International Association of Public Transport
Union Internationale des Transports Publics
Internationaler Verband für öffentliches Verkehrswesen
Unión Internacional de Transporte Público

MEDIA BACKGROUNDER

INFORMATION TECHNOLOGY AND PUBLIC TRANSPORT

Information technology (**IT**) is the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware. IT deals with the use of electronic computers and computer software to convert, store, protect, process, transmit and retrieve information data. This includes the field of electronic communication (ICT).

IT is playing an ever-more crucial role in many sectors of modern society offering the most important solutions that we have today to efficiently help increase capacity, safety and security among other aspects.

This is even more the case in the public transport sector, for which IT tools are potentially always available, widely applicable and –actually– already well integrated in many public transport systems around the world.

In our time fundamental developments of existing public transport modes have practically come to an end. Now the challenging task is finding the last potential improvements in the small details: IT tools are the most valid solutions to successfully achieve this purpose.

Main fields of application of IT in public transport:

- Electronic Ticketing/ Automatic Fare Collection
- Fleet and Traffic Management
- Administration and Back Offices
- Dynamic Passenger Information
- Customer Services
- Security and Safety
- Maintenance
- Multimedia and Internet Access
- Computer Aided Design and Simulation

Key players:

- Train, metro, bus and other transport operators
- Councils and local transport authorities
- Suppliers of equipment and services
- Consultants and engineering firms
- Politicians and government officials

Benefits of IT:

- Integrated systems for intermodal transport, inter-operator fare collection
- Improved safety
- Reduced travel times
- Optimised passenger throughput
- Lower maintenance costs
- Proven reduction in error, theft and fraud
- Technologies to reduce cash handling, transferring and securing

Furthermore, as a consequent additional benefit, IT solutions put all the competence in place to improve and create better city climates: to make our cities and towns healthier, more liveable and more competitive; to reduce our dependence on imported oil; and to cut greenhouse gas emissions that cause climate change.

E-Ticketing overview

In public transport, e-ticketing systems are not only a means of payment but they also process a huge amount of information which offers a large range of possibilities to make public transport easier to use, to manage and to control. This can be in the areas of security, intermodality, customer relations management and much more.

They offer as well opportunities to introduce integrated pricing structures that are not easy to implement with traditional payment tools. Nevertheless the level of organization and cooperation is often inadequate or presents some administrative or legal barriers – national and international – that are not so easy to overcome.

The basic principle underlying the relation between the fare and the tangible ticket is that the closer the card is to the payment system, the more reliable the transaction is, but the more constraining it is for the user. In this light, the long-term goal of e-ticketing is to enable the customer to pay for public transport without having to show or validate any card, relying on fully automatic fare payment.

The first step on this path was the introduction of ***contactless ticketing*** in the 90s. This relies on a technology that has many advantages and quickly replaced the older tokens, paper and the magnetic tickets – still widely used worldwide, in any case.
Some public transport networks, for instance, are replacing their first-generation ticketing system directly with a contactless one.

Contactless ticketing uses **Radio Frequency Identification** (RFID) or **Near Field Communication** (NFC) technology to establish a communication between the card and the validation device.

These technologies can be sorted on a ‘distance-range’ criterion:

- *Contact-based* technologies are mainly based on a standardised communication between user devices (only memory or smart cards) and access systems according to the ISO 7816 standard.
- *Proximity* technologies are often based on contactless communications according to the different sub-standards ISO 14443, which results in theoretical transmission distances of about 10 cm.
- *Vicinity* technologies are related to ISO 15693 and usually cover transmission distances of up to 1m.
- *Long-range* (or wide-range) technology requires a battery in the user device (card) and combines inductive coupling with radio frequency data transmission. While the first communication method is used to activate the user device when entering a transport vehicle, the second one allows contactless data transmission between all places within the vehicle and, for instance, electronic access components at its ceiling. The technology provides anti-collision mechanisms to prevent the collision of electronic transactions, as they may occur otherwise.

Nowadays, however, the step forward is represented by ***mobile ticketing systems*** based on the use of the passenger’s mobile phone for the payment of travel cost.
Mobile tickets are being issued using **SMS** (**short text message**) or mobile barcodes. The ticket selection is performed by sending an SMS to the background system, either accompanied by a specifying text or by sending it to a specific phone number for each possible ticket. An electronic ticket is then returned via SMS to the user. Users can also

use mobile phones to purchase tickets in the same way as they do with contactless smartcards by placing the RFID technology into the battery casing of the device.

Applications of e-ticketing systems

Open payment schemes: E-ticketing could be potentially integrated in existing bank or credit cards

Intermodality: E-ticketing makes payment for multi-modal trips easier to implement and generated revenues easier to re-distribute across the different modes after clearing.

