuses on the added value of subsequent sets of measures: do minimum compared with do-nothing (status quo); do something compared with do minimum etc

5.2 Analysing the Impacts of Options

Table 5.1 summarises the underlying assumptions that have been made, regarding future new schemes. The progressive deployment of schemes is based on informed judgement, taking into account the results of the consultations and reviews undertaken as part of the study.

Table 5.1 Estimate of Deployment – Future New Schemes

	New Schemes likely to be deployed by 2015			**New Schemes likely to be deployed by 2020 (inclusive of those deployed by 2015)**		
Scenario	Town/City wide	Region wide	Fully Integrated (Region wide)	Town/City wide	Region wide	Fully Integrated (Region wide)
Do-Nothing	5	1	0	10	2	0
Do-Minimum – Strategic Leadership	6	1	0	12	2	0
Incremental impact (compared with Do-Nothing)	1	0	0	2	0	0
Do- Something – Supporting Roll out	9	2	0	18	4	0
Incremental impact (compared with Do-Minimum)	3	1	0	6	2	0
Incremental impact (compared with Do-Nothing)	4	1	0	8	2	0
Do-Something – Encouraging Integration	10	3	0	20	4	2
Incremental impact (compared with Do-Something)	1	1	0	2	0	2
Incremental impact (compared with Do-Nothing)	5	2	0	10	2	2

5.3 Costs and Benefits of Deployed Schemes

Table 5.2 summarises the underlying assumptions that have been made regarding the costs and benefits of schemes. They are based upon the capital costs and indicative pay back period for the investment made summarised within the indicative business case set out within Appendix A5.(Values expressed in pounds sterling within Appendix A5 have been converted to Euros, using an exchange rate of 1.2).

This showed a capital investment of €400m (£330m) with a payback period on investment (both capital and operating costs), taking account of net social benefits, of 3+ years.

For the purposes of the analysis this has been taken to apply to a region-wide scheme (based on the definition used within this analysis), but with costs scaled to reflect the more compact nature of schemes likely to be deployed in the areas identified within the consultations.

The costs at the regional level are based on a bus usage figure of 5 million passenger journeys a day. This reduces the capital costs for a regional scheme from €400m, as set out within the indicative business case, to €300m.

Net benefits have been estimated to give the suggested payback period on capital and ongoing operating costs of 3+ years, suggested by the indicative business case. The assumption is therefore that net benefits would be in the order of €360m after a 5 year period, for a region-wide scheme.

The relative costs and net benefits of other scales of deployment (as summarised in table 5.2), within the same overall payback period of 3+ years, are based on informed judgement

It should be noted that future costs and benefits have not been 'formally' discounted as part of the analysis. However, net benefits of schemes and costs of EU level actions for the period between years 5 and 10 are assumed to be proportionately lower than those assumed for earlier years.

Table 5.2 Underlying Cost assumptions

Scale of Deployment	Capital Costs	Net Benefits (benefits less operating costs) over 5 year period	Net Benefits (benefits less operating costs) over 10 year period
Town/City wide	€150m	€156m	€192m
Region wide	€300m	€360m	€480m
Integrated scheme – Regional Basis	€600m	€660m	€720m

5.4 Costs of EU Level Actions

Table 5.3 summarises the underlying assumptions that have been made regarding the costs of actions at an EU level; to firstly raise awareness, thereafter to take directed actions (including 'fiscal' measures) to support scheme implementation and, thereafter, take further directed actions (also including some fiscal measures) to encourage integration between schemes.

Table 5.3 Costs of Actions at EU Level			
Scenario	Tasks	Costs over 5 Years	Costs over 10 Years
Do-Minimum: Providing Strategic Leadership,(Raising Awareness)	Conducting detailed assessments of schemes, identifying and facilitating the sharing of best practice;	€600k (for related studies)	€900k
	Setting out 'model' scheme designs, business cases and model agreements between partners	€300k (for specialist staff employed in the production of related documentation)	€480k
	Engaging with key stakeholders, including new technologists like EMV and NFC developers and supporting relevant research into new technologies, seeking / supporting technological convergence;	€1.2m (support funding provided for 'directed' research)	€2.4m
	Providing incentives to stimulate further public and private investment and delivery;	€600k (sponsorship / through hosting of workshops and seminars	€1.2m
	Ensure the right 'tools' are available (scheme architecture, standards and specifications) and encourage their use.	€600k (development and maintenance of dedicated resource and promotion of best practice)	€1.2m
	Total Costs	**€3.3m**	**€6.18m**
Supporting the Roll out of Schemes	Providing additional funding for schemes that conform with the Vision and Plan to speed up the development of integrated smart ticketing schemes, in particular schemes which include the delivery of relevant, enhanced user data / information	€30m (level of 'pump priming' funds provided to be relative to the scale / level of integration, up to a maximum of €12m per scheme)	€60m
	Developing model Framework agreements for the supply of services and equipment	€1.2m (for specialist staff employed in the production of related documentation and liaison with authorities in question)	€2.4m
	Including smart ticketing requirements in all newly let franchises;	€6m (additional monies provided, up to a maximum of €2.4m to support development of additional functionality within schemes)	€9m
	Total Costs	**€37.2m**	**€71.4m**
	Total Aggregate Costs	**€40.5m**	**€77.22m**
Encouraging Integration:	Produce best practice guidelines for the implementation of smart and integrated products;	€1.2m (for specialist staff employed in the production of related documentation and liaison with authorities in question)	€1.8m
	Use existing levers and mechanisms to help shape the institutional and operational arrangements required to deliver integrated ticketing;	€6m (for specialist staff employed in the operation of such measures in liaison with authorities in question documentation)	€12m
	Encourage integration between bus and rail local and national schemes (end to end journey ticketing)	€6m (Providing additional funding for schemes, up to a maximum of €3m per scheme)	€18m
	Closely monitor developments and check if additional levers and mechanisms (possibly involving legislation) are warranted in the future.	€600k (for specialist staff)	€1.2m
	Incentives provided for the provision of real time information (fed by data from smart ticketing schemes) within public transport;	€6m (Providing additional funding for schemes, up to a maximum of €3m per scheme	€12m
	Produce a Privacy Impact Assessment approach and related guidance, as a 'seal of approval' for schemes which comply with appropriate standards	€2.4m (for specialist staff employed in the production of related documentation and operation of the scheme)	€3.6m
	Total Costs	**€22.2m**	**€48.6m**
	Aggregate Costs	**€62.7m**	**€125.82m**

5.5 Comparing Options

Table 5.4 summarises the estimated incremental costs and benefits of progressive actions at the EU level, based on the preceding analysis. The costs are those incurred by the EC (summarised in 5.3). The scheme capital costs are borne by the scheme owners and public transport operators. Operating costs, also borne by the scheme owners and operators, are subsumed within the scheme net benefit figures within Table 5.4. .

The benefit to cost ratios presented relate only to the additional costs, incurred by the EC, which relate to the EU levels taken to encourage and support the implementation of schemes. Such actions result in additional schemes being implemented, than would otherwise be the case, which delivers additional net benefits. These additional net benefits, which accrue to owners, operators, users of the schemes and the public at large, through, for example, the realisation of reduced emissions and congestion from increased usage of public transport, are set against the costs incurred by the EC as a result of the actions taken.

The results presented indicate that the proposed actions summarised in Chapter 4 are likely to be cost effective in bringing forward schemes earlier than might otherwise be the case (if the predicted impacts of the proposed actions and the underlying costs and benefits are as assumed in the analysis).

The biggest benefit to cost ratio is based on the EC providing strategic leadership, raising awareness of what is possible, over a long term (10 year horizon). Providing practical support, including some level of funding for those seeking to implement schemes will require substantially more investment by the EC over such a period.

The analysis suggests that in benefit to cost ratio terms, while the additional costs are justified, this is not as cost effective a strategy as the Do-minimum option proposed (providing strategic leadership).

If a shorter, 5 year horizon is considered, the provision of practical support and funding would be more beneficial that providing strategic leadership alone. Although this is unlikely to deliver any noticeable increase in integration between schemes, which might be achieved longer term, it is considered that such actions taken short term might persuade several authorities / operators, currently considering the introduction of smart ticketing, to move forward quicker with the implementation of their schemes.

The additional evidence of how schemes can be implemented and operated cost effectively might then deliver a greater return on investment for the Do-minimum actions which would continue on their own over the longer term. However, this is unlikely to deliver the same return, in benefit to cost ratio terms as providing long term strategic leadership alone.

