

NFC in Public Transport

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ABSTRACT

This white paper is produced by members of the NFC Forum, representing a wide spectrum of the ecosystem needed to develop and introduce public transport programs based on Near Field Communication (NFC). It is intended to be a general overview and an introduction for transport operators and possibly other entities to the use cases, benefits, and requirements of using NFC. The term "transport services" covers a broad range of methods of moving people from place to place, including trains, buses, subways, trams, taxis, ferries, bicycle rentals, etc. Selected public transport use cases are included to illustrate how NFC can benefit both travelers and transport operators.

For more information on Near Field Communication, visit www.nfc-forum.org.

The NFC Forum recommends the following documents to assist transport operators in planning a transport program:

- "GlobalPlatform's Value Proposition for the Public Transportation Industry: Seamless, Secure Travel Throughout Multiple Transportation Networks" http://www.globalplatform.org/documents/whitepapers/GP_Value_Proposition_for_Public_Transportation_whitepaper.pdf
- Various papers from the Smart Card Alliance Transportation Council http://www.smartcardalliance.org/pages/activities-councils-transportation



Executive Summary

Near Field Communication (NFC) technology may have many benefits to transport operators. The use of NFC in consumer mobile phones, transit contactless readers, and onsite "smart posters" enables fast and easy ticketing, speedy access control, the downloading of pertinent travel- and entertainment-related information, and much more.

NFC-enabled phone transactions can be used today with existing transport contactless infrastructure, requiring no additional investment. When NFC capability is added to readers to enable two-way communications, more functionality is possible, such as redeeming a ticket and sending a receipt at the same time. NFC Forum tags placed behind posters or other printed media ("smart posters") allow travelers to touch and read schedules, get special offers, learn about destination highlights, etc.

NFC adds benefits to all steps in the ticketing scheme. Proof of registration needed to receive special travel discounts and entitlements can be stored on the phone. Tickets can be purchased, downloaded, and accessed on the phone. NFC readers can speed a traveler through gates with just a tap of an NFC-enabled phone.

There are several ways to introduce NFC into a transport system, from simple point-to-point "pay-as-you-go" schemes to more complex implementations that include multiple operators and multiple payment options. NFC also supports all forms of ticketing systems, from open (ungated) systems, to controlled entry programs, to completely gated schemes. These implementations are supported by a variety of vendors and suppliers. The timeframes for potential implementations are dependent on their complexity.

Operators can see both financial and operational benefits from adopting NFC. There are cost savings in eliminating equipment, ending issuance of paper and plastic cards, and reducing cash handling. There are also increased efficiencies because of faster throughput. Higher customer satisfaction can mean increased travel and retention, and new revenue streams from advertising and promotional opportunities can benefit the bottom line as well.



1 Introduction

Today, various public transport agencies in Europe, the United States, and Japan have piloted and implemented the use of NFC-enabled mobile phones.

NFC is used in the context of transport ticketing in gateless systems to enable a simple start-up program. Other trials have added retail contactless payment cards to the ticketing options. Multiple applications, including online payment and over-the-air ticketing, have also been enabled by the phone.

The following sections give a general overview of the use of NFC technology and its application in a transport and ticketing environment.

1.1 What is NFC?

NFC is a standards-based, short-range wireless connectivity technology that enables simple and intuitive two-way interactions between electronic devices. With NFC technology, consumers can perform contactless transactions, access digital content and connect NFC-enabled devices with a single touch. NFC simplifies setup of some longer-range wireless technologies, such as Bluetooth and Wi-Fi. It is also compatible with the global contactless standards (ISO 14443 and/or ISO 18092), which means transport agencies that have already deployed contactless programs enjoy a built-in advantage, as their equipment may readily interact with NFC-enabled mobile devices and provide richer services.

The following chart shows how NFC compares in range and speed with other wireless technologies that can be used in a mobile phone. Communication occurs when two NFC-compatible devices are brought within about four centimeters of each other. By design, NFC requires close proximity and it offers instant connectivity, which provides an intuitive consumer experience that can be readily applied to the transit environment.



NFC Compared with Other Wireless Technologies



While NFC can be placed in many consumer devices, the focus of this paper is primarily on NFC in mobile phones, readers, and smart posters. However, other NFC-enabled devices, such as fobs, PDAs, PCs, readers, etc., have possible applications in the transport arena and should not be overlooked when planning a system. Although NFC use is also beneficial for streamlining backroom operations and security, the main focus of this paper is on how implementers can improve the consumer experience. Further details on the use of NFC in mobile phones can be found in the NFC Forum white paper Essentials for Successful NFC Mobile Ecosystems (October 2008).



2 What Can NFC Do in Public Transport?

The NFC Forum has identified three basic use cases for NFC: connection, access, and transactions. All three have application in transport. For example, an NFC-enabled phone can connect with an NFC-enabled kiosk to download a ticket, or the ticket can be sent directly to an NFC-enabled phone over the air (OTA). The phone can then tap a reader to redeem that ticket and gain access.

NFC Forum tags may be of particular interest to transport operators, as they can be embedded in posters, products, maps, etc., to provide transport service-related information. These inexpensive tags can be integrated in smart posters and can contain a variety of information or automatic links to pertinent information and transport service websites. Examples of information that can easily be accessed and activities that can be initiated by tapping a tag with an NFC-enabled phone include:

- Transport timetables
- · Links to an up-to-date weather report website
- · Location-relevant map
- · Special discounted travel offers
- · Next bus arrival time
- Taxi services
- · Emergency calls
- · Phone-to-phone transfer of destination addresses and maps to taxi drivers

Let's look at some ways in which NFC can improve the traveler's experience in these sample use cases taking place before, during, and after a journey.

2.1 Before the Journey

Julia is planning a day trip to London to visit some museums. She has checked the fares online with her mobile phone, purchased her train ticket, reserved her seat, and downloaded the ticket to her phone. The ticket also includes a one-day parking pass at her local station. Julia drives to the station and taps her phone on the gate to redeem the pass and enter the parking lot.

