ITSO SMART CARDS IN WELSH PUBLIC TRANSPORT

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ABSTRACT

This paper will discuss the progress of the Welsh Assembly Government project to introduce smart card technology to public transport in Wales, UK and addresses the achievements of the project to date, how the lessons learnt during its initial phases can benefit other smart card schemes looking to implement within the ITSO environment and how the further exploration of smart card technology will move forward in Wales.

KEYWORDS
Smart card, government, public transport, ITSO, interoperable, electronic ticketing

WALES’ ITSO ENVIRONMENT FOR SMART CARDS

Wales is one of the four nations that make up the United Kingdom and has a population of just over 2.9 million. The Welsh Assembly Government is the devolved government for Wales and is responsible for health, education, economic development, culture, the environment and transport. Residents aged over 60 and disabled passengers of all ages are entitled to free travel on local bus services across Wales since 2002, and the concessionary fares scheme remains part of the Top 10 Assembly Government commitments to the electorate, where over £50m of public money is provided per annum in revenue support to bus operators each year. In 2008, the Welsh Assembly Government began to issue standardised contactless smart cards to over half a million concessionary pass holders, to further enhance the concessionary fares scheme, provide quicker boarding times, accurate data capture and more efficient and auditable reimbursement.

The benefits of ITSO standards in Wales

The scheme makes use of integrated systems that follow a common open specification developed by ITSO [2], an organisation formed by leaders in the UK transport industry to establish standards in smart card technology with the intention to make national multi-
modal interoperability a reality. In contrast to other “closed” or “black box” smart card schemes that act within self-prescribed boundaries, the interoperable ITSO specification is built on the vision that multiple schemes (both commercial and public sector) will be able to share and interlink acceptance of their ticketing products and services so that passengers may experience a seamless journey on any mode of public transport that they choose using electronic ticketing. In addition to this, the chip embedded within the smart card allows opportunities for extension beyond ITSO and the transport environment, with enough memory to hold additional applications that may be used for services such as prepayment, citizen entitlement privileges, loyalty bonuses, and beyond: services of this kind are already being used effectively by ITSO schemes in Scotland and England.

The ITSO operating licence

After becoming a member of ITSO, signature of the ITSO Operating Licence is the first step in setting up a live transport smart card environment, and forms the contractual basis of a scheme’s relationship with other scheme owners and ITSO themselves. It represents the agreement between all parties to protect the integrity of the environment, and includes clauses that cover use of the ITSO systems themselves, service level agreements and fees. Although called a Licence, it is a binding contractual document that must be treated as such, and adequate time should be given to allow a thorough understanding of the implications of signature by senior members of the operator’s organisation and, more than likely, lawyers. Because the document is owned by the ITSO membership, changes to clauses are not easily negotiable and would have to go through a full consultation period with all ITSO members if it were to change – meaning potential delays to the start of any scheme. In Wales the Operating Licence took months to agree and signature was ultimately raised to a Cabinet level. Our recommendation would be to have early sight of this document at the project inception stage, identify any potential issues at the start and to discuss and understand them with ITSO at the earliest opportunity. This may well help to expedite a potentially lengthy process, and is very important as the systems cannot be built without signature of this document.

Setting up the HOPS

The central hub of the ITSO system is known as the AMS/HOPS (Asset Management System / Host Operator Processing System – usually known simply as the “HOPS”), and acts as a passenger journey database through which all secure ITSO transactions are processed. Setting up a HOPS is one of the most technically challenging aspects of entering the ITSO environment and requires experienced suppliers and advisors as it is the mission-critical system that must be addressed before any other. Schemes must first understand how they wish their Operator Identification (OID) structure to work – this is essentially a set of identifiers that allow definition of the structure of your scheme, to allocate ticketing product ownership, provide the ability to uniquely encode the ITSO
artefacts and configurations, and future proof for changes in that structure. Wales has an “umbrella” OID structure, where the Welsh Assembly Government retains the top level (or parent) OID identification, with a series of other OIDs that sit below. Every scheme has their own requirements, need for different types of flexibility and different goals, however, the thought around considering an OID structure and the relationships held therein is critical to ensuring that your ITSO scheme may remain flexible enough to change in the future with minimum impact on time, resource and cost. It is from this that the HOPS can then be built, the system can be commissioned and linked to your Card Management System, and enable personalised card-encoding, ISAM commissioning, and POST messaging to begin.

