Smart Ticketing

10

Senta Belay

Abstract

Advanced mobility offerings, as Smart Mobility proclaims, are directly connected to the purchase or booking of the access right to travel or use a means of transport. Each and every mobility consumer is busy considering the outcome, be this a paper or a digital format, a smart card, or checking the confirmation to access a plane or train. Access permission provides security and comfort that the seat is reserved and the trip is happening. The future of ticketing has already been penetrated by digital means and will most likely surprise not only consumers, but also transport operators, with new media and inventions.

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To substantiate trends in the travel and tourism sectors in the long run and present these similar to service oriented acting holistically and in an intermodal manner, consumers need a "wow" factor! Wow refers to the experience before booking a service. Wow refers to the simple one-stop shop that fulfills the entire booking-to-payment lifecycle.

Despite already functioning product selection pages, product ordering and payment offerings, the traditional way of service acting in the mobility industry will not succeed.

S. Belay (✉)
SAP America, Palo Alto, USA
e-mail: sentayehu.tessema.belay@sap.com

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Those traditional, punctual approaches that cover one or multiple mobility related functions are being substituted, yet enhanced, by entire offerings and bundles. And this becomes abundantly clear when the services needed are no more point-to-point type solutions but rather a bundle of products and services that encompass an end-to-end service need. The ideal offering, "click-to-purchase", facilitates the business traveler, the family, or the group of friends that consume the offering that best fits their needs. A pre-selection of carriers, multiple data or order entries, or endless price comparisons in the tariff jungles disappear.

The European Union Directive "*one ticketing*" [141], postulates the design and issue of one single ticket, the digital enabler so to speak, that fosters intermodal bookings and subsequently Smart Mobility:

> Integrated ticketing (i.e. combining all transport methods on a single ticket) is the natural partner to full availability of multimodal travel information and planning services. [141, p. 3]

Smart Ticketing is one of the three key elements in door-to-door mobility enablement – next to outdoor and indoor navigation and a diagnostics triggered business process management. How did ticketing evolve over the past years? Is it lagging behind or is it far more advanced? The following gives some useful insights.

10.1 Trajectory of Ticketing

To put the trajectory of *ticketing* in context, we make use of a simple process where an individual passenger buys a ticket and uses a service from a single mobility provider. The carrier offers three stations on a particular leg of a route; A, B, and C. The mobility offerings might be a subway ride, a flight, or the use of a rental car.

Travelers that arrive at A or move away from C switch often from one means of transport to another. C might even be a transit station or an airport. Other travelers return the rental car at A and then use the metro. For each and every segment, tickets are made available – once or temporarily valid. Any of the ticketing – whether a boarding pass, a subway stub, or a mobile app – appears to the consumer as a distinct design element that is not interconnected on the regional level or internationally where multiple currencies come into play, for example.

The necessary media are not apparent to the consumers either and therefore remain uncovered. More often it is the role of the travel agencies, ticketing machines, or cash registries that permit the use of the means of transport once the payment is successfully executed. Still encountered in various regions, this is essentially a ticket agent at the respective stations receiving coins and cash before allowing the passenger to get on board to utilize the service.

10.1.1 The Ticket as Design Element of Smart Mobility Offerings

The ticket is the anchor of mobility. A typical example is where a bus driver allows passengers to board a bus when they post the right amount of coins into the coin receiving

machine, called naturally the "*farebox*". There is quite a lot of effort involved in terms of ensuring the flow of cash and coin from the different stations, as well as onboard the carriers, to the offices. These revenue accounting systems where cash is accounted for rely heavily on manual means to ensure theft is avoided. Moreover, this enables the mobility service company to know the extent of the usage of its service. This element of reconciliation is still in use today.

