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## **CALYPSO ELECTRONIC TICKETING TECHNOLOGY: THE CONTACTLESS STANDARD FOR A MODERN TRANSPORT**

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**Abstract:** *Every day most of the urban and suburban population use public transport. Until recently, passengers were anonymous but now they have become customers and require a seamless access to transport. Therefore related services should simplify their daily life while fostering their loyalty and maximizing their relationship with the transport network. Transport operators have the dual challenge, to improve service quality and maximize their income. Transport operators also have to improve corporate management by avoiding fare evasion and by adapting the supply to the demand. The new system of electronic ticketing is now playing a major role throughout the whole transport system. For this reason the electronic ticketing system must be secure and reliable.*

*One of the electronic ticketing standard is Calypso standard. It is the electronic ticketing standard which defines the secured dialogue between cards and terminal and it is designed by transport operators for transport operators to meet their challenges. Calypso standard was developed by a group of European partners from the cities of Brussels in Belgium, Lisbon in Portugal, Konstanz in Germany, Paris in France and Venice in Italy. After a 10 years development program, succeeded in creating the smartcard contactless technology adapted to the public transportation uses some functional choices have been taken into account to answer the transit operators' needs, as contactless technology, fast, safe transaction (decentralised security), communication within the transaction time, flexible transport application to build system step-by-step, targeted products to address all users and new services, upgradable and respect for current standards, microprocessor - contact and contactless interface or contactless interface only, in accordance to ISO 14443, ISO 7816-1, 2, 3, 4 and CEN 1545 standards. It offers the best solution, suited to all transport needs: open, widespread, secure and proven.*

*In the choice of technology, the card is the key component of an electronic ticketing system, because the card determines the system performance and the global security level. That is why calypso has focussed on card specifications like multisource, security, common interface for a range of cards, providing all passengers with a contactless solution, open platform for other services, the respect of privacy, reliability. After using paper tickets, then magnetic technology, the 3rd generation widely developed nowadays is based on smart cards using contactless technology. Electronic ticketing uses a smart card type support, with an interface which is either, as required, with contact or contactless. Contactless technology is based on inductive transmission, which is used in the transmission between a smart card and a terminal. The smart card holds and processes information, the terminal*

*(validators, vending machines, etc.) reads or modifies this information. The use of a microprocessor allows for a high level of communication and security. Based on tight card specifications and standards the Calypso card-terminal transaction is: fast, easy and secure (encoding that maximises transaction speed without limiting data exchange), standardised and future proof (use of microprocessor cards compliant with standards), interoperable (being able to manage cards from various networks, relying on calypso specifications), multi-application (according to needs, a transit cards with an electronic purse, access to car parks, entrances to museums, sports events, conventions, access to tourist facilities, etc.). Technical standard of Calypso contactless smart ticketing technology offers a time proven and operational interoperability at all requires interoperability levels: a common technical platform, a same ticketing application and a common fare management.*

*Calypso technology is a set of technical specifications describing a fast and secure contactless transaction between a terminal and a portable device. A Calypso portable device was historically a microprocessor smart card, but, as technology moves on, it could now be one of the following devices: traditional contactless smart cards, JAVA contactless cards, NFC mobile phones, USB key with a contactless communication interface (smart key), and any other contactless customer media.*

*Calypso technology is used in more than 80 cities in 21 countries, and around 300,000 terminals and 70 million microprocessor contactless cards have been issued from the beginning. The biggest intermodal networks as well as numerous cities have integrated all or part of Calypso into their transit system (paris, Lisbon, Mexico City, Brussels, Milan, Avignonvenice, Glasgow, Maastricht and others).*

*To carry out theses missions, the Calypso founders and users established Calypso Networks Association, a non for profit organisation by European research program with objective to maintain a set of specifications addressing transit business needs in the context of developing contactless systems.*

*The main tasks of Calypso Networks Association are to establish long lasting relations with all the partners using the Calypso specifications, define and direct the reference specifications, implement a certification policy, to guarantee the compatibility of all current and future products, establish a Calypso label issued by an independent organisation, promote Calypso to operators and manufactures to yield its distribution, contribute to the international standardisation process, facilitate and harmonise the shared members' needs and experiences, encourage all actions of mutual assistance in the implementation of Calypso e- ticketing systems.*