**POSTs, ISAMs, PersoPOSTs, and the CMS**

The HOPS communicates with the front office bus depot systems and Point of Service Terminals (POSTs): these are the Electronic Ticket Machines (ETMs) on-board buses which allow the flow of data to and from the ticket machine to the bus depot system to the HOPS on a daily basis. Inside every POST is a specially commissioned ITSO Secure Application Module (ISAM), a literal “key” to interoperability, which determines which ticketing products and services can be accepted and includes the ability to securely add additional ITSO ticketing products and services to the smart card on bus. The ISAM also allows the ITSO transaction to be identified for operator reimbursement. When the chip is encoded, as well as containing the unique Wales identification, it is assigned to a public transport operator so that it may be individually managed and tracked throughout the course of its life, and so that each operator’s transactions can be differentiated from the next – especially important for reimbursement.

The personalised smart card issuance equipment (Perso-POSTs) in Welsh Local Authorities enable new live smart cards to be produced and encoded on demand, and for products and services on the card to be added, confiscated, hot-listed or deleted by the issuer through a direct and secure web-based interface with the centralised Card Management System (CMS). The CMS can be accessed by all 22 Local Authorities in Wales with hierarchy based security partitions to protect both the integrity of the data and to ensure that certain functions are only accessed by those with appropriate system privileges. The system also has comprehensive reporting capabilities which allow the Welsh Assembly Government and Local Authorities to analyse and model the passenger data held in the system. During the bulk card re-issue and rollout in Wales, a temporary remote central bureau was also formed using multiple concurrently running perso-POSTs to allow thousands of cards to be encoded and switched on each day, whilst maintaining real-time communication with the HOPS and CMS.

**Reimbursement system**
The centralised reimbursement system, also web-based and securely partitioned, receives detailed extracted data from the HOPS on journey transactions so that Local Authorities may accurately calculate the amounts owed to bus operators for concessionary travel. It is at this point that the ISAMs allocated to operators allow transactions to be identified, grouped, analysed using time parameters or geographical boundaries, and then translated into a monetary value using a reimbursement factor set by the Welsh Assembly Government. Currently in Wales, operators are reimbursed for each concessionary journey based on the passenger’s point of boarding (i.e.: the boarding point signifies the Local Authority responsible for the administration and payment for the travel). Therefore if a passenger uses multiple operators across multiple boundaries or regions, at the point of reimbursement the transaction is grouped according to location and service provider and reimbursement occurs for the journey (or part journey) that has taken place. The system also retains enough flexibility to adjust the parameters to protect against change in reimbursement principles, for example adjustments in geographical boundaries or routes.

**ISMS, external HOPS, and ITSO compliance**

Finally, to complete the ITSO architecture and provide interoperable transactions, the Welsh architecture is linked to external ITSO systems: the ITSO Security Management System (ISMS), which facilitates multi-HOPS communication with other schemes; and a “HOPS to HOPS” capability which allows Wales to directly communicate with HOPS that are owned by schemes that share our back-office systems supplier. So, if two schemes agree to accept and/or recognise each others ticketing products but have different systems suppliers, the ITSO transaction is forwarded to their HOPS via the ISMS as and when that smart transaction is recorded. The ISMS also provides the ability to send certain types of messaging to ISAMs in POSTS across the ITSO environment, which is especially important when dealing with “hot-lists” that protect all schemes against fraudulent card or product use. Hotlisting is described in further detail later in this paper.

To maintain system security and integrity, each aspect that sits within the Wales architecture that requires reciprocal messaging from the HOPS must be ITSO compliant, and tested and certified to this standard. This is incredibly important not only for the immediate needs of Wales’ scheme, but also for the integrity of any operator that sits within the ITSO environment. True interoperability means that all the secure systems are interacting constantly, so the ITSO community as a whole must remain confident that any new scheme owner or “ITSO Licensed Operator” protects the security and integrity of the entire estate and not merely their own portion of it. On signature of the ITSO Operating License, this also becomes a contractual obligation, and although this certification comes at a premium in terms of contractual and financial commitment, the ultimate benefits of cross-scheme capability for passengers merits the investment.

**Project Implementation Phase 1: Commissioning systems and migration**
The first major phase of the project has been system commissioning and the bulk reissue of bus passes to eligible concessionary travellers. Prior to this project, concessionary travel pass data was held on local databases by each of Wales’ 22 Local Authorities. For a cost-effective implementation of an all-Wales scheme the migration to the centralised CMS database was necessary to benefit from economies of scale: the systems were procured in 2006, commissioned in 2008, with card rollout finishing in 2009. The project worked through many challenges, the technical problems mainly experienced during the integration and testing phases in the first two months after system commissioning. Building in contingency weeks for testing and for each migration phase has also proven invaluable and although it has taken 18 months in total this has been an acceptable timescale for the phased authority-by-authority approach. The avoidance of a “big-bang” rollout has been beneficial to Wales, most especially in the confidence that now exists with regard to the quality and security of our national passenger database. The ability to show flexibility in addressing 22 different sets of needs in each location has also been essential to retain enthusiasm, momentum and buy-in from all the Welsh authorities.

