keyple

Blueprint for a Smarter Future:

How Open Software Development Kits (SDKs) are Advancing
Ticketing Systems for Public Transport Operators & Authorities

Calypso
Networks Association

Welcome to Eclipse Keyple:

a simple, universal, and open tool for developers to effectively produce the next generation of innovative smart ticketing solutions.

Transforming Ticketing

For over 25 years, Calypso®, an open, secure ticketing standard has grown to become the contactless ticketing specification supporting millions of passengers across 170 cities in 25 countries.

Throughout this time, the Calypso Networks Association (CNA) community has shaped the evolution of the Calypso standard to ensure long-term usability and sustainability. For ticketing transactions, Calypso specifications offer openness, security, and speed, enabling all ticketing functions: purchasing, loading, validation, control of ticketing, for all kinds of transport contacts.

Countries and regions with Calypso deployment*

*based on member-declared implementations of the Calypso standard.
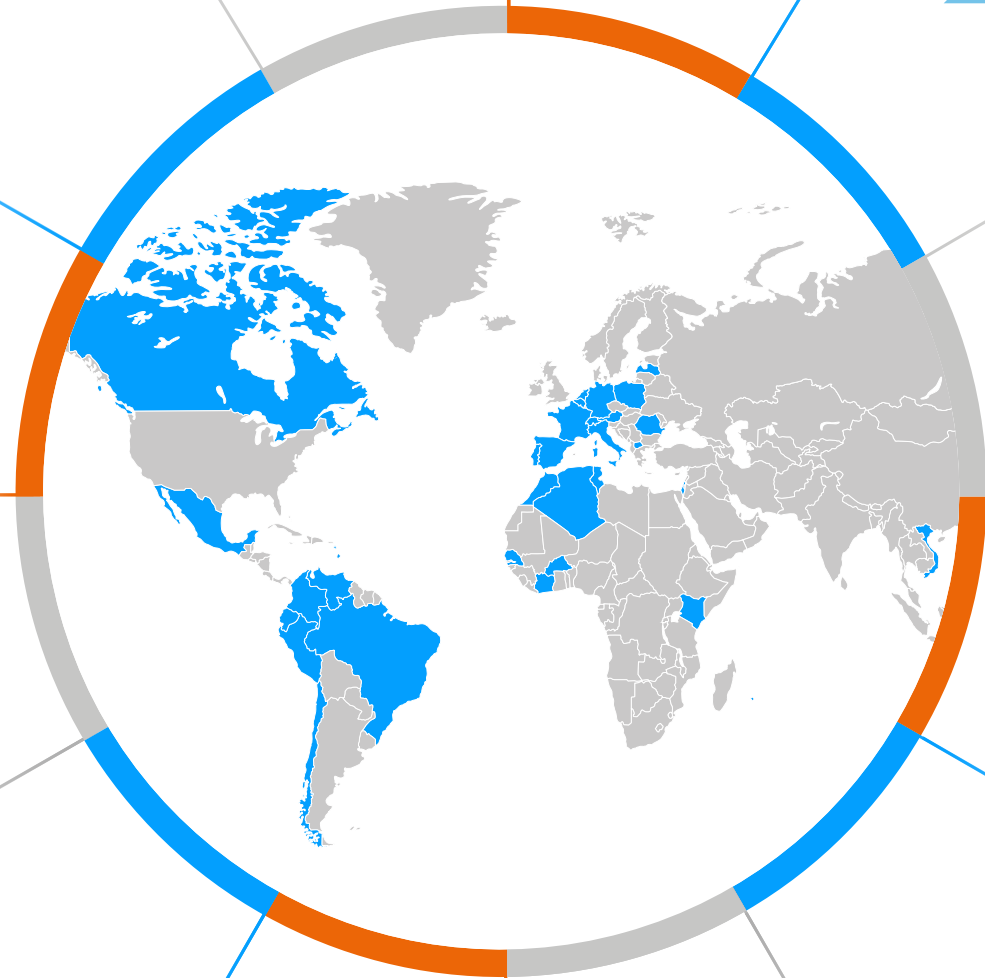
Today, transit is facing an increasingly complex challenge of incentivising passengers towards public transit over private vehicle use. Ticketing needs to play its part and provide passengers and networks with seamless, end-to-end transit experiences through new, scalable ticketing offerings that also align with wider transit trends such as Mobility-as-a-Service (MaaS).