*The paper presents Calypso electronic ticketing technology as a contactless standard for a modern transport*

**Key words:** *eTicketing, Calypso technology, transportation*

## **INTRODUCTION**

Every day most of the urban and suburban population use public transport. Transport operators have to rise to the dual challenge of improving service quality and maximizing their income. Until recently, passengers were anonymous but now they have become customers and require a seamless access to transport. Related services should simplify their daily life while fostering their loyalty and maximizing their relationship with the transport network. Transport operators also have to improve corporate management by avoiding fare evasion and by adapting the supply to the demand. The new system of electronic ticketing is now playing a major role throughout the whole transport system. It is for this reason that it must be secure and reliable. One of the electronic ticketing standard is Calypso standard. It is the electronic ticketing standard which defines the secured dialogue between cards and terminal and it is designed by transport operators for transport operators to meet their challenges. It offers the best solution, suited to all transport needs: open, widespread, secure and proven. Moreover, Calypso is not simply restricted to transport applications but also offers the perfect opportunity to enable access to third-party services, using the same device within a multi-applications scheme.

## **CONTACTLESS TECHNOLOGY**

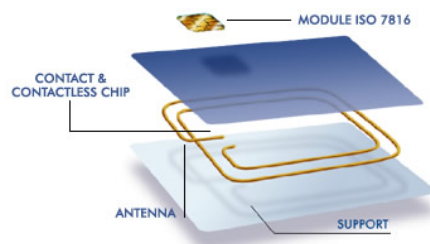
Ticketing is defined as the management of contracts linking a service provider with its customers. It covers all the operations connected with the issuing of a use and/or an access right, its selling,

reloading, validation and controlling. Electronic ticketing uses a smart card type support, with an interface which is either, as required, with contact or contactless. After using paper tickets, then magnetic technology, the 3rd generation widely developed nowadays is based on Smart cards using contactless technology. Contactless technology is based on inductive transmission, which is used in the transmission between a smart card and a terminal. The smart card holds and processes information, the terminal (validators, vending machines, etc.) reads or modifies this information (**Fig.1**). Inductive transmission offers several advantages: contactless transactions, optimum speed of transaction, no need for energy supply on the card, ease of ergonomics, reliable (no mechanical system used) and less expensive than infra-red, offers the possibility for more applications. Furthermore, the use of a microprocessor allows for a high level of communication and security. Main characteristics of contactless applications:

- ◆ Ticketing: allows quick transactions, heavy volumes of trips, statistics collection and evolution of fares

- ◆ Payment: An electronic purse for the payment of small amounts can be integrated in the card's chip. Being open to several applications, the payment function allows to generate a high volume of transactions, which is necessary for the efficiency of the electronic purse. In addition, the electronic purse is an easy way to ensure the interoperability between the various service providers who may also benefit from rapid transactions, where use of a contact card is impossible (not equipped or amount too small). The contactless technology avoids acts of vandalism on the equipment (no slot, no coins)

- ◆ Services: Various loyalty areas can be loaded on the card. This zone allows to set up loyalty programs particularly adapted to marketing stakes between the different service providers (additional advantages for the customer, and tracking for the service provider). The benefit for customers to possess a tool bearing several services is obvious (all-in-one card).



**Fig.1** Contact and contactless modes

## ABOUT CALYPSO TECHNOLOGY

Calypso is the only electronic ticketing platform specified by transit operators for all transit operators and offers a large access to an innovative and wide-open technology, independent of any industrial monopoly. It is the electronic ticketing standard which defines the secured dialogue between cards and terminal. The main characteristic of Calypso technology are:

- ◆ Ticketing: Contactless technology
- ◆ Fast, safe transaction (decentralised security)
- ◆ Communication within the transaction time
- ◆ Flexible transport application to build system step-by-step
- ◆ Targeted products to address all users and new services
- ◆ Upgradable and respect for current standards
- ◆ Microprocessor - contact and contactless interface or contactless interface only
- ◆ In accordance to ISO 14443, ISO 7816-1, 2, 3, 4 and CEN 1545 Standards [1].

