TRUSTED
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Interoperability Stepping Stones

Release 6

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Figure index

1 Introduction

In today's telecom environment, innovative services must be launched not only within the shortest timeframe, but also with greater flexibility for future upgrades and easy service maintenance. During the years, Java Card has proved itself as the key technology in service deployment.

The Java Card™ 2.1 standard was released by the Java Card Forum in early 1999. At the same time, ETSI endorsed the use of Java Card™ in SIM cards and defined the GSM SIM API for Java Cards.

Since them, Java Card technology and ETSI specifications have been continuously evolving to face new services and new potentiality, up to the 3G telecommunication world, finalized in the Release 6 of ETSI specifications.

At the same times, interoperability between smart cards improved due to the field experience and also due to the *Interoperability Stepping Stones*, intended to address and solve all different interpretations of the specifications that could lead to different implementations.

Completing ETSI's work of releasing specifications and test suites, the purpose of this guide is to provide developers with information concerning Java Card™ SIM constraints and a common interpretation of the standards for the members of the SIM Alliance that contributed to this document.

The target audience of this guide is Network Operators, Wireless Service Providers and anyone interested in interoperable Java Card applet development.

Used in conjunction with the Java Card Applet Developer's Guide from SUN Microsystems, this guide aims to allow interoperable Java Card applications to be developed, thereby providing:

- Interoperable behaviors of the Java Cards
- A common implementation of the standard APIs

This was achieved following a detailed gap analysis of all the Java Cards on the market, the results of which clarify and explain the following standards:

- Java Card (JCRE, API)
- Toolkit APIs
- Toolkit security
- Remote Management (Application Loading, File Management)

2 Reference Documentation

Entity	Reference	Title
ETSI (www.etsi.org)	TS 101 220 Release 7	ETSI Numbering System for Telecommunications; Application Providers (AID)
	TS 102 221 Release 6	UICC-Terminal interface; Physical and logical characteristics
	TS 102 222 Release 6	Administrative commands for telecommunications applications
	TS 102 223 Release 6	Card Application Toolkit (CAT)
	TS 102 225 Release 6	Secured packet structure for UICC based applications
	TS 102 226 Release 6	Remote APDU structure for UICC based applications
	TS 102 241 Release 6	Java Card(TM) API for the UICC
3GPP (www.3gpp.org)	TS 31.101 Release 6	UICC-terminal interface; Physical and logical characteristics
	TS 31.102 Release 6	Characteristics of the USIM application
	TS 31.111 Release 6	Universal Subscriber Identity Module Application Toolkit (USAT)
	TS 31.115 Release 6	Secured packet structure for (Universal) Subscriber Identity Module (U)SIM Toolkit applications
	TS 31.116 Release 6	Remote APDU Structure for (Universal) Subscriber Identity Module (U)SIM Toolkit applications
	TS 31.130 Release 6	(U)SIM Application Programming Interface (API); (U)SIM API for Java Card
	TR 31.900 Release 6	SIM/USIM internal and external interworking aspects
	TR 31.919 Release 6	2G/3G Java Card(TM) Application Programming Interface (API) based applet interworking
GlobalPlatform (www.globalplatform.org)		Global Open Platform Card Specification, Version 2.1.1 (plus Amendment A – check by all)
Sun Microsystems (http://java.sun.com/products/javacard/)		Java Card 2.2.1 Virtual Machine Specification
		Java Card 2.2.1 Runtime Environment (JCRE) Specification
		Java Card 2.2.1 Application Programming Interface
		Java Card Applet Developer's Guide, Java Card Version 2.2.1
ISO	ISO 8825-5: 2004	Information technology - ASN.1 encoding rules: Mapping W3C XML schema definitions into ASN.1

3 Abbreviations

2G	2nd Generation Network
3G	3rd Generation Network
3GPP	3rd Generation Partnership Project
ADF	Application Dedicated File
AID	Application Identifier
AM_DO	Access Management Data Object
APDU	Application Protocol Data Unit
API	Application Programming Interface
APN	Access Point Name
ATR	Answer To Reset
AuC	Authentication Center
BER	Basic Encoding Rules
BIP	Bearer Independent Protocol
CAP	Converted Applet Package
CAT	Card Application Toolkit
CAT_TP	CAT Transmission Protocol
CC	Cryptographic Checksum
CHV	Card Holder Verification
CLA	Class byte of the APDU
CSD	Circuit Switched Data
DAP	Data Authentication Pattern
DEK	Data Encryption Key
DES	Data Encryption Standard
DF	Dedicated File
DO	Data Object
DS	Digital Signature
EF	Elementary File
ETSI	European Telecommunications Standards Institute
EXP	Export File
FCP	File Control Parameters
FDN	Fixed Dialing Numbers
FID	File Identifier
GGSN	Gateway GPRS Node
GP	Global Platform
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HLR	Home Location Register
HSCSD	High Speed Circuit Switched Data
ICC	Integrated Circuit Card
INS	Instruction byte of the APDU
IP	Internet Protocol
IrDA	Infrared Data Association
ISD	Issuer Security Domain
JC	Java Card
JDK	Java Development Kit
K	Secret Key in 3G
Ki	Secret Key in 2G
KIc	Key and algorithm Identifier for ciphering
KID	Key and algorithm Identifier for RC/CC/DS

Lc	Length of the Command data sent by the application layer
Le	Length Expected
LND	Last Number Dialed
ME	Mobile Equipment
MF	Master File
MSISDN	Mobile Station International ISDN Number
MSL	Minimum Security Level
NAA	Network Access Application
OPEN	Global Platform Environment
OTA	Over The Air
P1	Parameter byte 1 of the APDU
P2	Parameter byte 2 of the APDU
P3	Parameter byte 3 of the APDU
PDP	Packet Data Protocol
PIN	Personal Identification Number
PIX	Proprietary application Identifier eXtension (part of the AID)
PoR	Proof of Receipt
RAM	Remote Applet Management
RC	Redundancy Checksum
RFM	Remote File Management
RID	Registered application provider IDentifier (part of the AID)
RMI	Remote Method Invocation
RS232	Recommended Standard 232
RTE	Runtime Environment
SAT	Sim Application Toolkit
SC_DO	Security Condition Data Object
SCP	Smart Card Platform
SD	Security Domain
SE	Security Environment
SGSN	Serving GPRS Node
SIM	Subscriber Identity Module
SMS	Short Message Service
SW	Status Word
TAR	Toolkit Application Reference
TCK	Test Compatibility Kit
TCP	Transmission Control Protocol
TLV	Tag Length Value
TS	Technical Specification
UDP	User Datagram Protocol
UICC	Universal Integrated Circuit Card
UMTS	Universal Mobile Telecommunication System
USAT	USim Application Toolkit
USB	Universal Serial Bus
USIM	Universal Subscriber Identity Module
UTRAN	UMTS Terrestrial Radio Access Network

4 Definitions

Global Platform API	The GlobalPlatform API provides services to Applications (e.g. cardholder verification, personalization, or security services).
Integrated Circuit Card	The most general term for a smart card is "ICC". It is always a physical and logical entity either a SIM or a UICC.
Issuer Security Domain	The representative entity of the card issuer. It provides support for control, security and communication requirements of the card issuer.
Over-The-Air	Technology which uses the mobile network features to download data to the UICC.
Remote Application Management	Remote Application Management applications are OTA interfaces to the Issuer Security Domain and other Security Domains.
Security Domain	A special application that supports a secure communication between an Application Provider's application and off-card entities during its personalization phase and runtime.
Subscriber Identity Module	"SIM" is the term that defines the ICC for a 2G card, there is no distinction between the physical and logical entity and the application itself. In a UICC, the "SIM" is an application. If it is active, the UICC is functionally identical to a 2G card.
Toolkit Application Reference	Unique identification for Toolkit applications when using Over-The-Air functionality.
Universal Integrated Circuit Card	The UICC is the physical and logical platform for the USIM. It can, at least, contain one USIM application and may additionally embed a SIM application.
Universal Subscriber Identity Module	The USIM is not a physical entity. It is a purely logical application on a UICC. It does only accept 3G commands and therefore it is not compatible with a 2G ME. The USIM may provide mechanisms to support 2G authentication and key agreement to allow a 3G ME to access to a 2G network. (see 3GPP TS 31 102)

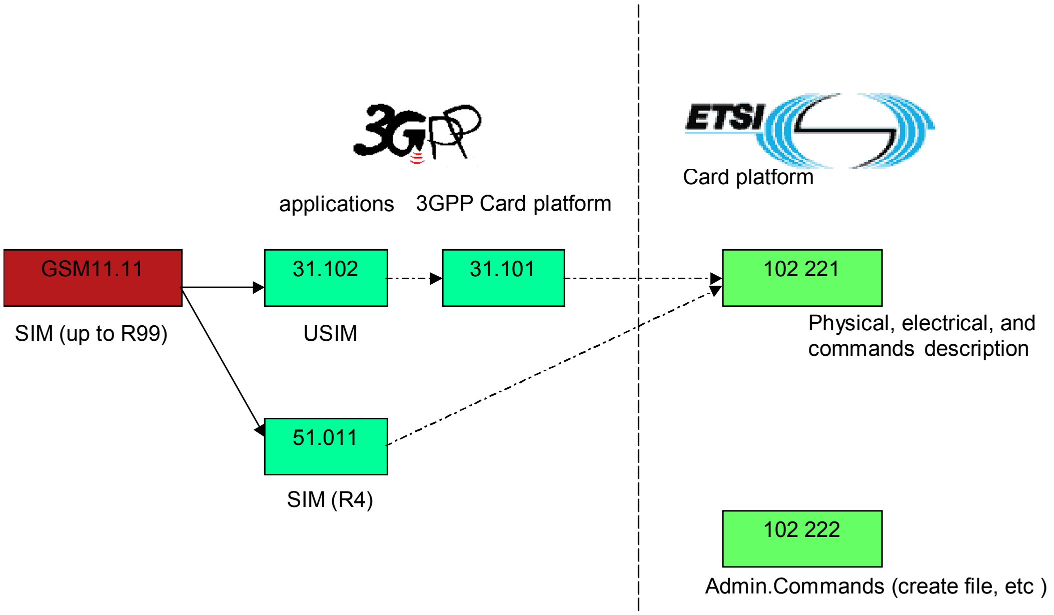
5 Release 6: the standard evolution

The Release 6 introduces a new set of standards for File System, Over The Air remote management, Toolkit feature and associated APIs. The following chapter lists the document specifications in order to help the reader in understanding the relationships between them. Historical evolution of the standard is also described to show the path from previous Release specifications to Release 6 specifications.

5.1.1 UICC physical/logical characteristics

UICC	
3GPP 31.101 : UICC-terminal interface - Physical and logical characteristics	
3GPP 31.900 : SIM/USIM internal and external interworking aspects	
ETSI 102 221 : Smart cards – UICC/Terminal interface - Physical and logical characteristics	
ETSI 102 222 : Integrated Circuit Cards (ICC) - Administrative commands for telecommunications applications	
USIM	SIM
3GPP 31.102 : Characteristics of the USIM application	**3GPP 51.011 R4 :** Specification of the Subscriber Identity Module - Mobile Equipment (SIM - ME) Interface

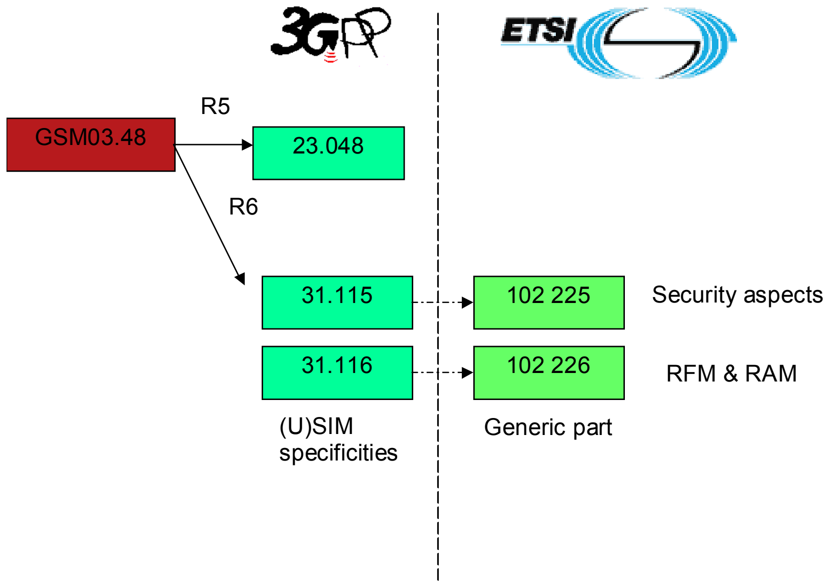
Evolution of standards can be represented as followed:



5.1.2 UICC OTA

UICC
ETSI TS 102 225 : Smart cards, Secured packet structure for UICC based applications
ETSI TS 102 226 : Smart cards, Remote APDU structure for UICC based applications
(U)SIM
3GPP TS 23.040: Technical realization of the Short Message Service (SMS)
3GPP TS 23.041: Technical realization of Cell Broadcast Service (CBS)
3GPP TS 31.115:Secured packet structure for (U)SIM Toolkit applications (SMS-PP and SMS-CB)
3GPP TS 31.116: Remote APDU Structure for (U)SIM Toolkit applications (RFM and RAM)

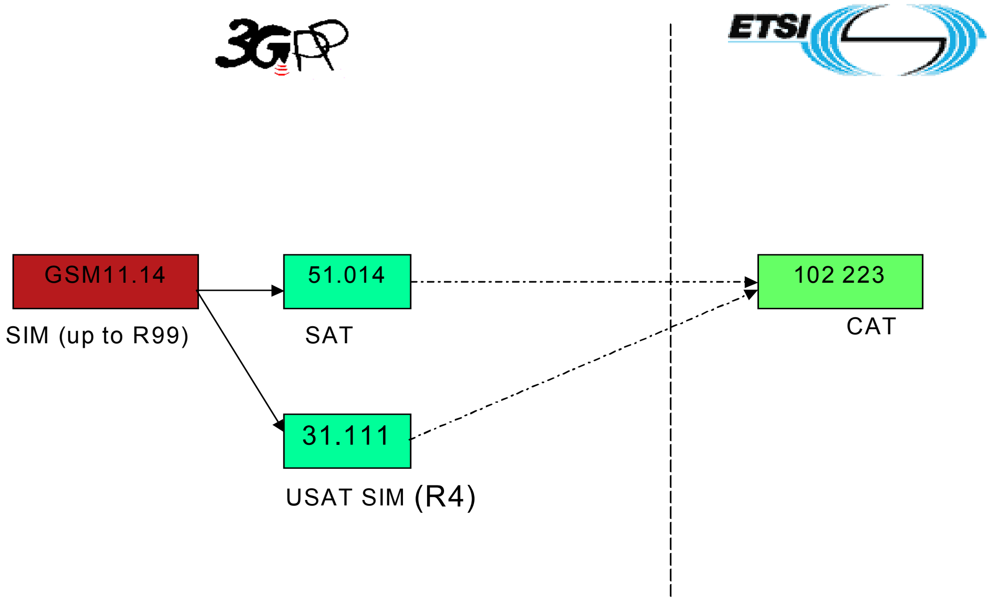
Evolution of standards can be represented as followed :



5.1.3 UICC Toolkit

UICC	
ETSI TS 102 223: Smart cards, Card Application Toolkit (CAT) Interface between the UICC and the terminal, and mandatory terminal procedures, specifically for NAA (Network Access technology) CAT (Card Application Toolkit).	
USIM	SIM
3GPP TS 31.111 : USIM Application Toolkit (USAT)	**3GPP 51.014 R4 :** Specification of the SIM Application Toolkit for the SIM - ME interface

Evolution of standards can be represented as followed:



5.1.4 UICC JAVA Card

UICC
ETSI TS 102 241 : Smart cards, UICC Application Programming Interface (UICC API) for Java Card
(U)SIM
3GPP TS 31.130 : (U)SIM Application Programming Interface,((U)SIM API) for Java Card This API allows developing a (U)SAT application running together with a (U)SIM application and using GSM/3G network features.

102 241 packages

`uicc.access`
Access to the UICC file system
`uicc.access.fileadministration`
Administrate the UICC file system
`uicc.system`
Utility package allows creating objects that are implementing TLV handler interfaces
`uicc.toolkit`
Register to the events of (CAT) framework, Handle of TLV information; send proactive commands according to TS 102 223.

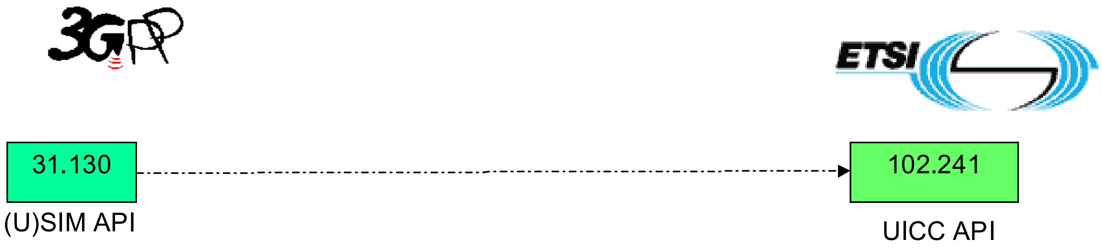
31.130 packages

`uicc.usim.access`
Access to the files defined in the USIM, SIM.

`uicc.usim.toolkit`

Register to the events defined in the USAT and STK, handle of TLV information and send proactive command according to 31.111 and 51.014.

Evolution of standards can be represented as followed :



6 The UICC Architecture

The present chapter is an overview of the UICC architecture and of its implementation for the UMTS environment.

Java Card applications developers can found in this chapter some clues to find information to develop services.

An overview of the card architecture can be found in Figure 1.

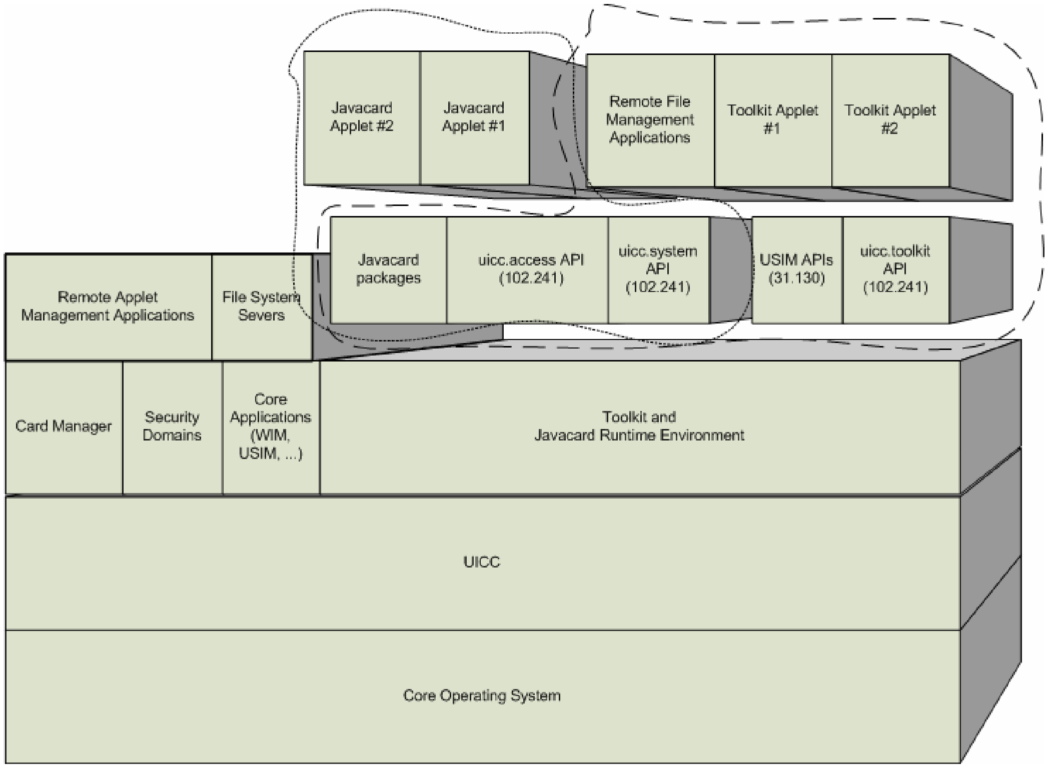

Javacard Applet #2
Javacard Applet #1
Remote File Management Applications
Toolkit Applet #1
Toolkit Applet #2
Javacard packages
uicc.access API (102.241)
uicc.system API (102.241)
USIM APIs (31.130)
uicc.toolkit API (102.241)
Remote Applet Management Applications
File System Severs
Card Manager
Security Domains
Core Applications (WIM, USIM, ...)
Toolkit and Javacard Runtime Environment
UICC
Core Operating System

Figure 1 - The UICC Architecture

6.1 Definition of UICC

The UICC is the physical and logical platform for 3G telecom applications. It contains at least one 3G telecom application (USIM), but it may also contain also a 2G telecom application (GSM) or other applications.

As a logical platform, the UICC provides some general mechanisms that can be used by each application on top of the UICC; these mechanisms cover application selection, file system access and management, and security features.

6.2 Application selection

Several applications can be present in an UICC; to initiate an application session, the terminal sends a SELECT command with the application's AID. Once an application is selected, subsequent APDUs are dispatched by the UICC to the selected application.

Any application based on 102 221 specifications is also the manager of a dedicated folder called ADF. The list of the AIDs of such applications is stored in EF_{DIR} under MF that can be accessed and read by other applications and terminals.

To have more applications selected on the UICC at the same time, the mechanism of the Logical Channels is present. On each Logical Channel a different application can be selected; moreover, files can be selected on each Logical Channel (see ISO/IEC 7816-4). This allows concurrent accesses to different files and also concurrent accesses to the same file.

6.3 File system

In the UICC, several kinds of file can be present:

- Dedicated File (DF) that allows functional grouping of files. They can be the parents of DFs and/or EFs. DFs are referenced by file identifiers.
- Application DF (ADF) is a particular DF that contains all the DFs and EFs of an application. ADF are referenced by a DF Name (or AID)
- Elementary File (EF), that contain data and no other files; they can be Transparent, Linear Record, Cyclic Record or BER-TLV structured as defined in ETSI TS 102 221

Elementary Files can be addressed by File Identifier (FID), a two-bytes ID, or by Short File Identifier (SFI). The SFI can be used in file system access APDUs to implicitly select the file without sending an explicit SELECT FILE APDU.

6.3.1 Security architecture

The security architecture in the UICC consists of the following parts:

- Security attributes: a set of access rules; they are attached to an ADF/DF/EF and they are part of the FCP (see § 6.4.2).
- Access rules: consist of an access mode and one or more security conditions.
- Access Mode (AM): indicates to which operations (commands) the security condition applies; they are coded in Access Mode Data Objects (AM_DOs).
- Security Condition (SC): contains references to the applicable key references (PINs); they are coded in Security Conditions Data Objects (SC_DOs).