In the past, there were few if any mechanisms to reconcile the actual amount of service rendered to the actual amount of money collected. This then evolved by correlating a predetermined amount of tickets or paper tickets with the available amount of carrier space. Mobility usage got reported by the tickets sold (the stubs) and reconciled with the amount of cash collected. This is still the case in one form or another used in a number of public transport companies globally; even in some advanced economies in the world. Furthermore, public transport offerings are still subsidized, as discussed in Sect. 2.8.2. In other cases ticketing processing and reconciliation is subject to commercial operators that rather focus on usage-based offerings and less on a maximum amount of space. The focus overall is in the provisioning of a fair and bookable service that is accessible to all actors in an ecosystem. This relates to the continuation of less frequented bus lines in remote areas or districts, for example.

Over the years, the original representation of coin and cash in relation to mobility products has seen massive changes. Of special note is the visible separation of the presentation and control layers. The most relevant milestones in the evolution of ticketing designs and digital enablement are depicted in Table 10.1. The table entries document the change and the progress made. The transformation from paper stubs and cash towards a digital consumerization of mobility services can hardly be overlooked. Especially in public transport

Table 10.1 Milestones in ticketing[a]

Year	Milestones	Comments
1993	Calypso	
1995	Seoul: Upass and T-Money	
1997	Hong Kong: Octopus Card	
1998	Transport for London: Oyster Card Foundation of ITSO Great Britain	Integrated Smart Card Organization (ITSO)
1999	Shanghai Public Transit Corporation (SPTC): SPTC Card Foundation of the EMVCo LLC	EMVCo is a consortium of the six credit card companies that manages the smart card payments standard. EMV stands for Europay, Mastercard, Visa. Further members are JCB, American Express, China Union Pay and Discover.
2001	Japan: Suica Card Singapur: EZ-Link Card	The Suica Card is a RFID chip, developed by Sony, and includes a payment function; replaces cash or credit cards. The Japan Rail East Railway Company is the provider of Suica Cards.

Table 10.1 (continued)

Year	Milestones	Comments
2002	Taiwan: Easy Card	
2003	VDV Germany Calypso Networks Association	
2004	EMVCo: upgrade (2004) Foundation of the NFC Forum through NXP Semiconductors, Sony and Nokia	NFC stands for Near Field Communication.
2005	First pilot with VDV Germany, Saarbrücken	
2006	Singapore e-Purse: CEPAS	
2007	European Union: Project launch of IFM (Interoperable Fare Media) of the European Union, called EU-IFM Japan: Pasmo 10 million EZ-Link Cards ISO/IEC 14443-1:2008	Pasmo is a card similar to Suica. Pasmo is operated by a private transit operator in the greater metropolitan area of Japan. The usage of Pasmo Cards is primarily focused on Tokyo. However, both Suica and Pasmo are interchangeable. ISO/IEC 14443-1:2008 is the first international standard for integrated circuits cards published by the International Standards Organization (ISO).
2008	Quebec: Opus Card	
2009	30.01 million Suica Cards Singapore: NETS FlashPay Singapore: SeP (Symphony for e-Commerce) based on CEPAS	
2010	EU-IFM Project phase completed and deliverables published	
2011	AFIMB France EU: SETA (Single European Transport Area) Google Wallet launch	
2012	MoU-IFM Alliance between standardization organizations and Union of International Public Transit Association (UITP) Foundation of Smart Ticketing Alliance (STA) ISO 24014-3 Standards published for interoperable ticketing management systems	Founding members of STA are the Integrated Smart Card Organization (ITSO), the VDV with the core application called VDV-KA-KG, the Calypso Network Association (CNA) and l'Agence Française de l'Information Multimodale et de la Billettique (AFIMB)

Table 10.1 (continued)

Year	Milestones	Comments
2013	Transport for London (TfL) Pilot: EMV Sign-off of the 4th Railway Package of the European Union	EMV stands for Europay, Mastercard, Visa.
2014	Great Britain announces use of ITSO standards Apple Wallet launch	
2015	Singapore launches Smart Nation initiative and the introduction of cashless, electronic payment system Introducing Samsung Pay The Global System for Mobile Communications Association (GSMA), the Near Field Communication (NFC) Forum, and STA work on harmonizing the specifications of NFC technologies in transit areas	
2016	Further innovations will follow	

[a] A comprehensive overview of ticketing advancements is provided by the (German only) website SecuPedia, http://www.secupedia.info/wiki/Hauptseite, last visited: September 30, 2016.

management systems a transformation took place. The table entries also outline the most notable regions where transformation occurred and still takes place.