The Calypso specifications are designed to improve and enhance any existing electronic ticketing application. They are used as part of a secure contactless system including: a central system, different front end terminals (reloading or re-charging appliances, validators, control devices, etc.) and portable devices (smart cards, mobile phones, USB keys). Calypso focuses essentially on the ticketing transaction between a terminal and a portable object and it has been designed to meet multi-modality,

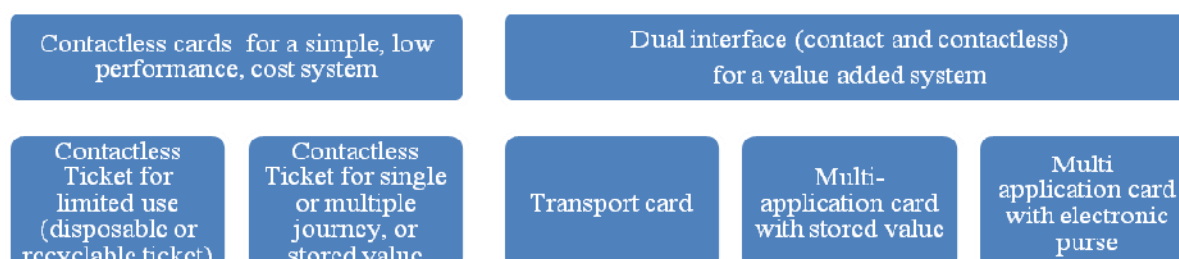
interoperability and multi-application requirements. The ticketing transaction is organized into layers, as illustrated in Table 1.

**Table 1**

	Layer	Standard	Description
7	Security Management and Architecture	Calypso Security Architecture	Describes the management of the security for a ticketing system, and recommends good practices and all available choices for transport providers.
6	Terminal Applicative Software	Calypso API	Ensures that the cards are managed in the same way by all terminals, and allows an easier enhancement of all kinds of terminals.
5	Data Model	Calypso Data Model	Describes the definition and the interpretation of the data in the files of the card, Calypso supplies a user-friendly generic data model for all ticketing systems. This data model is not fixed and can be tailored to the specific needs of each operator.
4	Card and SAM Security Mechanisms	Calypso card application	Calypso specifies the PO, SAM commands and files used during the ticketing transaction. These functions are optimized for ticketing (fast, secure) and include innovative patented technology such as the Secure Session and Ratification functions.
3	Card Data structure	CEN EN 1545	EN 1545, defines the coding of data elements used for public transport (such as: date, time, validation event, transport contract, etc.)
2	Card OS and Files structure & Commands	ISO/IEC 7816-4	ISO/IEC 7816-4 defines the card data organisation in a file structure's basic card commands.
1	Contactless Communication Interface and Contact Communication Interface	ISO/IEC 14443 ISO/IEC 7816-3	ISO / IEC 14443 (Type B & A), defines the radio signal and protocol for an induction transmission at 13.56 MHz. For dual interface cards, ISO 7816 (1-3) describes the physical characteristics and the electronic signals and transmission protocols of Integrated Circuit Cards. It is also compatible with NFC (Type 4).

## RANGE OF CARD

There is a range of cards compliant to Calypso standard that covers the functional spectrum of most ticketing systems, from the most simple to the most sophisticated and high performance, value adding systems working in multi application and interoperable environments (**Fig. 2**). The card is the key component of an electronic ticketing system because the card determines the system performance and the global security level. That is why Calypso has focussed on card specifications like multisource, security, common interface for a range of cards, providing all passengers with a contactless solution, open platform for other services, the respect of privacy and reliability. An easy integration, security, flexibility and low cost make the contactless ticket is the ideal solution for mass transit, access control (Museums, leisure parks, stadiums) and tagging applications. With a lower security level than that of the microprocessor card, but undoubtedly more secure than the magnetic ticket, it is totally well suited to small scale applications and to manage low price contracts (single/multi trip, day pass, event pass).



**Fig.2** The Calypso range of cards

*Transport card* offers a high security level managing a Calypso transport application allowing several contracts in the card. The microprocessor smart card can handle at least 4 contracts of all types (special limited-time fare, electronic token facility, or tickets by the unit). The card contacts provide a flexibility that enable passengers to reload their transit card on a network of different terminals. Reloading can be done on current terminals (card-operated public telephones, banking terminals etc.) or on specific terminals (card-reading mobile phones, internet access systems equipped with card readers, etc.).