Prior to migration, the quality of the data held by Local Authorities varied widely and, as part of their responsibility as data owners, extensive data cleansing was carried out by each prior to the migration to the new database. For the majority, this phase usually worked through 2 cycles over 2 years to ensure maximum benefit and minimum risk: usually data was sent to a contracted cleansing service and the remaining records were manually, sometimes painstakingly, searched and updated in-house based on the up to date information available. The relationships between local registrars during this process also both helped and hindered progress dependent on the strength of information that could be obtained at each local authority and, ongoing, recommendations have been taken forward to further improve internal relationships and an understanding of the real and sometimes assumed boundaries around sharing data.

In addition to these steps, during the migration process itself authorities have been able to use a “holding area” within the CMS for any record which may have had a question mark on its validity. This has allowed authorities to continue checking their data immediately after their migration, ‘flushing out’ erroneous data after the initial reissue, although this has been minimal. This has ensured that a proportion of cards that could have been reissued in error have been managed over a designated period of time without any undue negative impact on the card holder. This has saved money, time and any unnecessary heartache for families with recently deceased relatives whose records may not have been identified. Mandatory field requirements and data handling business rules within the system also ensure that data is recorded accurately and consistently across the country, ensuring quality ongoing.

These extra steps in addressing data quality have given the Welsh Assembly Government a great deal of confidence in the class of the data held in the system – very important given that each Local Authority is grant-aided based on the number of live concessionary travel card users they have on their system each year. Again, the accuracy of this process and ability to centrally audit this information if required has
enabled the government to ensure that public money is being spent appropriately (and saved where possible), and apportioned fairly. It has also meant that the requirement for large investment in the additional integration of large-scale data cleansing tools has been avoided as the scale of any issues remains relatively small and data quality can continue to be managed in-house. For any scheme looking to migrate to live smart card use, ITSO or not, this aspect can be endorsed as a major benefit.

As well as renewed confidence in the quality of the national database, records are also partitioned within the CMS allowing Local Authorities access to the data of residents within their area, with access to others’ partitions being granted on a per-request basis, which allows updating of records to take place locally. Allowing this responsibility to remain local, with residents contacting their own Authority directly in all related matters, retains a sense that a local service is being provided, even within the larger national scheme. This is, arguably, particularly significant given the vulnerable demographic of the concessionary fare scheme. The economies of scale brought by the migration to one centralised national system have therefore been achieved without sacrificing the benefits of local services.

**Project implementation phase 2: electronic ticket machine (ETM) rollout**

The Welsh Assembly Government’s aim of encouraging local business and inward economic investment by small and large commercial enterprise is also promoted through the project by the award of sliding-scale grants to bus operators for the full, part, or loan-purchase agreements for ITSO compliant ticket machines and provision of regionalised depot systems to support smaller public transport businesses. This was particularly significant to Wales’ ninety locally based small to medium sized operators, where the cost of smart equipment may otherwise have precluded involvement. While a small number of larger operators have installed their own back office systems that allow data to be transferred directly to the HOPS, central systems have been installed and are managed within each transport Region by a lead authority on behalf of the 4 Welsh transport consortia for use by its smaller operators.

Rollout of ticket machines in Wales began in November 2008 and has been subject to significant delay beyond original expectations. Rollout is planned as a phased activity due to the number of stakeholders involved, both to minimise the risks of a wholesale migration and to ensure that all operators are adequately prepared for the change. Delays have occurred mainly due to the complex set of dependencies that need to be met before progress can be made: software needs to be tested to a very detailed level to ensure that all former capability for ticketing is retained alongside ITSO capability, integration of the many other software products that communicate with the ticket machine (e.g.: GPS systems) also requires sufficient time to be tested, multiple depot systems need to either be created or updated, and drivers need to be trained and educated to a sufficient level to provide confidence for the operator and the general public. The relative immaturity of schemes in this area has meant that delays have often
impacted the project plan as new previously undiscovered problems are resolved. This has been common and impacted all ITSO implementations in the UK.

Managing the logistics involved in delivering hundreds of machines to buses across many operators in short installation timescales with limited resource has also been difficult: scheduling fitting around weekend services has proven the best option, although this has meant complex planning to ensure that all buses (often across a very large geographical area) can maintain day to day business with minimum or no impact during installation. Good relationships and partnership working between Local Authorities, Regional Transport Consortia, Government and each and every bus operator has been critical to success, especially where timescales have been affected and plans changed.