Transformation can also be observed in the presentation layer where one single product evolved. Examples are the cash to be paid for a one-way passage on the service provider's carriers to multiple products, such as return services or services including other onboard amenities like "priority seats", "meals", etc. Other examples refer to monthly or yearly passes for families, the elderly, and students. In some cases these are issued by distinct parties depending on geography and context as described earlier in the ecosystem of actors (in Chap. 5.3).

Access to these services is given in the presentation layer. Verification takes place by a person, visually or by a verification layer such as a boarding pass, a paper ticket, or a validator. Examples of validators are turnstiles that allow access with a valid ticket. The validator will ascertain that the right amount is paid for and grant the access, as for example in the central station of Rotterdam. Validation marks appear in the form of a magnetic token, a barcode, or QR code. Others make use of NFC technology in combination with WiFi or Bluetooth to allow passengers to Bring their Own Device (BYOD). Overall, any of the used technologies or procedures confirm the actual presence of a valid permission to travel, and signal the authority that a service, hence ticket, has been pre-purchased.

Innovations at all points across the products and services flow have evolved. The presentation layer has been by far the most visible. The Physical Mobility Front Office gets more and more enriched by the Digital Mobility Front Office (see Sect. 5.3).

Card centric systems, where chips are loaded on devices or cards and next give access to load various services on them, have evolved. This approach has heavily influenced the last 20 years in the evolution of the ticketing sphere, especially in the level of sophistication and standards with regard to the payload characteristics that a specific format can have and in which systems it is readable from. To enable a vision of *E2E mobility* and *Mobility-as-a-Service* however, there is quite a large burden as to harmonizing the way that the chip and the fare media have been used in the context of Smart Ticketing and smart travel. *Fare media* in this context refers to all ticketing relevant technologies that are in use for loading products and services onto the respective media. Next to the devices, credit and debit cards, loyalty cards and frequent flyer cards make up fare media.

Approaching E2E mobility from this angle requires a huge amount of work where the industry has to come together and agree on the definitions of fare media and which media are going to be readable by which readers. It also goes without saying that security mechanisms are in place to protect the users and the money loaded so it is utilized only by authorized users.

The efforts of various organizations such as ITSO in the UK [142], Calypso in France [143], AFIMB in mainland Europe [144], and VDV in Germany [145] work in tandem to come up with a mechanism for standardization of such exchanges of information on the *fare media* and presentation layer. The desired outcome from a traveler's point of view is an interchangeable format, used in different regions and states. Standardization efforts are conducted, for example, by the named institutions. Joint efforts are necessary to foster interchangeability, especially by taking into account the necessary steps, such as:

- Definition of transfer protocols and data formatting
- Definition of authentication and security mechanisms before, during, and after data transfer
- Usage agreements concerning user data
- Usage agreements concerning the transfer of money and money-like currencies.

Driven by the IoS Role model these efforts are further executed by interoperability providers (*Service Gateways*).

Fare media formats help to get closer to Smart Mobility enablement. The configuration of the medium be it a smartphone, a dongle in a car, or a credit card is then subsequently a simplified download of "credit points" that can be freely used based on the traveler's needs. The previously old-fashioned payment procedure and reconciliation of cash turns into digital processing upfront – without reformatting or physical checks.