*Multi-application card with stored value* carrying one or several Calypso applications, and possibly other applications (loyalty, private payments, stored value, access control etc.) The card, equipped with a contact and contactless chip, incorporates several zones. Each zone includes a set of secret keys that firewall the applications: a transit zone, an exclusive stored value zone, and one or several multiservice zones. It is the card with the edge, enhancing the offer with additional services for the transport chain (special rates for a car park, customer loyalty counters) or for a business.

*Transport card or multi-application card with Electronic Purse:* The Electronic Purse (EP) may be used for small purchases in shops, at vending machines, for public transport tickets, at pay phones. For transport companies, EP offers a new means of payment for mass transit users. Combined with a contactless card, the EP could be an answer to manage occasional travellers. The EP is an ideal tool for a differential tariff policy: All transport companies must have a system which enables them, firstly to get to know their clients better in order to provide them with better service, secondly to apply their tariff policy and its variations, depending on the requirements.

## **CALYPSO TECHNOLOGIE VERSUS OTHER TECHNOLOGIES**

The use of microprocessors which has formed the basis of Calypso now appears, after several cases of fraud, to be essential, to ensure a sufficient level of security for contactless transactions. The main rival technology now uses the guiding principles promoted by Calypso as a migration path of their proprietary solutions towards higher security and performance. But as it is often the case in many industries, the followers are not able to reach the same as the original and most comparisons prefer Calypso. Most differences with other technologies are in:

### **1. Standard compliance**

◆Calypso: generic applet is fully compatible with the Global Platform specification from v1.0 to 2.2, several applets are already available.

◆Other technologies: offer proprietary solutions, only partially compliant to ISO 14443 A. Their command set being not fully compliant with ISO 7816, blocks the way to a direct & open application management on multi application platforms as SIM can be in mobiles, and require to add a supplementary layer in a special SIM supplied by the solution provider (**Fig.3**)

### **2. Transaction completion**

◆Calypso: secure session includes a BEGINNING and END, ensuring that the transaction is done and entirely done securely.

◆Other technologies: doesn't include either secure closing of the transaction (possible hacker attack), nor graceful management at the end of the transaction (the state might be unknown to the terminal if the communication link is broken at the very end)

### **3. Security,**

Calypso: specifications are for different forms of media based upon microprocessor technologies, the security part is available to manufacturers (signing NDA). Calypso uses the most secure and time proven cryptographic algorithms existing in the smartcard industry.

◆Other technologies: offer no security or only proprietary security including proprietary SAM.

### **4. Open Procurement,**

Calypso: opens up true competition in the market place. The set of specifications is available to suppliers under RAND conditions Reasonable And Non Discriminatory, so that different compatible products can be supplied by different manufacturers. As Calypso is an application, it can be put onto any platform, whatever the protocol used, whatever the chip manufacturer and whatever the form factor. Calypso specifications have always been thought, to cover the needs of any ticketing system, to last a long time and to cater for a range of compatible products. Schemes can therefore choose the

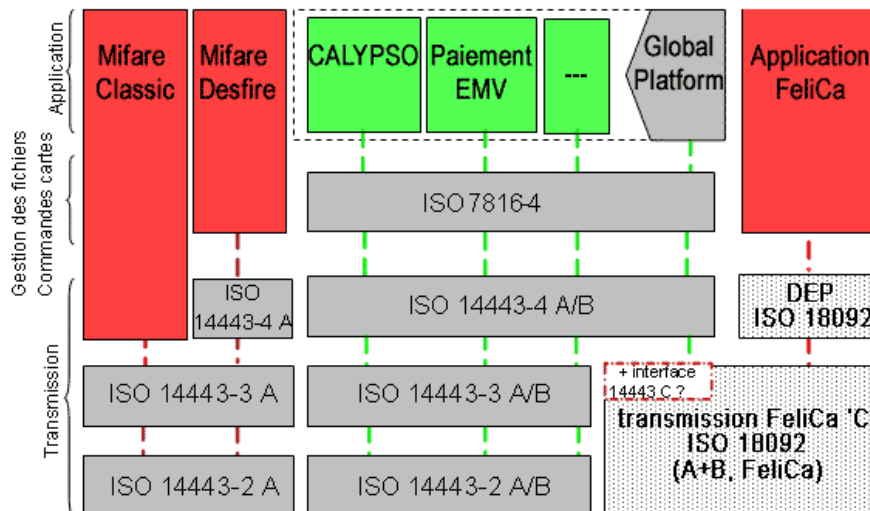
most appropriate product for their needs and be guaranteed the migration to new generations or to new suppliers without disproportionate efforts as the industry goes forward.