While waiting for the train, Julia remembers that she has a loyalty card stored in her phone because she is a frequent traveler. This enables her to touch a reader on the door to enter the executive lounge to wait for the train. There are smart posters on the walls of the lounge, and she taps her phone on



Using NFC to Pay for Parking

one to download alternative return schedules in case she runs late. One of the museums she plans to visit is advertising a reduced admission fee, and she taps that poster to download the discount coupon and store it in her phone. She also taps to opt in to promotions from stores and restaurants in the vicinity, and she immediately receives coupons in her phone. With these waiting-room posters, the retailers have a unique opportunity to



attract Julia to their stores, and Julia can take advantage of discounts for her favorite products and places. There's a map of London on the wall, too, and she taps various spots to make sure she has directions to all the museums stored in her phone.

As she's about to get on the train, Julia spots a vending machine and uses her phone to pay for coffee and a snack to enjoy on her trip.



Demonstration of a Smart Poster for a Retailer in California

2.2 During the Journey

Julia uses her phone to tap a reader, redeem her ticket, and board the train. She holds her phone out and displays her ticket and seat reservation to the conductor, who asks if she would like to purchase a newspaper for the journey. Julia taps the conductor's handheld reader with her phone to pay for the paper.

A colleague she hasn't seen in some time sits down next to her. They chat and tap their NFC-enabled phones together to exchange contact information.





Exchanging Information via NFC-enabled Phones

The journey ends pleasantly, and Julia hails a taxi. She pays the driver by touching her phone to the reader in the cab and receives a virtual receipt in return, which she stores in her receipts folder in the phone. At the first museum, Julia redeems her discount coupon when she pays her admission fee with her phone. While she is visiting the second museum, however, she receives an SMS saying her return train has been delayed. She checks the other times in the schedule she downloaded that morning in the lounge and requests a new seat reservation, which is sent to her and stored on her phone.



Using an NFC-enabled Phone to Exit a London Train Station



2.3 After the Journey

Julia has spent a pleasant day, and the delay on her return trip was not long. She knows that each time she used her phone to pay that day, she received receipts in return. She checks her phone when she gets home and sees receipts stored for the train fare, her vending machine purchases, the taxi ride, and the museum entrance fees. She taps the phone to her NFC-enabled PC and transfers the receipts to her company expense report. It is fortunate that she works for a competitive museum and can claim this trip as a business expense!

The NFC Forum has issued technical specifications that enable each of these basic use cases. See <u>Standards and Compliance</u> for a complete list. A certification program was introduced by the NFC Forum in late 2010 for vendors to build and test to these global specifications.



3 Benefits of NFC for Transport

Billions of mobile phones are already in use, making them convenient devices for travelers. Mobile phones are network-connected and have easy-to-use sound and text interfaces. They provide anytime-anywhere access to information, and applications are easy to download over the air and manage on the phone. When these features are combined with NFC, travelers can experience a host of new, intuitive, and rewarding experiences on their mobile phones.

3.1 Benefits for Travelers

From the traveler's perspective, NFC-enabled phones have great benefits over paper tickets. Tickets stored virtually in phones are inherently more durable, less likely to be lost, and are perceived to be more environmentally friendly than paper versions. They are even more convenient than plastic cards, with no fumbling in a wallet for the right card. NFC-enabled phones can hold multiple payment applications, allowing the traveler to select which method to use—credit, debit, travel passes, or prepaid tickets.



Selecting a Payment Method in London

Updates are easy and can be done over the air, avoiding a trip to the bank or other point of sale. (See <u>Comparison to Other Technologies</u> for a more detailed comparison to legacy technologies such as paper tickets, contactless cards, online options, and 2D barcodes.)



Travelers can tap information tags embedded in smart posters to download train schedules or information on nearby attractions, enhancing the passenger's travel experience as well. A simple tap also provides fast access to Internet services and rich information.

NFC can also be incorporated into readers to enable services such as renting bicycles or opening storage lockers.

3.2 Benefits for Transport Operators

Existing programs have shown an increase in traveler satisfaction because easy and convenient contactless ticketing and payment solutions were used. In closed gate systems, throughput has increased and bus boarding times have improved.



A Bus Rider in China Uses Her Phone to Redeem Her Pass

NFC programs in the field have also created new revenue streams for transport operators from promotional opportunities, such as downloads from inexpensive tags placed behind smart posters or complementary retail purchases.

Transport operators can also benefit from reduced operating and maintenance costs by cutting down on the use of paper tickets, ticket machines, ticket sellers, and even ticket collectors. Paper tickets require production, storage, and distribution. Kiosks need maintenance, and personnel costs for all of these processes can be high. Customer service issues with lost paper tickets are also costly, and environmentally unfriendly paper tickets can be detrimental to a transport operator's image.

A mobile device allows the operator to provide additional services such as language settings, advertising and promotional opportunities, tourism information, loyalty schemes, and direct marketing. Risk management can also be improved through the use of NFC-enabled phones for over-the-air blocking and updates to prevent fraud, know-your-customer protections, and general management information. The speed of over-the-air updates is a major benefit compared to delays that can occur when blocking contactless cards.

(Many business-to-business efficiencies can also be gained, such as personnel tracking, maintenance, etc., but these use cases are outside the scope of this paper.)



3.3 Comparison to Other Technologies

3.3.1 The Consumer Benefits of NFC-enabled Phones vs. Paper Magnetic Stripe Tickets

There are many benefits consumers can obtain by using NFC phones with stored tickets instead of paper tickets.

• Paper season tickets can wear out with use if they are repeatedly inserted into readers. Tapping an NFCenabled phone at a contactless reader requires no moving parts that could wear out. An NFC-enabled phone is more robust and more convenient than a paper ticket, so the consumer will get through the gate quickly and more reliably.