Table 5.4 Estimated Incremental Costs and Benefits

	Additional Schemes, costs and benefits – over 5 years			Totals	Additional Schemes, costs and benefits – over 10 years			Totals
	Town/City wide	Region wide	Fully Integrated		Town/City wide	Region wide	Fully Integrated	
Do Minimum – Do Nothing	1	0	0		2	0	0	
Scheme Costs (from Table 5.2, factored according to the number of additional schemes)	€150m	0	0		€300m	0	0	
Scheme Net Benefits (from Table 5.2, factored according to the number of additional schemes)	€156m	0	0		€348m*****	0	0	
Benefits Less Costs	€6m	0	0	€6m	€48m	0	0	€48m
Aggregated EC Costs (from Table 5.3)				€3.3m				€6.18m
Benefit / cost ratio				1.8				7.8
Do Something (Supporting roll out) – Do Nothing	4	1	0		8	2	0	
Scheme Costs (from Table 5.2, factored according to the number of additional schemes)	€600m	€300m	0		€1,200m	€600m	0	
Scheme Net Benefits (from Table 5.2, factored according to the number of additional schemes)	€624m	€360m	0		€1,392m	€840m	0	
Benefits Less Costs	€24m	€60m	0	€84m	€192m	€240mm	0	€432m
Aggregated EC Costs (from Table 5.3)				€40.5m				€77.22m
Benefit / cost ratio				2.1				5.6
Do Something (Encouraging integration) - Do Nothing	5	2	0		10	2	2	
Scheme Costs (from Table 5.2, factored according to the number of additional schemes)	€750m	€600m	0		€1,500m	€600m	€1,200m	
Scheme Net Benefits (from Table 5.2, factored according to the number of additional schemes)	€780	€720m	0		€1,740m	€960m	€1,320m	
Benefits Less Costs	€30m	€120m	0	€150m	€240m	€360m	€120m	€720m
Aggregated EC Costs (from Table 5.3)				€62.7m				€125.82m
Benefit / cost ratio				2.4				5.7

*****In this instance Benefits are an aggregation of 1 scheme's operation over 10 years and one scheme's operation over 5. The same principle of aggregating benefits applies throughout

5.6 Sensitivity Testing

To further explore the value of the action that might be taken at an EU level and the robustness of results across a range of assumptions, an assessment has been made of the minimum number of schemes that would need to be brought forward by the proposed Do-minimum strategy (providing strategic leadership), in order to justify the costs involved. Based on the estimated costs to the EC of just over €6m, over a 10 year horizon, even if this resulted in only one additional scheme being implemented, the investment made would likely be justified (if the underlying costs and benefits are as assumed in the analysis). The benefit to cost ratios that have been calculated further indicate that even if costs were doubled and the number of schemes brought forward were halved, over the 10 year, benefits would still outweigh the costs involved.

5.7 Outlining Indicators to Monitor Progress

The final stage set out within the EC's guidance on impact assessment is to identify indicators, by which progress relative to 'plan' can be assessed. In the context of the proposed actions and anticipated outcomes, the suggested indicators include:

- The number of schemes which are implemented, compared with preceding trends in scheme deployment
- The engagement with representatives of the Value Chain, as measured through attendances at EC hosted workshops and seminars
- Response to EC calls for targeted research, compared with preceding trends
- Take up of available guidance, measured by requests for documentation / log-ins to access material

5.8 Conclusions

Based on the preceding assessment of options and in consideration of the results of the analysis undertaken to date, it is considered that the EC might reasonably implement a programme of measures, along the lines of those set out within the Do-minimum scenario, to encourage greater adoption of smart ticketing within public transport. The approach taken and the effectiveness of the funds directed towards these actions should however be reviewed, after a period of, say, 3 years to confirm the appropriateness of this approach.

Indicators which might be used for this purpose are summarised in the preceding section.

Subject to the results of this later review, the EC might wish to reassess / reconsider the merits of the additional (Do-something) actions set out within the report.

Appendix - Supporting Documentation

Appendix - Supporting Documentation

A1 Consultations with Scheme Owners

Questionnaire 1 – Assessment of Current Smart-ticketing Systems

Scheme Name, Area/Region, Country:	

Section 1 – Administrative Issues	
1. Who are the partners involved in delivering the scheme?	
2. How many individual Public Transport operators participate in the scheme?	
3. What is the approximate size of the scheme? (e.g. Number of cards issued per 1000 head of population; number of route-kilometres; number of regular users)	
4. What was the approximate cost of implementing the scheme, and who funded the implementation?	
5. Does the Local Government or other Administrative Authorities have an input into smart-ticketing in your area?	
a. If so, at what level of the Government hierarchy is this?	
b. Do you feel this is the most suitable level of Government, or should it be at a higher/lower level to make schemes more successful?	

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Section 2 – Drivers for Implementation	
6. When was smart-ticketing introduced in your area, and why at this point in time?	
7. What were the key drivers behind the introduction of smart-ticketing in your area?	
8. What are the aims and aspirations of your smart-ticketing scheme?	
9. Depending on the stage of your scheme, what positive experiences have you had in planning, developing and operating the smart-ticketing scheme?	
10. Depending on the stage of your scheme, what negative experiences have you had in planning, developing and operating the smart-ticketing scheme?	
a. Were there any particular barriers (political, economic etc.) that posed a problem?	
b. How were these barriers overcome?	

Any additional comments related to this section:

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Section 3 – Technical Aspects	
11. Which types of smart-media are currently in use for your scheme? (E.g. Smartcards [MiFare, Desfire, 2K, 4K etc.], e-ticketing, m-ticketing)	
12. What tarification systems and structures are currently in use? (E.g. Flat-fare, Scan-on and Scan-off, Automated Fare Calculation etc.)	
13. What front-end equipment is in use?	
14. What HOPS/back-office equipment is in use?	
15. Which organisation provided the funding for the equipment? (e.g. Government/Authority, Public Transport company, co-operative funding)	
16. What security measures are in place? Does this include any form of trust model?	

Any additional comments related to this section:

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Section 4 – User Benefits	
17. In your opinion, what benefits does smart-ticketing bring to regular travellers?	
18. Do smart-ticketing users enjoy additional benefits that cash users do not?	
19. Are there any additional non-transport functionalities which smart-ticketing offers?	
20. Does smart-ticketing remove barriers to travel for irregular and/or unfamiliar travellers?	

Any additional comments related to this section:

.

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A2 Supplementary Questionnaire of Scheme Owners Related to Standards and Specifications Adopted

AECOM, Newcastle University, PJ Associates, AustriaTech, NEA

As part of the EC Smart Cards study we are researching which International standards systems comply to.

Please could you assist by highlighting below which standard your system complies with. If your system only complies with some parts of the standard, and not all parts, then please indicate which parts you are compliant with.

Scheme:		Completed By:	

Standard	Name	
ISO/IEC 7816	Identification cards – Integrated circuit(s) cards with contacts	
ISO/IEC 10170	Information technology – security techniques – Key management	
ISO/IEC 11770	Information technology – Security techniques – Key management	
ISO/IEC 14443	Identification cards – Contactless integrated circuit(s) cards – Proximity cards	
ISO/IEC 17799	Security of IT systems	
ISO/IEC 18902	Near field communications (NFC)	
ISO EN 24014	Public transport — Interoperable fare management system (IFM)	
ISO/IEC 27001	Information technology – Security techniques – Information security management systems – Requirements	
EN1545	Identification card systems – Surface transport applications	
EN1546	Identification card systems – inter-sector electronic purse	
EN12896	Reference Data Model For Public Transport (Transmodel)	
prEN15320	Interoperable Public Transport Application (IOPTA)	
Others	*Please list*	

Please can you also advise which open specifications your system conforms to (if any):

Once completed, please return to steve.tarry@aecom.com

Capabilities on project:
Transportation

A3 Invited Members of Practitioner Panel

Invited Panel Member	Organisation	Involvement	Country / Region
J Jenks	Metropolitan Atlanta Transit	Consultant	USA
M Pollack	Metropolitan Atlanta Transit	Consultant	USA
J van Ieperen	UITP	European Association	EU
I Cre	POLIS	European Association	EU
A Sabine	EMTA	European Association	EU
J Frank	Eurocities	European Association	EU
J Dirand	CEMR	European Association	EU
V Holve	Eurocities	European Association	EU
J Verity	ITSO	Standards Development	UK
P Kompfner	ERTICO	European Association	EU
S Haon	POLIS	European Association	EU
U Weber	UITP	European Association	EU
H Meyer	ERTICO	European Association	EU
T Antonissen	Eurosupport	European Affairs Advisor	Belgium
J Krossnes	Skyss	Operator	Norway
T Dunn	Espsystex	Card Producer	UK
L Crusey	Laz Parking	Consultant	USA
M Lane	Southampton CC	Authority	UK
D Batchelor	Kent CC	Authority	UK
S Bulloch	Aberdeen CC	Authority	UK
G Williams	Unicard	Systems Supplier	UK
M Berg	Resekortet	Operator	Sweden
J Spencer	US DoT	Government Body	USA
G Thiesing	BLIC	Systems Designer	Germany
K Wilby	Denbighshire CC	Authority	UK
M Sandrock	Telematicspro	European Association	Germany
J Yu	Calcary CC	Authority	Canada
J Sherry	Northants CC	Authority	UK
W Judge	TfL	Authority	UK
S Prakasam	Land Transport Authority	Authority	Singapore
R Easley	E-squared Engineering	Systems Supplier	UK
D Owen	Gwnedd CC	Authority	UK
B Allen	Ontario CC	Authority	Canada
C Kennington	Cheshire CC	Authority	UK
J Caffrey	Irish Transport Ministry	Government Body	Ireland
W Reddington	Bolton CC	Authority	UK
V Collins	Welsh Assembly Government	Government Body	UK
M Duflou	SRWT	Operator	Belgium
B Radermarcher	VDV	European Association	Germany
G Hanning	Transport Scotland	Government Body	UK
Hendbukt	Public Roads Administrator	Government Body	Norway
C Shire	Infineon Technologies	Chipset / Card Producer	Global
C Lavorel	Eurosmart	European Association	Belgium
S Cassidy	MRCMH	Consultant	UK
B Hylen	VTI Transport Research	Government Research	Sweden
B Michel	Ratp Paris	Operator	France

Capabilities on project:
Transportation

A4 Preliminary Questions Asked of Panel Members

AECOM, Newcastle University, PJ Associates, AustriaTech, NEA

Concerning an Analysis of Functional Requirements - Covering: Views on future developments

Future of Smart-ticketing

1. The term 'smart card' has been said to not be appropriate anymore, given the range of current 'smart-media' now available.
    a. Do you feel the travelling public truly understands what a smartcard is, and the benefits they can bring?
    b. Should we be moving to embrace and promote new, more appropriate definitions which encompass the wider smart-media arena?