Each operation applicable to a file (except its selection) is protected by one or more Security Conditions, identifying the prerequisites of the operation. The UICC checks, in order to allow a file operation, the Security Condition related to the relevant Access Mode to verify if the security related procedures (e.g. user PIN verification) are satisfied.
The default security condition associated to an operation is NEVER. This means that the security condition for an operation whose SC_DO object can not be found is set to NEVER.

The Security Attributes can be specified, for each file, in several formats:

- Compact format
- Expanded format
- Access rule referencing

The different formats have different limitations: the Compact Format is less flexible than the Expanded format, and the Expanded format is less flexible than the Access Rules Referencing format.

Though in the UICC there are three different ways to code security attributes, in the USIM all Security Attributes are coded in Access Rules Referencing format (EF_{ARR}) according to TS 31.102; as a consequence, we consider Compact format and Expanded format out of the scope of the present document.

6.3.2 Referencing a EF$_{ARR}$ record: the Referenced Format

The referenced format is indicated in the FCP following tag '0x8B'. The access rule is stored in a file, EF$_{ARR}$. This file is a linear fixed file. Referencing is based on the following two methods:

- File ID and record number (File ID, record number);
- File ID, SE ID and record number (File ID, SE ID, record number).

The second possibility allows the usage of different access rules in different security environments as defined in the following. When referencing EF$_{ARR}$ is based on the file ID, the rules for the location of the access rules are as follows:

- for an EF, if the EF$_{ARR}$ file with the file ID indicated in tag '0x8B' cannot be found in the current DF, the parent DF shall be searched for EF$_{ARR}$. This process shall continue until the EF$_{ARR}$ is found or until an ADF or the MF is reached;
- for a DF, if the EF$_{ARR}$ file with the file ID indicated in tag '0x8B' cannot be found in the parent DF, the grandparent DF shall be searched for EF$_{ARR}$. This process shall continue until the EF$_{ARR}$ is found or until an ADF or the MF is reached;
- for the MF or an ADF, the EF$_{ARR}$ file with the file ID indicated in tag '0x8B' shall be searched under the MF.

The structure of the access rule referencing DO is as follows.

Tag	Length	Value
'8B'	'03'	File ID, record number
'8B'	'02' + n x '02'	File ID, SE IDn1, Record number X, SE IDn2, Record number Y, etc.

6.3.3 Structure of the EF$_{ARR}$ file

The structure of the EF$_{ARR}$ file is as follows.

<table>
<tr><th>Record Number (ARR)</th><th>Record Content (Access Rule)</th></tr>
<tr><td>'01'</td><td>AM_DO||SC_DO1||SC_DO2||AM_DO||SC_DO3||SC_DO4 ….</td></tr>
<tr><td>'02'</td><td>AM_DO||SC_DO1||AM_DO||SC_DO5||SC_DO6 ….</td></tr>
<tr><td>…</td><td>…</td></tr>
</table>

6.3.3.1 AM_DO coding

The AM data objects are coded in different formats depending on the operation to be protected.

6.3.3.2 AM_DO coding for EF operations

For Elementary files, all the following operations are coded in the AM_DO as a bit mask:

	b8	b7	b6	b5	b4	b3	b2	b1
DELETE (self)	0	1	-	-	-	-	-	-
TERMINATE	0	-	1	-	-	-	-	-
ACTIVATE	0	-	-	1	-	-	-	-
DEACTIVATE	0	-	-	-	1	-	-	-

UPDATE BINARY
UPDATE RECORD
SET DATA
	0	-	-	-	-	-	1	-

READ BINARY READ RECORD SEARCH RECORD	0	-	-	-	-	-	-	1

RETRIEVE DATA								

The bit mask is stored in an AM_DO TLV with the tag set to 0x80:

TAG	LEN	AM Byte
0x80	0x01	

As the above operations are coded in bit masking, it's possible to code more operations in the same AM byte; in this case, all the operations indicated in the bit mask will share the same Security Conditions.

The INCREASE and the RESIZE commands have a different way to code the AM_DO byte:

TAG	LEN	AM Byte
0x84	0x01	(0x32)

for the INCREASE command and

TAG	LEN	AM Byte
0x84	0x01	(0xD4)

for the RESIZE command.

Only the INCREASE command or the RESIZE command can be stored in the TLV; so it's not possible to code more operations in this AM_DO TLV.

6.3.3.3 AM_DO coding for DF operations

For Dedicated files, all the following operations are coded in the AM_DO as a bit mask:

	b8	b7	b6	b5	b4	b3	b2	b1
DELETE FILE (self)	0	1	-	-	-	-	-	-
CREATE FILE DF creation	0	-	-	-	-	1	-	-
CREATE FILE EF creation	0	-	-	-	-	-	1	-
DELETE FILE (child)	0	-	-	-	-	-	-	1

The bit mask is stored in an AM_DO with the tag set to 0x80:

TAG	LEN	AM Byte
0x80	0x01	

The same procedure as for AM_DO bitmap for EFs applies.

The RESIZE command has a different way to code the AM_DO byte:

TAG	LEN	AM Byte
0x84	0x01	(0xD4)

Only the RESIZE command can be stored in the TLV; so it's not possible to code more operations in this AM_DO TLV.

> **Interoperability issue**
> The RESIZE command may not be supported for a DF.

6.3.3.4 SC_DO coding

The Security Condition (SC) indicates which security related procedures are requested in order to perform a file operation. In the UICC three different SC_DOs are defined:

- Always
- Never
- PIN Verification

TAG	LEN
0x90	0x00

An Always SC_DO

TAG	LEN
0x97	0x00

A Never SC_DO

TAG	LEN	TAG	LEN	PIN	TAG	LEN	U.Q.
0xA4	0x06	0x83	0x01	ID	0x95	0x01	08

A PIN SC_DO

It's also possible to define more PIN SC_DOs for the same operation, both in AND (all conditions are required to be fulfilled) / OR (just one condition must be fulfilled) mode:

TAG	LEN	SC-DO TLV #1	SC-DO TLV #2
0xA0	xx		

Two SC_DOs in OR

TAG	LEN	SC-DO TLV #1	SC-DO TLV #2
0xAF	xx		

Two SC_DOs in AND

6.4 PIN in the UICC

Different types of PINs are present on the UICC: the Application PINs, the Local PINs, the Universal PIN and the Administrative PINs,. Each PIN that is present under a (A)DF is indicated in the FCP of the (A)DF in the PIN Status template DO; each PIN is identified by the Key Reference number.

The Key reference number is used also in PIN related APDUs to address PIN.

Application PIN
An application PIN is a PIN that allows access to any file on the UICC where it is referenced in the access rules. It is uniquely identified by the Key Reference number that is in the set 0x01 – 0x08

Local PIN
A local PIN is a PIN that uses a local key reference which is only valid within the ADF/DF where it is indicated in the FCP. Key reference numbers for Local PIN are in the set 0x81 – 0x88; two different ADFs can use the same local key reference number with different PIN value and different status (enabled, disabled, verified, blocked), one for each ADF.

Universal PIN
The Universal PIN is a PIN that is used in a multi-application environment to allow several applications to share one common PIN. The Universal PIN is a global access condition that has been assigned a key reference value '11'.

Administrative PIN
Up to 10 administrative PINs may be available. They are usually dedicated to the operator. They are uniquely identified by the Key Reference number that is in the global set 0x0A – 0x0E and the local set 0x8A – 0x8E.

> **Interoperable issue:**
>
> It's not guaranteed by all SIM Alliance members that the Local PIN may be defined under DFs that are different from the ADF; usage of local PIN defined under the ADF is guaranteed.

> **Interoperability Issue**
>
> SIM Alliance Members can not guarantee that the uses of the administrative PINs are fully interoperable especially concerning the range 0x8A – 0x8E.

6.4.1 Security Environments in the UICC

The Security Environment (SE) is a mechanism to specify, for the card system, the security functions that are available to provide protection to commands for a specific application of the card.
As the security functions in the UICC concern PIN verification, the changing of PIN status can affect the currently active security environment.

In multi-application UICC with Universal PIN, two different Security Environments are defined depending on Application PIN status; each Application PIN can be in one of the following status:

- The Application PIN is enabled. In this case, each operation protected by the Application PIN still requires the PIN verification to be allowed.
- The Application PIN is disabled. In this case, card behavior depends on the **usage qualifier** specified for the Application PIN. This can be:
  "Use Universal PIN" (Usage qualifier set to '08'). In this case, the operations protected by Application PIN are considered as protected by the Universal PIN: it's required to verify the Universal PIN to allow such operations.
  "Do not use Universal PIN" (Usage qualifier set to '00'). In this case, the operations remain protected by the Application PIN, that is disabled (this allows the operations).

The current SE depends on the state of the Application PIN of the current application; if the Application PIN of the current application is disabled with Usage Qualifier set to "Use Universal PIN", the current SE is the SE 00; in the other cases, the current SE is the SE 01.

> **Developer tip:**
> Toolkit applet access conditions consider the active Security Environment as the SE 01; they don't care Universal PIN.

6.4.2 Retrieving information about a file: the FCP template

In case of successful selection using the SELECT APDU, the File Control Parameters (FCP) template is returned by the card; this template contains some information about the selected file and the card itself.

Each FCP template is a BER-TLV (tag '62') made by a list of TLVs; the available TLVs differ depending on file type (e.g. EF or DF).

FCP template for MF, DF or ADF:

Description	**Tag**	**Status**
File Descriptor	'82'	M
File Identifier	'83'	C1
DF name (AID)	'84'	C2
Proprietary information	'A5'	C3
Life Cycle Status Integer	'8A'	M
Security attributes	'8B', '8C' or 'AB'	C4
PIN Status Template DO	'C6'	M
Total file size	'81'	O
M: Mandatory. O: Optional. C1: The File identifier is mandatory for a DF or the MF. For a ADF the File identifier is optional. C2: DF name is mandatory for only ADF. C3: Proprietary information is mandatory for the MF. For a DF/ADF the Proprietary information is optional. C4: Exactly one shall be present.		

FCP template for EF:

Description	Tag	Status
File Descriptor	'82'	M
File Identifier	'83'	M
Proprietary information	'A5'	O
Life Cycle Status Integer	'8A'	M
Security attributes	'8B', '8C' or 'AB'	C1

File size	'80'	M
Total file size	'81'	O
Short File Identifier (SFI)	'88'	O
M: Mandatory. O: Optional. C1: Exactly one shall be present.		

TLV description:

- **File Descriptor**: specifies the file accessibility, the file type and structure. It indicates if a file is an EF or a DF, if it is record based or transparent, and so on.
- **File Identifier:** The File Identifier is a two bytes data unique for each DF identifying the file.
- **DF Name (or AID):** is a string of bytes which is used to uniquely identify an application dedicated file in the card.
- **Proprietary Information**: is a Constructed TLV (i.e., a TLV containing Simple TLVs), containing some TLV specified by the standard and also some TLV specified from singular SIM Vendors.

> **Developer Tip**
> The proprietary TLV contained in this Constructed TLV may vary among card vendors and among different card versions.
> Concerning the Security Attributes only the tag '8B' is managed. The other ways of coding (tags '8C' or 'AB') are out of the scope of this document. See chapter "Security architecture".

- **Life Cycle Status Information (LCSI):** is a TLV indicating file status respect to its activation status (i.e. Activated / Deactivated) and its administrative status (just created, initialized, and so on).
- **Security Attributes**: contains information about the security related procedures required to allow file operations. (See § 6.3.1).

> **Developer Tip**
> Only the tag '8B' is managed. The other ways of coding (tags '8C' or 'AB') are out of the scope of this document.

- **PIN Status template DO**: contains a list of all the PINs available in that (A)DF or MF and their activation status (enabled / disabled).
- **File Size**: indicates the size of the BODY of the EF.
- **Total file size:** indicates the size occupied on the card by the file (including structural information)
- **Short File Identifier (SFI)**: if the SFI is indicated, it can be used as defined in § 6.3.

A possible FCP template for a DF or MF follows:

BER TAG 0x62	Len	File Descriptor TLV Tag: 0x82	File Identifier TLV Tag: 0x83	Proprietary info TLV Tag: 0xA5	Security Attributes Tag: 0x8B, 0x8C or 0xAB	PIN Status Tag:0xC6

6.4.3 Files Life Cycle Status

Any file on the UICC – both EFs and DFs - moves during its life through different Life Cycle Status; depending on the current status, some operations concerning the file are allowed or denied or they are protected by different access conditions.

The concept of Life Cycle Status is specified in ISO IEC 7816-9, but the concept has been partially endorsed by ETSI specification; as an example, the above specified LCSI in the FCP indicates the current status.

The following states are defined according to ISO specification:

- Creation, right after a file has been created
- Initialization

- (Operational) Activated
- (Operational) Deactivated
- Terminated

Transitions between different states are performed by Administrative Commands (like Activate or Terminate).

The “operational” states are to be considered as the most common states for deployed cards.

> **Example**
> A file moves from Activated state to Deactivated state and vice versa by the commands Activate File and Deactivate File.

> **Interoperability Warning**
> SIM Alliance members don’t guarantee that transitions between the above states can be done in an interoperable way
> SIM Alliance members don’t guarantee that any of the above states is reachable on the different smartcard products, especially concerning the non-operational states.

6.5 Mapped files

A new concept in 3G specifications is the “mapped files”. Two files are considered mapped when they share the same body; the concept has been introduced as both GSM and USIM specifications define some files that are present in different directory, but with the same format and the same meaning; if these files are mapped each other, the card benefits both of resource saving and of content coherency.

> **Example**:
>
> The EF_ADN defined in USIM specification and the EF_ADN defined in GSM specification are usually linked in order to have the same list of contacts for both subscriptions.

Two mapped files does not share only the file body but they share also some other information, like the file structure (e.g. both are record based or both are transparent) the size, the record length, the last increased record (for cyclic file) and so on. Some other information may be different for the two files, like the file id, the access conditions or the file status (e.g. one file can be activated while the other one is deactivated).

> **Interoperability issues:**
>
> - There is no standard way to indicate, in the CREATE command, that two files are mapped. SIM Alliance members extend the CREATE command by using proprietary mechanisms to create mapped files.
> - There is no information in the FCP template indicating if two files are mapped.

7 Java Card Features

7.1 Java Card Language: a Subset of Java Language

Because of its small memory resources, the Java Card platform supports only a carefully chosen, customized subset of the Java language's features. This subset includes features that are well suited for writing programs for smart cards and other small devices while preserving the object-oriented capabilities of the Java programming language. The next table highlights some notable supported and unsupported Java language features.

Supported Java Features	**Unsupported Java Features**
• Small primitive data types: boolean, byte, short, • One-dimensional arrays, • Java packages, classes, interfaces, and exceptions, • Java object-oriented features: inheritance, virtual methods, overloading and dynamic object creation, access scope, and binding rules, • The int keyword and 32-bit integer data type support are optional. • The Garbage Collector	• Large primitive data types: long, double, float • Characters and strings • Multidimensional arrays • Dynamic class loading • Security manager • Threads • Object serialization • Object cloning

Note: The Garbage Collector is optional according to the Java Card 2.2.1 specification but is mandatory according to the TS 102 241 specification.

7.2 Backward Compatibility

The new version of the Java Card specification (revision 2.2.1) allows to run applications developed with the previous version. In facts, Java Card version 2.1, or 2.2, applications will run on Java Card 2.2.1 products without any modifications.
Also, an applet developed with the previous version can be converted with the JavaCard 2.2.1 converter tool.

7.3 The Java Card Runtime Environment

The Java Card™ platform, version 2.2.1 Runtime Environment contains the Java Card virtual machine (VM), the Java Card Application Programming Interface (API) classes (and industry-specific extensions), and support services.

7.3.1 Atomicity and Transactions

To ensure that the data and the applets stored on a smart card are always defined, even after a power failure or the card is removed during a session, the concept of atomicity and transaction was created. In the JC API (`javacard.framework.JCSystem` class), developers are provided with methods that allow them to write to the memory atomically; in other words, one memory field is fully updated before the next memory field is updated. Sessions, where the memories are updated atomically, are called transactions. If a transaction is interrupted, all memory fields are restored to the values set before the transaction started (rollback). Therefore, all memory field updates during a transaction are conditional. The end of the transaction must be committed programmatically (refer to the API description of the `javacard.framework.JCSystem` class), so that the updates can be definitively applied.

> **Interoperability Issue**
>
> Atomicity and Transactions are currently defined only for javacard memory fields and objects; SIM Alliance members are not interoperable about the applying of such concepts also to file system operations, as it is not explicitly required by the documentation standard.

7.3.2 Security Concept and Firewalls

Since smart cards are mainly used in fields where security is very much an issue, a special security concept was designed for Java on smart cards. First of all, applet developers may use the same concept of package and class visibility with which they are familiar when using conventional Java. Additional security is ensured in smart cards via a context firewall system. Each applet belongs to a specific *context*. One or more applets may belong to the same context. In current Java Card technology, all applets sharing the same package are in the same context (*package context*). Only the objects belonging to the context of the selected applet can be accessed. Whenever an applet is deselected and an applet belonging to another context is selected, the context is also deselected and the other context becomes active (selected). The JCRE ensures that references to objects do not cross over context borders.
If applet developers want objects to be shared by applets, the JCRE provides a secure sharing mechanism. Nevertheless, object fields cannot be accessed over context borders, but an applet can provide some object-processing methods via a public shareable interface and thereby give other applets controlled access to its own objects.

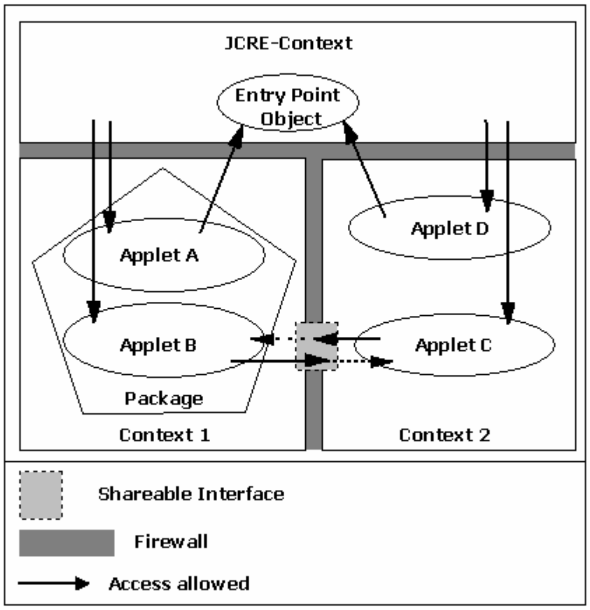


Figure 2 - The JCRE Context

A basic example of using a shareable interface object is as follows.

Step 1: defining a shareable interface.

```
package com.simalliance.serverappletpackage;

import javacard.framework.Shareable;

public interface ServerInterface extends Shareable {
        public void myMethod (short myParameter);
}
```

Step 2: the server applet must implement the interface containing the method to be called from a client applet (in this case, `myMethod`), the parameters to be processed (`myParameter`) and an implementation of the `getShareableInterfaceObject` method (this is to override the method implementation of the `javacard.framework.applet` class which returns null by default).

```
package com.simalliance.serverappletpackage;

import javacard.framework.*;

public class ServerApplet extends Applet implements ServerInterface {

        short myParameter;

        public void myMethod(short increment) {
                myParameter = (short) (myParameter + increment);
        }

        public Shareable getShareableInterfaceObject(AID clientAID, byte anyParameter){

                // anyParameter may be used to authenticate the client applet

                return this;
        }
}
```

Step 3: the client applet must retrieve the AID of the shareable interface object (`sio`) from the JCRE. With this, it can call the method to obtain the `sio` from the server applet.

```
package com.simalliance.clientappletpackage;

import javacard.framework.*;
import com.simalliance.serverappletpackage;

private short thisParameter = ANY_NUMBER;
static final short SW_SERVER_APPLET_NOT_EXIST = (short) 0x6F01;

// Server AID has to be coded in the client applet or assigned in the personalisation private
byte[] server_aid_bytes = SERVER_AID_BYTES;

public class ClientApplet extends Applet {

        private void addParameterViaSio() {

                // obtain the server AID object
                AID server_aid = JCSystem.lookupAID(server_aid_bytes,
                  (short)0,
                  (byte)server_aid_bytes.length);
                if (server_aid == null)
                        ISOException.throwIt(SW_SERVER_APPLET_NOT_EXIST);

                //request sio from server applet
                ServerInterface sio = (ServerInterface)
                        (JCSystem.getAppletShareableInterfaceObject(server_aid,
                        ANY_PARAMETER));

                //execute myMethod of the server applet
                sio.myMethod(thisParameter);
        }
}
```

7.3.3 Entry Point Objects

In the idea that the security of a smartcard must have a way for non-privileged user processes to request system services performed by privileged "system" routines, entry points objects have been defined.
These are objects owned by the JCRE context. They have been flagged as containing entry point methods. This designation allows the methods of these objects to be invoked from any context. The request system service is performed according to the verification of the method parameters, checked by the JCRE. The firewall restricts accesses to these objects (detect and restrict attempts to store these objects).
These entry points objects can be divided between two categories:

- Temporary JCRE Entry Point Objects (i.e. `APDU` and `ProactiveHandler` objects)
  References to these objects can only be used locally, e.g. they can not be stored by the applet in instance and class attributes
- Permanent JCRE Entry Point Objects (i.e. `AID` instance and `ToolkitRegistry` objects)
  References to these objects can be stored and freely re-used.

7.3.4 Global Arrays

Normally, the firewall would prevent objects from being used in different context. However, some objects need to be accessible from anyone. The Java Card VM allows an object to be designed as "global".
All global arrays are temporary global arrays objects which are owned by the JCRE context. This allows to any context to access to these objects.

> **Developer tip:**
> An applet can not create Global arrays in a standard way as no API is defined.

7.4 The Java Card VM

A primary difference between the Java Card virtual machine (JCVM) and the Java virtual machine (JVM) is that the JCVM is implemented as two separate pieces. The first, the on-card portion of the Java Card virtual machine, includes the Java Card bytecode "interpreter". The Java Card "Converter" runs on a PC or a workstation. The converter is the off-card piece of the virtual machine. Taken together, they implement all the virtual machine functions—loading Java class files and executing them with a particular set of semantics.
The Java Card Virtual Machine (JCVM) specification defines a subset of the Java programming language and a Java-compatible VM for smart cards, including binary data representations, file formats, and the JCVM instruction set.
The VM for the Java Card platform is implemented on the card itself. The on-card Java Card VM interprets bytecode, manages classes and objects, and so on. The input data for the VM are produced by an external development tool, the *Java Card Converter tool*, which verifies and prepares the Java classes in a card applet for on-card execution. The converter ensures that the classes conform to the Java Card specification. The output of the converter tool is a Converted Applet (CAP) file, a file that contains all the classes in a Java package in a loadable, executable binary representation.

7.4.1 Summary of Java Card Language Limitations

Language Features Dynamic class loading, security manager (`java.lang.SecurityManager`), threads, object cloning, and certain aspects of package access control are not supported.

Keywords `native`, `synchronized`, `transient`, `volatile`, `strictfp` are not supported.

Types There is no support for `char`, `double`, `float`, and `long`, or for multidimensional arrays. Support for `int` is optional.