Using an NFC-enabled Phone for Transport Entry in Japan

- Tickets stored in phones are less likely to be lost than paper tickets.
- Studies have repeatedly shown that people are less likely to leave home without their phones than without their wallets. Carrying a ticket within a phone means fewer missed trains or buses due to long lines or searching for cash, and no more buying one-time tickets because of a forgotten season ticket.
- Obtaining a ticket is much more convenient, because it can be sent electronically to the NFC-enabled phone. Consumers do not need to visit a ticket office or line up for a ticket machine.
- · Sending tickets electronically to NFC-enabled phones clearly uses fewer trees than paper tickets.



3.3.2 The Consumer Benefits of NFC-enabled Phones vs. Contactless Cards

Because contactless smart cards can hold electronic tickets, they provide some, but not all, of the same consumer benefits as NFC-enabled phones in replacing paper tickets. The benefits to consumers of using phones instead of contactless smart cards are:

- An NFC-enabled phone can hold more than one ticket from more than one transport operator. Thus, as with their wallets, consumers can manage all their tickets in their phones, along with similar items like payment cards. With contactless smart cards, a consumer must carry several different physical cards in a physical wallet.
- A passenger can easily choose which application to use from a menu display or have a default application set on the phone. With contactless smart cards, a consumer would have to physically remove the chosen card from a wallet, pocket, or handbag to use it, and then run the risk of dropping or not finding the ticket.
- Smart cards stored in an NFC-enabled phone are less susceptible to "collision." If a contactless ticket card is kept in the same wallet as another contactless card, such as a payment card or identity card, and the entire wallet is presented to a reader, the reader can't decide which one to read and the barrier won't open.
- Using their NFC-enabled phones, consumers can manage their cards and tickets anywhere at any time. Season tickets can be automatically renewed over the air; there is no need to physically visit a ticket office to order, pay for, or even collect the new ticket. And this can be done while a consumer is walking from the parking lot to the train station or bus stop—it doesn't need to take place at a computer or at the point of sale.

3.3.3 The Consumer Benefits of NFC-enabled Phones vs. PC-based Online Ticketing

Online websites provide consumers with the convenience of purchasing travel tickets in the comfort of their own homes from their computers. Electronic tickets can be picked up from a designated ticket office, ticket machine, or entry gate, or can be downloaded to the PC and printed out as (for example) 2-D barcodes.

The benefits to consumers of using NFC phones instead of (or in conjunction with) computers are:

- By sending the electronic tickets to their NFC-enabled phones that can read and display the ticket details, consumers are immediately assured that they have the correct tickets. They don't need to wait until they start their travel for that confirmation.
- NFC phones provide simple, fast access to Internet services and information. By using the phone instead of the PC, tickets can be managed directly from the phone, anywhere and at any time.
- Electronic tickets mean that people don't have to print out paper tickets from the PC, don't have to remember to bring the tickets, and can't lose them.

By using their NFC phones as part of their travel experience, consumers can derive further benefits, such as:

- Receiving up-to-date travel information tailored to individual travelers, based on the tickets stored in their phones, such as delays and gate changes
- Obtaining information of specific interest to the consumer by touching an NFC-enabled phone to a smart
 poster (which has an NFC Forum tag behind it) and being automatically directed to the relevant Internet page
 or website
- Receiving information about interesting tourist attractions near the destination—again based on the tickets in the NFC-enabled phone
- · Receiving special offers and information about vendors and retailers in or near the station or airport



3.3.4 The Consumer Benefits of NFC-enabled Phones vs. Barcodes

Consumer benefits associated with NFC-enabled phones are:

- Two-dimensional barcodes are easy to send to a phone but can often be difficult to read. The phone must be held at just the right angle, and a need for repeated tries can often cause delays. NFC-enabled phones can be read within a short, broader range, avoiding that problem. Barcode readers in a busy station can also get dirty, and optical barcodes must be clearly displayed on the phone and clearly seen by the reader.
- NFC ticketing is also faster. There is no need to open an application to find the 2D barcode; the phone experience is a simple tap-and-go.
- NFC-enabled phones are two-way devices, enabling the traveler to both send and receive information, while 2D barcodes are read-only. Two-way communication is the basis for many of the rich consumer experiences described in this paper.



4 NFC and Ticketing

This section describes how NFC can improve ticketing operations. These services can be broken down into individual components, such as obtaining information on the schedule of public transport services, deciding which ticketing product to use and obtaining it, updating frequent traveler programs, and so on. Implementation options and key stakeholders are also described to help transport operators plan NFC-based programs.

To use public transport in most parts of the world, passengers must either obtain a ticket before traveling (prepaid) or use a ticket product or token that is offered on that transport mode. This ticket product or token could be a concessionary pass that is provided by the local authority or a smart card that has a pay-as-you-go travel product on it. In this scenario, the passenger only needs to add stored value to the smart card before traveling, rather than purchasing a specific prepaid ticket.

4.1 Ticketing Processes

The key ticketing service processes can be described as registration (optional), provision, validation, and inspection. NFC can add value to each of these steps.

4.1.1 Registration

The majority of tickets provided to passengers are at a full adult rate for the relevant time of travel. If some passengers are entitled to discounted fares (e.g., a child, senior, student, etc.), they may have to provide physical identification to the transport operator to demonstrate entitlement to this discounted fare. They may also receive a concessionary ticket product that allows free travel or travel with certain time restrictions, such as off-peak only. Many transport operators require registration before providing season tickets (weekly, monthly, annual), as these are sold at a reduced fare price compared to purchasing daily tickets.

To obtain reduced fares, travelers may need to provide evidence of eligibility using a registration process in advance of travel. This can involve completing a special form and showing identification such as a driver's license or college ID. The resulting electronic discount token or photo ID can be sent to an NFC-enabled phone and shown to the ticket sales agent. The token in this case is a unique identifier that is managed in the operator's system but can be stored on the phone for easy recognition. It can initiate the ticket as in Rhein-Main-Verkehrsverbund's program in Germany (see <u>Open (Ungated) Systems</u>) or it can be separate from the ticket that may also be stored in the phone. In addition, registration for a ticket service can be done at any time using the phone's keyboard and Internet connection. An NFC-enabled phone greatly speeds registration, along with setup and personalization.