2. What added value and functionalities could smart technologies bring to future Public Transport ticketing systems?

3. What do you feel will be the leading future trend for smart technologies in Public Transport ticketing? (E.g. QR codes, NFC devices, m-ticketing etc.)

4. Which technology could open up the greatest number of future opportunities for developments in Public Transport ticketing and wider applications?

5. Who should be leading the development of future smart-ticketing in Europe? (e.g. Public Transport Operators, Local/National Government, Third Party Technology Providers, perhaps partnership agreements between different organisations)

6. What, in your opinion, are the main barriers to the future interoperability of smart-ticketing across Europe? Please consider this from any of the following aspects:
    a. Technical (e.g. different security models, front-end and back-end systems)
    b. Economic (e.g. different tarification schemes, currency exchange rates between countries)
    c. Political (e.g. who is responsible for any problems, how can trust between different systems be fully managed)
    d. Social (e.g. public acceptance, willingness to use cards in a different country on a different system)
    e. Other

Influence of Additional Technologies

7. Are there any other ICT technologies which you feel are set to play a role in future Public Transport smart-ticketing? (E.g. Influence of Google Transit, iPhone apps, third party online agencies moving away from traditional set-up where PT operators are primary ticket providers etc.)

8. Is there a potential conflict between the need to provide the travelling public with affordable ticketing solutions, and the commercial interests of these future technology service providers? (E.g. a PPP could deliver innovative ticketing solutions, but with the added pressure of a financial return on the investment from the private partner).

9. Do you feel integrated transport and civic services i.e. a 'Citizen' Card will become more commonplace with the introduction of future technologies?

a. Where should the funding come from to provide such services?
b. Would any additional costs be transferred to the travelling public (for Public Transport services), or even the taxpayer (for civic services)?

Regulatory Frameworks

10. Does a regulatory framework exist in your country for the provision and control of smart-ticketing in Public Transport? If so, at what level of authority is this – National Government, Regional Government, Local Authority etc.

11. Are smaller cities/regions able to invest in smart-ticketing given the financial and technical requirements for implementing these systems?

12. How can information be shared amongst interested parties to help cities/regions make informed decisions about how to implement smart-ticketing in their area?

13. What, if anything, can be done at the Europe-wide level to assist with the regulation and promotion of smart-ticketing?
    a. Should there be the opportunity for direct regulation and advisory frameworks to be defined and operated from the highest level?
    b. Is it more appropriate for decisions to be made at a lower level (national/regional/local) with an eye to wider interoperability?
    c. Should we be looking at a 'do nothing' approach, allowing the market to establish a natural position of self-regulation and operation?

Concerning Public Acceptance and Future Developments -Covering: Public acceptance of smart cards; Impact on changing demographics

Public Acceptance

1. Do the general public actually want smart-ticketing for Public Transport services?

2. What sector of the public want/use smart-ticketing?
    a. Is there a gap in the market which needs to be addressed through better marketing, training or other actions?
    b. Will the greater introduction of smart-ticketing help change future travel habits?

Changing Demographics

3. Younger generations are now exposed to various technologies on a daily basis and have been brought up and educated using ICT. How should smart-ticketing be marketed and targeted at these users to 'tap-in' to their technology-rich lifestyles to promote future use of Public Transport?

4. Given the increase in life expectancy, a larger proportion of the population are defined as elderly. Traditionally, these older users are not as comfortable using new technologies, and similar barriers are faced by those with cognitive and mobility impairments.
    a. Can smart-ticketing be used to provide these users with easier access to Public Transport services?
    b. Can smart-ticketing be implemented to open up new services to these users, moving beyond the traditional services provided?

5. Given the need to promote greater use of Public Transport, which user group(s) should future smart-ticketing initiatives focus on?

Marketing Strategies

6. What marketing strategies are being used to promote the uptake of smart-ticketing in your area?

7. What strategies have been implemented to promote smart-ticketing to non-users of Public Transport?

8. For future interoperable smart-ticketing schemes covering more than one scheme across wider areas, how should these be promoted to users?
    a. Who would be responsible for co-ordinating the marketing?
    b. Who would fund the cost of such a large marketing operation?

Future of Smart cards in the Public Domain

9. Are people in your area beginning to embrace new smart-media? (m-tickets, iPhone apps)

10. How long can we expect smart cards to be the dominant form of smart-media for Public Transport ticketing?

11. Given the potential for QR tickets on smartphones, PDAs and other electronic handheld equipment, should we be focussing R&D into these services?

12. Can these newer technologies provide better opportunities to extend the functionality of smart-media to provide multiple services beyond simple transport applications?

A5 The Position of Value Chain Members Within the Business Case

An indicative business case for the introduction of Smart ticketing is presented at the conclusion of this Section.

Benefits accrue through a wide range of changes which occur following the introduction of integrated smart ticketing, including operational enhancements to the service and the implementation of simplified and integrated fare structures

- benefits accrue to existing **users** and **additional passengers** who are attracted to use public transport (additional passengers accrue, on average, 50% of the benefits of existing passengers
- Increased patronage provides increased revenue for **operators** – 6% - 20% increases in passenger levels have been reported (Booz and Company report). Key attractors are enhanced ease of use of public transport (less need to carry cash, more certain budgeting), more flexible journey choice of mode, route, timing and easier interchange within and between modes. (with enhanced real time information), faster boarding times, more frequent services
- Modal shift away from private cars to public transport reduces congestion and improves journey time predictability for bus **users** (as well as for **other road users**)
- Savings from reduced bus vehicle hours and km, reduced operating costs and fuel accrue to **operators**, the benefits of reduced overall emissions (CO2 'costs') accrue to the **public at large**
- Increased revenue for **operators** has been assessed to be in the order of 1% to 12% (Booz and Company report) with 15% increase in fares from non concessionary fares, due to increased patronage and reduced fraud (Detica Report)
- Increased passenger satisfaction results from reduced time through station gates and at kiosks, faster boarding and enhanced real time information, as a result of the richness of data available from smart ticketing systems
- Reduced transaction and administrative costs accrue to the **operators** and **authorities** along with reductions in fraud – and more accurate data for reimbursement of concessionary fares (17% saving in reimbursements in Nottingham – Detica Report)
- **Social benefits**, including a wider contribution to urban life and identity accrue to the community as a whole
- Acquisition of accurate data on passenger behaviour enables better capacity and network planning, reducing potential costs to **authorities**
- Faster boarding times allows buses to run more reliably, faster and frequently, reducing **operating** costs, fuel and CO2

In terms of costs, these are predominantly borne by operators and by transport authorities, who need to invest in the procurement and operation of systems. Users are not inclined to pay for the new technology rather they anticipate that the introduction of integrated smart ticketing will result in reduced fares. Passengers benefit (should) drive the policy of an authority and or operator towards the implementation of integrated smart ticketing. This helps an authority to meet its transport, environmental and wider policy objectives, while operators' revenues also increase.

Costs are generally minimised where appropriate standards are adopted when schemes are first implemented, given inevitable need for migration based on a propensity to seek future integration and this is one particular are where the Commission can have a clear role to play in the future.

The Role of Value Chain members in effecting change

The following summarises the role that particular stakeholders are envisaged to play in delivering the UK Government's vision for integrated smart ticketing, as set out within their 'Smart and Integrated Ticketing Strategy' document. (It should be noted that ITSO plays a specific role within the UK market, leading the development of standards and specifications upon which a UK national scheme would be based).

Smaller and Rural Transport Authorities	• Seek partnership working with larger authorities for economies of scale • Lead on local integrated ticketing development • Administer concessionary travel
Local Transport Operators	• Invest in smart infrastructure • Engage with integrated ticketing schemes • Develop new, innovative ticketing products
Train Operating Companies	• Deliver franchise agreements around infrastructure and smart ticketing usage • Better integration with local ticketing and smart schemes
Suppliers	• Continue to develop smart equipment • Develop integrated infrastructure • Possible role of delivering a managed service to smaller operators or even some Local Authorities
Banking / mobile phone sectors	• Engage with transport providers and the Department for Transport to develop products and eco-systems for the transport ticketing market
Department for Transport	• Provide strategic leadership and deliver the commitments outlined above

Stakeholder	Envisioned Role
ITSO Ltd	• Provide a robust specification, and maintain the ITSO environment • Incorporate new technologies within the ITSO environment • Act as champion for the ITSO specification • Engage with European and ISO standards work
PTE / Large Urban Transport Authorities	• Work in partnership with operators to develop urban integrated smart schemes • Deliver back offices capable of wider expansion for economies of scale • Lead on integrated ticketing development • Administer concessionary travel

Indicative Business Case

The following indicative business case for the implementation of smart ticketing is based on figures presented within the DfT's "Smart and Integrated Ticketing Strategy" document, published in December 2009. This looks at public transport operations outside of London involving around 6.7 million passenger journeys per day. For the purposes of the study, it is taken as indicative of socio-economic / financial returns, broad capital costs and hence payback period for a scheme that might be implemented in other countries on a region-wide basis, scaled according to the anticipated passenger loadings of such a scheme. Costs and benefits below are in pounds sterling, as in the DfT's document. However, for the purposes of the Impact assessment made of EU-level actions, set out within Section 5, cost and benefits are expressed in Euro values, using a euro to pound sterling exchange rate of 1.2.

