

*In the 16 year history of electronic charging of road users there has never been a larger choice of technologies available to highway operators. The development of standards in parallel with component technologies and systems has already enabled 20 million users worldwide to enjoy the benefits of Electronic Fee Collection. But the more operators adopt EFC the greater the need to agree how the EFC standards shall be used...*

## **The Short Guide to EFC**

Andrew Pickford  
Transport Technology Consultants

**M**aking life easier for highway users to pay a fee for using a highway, bridge or tunnel led the modern-day pioneers of highway tolling such as France and the US to experiment with a variety of payment technologies.

The long term shift in investment from defence to civil use, increased availability of private finance to fund infrastructure development and attempts to manage congestion has since ensured a healthy stream of innovations in a wide variety telematics products to securely charge highway users for the direct benefit received – typically to use a highway segment or crossing.

### **TECHNOLOGY DARWINISM**

Some payment solutions disappeared as rapidly as they arrived. Other more enduring methods such as manual cash collection and vehicle to roadside communication systems were partly responsible for the emergence of a whole industry serving the public and private highway operator - providing everything from paper ticket systems to advanced classification systems and vehicle-to-roadside communication technologies.

*“...suppliers are witnessing underlying growth of opportunities in public sector urban congestion pricing – driven by political courage and enabled by increasing public acceptance that roads may not always be free...”*

The most widely used method of Electronic Fee Collection (EFC) requires users to install a low cost ‘tag’ or On Board Unit (OBU) on the windscreen, usually in an unobtrusive position behind the rear view mirror. In many systems deployed worldwide the OBU uniquely and securely provides the road user’s account details and declared vehicle parameters to the Roadside Equipment (RSE) using a Dedicated Short Range Communication System (DSRC) owned and operated by the highway operator. Operator demands have also guided the ongoing development of EFC to support on-board electronic purses and the ability to manage complex classification

schemes, exceptions, tariffs and several vehicle classifications in regional multi-operator networks.

EFC technologies have evolved in a highly competitive market served by an increasingly consolidated industry. Road operators and highway agencies are now routinely co-operating across national borders in Europe and public acceptance of EFC in the form of tolls or as congestion charges is gathering momentum. EFC systems and component suppliers are also witnessing underlying growth of opportunities in public sector urban congestion pricing – driven by political courage and enabled by increasing public acceptance that roads may not always be free.

The impact of these market shifts has already been felt by highway operators in one critical area of procurement. The availability of standardised interfaces now permits multi-sourcing. But what does this increased choice mean and how can it be used in the interest of highway operator and road user?

### **BATTLES IN BRUSSELS**

The process to develop DSRC standards in Europe has, on many occasions, looked like an obscure technical conflict between technology vendors that choose to meet each other periodically at the offices of CEN (Comité Européen de Normalisation) in Brussels.

Nevertheless the pack of documents, developed by CEN TC278, is known collectively as “the CEN DSRC standard”. This includes prescriptive and normative definitions – a sort of common language to achieve a well-understood benefit – to enable highway users and operators freedom of choice and predictable performance when selecting of OBU and RSE from different suppliers. CEN TC278 initiated the development of the CEN standard in 1992. This

#### **DSRC in heavy goods vehicles**



Fig 1. Interoperable OBU in an HGV.

marathon work was recently concluded with a final set of specifications at a ‘last chance’ meeting on 8 January 2003 in preparation for final ratification at the CEN TC278 plenary in Prague in mid-March. This new pack of documents is known as the ‘EN’ (European Norm) for DSRC on which all future public procurements for DSRC products in Europe will be based.

In addition to the DSRC standard the CEN/TC278 and ISO/TC204 created an Application Interface standard for EFC that can be used to design EFC applications. This Application Interface defines possible EFC function and EFC data elements to be used in an application but it leaves important issues such as security and transaction schemes open for definition elsewhere.

*“...the common language defined by the standards can be used to form a sort of Eurospeak for an EFC transaction...”*

The complexity and range of options defined by the EN and its earlier provisional versions led to several EC-funded projects and other industry initiatives to develop ‘rules’ that grouped these options into understandable ‘phrases’ - a sort of Eurospeak for an EFC transaction.

### **SECURING INTEROPERABILITY**

When specifying an EFC system a highway operator needs to precisely define the requirements at each of three levels; physical, procedural and contractual (Fig 2.). It is no coincidence that different segments of industry and public bodies have also focused on each of these levels creating a further set of documents.. Unsurprisingly, EFC technology vendors focused on the physical level (microwave air interface) and, at the procedural level, created a ‘tool box’ (subset of the EFC Application standard). Road operators and highway authorities focused instead on the higher level application and contractual layers.