4.1.2 Provisioning

Most transport operators have ticket offices and retail agents to sell prepaid tickets to travelers before starting their journey. These prepaid tickets range from a single journey on one transport mode to a ticket that allows unlimited travel across multiple travel modes for up to one year. Self-service ticket-issuing terminals are now increasingly used, allowing the traveler to avoid lengthy lines at ticket offices. In addition to prepaid tickets, postpaid passes must also be distributed to the customer one way or another; currently, this is usually done with mail or onsite staff.

NFC-enabled phones provide convenience for both the customer and the transport operator. NFC-enabled phones can be used to purchase tickets at either the ticket office or kiosk, and then can be used to download and store them. They can also be used to provide tickets remotely over the air using a ticket distribution network.



4.1.3 Validation

When passengers enter a transport vehicle or a "ticket validation area," they must be prepared to manually show or electronically present their valid tickets. For many transport modes, passengers may also have to electronically present their tickets to exit the vehicle or "validation area."

Manual validation is often performed by the vehicle driver or a conductor/guard on the bus or streetcar, or by a ticket checker before passengers enter the boarding area of a train, subway, or ferry.

Increasingly, this validation is being performed electronically by readers on the vehicle or gate lines at train, subway, or ferry boarding points. This is both faster and more accurate than manual validation.

Electronic validation has allowed the introduction of pay-as-you-go tickets. The traveler loads stored value on an NFC-enabled phone before the journey. The validation devices then deduct value from the stored balance throughout the passenger's travel on the various transport modes that support the technology's use. This can significantly reduce the need to issue prepaid tickets.

Some transport operators are also planning to introduce pay-after-you-travel tickets where a valid travel token on an NFC-enabled phone or contactless payment card is used as a guaranteed payment method to the transport operator. The entry and exit validation taps are collected and priced in a centralized back-office fare generator, and an overall aggregated charge is made to the associated bankcard account. This contrasts with the need for validation readers to hold all fare tables and fare pricing software to support pay-as-you-go product fare calculations. Pay-after-you-travel allows passengers to use their NFC-enabled phones to travel without having to obtain a specific travel smart card or prepaid ticket. This will further reduce the need for ticket-selling facilities and associated commission costs.

4.2 Non-ticketing Applications

Many processes are associated with the provisioning and publication of fare products and prices, which include service timetables, information about planned service outages such as track renewal or station refurbishment, notification of current service disruptions such as signal/power faults, vehicle malfunctions, and even details/ coupons for special leisure events or discounted fare prices. Passengers need to access this information before and during their use of public transport. While SMS messages to phones can deliver much of this information, NFC-enabled phones and smart posters have the added benefit of enabling passengers to initiate these queries and get the relevant content themselves.

Customer service—key to customer satisfaction and loyalty—can also be improved using NFC. A passenger may seek assistance while traveling or may need to call a help desk. A traveler may also want to complain if unsatisfied with the service or may want to inquire whether an item lost on the journey has been found. Smart posters with tags that include contact information for these purposes can make customer service easy and reliable. The customer can just tap the NFC-enabled phone to the promoted service or information on the smart poster and get access to it.

4.3 Implementation Options

To illustrate the potential use of NFC-enabled phones by travelers in transportation business processes, several approaches to implementations are outlined below, showing what happens before, during and after the journey. These range from a simple introduction of tags in existing paper ticket schemes with an open validation environment, to a situation where gates control entry to the public transport system.



4.3.1 Open (Ungated) Systems

This scenario describes potential implementations for conventional systems that are not gated and use paper tickets today. In such a system a transport application can be loaded on an NFC-enabled phone.

The minimum required infrastructure to provide easy use of the NFC-enabled phone is an NFC Forum Compliant tag. These are used for two things:

- Automatic start of the installed ticketing application or ticket purchased through a website (e.g., SMS ticket)
- Authenticating the location (e.g., the location information can be stored on the tag)

To purchase a ticket or to register a trip in the system, the passenger taps an NFC-enabled phone against the NFC Forum tag at the departure station. The tag provides data about the current location to the transport application or opens a dedicated website that then prompts the traveler to enter a destination. The destination can be selected either from a personalized list of preferred locations or entered with the phone's keyboard. To identify the customer in the system, either the phone number or a unique ID stored in the application in the phone is used and forwarded to the system.



"Touch and Travel" with an NFC-enabled Phone in Germany

Departure and destination data, as well as the customer's identifier, is sent to a back-end system over the air. The back-end system provides feedback about ticket and travel options. Based on the customer's selection, a valid ticket is sent to the phone either as an SMS or a 2D barcode in the Java MIDlet (an application that permits such displays on mobile phones), which can be controlled using a regular barcode reader. The ticket can also be stored in the phone's secure element for security reasons and inspected using a contactless reader. The charge for the ticket can appear on a separate bill paid to the system provider or it can be linked to the passenger's mobile phone bill if the service provider and the mobile network operator have an agreement in place. This open (ungated) system is employed by Rhein-Main-Verkehrsverbund in Frankfurt Germany (using a Java MIDlet) and by mobilkom austria (using SMS).



If the transport operator wants to offer a check-in/check-out travel product, then the NFC-enabled phone could transmit the relevant taps at departure and destination to a back-office computer system where fares can be calculated. In this case, the NFC Forum tags at each station are used as check-in/check-out touchpoints. The system requires travelers to register their phones and set up payment arrangements through their mobile operators or banks. The Touch&Travel implementation of Deutsche Bahn in Germany uses an application stored on the secure element of the phone.

4.3.2 Controlled Entry Systems

In this implementation, there are electronic validators at entry points on transport vehicles or in a boarding area. There is an NFC reader as part of the validator that may already be accepting contactless cards. The transport operator arranges for the transport application to be placed on a secure element in the NFC-enabled phone that is equivalent to what people have on their contactless cards.