Interoperability: E-ticketing makes payment for multi-operator trips easier to implement and generated revenues easier to re-distribute across the different operators after clearing.

Interservices (e-purse): E-ticketing enables the use of public transport smartcards to pay for additional services offered in conjunction with public transport (e.g. parking space payment or retail purchase).

Parking and road pricing: The integration of electronic toll collection for road usage or parking with electronic fare management allows travellers to pay for public transport and private car use with the same card.

Customer relationship management (CRM): E-ticketing is a strong marketing tool since it enables detailed data collection on the mobility behaviour of customers, which helps to develop targeted products.

Network monitoring and planning: Data collected from ticketing will improve knowledge on boarding and therefore allow for bus capacity and timetables to be adapted to the actual use of the route.

Secured access and Individual safety: Smartcards could be also used as an access card to designated buildings. They can be equipped with an individual alarm function, which either informs the driver or automatically transfers the passenger’s location to an emergency response centre.

Some of the above-mentioned possibilities will be only feasible with a *check-in check-out system*. On the other hand, restrictions imposed by individual freedom and privacy-related regulations will limit the potentialities of exploiting passenger-related data. Generally speaking, e-ticketing offers a large number of benefits compared to traditional payment methods as listed in the table below.

1. *Check-in/check-out* (CICO) requires an intentional user action. In other words the customer has to present his user device at an in-vehicle validation device while entering and/or leaving a vehicle or alternatively at a platform.
2. *Walk-in/walk-out* (WIWO) is based on antennas which are for instance placed at vehicle doors. They perform an entrance and exit registration by detecting the user device carried by a passenger without a required user action.
3. *Be-in/be-out* (BIBO) systems detect the user devices carried by passengers while the vehicle is moving from one station to the next, thus making it possible to register all passengers that are actually on board at that time.

Mining of the public transport data collected through the e-ticketing system provides valuable information on network usage and travel patterns which could be used for planning, operation and marketing purposes, for example:

- Monitoring capacity utilisation and loading on different routes;
- Monitoring bus headways and punctuality;
- Monitoring boarding and alighting at stops and estimating passenger volumes at stops;
- Estimating ridership per operator and ticket types;
- Analysing travel patterns for different groups of passengers, introducing incentives;
- Estimating O-D (origin-departure), time, cost, modes, transfer information, related to any journey.

Radio-frequency identification (RFID)

The purpose of this technology is to identify and track an object (typically referred to as an RFID tag) using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader.

Radio-frequency identification comprises *interrogators*, also known as *readers*, and *tags*, also known as *labels*.

Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, and other specialized functions. The second is an antenna for receiving and transmitting the signal.

There are generally three types of RFID tags: active RFID tags, which contain a battery and can transmit signals autonomously; passive RFID tags, which have no battery and require an external source to provoke signal transmission; and battery assisted passive tags (BAP) which require an external source to wake up but have significantly higher forward link capability providing greater read range.

This kind of technology is becoming increasingly prevalent and mainly used by the banking industry for payments from mobile phones.

In public transport RFID applications are largely exploited for travel payments and traffic management as well as for car-sharing: in some systems RFID cards lock and unlock cars and identify members.

Near Field Communication (NFC)

Near Field Communication is a short-range high-frequency wireless communication technology which enables the exchange of data between devices over about a 10 cm (around 4 inches) distance. The technology is a simple extension of the ISO/IEC 14443 proximity-card standard (contactless card, RFID) that combines the interface of a smartcard and a reader into a single device. An NFC device can communicate with both existing ISO/IEC 14443 smartcards and readers, as well as with other NFC devices, and is thereby compatible with existing contactless infrastructure already in use for public transportation and payment.

NFC technology is currently mainly aimed at being used with mobile phones. Amongst the many possible applications, one use in public transport is for Mobile Ticketing in an extension of the existing contactless infrastructure.

Security aspects related to NFC

Although the communication range of NFC is limited to a few centimetres, NFC alone does not ensure secure communications. However the main different possible types of attacks have been circumscribed and are:

- Eavesdropping
- Data modifications
- Relay attack

Applications have to use higher-layer cryptographic protocols (e.g., SSL) to establish a secure channel.

Interoperable Fare Management Project (IFM)

Why do we need interoperability? This is a question often heard and it is very legitimate. If there is no need to deal with other eTicketing systems, now or in the future, interoperability is naturally not a pressing issue. It is possible to purchase a proven proprietary solution and be on one's way.
If, on the other hand, it is likely that a fare area will overlap with that of one's neighbour, there is a need to consider how to welcome those (paying) passengers as well.
This is almost always true for all railway operators, and authorities within large conurbations. There is a world of possibilities available to cope with this issue, from ignoring it to full cooperation with one's neighbours.