However, the flexibility of a standard that contains a wide choice of parameters from the physical level to the application level means more scope for confusion and misunderstanding when an OBU is processed by an RSE as part of an EFC transaction. Misunderstandings may also arise when an EFC transaction created by one operator is presented for payment by the authority that manages the user’s account. This potential confusion was identified and triggered an array of projects

that included DSRC technology suppliers, highway operators and road authorities to define exactly which parameters in the standards need to be used. The result of this co-operation is a set of specifications (Fig 3.) that enable OBUs to be processed in a predictable, secure manner and transactions to be reconciled between operators.

#### **Interoperability - Levels**

1. Physical – to reliably establish OBU to RSE communication
2. Procedural – to securely exchange information and manage the payment process during the transaction
3. Contractual – to ensure that a payment transaction is acceptable and can be reconciled by the organisations that manage OBU users’ accounts.

Fig 2. Levels of Interoperability

*“It is therefore critical that operators talk to each other...”*

So, interoperability can be ensured by ensuring that EFC components and systems comply with publicly accessible documents such as CEN DSRC (EN or ENV), ISO/TR 14906 EFC Application Interface [1], GSS [2], A1 [3], A1+, CARDME [4], CESARE II [5] and PISTA [6]. To enable a highway operator to define an unambiguous Requirement Specification for EFC equipment and systems (for open highway charging or plaza-based charging) the operator needs to review each of the 3 levels separately, taking into account decisions that may have already been made by other regional operators. This will ensure that an operator can take advantage of an

### **Interoperability Initiatives at each Level**

#### Level 1

- EN (formerly ENV) DSRC specifications; two parameter sets A or B
- GSS (Global Specification for Short Range Communication), originally founded by several vendors
- EN ISO 14906 EFC Application Interface Definition

#### Level 2

- A1 (and A1+ for on-board accounts), toolbox defined by 5 vendors
- TIS (Télépeage Intersociété), an interoperable EFC application to be used by all French highway operators
- CARDME (now CARDME 4), founded by regional road authorities
- PISTA (Pilot on Interoperable Systems for Tolling Applications), a pilot to validate available interoperable EFC equipment initiated by ASECAP members.

#### Level 3.

- OMIS (Open Minimum Interoperability Specification), initiated by the UK’s Department for Transport (DfT) and being developed and validated by system integrators and EFC vendors
- CESARE (Common EFC System for an ASECAP Road Tolling European Service), now CESARE II, founded by ASECAP highway operator members to define a pan-European interoperable EFC service.

Fig 3. Initiatives

existing OBU population and benefit from economies of scale within the regional

multi-operator clusters when reconciling EFC transactions. It is therefore critical that operators talk to each other.

For example, a Requirement Specification for OBU, RSE and back office systems could require compliance to the DSRC EN (Profile 0/1 and parameter set B – the most widely used), GSS and CESARE II. For several years France’s highway operators have requested compliance with the ‘TIS’ specification. Similarly Austria’s emerging national requirements are DSRC EN, GSS, A1 and CARDME. Finally, the emerging UK-specific OMIS document, currently in a provisional form known as OPMIS, refers to the ENV, GSS, A1 and A1+ and describe exemption schemes, vehicle classifications and many other account and vehicle-specific parameters (Fig. 4).

During the transition phase from the ENV to EN there will continue to be exceptions and local variations that also require operators to agree how best to use OBUs that have already been issued that comply with an earlier revision of the DSRC specifications. For example, in France, the TIS specification has already secured a critical mass of acceptance between operators, EFC technology vendors and system integrators so any evolution of RSE will need to be backwards compatible with OBU complying with the ENV.

#### WORD PERFECT

The development of EFC standards in Europe led to vendors finding ways to compete that do not depend on having a proprietary flavour to the DSRC interface. However regional ‘dialects’ will continue to exist within a greater European transaction based on CEN DSRC and EFC specifications. The CARDME concept concludes that in France in 2000 there were 1 billion transactions resulting in the collection of Euro5bn. Furthermore the adoption of EFC as a primary revenue collection toll “...*would almost certainly be more rapid if a consistent approach offering a Europe-wide interoperability for applications [for open highway and plaza-based charging]...*”. Level 2 specifications such as CARDME 4 and CESARE II aim to specify interoperability that are hardware-independent so do not (and should not) be specific to one manufacturers’ DSRC products.

So, whilst interoperability may be a good thing, securing it is not always easy. Interoperability needs to exist at all levels from the front end

#### Validating OPMIS



Fig 4. One of 15 DSRC trial sites in Leeds

(air interface) and back-end (between operators). So securing interoperability needs a simple but unambiguous specifications and agreements between operators to reconcile EFC transactions. OBU to RSE interoperability, in particular, also needs to be two-way (not one way) to ensure that an OBU issued by operator A can be read by operator B and vice versa! Although an RSE could be upgraded to support different versions such as from A1 (off board account) to A1+ (on board account) it would be difficult and probably uneconomic to upgrade A1 compliant OBUs that have already been issued.