10.1.2 Usage-Based, Hence Subscription-Based Billing

Another paradigm in the end-to-end mobility sphere is the advance in technology. This has evolved in particular from the services industry in the connected and digital age where by a subscription to a service, access to further products and services are guaranteed. In the travel and transit industry this translates to account-based ticketing.

Efficiency gains are projected as the logic embedded in the fare media and chip card is removed and the card/fare media is delegated to being a single identity confirmation tool. The logic of the products and service actually reside in a backend system. In essence this replaces the card centric ticketing systems that have been well positioned in the industry over the last few decades.

The concept is equally applicable to the above described single A-B-C route and could possible augment, and in the long run be, a viable option as a replacement of card centric transit. In addition, it is the most logical one that addresses the more complicated end-to-end mobility scenario – where multiple products and multiple services are being provided to the traveler (the end user) from multiple providers – to fully orchestrate in a seamless manner.

In a single product/service scenario the backend is a simple haulage operation of cash and coins collected to the banks and assigning relevant entries in the income statements of the company. This involves a process of collecting cash from the ticket offices to the bank, getting the relevant receipt, and posting entries in the debit side of the general ledger to finalize the actual transactions that have happened.

There is no mechanism to ascertain the matching of products and services to the number of consumptions of the service. There is no auditable track. The auditability starts at the point when the bank has received the cash and noted the amount. As we evolve further, a simple Point of Sale (POS) system takes the control of products and services one step further – equipped with a cash register to account for the tickets issued.

For each token or product issued, the relevant cash received is accounted for at the level of the ticket counter, or cash desk. In the case of transit across states, as in rail and high-speed travel, the simple purchasing of tickets at the ticket counter is also augmented by a reservation system whereby the products and services are not only exchanged for a payment, but also assignment of the ticket to a particular seat that has to be accounted for. Hence the ticketing system evolves into a reservation system.

In E2E mobility a ticket is used as a permission to travel without the need to assign a specific seat and a ticket, much in the same way as the airlines currently do from a booking and reservation standpoint.

One further thought. The moment we start thinking that a seat needs to be assigned to a traveler, we need to identify that traveler. This identification raises the bar once more from a purely anonymous trip to one where travel has to be booked for and reserved to a particular person – thus the need for a customer/traveler identity management system arises.

10.2 Enhancing Smart Ticketing

In all described cases an intelligent, usage-based accounting system is key. It builds upon two elements:

1. Identification of the user
   - How much information should be needed for rendering travel?
   - Is it anonymous travel only or are we considering a true end-to-end mobility? Will there be a mix of transit modes, needs for reservation in some cases, or just validation of travel rights in others?
2. System to achieve the seamless nature for order capture and payment
   - How many services need to be orchestrated for the traveler?
   - A desirable outcome is the removal of complicated or multiple ticket purchases from the customer to a backend where logic and process execution steps are held and render only the most pertinent needs.

Figure 10.1 illustrates the *Smart Ticketing* schema.

Consumer and Identity Management Similar to a Customer Relationship Management (CRM) system, the consumer and identity management maintain the customer's profile, including financial details. There is the option of having the bare minimum of an anonymous customer who will have a unique identifier that is capable of being attached to a product and/or service. However, whatever type of service is going to be provided, such a customer will need to be identifiable. Usually this is achieved by a numbering system, for example consider the smart cards in circulation in most cities. Smart cards do not have a specific owner or customer identity attached to them in the system but there still exists a unique identifier for the smart card.