Benefits of Smart Ticketing

The following benefits accrue from the use of smart ticketing using Smartcards (in comparison with a more conventional paper based ticketing system);

- **Journey time savings - bus passengers -** Indicative savings are of between 1.5 and 4 seconds for an average number of people on a bus of between 10 and 15. Resultant average journey time saving: between 15 seconds and 1 minute. Based on an average value of time of £7.49, this gives benefits to existing bus users of between £77m and £309m per annum. Benefits to new bus users estimated to be between £2m and £13m
- **Benefits of Smart tickets to existing bus users –** Factors including ease of use, more flexible journeys in terms of choice of mode, travel time and easier interchange estimated to be worth a 2.5% reduction of average bus fare. This provides benefits of around £55m per annum
- **Operational cost savings for bus operators** – Based on predicted reductions in overall boarding times (reducing bus dwell times), average speed of vehicles and average vehicle operating costs, indicative benefits are £21m to £57m.per annum
- **More accurate concessionary fare reimbursement** - Based on a typical 5% reduction in reimbursement, benefits would amount to £39m per annum
- **Reduction in fraud (overriding)** - With an assumed 2% uplift in bus revenues, benefits would be £42m per annum
- **Savings in surveys** (for concessionary fare schemes etc) – Estimated to be £5m
- **Additional revenues for bus operators** – Benefits as a result of increased patronage etc estimated to be between £34m and £101m pa
- **Emissions savings** – As a result of reduced bus Km, estimated to be worth between £1m and £2m
- **Congestion savings** – Taking account of reductions in dwell times and increased use of public transport reducing cars on the network with resultant congestion savings, based on a saving of £0.2 per vehicle Km, benefits resulting from the transfer to bus estimated to be between £28m and £75m per annum
- **Emissions savings** - As a result of reduced car Km and reduced congestion, estimated to be between £2m and £4m

Overall Social Cost Benefit Business Case

Net benefits

- From the above figures, **bus annual benefits** are estimated to be between £276m and £623m
- These need to be set alongside **additional bus operating costs** as a result of the use of Smartcards estimated to be £66m
- Hence **net bus savings** have been estimated to be between £210m and £557m
- **Decongestion benefits**, including carbon savings estimated to be between £30m and £79m
- Hence **Net social benefit** estimated to be between £240m and £636m

Capital Costs

Total capital costs estimated to be £330m

Payback Period

Payback period for investment made, accounting for both capital and operating costs is 3+ years

A6 IFM Project Deliverables

The following sections present an overview of deliverables from the IFM project of particular relevance to the Smartcards study, as summarised within Table A6.1

Table A6.1 Summary of IFM Deliverables.

Ref.	Title	Status	Author(s)	Date
1	WP1 Deliverable 1.1: "Collection of Information on Existing Trust Management Models"			February 2009
2	WP1 Deliverable 1.2: "Existing Trust Models and Comparison to Published Best Practice in Other Relevant Business Sectors"			March 2009
3	WP1 Deliverable 1.3: "Report on the follow-up workshop to explain and disseminate the agreed Common Methodology for preparing a Trust Management Model			Sep 2009
4	WP1 Deliverable 1.4: "Report on the Common Requirements for a Secure Domain to support the Trust Management Model"			March 2010
5	WP2 Deliverable 2.1: "Functional survey of existing sets of privacy protection rules applicable to transport IFM applications by national institutions and regulations in different contractors European countries."			March 2009
6	WP2 Deliverable 2.2: "Consensus paper on privacy in transport IFM applications"	V4.3		Dec 2009
7	WP2 Deliverable 2.3: "European handbook on rules and regulations for privacy protection in fare devices and back-offices"	V2.4		March 2010
8	WP3 Deliverable 3.1: "State of the art on interoperable media and multi-application management"			February 2009
9	WP3 Deliverable 3.2: "Common requirements and recommendations on interoperable media and multi-application management"			Sep 2009
10	WP3 Deliverable 3.3: "Migration paths"			February 2010
11	WP4 Deliverable 4.1: "Inventory of functions, organisational models and economic issues of existing IFM Systems"			March 2009
12	WP4 Deliverable 4.2: "Report on the organisational structures and the differences of the existing IFM systems"			March 2009
13	WP5 Deliverable 5.2 "Generic common architecture, interfaces and security principles Strategy Paper"			January 2010
14	WP6 Deliverable 6.2a: "UITP IFM Forum annual report 2008 Deliverable 6.2a, version 2"	V2		March 2009
15	WP7 Deliverable 7.2: "Road Map for the long-term development strategy – conceptual outline"			Sept 2008
16	ISO 24014-1:2007 - Public transport - Interoperable fare management system - Part 1: Architecture (IFMS)			2007
17	Working Paper about E-Ticketing in Public Transport adopted by the G29 working party at the 42nd meeting, 4-5 September 2007, Berlin			Sept 2007
18	German Federal Office for Information Security 53 TG 03126-1Application area "eTicketing in public transport"			
19	Focus paper on "Privacy in transport IFM applications"	V3.2	Gilles de Chanterac	

Work Package 1

The primary objective of WP1 is to identify the Trust Models already in place within the consortium, and to understand and recommend the process to be adopted in the production of an EU IFM Trust Model for existing members. In this context the definition of trust is taken as: "A statement of residual risks that need to be accepted between system operators."

Key Deliverable: D1.1"Collection of Information on Existing Trust Management Models" **Date:** February 2009

This deliverable presents the first findings for Work Package 1 where the group set out to identify the existing Trust Models within the IFM consortium. Using a survey designed to analyse existing risk and risk mitigation, the group found that there is some ambiguity between Trust and Risk, and that the definition of a Trust Model in this project may not have been shared by all the partners.

After a workshop a definition of a Trust Model was agreed with the addition of the concept of 'residual trust' required to deal with the remaining risks, and differing levels of trust required for different transactions, and to reflect the many relationships both Business to Business and Business to Customer.

D1.1 collates this information and reports the results of the survey, together with an example Trust Model (UK-ITSO).

Key Deliverable D1.2 "Existing Trust Models and Comparison to Published Best Practice in Other Relevant Business Sectors" **Date:** March 2009

D1.2 builds on the results of D1.1 and is concerned with collating data about Best Practise Trust Models in other business sectors and detailing the relevance to an EU IFM. The methodology was a stepwise analysis of three case studies covering a wide range of activities:

- Integration of ticketing for air and rail and confirmed the need define a set of rules for IFM players to accepted and trust by all parties involved;
- Local Government Identity and Access Management Trust Model (New York State). Here a matrix of risk versus the impact to the players was created, enabling the level of trust required by players to be identified;
- E-commerce and internet banking, both of which highlight the way to obtain customer trust online.

The analysis steps were: 1 Ascertain the level of trust; 2 Establish the relevant features and 3 Find the possible impact for an EU IFM Trust Model. Although each of the case studies demonstrated key trust levels and requirements and pointed to the overall best practice that should be sought, *the work confirmed that there are no Trust Models that fully meet the needs of this project and that WP1 should design the methodology from scratch*.

Key Deliverable D1.3 "Report on the follow-up workshop to explain and disseminate the agreed Common Methodology for preparing a Trust Management Model" **Date:** September 2009

D1.3 has suggested a simple methodology for the derivation of a Trust Model for IFM. However, the detail of this model will depend on: (i) What IFM is achieving; (ii) How it achieves it; and (iii) The responsibilities accepted by each of the players; especially any new EU IFM organising body.

D1.3 reports the results of the workshops held in early September 2009 where they considered:

- The Trust Management scenarios and their implementations
- The customer offering
- The operator challenges
- Relationships including the EU IFM organisation
- Certification and qualification
- Hotlisting and other back office processes

The relationship between the security management and the operational entities within the EU IFM environment are well summarised in Figure A6.1 taken from the ISO 24014-1 Architecture standard.