Classes and Interfaces Some of the Java core API classes and interfaces (`java.io`, `java.lang`, `java.util`) are partially supported by Java Card. However, additional classes are defined to support smart cards' specific features.

Exceptions Some `Exception` and `Error` subclasses are omitted because the exceptions and errors they encapsulate cannot arise in the Java Card platform.

Summary of Java Card VM Constraints

Packages A package can refer to up to 128 other packages

A fully qualified package name is limited to 255 bytes. Note that the character size depends on the character encoding.

A package can have up to 255 classes.

Classes A class can directly or indirectly implement up to 15 interfaces.

A package can have up to 256 static methods if it contains applets (an *applet package*), or 255 if it is a library package.

A class can implement up to 128 public or protected instance methods, and up to 128 with package visibility.

7.5 Development tools

7.5.1 Converter

The Java Card Converter takes as input all of the class files which make up a Java package. A package that contains one or more non-abstract subclasses of the `javacard.framework.Applet` class is referred as an applet package. Otherwise the package is referred as a library package. The Java Card Converter also takes as input one or more export files. An export file contains name and link information for the contents of packages that are used in classes. When an applet or library package is converted, the converter can also produce an export file, for that package, representing the public APIs of the package being converted.
A Java Card CAP file contains a binary representation of a package that can be installed on a device and used to execute the classes on a Java Card virtual machine. A CAP file is produced by a Java Card converter when a package is converted. A CAP file consists of a set of components, each of them describes a different aspect of the content. The set of components in a CAP file can vary, depending on whether the file contains a library or applet definition(s). (See specification Java Card 2.2.1 for more details).
If the converter encounters any errors (i.e. any unsupported language features used in an applet are detected by the converter), no CAP file is produced and the problem is reported in the Tasks view.
See the following “conversion process” illustration:

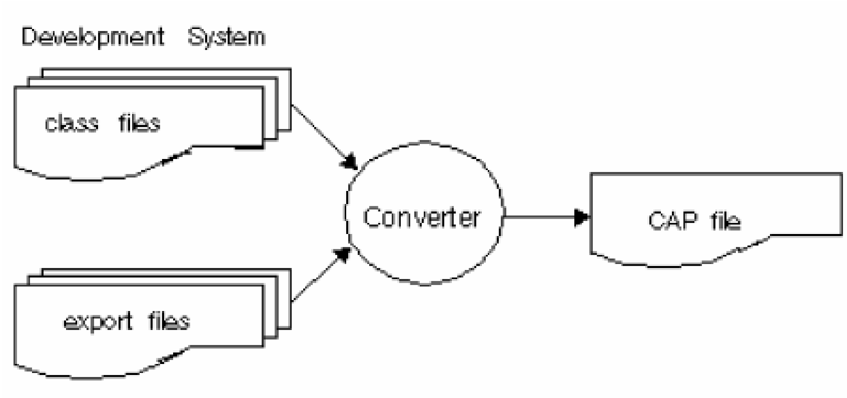


Figure 3 – Converting a CAP file

Concerning the converter, it is recommended to use the one included in CJDK 2.2.1. The version of this converter is 1.3.

7.5.2 Verifier

The verifier is a powerful tool that performs security checks to the CAP file. Actually, the converter checks only if the Java files are compatible with the Java Card language limitations; the verifier enforces security verifying the CAP file structure and that operations are well typed to avoid reference forgery. The set of conformances checks guarantees that such files do not attempt to compromise the integrity of a Java Card virtual machine and hence other applets.

7.6 The Java Card API

In addition to its subset of the Java core classes the Java Card Framework defines its own set of core classes specifically to support Java Card applications. These are contained in the following packages:
`java.io`
`java.io` defines one exception class, the base `IOException` class, to complete the RMI exception hierarchy.

Exceptions `IOException`: A Java Card runtime environment-owned instance of `IOException` is thrown to signal that an I/O exception of some sort has occurred.

java.lang

`Java.lang` defines *`Object`* and *`Throwable`* classes. It also defines a number of exception classes: the *`Exception`* base class, various runtime exceptions, and *`CardException`*.

Classes `Object`: Class Object is the root of the Java Card platform class hierarchy.

`Throwable`: The `Throwable` class is the superclass of all errors and exceptions in the Java Card platform's subset of the Java programming language.

Exceptions `ArithmeticException`: A Java Card runtime environment-owned instance of `ArithmeticException` is thrown when an exceptional arithmetic condition has occurred.

`ArrayIndexOutOfBoundsException`: A Java Card runtime environment-owned instance of `ArrayIndexOutOfBoundsException` is thrown to indicate that an array has been accessed with an illegal index.

`ArrayStoreException`: A Java Card runtime environment-owned instance of `ArrayStoreException` is thrown to indicate that an attempt has been made to store the wrong type of object into an array of objects.

`ClassCastException`: A Java Card runtime environment-owned instance of `ClassCastException` is thrown to indicate that the code has attempted to cast an object to a subclass of which it is not an instance.

`Exception`: The class `Exception` and its subclasses are a form of `Throwable` that indicate conditions that a reasonable applet might want to catch.

`IndexOutOfBoundsException`: A Java Card runtime environment-owned instance of `IndexOutOfBoundsException` is thrown to indicate that an index of some sort (such as an array) is out of range.

`NegativeArraySizeException`: A Java Card runtime environment-owned instance of `NegativeArraySizeException` is thrown if an applet tries to create an array with negative size.

`NullPointerException`: A Java Card runtime environment-owned instance of `NullPointerException` is thrown when an applet attempts to use null in a case where an object is required.

`RuntimeException`: It is the superclass of those exceptions that can be thrown during the normal operation of the Java Card Virtual Machine.

`SecurityException`: A Java Card runtime environment-owned instance of `SecurityException` is thrown by the Java Card Virtual Machine to indicate a security violation.

javacard.framework

`javacard.framework` defines the interfaces, classes, and exceptions that compose the core Java Card Framework. It defines important concepts such as the Application Protocol Data Unit (`APDU`), the Java Card applet (`Applet`), the Java Card System (`JCSystem`), the Personal Identification Number (`PIN`), and a utility class. It also defines various ISO7816 constants and various Java Card-specific exceptions.

Interfaces `ISO7816`*:* defines constants related to ISO 7816-3 and ISO 7816-4.

`MultiSelectable`*:* identifies applets that can support concurrent selections.

`PIN`*:* represents a personal identification number used for security (authentication) purposes.

`Shareable`*:* identifies a shared object. Objects that must be available through the applet firewall must implement this interface.

Classes `AID`*:* defines an ISO7816-5-conforming Application Identifier associated with an application provider; a mandatory attribute of an applet.

`APDU`*:* defines an ISO7816-4-conforming Application Protocol Data Unit, which is the communication format used between the applet (on-card) and the host application (off-card).

`Applet`*:* defines a Java Card application. All applets must extend this abstract class.

`JCSystem`*:* provides methods to control the applet life-cycle, resource and transaction management, and inter-applet object sharing and object deletion.

`OwnerPIN`*:* is an implementation of the `PIN` interface.

`Util`*:* provides utility methods for manipulation of arrays and shorts, including `arrayCompare()`, `arrayCopy()`, `arrayCopyNonAtomic()`, `arrayFillNonAtomic()`, `getShort()`, `makeShort()`, `setShort()`.

Exceptions Various Java Card VM exception classes are defined: `APDUException`, `CardException`, `CardRuntimeException`, `ISOException`, `PINException`, `SystemException`,

> **Developer tip:**
>
> The `OwnerPIN` class can be used by Java Card applets to define additional PINs but it does not offer interface to handle PINs defined by network access applications.

`javacard.framework.service`

`javacard.framework.service` defines the interfaces, classes, and exceptions for services, including RMI services.

Interfaces `Service`*:* defines the methods `processCommand()`, `processDataIn()`, and `processDataOut()`.

`RemoteService`*:* is a generic `Service` that gives remote processes access to services on the card.

`SecurityService`*:* extends the `Service` base interface, and provides methods to query the current security status, including `isAuthenticated()`, `isChannelSecure()`, and `isCommandSecure()`.

Classes `BasicService`*:* is a default implementation of a `Service`; it provides helper methods to handle APDUs and service collaboration.

`Dispatcher`*:* maintains a registry of services. Use a dispatcher if you want to delegate the processing of an APDU to several services. A dispatcher can process an APDU completely with the `process()` method, or dispatch it for processing by several services with the `dispatch()` method.

`CardRemoteObject`: base class to enable or disable remote access to an object from outside the card.

`RMIService`: this class extends `BasicService` and implements `RemoteService` to process RMI requests

javacard.security

javacard.security defines the classes and interfaces for the Java Card security framework. The Java Card specification defines a robust security API that includes various types of private and public keys and algorithms, methods to compute cyclic redundancy checks (CRCs), message digests, and signatures :

Interfaces Generic base interfaces Key, PrivateKey, PublicKey, and SecretKey, and subinterfaces that represent various types of security keys and algorithms: AESKey, DESKey, DSAKey, DSAPrivateKey, DSAPublicKey, ECKey, ECPrivateKey, ECPublicKey, RSAPrivateCrtKey, RSAPrivateKey, RSAPublicKey

Classes Checksum: abstract base class for CRC algorithms

KeyAgreement: base class for key-agreement algorithms

KeyBuilder: key-object factory

KeyPair: a container to hold a pair of keys, one private, one public

MessageDigest: base class for hashing algorithms

RandomData: base class for random-number generators

Signature: base abstract class for signature algorithms

Exceptions CryptoException: encryption-related exceptions such as unsupported algorithm or un-initialized key.

> **Developer Tips:**
>
> Not every algorithm is supported by each card (RSA, Elliptic Curves…).
> If an unsupported algorithm is used, a CryptoException with the specific reason: NO_SUCH_ALGORITHM is thrown.

javacardx.crypto

This extension package that defines the interface KeyEncryption and the class Cipher, each in its own package for easier export control.

Interfaces KeyEncryption: Generic bas interface used to decrypt an input key used by encryption algorithms

Classes Cipher*:* base abstract class that all ciphers must implement

java.rmi

java.rmi defines the Remote interface and the RemoteException class.

Interfaces Remote: The Remote interface serves to identify interfaces whose methods may be invoked from a CAD client application.

Exceptions RemoteException: A Java Card runtime environment-owned instance of RemoteException is thrown to indicate that a communication-related exception has occurred during the execution of a remote method call.

7.7 New JC 2.2.1 Features

The version 2.2.1 of the Java Card specification provides to developers and smart cards issuers the same benefits that the Java Card 2.1.1 specification brought with these following improvements:

- **Improved memory management** - Enables issuers to optimize use of memory space on a smart card. For example, mechanisms of Applet, Package and Object Deletion have been updated.
- **Logical Channels support -** Provides multiple concurrent access to more sophisticate and interoperable services.
- **Easier design and development of applications** - Java Card Remote Method Invocation allows developers to design applications more easily by enabling the use of Java technology for both the card and terminal.
- **State of the art cryptographic engines** - Provides more security options by supporting additional cryptographic algorithms AES and Elliptic Curve.

7.7.1 Logical Channels

Logical channels allow to a terminal to open up to four channels into the smart card (Java Card 2.2.1 platforms). This mechanism creates the ability to have different session on different logical channel (see ISO7816-4 for logical channels functionality).
Only one logical channel, logical channel 0 (the basic logical channel), is active on card reset. A MANAGE CHANNEL APDU command may be issued on this logical channel to instruct the card to open a new logical channel.
Legacy applets (written for version 2.1 of the Java Card platform), running on version 2.2.1, still work correctly, they do not need to take care about logical channel support.
Since Java Card 2.2, the `javacard.framework.MultiSelectable` interface is implemented. Multiselectable applets can be selected on multiple logical channels at the same time. They can also accept other applets belonging to the same package being selected simultaneously.
Multiselectable applets shall implement the `MultiSelectable` interface. In case of multiselection, the Java Card RE will inform the applet instance by invoking methods `MultiSelectable.select()` and `MultiSelectable.deselect()` during selection and deselection respectively.
The Java Card RE guarantees that an applet, not implementing the `Multiselectable` Interface, is not selected more than once or concurrently with another applet from the same package.
A new method (“`isAppletActive(AID)`”)indicates whether a specified applet is active on a logical channel.
SIMAlliance members guarantee that it is possible to configure 4 logical channels (depending on the card configuration).

> **Developer Tips**
>
> Transient objects, CLEAR_ON_DESELECT type, can be shared between two applets from the same packages even though they are selected on two different channels.

7.7.2 Applet and Package deletion

To prevent deletion of applications whose functionalities are referenced by other applications, new rules concerning applets and packages deletion are defined:

An applet can NOT be deleted by the JCRE if:

- an object of this applet is referenced in an other applet,
- an object of this applet is referenced in the static field of any package.

In any of the previous cases, deletions are aborted.

In order to prevent inter-blocking problems, it is also possible to delete a package and all the applets inside.(Group Deletion).

When a deletion is requested, the Applet Deletion Manager informs each applets which are being deleted by invoking, if implemented, the applet’s `uninstall`() (`javacard.framework.AppletEvent.uninstall`()) method; deletion checks are performed after the `uninstall`() method invocation.
When multiple applets are being deleted, the order of invocation of the `uninstall`() methods is unspecified.
After an applet deletion, it will not be possible to select any of the deleted applets, and no object owned by the deleted applets can be accessed by any other applet (present or future applets).
Resources used by the applet instances are recovered for re-use. Also, the AID of the deleted applet instances may be re-assigned to new applets instances.

> **Developer tip:**
>
> The `uninstall()` method can be used to un-reference objects in static fields, to be sure that that the applet can be deleted.

7.7.3 Java Card Remote Method Invocation (JCRMI)

General description

JCRMI can be viewed as a second model of communication. It relies on a subset of the J2SE RMI distributed object model.

In one hand, a server application creates and makes accessible remote objects. In another hand, a client application will request to obtain a reference (16-bit unsigned number which identifies a unique remote object on the card). If the request is accepted by the server, depending on its rules, the client will be able to invoke remote methods on those remote objects.

In this model, the Java Card applet is the server and the host application (in the terminal) is the client.

The client application handles communication among the user, the Java Card applet, and the provider's back-end application. The host program accesses the services provided by the sever applet. It resides on a terminal or card acceptance device such as a mobile phone.

JCRMI is provided in the extension package `javacardx.rmi` by the class `RMIService`. JCRMI messages are encapsulated within the APDU object passed to the `RMIService` methods. In other words, JCRMI provides a distributed-object model mechanism *on top of the APDU-based messaging model*, by which the server and the client communicate, passing method information, arguments, and return values back.

Compared to an applet "using APDU", the Java Card applet does not have to analyze the APDU buffer. In the JCRMI model, APDUs are formatted by the RMI services that directly invoke the addressed methods of the server applet by using Global Array for this buffer. A unique ID (stub) is assigned to the "remote methods", during the compilation.

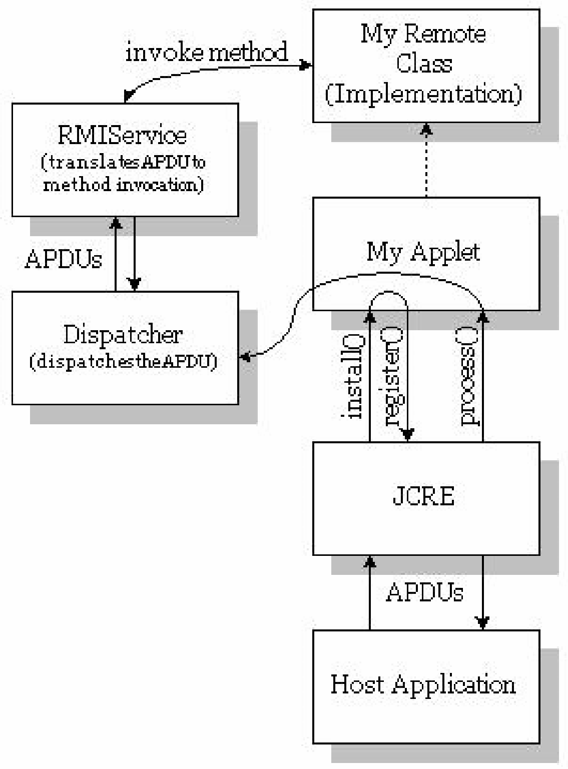

invoke method
My Remote Class (Implementation)
RMIService (translates APDU to method invocation)
APDUs
My Applet
Dispatcher (dispatches the APDU)
install()
register()
process()
JCRE
APDUs
Host Application

Figure 4 – RMI communications

Remote Objects

A remote object is described by one or more remote interfaces. A remote interface is defined as an interface that extends the interface `java.rmi.Remote`. The methods of a remote interface are referred to as remote methods. Moreover, it is needed to include, in the declaration of the remote method, the `java.rmi.RemoteException` in its "throws" clause.

Description of the mechanism

The JC RMI communication is based on two commands.

Applet Selection:

First, it is needed to get the initial object reference from the server applet through the SELECT FILE command (see ISO 7816-4). The answer to this command is a constructed TLV that include:

- The INS byte which is going to be used for the next commands (invocation).
- The remote object identifier and information to identify the associated class.

> **Developer tip:**
> The command needs to have the following options:
> - Direct Selection by DF name, also used to select an applet by its AID
> - Return File Control Information (FCI): this option is used to retrieve FCI information from the applet.

Method Invocation:

Concerning the second step, it consists to invoke a remote method. For example, the client application (CAD application) wants to retrieve some information. It is needed to provide some parameters:

- The INS byte: it has been sent by the server in the "Select Answer".
- The remote object identifier: it is the reference on the remote object that has been sent, by the smart card, during the applet selection.
- The invoked method identifier: it permits to retrieve which remote methods is to be execute.
- The parameters' values of the remote method: it is needed to indicate the length of the argument followed by its value (seems to be in the same order).

The server answers by returning the retrieved information (value, arrays …). The return values are always followed by a good completion status code "0x9000". In case an error occurs, the remote method throws an exception.

Allocation of incoming objects

As a consequence that in the INVOKE command it is possible to transmit arrays, array objects need to be allocated in the server part (smart card part). Global arrays must be used for this particular type of parameter. These arrays are temporary objects and they cannot be stored in any object and they can be accessed from all contexts as they are owned by the JCRE.

Functional limitation

- Parameters of a remote method must be any supported data types or any single dimension array of supported data types.
- Returned values of a remote method must only be one of the following type:
    - Any supported data type or any single dimension array of supported data type (transmitted by value)
    - A void return
    - Any remote interface (transmitted by reference using a remote object reference descriptor)
- CAD remote objects can not be passed as arguments to remote methods
- Applets can not invoke remote methods on the CAD client
- Method argument data and returned values must not be higher than the size constraint of an APDU.

Realization of the client stub

This is a mandatory step. When the server part has been developed, it is needed to assign a unique identifier to each remote class present in the applet. This is done by the "rmic" tool provided in the Development Kit. The command is the based on the following example:

"rmic -v1.2 -classpath path -d output_dir class_name"

where:

- -v1.2 is a flag required by the Java Card RMI client framework.
- -classpath path identifies the path to the remote class.
- output_dir is the directory in which to place the resulting stubs.
- class_name is the name of the remote class.

The JCRMI Client API is defined in the following packages:

- com.sun.javacard.javax.smartcard.rmiclient contains the core JCRMI Client API. It defines:
  - The CardAccessor interface that JCRMI stubs use to access the smart card.
  - The CardObjectFactory class that is the base class for JCRMI-stub generation implementations. An instance of this class is associated with one Java Card applet selection session.
  - The JavaCardRMIConnect class that is used by the client application to initialize a JCRMI session, and obtain an initial remote reference.
  - A number of Java Card exception subclasses, such as APDUExceptionSubclass, CardExceptionSubclass, CardRuntimeExceptionSubclass, CryptoExceptionSubclass, ISOExceptionSubclass, PINExceptionSubclass, PINException, ServiceExceptionSubclass, SystemExceptionSubclass, TransactionExceptionSubclass, and UserExceptionSubclass.
- javacard.framework defines a number of Java Card exceptions that can be re-thrown on the client: APDUException, CardException, CardRuntimeException, ISOException, PINException, SystemException, TransactionException, and UserException.
- javacard.framework.service defines the ServiceException, which represents an exception related to the service framework.

7.8 Managing Memory and Objects

On a Java Card device, memory is the most valuable resource. A garbage collector is present on Rel6 cards. When an object is created, the object and its contents are preserved in non-volatile memory, making it available across sessions. In some cases application data doesn't need to be persistent - it is transient.

> **Developer Tip:**
> For frequently updated data it is recommended to use transient. It is possible to check the available memory through the method: JCSystem.getAvailableMemory(). Remember that transient memory is a limited resource.

As defined previously, two kinds of objects are present for smart cards:

Persistent objects:

All objects registered or referenced from a static field become persistent. They are saved in a non-volatile memory area, such as EEPROM. They are not deleted after a power down or reset, and can be accessed, provided that they have a valid reference.

Transient objects:

The Java Card technology does not support the *transient* keyword. Instead the Java Card API (javacard.framework.JCSystem) defines four methods that allow you to create transient data at runtime, and a fifth that lets you check whether an object is transient:

- static byte[] makeTransientByteArray(short length, byte event),

- `static byte[] makeTransientBooleanArray(short length, byte event)`,
- `static Object makeTransientObjectArray(short length, byte event)`,
- `static short[] makeTransientShortArray(short length, byte event)`,
- `static byte isTransient(java.lang.Object theObj).`

A transient array of primitive data types or `Object`'s references can be created. A transient array exists as long as references to it remain.
The contents of a transient array get reset to the field's default value (`zero`, `false`, or `null`) when an event such as a card reset or applet deselection occurs depending on the transient type (`CLEAR_ON_RESET` and `CLEAR_ON_DESELECT`).

> **Developer Tips**
> For toolkit applets, the use of COD is prohibited.
>
> In a Java Card environment, arrays and primitive types should be declared at object declaration, and you should minimize object instantiation in favor of object reuse. Instantiate objects only once during the applet lifetime. It is recommended to allocate memory in the `install`() method as it is invoked only once and the applet is ensured that all the reserved memory is available for all the applet lifetime.
> In order to avoid resource wasting, a global array has been defined as a buffer that can be used by any applet (see *uicc.system*).

7.8.1 Garbage collector:

The garbage collector is a mechanism that retrieves every unreferenced object on the card and removes them. In Java Card, this service is triggered by the invocation of a method `JCSystem.requestObjectDeletion().`

7.9 Java Card Technology Compatibility Kit

The Java Card Technology Compatibility Kit (JC TCK) is a test suite provided by Sun. It has been created to prove that a card is compliant with the current release of Java Card 2.2.1. Tests are grouped in three main packages: the API(s), the JCRE and the JCVM. They guarantee that cards had passed the most current tests. The actual release for those tests is 2.2.1.
For example, those tests concern cast of variables, exceptions (arithmetic, out-of-bounds…), APDU, PIN, Transactions, the crypto verification (not mandatory)…

7.10 Overview of Versions needed for basic interoperability

• JCVM Specification	2.2.1
• JCRE Specification	2.2.1
• JC API Specification	2.2.1
• Sun Cap File Converter	1.3 (CJDK 2.2.1)
• Sun CJDK	2.2.1
• Sun JDK	1.4.1

8 Card Application Toolkit (CAT) - USIM Application Toolkit (USAT)

8.1 Scope

This chapter describes the Card Application Toolkit (CAT) defined in the ETSI TS 102 223 and the USIM Application Toolkit (USAT) defined in the 3GPP TS 31.111.