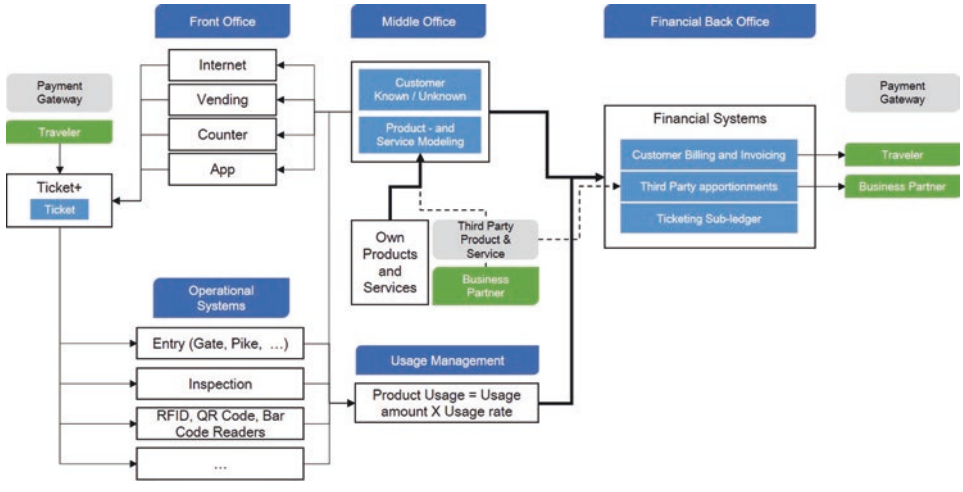

Fig. 10.1 Smart Ticketing – overview schema

At the other end, a smart card could have an identified customer whereby the profile could be rich, including various attributes of the identified customer such as choice of transit modes, frequented routes, and add-on service needs. In the case of travel modes, the attribute for the identified customer such as the choice of aisle or window seats, first class business or economy class, etc., are also captured.

As the industry is gradually evolving, we see that many operators are building a CRM system and have more ability to allow opt-in for the end users, allowing previously unknown customers to become a known customer in the system.

In most cases, the choice to be identified, as well as further provided details of the travel needs and choices, should present automatically to the customer and such a system should provide this option: and that is exactly what is happening in the industry.

Product and Service Management This is the core of end-to-end mobility. The system should be capable of designing the service, be able to distribute the service to the end user, and be able to measure the level of usage that each customer has utilized. As outlined before *service enablement* and *service enrichment* take (see Chap. 5.3) place here.

Product and Service Design To provide an *E2E mobility* scenario, all the products and all the services that are available to the end consumer are accountable. These could be provided by one carrier or multiple operators in a multimodal approach. And there also could be added services that are not core travel or transit, but rather services that are ancillary. The system thus needs to be aware of all available product and service combinations that the end user might need in the quest for end-to-end mobility.

Similar to the telecommunications industry the product, the mobile device, has been enriched with services such as voice, data, roaming and others. The phone has an identifier, the phone number. The services provided are billed per usage and consumption that the phone number has utilized over the standard course of a month. The provider in the telecommunications industry should have considered all the product combinations available (all available types of phone devices), all the service combinations (voice, data, roaming), and in addition considered if the service is provided by itself or by a partner in another country. The same logic now applies to the travel industry.

The product in the case of the travel industry could be a card (either chip, magnetic paper, app, smart card, etc.) that would have a physical representation of the available product. It could also be a reserved ticket for travel where an assignment is needed. The service piece will hence be the core service of travel from A, via B to C, or it could be additional multimodal transit (which should be attached to the same product), or all other add-on services that could be attached to the same product.

Hence the product design phase takes into consideration all available products and services and ensures that the combination of this and all the logical analysis resides in the system. The next steps will be the actual distribution of the products and services to the end user. The other aspect of the product and service design is the consideration of the rate at which the product and service should be charged. This part will have to be built in and represented as

the amount to charge for the service usage. In our initial example of the A-B-C route, each leg could have a separate rate to be applied when the customer travels. Hence, the products and services should have a corresponding rate at which the service is to be consumed.

This matters quite a bit, as the definition of the rate could be multifaceted. In the single journey of "A", it could be an x amount. Alternatively, if we scale this route and say there are a 100 or even a 1000 or more combinations that could be traversed by a customer, then the design of assigning a rate of x amount will not be scalable enough. In this instance, in the transit industry a "zone" approach is created to assign simplistically a certain rate for a certain zone.