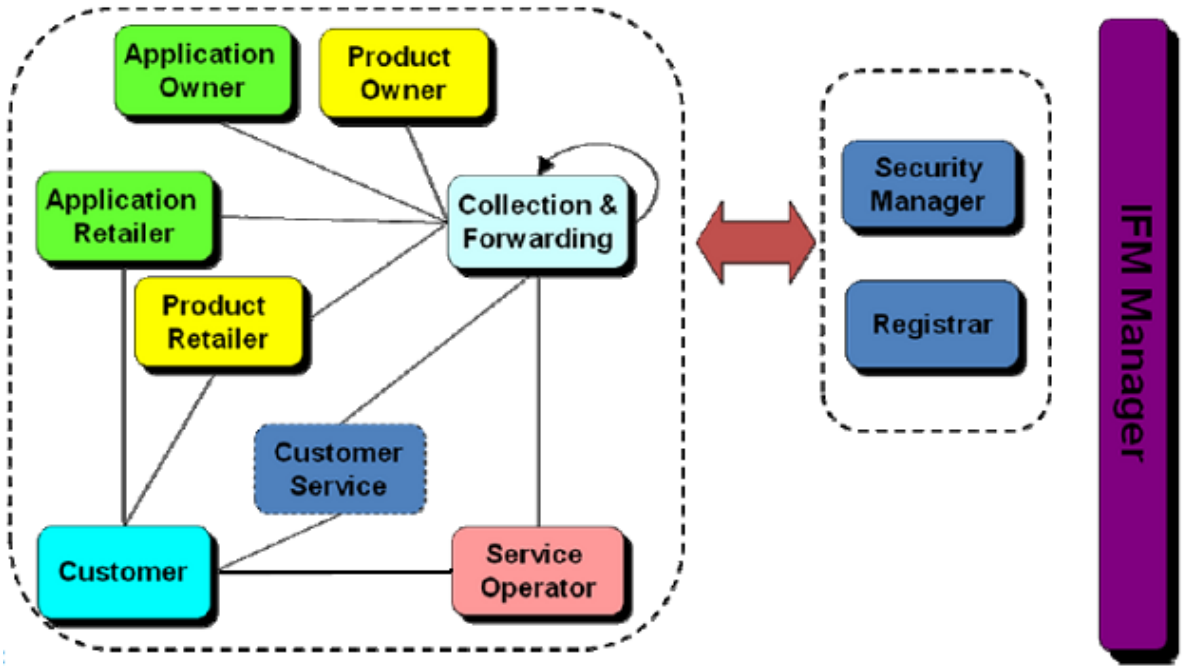

Figure A6.1 Security and operational Entities

It is clear from the Work Package that any Trust Management Model must consider the relationships between these players and the functionality of their relationships and these would be reflected in membership agreements, licenses and contracts to ensure interoperability.

Work Package 2

The objective of WP2 is to propose a privacy model to address traveller's personal data protection issues. This proposed model is compliant with the working paper "e-ticketing in public transport" that was adopted by the international working group on data protection in telecommunications at the Berlin Group meeting in September 2007 (Ref 16). There have been three reports from this working group.

Key Deliverable D 2.1."Functional survey of existing sets of privacy protection rules applicable to transport IFM applications by national institutions and regulations in different contractors European countries." **Date:** March 2009

D2.1 reports the results of a survey that investigated and compared National and European privacy protection regulations applied to public transports as well as existing sets of privacy protection rules implemented in IFM applications by transport agencies and operators.

In particular, the working group looked at privacy protection regulations in France, Germany, Sweden and the United Kingdom. The Netherlands and Portugal were planned to be added later. Annexes report the privacy policies found in France "Privacy regulations for electronic ticketing in transport services in France; Germany:"Constitutional Privacy Framework in Germany" and the UK: "Keeping Your Data Safe".

The survey received replies from five major organisations involved in public transport IFM projects: ITSO (UK); RATP (France); SNCF (France); VDV (Germany and Västtrafik (Sweden) who play multiple roles within IFM including: application owner/ retailer, product owner/retailer, media owner/retailer as well as controller and processor.

It is clear that the objective for gathering customers' personal data is to better address their demands, offer improved services and more targeted direct marketing. However, it is inevitably that the full scope of personal data (first name, last

name, gender, age, postal address, email, telephone and other social data) that is requested when the ticket is purchased is also likely to be available to the functions within the IFMS.

It was also found that personal data stored on the smart medium was usually first name, last name, age, gender, but in some cases none of these data are stored.

One conclusion is that it will be essential for IFM schemes that want to interoperate to promptly identify the risks of undue dissemination of customer personal data and establish the rules for ensuring that these data are protected. The option of setting up a trusted third party to manage and service personal data is also considered and it is suggested that the role of 'Personal Data Manager' is added to the overall IFM architecture.

Key Deliverable D 2.2: "Consensus paper on privacy in transport IFM applications" **Date:** December 2009

The objective of D2.2 was to propose a common basis to build a consensus on the concepts and principles for regulating e-ticketing regarding privacy and giving some directions towards practical implementation by providing best practice guidelines.

The Berlin Group (Ref 16) noted that *"the adoption of a privacy code of conduct should be encouraged. As regards, in particular, processing of data concerning users' movements, the information systems of transportation companies should be designed and implemented by prioritizing the use of anonymous data".* This idea underpins D2.2 where: "*best practice guidelines could be seen as a series of recommendations in order to respect a set of rules in agreement with European directive 95-46 as well as national regulations with the common goal to help public transport authorities and operators to build interoperability and provide seamless travel throughout Europe in due respect of citizens privacy."*

Further, the best practice guidelines might also provide European and member state authorities with a framework which facilitates adapting their decision making process to the organisational and professional context of e-ticketing in public transport.

The report is a useful reference defining the principles for a privacy code such as transparency (duty to inform passenger), fulfilment of transport agreement, anonymity (an option to be offered systematically), security (against misuse of passenger personal data), responsibility for privacy, limits for marketing and research, retention period of personal data, rights of passenger to know, complaint procedures.

At this point in the project, it is evident that consensus was elusive; since existing schemes recognised that they cannot afford to make changes to their already established IFM architectures. Nevertheless, the common understanding of these different issues has provided the basis for the handbook published in March 2010 as D2.3.

Key Deliverable D2.3: "European handbook on rules and regulations for privacy protection in fare devices and back-offices" **Date:** March 2010

D2.3 is the most recent of the EU IFM deliverables where the objective is to provide a code of conduct and a European Handbook on rules and regulations for privacy protection in fare devices and back-office of IFM transport systems. This process has to be performed under stakeholders' control in order to: (i) Increase their confidence; (ii) Remain customer oriented as well as (iii) Technologically flexible.

The handbook provides a common set of rules and regulations for information security and privacy for travellers. The system architecture and the monitoring principles are specified together with definitions of data typology including: privacy; confidentiality; integrity; availability; 'unlinkability'; 'unobservability'; anonymity; authenticity; non-repudiation and accountability. Operational concepts are defined such as: personal identifiers; anonymous objects; subscriber identity; transaction fare data; bank transaction data; indirectly personalised fare transaction data and authorised user identity.

Specific information security and privacy targets include protection of personal data, protection of entitlements, anonymous usage data, reliable invoicing/reimbursement, protection of applications and entitlements and protection against the creation of user movement profiles.

The result is a code of conduct which guarantees anonymous accessibility, protection against risks of personal data abuse by staff or other means, such as of hacking or criminal use.

Generic safeguard measures are finally presented in agreement with the common IFM System Architecture.

Interoperable Media, Migration, IFM Organisation and the EU IFM Road Map

In parallel with the issues affecting privacy, the project has also considered how the various components within a fare management scheme can interoperate successfully. They looked at media support for multi-applications, possible migration paths from legacy media, functional, organisational and economic issues for fare management systems in: France; Germany; The Netherlands; Portugal; Sweden; United Kingdom. Early on in the project, a road map was produced and this is currently under review by the project steering committee.

Work Package 3

WP3 studies the path for introducing interoperable media to provide access to networks that are part of different IFM schemes:

- By defining common requirements to the media themselves and
- By using the media as multi-application devices.

Key Deliverable D3.1: "State of the art on interoperable media and multi-application management" **Date:** February 2009

The D3.1 objective was to provide a state of the art vision of the benefits for multi-application media for end users, a description of multi-application management functions.

At the present, there are many different schemes for Fare Management Systems in operation that are not capable of interoperation because the limitations of their design or because they are implemented using proprietary products. A vision is presented in Figure A6.2 for building interoperability in six clear steps:

Step 1: Multi application Customer Media
Dedicated customer media replaced by more flexible media supporting multi applications allowing products from different IFMs to co-reside and interoperate. In this step customers may load the transport applications they need as they move across EU. Of course, technical and organisational agreements will be needed to ensure seamless operation.

Step 2: EU Status Application

This is a common application indicating the traveller's EU Status.

Step 3 : Common Web Portal

Customers can find help and guidance from a common European web-portal to download the applications and purchase the products they need.

Step 4 : Common template for local products

Inside the common EU IFM application, a standardised template is specified. The EU IFM application will be used for hosting all the local products that the customer may need during his journey across EU.

Step 5 : Common template for common products

Common products are proposed that can be loaded into the EU IFM application and can be used on any Transport networks which are EU IFM compliant. These products include interoperable transport payment-schemes.

Step 6: Common application

In an ultimate phase when all / a part EU transport networks will be EU IFM compliant, IFM schemes may decide to stop maintaining their initial applications and to use only the EU IFM application.