The Card Application Toolkit (CAT) is a set of generic commands and procedures which allow applications, existing in the UICC, to interact and operate with the Mobile Equipment (ME).

The USIM Application Toolkit (USAT) procedures described in the 3GPP TS 31.111 are available when the current Network Access Application (NAA) is the USIM.

8.2 CAT commands

The CAT procedures are based on the following commands defined in the ETSI TS 102 221.

- TERMINAL_PROFILE
  This command is used by the terminal to transmit its CAT capabilities to the applications present on the UICC, let say the USIM in our case.
- ENVELOPE
  This command is used to transfer CAT information from the terminal to the USIM.
- FETCH
  The terminal uses this command to retrieve a proactive command from the UICC (e.g. from the CAT Runtime Environment or from a CAT application).
- TERMINAL_RESPONSE
  This command is used by the terminal or UE to send the response for a previously fetched proactive command (e.g. a CAT command).

The card uses the status word '91xx' to indicate that a proactive command is pending. The terminal uses the command FETCH to get the pending proactive command. The terminal sends the response of the proactive command execution with the command TERMINAL RESPONSE. If the card has no other pending proactive command, it sends the status word '9000' after the TERMINAL RESPONSE to close the proactive session.

The details of the structure and the coding in the data part of the commands TERMINAL_PROFILE, ENVELOPE and TERMINAL_RESPONSE are defined in the ETSI TS 102 223. The proactive commands are also defined in the ETSI TS 102 223. The extension relative to the USIM available when current Network Access Application (NAA) is the USIM are defined in the 3GPP TS 31.111.

8.3 What is a CAT session?

A CAT session starts with the TERMINAL PPROFILE and ends with the reset or deactivation of the card.

At the beginning of a CAT session, the card performs the following actions:

- It triggers any applet registered to the TERMINAL PROFILE event
- It sends a SET UP MENU system proactive command, if at least one menu entry is registered and enabled by a selectable Toolkit Applet. Thus, the card supplies a list of items to be incorporated into the UE's menu structure
- It sends a SET UP EVENT LIST system proactive command, if at least one of the EVENT_EVENT_DOWNLOAD_* events is registered by a selectable Toolkit Applet. Thus the card supplies a list of events which it wants the UE to provide details of when these events happen

- It sends a POLL INTERVAL system proactive command, if at least one Toolkit Applet has requested poll interval duration. The card requests with this command the terminal to adjust the time between the STATUS commands sent to the card by the terminal during idle mode.

This is done by the CAT Runtime Environment using the system proactive commands SET UP MENU, SET UP EVENT LIST and POLL INTERVAL. The list depends on the requirements of the toolkit applets installed on the card.

During a CAT session the card shall inform the ME and send the system proactive commands SET UP MENU, SET UP EVENT LIST, POLL INTERVAL and POLLING OFF when a change occurs (e.g. change in the menu list, change of the menu title - an update of the content of EF_{SUME}, change in the event list, change in the polling interval).

8.4 What is a proactive session?

A proactive session enables the card to access resources of the UE by sending commands. A proactive session allows toolkit applications in the card to interact and operate with any UE supporting this feature. For this purpose, a toolkit application shall use the (U)SIM or UICC API.

A proactive session is a sequence of related CAT commands and responses which starts with the status response '91xx' (proactive command pending) and ends with a status response of '90 00' (normal ending of command) after Terminal Response.

9 (U)SIM and UICC API description

9.1 Scope

This chapter describes the UICC Application Programming Interface and the (U)SIM Application Programming Interface available on a (U)SIM card. It also describes the corresponding Runtime Environment.

The UICC API and the CAT Runtime Environment extends the "Java Card™ 2.2.1 API" and the "Java Card™ 2.2.1 Runtime Environment" (JCRE) to allow an application to get access to the functions and data available on a UICC platform as described in ETSI TS 102 221 and ETSI TS 102 223. By this way an application can access the UICC shared file system and the ADF file system or interact with the user equipment by using the toolkit features.

The (U)SIM API and its USAT Runtime Environment is an extension of the UICC API and of the CAT Runtime Environment to manage the characteristics of the USAT defined in the 3GPP TS 31.111 or to manage the characteristics of the USIM defined in the 3GPP TS 31.102.

The UICC API is composed of 4 packages: `uicc.system`, `uicc.toolkit`, `uicc.access` and `uicc.access.fileadministration`.
The (U)SIM API is composed of 2 packages: `uicc.usim.toolkit` and `uicc.usim.access`.
The (U)SIM toolkit API consists of the `uicc.usim.toolkit` package for toolkit features enabling 3GPP TS 31.111 and 3GPP TS 51.014 features.

A (U)SIM Application Toolkit is a Toolkit Applet registered in (U)SIM Toolkit Runtime Environment.

Network Access Application specific events are available for this type of Toolkit Applet. Corresponding constants are described in `uicc.usim.toolkit.ToolkitConstants` interface.

The USAT Toolkit Applet is able to communicate with the terminal by using the `Proactive-`, `ProactiveResponse-`, `Envelope-` and `EnvelopeResponseHandler` located in the `uicc.toolkit` package as the SIM Toolkit Applets. But there are additional features a USAT Toolkit Applet can handle compared to a SIM Toolkit Applet.

9.2 Toolkit API and CAT Runtime Environment

9.2.1 The CAT Runtime Environment

The CAT Runtime Environment is an addition to the Java Card Runtime Environment (JCRE) in order to manage the toolkit applets.
It is composed of the **Toolkit Registry**, the **Toolkit Handlers** and the **Triggering Entity**.

The Toolkit Registry handles all the registration status of the toolkit applets.
The Toolkit Handlers handle the communication between terminal and the Toolkit Applet.
The Triggering Entity handles the Toolkit Applet triggering upon reception of some APDU commands sent by the terminal.

9.2.2 Toolkit applet

9.2.2.1 What is a toolkit applet?

A toolkit applet is a Java Card applet with the following additional capabilities:

- It provides an additional entry point: the `processToolkit()` method

- It may register to some toolkit events such as the menu selection or the reception of a SMS. When such an event occurs the CAT Runtime Environment triggers the applet through its `processToolkit()` method.
- When triggered, it may request the CAT Runtime Environment to send a proactive command and analyze the mobile response.

In fact a toolkit applet derives from `javacard.framework.Applet` and provides the same entry points. But it also provides an object implementing the `uicc.toolkit.ToolkitInterface` interface. This object shall implement the method `processToolkit()`. This method is called by the Triggering Entity of the CAT Runtime Environment to process the current event if the applet is register on this event.
This object might be the applet itself or another object owned by the applet.

9.2.2.2Toolkit applet installation and registration

The loading and the installation of a toolkit applet as well as its life cycle complies with the ETSI TS 102 226 and does not differ from a java card applet with the exception that

- the installation command shall include toolkit parameters as specified in the ETSI TS 102 226 (“UICC Toolkit Application specific parameters” field) to initialize the toolkit registry of this applet
- the applet shall first register to the JCRE as defined in the "Java Card™ 2.2.1 Runtime Environment (JCRE) Specification" by calling one of the `Applet.register()` methods. Then it shall register to the CAT Runtime Environment by calling the `ToolkitRegistrySystem.getEntry()` method and it gets a reference to its registry entry (object implementing the `ToolkitRegistry` interface).

Developer tips
The `ToolkitRegistrySystem`.getEntry() method has to be invoked after the invocation of the `Applet.register`() method. Usually the invocation of the installation method includes the invocation of the `register`() method, the invocation of the `ToolkitRegistrySystem.getEntry`() method and then the toolkit registry configuration (menu creation and configuration, event registration).

The applet installation is considered successful when the call to `register()` completes without any exception.
The installation is considered unsuccessful if an exception is thrown prior to the call to a `register()` method, or if the call to the `register()` method results in an exception. If the installation is unsuccessful, the Java Card Runtime Environment performs all the necessary clean up to reclaim all the allocated resources. So it is recommended to allocate all the resources such as objects and arrays allocation before calling the `register()` method. But the toolkit registry entry has to be retrieved after the `register()` method so the toolkit resources are reclaimed only when the applet is explicitly deleted using a DELETE command.

Once installed and registered to the Toolkit Registry, the toolkit applet can register to the different toolkit events and manage its menu entries if any. The Toolkit Registry updates are available during all the applet life time and are not affected by the current applet life cycle state (`selectable` or not). All the methods relative to the Toolkit Registry updates are available in the `ToolkitRegistry` interface.

(U)SAT applet template

```
package example;

import uicc.toolkit.* ;
import uicc.access.* ;
import javacard.framework.*;

/**
 * 102 241 Toolkit Applet Example
 */
public class AppletExample extends javacard.framework.Applet implements ToolkitInterface, ToolkitConstants {

    /**
     * Toolkit Registry object.
     */
    public ToolkitRegistry toolkitRegistry ;
    private byte[] menuEntry = {(byte)'1',(byte)'0',(byte)'2',(byte)' ',(byte)'2',(byte)'4',(byte)'1',(byte)'
',(byte)'A',(byte)'p',(byte)'p',(byte)'l',(byte)'e',(byte)'t'};

    private byte itemId;

    /**
     * Applet constructor
     */
    public AppletExample () {
        // Register to the JCRE
        register() ;

        // Retrieve the Toolkit Registry object
        toolkitRegistry = ToolkitRegistrySystem.getEntry();

        // Create a menu
        itemId = toolkitRegistry.initMenuEntry(menuEntry, (short)0, (short)menuEntry.length, (byte)0, false,
(byte)0, (short)0) ;
    }

    /**
     * Method called by the JCRE at the installation of the applet
     */
    public static void install(byte bArray[], short bOffset, byte bLength) {
        AppletExample thisApplet = new AppletExample();
    }

    public Shareable getShareableInterfaceObject(AID aid, byte p) {
        if (aid == null && p == (byte)1) {
            return this ;
        }
        return null ;
    }



    /**
     * Called by the JCRE to process an incoming APDU command. An applet is
     * expected to perform the action requested and return response data if
     * any to the terminal.<p>
     */
    public  void process(APDU apdu) throws ISOException
    {
    }


    /**
     * Method called by the CAT Runtime Environment.
     */

     public void processToolkit (short event) {
                // process Toolkit events
                switch (event)
                {
                            ...
                }
    }
}
```

9.2.2.3 Toolkit applet triggering

When receiving an incoming APDU a Translator converts it into the corresponding Event. The Triggering Entity asks the Toolkit Registry which toolkit applets are registered to this Event and then triggers all registered Toolkit applets by calling the `processToolkit()` method of the `ToolkitInterface` Object. A toolkit applet is only triggered if it is in the selectable state.

The difference between a Java Card applet and a toolkit applet is that the toolkit applet does not handle APDUs directly, the `select()` method is also not launched since the toolkit applet itself is not selected.

> **Developer tip**
>
> As a consequence a toolkit applet can not use the Transient CLEAR_ON_DESELECT objects defined in Java Card™ 2.2.1 Runtime Environment (JCRE) Specification".

In fact, the CAT Runtime Environment uses the shareable interface feature specified in "Java Card™ 2.2.1 Runtime Environment (JCRE) Specification" as the `processToolkit()` method is a method of the `ToolkitInterface` shareable interface object provided by the toolkit applet:

- The CAT Runtime Environment invokes the `getShareableInterfaceObject()` method of the toolkit applet to retrieve the reference of its `ToolkitInterface` object. This method is invoked before the first triggering of the toolkit applet. The AID parameter of the `getShareableInterfaceObject()` method is set to null. The byte parameter of the `getShareableInterfaceObject()` method is set to one (i.e. "01").
- The CAT Runtime Environment invokes the `processToolkit()` method of the `ToolkitInterface` object to trigger the toolkit applet. As a consequence all the rules defined in the "Java Card™ 2.2.1 Runtime Environment (JCRE) Specification" apply: the JCRE performs a context switch, etc.

> **Example:**
>
> ```
> /**
>  * Process toolkit events.
>  */
> public void processToolkit(short event) throws ToolkitException
> {
>       if (event == EVENT_MENU_SELECTION)
>       {
>         // put the applet behavior on menu selection
>         }
> }
> ```

When triggered, a toolkit applet can get details about the event by using the EnvelopeHandler if available. It can request the CAT Runtime Environment to send several proactive commands using the ProactiveHandler if available and then analyze the response of the UE (TERMINAL RESPONSE) by using the ProactiveResponse Handler.
For some specific events the EnvelopeResponseHandler is also available to transmit the response of the applet to the command sent by the terminal (e.g. Envelope).
The handler availability for the different events is defined in the ETSI TS 102 241 and the 3GPP TS 31.130 specification.

9.2.2.4 Multi-triggering

Depending on the event there might be more than one applet registered. The CAT Runtime Environment triggers the different toolkit applets consecutively according to their priority level assigned at the installation time (see the priority level parameter in the "UICC Toolkit application specific parameters" field of the install (for install) command). If several toolkit applets have the same priority level, the applets are triggered according to their installation time (i.e. the last installed if triggered first).

9.2.2.5 Re-entrance

Re-entrance refers to the case whereby a proactive session (initiated by an APPLICATION A) execution is interrupted, and a second APPLICATION B (which can be the same one) is triggered. The application A is then in a suspended mode, and the nested APPLICATION B (in other words, the application triggered while another application is suspended) has its own file and access conditions context.
After APPLICATION B has been finished, and no additional event occurs before the terminal response is received, control is returned to the first application, so that its own execution can be finished.

Interoperable re-entrancy is supported at least for the following events:

- EVENT_CALL_CONTROL
- EVENT_SMS_MO_CONTROL
- EVENT_STATUS_COMMAND
- EVENT_PROFILE_DOWNLOAD.

Even if only four re-entrant events are supported by all SIM Alliance members' cards, all members guarantee that no data is lost from a card point of view.

All SIM Alliance members agree that the re-entrance list is highly configurable depending on customers need.

System handler availability:
SIM Alliance member guaranty at least than one system handler is available.
We strongly recommend applet developer to verify the handler availability with exception mechanism.
As a consequence, the `ProactiveHandler` may be not available for applets triggered in re-entrance; to overcome this issue, i.e. to perform proactive commands, the re-entrance applet may register itself to the `EVENT_PROACTIVE_HANDLER_AVAILABLE` in order to be triggered again when the proactive handler is available.
The applet shall save the content of the EnvelopeHandler if needed as it will not be available when triggered on the `EVENT_PROACTIVE_HANDLER_AVAILABLE`.

9.2.2.6 Exception handling

All exceptions thrown by the application are caught by the CAT Runtime Environment. The exceptions are not propagated to the terminal except if the applet is the only one triggered by the current processed event and the exception is an `ISOException` with the reason code REPLY_BUSY (0x9300).

But the ETSI TS 102 241 recommends to use an `ISOException` with reason code 0x9300 only for events where reply busy is allowed as defined in the ETSI TS 102 241 and 3GPP TS 31.130.

9.3 Terminal Profile

Upon reception of a TERMINAL PROFILE APDU command, the CAT Runtime Environment stores the terminal profile. The content of the Terminal Profile is defined in the ETSI TS 102 223 and TS 31.111 specifications.
A toolkit applet can check the mobile facilities using the different methods defined in the `uicc.toolkit.TerminalProfile` class.

9.4 Envelope management

9.4.1 Envelope management

When triggered, a toolkit applet can use the EnvelopeHandler to get details about the event. The EnvelopeHandler is available for all the events except EVENT_STATUS_COMMAND, EVENT_PROFILE_DOWNLOAD, EVENT_PROACTIVE_HANDLER_AVAILABLE and EVENT_FIRST_COMMAND_AFTER_ATR.
The EnvelopeHandler contains the list of the simple TLV data objects as sent by the terminal in the ENVELOPE APDU command or is set by the CAT Runtime Environment itself if the event is not generated by an ENVELOPE command (for example, for the EVENT_EXTERNAL_FILE_UPDATE or EVENT_FORMATTED_SMS_PP_UPD events) .
The detail on the different TLV data objects is given in the chapters relative to the ENVELOPE commands and COMPREHENSION_TLV data objects of the ETSI TS 102 223 and the 3GPP TS 31.111 specifications when corresponding

to an ENVELOPE APDU command sent by the terminal. Otherwise the content of the EnvelopeHandler is described in the ETSI TS 102 241 and the 3GPP TS 31.130 specifications in the chapter relative to the event description.
The toolkit applet retrieves the `EnvelopeHandler` by using the `uicc.toolkit. EnvelopeHandlerSystem.getTheHandler()` method.

For toolkit applets using the (U)SIM API, the `USATEnvelopeHandler` is also available. The `USATEnvelopeHandler` is mainly useful when managing the events relative to the SMS_PP and SMS_CB. It provides additional methods to handle the different fields of the SMS message or Cell Broadcast message: methods to get the length, offset and content of the message.
The toolkit applet retrieves the `USATEnvelopeHandler` by using the `uicc.usim.toolkit. USATEnvelopeHandlerSystem.getTheHandler()` method

The `EnvelopeHandler` and the `USATEnvelopeHandler` are two distinct object instances but their content (TLV data objects) is exactly the same. The `USATEnvelopeHandler` availability is the same as the `EnvelopeHandler` including all the events defined in the TS 102 241 specification. For example the Toolkit Applet can use the `USATEnvelopeHandler` also for the event EVENT_EXTERNAL_FILE_UPDATE.

The toolkit applet can post a response to some specific ENVELOPE commands by using the `EnvelopeResponse` Handler. The `EnvelopeResponseHandler` is available only for the following events: EVENT_FORMATTED_SMS_PP_ENV, EVENT_UNFORMATTED_SMS_PP_ENV, EVENT_CALL_CONTROL_BY_NAA, EVENT_MO_SHORT_MESSAGE_CONTROL_BY_NAA and EVENT_UNRECOGNIZED_ENVELOPE.
The toolkit applet retrieves the `EnvelopeResponseHandler` by using the `EnvelopeResponseHandlerSystem.getTheHandler()` method. If the handler is not available, a ToolkitException with the reason code HANDLER_NOT_AVAILABLE is thrown.
The toolkit applet fills the `EnvelopeResponseHandler` and then posts the response by using the `EnvelopeResponseHandler.post()` or the `EnvelopeResponseHandler.postAsBERTLV()` method. The applet can continue its processing after the call to one of these methods.

9.4.2 EnvelopeResponseHandler management for the EVENT_FORMATTED_SMS_PP_ENV event

The Toolkit applet fills the `EnvelopeResponseHandler` by using the methods inherited from the `EditHandler`.
Then, the applet posts the response using the `EnvelopeResponseHandler.post(value)` method, *value* is a Boolean. When the PoR is sent using the SMS_DELIVER_REPORT mechanism, the *value* is used to indicate if the PoR is sent in a RP-ACK message (*value* set to true) or if the PoR is sent using a RP-ERROR (*value* set to false).
When the PoR is sent using the SMS_SUBMIT mechanism, the *value* is not used.
The content of the `EnvelopeResponseHandler` is used to set the applet response to the OTA request. It is inserted by the CAT Runtime Environment in the Additional Response Data of the PoR according to the TS 31.115. This content will be transmitted back to the OTA server.

9.4.3 EnvelopeResponseHandler management for the events EVENT_CALL_CONTROL_BY_NAA or EVENT_MO_SHORT_MESSAGE_ CONTROL_BY_NAA_SMS_PP_ENV

The Toolkit Applet uses the EnvelopeResponseHandler to set the response to the ENVELOPE (CALL CONTROL) APDU command or to the ENVELOPE (MO_SHORT_MESSAGE_CONTROL) APDU command.
The Toolkit Applet may fill the EnvelopeResponseHandler by using the method inherited from the *EditHandler* to define the content of the different data object (Address, etc). See the structure of the ENVELOPE response defined in the 3GPP TS 31.111.
Then, the applet posts the response by using the `EnvelopeResponseHandler.postAsBERTLV(value, tag)` method. The *value* is ignored by the CAT Runtime Environment. The *tag* shall be set according to the applet response "00" for "Allowed, no modification", "01" for "Not allowed" and "03" for "Allowed with modifications". The CAT Runtime Environment uses the *tag* as the Call control result or the MO short message control result of the response.

Developer tip

The CAT Runtime Environment sends the response to the ENVELOPE before the emission of the next proactive command or when all the Toolkit Applets triggered by the event have finished their processing. If the applet want to send a specific response, it shall post it before any invocation of the `ProactiveHandler.send()` method.

9.4.4 Details

The `EnvelopeHandler`, `EnvelopeResponseHandler` and `USATEnvelopeHandler` are Temporary JCRE Entry Point Objects.

When the corresponding `getTheHandler()` method is called or a method of the handler is called, a system handler is considered available if a `ToolkitException` with the reason code HANDLER_NOT_AVAILABLE is not thrown

EnvelopeHandler and USATEnvelopeHandler:

- When available, the `EnvelopeHandler` remains available and its content remains unchanged from the invocation to the termination of the `processToolkit()` method.
- The `EnvelopeHandler` and `USATEnvelopeHandler` TLV lists are filled with the simple TLV data objects of the ENVELOPE APDU command. The simple TLV data objects are provided in the order given in the ENVELOPE command data if they result of a ENVELOPE command sent by the ME otherwise the order is undefined (for exemple when built by the CAT Runtime Environment for the EVENT_EXTERNAL_FILE_UPDATE.

Developer tip
The order of the different TLV data objects is not specified so it is recommended to use the `ViewHandler.findTLV()` methods to get each COMPREHENSION TLV.

EnvelopeResponseHandler:

- The `EnvelopeResponseHandler` is available (as specified in the ETSI TS 102 241 or the 3GPP TS 31.130 specifications) for all triggered Toolkit Applets, until a Toolkit Applet has posted an envelope response or sent a proactive command.
- After a call to the `post()` method the handler is no longer available.
- After the first invocation of the `ProactiveHandler.send()` method the `EnvelopeResponseHandler` is no more available.
- At the `processToolkit()` method invocation the TLV-List is cleared.

9.5 Event management

9.5.1 Overview

A toolkit applet can register or un-register to the different toolkit events and manage its menu entries using the different methods defined in the `ToolkitRegistry` interface. The applet gets the reference to its registry entry by using the `ToolkitRegistrySystem.getEntry()` method.

All the toolkit registry updates are available during all the applet life time and are not affected by the current applet life cycle state. In particular, a toolkit applet is still considered as registered to an event if it is not in the `selectable` life cycle state. But as long as the applet is not in the `selectable` state, it will not be triggered by the CAT Runtime Environment if the event occurs.

The main methods to manage the registration for the events are the `ToolkitRegistry.setEvent()` and `ToolkitRegistry.clearEvent()` methods with the indication of the event the applet wants to register or un-register to.