To navigate these challenges, the ticketing community needs to consider…
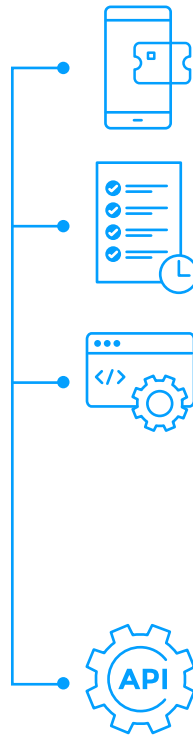
How can we develop smart, innovative new ticketing offerings that are low-cost and easy to implement?

How can we effectively and easily manage changes within existing solutions such as tariff changes, functional and commercial modifications?

How is the ticketing system's software organised to help set up these requirements throughout its entire life cycle?

To solve these issues, the ticketing community can ask itself one key question:

Does the software behind the solution rely on open, documented Application Programming Interfaces (APIs), providing the capacity for a solution to evolve efficiently?

Open, community defined technologies are the key to ticketing's future, supporting an ecosystem of innovation and competition amidst constant change.

Recognising the importance of open APIs in evolving ticketing, CNA has developed Eclipse Keyple: an open-source Software Development Kit (SDK) hosted on the Eclipse platform. This represents a longstanding interest for CNA, as it extends the values of the open Calypso® standard to the upper layers of a ticketing system, allowing networks to realise the full range of benefits of open technology.

Keyple offers open and fully documented APIs and is a framework that enables developers to design smart ticketing software for ticketing terminals that manage the different transaction layers, from lower layers to the higher-level Calypso ones in a way that's similar to 'plug and play'.
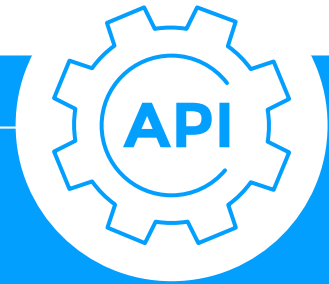
What is an API and why is it important?

An API is the route by which a developer creates and manages software, compared to a user interface, which links the end user (in transport's case: the passenger) with the software. APIs are vital tools for all industries, allowing developers to build software in a creative and innovative way.

APIs help developers make software more easily and efficiently. When building software applications, an API simplifies the process by taking complex programming and presenting it to developers in a simple, manageable format. This means that developers are more productive when writing the code for their programme. Without an API, it would require writing a lot of code from scratch. Whereas with an API, they can focus on how to make the best programme without having to worry about complex coding requirements.

As an open API, Keyple ensures transport operators and authorities have easy and low-cost access to advanced, compliant smart ticketing software to help them evolve freely and implement their own software modifications without relying on their existing hardware provider.
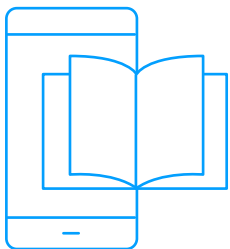
In this eBook you will learn:

Why…

…standards play a key role in delivering long-term cost-effective transport ticketing.

What…

…Keyple is and the ticketing challenges it addresses.

How…

…Keyple benefits the transport ticketing market.

Who…

…evolves Keyple to ensure quality and security.

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From open standard to open source

From open standard to open source

Calypso is an open technology standard as defined by the International Telecommunications Union:

"Open Standards" are standards made available to the general public and are developed (or approved) and maintained via a collaborative and consensus driven process. Open Standards facilitate interoperability and data exchange among different products or services and are intended for widespread adoption.

Since Calypso was first established, it has embraced the concept of open standards to empower the transit community to control and advance ticketing technology to support the needs of networks and passengers by ensuring full sovereignty with ticketing solutions.