Demanding interoperability based on a consistent selection of specifications from at least level 1 and level 2 will also ensure that a critical mass of EFC technology vendors and system integrators will be able to comply. A precise Requirement Specification that recognises regional EFC transaction preferences will further reduce the deployment risk of what is, after all, a business critical purchase. Projects such as MOVE-it and pilot deployments such as PISTA aim to validate EFC equipment and provide the basis for peer-to-peer contractual agreements for operators.

## **NEXT STEPS**

The RSE and OBU manufacturers continue to innovate with an increasing variety of products. Since their announcement in 1991 OBUs are now available commercially that support on-board account debiting (some using a smart card) complying with the A1+ specification. Still, there remains a difference between system integrators and operators on what level of transaction security is required, which commands should be used for common EFC functions and, as a minimum, what level of account or issuer-specific information would be readable by a highway operator. Although these types of questions have so far been agreed regionally, there is an opportunity for a common European open specification or ‘phrase’ book that would be universally available to highway operators whilst being consistent with existing Level 2 (application layer) specifications.

*“...securing interoperability is now the responsibility of the highway operators”.*

As more operators adopt EFC, pressures are continually being placed on the underlying technologies and systems in two main areas

- Demands for increased transaction flexibility. This allows a highway operator to define a transaction based on ‘phrases’ that may be simple or complex but, in any case, will require OBUs to be more flexible. The existence of level 2 specifications are driving this process
- Demands for increased payment flexibility. Most EFC systems depend on a central account driven by a large population of mass-produced low cost OBUs. Advanced OBUs, not currently available in large volumes commercially, will

permit on-board debiting in open highway charging applications using multi-application intermodal smart cards.

In any case, the agreement on the final content of the EN and new focus of technology developments means that securing interoperability is now the responsibility of the highway operators. Initiatives such as TIS, CESARE, CARDME, PISTA and development of OMIS will continue to be relevant to highway operators. Finally, the pan-European specifications such as the CEN ENV (and the EN from mid March 2003), A1 and GSS specifications are also being adopted in developing regions outside Europe such as South Africa, South America, Australia and China. Highway operators and road authorities are now in the driving seat of expansion of interoperable EFC worldwide.

Further information on CEN can be found at [www.cenorm.be/](http://www.cenorm.be/), the CEN TC278 document list is at [www.nni.nl/cen278/](http://www.nni.nl/cen278/), ISO/TR 14906:1998 can be purchased from [www.iso.org](http://www.iso.org), copy of GSS and A1 can be downloaded at [www.etc-interop.com](http://www.etc-interop.com), A1+ at [www.cordis.lu/telematics/tap\\_transport/research/projects/a1.html](http://www.cordis.lu/telematics/tap_transport/research/projects/a1.html), MOVE-it at [http://www.cordis.lu/telematics/tap\\_transport/research/projects/move-it.html](http://www.cordis.lu/telematics/tap_transport/research/projects/move-it.html), CESARE II and PISTA by contacting ASECAP (details at [www.asecap.com](http://www.asecap.com)), CARDME 4 at [www.cardme.org](http://www.cardme.org), and reference to OPMIS at [www.dft.gov.uk/itwp/consult/research/05.htm](http://www.dft.gov.uk/itwp/consult/research/05.htm). The author Andrew Pickford can be contacted directly at [andrew.pickford@dial.pipex.com](mailto:andrew.pickford@dial.pipex.com).

## **BIBLIOGRAPHY**

- [1] ISO/TR 14906:1998 Road Transport and Traffic Telematics (RTTT) -- Electronic Fee Collection (EFC) – ‘Application Interface Definition for Dedicated Short Range Communications’
- [2] GSS: ‘Global Specification for Short Range Communication’, Version 3.0, December 2001
- [3] A1: TR4001 A1, ‘Interoperable EFC Transaction Using Central Account Based On DSRC’, Version ER9\_1.3, June 1999
- [4] CARDME-4: ‘The CARDME Concept’ Project IST-1999-29053, deliverable 4.1 (Final), 1 June 2002
- [5] CESARE II: D032.1 ‘Detailed CESARE Technical Specification’, Version 3.0, 2002
- [6] PISTA: ‘Transaction Model’, Project IST-2000-28597, deliverable 3.4, Version 6, Nov 2002
- [7] MOVE-IT: TR1105, ‘Initial Validation Requirements for Inter-operable Electronic Fee Collection using Dedicated Short Range Communications’, 1998