The CAT Runtime Environment prevents the applet to explicitly register to some specific events relative to the menu management, the timer management, the polling interval, the service management and the file updates management. In this case, the `ToolkitRegistry.setEvent()` method throws the exception EVENT_NOT_ALLOWED. The registration to these events is done by the CAT environment implicitly by particular methods:

- The registration to the EVENT_MENU_SELECTION and EVENT_MENU_SELECTION_HELP_REQUEST is done when the menu entry has been initialized using the `ToolkitRegistry.initMenuEntry`() method.
- The registration to the EVENT_TIMER_EXPIRATION is done using the `ToolkitRegistry.allocateTimer()` method.
- The registration to the EVENT_STATUS_COMMAND is done using the `ToolkitRegistry.requestPollInterval(short)` method with the indication of requested duration.
- The registration to the EVENT_EVENT_DOWNLOAD_LOCAL_CONNECTION is done using the `ToolkitRegistry.allocateServiceIdentifer()` method.
- The registration to the EVENT_EXTERNAL_FILE_UPDATE is done using one of the `ToolkitRegistry.registerFileEvent` methods with the indication of the file or the file list that shall be monitored.

The CAT Runtime Environment allows only one toolkit applet to be registered to some limited events such as the `EVENT_CALL_CONTROL_BY_NAA` or the `EVENT_MO_SHORT_MESSAGE_CONTROL_BY_NAA`. The `ToolkitRegistry.setEvent()` method throws the `ToolkitException` with the reason code EVENT_ALREADY_REGISTERED if an applet is already registered to an limited event another applet wants to register to.

The CAT Runtime Environment can reject also an event registration, for example if the event registration requests a TAR and the applet has not at least one TAR value assigned.

The `ToolkitRegistry.setEvent()` method does not throw any exception if the applet registers more than once on the same event.

The `ToolkitRegistry.setEventList()` method is also available to register to several events.

> **Developer tip**
> This method is atomic: if the registration to one of the event is rejected, then the applet is not registered to any of the events.

9.5.2 List of the available Events

Event name	**Reserved short value**	**Comment**
EVENT _PROFILE_DOWNLOAD	*1*	Get the mobile capabilities
EVENT _STATUS_COMMAND	*19*	Get triggered when a STATUS command is sent by the mobile (CAT polling procedure)
EVENT _UNRECOGNIZED_ENVELOPE	*-1*	Handles the evolution of the events for the future
User related events		
EVENT_MENU_SELECTION	*7*	Handle the toolkit menu selection by the user
EVENT_MENU_SELECTION_HELP_REQUEST	*8*	
OTA related events		
EVENT_FORMATTED_SMS_PP_ENV (1)	*2*	Handle the SMS-PP messages sent by the network
EVENT_FORMATTED_SMS_PP_UPD (1)	*3*	
EVENT_UNFORMATTED_SMS_PP_ENV (1)	*4*	
EVENT_UNFORMATTED_SMS_PP_UPD (1)	*5*	
EVENT_UNFORMATTED_SMS_CB (1)	*6*	Handle the SMS-CB messages sent by the network
EVENT_FORMATTED_SMS_CB (1)	*24*	
Terminal related events		
EVENT_TIMER_EXPIRATION	*11*	Use the timer capabilities of the handset
EVENT_CALL_CONTROL_BY_NAA	*9*	Control the outgoing calls and the outgoing SMs

EVENT_MO_SHORT_MESSAGE_CONTROL_BY_NAA (1)	*10*	
EVENT_EVENT_DOWNLOAD_		
_MT_CALL	*12*	Track changes of the current call states
_CALL_CONNECTED	*13*	
_CALL_DISCONNECTED	*14*	
_LOCATION_STATUS	*15*	Track changes of the location status or location information
_USER_ACTIVITY	*16*	Track the user activity
_IDLE_SCREEN_AVAILABLE	*17*	Get triggered when the mobile screen becomes available.
_CARD_READER_STATUS	*18*	Used when multiple cards are available on the handset
_LANGUAGE_SELECTION	*20*	Track changes of the currently used language
_BROWSER_TERMINATION	*21*	Track the handset browser termination
_DATA_AVAILABLE (2)	*22*	Handle the BIP protocol
_CHANNEL_STATUS (2)	*23*	
_ACCESS_TECHNOLOGY_CHANGE	*25*	Track changes in the access technology (GSM, UTRAN, etc)
_DISPLAY_PARAMETER_CHANGED	*26*	Track changes of the display parameters (number of characters, text wrapping, etc)
_LOCAL_CONNECTION (3)	*27*	Track the incoming connection request on a local bearer using a service previously declared by the UICC
_ NETWORK_SEARCH_MODE_CHANGE	*28*	Track changes in the network search mode (manual or automatic)
_BROWSING_STATUS	*29*	Track the error code sent by the network and received by the browser
UICC related events		
EVENT_PROACTIVE_HANDLER_AVAILABLE	*123*	Get informed when the proactive handler becomes available
EVENT_EXTERNAL_FILE_UPDATE	*124*	Track the updates done by the handset on the specified files
EVENT_APPLICATION_DESELECT	*126*	Get informed that an application (NAA) is no more selected
EVENT_FIRST_COMMAND_AFTER_ATR	*127*	Get triggered just after the card reset.
(1) This event is defined in the 3GPP TS 31.130 specification (2) This event is linked to the Bearer Independent Protocol (OPEN CHANNEL, CLOSE CHANNEL, SEND DATA, RECEIVE DATA and GET CHANNEL STATUS proactive commands) (3) This event is linked to the DECLARE SERVICE proactive command		

> **Developer tip**
> The range of values [-2; -128] is reserved for proprietary events. A card can manage proprietary events but if an applet uses one of these events, it will not be working properly on another card that may not handle this event. In order to be interoperable, applets should not use these events.

9.5.3 Events Description

The complete description of the CAT Runtime Environment regarding each event is available in the ETSI TS 102 241 and 3GPP TS 31.111 specification.

The following gives additional information when there are interoperability issues or when a clarification is required for the applet developer.

- EVENT_PROFILE_DOWNLOAD

Upon reception of a TERMINAL PROFILE APDU command, the CAT Runtime Environment stores the terminal profile and triggers all the Toolkit Applet(s) registered to this event.
The TERMINAL PROFILE APDU command is sent by the mobile during the UICC initialization procedure and when the CAT functionality is modified in the mobile. The TERMINAL PROFILE indicates which CAT features are supported by the mobile. The CAT Runtime Environment stores the profile sent by the mobile and an applet can check the mobile facilities by using the different methods of the class `uicc.toolkit.TerminalProfile`.

Developer tip

An Applet is only able to send proactive commands if the TERMINAL PROFILE has been received after an ATR

- EVENT_MENU_SELECTION,
- EVENT_MENU_SELECTION_HELP_REQUEST

Upon reception of an ENVELOPE (MENU SELECTION) APDU command the CAT Runtime Environment only triggers the Toolkit Applet registered to the corresponding event with the associated menu identifier. A Toolkit Applet is triggered by the EVENT_MENU_SELECTION_HELP_REQUEST event only if help is supported for the corresponding Menu entry.

A Toolkit Applet registers to these events using the `ToolkitRegistry.initMenuEntry` method. There is no method to un-register to these events but the applet can use the method `ToolkitRegistry.disableMenuEntry` to disable the menu entry. If a menu entry is disabled, it does not appear on the toolkit menu of the terminal and the applet will not be triggered. The method `ToolkitRegistry.enableMenuEntry` enables the menu again.

The maximum number of menu entries available for a toolkit applet is defined during the installation phase in the "UICC toolkit parameters" field of the install(for install) command. The maximum length of a menu string is also defined.
The `ToolkitRegistry.initMenuEntry` method throws an exception if all the menu entries available for the applet are already initialized or if the length of the menu entry string exceeds the length defined during the installation phase.
Once initialized the different properties of a menu entry can be updated using the `ToolkitRegistry.changeMenuEntry` method.

Developer tip
The `ToolkitRegistry.initMenuEntry` method shall be called by the applet in the same order as the order of the item parameters defined at the applet installation if the applet has several menu entries.
It is recommended that an applet initialize its menu entries during its installation.

Example:

```
public class AppletExample extends javacard.framework.Applet implements ToolkitInterface, ToolkitConstants {
    public ToolkitRegistry toolkitRegistry ;
    private byte[] menuEntry1 = {(byte)'M',(byte)'y',(byte)' ',(byte)'M',(byte)'e',(byte)'n',(byte)'u',(byte)' ',(byte)'1'};
    private byte[] menuEntry2 = {(byte)'M',(byte)'y',(byte)' ',(byte)'M',(byte)'e',(byte)'n',(byte)'u',(byte)' ',(byte)'2'};
    private byte menuId1, menuId2;

    /**
     * Applet constructor
     */
    public AppletExample () {
        // Register to the JCRE
        register() ;

        // Retrieve the Toolkit Registry object
        toolkitRegistry = ToolkitRegistrySystem.getEntry();

        // Create the menus
        menuId1 = toolkitRegistry.initMenuEntry(menuEntry1, (short)0, (short)menuEntry1.length, (byte)0, false,
(byte)0, (short)0) ;
        menuId2 = toolkitRegistry.initMenuEntry(menuEntry2, (short)0, (short)menuEntry2.length, (byte)0, false,
(byte)0, (short)0) ;
    }

    ...

    /**
     * Process Toolkit events
     */
    public void processToolkit (short event) {
            if (event == EVENT_MENU_SELECTION)      {
              EnvelopeHandler theEnv = EnvelopeHandlerSystem.getTheHandler() ;
              byte menuId = theEnv.getItemIdentifier() ;
              if (menuId == menuId1) {
                    // Insert Menu1 process
              }
              else if (menuId == menuId2) {
                    // Insert Menu2 process
              }
            }
    }
}
```

- EVENT_TIMER_EXPIRATION

Upon reception of an ENVELOPE (TIMER EXPIRATION) APDU command, the CAT Runtime Environment only triggers the Toolkit Applet registered to this event with the associated timer identifier.

A toolkit applet registers to this event using the method `ToolkitRegistry.allocateTimer`, the CAT Runtime Environment will then allocate a timer resource to the applet. The applet may un-register invoking the `ToolkitRegistry.releaseTimer` method.
Once the applet has allocated a timer, it shall send the proactive command TIMER_MANAGEMENT to start the timer, configure the timer duration or stop the timer.

Developer tip
The method `ToolkitRegistry.allocateTimer` throws an exception if all the available timers are already allocated or if the maximum number of timer available for this applet is reached.
The timer remains allocated to the applet until it explicitly releases it using the method `ToolkitRegistry.releaseTimer`.
The maximum number of timers available on a UICC is 8 timers. The maximum number of timers available for a given toolkit applet is defined in the UICC Toolkit application specific parameter of the install(for install) command see ETSI TS 102 226.

Example:

```
ToolkitRegistry reg;
byte bTimerId;
final byte[] timerValue = {(byte)0x00, (byte)0x01, (byte)0x00};

/* Timer allocation */
reg = ToolkitRegistrySystem.getEntry();
bTimerId= reg.allocateTimer();

/* Send the proactive command to start the timer */
ProactiveHandler proHdlr = ProactiveHandlerSystem.getTheHandler() ;
proHdlr.init(PRO_CMD_TIMER_MANAGEMENT, (byte)0x00, (byte)DEV_ID_TERMINAL);
proHdlr.appendTLV(TAG_TIMER_IDENTIFIER, bTimerId);
proHdlr.appendTLV(TAG_TIMER_VALUE, timerValue, (short)0x00,  (short)timerValue.length);
proHdlr.send();
```

- EVENT_STATUS_COMMAND

Upon reception of an STATUS APDU command the CAT Runtime Environment shall trigger all the Toolkit Applet(s) registered to this event.

The applet registers to this event by calling the method `ToolkitRegistry.requestPollInterval` with the indication of the requested duration negotiated with the mobile for the Proactive Polling procedure (STATUS command regularly sent by the terminal according to the TS 102 221 and TS 102 223 specifications).
The `ToolkitRegistry.requestPollInterval` method can be used each time the applet wants to adjust a new duration. If the duration is set to POLL_NO_DURATION, the applet deregisters from the event EVENT_STATUS_COMMAND.
Several applets can register on this event and can request a different duration so the CAT Runtime Environment may adjust the duration. The terminal can also adjust the duration to the one it can offer.

Developer tip
The ETSI TS 102 223 specification recommends that applets should not request short time intervals for an extended period, as this will have an adverse effect on battery life, and should not use this command for time management purposes.

- EVENT_FORMATTED_SMS_PP_ENV[1]

Upon reception of a formatted Short Message Point to Point via the ENVELOPE(SMS-PP DOWNLOAD) APDU command, the CAT Runtime Environment verifies the security of the Short Message according to the 3GPP TS 31.115 specification and then triggers the applet registered to this event and having the corresponding TAR value.
The toolkit can retrieve the message using the `uicc.usim.toolkit.USATEnvelopeHandler` defined in the 3GPP TS 31.130. The data is provided deciphered.
The toolkit applet can post a response using the `EnvelopeResponseHandler.post` method. The CAT Runtime Environment will insert the data in the additional data field of the Response Packet, compute the security as defined in the 3GPP TS 31.115 and send the response packet using the SMS_DELIVER_REPORT or the SMS_SUBMIT.

When a SMS is received as a concatenated SMS as defined in the 3GPP TS 23.040, the CAT Runtime Environment links the different single SMS to re-assemble the original message and fills the `USATEnvelopeHandler` with the original message (the concatenation headers are not present and the TP_elements and TS_ServiceCenterAddress fields are the ones of the last received SMS).

See the 3GPP TS 31.130 for details.

A toolkit applet registers to this event by using the `ToolkitRegistry.setEvent` method with the event value set to EVENT_FORMATTED_SMS_PP_ENV. This method throws an exception if no TAR value is defined for the applet.

[1] This event is defined in the TS 31 130 specification

The TAR value associated to a toolkit applet is defined during the applet installation phase: the "UICC toolkit parameters" field of the install (for install) command can include a list of TAR values to which the applet wants to subscribe to, otherwise the TAR is taken from the AID.

> **Developer tip**
> The applet is triggered only if the security according to the 3GPP TS 31.115 specification has been successfully verified by the CAT Runtime Environment and if the security level used complies with the minimum security level required by the applet (parameter defined during the applet installation phase).

> **Interoperability issue**
> The CAT Runtime Environment may reply busy and not trigger the toolkit applet if e.g. a PoR using SMS SUBMIT is required in the incoming message and a proactive session is ongoing.

- EVENT_FORMATTED_SMS_PP_UPD[1]

Upon reception of a formatted Short Message Point to Point via an UPDATE_RECORD EF_{SMS}, the CAT Runtime Environment updates the EF_{SMS} file, converts the UPDATE_RECORD EF_{SMS} to emulate an ENVELOPE (SMS-PP DOWNLOAD) and fills the `uicc.usim.toolkit.USATEnvelopeHandler`. Then it verifies the security of the SMS according to the 3GPP TS 31 115 and triggers the applet registered to this event and having the corresponding TAR.
The details of the construction of the `USATEnvelopeHandler` TLV from the elements of the UPDATE_RECORD EF_{SMS} are described in the 3GPP TS 31 130 specification. The toolkit can retrieve the message using the `USATEnvelopeHandler` defined in the 3GPP TS 31.130. The data is provided deciphered.

When a SMS is received as a concatenated SMS as defined in the 3GPP TS 23.040, the CAT Runtime Environment links the different single SMS to re-assemble the original message and fills the `USATEnvelopeHandler` with the original message.

> **Developer tip**
> - The order of the TLVs given in the `USATEnvelopeHandler` is not specified so it is recommended to use the `ViewHandler.findTLV()` methods to get each COMPREHENSION TLV.
> - The `EnvelopeResponseHandler` is not available.
> - The applet is triggered only if the security according to the TS 31.115 specification has been successfully verified by the CAT Runtime Environment.
> - Even if the `EnvelopeHandler` is available for these events and contains the same data, the usage of the `USATEnvelopeHandler` is recommended as it provides methods distinguished to handle SMS functionality.

- EVENT_UNFORMATTED_SMS_PP_ENV[2]

Upon reception of an unformatted Short Message Point to Point (Single or Concatenated) via the ENVELOPE(SMS-PP DOWNLOAD) APDU command, the CAT Runtime Environment triggers all the toolkit applets registered to this event.
The applet can get the message using the `USATEnvelopeHandler`. The toolkit applet can post a response using the `EnvelopeResponseHandler.post` method.

> **Developer tip**
> According to the `EnvelopeResponseHandler` availability rules only the first triggered applet is guaranteed to be able to send back a response.

- EVENT_UNFORMATTED_SMS_PP_UPD[2]

Upon reception of an unformatted Short Message Point to Point (Single or Concatenated) via an UPDATE_RECORD EF_{SMS}, the CAT Runtime Environment updates the EF_{SMS} file, converts the UPDATE_RECORD EF_{SMS} to emulate an ENVELOPE (SMS-PP DOWNLOAD) and fills in the `uicc.usim.toolkit.USATEnvelopeHandler`, and triggers all the toolkit applets registered to this event.

> **Developer tips**
> The order of the TLVs given in the `USATEnvelopeHandler` is not specified so it is recommended to use the `ViewHandler.findTLV` methods to get each COMPREHENSION TLV.
> The `EnvelopeResponseHandler` is not available.
> The content of EF_{SMS} may have been modified by a previously triggered Toolkit Applet.

- EVENT_FORMATTED_SMS_CB[2]

Upon reception of a formatted Cell Broadcast message via the ENVELOPE (CELL BROADCAST DOWNLOAD) APDU command, the CAT Runtime Environment verifies the security of the Short Message according to the 3GPP TS 31.115 and then triggers the applet registered to this event and having the corresponding TAR.
The toolkit can retrieve the message using the `uicc.usim.toolkit.USATEnvelopeHandler` defined in the 3GPP TS 31.130. The data are provided deciphered.

When a Cell Broadcast Message is received as multiple pages as defined in the 3GPP TS 23.041 specification, the CAT Runtime Environment links the different single pages to re-assemble the original message and fills the `USATEnvelopeHandler` with the original message as a one Cell Broadcast page TLV (the concatenation headers are not present and the TP_elements and TS_ServiceCenterAddress fields are the ones of the last received SMS).

- EVENT_UNFORMATTED_SMS_CB[2]

Upon reception of an unformatted Cell Broadcast message via the ENVELOPE (CELL BROADCAST DOWNLOAD) APDU command, the CAT Runtime Environment triggers all the Toolkit Applets registered to this event.

- EVENT_CALL_CONTROL_BY_NAA
- EVENT_MO_SHORT_MESSAGE_CONTROL_BY_NAA[2]

Upon reception of the ENVELOPE (CALL CONTROL) APDU command or the ENVELOPE (MO_SHORT_MESSAGE_ CONTROL) APDU command the CAT Runtime Environment triggers the Toolkit Applet registered to this event.
Regardless of the Toolkit Applet state the CAT Runtime Environment does not allow more than one Toolkit Applet to be registered to this event at a time. In particular, if a Toolkit Applet is registered to this event but not in selectable state the CAT Runtime Environment must not allow another Toolkit Applet to register to this event.
When triggered on this event, this applet can define which response shall be sent to the terminal in response to the ENVELOPE (CALL CONTROL) command in order to allow the call, to reject the call or to allow the call but with modification. This is done by the applet using the `EnvelopeResponseHandler.post()` method or the `EnvelopeResponseHandler.postAsBERTLV()` method.

> **Developer tip**
> The Call Control resource is shared between the (U)SAT API and the (SAT) API. So - If an applet is registered to Call Control with (U)SIM API, an applet using SIM API can not register to Call Control and vice versa.

- EVENT_EVENT_DOWNLOAD_MT_CALL
- EVENT_EVENT_DOWNLOAD_CALL_CONNECTED
- EVENT_EVENT_DOWNLOAD_CALL_DISCONNECTED
- EVENT_EVENT_DOWNLOAD_LOCATION_STATUS
- EVENT_EVENT_DOWNLOAD_USER_ACTIVITY
- EVENT_EVENT_DOWNLOAD_IDLE_SCREEN_AVAILABLE
- EVENT_EVENT_DOWNLOAD_CARD_READER_STATUS
- EVENT_EVENT_DOWNLOAD_LANGUAGE_SELECTION
- EVENT_EVENT_DOWNLOAD_BROWSER_TERMINATION
- EVENT_EVENT_DOWNLOAD_NETWORK_SEARCH
- EVENT_EVENT_DOWNLOAD_BROWSING_STATUS

[2] This event defined in the 3GPP TS 31 130 specification

- EVENT_EVENT_DOWNLOAD_ACCESS_TECHNOLOGY_CHANGE
- EVENT_EVENT_DOWNLOAD_DISPLAY_PARAMETER_CHANGED

Upon reception of the corresponding ENVELOPE (Event Download) APDU command, the CAT Runtime Environment triggers all the Toolkit Applets registered to the corresponding event.

- EVENT_EVENT_DOWNLOAD_DATA_AVAILABLE
- EVENT_EVENT_DOWNLOAD_CHANNEL_STATUS

Upon reception of the corresponding ENVELOPE (Event Download) APDU command, the CAT Runtime Environment only triggers the Toolkit Applet registered to the corresponding event with the associated channel identifier.
The applet registers to these events using the `ToolkitRegistry.setEvent` method but the registration is effective only once the toolkit applet has issued a successful OPEN CHANNEL proactive command, and is valid until the first successful CLOSE CHANNEL with the corresponding channel identifier, or the end of the card session.
When a Toolkit Applet sends an OPEN CHANNEL proactive command and receives a TERMINAL RESPONSE with General Result = "0x0X", the framework assigns the channel identifier to the calling Toolkit Applet.
When a Toolkit Applet sends a CLOSE CHANNEL proactive command and receives a TERMINAL RESPONSE with General Result ="0x0X", the framework releases the corresponding channel identifier.

> **Developer tip**
> In case of channel drop, we recommend to explicitly close the channel using the CLOSE CHANNEL command prior to open it again using the OPEN CHANNEL command. In this case, it is also recommended to catch the exception that can be thrown by the CAT Runtime Environment when the applet closes the channel.

- EVENT_EVENT_DOWNLOAD_LOCAL_CONNECTION

Upon reception of an ENVELOPE (DOWNLOAD LOCAL CONNECTION) APDU command, the CAT Runtime Environment only triggers the Toolkit Applet registered to this event with the associated service identifier.
The applet registers to the event by calling the method `ToolkitRegistry.allocateServiceIdentifer`. The applet can deregister by calling the method `ToolkitRegistry.releaseServiceIdentifer`. Once the applet has allocated a service, it issues the proactive command DECLARE SERVICE to add or delete a service to the mobile service database.
The registration to this event is effective once the toolkit applet has issued a successful DECLARE SERVICE (add) proactive command, and is valid until the first successful DECLARE SERVICE (delete) with the corresponding service identifier, or the end of the card session.

- EVENT_PROACTIVE_HANDLER_AVAILABLE

The CAT Runtime Environment triggers all the Toolkit Applets registered to this event when the `ProactiveHandler` is available and all the Toolkit Applets registered to the previous event have been triggered and have returned from the `processToolkit` invocation.
When a Toolkit Applet is triggered, it is automatically deregistered from this event by the CAT Runtime Environment.

> **Developer tip**
> When the Toolkit Applet is triggered on this event, the `EnvelopeHandler` is not available. We advise that the Toolkit Applet stores the handler data before registering to this event.