Open standards unlock several benefits compared to 'black box' proprietary solutions.

You can learn more about the role of open standards in transport ticketing in our dedicated eBook.

Open standards vs 'black box' proprietary solutions

OPEN	PROPRIETARY
✓ Unlocks a competitive, flexible ecosystem for sustainable investments	✗ Gateway to vendor lock in
✓ Supports innovation	✗ High medium - and long-term costs
✓ Accessible to all	✗ Barrier to creative thinking
✓ Interoperable and adapts to new services	✗ Limited to customers
	✗ Narrow potential for integration

Thanks to open standards, Calypso users benefit from a truly competitive environment, which generates lower costs and offers a wide choice of solutions for cards and wearables. Calypso is the only NFC ticketing technology to offer multi-sourcing of electronic components.

Beyond these real and proven benefits of open standards, CNA's ambition is to take the concept further through open source technology, unlocking the benefits of Calypso to wider members of the ticketing community, such as new entrants offering MaaS solutions.

This commitment led CNA to create Keyple, which offers open APIs developed according to the principles, spirit and strict compliance with the rules of open-source (guaranteed by the Eclipse platform) and donate it, making it accessible and free of charge to the ticketing community.

Open standards are the basis of an adaptable, resilient network, and open-source technology helps make it a future-proofed reality for all.

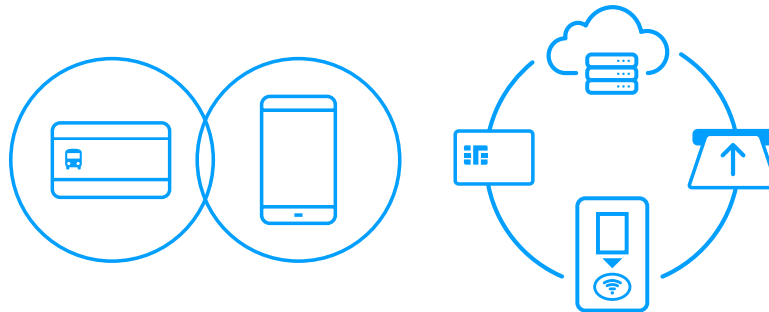# What is Eclipse Keyple and why is it important?

What is Eclipse Keyple and why is it important?

Keyple is a simple and universal tool (sometimes known as a Software Development Kit - SDK) for technology developers in the transport ticketing community. It is used as a framework to help them innovate, create and deliver advanced contactless ticketing software for use in terminals.

It is a library of Java and C++ functions used to develop integrated ticketing terminal applications similar to 'plug-and-play', which communicate with NFC fare media such as smartcards, smartphones, or wearables, and operating within several operating systems: Windows, Linux, Android, iOS, etc.

It supports developers regardless of their experience or status, whether they are seasoned players or relatively new entrants to the transport ticketing sector.

Keyple provides developers, when they are scoping and designing their ticketing software, with a generic interface that automatically manages transactions, whether it is on a card-centric or server centric (account-based ticketing) architecture.

Alongside supporting the development of Calypso compliant ticketing software and standard terminal readers, solutions developed using Keyple can also be interfaced with proprietary systems by the development of a plug-in. This makes the terminal software free of any proprietary hardware.

Even if you are not using Calypso, you can still benefit from the 'plug and play' messages that Keyple offers.

As an open, dynamic tool readily accessible to developers, Keyple enables low-cost development of advanced ticketing systems similar to 'plug-and-play'. This is achieved by freeing the developers from proprietary constraints such as card reader exchanges, allowing them to focus and innovate on operator and passenger needs.

The lack of costly proprietary constraints means new and innovative features can be integrated easily and without the large price tag.

By being community driven, Keyple ensures best practices lie at the heart throughout every stage of the product cycle.

By guaranteeing interoperability and Calypso (alongside other ticketing standards) compliance from the start, Keyple provides peace of mind to developers and leaves them free to be creative and innovative while laying the foundation for a joined-up ticketing solution.