Capabilities on project:
Transportation

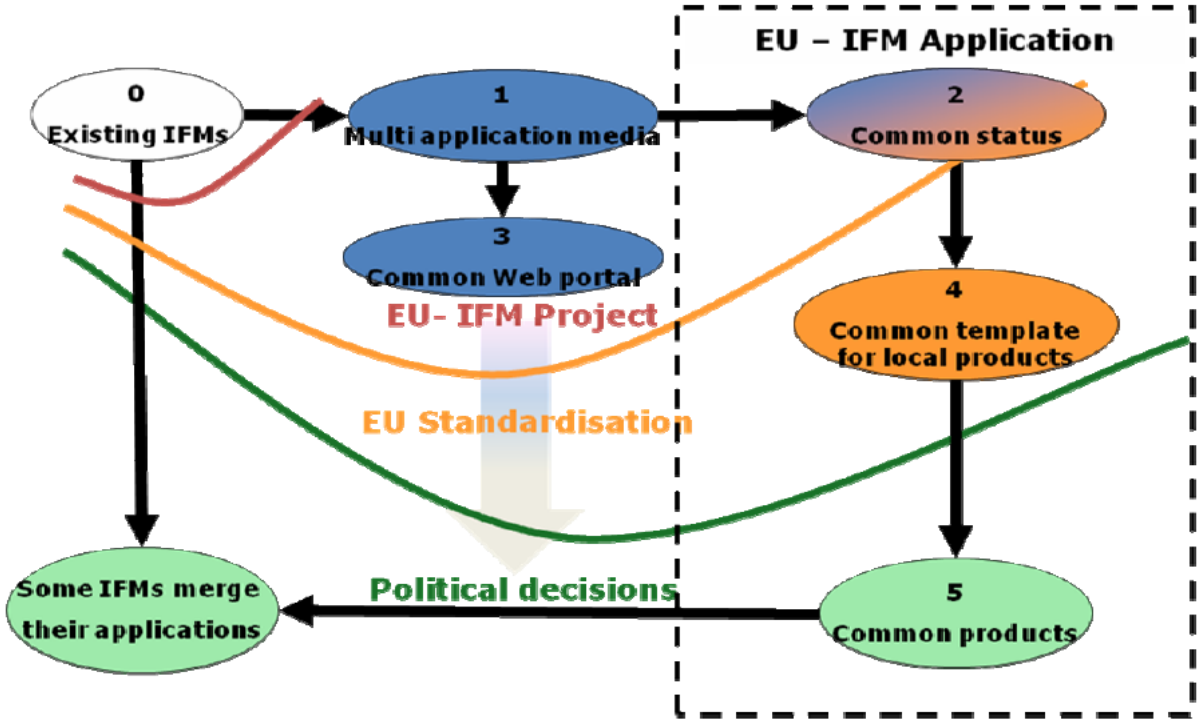

Figure A6.2 Steps to Deliver Interoperability

Steps 1 and 3 can already be defined within the scope of the EU IFM project and made available for use, whereas Steps 2 and 4 can only be achieved after require further standardisation.

Key Deliverable D3.2: "Common requirements and recommendations on interoperable media and multi-application management" **Date:** September 2009

The D3.2 objective is to define common requirements on interoperable contactless media and multi-application management for Public Transport.

Key Deliverable D3.3: "Migration paths" **Date:** February 2010

D3.3 is another recent deliverable covering the migration paths from existing media and applications towards IFM recommended interoperable and multi application media.

It is reported that migration to new media for public transport networks using either VDV KA or Calypso can be reasonably seamless, but it is much less easy to handle for networks only using MIFARE. In the latter case the work of Translink (and Oyster) to migrate to new platforms might be seen as an opportunity to promote and foster the introduction of an EU IFM application.

Work Package 4

WP4, using survey data, has analysed the functions, organisational models and economic issues for the following European fare management systems in: France;- Germany; The Netherlands; Portugal; Sweden; United Kingdom.

Key Deliverable D4.1: "Inventory of functions, organisational models and economic issues of existing IFM Systems" **Date:** March 2009

In D4.1 the working group have applied analysis of functions, organisational models and economic issues for the following European fare management systems throughout the EU Community including: France; Germany; The Netherlands; Portugal; Sweden and the United Kingdom. Representatives from each country were surveyed using a questionnaire on their national system. The questions were categorised as:

- Criteria Group 1: IFM System Architecture
- Criteria Group 2: System Concept
- Criteria Group 3: Security
- Criteria Group 4: General Conditions / Legal Framework

It was found that all systems support Specific National Standards for IFM/EFM, providing a good common basis for a migration to a EU-IFM and that all of the various systems more or less comply to common IFM System Architecture described in the standard ISO EN 24014-1 (Ref 16).

Key Deliverable D4.2: "Report on the organisational structures and the differences of the existing IFM systems" **Date:** March 2009

Although D4.1 found some cause for optimism in that most scheme designers had adopted ISO EN 24014-1 as the basis for their system architecture, D4.2 reports large differences in the implementation of EFM systems based on the national standards. Pragmatically, short term solutions should be based on the existing national Ticketing Applications and support the migration to the forthcoming long-term objective.

Again the working group looked at the situation in France; Germany; The Netherlands; Portugal; Sweden and the United Kingdom and considered six scenarios to test the sophistication of each with regard to interoperation.

Today ITSO (UK) and VDV-KA (Germany) guarantee the highest requirements in terms of organisation. The future organization to manage the Europe ticketing application will need to orient in such requirements.

As for the applications loaded onto the customer media, VDV-KA and INTERCODE/OTLIS meet the highest requirements using only micro-processor cards. Both these systems guarantee that the application on the media have the same specified interface.

ITSO and VDV KA already support product interoperability and have developed back office systems for nationally interoperable products, giving both systems an advantage when interoperability is required between transport authorities or ultimately across national boundaries.

Work Package 5

Key Deliverable D5.2 "Generic common architecture, interfaces and security principles Strategy Paper" **Date:** January 2010

The objective of this deliverable is to analyse the scenarios identified in the IFM road map with the goal of identifying the relevant national interfaces and establishing the requirements which will ensure that the successful interoperability at these points.

A generic system model is proposed based on the EFM system according to ISO 24014-1 at a technical system level which identifies generic components and interfaces as well as generic elementary processes and which will be used as a framework in the analysis.

A set of national IFMs can then be viewed as being encapsulated in such a model IFM and the analysis reported identifies the processes at this encapsulated level which will require interaction with the established national (sub-) systems.

The final chapter identifies the “interactive” processes which should be “standardized” in order to assure interoperability, including:

- Data structures and communication;
- Security measures;
- Assignment of residual risk;
- Cooperation agreements (rules);
- Commercial agreements and Service level agreements between partners.

Work Package 6

Key Deliverable D6.2a: “UITP IFM Forum annual report 2008 Deliverable 6.2a, version 2”**Date:** March 2009

Work Package 7

The ultimate goal of the IFM Project is a European-wide agreed Road Map developing shared

back-office rules for cross-border data exchange and the associated downloadable European Security Platform and Application.

The largely successful objective for IFM1 was to deliver a documented framework by 2010 to deliver the requirements for secure, fully interoperable portable object for seamless mobility on public transport accessible to all European Citizens.

Beyond IFM Phase I which was due to complete at the end of 2009, the IFM-Project Phase II has the primary aim to make public transport more user-friendly by facilitating this seamless accessibility to different public transport networks across Europe using smart media.

Key Deliverable D7.2: “Road Map for the long-term development strategy – conceptual outline” **Date:** September 2008

D7.2 was published shortly after the project started and set out the aims and objectives for the IFM initiative and the EU-IFM steering committee are expected to publish an update shortly.

Capabilities on project:
Transportation

A7 Use of Standards Within Reviewed Schemes

Scheme:	ITSO	Vestfold	PASTEL – Tisséo - Toulouse	Wallonia	OV-Chipkaart	TfL Oyster

Standard	Description	ITSO Response	Vestfold Response	PASTEL Response	Wallonia Response	OV-Chipkaart Response	TfL Oyster
ISO/IEC 7816	Identification cards – Integrated circuit(s) cards with contacts	No	Yes	7816-4	Yes	7816-4	Yes
ISO/IEC 10170	Information technology – security techniques – Key management	May be adhered to, but not mandated by ITSO					No
ISO/IEC 11770	Information technology – Security techniques – Key management	May be adhered to, but not mandated by ITSO					No
ISO/IEC 14443	Identification cards – Contactless integrated circuit(s) cards – Proximity cards	Yes	Yes	Full A/B	Type B	Yes 14443-1,-2,-3 & -4	Type A (Mifare)
ISO/IEC 17799 Revised as ISO/IEC 27002	Security of IT systems	May be adhered to, but not mandated by ITSO				Yes	Yes
ISO/IEC 18902	Near field communications (NFC)	Yes through emulation of for example: DESFire					Hardware support
ISO EN 24014	Public transport — Interoperable fare management system (IFM)	Yes	Yes			Yes	No
ISO/IEC 27001	Information technology – Security techniques – Information security	May be adhered to, but not mandated by				Yes	Yes