- EVENT_APPLICATION_DESELECT

When an application session is terminated, the CAT Runtime Environment triggers all the Toolkit Applets registered to this event.
The AID of the deselected application is available to the Toolkit Applet in the `EnvelopeHandler`.

> **Interoperability issue**
> The SIM Alliance members agree that this event is triggered when a first level application including NAA is deselected and independently by the used logical channel.
> In case of card reset, the CAT Runtime Environment may not trigger the event.

- EVENT_FIRST_COMMAND_AFTER_ATR

Upon reception of the first APDU after the ATR and before the Status Word of the processed command has been sent back by the UICC, the CAT Runtime Environment triggers all the Toolkit Applet(s) registered to this event.
If the first APDU received is a toolkit applet triggering APDU (e.g. TERMINAL PROFILE), the toolkit applets registered to the EVENT_FIRST_COMMAND_AFTER_ATR event are triggered before the one registered to the EVENT_TERMINAL_PROFILE if any.

The ProactiveHandler is not available as the CAT session is not open.

- EVENT_UNRECOGNIZED_ENVELOPE

Upon reception of an unrecognized ENVELOPE APDU command, the CAT Runtime Environment triggers all the Toolkit Applet(s) registered to this event.
An ENVELOPE APDU command is considered as unrecognized by the CAT Runtime Environment if its BER-TLV tag is not defined in the ToolkitConstants interface. Only the first triggered toolkit applet is guaranteed to be able to post a response.

- EVENT_EXTERNAL_FILE_UPDATE

Upon successful execution of an UPDATE BINARY or UPDATE RECORD or INCREASE APDU command (sent by the Terminal and received by the UICC on the I/O line), the CAT Runtime Environment triggers all the Toolkit Applets registered to this event with the associated updated file. An Applet is only triggered once per command.
The toolkit applet can get the details of the file update by reading the EnvelopeHandler. The details of the content of the EnvelopeHandler are defined in the ETSI TS 102 241 specification.
The applet registers to this event using one of the ToolkitRegistry.registerFileEvent methods with the indication of the file or the file list that should be monitored.
The applet can deregister for a particular file using one of the ToolkitRegistry.deregisterFileEvent methods.
A call to the ToolkitRegistry.clearEvent(EVENT_EXTERNAL_FILE_UPDATE) clears the registration to the event EVENT_EXTERNAL_FILE_UPDATE for all the registered files.

Developer tip
- The order of the TLVs in the EnvelopeHandler is not specified so it is recommended to use the ViewHandler.findTLV() methods to get each COMPREHENSION TLV.
- The value of the File Update Information tag is 0x3B (BER-TLV tag for intra-UICC communication as defined in the ETSI TS 101.220 specification)
- When calling one of the methods ToolkitRegistry.registerFileEvent() or ToolkitRegistry.deregisterFileEvent(), the value of the fileEvent parameter should be set to EVENT_EXTERNAL_FILE_UPDATE (as it is the only standardized one at the moment).

Interoperability issue
It is not interoperable if the event EVENT_EXTERNAL_FILE_UPDATE is generated on a specific file also in case of updating of a file mapped with that file.

9.6 Proactive Command

9.6.1 Proactive command management

The proactive protocol (i.e. 91xx, Fetch, Terminal Response) is completely handled by the CAT environment. A toolkit applet can ask the CAT Runtime Environment to send a proactive command through the ProactiveHandler. The toolkit applet can get the terminal response to the proactive command (Terminal Response) using the ProactiveResponseHandler.

Developer tip
- As the ProactiveHandler may not be available (re-entrance), it is recommended to check the handler availability using the exception mechanism: a ToolkitException with the reason code HANDLER_NOT_AVAILABLE is thrown if the handler is not available.

The toolkit applet retrieves the ProactiveHandler using the uicc.toolkit ProactiveHandlerSystem.getTheHandler() method. Then the applet can build the proactive command:
- Initialize the proactive command with the ProactiveHandler.init() method or any of the other methods ProactiveHandler.initDisplayText(), ProactiveHandler.initGetInkey(), ProactiveHandler.initGetInput() or ProactiveHandler.initMoreTime().
- Use one of the EditHandler.appendTLV() methods to add the different TLVs that are required for the proactive command as defined in the TS 102 223 specification

- Call the method `ProactiveHandler.send` to request the CAT Runtime Environment to send this proactive command to the mobile and wait for the Response.

The execution of the toolkit applet is paused until the CAT Runtime Environment has transmitted the proactive command and received the response of the terminal. When receiving the Terminal Response, the CAT Runtime Environment resumes the toolkit applet.

On the return from the `send` method, the toolkit applet can analyze the response of the mobile:

- The `send` method returns the general result of the proactive command execution (first byte of Result TLV in Terminal Response)
- The `ProactiveResponseHandler` contains all the simple TLV data objects of the TERMINAL RESPONSE command sent by the terminal in response to the proactive command.

The toolkit applet retrieves the `ProactiveResponseHandler` using the `uicc.toolkit.ProactiveHandlerSystem.getTheHandler` method. Several methods are defined in the `ProactiveResponseHandler` class to ease the terminal response analysis. The methods inherited from the `ViewHander` class can also be used.

The `send` method may throw the exception COMMAND_NOT_ALLOWED if the Proactive command to be sent or one of its parameter is not allowed by the CAT Runtime Environment:
The CAT Runtime Environment checks the content of `ProactiveHandler`:

- The CAT Runtime Environment prevents the Toolkit Applet from sending the following system proactive commands: SET UP MENU, SET UP EVENT LIST, POLL INTERVAL, POLLING OFF.
- The CAT Runtime Environment prevents a Toolkit Applet from sending a TIMER MANAGEMENT proactive command using a timer identifier, which is not allocated to it.
- The CAT Runtime Environment prevents a Toolkit Applet from sending a DECLARE SERVICE (add, delete) proactive command using a service identifier, which is not allocated to it.
- The CAT Runtime Environment prevents a Toolkit Applet from sending a SEND DATA, RECEIVE DATA and CLOSE CHANNEL proactive commands using a channel identifier, which is not allocated to it.
- The CAT Runtime Environment prevents a Toolkit Applet from sending an OPEN CHANNEL proactive command if it exceeds the maximum number of channel allocated to this applet.

All the proactive commands are sent to the terminal as constructed by the Toolkit Applet without any check by the CAT Runtime Environment.

Developer tips

- Several methods are defined in the `ProactiveHandler` class to simplify the building of some proactive commands: `initDisplayText()`, `initGetInkey()`, `initGetInput()`, `initCloseChannel()` and `initMoreTime()`.
- At the `send` method invocation, a pending Toolkit Applet transaction is aborted.
- If an applet wants to use the SET UP IDLE MODE TEXT proactive command, the CAT Runtime Environment cannot guarantee that another Toolkit Applet will not overwrite this text later on.

Example:

```
byte[] String = {(byte)'H',(byte)'e',(byte)'l',(byte)'l',(byte)'o'} ;

 /**
   * Send a DISPLAY TEXT.
   */
ProactiveHandler proHdlr = ProactiveHandlerSystem.getTheHandler() ;
proHdlr.initDisplayText(        (byte)0,
   (byte)0x04,
   String,
   (short) 0,
   (short) String.length) ;
proHdlr.send() ;
```

9.6.2 Details on the Proactive Handler and ProactiveResponse Handler

The ProactiveHandler, ProactiveResponseHandler are Temporary JCRE Entry Point Object.
When the corresponding getTheHandler() method is called or a method of the handler is called, a system handler is considered available if a ToolkitException with the reason code HANDLER_NOT_AVAILABLE is not thrown

ProactiveHandler:

- The ProactiveHandler is not available if the Terminal Profile command has not yet been processed by the CAT Runtime Environment.
- When available the ProactiveHandler remains available until the termination of the processToolkit() method.
- If a proactive command is pending the ProactiveHandler may not be available.
- At the processToolkit() method invocation the TLV-List is cleared.
- At the call of its init method the content is cleared and then initialized.
- After a call to ProactiveHandler.send() method the content of the handler is not modified by the CAT Runtime Environment.

ProactiveResponseHandler:

- The ProactiveResponseHandler is available as soon as the ProactiveHandler is available, its TLV list is empty before the first call to the ProactiveHandler.send() method. It remains available until the termination of the processToolkit() method.
- The ProactiveResponseHandler is not available if the ProactiveHandler is not available.
- The ProactiveResponseHandler TLV list is filled with the simple TLV data objects of the last TERMINAL RESPONSE APDU command. The simple TLV data objects is provided in the order given in the TERMINAL RESPONSE command data.
- The ProactiveResponseHandler content is updated after each successful call to ProactiveHandler.send() method and remains unchanged until the next successful call to the ProactiveHandler.send() method.

9.6.3 System Proactive commands

The CAT Runtime Environment is in charge of the system proactive commands SET UP MENU, SET UP EVENT LIST and POLL INTERVAL. These commands are used to inform the mobile on the menu items, the event list and the poll interval duration required by any toolkit applet installed on the card. But it only contains information relative to the Toolkit Applets that are in the selectable state.

The system proactive commands are sent at the beginning of a CAT session. During a CAT session, the CAT Runtime Environment sends a system proactive command SET UP MENU, SET UP EVENT LIST, POLL INTERVAL or POLLING OFF whenever the menu items, the registered event list or the poll interval duration has changed.
The CAT Runtime Environment sends its system proactive command(s) as soon as no proactive session is ongoing and after all the Toolkit Applets registered to the current events have been triggered and have returned from the processToolkit() method invocation.

The full CAT Runtime Environment behaviour to generate the SETUP MENU , the SETUP EVENT LIST, the POLL INTERVAL and POLLING OFF is described in the ETSI TS 102 241 specification.

Concerning the SETUP MENU, here are some highlights:

- If one toolkit applet indicates that help is available for at least one menu entry, the CAT Runtime Environment indicates to the mobile that help information is available.
- The CAT Runtime Environment uses the content of the EF_{SUME} file to set the menu title. The EF_{SUME} file is defined in the ETSI TS 102 222 specification.
- If a text attribute different from the default format is provided by at least one menu entry, the CAT Runtime Environment inserts an Item Text Attribute list.
- The CAT Runtime Environment provides an Item Icon identifier list only if a icon is requested for all the menu items. The Icon list qualifier transmitted to the mobile is 'icon is not self explanatory' if one of the applet indicates this qualifier.
- The CAT Runtime Environment provides the items to the mobile in the same order than in its Menu Entries' list.

- The CAT Runtime Environment provides only the items corresponding to enabled menu entries and if the toolkit applet life cycle state is selectable.

The position of a toolkit applet menu entry in the Menu Entries' list depends on the position requested at the applet installation ("position" field in the uicc.toolkit specific parameters of the install (for install) command) but also on the content of the Menu Entries' list when the applet has been installed. The Menu Entries' list is managed by the CAT Runtime Environment regardless of the menu entry state (enable/disable) as well as regardless of the Toolkit Applet(s) life cycle state (e.g. Selectable/Locked, etc.). Several examples are provided in the Annex D of the ETSI TS 102 241 to illustrate the management of the menu entry order in the Menu Entries' list of the CAT Runtime Environment.

The item identifier used for a menu entry is allocated by the CAT Runtime Environment according to the request done at the applet installation ("identifier" field in the uicc toolkit specific parameters of the install (for install) command).
The maximum numbers of menu entries available for the toolkit applet and the maximum length available for a menu item text is defined at the applet installation (fields in the uicc,toolkit specific parameters of the install (for install) command).

> **Interoperability issue**
> To avoid any interoperability issue on a 2G/3G card, the SIM Alliance members recommend to map the EF_{SUME} file under the $DF_{TELECOM}$ (USIM specification) with the one under the DF_{GSM} (SIM specification).

9.7 File access API and File administration API

9.7.1 Structure of the File System

The UICC file system has the following structure:

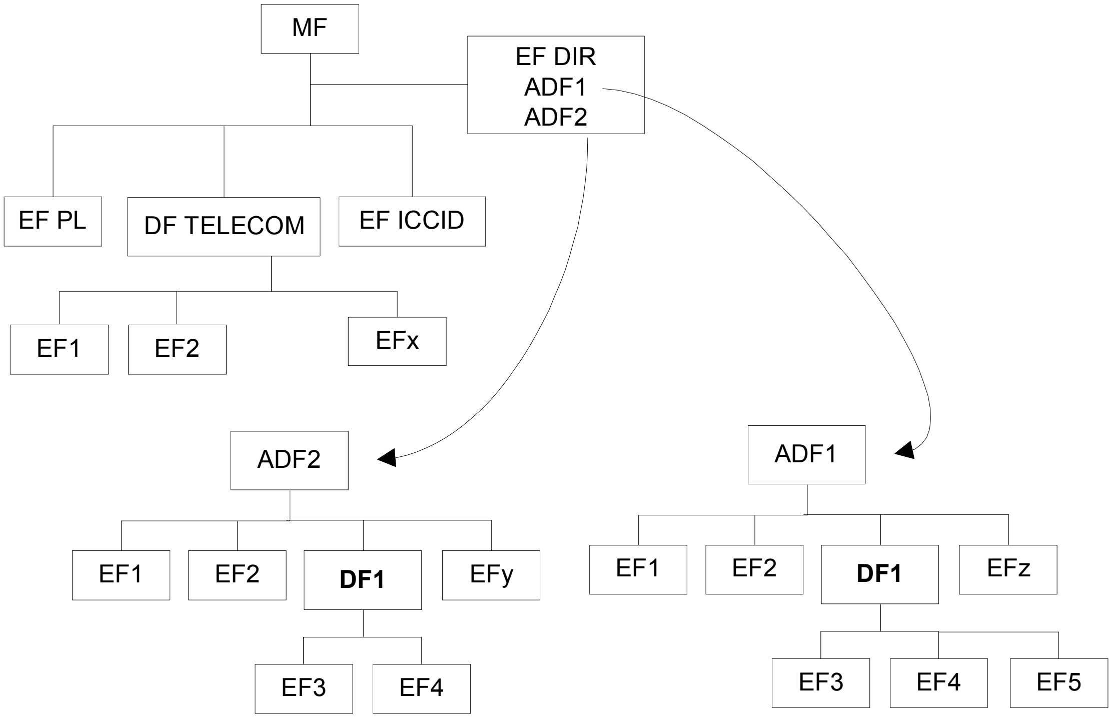


Figure 5 – File system structure in the UICC

9.7.2 The file access API

The file access API consists of the `uicc.access` package defined in the ETSI TS 102 241 specification. It allows to access files located under the UICC shared file system or under an ADF file system.
The (U)SIM file access API consists of the package `uicc.usim.access`. This package defines additional constants to those defined in the `uicc.access` package.

9.7.2.1 FileView objects

The access to the file system is handled using `FileView` objects, either a UICC `FileView` object or an ADF `FileView` object:

- The UICC `FileView` object allows accessing the MF and all the DFs and EFs that are located under the MF including $DF_{TELECOM}$. The access to the DFs or EFs under any ADF is not allowed. The UICC `FileView` object can be retrieved using the method `UICCSystem.getTheUICCView()`.
- An ADF `FileView` object allows accessing only the DFs and EFs that are located under the ADF but not the DFs or EFs under the MF. An ADF `FileView` object can be retrieved using one of the methods `UICCSystem.getTheFileView(...)` by passing the full AID of the application owning the ADF as parameter (for example the full AID of the (U)SIM application).

> **Developer tips**
> - The AIDs of the applications owning an ADF and available on a UICC are listed in the EF_{DIR} file under the MF (see the ETSI TS 102 221 specification for the description of the EF_{DIR} content).
> - The only way to access the DF GSM is to use the UICC `FileView` object.
> - The access to the SIM file system defined in the 3GPP TS 51.011 is available using the UICC `FileView` object.
> - It is recommended to call the `getTheFileView(...)` or `getTheUICCView()` methods in the applet constructor, as they are memory consuming.

Each time the `getTheFileView(...)` or `getTheUICCView()` methods are called, a new `FileView` object is created (as a permanent JCRE entry point object).
A separate and independent file context[3] is associated to each `FileView` object: the operation performed on files in a given `FileView` object shall not affect the file context associated with any other `FileView` object. After the applet termination, the context (current selected file, etc) may remain depending on the object type and can be retrieved during the next applet execution.
The context can be transient or persistent depending on what was required by the Applet during the creation of the `FileView` object (`event` parameter of the `getTheFileView() or getTheUICCView()` methods).

The root of the context of a `FileView` object is the MF for the UICC `FileView` or the ADF for an ADF `FileView`.
At the creation of a `FileView` object or when the transient context of a `FileView` is cleared, the current DF of the `FileView`'s context is set to the root.

[3] The file context includes at least information about the current DF, the current EF and the current record (for linear fixed or cyclic files).

The access control privileges associated with each FileView object is given by the Access Domain of the toolkit applet during its installation phase. The Access Domain of the toolkit applet is defined in the UICC Access Application specific parameter field of the install (for install) command (tag value '81'). A toolkit applet can have an Access Domain relative to the access to the UICC file system part and an Access Domain for each ADF file system part.
The access domain for the UICC file system part is associated to the UICC FileView objects; the access domain for an ADF file system part is associated to the ADF FileView objects relative to this ADF.
Each time a method of the FileView object is invoked, the access control privilege of the FileView object is verified against the access rules of the given DF/EF as described in the ETSI TS 102 221.

9.7.2.2 FileView operations

The different methods defined in the FileView interface are

- select(): selects a file or a directory using the file ID or the SFI.
- status(): returns the FCP of the current selected DF
- readBinary(): reads the content of the current transparent EF
- readRecord(): reads a record or a part of a record of the current linear fixed/cyclic EF
- updateBinary(): updates the content of the current transparent EF
- updateRecord(): updates a record or a part of a record of the current linear fixed/cyclic EF
- searchRecord(): searches a pattern in the current linear fixed/cyclic EF
- increase(): increases the current record of the current cyclic EF
- activateFile(): activates the currently selected EF
- deactivateFile(): deactivates the currently selected EF

These methods implement in fact the same functionality as the SELECT, STATUS, READ BINARY, READ RECORD, UPDATE BINARY, UPDATE RECORD, SEARCH RECORD, INCREASE, ACTIVATE, DEACTIVATE commands defined in the ETSI TS 102 221 specifications.

Developer tips

- When a non-shareable file is selected using one of the select() methods, this file is no more accessible by other applets, by the Remote File management application or by terminal operations. Furthermore when a non-shareable file is selected by the mobile, this file is no longer accessible for any other application. The file is accessible again when the application selects another file. If the FileView context is transient, the file becomes also accessible when the context is cleared.
- The reserved FID '7FFF' can be used as a FID for the ADF to select the root of an ADF FileView object
- When selecting a cyclic file the current record number is undefined.

Example:

```
public static FileView  uiccView;
private byte[] Buffer = {(byte)'H',(byte)'e',(byte)'l',(byte)'l',(byte)'o'} ;

// get a reference to the UICC interface
uiccView = UICCSystem.getTheUICCView(JCSystem.CLEAR_ON_RESET);

uiccView.select( MF_ID);
uiccView.select( UICCConstants.FID_DF_TELECOM)
uiccView.select( EF_TEST_ID);
 // Update file
uiccView.updateBinary((short) 0, Buffer, (short) 0, Buffer.length);
```

9.7.3 File Administration API

A specific API is available for the file administration (create, delete and resize operations) in the uicc.access.fileAdministration package defined in the ETSI TS 102 241 specification.

9.7.3.1 `AdminFileView` objects

The administrative access to the file system is handled using `AdminFileView` objects. Two `AdminFileView` objects are available, one for the UICC file system administration and one for an ADF file system administration:

- The UICC `AdminFileView` object allows administrating the EFs and DFs under the MF. The UICC `AdminFileView` object can be retrieved using the method `getTheUICCAdminFileView(...)` defined in the `AdminFileViewBuilder` class.
- An ADF `AdminFileView` object allows administrating only the DFs and EFs that are located under the ADF. An ADF `AdminFileView` object can be retrieved using one of the methods `getTheAdminFileView(...)` with passing the full AID of the application owning the ADF as parameter (for example the full AID of the (U)SIM application). The `getTheAdminFileView(...)` methods are defined in the `AdminFileViewBuilder` class.

The `AdminFileView` interface inherits of the `FileView` interface and the `AdminFileView` objects follows the behavior of the `FileView` objects: the associated context can be persistent or transient; the context initialization rules are the same, etc.

The access control privileges associated to each `AdminFileView` object is given by the Administrative Access Domain of the toolkit applet during its installation phase. The Administrative Access Domain of the toolkit applet is defined in the UICC Administrative Access Application specific parameter field of the install (for install) command (tag value '82'). A toolkit applet can have an Administrative Access Domain relative to the access to the UICC file system part and an Administrative Access Domain for each ADF file system part.

The Administrative Access Domain for the UICC file system part is associated to the UICC `AdminFileView` objects; the Administrative Access Domain for an ADF file system part is associated to the ADF `AdminFileView` objects relative to this ADF.

Each time a method of the `AdminFileView` object is invoked, the access control privilege of the `AdminFileView` object is verified against the access rules of the given DF/EF as described in the ETSI TS 102 221.

9.7.3.2 `AdminFileView` operations

The different methods defined in the `AdminFileView` interface are

- `createFile()`: creates a new EF or a new DF under the current DF or ADF
- `deleteFile()`: deletes an EF under the current DF or deletes a DF with its complete sub-tree.
- `resizeFile()`: resize an EF DF under the current DF or ADF

These methods implement in fact the same functionality as the CREATE, DELETE and RESIZE commands defined in the ETSI TS 102 222 specifications.

The details of the different methods are defined in the ETSI TS 102 241.

If EF or DF file already exists, or if memory is not available for creation, then an `AdminException` is thrown.

> **Developer tip**
> The `createFile()` and `resizeFile()` methods uses a `ViewHandler` object to define a data field identical to the one used for the CREATE and RESIZE commands. The `uicc.system.HandlerBuilder.buildTLVHandler()` method is useful to create a `ViewHandler` object. The TLV content can be set either when creating the `ViewHandler` object or later on. In this case the handler can be cast to an `EditHandler` and then filled with the TLV content. To avoid memory allocation during lifecycle of the applet, it is recommended to invoke the `buildTLVHandler()` method in the constructor of the applet.
> The `AdminFileView` interface inherits of the `FileView` interface so all methods such as `select`(), `readBinary`() and so one are also available.
> When the `deleteFile`()method is invoked, SIM Alliance members agree that they all provide mechanisms to recover memory space but the implementation of this features can be different for the SIM Alliance members.

```
private byte [] fileDescriptor = {
    (byte)0x42,(byte)0x21,(byte)0x00,(byte)0x04};
        // File Descriptor: EF linear fixed, record length 4

private short fileId = (short)0x8302;   // File Id

private byte LCSI = (byte)0x05;   // LCSI activated

private byte [] securityAttribute = {
    (byte)0xAC,(byte)0x00,        // Security attribute (EF Arr)
    (byte)0x01,(byte)0x01,        // Security attribute (SD 1, record nb)
    (byte)0x00,(byte)0x01};       // Security attribute (SD 0, record nb)

private short fileSize = 0x0064;   // File Size (25 rec * 4 bytes = 100)

private byte [] sfiTLV = {
    (byte)0x88,(byte)0x00};       // sfiTLV – no SFI – length = 0

AdminFileView adminFileView= AdminFileViewBuilder.getTheUICCAdminFileView(JCSystem.CLEAR_ON_RESET) ;

// Select the MF
adminFileView.select((short)0x3F00);
// Create EF AF80
createCmd = HandlerBuilder.buildTLVHandler(HandlerBuilder.EDIT_HANDLER, (short )255);

createCmd.appendTLV((byte)0x82, fileDescriptor, (short)0x00, (short)fileDescriptor.length);
createCmd.appendTLV((byte)0x83, fileId);
createCmd.appendTLV((byte)0x8A, LCSI);
createCmd.appendTLV((byte)0x8B, securityAttribute, (short)0x00, (short)securityAttribute.length);
createCmd.appendTLV((byte)0x80, fileSize);
createCmd.appendArray(sfiTLV, (short)0x00, (short) sfiTLV.length);

adminFileView.createFile(createCmd);
```

9.8 An useful resource: the uicc.system *package*

The `uicc.system` package provides facilities useful to developers to improve functionalities and reduce memory consumption for the applications.

