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Open Payments forum

> REPORT

OPEN LOOP PAYMENT IN PUBLIC TRANSPORT

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Acknowledgements

Members of the Urban Mobility Open Payments Forum:

International Association of Public Transport (UITP)

Rue Sainte-Marie, 6 | B-1080 Brussels | Belgium

Tel: +32 2 673 61 00

info@uitp.org

www.uitp.org

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TABLE OF CONTENT

INTRODUCTION

In July 2021, UITP (the International Association of Public Transport) launched the Urban Mobility Open Payments Forum. Gathering a selection of partners from across the public transport ecosystem, including operators, payment schemes and technology providers, the Forum answers the call from the public transport sector to create a clear framework for engaging in a more open dialogue at an international level on open loop payments.

The Forum helps pave the way in which paying for public transport anywhere in the world is as familiar and compelling as it is in your home city. The Forum is uniquely placed to understand the challenges of different markets, to help educate and inform cities, and together advance projects. It will lead a series of initiatives to improve understanding and the know-how of stakeholders in the public transport sector, in particular public transport operators and authorities.

Finally, the Forum facilitates the exchange and dialogue on solutions and processes, raising awareness to make it easier and less costly for public transport organisations to implement open loop payment.

This whitepaper explores the basics of open loop payments in public transport and discussed how it differs from other and more historic ticketing approaches.

While some specific rules and requirements may differ between Payment Schemes, the general principles laid out in this document apply for all contactless EMV® based open loop payment offerings.

EVOLUTION OF TICKETING AND PAYMENT

Ticketing and payment systems in public transport have rapidly evolved in recent decades. Paper tickets, sold at ticket vending machines, counters or by staff were increasingly replaced with automatic fare collection (AFC) systems, including closed loop smart cards, such as the Oyster system in London and NaviGo in Paris.

The aim of these new AFC systems was to speed up passenger flows, reduce the cost of fare collection and provide a better service to passengers. These systems have been very successful, with millions of cards issued and generally high passenger satisfaction.

However they have come at a cost, with the public transport operator (PTO) responsible for the maintenance of a large ticket retailing estate, and the costs of issuing cards all falling on the operator itself.

Outside of the transport payments networks, the way that people choose to pay globally has continued to evolve, and since 2010 onwards contactless payments cards have become increasingly popular – a trend which has been accelerated by the Covid-19 pandemic.

Combining the merits of both, smart card tickets and payment cards into one system where the public transport operator no longer needs to provide and manage dedicated closed loop smart cards is the underlying idea of open loop payment in public transport.

- ❯ Smart card tickets offer touch free technology but leave the cost of transit-specific card issuance and management to the public transport operator, using one of many different smart card standards.

- ❯ Open loop, on the other side, enables public transport operators to take advantage of existing, globally interoperable payment media most customers already have in their pocket, with card management and issuance being the responsibility of the issuing institution, typically a bank.

There is no uniform way to innovate ticketing and payment. While technology offers a variety of options to innovate, the speed and steps taken by public transport operators depend on the performance of current solutions, investment strategies and, of course, passenger expectations.

Upgrading existing infrastructure and integrating both types of solutions can be a complex challenge. Transport for London was first to offer open loop payment for buses in 2012. Since then, the system was further expanded, and from 2014 onwards is available across all TfL services.

Integrating both worlds has been a complex challenge. Transport for London was first to offer open loop payment for busses in 2012. Since then, the system has been further developed, is now available across all TfL services and the growing number of payments done prove how popular open loop payment is with passengers.

Inspired by the success and experience gained in London, open loop payment has now been implemented all around the world.

While technology offers a variety of options to innovate, the speed and steps taken by public transport operators depend on the performance of current solutions, investment strategies and, of course, passenger expectations.