Entering the transport vehicle, travelers tap their NFC-enabled phones against the NFC reader and can travel, add new prepaid tickets, and top up pay-as-you-go value, exactly as they would with contactless cards. The NFC-enabled phone adds additional value in that it can display the ticket and resulting stored value balance to the passenger.



Transport System Phone Top-up in London

The transport application can be enhanced to allow over-the-air ticket products to be added into the secure element and/or stored values to be added over the air as the need arises. This significantly reduces the need to provide prepaid ticket selling facilities and reduces commission costs.

4.3.3 Gated Systems

Many cities today already have automatic fare collecting systems using gates and smart cards; e.g., London, Madrid, and Paris. The transport operator arranges with the NFC-enabled phone provider to support the installation of that city's transport application, such as Oyster in London or Calypso in Paris, on the secure element in the phone.



Whether multiple city transport applications can reside on the same secure element in an NFC-enabled phone depends on the arrangements that the various transit application owners have set up with the owner of the secure element. In the future, there may be a global application on the secure element, such as a payment application that can be detected and is accepted in any transport system. Passengers can then decide whether to pay by bankcard or use the relevant transport application as they travel domestically and internationally.

The implementation of the NFC ticketing system is similar to today's smart card system. The advantage of using NFC-enabled phones is the capability to automatically load tickets or value over the air using the mobile network.

4.4 Stakeholders/ Collaboration Model

In planning the introduction of NFC services for transport, the existing travel and customer information services, ticketing, access control (validation), and payment infrastructure must be taken into account. For example, the access control system could be an open gate (contactless reader) as in buses and trams, a closed gate as used in subways, or one using ticket inspectors who look at tickets but do not collect them (using handheld contactless readers).

4.4.1 Stakeholders

There are many players who need to be involved in developing an NFC transport system. In most cases, the requirements will be driven by the transport operator, who will be looking to integrate NFC applications into an existing structure for travel and customer service, ticketing, access control, and payment. This may or may not already include contactless acceptance capability.



Public transport ticketing with NFC phone

There are three options for storing the ticket securely on the phone, each of which may have a different provider:

- · A handset manufacturer can provide NFC-enabled phones with embedded secure elements
- SIM manufacturers can provide the SIM cards, via the mobile network operators, needed to store ticket applications
- Secure Digital card manufacturers can offer SD cards, when the ticket is stored in a pop-out card



Others directly involved in the system's technical support and development will usually include:

- · A systems integrator to oversee a smooth installation and provide overall technical coordination
- · A customized software provider to upgrade existing infrastructure and include security key management
- · A personalization entity to provide the initial application and any personal security required
- · A handset manufacturer to provide NFC-enabled phones and a distributor to sell or rent the phones
- · Tag manufacturers to provide NFC Forum-compliant smart tags for posters
- Internet service providers to build and maintain the applications that provide the travel and customer service information over the air to the NFC-enabled phones
- A mobile network operator to ensure effective communications between devices and their supporting infrastructure
- · SIM manufacturers to provide the SIM cards, via the mobile network operators
- A Trusted Service Manager (TSM) to control security of the applications, data files, and associated security keys that have been downloaded to the secure element on the NFC-enabled phone
- An over-the-air service provider to download purchased tickets, pay-as-you-go stored value, or new applications (most often the mobile operator or TSM)
- A reader manufacturer/distributor to ensure that any existing contactless infrastructure is ready to interface with NFC-enabled phones and that, where appropriate, NFC functionality is added to these readers

Outside of the technical implementation, other entities that may be included in an NFC project include:

- · Fare collection operators, if separate from the transit agency
- · Ticket sellers, which may include retail agents, self-service machines, or transport operator staff
- Payment card schemes and issuing banks that will supply the contactless applications and supporting systems for NFC payments
- · Vending machine makers that may need to upgrade readers to accept contactless payments
- Retailers in the station or nearby who also accept payment via NFC-enabled phones and may participate in joint promotions
- Advertising agencies to plan and execute smart poster promotions and educate consumers about the new services available

The plan should also take into account the needs of passengers and their ability and willingness to adapt to new form factors and new services. Customer service should also be considered, and plans should be made to handle questions and requests and to provide education.





A Traveler in Tokyo Purchases Candy at a Store in the Station Before Boarding the Train

4.4.2 Economics

The business case for deploying an NFC program can be built on a variety of cost savings and revenueproducing elements. With the introduction of smart card travel products, cost savings have been reflected in the reduced need for deploying and maintaining ticket selling machines, paper tickets, ticket sellers, and associated commission costs.

These smart card programs have shown that passengers are likely to pay for their travel more often because of the improved validation. Transport for London estimates 10 million pounds per year in more paid-for travel in their gated environment. Revenues are further increased due to significant reductions in or even elimination of queuing time to obtain ticket products. Other revenues come from new services that can be offered with advertising, sponsorship, and promotional opportunities. Transit agencies can also look for revenue-sharing opportunities with partners and local businesses.

Finally, improved traveler satisfaction is a major benefit that may be harder to measure but should be considered as a retention factor.

4.4.3 Timing/Milestones

Existing programs, depending on their complexity, have taken anywhere from six to 18 months to implement after the various contracts have been put in place.



5 Examples of NFC in Transport

NFC applications have been implemented in public transport programs in a number of countries, involving a variety of ecosystem players and transport modes. This section briefly highlights a few successful programs.

5.1 London – Testing Transport Ticketing on NFC Mobile Phones

In 2007, a trial of NFC for mobile transport ticketing and small payments was carried out in London – the largest such trial up to that time. A collaboration that involved the city's transport authority Transport for London (TfL), phone provider O2, Nokia, Barclaycard, and Visa, it was conducted to test consumer demand for having cards normally carried in a wallet, such as Oyster (the UK transport card) and credit cards, available on a Nokia 6131 NFC mobile phone.