This zoning might not be sufficient as cities get larger, and E2E mobility needs get even more complicated. Current advances in technology offer parameter-based such as distance-based or time-based rates. In essence, the traveler can choose whichever commute and travel he needs. More advanced mathematical models will soon enhance the decision-making process by incorporating sensual and emotional states of the traveler. Further decision criteria resonate from the number of clicks a traveler used in his app before booking. The most commonly used models to date employ a flat rate of distance based or time based billing.

Compared to the telecommunications industry, it has created a plan for telephone or mobile subscription. A similar travel plan could be designed to apply to not only a single operator's route but multi-modal routes, in an easy way. This fosters a complex combination of travel needs but later one will be able to clearly and exactly invoice the service. The plan, whether it is monthly, quarterly, or anything else, can easily be modified and adjusted.

Product and Service Dissemination All the carriers that are involved in providing travel services disseminate product and service offerings in a slightly different way. The airlines industry is heavily reliant on the *Global Distribution Systems* (*GDS*'s) and it leverages the strong inventory building and distribution capability of GDSs. In the transit industry, as there is no or minimal need for inventory build and seats. And added to this, the cost of the ticket itself is too small, so the business is more reliant on automated ticket vending machines. Because of the pricing and booking habits long distance and high speed trains have much closer distribution opportunities similar to the airlines industry: the distribution is made online and the representation layer, the boarding pass is similarly digitized and presented as QR or any other code.

Measurement and Billing Once a digitized product or service has been bought, the consumption measurement becomes a simple authentication and knowledge of whether the said ID holder of the product or service has actually used the mobility provider's offering. This is an operational task and is linked to knowledge about usage.

Assume, for example, the product is a one off-travel, like a plane journey, then the boarding gate will be in a position to identify if the boarding pass does indeed belong to the person holding an authorized passport that is being whisked through.

In *multimodal* transport, where the product is not designed for a one-off approach, but rather as a rate plan, the operational readers (such as the turnstiles, the conductors, the gates, etc.) identify the on-boarding time and the off-boarding time. This is will be the measure to be used to properly account for the service usage.

One could argue that the card centric type, where the fare logic is directly embedded in the fare medium, and the medium is gradually deducted according to usage, might be the ideal case. The readers would need to be aware of the amount of fare in the medium and be able to deduct accordingly per usage. There is a huge cost associated with deploying such a system. In E2E mobility travel this becomes very difficult. That is why the idea of only identity on the fare media has evolved.

The amount of operational know-how that the readers will have to possess becomes a bare minimum – and all logic for processing is sent to the backend. Such will be an approach to measure usage amount, based on the product and service design that were designed previously. In such cases, an account-based ticketing system will work elegantly to provide the required billing information for the service that has been rendered to the end user. This can be done for all transit and all multimodal approaches, so long as the engaged parties and service providers have been taken into consideration in the initial design of the products and services for the end user.

Finance Management In end-to-end mobility, the other main complication is to effectively understand how multiple operators' services and products are going to be apportioned to the right carrier. And it is of significant importance to be able to apportion net values instead of running individual transactions by each customer.

In essence, this exercise is not simple. A case in point would be the clearing house concept in the airlines industry through a trusted intermediary. Here the airlines industry has achieved a settlement system where all airlines can sell products and services of their partners in a "code-sharing" agreement. They do not have to settle this account by account, but rather at a certain predetermined time they settle the entire agreement that they have. Likewise, the other code sharing agreement participants would do the same.

This is the type of settlement, and in the transit industry terminology "apportionment", that needs to be considered. Hence in the E2E mobility scenario, we need to have the products and services paid for and utilized, accounted for by each service provider and the money allocated to each one. Financial systems thus would need to act not only as a revenue accounting system, but ensure that they settle accounts accurately with partner organizations involved in the provision of products and services as well.