Cities adopting open loop ticketing in public transport
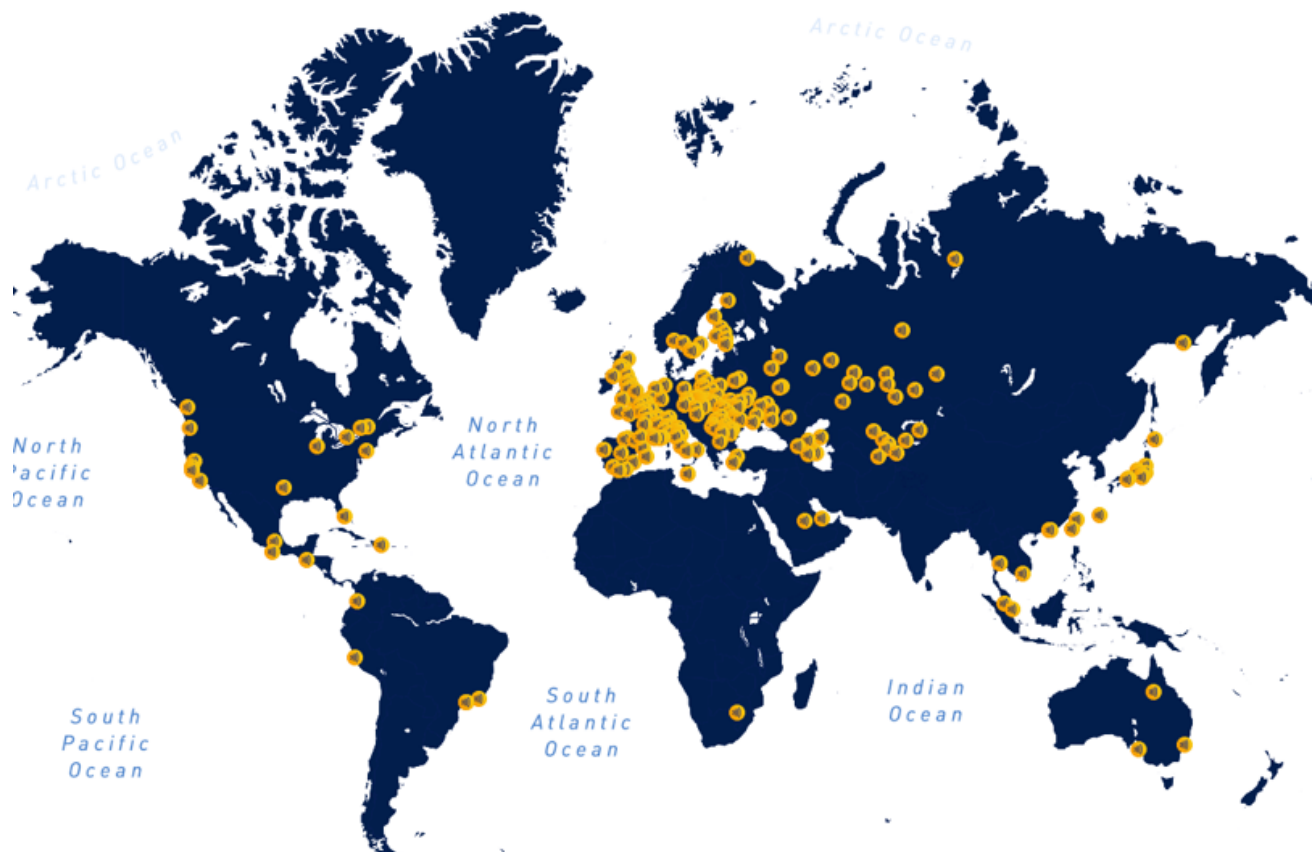
WHAT IS THE DIFFERENCE BETWEEN CLOSED AND OPEN LOOP?

Closed loop ticketing, relying on dedicated cards such as those based on MIFARE®, CIPURSE™ or Calypso®, which store all funds, travel rights and records associated with the passenger. It reflects the classic process in public transport. This requires customers to buy a ticket first, which enables them to travel and they use this ticket to gain access into that public transport operator's system.