This trial was a large-scale customer research and feedback project designed to understand a series of customer experiences enabled by NFC. For TfL, it was important to obtain specific understanding of consumers' use of mobile handsets for transport as a potential alternative to Oyster cards.

The project involved 500 O2 customers, who were given Nokia handsets with NFC functions. Three main NFC applications were used:

- O2 -- Participants could use their NFC handsets to tap and gain entry into the Blueroom at The O2 Arena the exclusive bar for O2 customers and guests at the venue.
- Oyster The trial handsets were all enabled with Oyster functionality, which allowed each participant to use the handset in place of an "adult" Oyster card – to load "pay as you go" value and weekly or monthly period tickets, and pay for travel on the Tube, buses and trams across the city. Each trial participant was given £50 in free credit.
- Barclaycard payments Selected trial participants were given £200 prepaid to make low-value payments. In addition to making payments, they were able to use their phones to check available funds and locate nearby retailers that accepted contactless payments. This application was provided through the Visa card scheme, along with standards for contactless payments.

Key findings of the research were that customers maintained high levels of interest and satisfaction throughout the trial and that the main customer benefits were convenience, ease of use, and status.

5.2 Germany – Touch&Travel Pilot Program

Touch&Travel is an NFC-based ticketing pilot project jointly conducted by Deutsche Bahn, the German rail authority, and its partners Vodafone, Deutsche Telekom and O2 Germany, with support from industry as well as local transport companies. The pilot project covers long-distance trains between the cities Berlin, Cologne, Dusseldorf and Frankfurt, as well as selected regional trains, the metro and trams in Berlin, and all means of transport -- including busses and a ferry -- in Potsdam. The project started in 2008, and currently about 3,000 participants are using the service on a frequent basis.

The major aim of the project is to test the technical feasibility and pre-commercial user acceptance of a tagbased check-in/check-out system using NFC-enabled mobile phones. During the pilot, various NFC-enabled phones from three brands have been introduced.



The basic benefits for the project's participants are:

- They gain simple and flexible access to transport systems across different cities and regions in Germany, regardless of the transport mode
- · No ticket purchase or fare knowledge is required

Using Touch&Travel is simple and easy. During the pilot program, the partner companies hand out NFCenabled phones with the Touch&Travel application preinstalled, residing securely in the phone's SIM card. The customer must register for the service on the Internet. After registration, the customer is ready to travel.

To use the system, the customer taps his/her phone to the Touchpoint at the departing station. The Touchpoint contains a passive NFC tag that securely holds information about the location. The location information is sent by the phone, via the mobile network, to the back end of the Touch&Travel system, which returns a checkin record to the customer's phone. This record is stored in the application on the SIM card, and it can be accessed by an authorized conductor with a mobile control device during the customer's travel.

At the conclusion of travel, the customer needs to check out of the system, which he/she accomplishes by touching a Touchpoint at the destination. The Touchpoint data is sent off and stored in the back-end system, and together with the check-in record, it will be used to calculate the price for the journey.

For Deutsche Bahn, the major benefit is the installation of a flexible and scalable ticketing system with low infrastructure and sales cost. After the expected successful completion of the trial at the end of 2010, Deutsche Bahn is considering rolling out the system across Germany.



The illustration below gives an overview of the Touch&Travel system's operation.



5.3 San Francisco – NFC Mobile Payment for Rapid Transit

In 2008, the contactless payment solution provider ViVOtech enabled the BART (Bay Area Rapid Transit) NFC mobile payment trial in San Francisco. In a partnership with Sprint, First Data, fast food purveyor Jack in the Box and BART, the project enabled hundreds of commuters to ride BART just by waving their NFC mobile phones at the gates to gain access to the stations.

The trial was the first in the United States to combine mobile-enabled transportation with mobile payments at retailers, by allowing participants to use their phones to pay for meals at Jack in the Box locations around the Bay Area. In addition, the trial featured targeted promotions to consumers via Smart Posters at BART transit stations that helped drive traffic to retailers.

The trial was a major success, enabling several thousand mobile-enabled BART trips and meals at Jack in the Box, with a very high rate of Over-the-Air (OTA) top-up of both BART and Jack in the Box prepaid accounts. In the project, ViVOtech deployed its award-winning mobile wallet, OTA provisioning service, Smart Posters and promotion engine, as well as contactless payment readers in stores.

Smart Posters in San Francisco BART Trial of NFC



1. Tap your phone on "Find Your Burger" NFC Poster at the Powell BART Station in San Francisco



5.4 Frankfurt – RMV-HandyTicket with NFC for Public Transportation

From July until November 2007, the German transport authority Rhein-Main-Verkehrsverbund GmbH (RMV) and its partners tested the "RMV-HandyTicket für NFC-Handys" in Frankfurt, based on its existing ticketing application for Java-enabled mobile phones. In the test, the 59 most-frequented stops in Frankfurt were equipped with passive NFC radio chips (ConTag). About 270 customers tested the ticketing system. In addition to buying tickets, the customers could also call up the departure timetable at a given stop with their NFC phones and obtain real-time information via the ConTags.



Today, full NFC HandyTicket service for Frankfurt is in operation -- more than 2,200 ConTags have been installed at stops and stations in Frankfurt, with about 800 additional ConTags in the neighboring district of Main-Taunus.

The ticketing software used for the RMV-HandyTicket project in Frankfurt was adapted to NFC functionality in connection with a passive NFC tag infrastructure, the ConTag. To buy a ticket, the user touches a ConTag at the stop where the trip starts. The start page of the RMV-HandyTicket program opens automatically and indicates the name of the stop. From this point it takes only three clicks to buy a single ticket, a day ticket or a short-distance ticket for trips within the city of Frankfurt or to/from the Frankfurt airport. All acquired tickets are billed to the customer at the end of the month.