Urban mobility needs to implement advanced, joined-up smart ticketing solutions quickly and cost effectively if it is to help guarantee impact at pace and scale.

As mobility evolves and trends such as MaaS and ABT change and develop, innovators and decision makers in the ticketing community are empowered to accommodate whatever trends come, thanks to tools like Keyple.
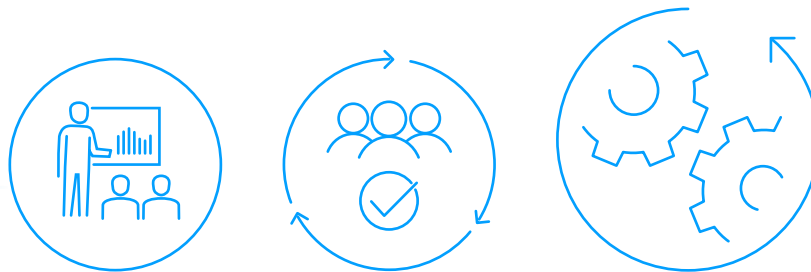
The technical details:

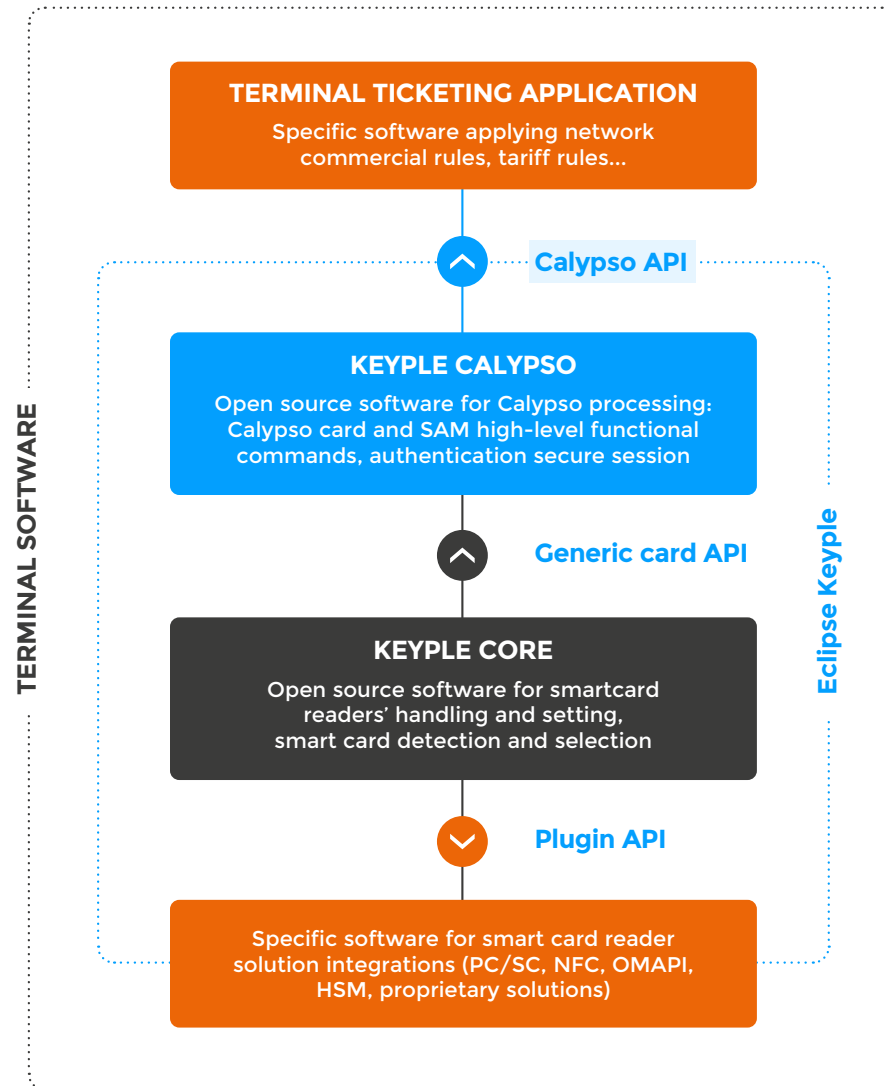Within the SDK are three different modular Keyple layers:

1 *plug-in*

2 *core*

3 *Calypso*

Keyple, which is hosted in a terminal, provides universal software that empowers developers to make scalable ticketing solutions. The Core layer is open to any kind of smart card and security module.