This form of ticket media is specific to public transport and can only be used for travel purposes on the services that the PTO who issued the closed loop ticket provides. The management of ticket media and related infrastructure is the responsibility of the PTO.

There are examples, where closed loop systems are pushing beyond these limitations to provide more value to customers:

- **Multi-operator smart cards** - these may be available where several PTOs use a common ticket system operator. An example can be found in The Netherlands, where Translink is operating the nationwide ticketing system "OV Chipkaart". Customers can use any public transport service after having purchased and pre-loaded such card.

  Another example are the "Verbundtickets" in Germany, where the regional transport authority is responsible to define the tariff system for public transport in its territory. They may issue fare products valid for any operator that adhered to this joint tariff system and customers only need one smart card to travel with any of them.

- **Multi-service smart cards** - The use of closed loop smart cards can also be extended to pay for non-transport services. Octopus, the contactless payment system launched in Hong Kong in 1997, cooperates with business partners across various sectors to facilitate using the Octopus card for payment in retail shops or leisure facilities. Still, the Octopus card is not universal, and merchants need to sign up to the system first, so customers can only use it within the Octopus ecosystem.

  France has also developed a Citizen Multi-Services Application card (ADCET *https://www.adcet.com/en/*) to manage third party services beyond pure transit application. This standard is in operation in several French provinces.

To further increase convenience, closed loop smart cards can also be complemented by mobile phone-based solutions and ticketing apps. These solutions remove the need to provide and manage smart cards for travellers, but PTOs are still in charge of sales and validation equipment as well as the ticket administration.

Open loop payment, removes the ticket from the equation entirely, as the payment card or mobile device becomes the ticket. Passengers are able to acess public transport simply by tapping a valid open loop contactless payment media on the payment terminal. The payment for the journey can either be realised during the trip, after completing the journey, or after all journeys taken that day, when the fare is calculated based on the actual use.

No prior ticket purchase, app download or manual sign-up process is needed, the customer simply uses the contactless payment method that they already use widely in their daily lives. With no dedicated smart card to be issued by the operator, open loop payment generally relies on account-based ticketing system, where travel rights and records are stored in the back-end, where travel logic, fare policy, and also fare calculations can be done.

Advantages:

- PTOs are not responsible for card management. They do not need to issue, stock, and replace smart cards as this is already managed by issuing institutions. EMV® already also supports a variety of media, hence mobile payment via phones or wearables can be offered with little to no extra effort. Digital payments offer the opportunity to shift sales from ticket vending machines or kiosks, which can help reduce costs.

- Operational efficiency: Digital payments can also improve customer throughput and increase efficiency. Removing the friction of payment has significant benefits for the operator, including reducing or removing queues at travel locations such as rail stations, reducing bus dwell times, and increasing efficiency of bus services.

- Improved cash flow: Open loop systems allow operators to manage customers' right to travel by holding their account information directly— rather than on a card—as is the case with card-centric, closed loop systems. These systems can settle revenues with operators the same day. This includes those from multi-operator or multi-modal caps or ticketing products, should the revenue distribution process be automated.

- Passengers do not have to pre-purchase a ticket, download a bespoke app or spend time understanding which fare product to buy, as they can simply tap the contactless card that they already have. Relying on the global interoperability of payment cards and the business rules as established by the PTO, they can just tap and go, which lowers the entry barrier to public transport for all users, both those using the system every

day, through to those occasional users. Improving the customer experience and making it easier for the passengers to use public transport can boost ridership.

- Risk management: Payment scheme open loop frameworks are designed to minimize potential lost revenues, with bespoke enhancements and mechanisms built in such as sophisticated liability share and debt recovery options.

Challenges:

- PTOs that already have a closed loop smart card system can add open loop payments to complement their existing services, rather than replace the system specific cards immediately; consequently, there may be the need to manage closed and open loop payment systems in parallel over a certain period.

- Replacing the concept of buying a ticket before travelling works best when the PTO provides transparency and trust; passengers want to be sure to be charged the correct amount and PTOs want to have the risks of post-payment managed.