All facilities offered by this package are usable not only by Toolkit applications, but also by general Java Card applications.

Two different classes are defined:

- `HandlerBuilder` – The `HandlerBuilder` is a factory providing methods to generate objects implementing the `uicc.toolkit.EditHandler` or the `uicc.toolkit.BEREditHandler` interfaces. The content of these objects is totally managed by the application who invoked the factory methods and they don't have any link with the system handlers (e.g. the Envelope handler).

Developer tip
Such object is really useful not only to build an object encapsulating a (BER) TLV structured byte sequence (like the `createFile` parameter, but also to parse (BER) TLV structured byte sequence to find inside it TLV data (like the FCP returned by the `FileView` method).

- `UICCPlatform` – The `UICCPlatform` allows the access by the application to same shared resources owned by the Toolkit; in Release 6 just one resource has been defined, i.e. a transient byte array that can be accessed by any application; the buffer is at least 256 byte long.

Developer tip
The volatile byte array has at least two use cases:

- An applet may use it as a "scratch" buffer, e.g. to perform a file access operation

- As it can be accessed by any Java Card firewall context, it can also be used to share data with other applications belonging to different contexts.

9.9 SIM API

The SIM Alliance members agree that they all provide the SIM API as formerly defined in 3GPP TS 43.019 for the Release 5. This API remains available to ensure that existing applets developed for the Release 5 (or for the previous versions) can still be loaded and installed on a card compliant with the Release 6.
But it is strongly recommended that all the new applets are developed by using the (U)SIM API.

Coexistence of SIM API and of (U)SIM API is described in § 11.10.

10 The phonebook

The aim of this chapter is to highlight some key features of the phonebook defined for the USIM application in 3GPP TS 31.102.

10.1 Phonebook Principle

The phonebook defined for the USIM application has been widely enhanced compared to the phonebook defined for the SIM application.

The former SIM phonebook mainly involves only one file, the EF_{ADN} file. The EF_{ADN} includes the name of a contact (alpha identifier) and its dialing number. It also includes an optional link to the EF_{EXT1} file if a called party sub address or additional digits are required, and an optional link to the EF_{CCP} file if specific network and bearer capabilities or mobile equipment configuration are required to establish the call.

The USIM phonebook manages contacts. Contact information includes the name of the contact and its dialing number, and if required the extension and capability/configuration parameters, as formerly defined for the SIM phonebook. But they can also include one or several email addresses, a second name, other dialing numbers like fax or mobile phone number, and a group such as business or friend. The different characteristics of a contact are spread out in different specific files. A phonebook can contain more than 254 contacts; this is managed using several EF_{ADN} files.

The structure of the phonebook is not frozen but depends on the card personalization. The EF_{PBR} file is used to determine the actual phonebook structure.

10.2 Structure of the phonebook

10.2.1 The different files used to define a contact

The USIM phonebook involves a set of files in order to manage the different characteristics of a contact.

The different files used to compose a contact are:

File name	File description	Summary of the content
EF_{ADN}	Abbreviated Dialing Number	Main alpha identifier and dialing number of the contact
EF_{ANR}	Additional Number	Additional phone number or Supplementary Service Control strings (SSC) attached to the contact
EF_{AAS}	Additional number Alpha String	Alpha string of the additional number
EF_{EXT1}	Extension 1	Extension data for the main dialing number or for an additional number. Extension data are required: - If the coding of the dialing number is greater than the 20-digit capacity of EF_{ADN} or EF_{ANR} or if common digits are required to follow a dialing number of less than 20 digits (DTMF string). - To define a called party sub address.
EF_{CCP1}	Capability Configuration Parameters 1	Network and bearer capabilities, and mobile equipment settings to establish the call (using the main dialing number or an additional number)
EF_{EMAIL}	Email Address	Email address of the contact
EF_{SNE}	Second Name Entry	Second name of the contact
EF_{GRP}	Grouping File	List of groups to which the contact belongs
EF_{GAS}	Grouping Information Alpha String	Alpha strings of the different groups

The only mandatory file is the file EF_{ADN}. The other files used to define the different fields of a phonebook entry are optional. Their presence depends on the structure required for the phonebook. For example, it is possible to attach none, one or several email addresses, additional numbers or second names to a contact. In this case none, one or several files EF_{EMAIL}, EF_{ANR} and EF_{SNE} are defined.

The different type of file linking
The number of records in a field file may be less than the number of records in the file EF_{ADN}. Several types of links are available to link all the field files to the EF_{ADN}.

Three types of file links are defined:

- The file link type 1: the field file contains as many records as the master EF_{ADN} file.
- The file link type 2: the field file contains fewer records than the master EF_{ADN} file. The link is done using a pointer defined in the EF_{IAP} administration file.
- The file link type 3: the record identifier of the field file is defined in the record of the master file. For example if an extension is required for a record in EF_{ADN}, the record identifier in the EF_{EXT1} file is defined in the record of EF_{ADN} itself.

The different types of file linking allowed for a specific file are defined in the 3GPP TS 31.102 specification.

According to the current version of the 3GPP TS 31.102 specification, only Type 3 files can contain records that can be shared between several contacts.

How to retrieve the different fields of a contact?
The configuration of the phonebook is defined in the EF_{PBR} file.
The entry point for a contact is the EF_{ADN} file. Once the record in EF_{ADN} is identified, the other fields are retrieved in the different files according to the type of linking:

- Directly by reading the same record number in the field file, if this file is linked with a Type 1 linking
- By reading the right pointer in the same record number of the EF_{IAP} file, if this field file is linked with a Type 2 linking. The value of the pointer gives the record number in the field file.
- Directly by reading the record number of the field file in the record itself, if this file is linked with a Type 3 linking

Creation/Deletion of information
In order to avoid unlinked data to introduce fragmentation of the files containing the phonebook, a specific procedure shall be followed when creating a new entry in the phonebook or when deleting a complete or part of an entry.
Refer to the chapter "Phone book procedures" of the 3GPP TS 31.102 specification for details.

10.2.2 The EF_{PBR} file (Phone Book Reference)

The structure of the phonebook is defined in the EF_{PBR} file. This file is mandatory. The file identifier is '4F30'.
All files representing the phonebook are specified in EF_{PBR} (except EF_{PSC}, EF_{PUID} and EF_{CC}). Certain kinds of file can occur more than once in the phonebook. For these kinds of file, no fixed file identifiers (FID) are specified. The assigned values are defined in EF_{PBR}. If a short file identifier (SFI) is assigned to a file defined in EF_{PBR}, this SFI value is also indicated in EF_{PBR}. The type of file linking is also indicated for each file.

The EF_{PBR} file may contain several records, each of them specifying the structure of up to 254 contacts in the phonebook. If more than 254 contacts have to be stored, a second record is needed in EF_{PBR}. The structure of a contact is the same for all the contacts in the phonebook even if several records are defined in EF_{PBR}.

Detailed content of EF_{PBR}:
A record in EF_{PBR} contains several constructed TLV objects, one for each type of file linking. The tag value is 'A8' for the files with a link type 1, 'A9' for the files with a link type 2 and 'AA' for the files with a link type 3.
Each constructed TLV object contains a list of primitive TLV objects, one for each file of this type defined for a contact. For example, if the phonebook contains two email files with a link type 2 and one additional number with a link type 2, the TLV object with the tag 'A9' contains 3 primitive TLV objects, one for each EF_{EMAIL} file and one for the EF_{ANR} file.
A primitive TLV object defines the type of the file (email file, additional number file, etc), the file identifier and the SFI value if available. The type of the file is coded through the Tag of the primitive TLV object, for example 'C0' for EF_{ADN}, 'CA' for $EF_{EMAIL,}$ etc. The identifier and the SFI value are coded in the Value of the primitive TLV object. The Length of the primitive TLV object is set to '03' if a SFI value is defined; otherwise the Length is set to '02'.
At the end of each record of EF_{PBR}, unused bytes, if any, are set to 'FF'.

An example of the phonebook content is given in Annex of the 3GPP TS 31.102 specification.

10.2.3 The EF*IAP* file (Index Administration Phonebook)

The EF_{IAP} file is present if some files with a link type 2 are defined in the phonebook. It contains the pointers to the different files of type 2 in order to retrieve the different fields of a contact.
It contains the same number of records as the corresponding EF_{ADN} file. It is linked to EF_{ADN} with a Type 1 linking: the records are mapped one to one.
The amount of bytes in a record of the EF_{IAP} is equal to the number of files with a Type 2 linking defined in the EF_{PBR}.
The order of the pointers in a record of EF_{IAP} is the same as the order of the file identifiers that appear in the constructed TLV object indicated by the Tag 'A9' (Type 2 linking) in the EF_{PBR} file.
The value 'FF' is used to indicate that no corresponding record in the indicated file is available.

10.2.4 The EF*PBC* file (Phone Book control)

The EF_{PBC} file contains the control information and the hidden information of each phonebook entry. It is present if one or both of the following features are managed: the hidden entries management, a GSM SIM application residing on the UICC.
The EF_{PBC} file contains the same number of records as the corresponding EF_{ADN} file. It is linked to EF_{ADN} with a Type 1 linking: the records are mapped one to one.
The control information is used when the EF_{ADN} and EF_{EXT1} files under $DF_{TELECOM}$ are modified by a terminal using the GSM SIM application.
The hidden information is used to indicate whether a secret code shall be verified before displaying the phonebook contact. The hidden key is defined in the $EF_{HIDDENKEY}$ file ('6F3C').

10.2.5 The other files

If the phonebook synchronization is supported, the EF_{PSC}, EF_{UID}, EF_{PUID} and EF_{CC} files are all mandatory (see § 10.6).

10.3 An example of phonebook content

The 3GPP TS 31.102 specification gives an example in Annex. An additional example is provided here:

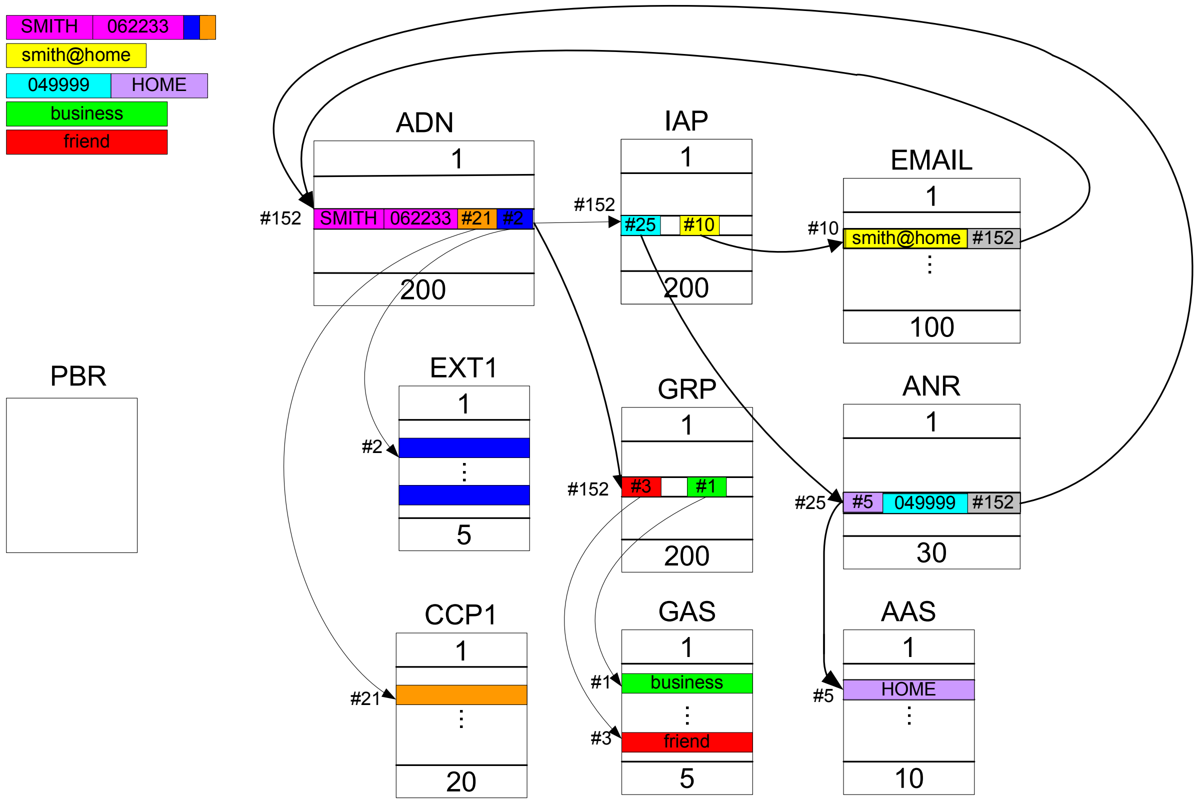


Figure 6 – A good example of a Phonebook

10.4 Global and local phonebooks

The UICC may contain a global phonebook, or application-specific phonebooks, or both in parallel. The global phonebook is located in the $DF_{PHONEBOOK}$ under $DF_{TELECOM}$. Each specific USIM application phonebook is located in the $DF_{PHONEBOOK}$ of its respective application ADF_{USIM}. All the files related to a phonebook are located under their respective $DF_{PHONEBOOK}$. When both phonebook types co-exist, they are independent and no data is shared. In this case, it shall be possible for the user to select which phonebook he would like to access.

10.5 Link with the GSM SIM phonebook

If a GSM SIM application resides on the UICC, the EF_{ADN} and EF_{EXT1} files from one $DF_{PHONEBOOK}$ are mapped to the EF_{ADN} and EF_{EXT1} files of the $DF_{TELECOM}$. Their file IDs are specified in TS 51.011, i.e. EF_{ADN} = '6F3A' and EF_{EXT1} = '6F4A', respectively. Only the first 254 contacts can be mapped.

Synchronization between the 2G phonebook and the 3G phonebook

If the UICC is inserted into a terminal accessing the EF_{ADN} and EF_{EXT1} files under $DF_{TELECOM}$ and a record of these files has been updated, a flag in the corresponding entry control information in the EF_{PBC} under $DF_{PHONEBOOK}$ is set from 0 to 1 by the UICC. If the UICC is later inserted into a terminal that supports the 3G phonebook, the terminal shall check the flag in EF_{PBC} and if this flag is set, update the EF_{CC}, and then reset the flag. A flag set in EF_{PBC} results in a full synchronization of the phonebook between an external entity and the UICC (when synchronization is requested).

10.6 Phonebook synchronization

To support synchronization of phonebook contacts with other devices, the USIM may provide the following files: a phonebook synchronization counter (PSC), a unique identifier (UID) and a change counter (CC) to indicate recent changes.

If synchronization is supported in the phonebook, then EF_{PSC}, EF_{UID}, EF_{PUID} and EF_{CC} are all mandatory.

All these files are used to keep track of the updates/deletions in an existing phonebook entry. It is also possible to update the phonebook in different terminals, which are still able to detect the changes (e.g. changes between different handset and/or 2nd and 3rd generation of terminals).

Refer to the chapter “Phone book Synchronization” of the 3GPP TS 31.102 specification for further details.

11 Interworking between SIM and USIM applications

A SIM application and a USIM application, which are implemented together on a unique UICC, can never be active at the same time. It is also impossible to switch from one to the other during a session (selection of the application depends depend on the ME (2G or 3G).

Applications (SIM/USIM) have to be virtually independent from a functional point of view. However, both applications may share certain objects to optimize memory consumption.

11.1 IMSI, secret key and authentication algorithm

A single subscription is identified by many elements:

- A particular IMSI (IMSI 2G = IMSI 3G)
- A particular secret key (Ki for 2G or K for 3G, where Ki can be equal to K)
- A particular type of authentication algorithm ("A3/A8" for 2G or "f1-f5" for 3G).

A particularity, that is valid for 2G and 3G contexts, is that a single IMSI can never be connected to more than one secret key or algorithm.

There are three possible options for the UICC:

- Separate IMSI & Separate Secret Key:
  This case applies if the network operator wants to administrate the 2G and the 3G subscription (i.e. the usage of a 2G and 3G ME, fully independent). Consequences are that USIM and SIM applications have to keep separate IMSIs and also their own authentication algorithm. (see 3GPP TR 31 900 Annex B and 3GPP TS 31 102).
- Separate IMSI & Shared Secret Key:
  From a functional point of view, it is similar to the previous option, except that the UICC saves 128 bits for the storage of a second secret key.
- Shared IMSI & Shared Secret Key:
  This option is valid when the network operator wants to have a single subscription for a user (independently of the ME (2G/3G)). IMSIs and secret keys are identical for SIM application and USIM application.

11.2 Secret codes

For the SIM application, only CHV1 and CHV2, are available. They apply to files situated in DF-GSM and DF-TELECOM.

For the USIM application, up to 8 Application PINs with global key references may be available. The UICC can also support up to 8 Local PINs with specific key references. Further, up to 10 administrative PINs can be defined. (see ETSI TS 102 221 §9.4)

Local PINs can be used within the MF or within any ADF or DF. A replacement PIN, called Universal PIN, may also exist.

Mapping of PINs between 2G and 3G operations mode like enabling, disabling or changing of a PIN in one operation mode impacts the other operation mode.

> **Interoperability issue**
>
> SIM Alliance members cannot guarantee Local PIN availability under the MF.

11.3 Mapping of CHV1

CHV1 in the SIM application can be mapped to any USIM application PIN with a global key reference, but only one at a time.

When the UICC is single verification capable, CHV1 is mapped to USIM application PIN. If the USIM application PIN is disabled, CHV1 is also disabled. (see 3GPP TR 31 900 Annex D1)

11.4 Mapping of CHV2

CHV2 (SIM application) can be mapped to the corresponding local key reference belonging to the USIM application to which CHV1 is mapped. Regarding to the requirements in TS 11.11 and TS 51.011 for CHV2, this PIN cannot be disabled in either operation mode. In that case, the UICC will return an appropriate error condition.

11.5 Mapping of Local PINs

A SIM does not support Local PINs.

11.6 Mapping of administrative PINs

The mapping of administrative PINs between 2G and 3G operation modes is fully under the discretion of each network operator and card manufacturer.

11.7 Access condition

In case an EF or DF is accessible in SIM application and USIM application, independent 2G or 3G access condition can be defined for this file. If necessary, it is the responsibility of the network operator and the card manufacturer that the security attributes for 2G and 3G sessions are consistent.

11.8 Access to file system for 2G / 3G applets

11.8.1 Definitions

There are two definitions of file system:

- The UICC Shared File System application shall have access only to files situated under the MF (DFs and EFs files). ADFs are not considered to be files under the MF.
- USIM File System allows access to DFs and EFs located under ADFs.

In this document, 2G applets correspond to applets using Release 5 APIs. For access file rules, theses applets will use `sim.access` package. The `sim.access` can only access to the UICC Shared File System by using the `SIMView` interface.

3G applets correspond to applets using Release 6 APIs. For access file rules, these applets will use `uicc.access` or `usim.access` package. The `uicc.access` can access the whole file system (see § 9.7.2)

11.8.2 Accessibility table

The different ways to access file system by each file context is explain in the following table:

		Accessing files under MF	**Accessing files under a specific ADF**
2G Applet	File Access	Yes	No
	Package JavaCard	`sim.access`	None
	Access Condition	2G	None
3G Applet	File Access	Yes	Yes
	Package JavaCard	`uicc.access`	`uicc.access`
	Access Condition	3G	3G

11.9 Activation of SIM and USIM applications

After a cold reset, no particular application is active on the UICC. The ME selects the right NAA (SIM or USIM application) according to its capabilities. A 3G or 2G/3G dual mode ME or a 2G ME of R99 or Rel-4 with USIM support or a 2G ME of Rel-5 will only send commands with class byte = '0X' or '8X' and will explicitly select the USIM application. A 2G ME of Rel-4 (or earlier) without USIM support will only send commands with class byte = 'A0' and then implicitly select the SIM application.

The application selection takes place regardless of the result of the command (i.e. command successful or not).

In case a USIM session has been activated, it excludes the possibility to activate a SIM session. In particular, this implies that once a USIM application is activated, all commands sent to the USIM with "CLA = 0xA0" shall return, to the terminal, the Status Words "0x6E00" (class not supported).
A toolkit applet can be triggered whatever SIM or USIM application is the current NAA.
Applets can access to any ADF independently from the current NAA and from the current card session.

11.10 SIM and USIM APIs interworking

It's declared as not specified, and so it is not interoperable, applet behavior in case of usage of both SIM APIs and USIM APIs.

It is recommended to develop application by using USIM APIs also in case of 2G functionalities, in order to take advantage of all the enhanced features of the USIM APIs.

11.10.1 Terminal Profile

The terminal profile info provided by the ME are given to 2G applet in the `MEProfile` object and to the 3G applets in the `TerminalProfile` object. Both objects have the same content.
As many features have been made mandatory for 3G ME, the relevant bits in the Terminal Profile are set to 1 in 102 223. When a 3G card is inserted in a 2G terminal, the bit verification of these features should be checked according to 51.014 also by 3G applets.

11.10.2 Triggering and Registration

The 2G applets and the 3G applets are not triggered on the same "Toolkit Interface". The SAT ones are triggered on `sim.toolkit.ToolkitInterface`. The USAT applets are triggered on `uicc.toolkit.ToolkitInterface`*.* The triggering order for applets will only depends on the priority level defined during the loading stage of the applet, independently of the applet type.
When a USIM is the current application or when there is no application selected, the SIM Toolkit Framework generates events based on APDUs defined in TS 102 221 and TS 31.102 in order to trigger an applet.

> **Example**
> ENVELOPE (MENU SELECTION) defined in TS 102 223 with class byte 0x80 should trigger SAT applets registered to EVENT_SELECTION_MENU)*.*

2G and 3G applets share the same card resources.

> **Example**
> As an example, if a USAT applet is registered to Call Control, an applet using SIM API can not be registered on Call Control. Moreover, if a Timer is allocated with a SIM API, it can not be allocated with a USIM API.