Other technologies: they are completely controlled by one chip manufacturer which may impose its views onto the whole market. Family products of rival technologies are often completely incompatible one with another (Different and incompatible sets of commands).

#### 5. Card cost

◆ Calypso: products are now much more competitive with prices at market value. They also offer the extra-value of the flexible range of products and of their full portability in JAVA & Global Platform environments as described above.

◆ Other technologies: The lower cost of memory cards compared to Calypso microprocessor cards used to be considered as an argument to accept a lower level of security and a higher risk due to possible hacker attacks.



**Fig.3** Contactless technologies vs. international standards

## IMPLEMENTATION

Calypso technology is used in more than 80 cities in 21 countries, and around 300,000 terminals and 70 million microprocessor contactless cards have been issued from the beginning. The biggest intermodal networks as well as numerous cities have integrated all or part of Calypso into their transit system (Paris, Lisbon, Mexico City, Brussels, Milan, Avignon, Venice, Glasgow, Maastricht and others). To carry out these missions the Calypso founders and users established Calypso Networks Association, a non for profit organisation by European research program with objective to maintain a set of specifications addressing transit business needs in the context of developing contactless systems.

## CONCLUSION

Modern urban living is rapidly changing with new technological innovations, one of which is the possibility to integrate different electronic services into one single medium. Therefore different applications can be brought together into one single device for the citizens of tomorrow in Europe. Calypso security technology and memory storage are tailored to meet multi functional requirements. A transport application and a dedicated city application may, for example, safely reside on the same secure element of a portable object, moreover they may live alongside third party applications, opening the road to the ideal urban pass. Calypso platform is ready to accept those new challenges: a generic applet is already available, fully compliant with the Global Platform API specifications, and is downloadable onto a Secure Element based on the Java Card environment and implemented in an NFC mobile phone or a contactless USB key.

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## ЕЛЕКТРОННА ТЕХНОЛОГИЯ ЗА ТАКСУВАНЕ КАЛИПСО: БЕЗКОНТАКТНИЯТ СТАНДАРТ ЗА МОДЕРЕН ТРАНСПОРТ

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**Ключови думи:** *електронно таксуване, технология Калипсо, транспорт.*

**Резюме:** *Един от стандартите за електронни билети е Калипсо. Това е стандарт, който определя защитен диалог между карти и терминал и е проектиран от транспортни оператори за транспортни оператори, за да отговарят на предизвикателствата. Стандартът е разработен от група европейски партньори от градовете Брюксел в Белгия, Лисабон в Португалия, Констанц в Германия, Париж във Франция и Венеция в Италия. След 10 годишно развитие програмата успя да създаде технология за безконтактни смарт карти, адаптирани към обществения транспорт, за да отговори на нуждите на транзитните оператори. Предлага се най-доброто решение, подходящо за всички видове транспортни нужди.*

*Технологията Калипсо е набор от технически спецификации, описващи бързо и сигурно безконтактно взаимодействие между терминал и преносимо устройство. Тя се използва в повече от 80 града в 21 страни. От началото до сега са създадени около 300 000 терминали и са издадени 70 милиона безконтактни карти. Най-големите мрежи за интермодален транспорт, както и множество градове, са интегрирали изцяло или част от Калипсо в своята система за транзитни превози (Париж, Лисабон, Мексико Сити, Брюксел, Милано, Венеция, Глазгоу, Маастрихт и др.).*

*За да осъществят мисията си, основателите и потребителите създадоха Calypso Networks Association – организация с нестопанска цел от Европейската изследователска програма с цел да се поддържа набор от спецификации, обърнати към нуждите на транзитния бизнес в контекста на развитието на безконтактни системи.*

*Докладът представя технологията Калипсо за електронно таксуване като безконтактен стандарт за модерен транспорт.*