- Ensuring the access to public transport requires the deployment of solutions for persons that do not already own a contactless card; this might apply to children or persons that do not meet the requirements to access banking services. Solutions exist that use EMV® contactless technology and can be explored as part of a full ticketing solution.

WHAT PARTIES ARE INVOLVED IN OPEN LOOP PAYMENT?

Aligning payment, ticketing, and access control for public transport into one process also means integrating standards, rules and terminology of different business worlds into one eco-system. Let's have a look at the players that need to be on board to make open loop payment work and the roles that need to be played.

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THE CUSTOMER SIDE COMPRISES:

- The Cardholder – this is the passenger having a contactless payment card, issued by their bank or a financial institution, to tap at the ticket gate or validator.

- The Issuer – banks and financial institutions that issue payment cards to customers, who will have requested a bank account or card and undertaken a screening process to meet the necessary criteria to access these services. Issuers approve or decline transaction requests received by acquirers on behalf of their merchants, and post settled transactions to cardholder statements.

THE PTO SIDE CONSISTS OF:

- The Merchant – this is the PTO or ticket system operator accepting bank card payment directly on their validators for their products and services.

- The Technology Partner – this is the PTO systems integrator and technology provider, who will supply the contactless terminals and back-office systems. They will manage the integration of a PTOs fare collection system with financial institutions so payments for journey charges can be received by the PTO

- The Acquirer – this is a financial institution that receives, processes and settles transactions for the PTO. They ensure that the payment due for journey charges is received and settled to the PTOs account.

- Global Payment Schemes – facilitate digital payments between cardholders, merchants, and financial institutions. They provide global standard payment rules that help connect these individual parties, and ensure transactions are routed correctly so payments can be processed successfully.

HOW DOES A CONTACTLESS OPEN LOOP PAYMENT PROCESS WORK?

Contactless open loop payment today allows three transaction models for public transport.

❯ The Known Fare Model

❯ The Accumulated Model

❯ The Pre-purchase Model

These models offer flexible urban mobility solutions that enable the acceptance of all EMV® Contactless payment cards and devices. They are designed for fast passenger throughput and efficient and secure automatic fare collection.

With the **Known Fare Model**, the value of the transaction is determined at the moment that the passengers tap their card at the validator. This model is applicable for single-ride tickets. Every time the passenger taps their card, a transaction is processed, and if approved by the issuing institution, the operator receives payment for the specified amount.

❯ This type of model is best suited for open loop contactless payments operating in a system with a single mode of transportation, either with a flat or distance-based fare. The passenger taps their bank card or payment device to access a transport service where the fare is always known at this time. Payment authorisation happens in real-time, although deferred authorisation is also possible to enable fast passenger throughput and help reduce vehicle dwell time.

With the **Accumulated Model**, the final transaction value is unknown at the start of a journey. The payment card is used as credential for travelling and a financial transaction is processed when the full journey is completed, and the fare is clear.

❯ This type of model offers a highly-flexible solution suitable for both single mode and multi-modal transportation environments. It enables operators to offer a range of flexible fares, including: fixed fares; distance- and time-based fares; multi-modal fares; and features like fare capping, concessions, and delay refunds. This model provides efficient fare collection processes and limits the operator's risk through payment mechanisms designed to minimise financial exposure.

In this model, the rider taps their EMV® Contactless card or device at the validator. The final fare charged is not always known at the time of travel, as the "tap data" is accumulated, and the total fare amount is calculated and charged by the PTO at the end of the travel period.

The **Pre-purchase Model** is based on a standard retail payment. It implies that a defined fare product needs to be purchased before travelling and is stored in a travel account that may be associated with a payment card.

❯ Upon the first tap of the card, which has to be the same that was used for the purchase, the fare product is activated at the central system and only to be monitored for validity as the transaction is already completed.

This model allows a direct integration of higher-value fare products, such as monthly or annual subscriptions into open loop payment. Careful consideration must be taken in how to support this use case as there can be some associated complexity and risk.