Capabilities on project:
Transportation

Standard	Description	ITSO Response	Vestfold Response	PASTEL Response	Wallonia Response	OV-Chipkaart Response	TfL Oyster
	management systems – Requirements	ITSO					
EN1545	Identification card systems – Surface transport applications	Yes	Yes	Consistent with the national standard Intercode V2	Yes	Yes	No
EN1546	Identification card systems – inter-sector electronic purse	No	Yes				No
EN12896	Reference Data Model For Public Transport (Transmodel)	No		Consistent with the national standard Intercode V2			No
prEN15320	Interoperable Public Transport Application (IOPTA)	Yes		Only in part because standards are not stabilised during the phases of Tisséo system design			No
Others	*Please list*						
X.680	ASN_1		Yes				
X.691	ASN_1 PER		Yes				
X.509	PKI for single sign on		Yes				
Calypso V2				Yes			
DES,3DES	Federal Information Processing Standards Publications: FIPS PUB 46-3 (October 1999): Data Encryption Standard (DES);					Security	
ISO 3166-1	English country names and code					Fare Media	

Capabilities on project:
Transportation

Standard	Description	ITSO Response	Vestfold Response	PASTEL Response	Wallonia Response	OV-Chipkaart Response	TfL Oyster
	elements						
ISO 8824-1:1995 ISO 8824-1/Amd.1	Abstract Syntax Notation One : Specifications					Fare Media	
ISO 8825-2:1995	ASN.1 encoding rules					Fare Media	
ISO 9594-8	Information technology – Open systems interconnection – the directory: public keys and attribute certificate framework					Security	
ISO 9798-2	Information technology – Security techniques – Entity authentication – Part 2: Mechanisms using symmetric decipherment algorithms (second edition: 1999-07-15)					Security	
ISO 9798-3	Information technology – Security techniques – Entity authentication – Part 3: Mechanisms using digital signature techniques (second edition: 1999-07-15)					Security	
ISO/IEC 10116	Information Technology – Security techniques – Modes of operation for an n-bit bloc cipher (1997)					Security	
ISO/IEC 7810	Identification cards – Physical characteristics (2003)					Security	
MD5	RFC 1321: MD5 Message-Digest					Security	

Capabilities on project:
Transportation

Standard	Description	ITSO Response	Vestfold Response	PASTEL Response	Wallonia Response	OV-Chipkaart Response	TfL Oyster
	Algorithm (April 1992)						
PKCS	Cryptographic algorithm: RSA Laboratories Public Key Cryptographic Standard					Security	
RSA	Encryption algorithm using a pair of private and public keys					Security	
X.509 v2	Certificate Revocation List: ITU-T Recommendation X.509 v2 / ISO/IEC 9594-8					Security	
X.509 v3	Certificate: ITU-T Recommendation X.509 v3 / ISO/IEC 9594-8					Security	
Specifications Document Open Architecture:						Complete set of specs to enable interoperable travel on e-purse and products. Including security management, fare calculation, central clearing & settlement.	
No of devices						60,000	
No of cards						7m	
No of suppliers						12	
No of transactions						16m	

Summary of the Predominant Standards with the Smartcards Industry

Term	Definition	Category
DES, 3DES	Federal Information Processing Standards Publications: FIPS PUB 46-3 (October 1999): Data Encryption Standard (DES);	Security
ENV1545-1:1998	Identification Card Systems-Surface Transport Applications Part 1 : General data elements	Fare Media
ENV1545-2:1998	Identification Card Systems-Surface Transport Applications Part 2 : Transport payment related elements	Fare Media
ISO 14443-1	Identification cards - Contactless integrated circuit(s) cards – Proximity cards -- Part 1: Physical characteristics	Fare Media
ISO 14443-2	Identification cards - Contactless integrated circuit(s) cards – Proximity cards - Part 2: Radio frequency power and signal interface	Fare Media
ISO 14443-3	Identification cards - Contactless integrated circuit(s) cards – Proximity cards - Part 3: Initialization and anti-collision	Fare Media
ISO 14443-4	Identification cards - Contactless integrated circuit(s) cards – Proximity cards - Part 4: Transmission protocol	Fare Media
ISO 3166-1	English country names and code elements	Fare Media
ISO 8824-1:1995 ISO 8824-1/Amd.1	Abstract Syntax Notation One : Specifications	Fare Media
ISO 8825-2:1995	ASN.1 encoding rules	Fare Media
ISO 9594-8	Information technology – Open systems interconnection – the directory: public keys and attribute certificate framework	Security

Capabilities on project:
Transportation

Term	Definition	Category
ISO 9798-2	Information technology – Security techniques – Entity authentication – Part 2: Mechanisms using symmetric decipherment algorithms (second edition: 1999-07-15)	Security
ISO 9798-3	Information technology – Security techniques – Entity authentication – Part 3: Mechanisms using digital signature techniques (second edition: 1999-07-15)	Security
ISO/IEC 10116	Information Technology – Security techniques – Modes of operation for an n-bit bloc cipher (1997)	Security
ISO/IEC 7810	Identification cards – Physical characteristics (2003)	Security
ISO/IEC 7816-4	Information technology – Identification cards Interindustry commands for interchange (1995-12-15)	Security
MD5	RFC 1321: MD5 Message-Digest Algorithm (April 1992)	Security
PKCS	Cryptographic algorithm: RSA Laboratories Public Key Cryptographic Standard	Security
RSA	Encryption algorithm using a pair of private and public keys	Security
X.509 v2	Certificate Revocation List: ITU-T Recommendation X.509 v2 / ISO/IEC 9594-8	Security
X.509 v3	Certificate: ITU-T Recommendation X.509 v3 / ISO/IEC 9594-8	Security

Capabilities on project:
Transportation

A8 Opinion Survey of Panel Members Related to Draft Study Recommendations and Conclusions

Dear Panel Member, this short survey presents preliminary conclusions and recommendations from the EC Smart Cards Study. It relates to actions which might be undertaken at an EU level to promote and support integrated smart ticketing.

The survey should take approximately 10 minutes to complete. Please indicate your level of agreement or disagreement with each of the statements below. At the end of each set of questions you are invited to add any further comments or suggestions that you may wish to make. At the end of the questionnaire, there are some more general questions posed concerning the role of the EC.

We look forward to receiving your views. Many thanks in advance for your contribution.

In terms of providing Strategic Leadership, the EC should:

	Strongly Disagree	*Disagree*	*Unsure*	*Agree*	*Strongly Agree*
Publish a Vision and suggested Roadmap, with indicative timescales, for how they would like to see integrated smart ticketing develop and evolve in the future	❑	❑	❑	❑	❑
Continue to conducting detailed assessments of schemes, identifying and facilitating the sharing of best practice	❑	❑	❑	❑	❑
Provide a framework and methodology for benefits and costs and establishing business cases for investment in new and integrated schemes	❑	❑	❑	❑	❑
Set out model scheme designs, business cases and model agreements between partners, to be adjusted according to local circumstances	❑	❑	❑	❑	❑
Engage with key stakeholders, including those developing new technologists like EMV and NFC devises and support relevant research, seeking / supporting technological convergence	❑	❑	❑	❑	❑
Provide financial incentives to stimulate further public and private investment and delivery	❑	❑	❑	❑	❑

Ensure the right 'tools' are available for those developing and implement schemes (overall architecture, standards and specifications) and encourage their use	❑	❑	❑	❑	❑

Additional comments /suggested actions:

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Q2 With respect to scheme Infrastructure, the EC should:

	Strongly Disagree	*Disagree*	*Unsure*	*Agree*	*Strongly Agree*
Provide additional funding for schemes that conform with best practice as advised by the EC, to speed up the development of integrated smart ticketing schemes	❑	❑	❑	❑	❑
Develop model Framework agreements for the supply of services and equipment to authorities and operators	❑	❑	❑	❑	❑
Include smart ticketing requirements in all new let franchises	❑	❑	❑	❑	❑

Additional comments /suggested actions:

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_____

Q3 In terms of encouraging integration between Tickets, the EC should:

	Strongly Disagree	*Disagree*	*Unsure*	*Agree*	*Strongly Agree*
Produce best practice guide for the implementation of smart and integrated products	❑	❑	❑	❑	❑

Capabilities on project:
Transportation

Use all existing policy, legal and financial levers and mechanisms to help shape the institutional and operational arrangements required to deliver integrated ticketing	❑	❑	❑	❑	❑
Closely monitoring developments and see if additional levers and mechanisms (possibly involving legislation) are warranted in the future	❑	❑	❑	❑	❑
Provided financial incentives for the provision of real time information, if fed by data from smart ticketing schemes, within public transport	❑	❑	❑	❑	❑
Produce a 'seal of approval' for schemes which comply with appropriate data security / personal privacy standards	❑	❑	❑	❑	❑

Additional comments /suggested actions:

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A9 Consultations with Financial Service Providers

Administrative Issues

From the responses received from the FSPs, it is suggested that partnership working between a diverse range of stakeholders will be important for the delivery of future Public Transport smart-ticketing. In addition to the FSPs and Public Transport service providers, other key partners include Government and other administrative authorities (from the European level down to the local level), equipment vendors and suppliers, as well as passenger groups. All organisations noted here represent the interests of agents across the smart-ticketing value chain, and so it was interesting to ascertain where the FSPs saw their role in the value chain, and what services they could potentially provide.

It was suggested that these organisations can provide business models, standards and solutions for the use of contactless media in Public Transport across different transport modes and networks. This included access to technical assistance and expertise to enable providers to accommodate specific needs in particular markets (such as Public Transport ticketing). The aforementioned link between the wider promotion of contactless technology and making Public Transport ticketing more comprehensive and efficient, thereby increasing the acceptance of contactless services by the general public, was once again mentioned.