Buying Tickets via RMV-HandyTicket for NFC Mobile Phones

As an added benefit of the project, the ConTag was programmed so that customers who had NFC-capable mobile phones without RMV-HandyTicket applications could access the real-time timetables at their respective stops, by just touching the phone to the Contag.

The participants in the project were not selected based on characteristics of the target groups, but by the distribution of the applications received for the project. The average age was 32, and men predominated, at 85% of participants. The results of online interviews showed a high level of satisfaction with the tested system: 81.7% of the users were absolutely satisfied or satisfied with the RMV-HandyTicket for NFC mobile phones.

The interviews also revealed that many aspects of mobile ticketing were perceived as positive. The intuitive ConTags application was particularly convincing: compared to the RMV-HandyTicket without ConTag (the Java-based mobile ticketing application), nearly three-quarters of the test participants preferred using the ConTag with NFC. The high level of acceptance of the "RMV-HandyTicket für NFC-Handys" is also shown in the fact that 82% of all those interviewed would recommend the NFC ticketing system to their friends without any reservations.



Using an NFC Mobile Phone with an RMV ConTag



Appendix A: Frequently Asked Questions

What is the N-Mark? Do I have to use the N-Mark on the readers or tags?

The N-Mark is a globally registered mark to indicate that NFC is enabled. It also indicates the user touchpoint for easy reading. It is recommended for use on smart posters at the present time, and guidelines for its use on devices will be available toward the end of 2010. The N-Mark can be used alone or in conjunction with proprietary marks, and it is especially encouraged for use cases where out-of-vicinity visitors and tourists may be a target audience. A license is currently available at no charge at http://www.nfc-forum.org/N-Mark.



If consumers lose their mobile devices, how are tickets reissued? What can the traveler do to avoid misuse of the stored ticket value on the lost phone?

If the phone is offline: ticket reissuing is done by ticket providers' back-end systems, as they will know if the tickets have been used or not. Together with the Trusted Service Manager (TSM), the ticket provider will transfer the ticket application and ticket value to the new phone. The old ticket should be blacklisted in the ticketing system in case the lost phone is ever used at the gate.

If the phone is online: the TSM, on behalf of the ticket provider, simply transfers the value from the old SIM card to the new SIM phone, and deletes the old value and application. If the lost phone has been turned on, the ticket can be rendered void over the air.

Will my readers (validation device/inspection device) need to be NFC Forum certified? What certification will they need? Why do they need to be certified?

For readers to have the best chance of interoperability with devices used by the public, the NFC Forum strongly recommends that readers be built to follow the NFC Forum specifications. Certifying the readers will ensure that devices meet all the requirements of the NFC Forum specifications and improve the likelihood of complete interoperability. To use the N-Mark, readers will need to go through the NFC Forum Certification Program, which will ensure that readers can perform both read and write functions, along with peer-to-peer functions.

How can NFC help to provide seamless travel across geographies?

In an ideal world, where all equipment from users' handsets to network gate reader-writers to information tags is compliant with NFC Forum specifications, consumers leaving home to travel nationally and internationally should be able to seamlessly use the various contactless systems deployed around the world. Technically, at the hardware, communication, and logical levels, the NFC Forum, together with other standardization bodies, is working to achieve this goal.

However, while this technical work is a prerequisite for seamless usage, it is not sufficient to ensure it. At the application and service level, various systems, generally known by their commercial names (FeliCa, MIFARE, Calypso, etc.) or under Type A, B, or C (a.k.a. F), are used by transport operators, and the systems encountered in travelers' journeys will have to be installed on their devices. This implies that:

- The mobile network operator and/or the Trusted Service Manager should enable the download of applications over the air or through any other method to install them before the journey.
- Transport operators, even when they use the same application, need to discuss and implement some revenue-sharing scheme to allow for collected fares to be distributed between them.



Therefore, in the real world, business conditions that are beyond the (current) responsibilities of the NFC Forum still need to be met.

Can a prepaid non-validated ticket be transferred from one NFC-enabled device to another NFC-enabled device?

Tickets can be transferred from one NFC-enabled device to another, provided that each device contains a secure element with a transport application trusted by the ticket supplier, in which the tickets are stored.

The transport applications must:

- Provide a method to transfer valid tickets over NFC and authenticate that transfer.
- Delete the original ticket (or decrease the value of that ticket) from the sending device once the NFC transfer has been authenticated as successful.
- · Activate the received ticket once the deletion has been confirmed.

What are the valid secure elements that NFC can support without compromising security?

The NFC Forum's specifications do not dictate which secure element the applications have to use. Each operator is free to choose how to implement NFC in a handset, but as NFC could potentially be installed into devices that do not have SD card slots or UICC slots, or have built-in secure elements, operators should look at what devices are available in their geographies and focus on those. In addition, a phone may have multiple secure elements. In this case, the consumer will decide which application is to be used for the next trip and select this one to be the active one.

Alternatively, the NFC Forum is currently working on a specification that will provide standardized interfaces between all secure element configurations. ETSI has completed a specification for accessing the secure element on the UICC, for which the GSMA provides additional support in the form of white papers. These materials can be found on the websites of the two organizations.

How can tickets be presented on-screen?

The NFC-enabled device must contain an application capable of reading the ticket details from the secure element, understanding the content of the ticket, and displaying it on a screen in a suitable form for the consumer to understand. In a typical NFC-enabled phone, for example, a software application would be used.

Can I use the phone as a smart card if the phone is off? And what functionality is enabled?

The NFC Forum specifications do not dictate the phone's usage; however, NFC can be used in card emulation mode when the power is switched off in the phone. Also, if the phone cannot operate due to low battery, it is possible to use the card emulation mode of the phone with the residual charge in the battery. If the battery is removed from the phone, it is extremely unlikely that any NFC functionality can be used. It is recommended that you check with mobile device manufacturers on the actual functions provided, as this may change from model to model.

Can I use the NFC functionality in the middle of a phone conversation? And what functionality is enabled?

In phones that have been used in trials and commercial rollouts for ticketing, NFC has been implemented in such a way that passengers do not need to interrupt ongoing phone calls to check in or check out of the public transport system.