The first operators in Wales went live with ITSO compliant electronic ticket machines in November 2008. At the end of April 2009, approximately 25% of the Welsh ISAM estate was live and fitted to ETM POSTs and Perso-POSTs. Within this initial 6 month period, each ETM supplier achieved live smart transactions on their equipment, giving greater confidence for a smoother and quicker rollout over the course of the summer. In South East Wales we have been able to immediately see the transactions that have passed through the HOPS and bus operators have submitted their claims for reimbursement for concessionary journeys based on the auditable data that the system has gathered.

The project has also had to take into account policy decisions that manage scenarios where the technology on-bus does not work as expected, and how drivers should deal with scenarios where a card malfunctions or is fraudulently used. Unfortunately, the root cause in each of these scenarios cannot be investigated and identified clearly and quickly enough to facilitate resolution for the user at the point where they wish to use their entitlement on board a bus. Parallel use of the new smart-card as a flash pass will mean that the difficulty in dealing with scenarios where the card does not work will be abated in the short term, but this will only be true up to a cut-off point when all transactions are smart. This will happen when all ticket machines are in the field and smart transactions are used everywhere by default. Using a flash pass indefinitely is not an option as it will undermine the purpose of using smart technology to collect valuable data, both for reimbursement and for planning purposes. Part of the work being carried out in Wales at the moment is around identifying real examples of these scenarios, quantifying non-functioning cards vs. fraudulent cards, and defining errors with ticket machines. Although experience to date indicates that the problem is not large, we will not have a clear picture across Wales until all ticket machines are installed and smart transactions become the default position.

**Project implementation phase 3: extending the Welsh ITSO environment**

Once the ITSO infrastructure is in place Wales has a selection of opportunities to pursue beyond a simple concessionary ticketing structure, as well as ongoing challenges in keeping up to date with changes in the technology. In the short term, Hotlisting requires implementation. This is a form of identifying fraudulently or invalid cards on bus via
ITSO messaging to the ticket machine via the HOPS and ISAM. Cards reported lost or stolen are flagged within the Card Management System and become part of a ‘warm-list’ in the HOPS; if a card is subsequently used on-board a bus, it will become part of the ‘hotlist’ when the transaction data is uploaded each day. The ‘hotlist’ is sent to each ticket machine and further use of the card will result in a message indicating to the bus driver that the card is not valid for travel.

Since the ITSO specification was formed, many theories on how hotlisting might work have been discussed but there are no definitive guidelines on implementation. In Wales, the initial applications of simple business rules around hotlisting are based on prioritising types of products (ticket types) and shells (the ITSO partition of a smart card). The decision to hotlist based either a product or a shell originates from a principle that takes future commercial implementations into account. Although at the moment an invalid concessionary card’s shell would be hot-listed if it was lost or stolen, in the future it may be that a product sits within an ITSO shell containing multiple products. If one product became invalid - for example, a cancelled prepaid product - no other product would be affected and there would be little point in incurring the additional cost and time involved in cancelling and reissuing a full card if it is only one aspect of it that is affected. Products could also then be prioritised on the hotlist based on their value: a season ticket has inherently more value than a prepaid day ticket.

We plan to use one hotlist that is broadcast to our OID group on a weekly basis with incremental updates of new or prioritised shells or products, avoiding the additional messaging traffic that would incur from a point to point approach (HOPS to individual POST). There are also certain constraints within this simple implementation: the capacity of memory on ticket machines dictates the maximum size of the list; the size of warm-list within the HOPS needs to be managed and pruned as the scheme grows; software changes will require implementation in the back office as well as changes to the ITSO specification itself; and interacting with other ITSO scheme hotlists in the future will become more complex as more operators become live and implement their own hotlisting policies. In Wales we are planning to implement our initial hotlisting structure by the end of 2009 and are currently likely to be the first ITSO scheme to do this.

As the Welsh scheme progresses towards a fully-smart environment, further benefits of the technology will also have been highlighted. Before the end of the year we will have also migrated the scheme to a new card media type where all new passes will be issued using a different specification of card. The ITSO platform has a selection of certified card media available for use, and Wales will shortly be using 2 card types in the scheme, retiring one card type to allow for better technology to take its place through another. The flexibility of the system will also have been demonstrated by the introduction of a commercial smart card scheme by Cardiff Bus, one of Wales’ major bus operators. The expansion into a commercial scheme will go further towards highlighting the key benefits of the replacement of paper ticketing by smart technology, such as the invaluable ability to capture data on passenger travel habits to better inform marketing practices and the potentially vast reduction in fraud. Wales remains committed to ITSO, interoperability, and the implementation of further ticketing types within the smart card environment which will extend across other modes of public transport in the future.