WHAT EQUIPMENT IS NEEDED FOR OPEN LOOP PAYMENT?

Facilitating payment for a journey requires infrastructure and equipment. The classic (card-centric) public transport ticketing system includes the following elements:

❯ **The ticket** - a paper ticket, magnetic card, smart card or digital ticket - is needed as proof that a passenger has paid the fare;

❯ **Sales equipment** - installations at staffed points of sales or ticket vending machines - allowing passengers to purchase a ticket;

❯ **Validation equipment** - fare gates or devices installed in vehicles and platforms - needed to validate the ticket and register the beginning (and the end) of a journey;

● Inspection equipment, which are handheld devices used to read tickets in order to verify whether a correct fare has been paid.

The public transport operator is responsible for the availability and reliability of all those equipment elements to ensure a smooth journey for the customer and correct revenue generation.

Open loop payment removes two of these elements from the equation - the ticket and the sales equipment. The token needed as passenger credential to start a journey, is a contactless payment card. Since there is no need to buy a ticket, no sales equipment needs to be provided. Passengers simply tap their contactless payment card and go.

Accepting payment cards directly, also has an impact on validation and inspection equipment.

● Inspection equipment no longer focusses on verifying if the correct fare has been paid, but on the question whether the passenger has presented a valid bank card to gain access to public transport.

● Validators interacting with payment cards need to respect the security standards of the payment sector and need to be certified accordingly.

WHAT SECURITY STANDARDS NEED VALIDATORS BE CERTIFIED FOR?

Deploying EMV in public transport implies ensuring that the whole infrastructure, from front-end devices to the back-end systems, is compliant with the security requirements expected by the bank industry. This is a major impact for the ticketing vendors as it means their products must comply with and be certified to specific standards.

Two organisations are leading the interoperability and security aspects for secure payment transactions, the EMVCo (EMV stands for Europay, Mastercard and Visa) and the PCI Security Standards Council (PCI stands for Payment Card Industry).

EMVCo is a standardization body that enables global interoperability by managing technical specifications and testing processes. It is co-owned by American Express, Discover, JCB, Mastercard, UnionPay and Visa.

PCI Security Standards Council promotes standards and assessment frameworks to ensure the security of the cardholder data, by the entities that process, transmit and store it. The cardholder data is the sensitive information that enables the payment.
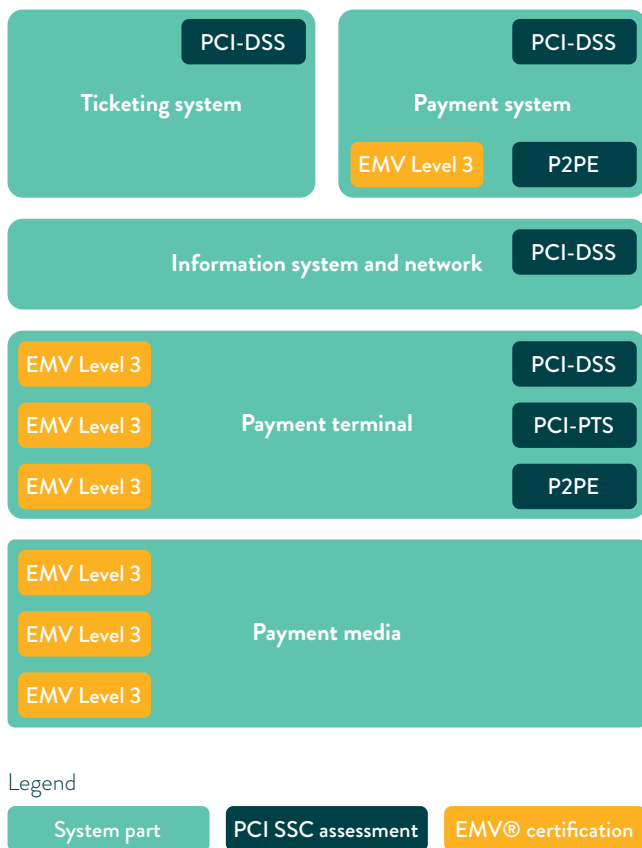
For EMVCo, there are three main categories of specification and testing areas:

● EMV® Level 1 (L1). This testing area focuses on the media (e.g. card, smartphone, wearable) and terminal compliance for the electrical and logical protocols and the data transfer (analog and digital compliance). This testing is common to all payment schemes.