Keyple can be implemented in any ticketing terminal. This includes proprietary systems as well as terminals that already use Calypso standards.

All layers are open and documented, providing an accessible API to make developing applications easy and cost-effective as developers only need to work with the layer they need.

Where does Keyple sit within the terminal software?

TERMINAL SOFTWARE

Eclipse Keyple

TERMINAL TICKETING APPLICATION
Specific software applying network commercial rules, tariff rules...

⌃ **Calypso API**

KEYPLE CALYPSO
Open source software for Calypso processing: Calypso card and SAM high-level functional commands, authentication secure session

⌃ **Generic card API**

KEYPLE CORE
Open source software for smartcard readers' handling and setting, smart card detection and selection

⌄ **Plugin API**

Specific software for smart card reader solution integrations (PC/SC, NFC, OMAPI, HSM, proprietary solutions)

SAM = Secure Application Module

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The benefits of Keyple

The benefits of Keyple are...

For developers:

Whatever their experience or budget

- Keyple provides developers quick and inexpensive access to the development tools needed to deliver an advanced ticketing solution for new entrants or experienced members of the ticketing ecosystem.

- Keyple is easy to handle, easy to adapt, easy to implement, and easy to maintain.

- It helps developers to shift their focus away from the constraints of any proprietary systems and develop advanced solutions evolving in line with network needs.

Guaranteed long-term solutions

- As an open, community-led SDK, Keyple has integration and best practices at its heart, providing peace of mind to developers that the solution they are developing is futureproofed.

Part of a community

- Keyple is not just a tool kit, but a gateway to a dynamic, like-minded developer community that is actively involved in shaping Keyple to ensure it continually aligns with the needs of the ticketing market.

The benefits of Keyple are...

For decision makers

Independence

- Keyple means no vendor lock-in, so transport operators and authorities become masters of their own system, leaving them in control, rather than their supplier, supporting sustainable investments for ticketing upgrade strategies.

- As an open source solution, Keyple ensures accessibility to any manufacturer without limiting the tender process.

Flexibility

- Keyple offers operators and authorities the flexibility to introduce new solutions that can be integrated seamlessly into existing infrastructure while guaranteeing specification compliance.

Supporting passengers

- Keyple supports the development and timely implementation of tailored solutions aligned with passenger needs e.g., cards, smartphones, and wearables, offering a convenient, joined-up ticketing experience matched with the network ecosystem. This delivers the best possible performance to passengers.

Empowerment

- Keyple means that operators and authorities can have an open dialogue with developers as they work together to scope, develop, test and roll-out an advanced ticketing solution.

The benefits of Keyple are...

For ticketing integrators

Improving responsiveness

- Keyple supports quick responses to customer demands, for example, when accepting a new smartcard solution.
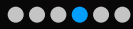
Refining business focus

- It enables integrators to look beyond any proprietary solution and offer a more complete, coherent, and efficient ticketing service.

Streamlining skills

- Keyple means integrators avoid the complexity of developing and maintaining specialist staff skills.

The benefits of Keyple are...

for the wider market

Accelerating ticketing and mobility

• Keyple helps make visions of an advanced, smart, joined-up ticketing ecosystem a reality for developers, transport operators, authorities, and passengers.

Beyond mobility

• Enables the development of an integrated ticketing ecosystem that lays the foundation for effective MaaS adoption.

• Keyple supports secure ticketing in every application, whether it is for events, sports and leisure infrastructure, or even value-added services such as retail loyalty schemes.

• With its roots in transport ticketing and Calypso DNA, Keyple encapsulates decades of experience gathered from the continually evolving public transit ticketing ecosystem.