However, because each ticketing solution will have its own specific implementation, it cannot be guaranteed that this will always be the case. To ensure a common user experience, public transport agencies and



service providers need to raise awareness of the need for such a requirement in the appropriate standards bodies. This means not only to request such functionality from the phone manufacturers and mobile network operators but also to standardize the application layer for public transport.

How can I use multiple ticketing/payment applications on the phone? Is it automatic or does the user have to choose?

A passenger will choose which application to use before tapping the NFC-enabled device at the gate. For convenience, that choice will be remembered by the device until the user needs to change it.

Can I put my legacy implementation into any NFC-enabled phone?

It is possible to put an existing application into an NFC-enabled phone. First, the mobile phone must have the ability for the legacy implementation to operate in a secure element. It is possible that some existing applications may not be supported in every NFC-enabled phone. For example, in the case of MIFARE Classic or MIFARE DESFire, this implementation resides in the software or hardware of the secure element (UICC, embedded secure element, microSD, etc.).

Next, once the NFC phone is equipped with this secure element, the application (transport, access, etc.) can be downloaded via the RF interface or over the air (OTA).

- RF Interface: as with every smart card, the application is provisioned via the RF interface once the NFC phone is placed in front of the contactless reader.
- OTA: the application is provisioned through the Mobile Network Operator (MNO). The MNO will facilitate a
 secure connection between the TSM server and the legacy implementation stored in the secure element
 of the mobile phone. A secure smart card Java-based applet will ensure that the application is securely
 provisioned into the legacy implementation inside the secure element.

In the case of MIFARE Classic and MIFARE DESFire, the MIFARE For Mobile smart card Java applet will ensure secure communication between the TSM server and the legacy implementation.

What type of tags can I use?

- Type 1: Innovision Topaz, ISO14443A, 7Byte UID, 96Byte memory + OTP, one-time lock: manufacturer is Innovision
- Type 2: MIFARE Ultralight, ISO14443A, 7Byte UID, 64Byte memory + OTP, one-time lock: large number of manufacturers
- Type 2: MIFARE Ultralight C, ISO14443A, 7Byte UID, 192Byte memory + OTP, one-time lock, 3DES authentication with option to detect clone: large number of manufacturers
- Type 3: Sony FeliCa, JIS X6319-4, 4kByte, 3DES, encryption: high security
- Type 4: MIFARE DESFire, ISO14443-4, 7Byte UID, 2k or 4kByte, 3DES, encryption, MACing, Enciphering: high security, large number of manufacturers



Appendix B: Standards and Compliance

The NFC Forum has created the specifications needed to implement the scenarios described in this paper. The NFC Forum's specifications are based on the ISO/IEC 18092 specification and on ISO/IEC 14443-A/B to improve interoperability between devices and support legacy technologies.

The NFC Forum specifications build up the NFC Forum Protocol Stack, which enables devices to read and write to tags and other devices or to communicate peer-to-peer. Optionally, the NFC Forum Protocol Stack does support card emulation mode, allowing an NFC-enabled device to act as a legacy card or tag meeting the above-mentioned specifications.

The NFC Forum specifications are mapped to the OSI model, layers 2, 4, and above. Levels 1 and 2 (the analogue and digital layer) are supported by the Analogue and Digital Protocol Specification and the Activity Specification. These support peer-to-peer and read/ write modes.

The Logical Link Control Protocol (LLCP) specification provides a standard interface to NFC applications. To support NFC applications, the NFC Forum's NDEF and RTD specifications provide a standard mapping for data communicated across an NFC transaction.

View a complete list of the NFC Forum specifications.

The NFC Forum's specifications are compliance-based specifications. The NFC Forum has developed a robust Certification Program, introduced in late 2010, in which devices can be internationally tested against a common set of test cases to ensure compliance with the NFC Forum specifications. When an NFC Forum member company's device passes certification, the device will receive this certification mark.



This mark will assure operators that selected devices have met international standards. The NFC Forum also conducts periodic "Plugfests," events where device manufacturers can anonymously measure the interoperability of their devices against other NFC devices, leading to opportunities for improvement.



Appendix C: Glossary

NDEF Application

The logical, higher-layer application on an NFC Forum Device that uses NDEF as a means to exchange information with other NFC Forum Devices or NFC Forum Tags.

NFC Data Exchange Format (NDEF)

Defines how information is shared.

NFC Forum Card Emulation Mode

The mode used when an NFC Forum Device is using the optional part of the NFC Forum Protocol Stack that responds to Master/Slave Communication from a Reader/Writer terminal. When in NFC Forum Card Emulation Mode, the NFC Forum Device (emulating either an NFC Forum Tag or a contactless card) cannot start the communication on its own. The communication for this mode is abbreviated as CE.

NFC Forum Peer-to-Peer Mode

The mode used when an NFC Forum Device is using the part of the NFC Forum Protocol Stack that enables Peer-to-Peer Communication with another NFC Forum Device using this same mode. Both NFC Forum Devices have the capability to be either initiator or target. This mode uses the NFC-DEP Protocol. The communication for this mode is abbreviated as P2P.

NFC Forum Reader/Writer Mode

The mode used when an NFC Forum Device is using the part of the NFC Forum Protocol Stack that enables Master/Slave Communication with NFC Forum tags or contactless cards. The NFC Forum Device starts the Master/Slave Communication and sends commands to an NFC Forum Tag or contactless card. The communication for this mode is abbreviated as RW.

NFC Forum Tag

A component that is expected to behave in the same manner as a contactless tag, compatible to at least one of the mandated tag operation specifications supported by the NFC Forum Protocol Stack. It implements the necessary protocols and supports the necessary data formats so that an NFC Forum Device can communicate and exchange data with the component).

As NFC Forum Tags themselves are not specified by the NFC Forum, they are neither required to support the complete specification nor the complete NFC Forum Protocol Stack.



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