The greater promotion of contactless technology is especially important as the banking sector continues the rollout of such technology for non-transport payments, so it is clearly seen by FSPs as an opportunity which the Public Transport sector should perhaps be embracing for the delivery of future ticketing services. This view was further supported by responses to questions about business models and card platforms; it was evident that the FSPs viewed their card platform as the one upon which future Public Transport ticketing should be delivered, and that future business model for these services should perhaps be based around Public Transport providers and operators accepting contactless payment from FSP cards at the barriers/gates and on-vehicles.

It was acknowledged that financial cards and Public Transport smartcards should continue to co-exist, to enable travellers to choose how to pay for their travel, but it was felt that using the FSP platform would deliver the greatest benefits. For the consumer, it would only require a single card in the wallet/purse, which would be accepted on all services and across borders, providing a fast and convenient payment service, with the added security of a bank card in case of loss, theft or fraud.

For the transport operators, working off the FSP platform could offer economies of scale and reduce the cost of distributing and managing the cards, thereby lowering potential operating costs. Transport-specific services, for example, the delivery of concessionary travel entitlements (for which hosting on a FSP card may not be the best solution) should still be maintained on the transport operator's card platform, suggesting that total migration of all Public Transport smart-ticketing onto the FSP platform is perhaps unlikely.

The Public Transport Smart-Ticketing Market and Drivers for Implementation

The consultations with scheme owners indicated that current smart-ticketing schemes had been introduced as early as 1998, whereas the FSPs had only entered the Public Transport market in (approximately) the last five years. Therefore, it was of interest to know how, as non-transport providers, they perceived the current global smart-ticketing market and what the key aspects were driving the greater entry of their services into the market.

The main message here was that FSPs perceived the current market to be highly fragmented, across international, national and regional scales. Whilst mature solutions do exist in individual areas/regions (for example, TfL's Oyster was specifically mentioned here), these are primarily based upon ***proprietary*** technologies with little scope for future integration. It was noted that national standards were emerging in this arena; however no specific mention was given any particular standard, nor was any reference given to ITSO, Calypso etc.

The fragmented nature of the current market was a clear opportunity for FSP services to be introduced into smart-ticketing to enable systems to be interoperable. In the short term, the general view was that existing systems would remain as is, although there would be a greater influx of EMV contactless technologies, perhaps following the examples adopted by cities such as London/Oyster. As EMV contactless technology becomes more abundant and accessible, the medium-to-long term future is seen as one where EMV contactless platforms become the standard upon which smart-ticketing is delivered, possibly in line with the development of a wider single European payment area; indeed some cities consulted by the FSPs have indicated a desire to move to a system wholly based upon EMV platforms and standards, including prepaid cards products for those without debit/credit cards.

Regarding the key drivers for entering into the smart-ticketing market, the primary reason appears to be related to the wider initiative to replace small cash (i.e. under £10 (€12)) transactions with e-payments.

The Public Transport sector is identified as being 'cash-dominated' and there are safety implications for staff having to transport large volumes of coinage from vehicles/ticket machines to safe storage. The adoption of contactless

payment would be applicable to the majority of local Public Transport fares, including many day tickets, especially as Pay As You Go tarification structures have been adopted by many scheme operators. FSPs identify that there would be clear benefits relating to convenience and efficiency for the user by removing the need for multiple small cash transactions for PAYG travel, in particular if the smart-ticketing back office can automatically apply a fare cap when the combined cost of individual journeys exceeds that of the relevant day ticket.

It was reiterated that the adoption of EMV in smart-ticketing could help further the general acceptance of contactless technologies, and that FSPs aspire to be a trusted and preferred partner for the provision of Public Transport smart-ticketing in the future. Indeed there are a number of ticketing schemes provided on the FSP platform which are now moving from pilot to full operation, and so it is no longer a question of 'when' will the FSPs move into Public Transport smart-ticketing, but 'where' will they implement their services next?

Returning to the fragmented nature of the current smart-ticketing market, when asked about what spatial level at which smart-ticketing should be provided, FSPs were very clear that given the solutions and opportunities provided by their services (there are 1 billion EMV cards now in service worldwide), ***global*** interoperability should be the ultimate goal. It is believed that Local Authorities should be giving serious consideration to this wider picture, through investment in smart-ticketing technologies which would not preclude greater interoperability with others and also achieving economies of scale.

This wider vision would still allow for local implementation of ticketing services whilst maintaining international standards, essentially allowing consumers to travel and use their cards anywhere in the EU. It was noted that such an approach would also be desirable from the perspective the Europe Commission's 'Single Market for Payments' project where there is a lot of work being done, and investment being committed, to developing a Single Euro Payment Area. The key driver here is that one bank account in the Euro currency should be enough to make payments cross-border with the same ease and speed as it currently available for purely national payments. It is believed that this approach should be taken in relation to smart-ticketing solutions i.e. one card for travel across the entire EU area. As a result, it is thought that there is no real future in existing/future systems relying on/developing proprietary solutions for smart ticketing services.

Implementation of these international requirements would also mean that existing and future scheme operators would have a greater selection of hardware and software providers to work with, and would not be limited to just one. This implied supplier monopoly can dictate costs leaving the scheme provider without any bargaining power, whilst having a larger pool of providers also means greater competition and more innovation.

One final, important note was that in addition to credit and debit cards, prepaid cards are a rapidly growing segment for FSPs. These cards – which can be contactless – can be either personalised or anonymous, offering those without bank accounts the opportunity to have e-payment for services, which would include Public Transport ticketing in the future.

Service Provision Planning and Technical Aspects

FSPs have been playing a role in the smart-ticketing market for around five years and have established positive working relationships with many scheme providers during this period. The realisation of contactless EMV payments in smart-ticketing pilot schemes shows that these working relationships are successful and have demonstrated that EMV technologies are now feasible for Public Transport ticketing. However, in a similar vein to the experiences of the scheme providers consulted previously, the main negative experiences have been related to the limitations of available budgets of transport providers to support the wider roll-out of new smart-ticketing technologies.

For FSPs, other negative aspects of attempting to enter the market have been the apparent lack of open data on global fare collection operations, as well as encountering some individuals who were 'ticketing traditionalists' entrenched in their existing systems and not open to the idea of new technologies. In particular, one major barrier still hindering the development of this sector are the costs associated with scheme implementation.

Financial institutions have to pay for the issuing of contactless cards and there are additional costs associated with promoting their services, convincing the transport industry about the security of EMV certification process for terminals. However, existing financial incentives for research and development intended to accelerate the adoption of smart-ticketing have been limited to transport-specific schemes and standards, with no consideration given to the acceptance of contactless banking cards and their standards. This lack of open competition is something FSPs feel needs to be addressed if future aspirations are to be realised.

Regarding the underlying technological systems, FSPs do not see their organisations as ones which would provide complete ticketing systems, from the front-end gates/barriers/terminals through to the back-offices. Instead, it is suggested that they are best positioned to provide various system components and services to support individual smart-ticketing systems. As mentioned, the main advantage the FSPs believe they can offer Public Transport providers is the provision of payment infrastructures with secure transactions, which will operate on a pan-global scale.

However, any payment solution for smart ticketing would need to be compliant with specific financial card standards as well as international standards (for example ISO, EN, EMV). It was also noted that unlike previous examples of integrated service cards (such as Citizen and Transport cards), the use of FSP cards in Public Transport would not necessarily imply that a

transport ticket (i.e. stored travel rights - STR) would be loaded onto a card, thus requiring a dedicated sector on a card's memory chip. This was also important as FSPs would not be in a position to influence tarification systems and structures for individual Public Transport networks; however the contactless technology would be particularly favourable for PAYG operations with appropriate fare capping.

User and Provider Benefits

The final section of questions addressed the potential benefits of FSPs entering into the Public Transport market. Many points raised in earlier sections are also valid here, but the main benefit for users from the FSPs perspective would be the convenience of 'swipe and go' and not having to carry small change to pay for individual Public Transport journeys. This would greatly increase the speed of transactions which would come directly from the user's bank account (with the added security of existing financial services), and not from a specific smartcard with STR, which users have to apply for prior to travel, as per most current smart-ticketing systems. People would only need to store one card in their wallet/purse, and would have the ability to use it domestically but also when they were abroad, be it on business or on holiday.

Existing smart-ticketing has demonstrated benefits over cash-based ticketing, and FSPs believe that their contactless card platforms can bring further benefits. For Public Transport providers, the main benefits would relate to the outsourcing of the management of card supplies and payment infrastructures, with the added benefit of global security mechanisms, all of which have the potential to reduce overall operating cost.

The advancement of FSPs into the Public Transport market is clearly viewed as a mutual relationship, as Public Transport ticketing has been specifically targeted by the FSPs as an important sector for the wider promotion of their contactless technologies. Their aspiration to shift the mindset of consumers by displacing everyday payments which are typically associated with cash purchases towards electronic payments is a move that the original smartcard concept was also designed to address. The main challenge for FSPs will now be persuading transport operators to consider their card platforms as the future foundation upon which Public Transport ticketing will be offered, and encourage more operators to move from their proprietary smartcard systems, embracing the wider adoption of EMV to introduce greater economies of scale in this sector.