● EMV® Level 2 (L2). This testing area assesses the compliance of the media application and terminal software (aka EMV kernels) to perform functional EMV® processing. This testing is specific per payment scheme.

● EMV® Level 3 (L3). This testing area targets the validation, per payment schemes or brand, of the integration between the payment terminal and the payment acquiring system.

The PCI Security Standards Council develops and drives data security standards to ensure trusted payment transactions. In public transport, transactions are possible with the secure handling of sensitive cardholder data amongst which being the Primary Account Number (PAN), the expiration date, or the CVV captured from the chip card data. There are three important standards:

● PCI DSS (Data Security Standard) is the global repository of requirements and procedures to provide guidelines that applies to all entities involved in the payment processing (merchants or transit operators, processors, acquirers, issuers and any services providers (hosting, networking)). The requirements address data protection but also information systems monitoring, staff skills and access restriction and regular checks.

● PCI PTS (PIN Transaction Security) requirements focus on the protection of the cardholder PIN. Even if the PIN is not used with validation device in transit, these requirements included in the implementation can ease the PCI DSS assessment.

● P2PE (Point-to-point encryption) provides a set of requirements to secure the cardholder data transmission between the payment terminal and the payment acquiring system thanks to cryptography. This makes the transmitted data unreadable if stolen. This encryption requires security keys and strong management processes.

The Figure below summaries graphically the certifications and assessment scopes over the payment infrastructure.

Ticketing system — PCI-DSS	**Payment system** — PCI-DSS; EMV Level 3, P2PE

Information system and network — PCI-DSS

Payment terminal — EMV Level 3, EMV Level 3, EMV Level 3 / PCI-DSS, PCI-PTS, P2PE

Payment media — EMV Level 3, EMV Level 3, EMV Level 3

Legend

System part	PCI SSC assessment	EMV® certification

DO VALIDATORS NEED TO BE ONLINE TO ENABLE OPEN LOOP PAYMENT?

Not necessarily, when a payment card is used to check into a public transport system, there are two possible processes of payment authorisation:

- Real-time authorisation
- Deferred authorisation

Real-time **authorisation** means that the payment transaction is carried out when passengers tap their card at the validator. Only a successful transaction allows travelling, and the operator receives the payment before delivering the service, as in a classic ticketing system.

Advantage:

- Real-time authorisation has a low commercial risk for the PTO, and passengers can only use public transport after they have paid for the journey.

Challenges:

- Real-time authorisation normally requires an online connection of the validator, which can be challenging for equipment in vehicles or remote areas.
- Every transaction takes time, which slows down the passenger throughput at the validator.
- With a real-time authorisation, the price must be clear before the journey, which limits open loop payment to the known fare model.
- Every journey equals a transaction, which is subject to a fee. This might lead to higher transaction costs.

In case of a **deferred (or delayed) authorisation**, specially designed for open loop transport systems, the bank card is only used as a unique credential for passengers. Upon tapping, an authorisation request for the card is made to and responded by the back-office system, but no financial transaction takes place yet. The card is authorised either during the journey if opting to charge fares individually, or after all journeys have taken place that day. If approved, the transaction can then be settled and payment received.

Advantages:

- The card authentication can be done offline, and no online connection is required for validators, enabling high passenger throughput as PTOs would expect.
- After check-in comprises a card authorisation when it is presented for the first time in a specified period, but there is no need to wait for a completed transaction. Therefore, deferred authorisation allows for high passenger throughput.
- Decoupling the card tap from the transaction, facilitates the accumulation of journeys, allowing for flexible fares and best price calculations using account-based ticketing.
- Accumulating multiple journeys into one financial transaction helps reduce costs for payment processing and also offers the best customer experience through clarity of fare charges.