Keyple case studies:
Journeys in ticketing innovation

Combatting fraud for Île-de-France Mobilités

Like any public transit network, Île-de-France Mobilités (IDFM) are always looking to stay one step ahead of ticketing fraudsters with its Navigo pass.

The issue:

Previously, IDFM's transport operators carried out their own investigations, but in 2020, IDFM launched a contract to carry out its own investigations and control customer passes regardless of the carrier.

The biggest challenge was developing the equipment to support this programme, as IDFM could not ask local offices to equip themselves. A consolidated, centralised ticket reader application was needed.

The solution:

Thanks to Keyple, a complete application for use on any Android smartphone was designed, developed, and commissioned in less than a year. It means investigators can quickly and easily tell – using one device only – whether a Navigo pass is being used legitimately or fraudulently. By the end of 2022, this app will be used for all fraud investigations throughout the IDFM networks.
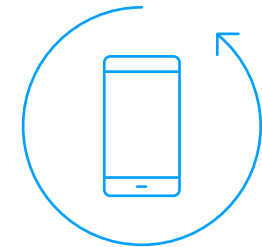
Consolidating ticketing sales channels for SNCF

The French national train operator, SNCF has always championed open contactless ticketing standards for interoperability, having first implemented Calypso over 20 years ago. Calypso now underpins SNCF's ticketing solution for its regional train networks, and thanks to its interoperability, works seamlessly with 99% of French public transit networks.

Like CNA, SNCF believes the development of Calypso-ready terminal software should come at a low cost and have always supported the concept of an open-source toolkit like Keyple to help liberate networks from existing ticketing suppliers and integrators.

The issue:

Recognising the importance of a seamless ticketing experience, SNCF is moving towards a centralised sales system that will consolidate various sales channels: mobile app, vending machines, counter sales, kiosks, high-street retailers.
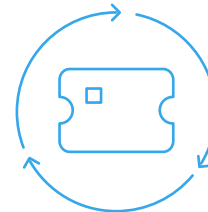
The solution:

They have identified that Keyple is the perfect tool to help harmonise the ticketing terminals throughout the entire regional trains network, even if the hardware or local operating system is different. Also, as Keyple is open-source and free to use, SNCF can specifically request it in requisition tenders for ticketing terminals.

Supporting developers for the OneWave card

From the beginning, OneWave's goal has been to create an innovative, connected smartcard that supports all our daily secure authentication needs, ranging from ticketing, payments to cyber-security access.

Its NFC-enabled OneWave smartcard has an inbuilt screen helping users to see important data. When used in a transport ticketing setting, this means that passengers can see at any time available funds, remaining valid time, and positive or negative validations, providing passengers with ticketing speed, flexibility, and convenience.

The issue:

Although the launch network for the OneWave smartcard already used Calypso terminal specifications, it turned out that some parts were not using the latest specification, making overall compatibility an issue.

The solution:

The developers used Keyple to create a workaround. Using code from the SDK library, the teams developed their own terminal integration element that was compatible with the entire target infrastructure – **and all in a single day.**

Overcoming pandemic related difficulties

When lockdown restrictions during the pandemic meant the developer team could not access a card-wiper, they used the Keyple SDK to make their own compatible one.

Streamlining skills for RATP

RATP already recognise the value of open standard solutions, especially when it comes to supporting operators who have deployed its ticketing solutions and need to intervene in any way with routine maintenance for example.

The issue:

Even though RATP had a smart ticketing solution that has been used for several years, this could only be used with one specific type of reader.

The solution:

Keyple supported RATP to develop a smart ticketing solution from scratch that could be used with multiple types of readers. Also, it allowed our developers who were not familiar with Calypso technology to operate independently in the knowledge that their solution will still be Calypso-ready. This was especially helpful as often it is a significant challenge to recruit developers for smart ticketing.