Starting in 2008, the aim of the IFM Project is to make access to public transport networks more user-friendly by facilitating their accessibility, providing travellers with shared types of contact-less media throughout Europe. These can be used for multiple transport products ("tickets") in different geographic areas and for sustainable modal switching, such as the use of "Park and Ride". Today, most media are restricted for use in specific networks. By 2015 smart ticketing systems will be compatible to ease access to all the users of public transport.

The "IFM Project" will be the first step of the **IFM initiative**. The ultimate goal of the IFM Project is a European-wide agreed concept (*Route Map*) developing shared back-office rules for cross-border data exchange and the associated European Secure Access Module (EU-SAM). It will create a documented framework by 2010 to deliver the requirements for secure, fully-interoperable portable objects for seamless mobility on public transport accessible to all European Citizens. In a second step comprising Research and Technological Development (RTD) and field operational tests, a European interoperable fare management standard will be developed and implemented in the next future.

After almost two years of hard work, the IFM Project and its Forum members have found consensus on a promising roadmap to a (voluntary) interoperable solution for electronic ticketing in (but not limited to) Europe. What looked like a little miracle two years ago seems to be the future of fare management for us all today!

The roadmap at first appears to be very complex because it is not a simple "black or white", "go or no go" solution. It consists of several different steps that can be taken one at the time, and/or in different orders. They range from very basic interoperability to very complex forms; from partial compatibility to being completely the same.

The project is expected, however, to significantly lower the barriers to mobility and encourage the use of public rather than private transport, contributing to a reduction of carbon emissions and a reduction or elimination of paper tickets, thus further enhancing the impact of smart media on the environment and on the efficiency of public transport. It will be possible to tailor the media to assist specific groups (e.g. existing concessionary travellers, benefit recipients or part-time workers) thereby supporting the EU's Social Inclusion Agenda.

Delivering information to our passengers – Urban Navigation

Mechanisms for communicating route, schedule and collateral information to existing and potential passengers are common.
Regular passengers typically go through a gradual process of learning the details of the routes they use most often. But that situation is pretty different for occasional public transport users or for infrequent routes for more regular passengers. Moreover,

information systems vary from one public transport system to another, and out-of -town visitors may be easily confused and frustrated. Basically passengers need to know what route to take, the nearest stop, and when the bus will actually arrive.
Assuming that passengers know where they want to go, finding their way through the urban fabric is not always easy, particularly when they do not own a car, as is the case for many city dwellers. An easy-to-use system for communicating public transport information would enhance and maximize the use of existing options, opening the path to a future where public transport would be the first and preferred mobility alternative.

A text messaging program that integrates information on routes and vehicle location using for example existing **GPS technology** and **mapping software** could answer these questions in real time. These compact instruments filled with technology and intelligence would guide individuals from door to door via a route which takes into account personal preferences and travel time predictions based on historic and real time data, even for the lower hierarchy road networks.
Such programs ultimately could include all modes of travel – rail and bus, public and private, local and intercity – and be standardized across one country or more, so that similar text requests could be sent in any different city. It could be supplemented with an automated phone hotline, smart phone, and updateable electronic signs at major public transport hubs.

There is much more to come however. With an abundance of data being generated and communicated by these gadgets, it is not unthinkable that “the system” would function as a kind of fleet management: it would know when and where users would share a section of road with the others, maybe even before they have started the engine.

It would be really innovative and customer-oriented to have (parts of) such a system in place also for public transport passengers: to guide them from door to door; to provide information before, during and after their trip, and also provide the missing links; maybe to include ticketing and payment.

This task is naturally far more complicated than “simple” car navigation.

As an example: in some cities, 10% of the bus stops change position annually! Indeed, a bus stop location is basically a very simple data element, but it becomes rapidly more complicated when other key characteristics need to be taken into account, such as all the different entry points, multiple and variable departure platforms, directions of travel, different services, exceptions, delays and incidents…
Certainly, the public transport sector is still far away from the ultimate form of *Demand Responsive Transport*, however, urban navigation as a system approach is on the rise and developments can move really fast.

Many attempts so far have failed. Next to the obvious technical solutions there are numerous fundamental issues to be addressed and resolved before being able to set the stage for urban navigation in public transport: data ownership rights, preferred local routing, (profitable) business models, information quality, data availability and delivery are but a few.

At the same time, a big question remains in terms of whether public transport stakeholders actually always know what exactly the passenger wants to know about their trip. Perhaps taking into consideration a re-evaluation from the passengers’ perspective will make the provision of travel information more effective.