Challenges:

- As the card authorisation only takes place after the passengers has started the journey, an insufficient card balance would only be discovered after the transaction is sent. However, by following open loop mass transit rules, the payment schemes can help balance the financial exposure for this first ride risk to some extent.

RISK MANAGEMENT WITH OPEN LOOP PAYMENT

As with every commercial process, risk management is key to ensure success.

CARD LOSS

No travel details are stored on the payment card. The card is only an identifier, linking a passenger to a ticketing account and a bank account at the same time. If journeys are accumulated, the travel and fare history is stored in the customer account, so transaction information can be recovered from the central system.

CARD FRAUD

When a payment card is tapped at the validator, two security checks take place:

❯ Offline Data Authentication (ODA) is a feature of EMV® chip cards, using secure key cryptography to verify that a payment card is genuine without the need to connect online to the issuer.

❯ The card is also checked against a deny list managed by the PTO, which comprises of cards securely stored on the readers or validators that were subject to issuer declines in the past; they might be blocked or not have had sufficient balance. Cards should be added to and removed, if subsequently approved, from the deny list as quickly as possible.

Only cards that successfully pass both checks should be permitted access to the public transport system.

CONFLICTS OF MULTIPLE CARDS

When a contactless terminal is correctly configured, it will ensure that it is impossible to charge two cards or more if multiple cards are presented. This process then ensures that only the card that the passenger intends to pay with is charged when presented to the terminal.

PASSENGER THROUGHPUT

The time needed to tap a payment card and authorise it with the back-end system is a key performance indicator for an efficient validation process. Typical tap processing time for open loop payment expected by transport operators is below 500 ms.

❯ In case of the Accumulated Model - considering the different steps performed for an open loop mass transit tap this target is achievable based on Offline Data

Authentication, cryptographic functions and deny list check. Since the account verification check will happen later, managed by the back office, speedy processing of passenger throughput will be expected by PTOs.

❯ In the Known Fare Model approach the online connectivity and bandwidth of 3G/4G/5G networks play an essential role since the passenger will not perform any additional interaction with the validation device as for instance in the pre-purchase approach. From this point of view the processing time may be higher than expected by the operator, unless the PTO opts for deferring authorisations to improve the customer experience.

❯ Processing of the Pre-purchase Model approach is in any case a totally different scenario in terms of throughput since the passenger needs to interact with the validation device or the bus driver to identify the desired fare product to purchase.

FINANCIAL RISK

Allowing passengers to travel before paying is a paradigm-shift in public transport and requires a new approach to risk management. Within a deferred authorisation model, where transactions take place either while the passenger is already travelling or after they have completed their journey(s), there is some risk of the first tap. This "first ride risk" must be carefully considered to manage in the best way to minimise financial exposure for the PTO, optimise the customer experience, and balance overall risk across the ecosystem. Mechanisms designed to minimise financial exposure for PTOs are offered by Payment Schemes.

THE WAY FORWARD

UITP is committed to helping PTOs create efficient and sustainable open loop systems through enabling secure digital payment solutions. To ensure the needs and interests from the entire sector are fostered, the Urban Mobility Open Payments Forum is actively looking for new members to broaden the discussion on payment and ticketing in public transport.

To learn more about UITP's Urban Mobility Open Payments Forum and how to get involved, please visit www.openloopmobility.uitp.org.

This is an official Report of UITP, the International Association of Public Transport. UITP represents the interests of key players in the public transport sector. Its membership includes transport authorities, operators, both private and public, in all modes of collective passenger transport, and the industry. UITP addresses the economic, technical, organisation and management aspects of passenger transport, as well as the development of policy for mobility and public transport worldwide.

This Report was prepared by the Urban Mobility Open Payments Forum

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