*For a list of Keyple's users visit **www.keyple.org***

# Fostering innovation without a price tag: Keyple's governance

Fostering innovation without a price tag: Keyple's governance

As a membership body, CNA has been representing transport operators, authorities, and ticketing suppliers and supporting contactless ticking's evolution since 2003. Since the beginning, CNA has recognised the need to create innovative ticketing solutions that are fully interoperable, reliable, secure, and flexible.

CNA created Keyple at the request of the transport operators and authorities it represents, recognising the importance of open APIs and SDKs to support developers in the ticketing community.

The Brussels (BEL)-based Eclipse foundation is an independent, not-for-profit international developer community body that acts as a steward of Keyple alongside over 400 open-source projects covering a wide scope of sectors alongside being the Keyple platform. As steward of Keyple and the developer community, Eclipse, working closely with CNA's transport ticketing community's expertise, is responsible for the day-to-day management of the Eclipse toolkit and ensuring Keyple maintains the strict conditions of an open source standard e.g., with intellectual property rights.
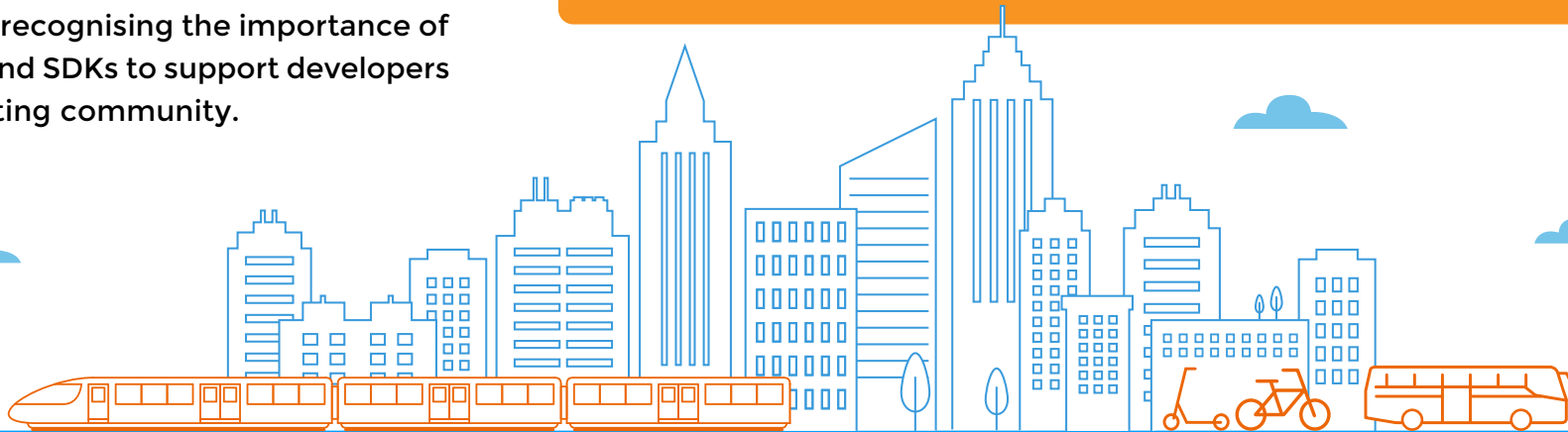
For the transport ticketing ecosystem to align with the community's and passengers' needs, open tools and standards must serve as a baseline, thereby supporting a flourishing, innovative ecosystem.

As innovation shouldn't come with a price tag, after creating Keyple, and in keeping with its ticketing community heritage, CNA donated it to the ticketing sector. By doing this, Keyple became a freely available SDK tool for developers in the ticketing community, enabling innovation without the price tag.

When developers turn to Keyple, they are not only accessing advanced ticketing standards that guarantee interoperability, but they are also accessing a community. This diverse and collaborative member network has one goal: to advance ticketing in a fair, open, and transparent way that benefits every member of the ticketing community and the passengers.

As the mobility sector faces unprecedented challenges, ticketing needs to become a dynamic technological ecosystem. The community driven Keyple SDK supports this, having been fully shaped by members, incorporating their experiences, lessons, and feedback.

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Want to get started with your
smart ticketing journey?

www.keyple.org