11.10.3 System handlers and proactive commands

The EnvelopeResponseHandler is available for all triggered applets (SAT and USAT) when available for the event. An envelope response or a sent proactive command, using specific applet API, has to be posted by the applet.
Also, the ProactiveHandler may not be available, for SAT and USAT applets, if a proactive command is pending (see TS 43.019, TS 102 241 and TS 31.130).

> **Note**
> The system proactive commands generated by the Toolkit Framework are independent of the current NAA.

The only exception is identified for the SET UP MENU proactive command. In fact two EF_{SUME} files can be created (one under DF_{GSM} and one under $DF_{TELECOM}$) and can be different (alpha and icon identifiers). The Toolkit Framework generates the same SET UP MENU proactive command if files are mapped (see § 9.6.3)

11.10.4 Behaviours of SIM API used in a 3G mode

> **Developer tip**
> SAT Applets can access to the functions and data described in TS 51.011 and TS 11.14, if the current application is the SIM one.

New features defined for proactive commands in TS 31.111 are not available for SAT applets. Moreover, new events introduced in UICC/USAT API are not available for SAT applets (e.g. `EVENT_DOWNLOAD_DISPLAY_PARAMETER_CHANGE`, `EVENT_EXTERNAL_FILE_UPDATE`).

11.11Behaviours of USIM API used in 2G mode

There is no restriction concerning USIM API in 2G mode as they were designed in the interworking view.

12 SMS PP and CB Packets for USIM Applications

USIM application offers Short Message Services. This chapter defines the protocol for Short Message Service in Point to Point and Cell Broadcast mode, for single and multiple messages. It also introduces mean to handle Short Message within USAT.

This mechanism can be used to trigger a toolkit application or to manage the card remotely.

12.1 Single Short Message Point to Point Description

12.1.1 General structure of Single Short Message Point to Point Envelope

The 3GPP TS 23.040 specifies the protocols and protocol layering for Short Message Service, within GSM/UMTS.
The ETSI TS 102 225 specifies the structure of Secured Packet in a general format (TP_UD fields) for UICC platforms.
The 3GPP TS 31.115 specifies the structure of Secure Packets for USIM Toolkit Applications.

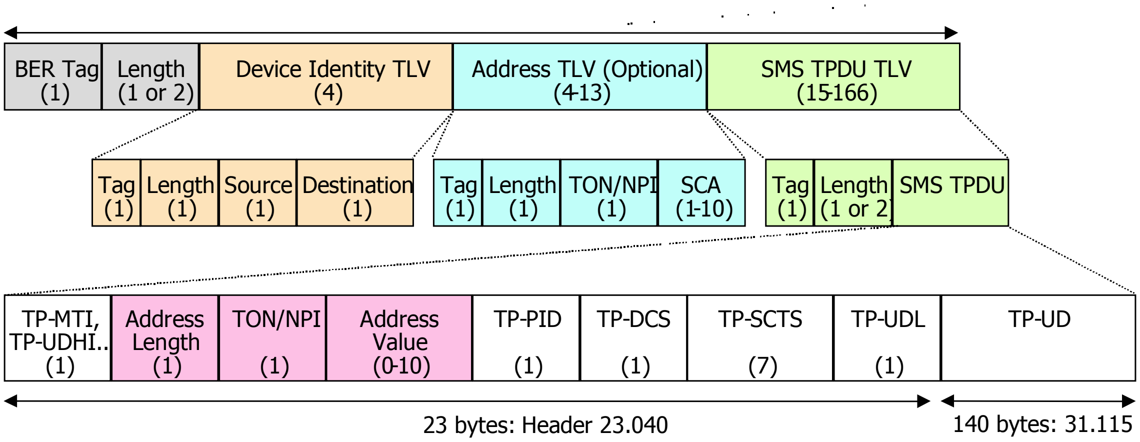


Figure 7 – Formatted SM structure

If the incoming message is secured then we speak of **formatted** Short Message. Otherwise the term is **unformatted**.

12.1.2 General structure of the User Data Header in a Secured Single Short Message Point to Point

If the incoming SMS PP is secured, the coding of the SMS_DELIVER (SC to MS), SMS_DELIVER_REPORT, SMS_SUBMIT (MS to SC), SMS_SUBMIT_REPORT header must indicate that:

- Secured data are binary (8 bits). For that the DCS (Data Coding Scheme) field should be set appropriately to 0x16 or to 0xF6 (see for details 3GPP TS 23.038).
- TP-User-Data field contains a header, in particular a 3GPP TS 31.115 header. For that the TP_UDHI (User Data Header Indicator) bit field, in the MTI (Message-Type-Indicator) field, is set to 1.

The User Data Header is part of the TP User Data of the Short Message element.

Structure of the UDH in an SM-PP:

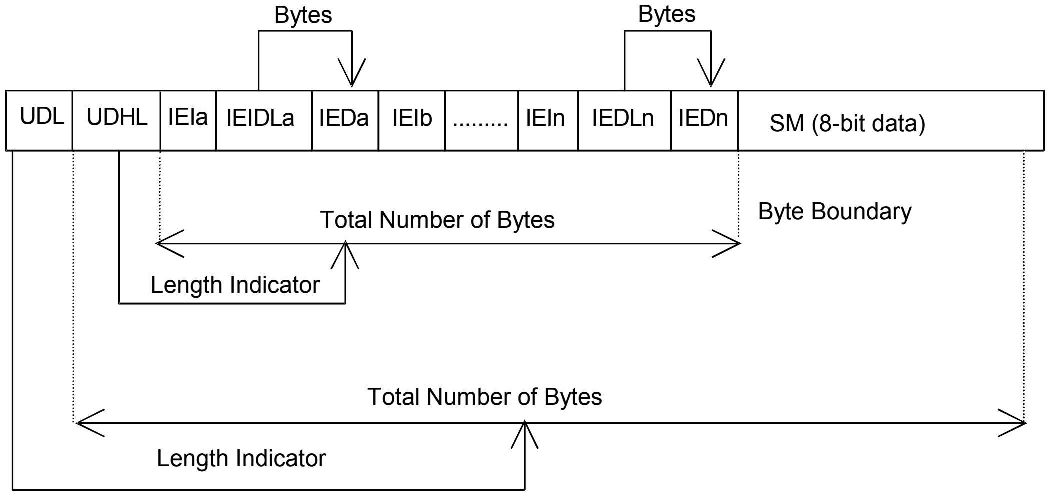


Figure 8 - The UDH in an SM-PP

The Command Packet and the Response Packet are partially mapped into the UDH structure.
Information Element Identifier (IEI's) value range '70-7F' are reserved in TS 23.040:

'70' and '71' are specified below,
'72' –'7D' are reserved for future use,
'7E' and '7F' are proprietary implementations.

If Command Packet and Response Packet are too large to be contained in a single Short Message (including the Command Header or the Response Header), it shall be concatenated as defined below.

12.2 Structure of the Command Packet contained in a single secured SM PP or in a Formatted SM

12.2.1 Structure of the UDH in the case of Command Packet

For Command Packet, the UDH is defined as following:

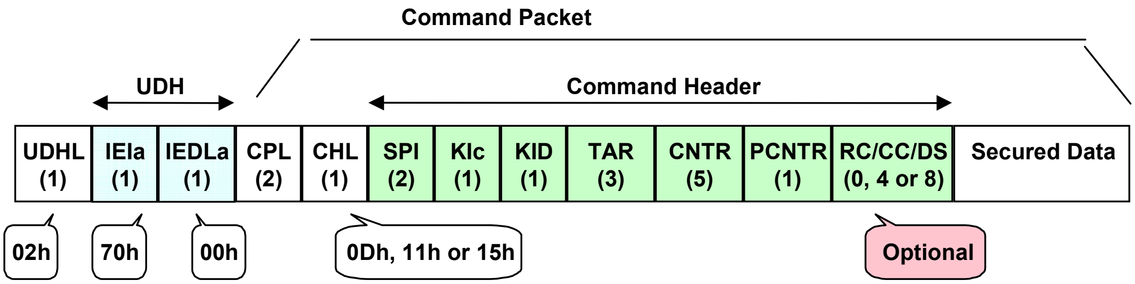


Figure 9 - The UDH structure

The UDH is mapped with the Command Packet Identifier. The CPI identifies the Command Packet and indicates the presence of the Command Packet Length and the Command Header before the Secured Data.

- The UDHL = "02",
- The CPI (or IEIa) = "70",
- **The IEDLa = "00"** accordingly with TS 23.040.

> **Developer tip**
>
> When sending a SMS SUBMIT, the applet developer should take care with the length of the secured data, as the length of the Command Packet cannot exceed 140 octets. If the length of the Command packet is greater than 140 octets, then the secured data should be concatenated (see Command Packet contained in Concatenated Short Message Point to Point chapter).

12.2.2 Structure of the Command Packet

Command Packet structure definition:

Element	Length	Comment
Command Packet Identifier (CPI)	1 octet	Identifies that this data block is the secured Command Packet.
Command Packet Length (CPL)	2 octets	This shall indicate the number of octets from and including the Command Header Identifier to the end of the Secured Data, including any padding octets required for ciphering.
Command Header Identifier (CHI)	Null field	Null field for SMS-PP.
Command Header Length (CHL)	1 octet	This shall indicate the number of octets from and including the SPI to the end of the RC/CC/DS.
Security Parameter Indicator (SPI)	2 octets	See detailed below
Ciphering Key Identifier (KIc)	1 octet	Key and algorithm Identifier for ciphering. See detail below
Key Identifier (KID)	1 octet	Key and algorithm Identifier for RC/CC/DS. See detail below
Toolkit Application Reference (TAR)	3 octets	Coding is application dependent as defined in TS 101.220.
Counter (CNTR)	5 octets	Replay detection and Sequence Integrity counter.
Padding Counter (PCNTR)	1 octet	This indicates the number of padding octets used for ciphering at the end of the secured data.
Redundancy Check (RC), Cryptographic Checksum (CC) or Digital Signature (DS)	variable	Length depends on the algorithm. A typical value is 8 octets if used, and for a DS could be 48 or more octets; the minimum should be 4 octets if used.
Secured data	variable	Contains the Secured Application Message and possibly padding octets used for ciphering.

12.2.2.1.1 SPI: Security Parameter Indicator

These two bytes defined the security level applied to the input and output message.

If the Security Parameter Indicator (SPI) field indicates that a particular field is not present, then the Sending Entity set the content of this field to zero, and the Receiving Entity ignore it.

If the Security Parameter Indicator (SPI) field indicates that no RC, CC or DS is present in the Command Header, the RC/CC/DS field is not present.

If the Security Parameter Indicator indicates that RC/CC/DS is performed, then the following Command Header fields are included in the calculation:

- SPI field,
- Kic field,
- KID field,
- TAR field,
- Counter field,
- Padding Counter field,
- Secured data field.

If the Security Parameter Indicator indicates that ciphering is performed, then the following Command Header fields are included in the calculation:

- Counter field,
- Padding Counter field,
- RC/CC/DS field computed,
- Secured Data.

If ciphering is performed, first the RC/CC/DS is calculated, and then ciphering is applied.
If the Padding Counter content is zero, this indicates no padding octets, or no padding is necessary.

For more details on the SPI coding, see Secured Packet Security Parameters Description chapter.

12.2.2.1.2 KIC: Ciphering parameters

This field defines the key set and algorithm to use for encryption and decryption.
For more details see Secured Packet Security Parameters Description chapter.

12.2.2.1.3 KID: Signature parameters

This field defines the key set and algorithm to use for Cryptographic Checksum and Redundancy check.
For more details see Secured Packet Security Parameters Description chapter.

12.2.2.1.4 TAR: Toolkit Application Reference

TAR allows to uniquely identify application loaded on card (first level applications: GSM application, Remote file application, USIM application… and second level applications: Toolkit applet), and cannot be duplicated.
A second level application can have several TAR assigned.

The TAR of an application is coded on 3 bytes, and the range values are defined by ETSI Technical Body:
The TAR values in the range '00 00 00' to 'AF FF FF' and 'C0 00 00' to 'FF FF FF' are under the responsibility of the first level application issuer.
The TAR values in the range 'B0 00 00' to 'BF FF FF' are reserved for allocation by ETSI to generic second level application independent of the first level application issuer.

Toolkit application reference	Application category
'00 00 00'	Issuer security domain
'00 00 01' to 'AF FF FF'	Allocated by the 1st level application issuer
'B0 00 00' to 'B0 FF FF'	Remote File Management
'B1 00 00' to 'B1 FF FF'	Payment application
'B2 00 00' to 'BF FE FF'	RFU
'BF FF 00' to 'BF FF FF'	Proprietary toolkit application
'C0 00 00' to 'FF FF FF'	Allocated by the 1st level application issuer

It is not mandatory for a second level application to have a TAR value assigned. In this case it is not possible to trigger such application on a Formatted Short message.

If a TAR value is assigned to a second level application it is not mandatory to be included in the AID.

> **Interoperability issue:**
> It's not specified if the TAR inside the AID is assigned to an application if no toolkit parameter is specified for that application.

12.2.2.1.5 Counter field:

The counter detects message replay and checks message sequence integrity. The anti replay level and integrity check level are defined in the SPI2 byte.
For more details see Secured Packet Security Parameters Description chapter.

12.3 Structure of a Response Packet contained in a Single Short Message Point to Point

The Response Packet is generated by the Receiving Entity, and can contain some data returned by the Receiving Application.

In the case where the USIM application is the receiving application, according the value of the bit 6 of the SPI2, the Response packet is:

- Retrieved by the ME, and included in the User-Data part of the SMS-DELIVER-REPORT,
- Fetched by the ME after the Send Short message proactive command

12.3.1 Structure of the UDH in case of Response Packet

In the case of a response packet originating from the SIM, the UDHI bit of the response packet SMS is not set, since the SIM cannot notify the ME that it should be set. The sending entity processes the response packet as if the UDHI bit were set.

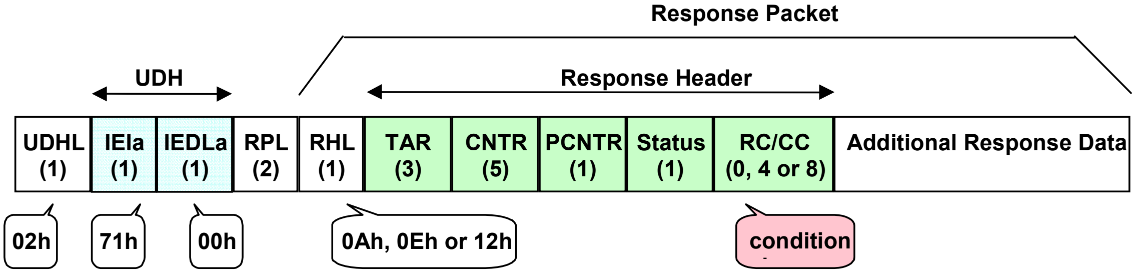


Figure 10 – Response packet structure

The UDH is mapped with the Response Packet Identifier. The RPI identifies the Response Packet and indicates the presence of the Response Packet Length and the Response Header before the Secured Data.

- UDHL = "02",
- RPI (or IEIa) = "71",
- **and the IEDLa = "00"** accordingly with TS 23.040.

> **Applet developer tips:**
>
> The applet developer should take care with the length of the additional response data, as the length of the Response Packet cannot exceed 140 octets. If the length of the Response Packet is greater than 140 octets, the additional response data should be concatenated (see Response Packet contained in Concatenated Short Message Point to Point chapter).

12.3.2 Structure of the Response Packet

Element	Length	Comment
Response Packet Identifier (RPI)	1 octet	Identifies a response packet.
Response Packet Length (RPL)	2 octets	Indicates the number of bytes from and including the RHI to the end of the additional response data, including any padding bytes.
Response Header Identifier (RHI)		Null field for SMS-PP.
Response Header Length (RHL)	1 octet	Indicates the number of bytes from and including the RC/CC/DS to the end of the response status code byte.
Toolkit Application Reference (TAR)	3 bytes	It is a copy of the contents of the TAR in the command packet.
Counter (CNTR)	5 bytes	It is a copy of the contents of the CNTR in the command packet.
Padding Counter (PCNTR)	1 byte	Indicates the number of padding bytes at the end of the additional response data.
Response Status Code Byte	1 byte	Coding defined below.
Redundancy Check (RC), Cryptographic Checksum (CC) or Digital Signature (DS)	Variable	Length depending on the algorithm indicated in the command header in the incoming message. A typical value is between four and eight bytes, or zero if no RC/CC/DS is requested.
Additional Response Data	Variable	Optional application specific response data, including padding bytes if required.

If the SPI byte 2 of the incoming message indicates that RC, CC or DS is performed on Response Packet, the fields included are:

- TAR field,
- Counter field,
- Padding Counter field,
- Status Code field,
- Additional Response data field.

RPI, RPL, RHI and RHL may be implemented for the signature computation.

If the SPI byte 2 of the incoming message indicates that cipher is applied on Response Packet, the fields included are:

- Counter field,
- Padding Counter field,
- Status Code field,
- RC/CC/DS field computed,
- Additional Response data field.

If ciphering is performed, first the RC/CC/DS is calculated, and then ciphering is applied.
If the SPI byte 2 of the incoming message indicates that a specific field is unused, then the content field is set to zero.
If the SPI byte 2 of the incoming message indicates that no RC; CC or DS is used, then the field is not present.
If the Padding Counter content is zero, this indicates no padding octets, or no padding is necessary.

12.3.2.1.1 TAR: Toolkit Application Reference.

The TAR is the same as the one defined in the incoming Formatted Message and is automatically provided by the framework.

12.3.2.1.2 CNTR: Counter.

The CNTR is the same as the one defined in the incoming formatted message and is automatically provided by the framework.

12.3.2.1.3 Response Status Code

This information is automatically provided by the framework in the event of an error in the incoming Formatted Message.

The value of this byte is defined in the following table.

Status Code	Meaning
00h	PoR correct.
01h	RC/CC/DS failed.
02h	CNTR low.
03h	CNTR high.
04h	CNTR blocked
05h	Encryption error.
06h	Unidentified security error. This code occurs when the receiving entity cannot correctly interpret the command header, and the response packet is sent unencrypted with no RC/CC/DS.
07h	Insufficient memory to process the incoming message. The meaning of this status code depends on the card manufacturer.
08h	This *more time* status code should be used if the receiving entity/application needs more time to process the command packet due to time constraints. In this case, a later response packet should be returned to the sending entity once processing has been completed.
09h	TAR unknown
0Ah	Insufficient security level
0B h	Actual response data to be sent using SMS-SUBMIT
0Ch - FFh	Reserved for future use.

12.4 Structure of the Single Short Message Point to Point throw the USIM API

There are two ways for card to receive a single Short Message Point to Point: through an ENVELOPE (SMS_PP_DOWNLOAD) APDU, or through an UPATE_RECORD EF_{SMS} APDU.
The received message can be:

- Formatted accordingly to identify explicitly a toolkit application (see chapter Structure of the Command Packet)
- Unformatted and send data to all registered toolkit application.

12.4.1 TLV structure for Envelopes (SMS-PP DOWNLOAD)

APDU Command: 80 C2 00 00 Length

Data Buffer:

Tag	Length	Device Identities				TS-SCA			3GPP-SMS TPDU (DELIVER)					
D1	XX	Tag	Length	Src	Dst	Tag	Length	Val	Tag	Length	23.40		TPUD	
		82	02	83	81	**06**	XX	….	**8B**	XX		**TPUDL**	31.115	Data

When receiving an envelope APDU containing an formatted SMS_DOWLOAD, the USIM Toolkit Framework:

- Verifies the security of the short message,
- Triggers the toolkit applet registered to *EVENT_FORMATTED_SMS_PP_ENV*, and with corresponding TAR,
- Takes the optional Application Data posted by the triggered toolkit application if present,
- Secures and sends response packet using SMS-DELIVER-REPORT or SMS-SUBMIT according the SPI byte 2

When the applet is triggered, the data of short message in the TLV structure are deciphered.

When receiving an envelope APDU containing an Unformatted SMS_DATADOWNLOAD BER simple TLV, the USIM Toolkit Framework triggers all the toolkit applications registered to the `EVENT_UNFORMATTED_SMS_PP_ENV`.

12.4.2 TLV structure for Update EF$_{SMS}$ APDU:

APDU Command: 0X DC 00 02 Length (see TS 102 221)

Data Buffer:

Status	TS-SCA			3GPP SMS TPDU (DELIVER)			
03	Length	TON	Value	23.40		TPUD	
	no. of bytes				**TPUDL**	31.115	Data

When receiving a formatted UPDATE RECORD EF$_{SMS}$, the USIM Toolkit Framework:

- Updates the EF$_{SMS}$ file with the data received; it is then up to the receiving toolkit applet to change the SMS stored in the file, if the applet has the access right,
- Verifies the security of the Short Message,
- Triggers the toolkit applet registered to *EVENT_FORMATTED_SMS_PP_UPD* and with corresponding TAR.
- Converts the Update Record EF$_{SMS}$ into a TLV List:

12.4.3 Structure of the USAT EnvelopeHandler

Tag	Length	Device Identities				TS-SCA			3GPP SMS TPDU (DELIVER)				
D1	XX	Tag	Length	Rcd No	Status	Tag	Length	Value	Tag	Length	23.40	TPUD	
		82	02	Absolute record nb		**86**	XX	….	**8B**	XX	**TPUDL**	23.048	Data

In the Device Identities field, record number is absolute, so that the applet can update EF$_{SMS}$ in absolute mode (e.g. a readable text).

In the TS-SCA field, the value of the TS-Service-Centre-Address is the one of the last Update Record EF$_{SMS}$

If the EF$_{SMS}$ file updated is under an ADF file, then an AID TLV can be added in the USAT `EnvelopeHandler`. The value of the AID TLV, is the AID of the ADF:

AID		
Tag	Length	Value
AF	XX	ADF AID

The order of the TLV in the `EnvelopeHandler` is not specified.

The USAT EnvelopeHandler, handlers by the toolkit applet returns

- The BTAG_SMS_PP_DOWNLOAD to the getEnvelopeTag method,
- the length of the TLV structure defined above to the getLength method.

When receiving an Unformatted UPDATE RECORD EF_{SMS}, the USIM Toolkit Framework:

- Updates the EF_{SMS} file with the data received;
- Convert the UPDATE RECORD EF_{SMS} APDU data into a TLV list as described for formatted Update Record,
- Trigger all toolkit applications registered to the EVENT_UNFORMATTED_SMS_PP_UPD.

12.5 Concatenated Short Message Point to Point Description

12.5.1 General structure of Concatenated Short Message Point to Point Envelope

The envelope structure of the SMS-TPDU is the same as for Single Short Message (see General structure of Single Short Message Point to Point Envelope Chapter).

Nevertheless, the TP element in the SMS_SUBMIT PDU, except the TP_ME, TP_SRR, TP_UDL and the TP_UD, should present same values for each concatenated SM of a same session, otherwise this lead to irrational behavior.

The UDHI bit is set to 1 whatever the Short Message is formatted or not as there is always a User Data Header: the concatenation control header.

12.5.2 General structure of the User Data Header in Concatenated Short Message Point to Point

Example of concatenation of one large SM in three SM:

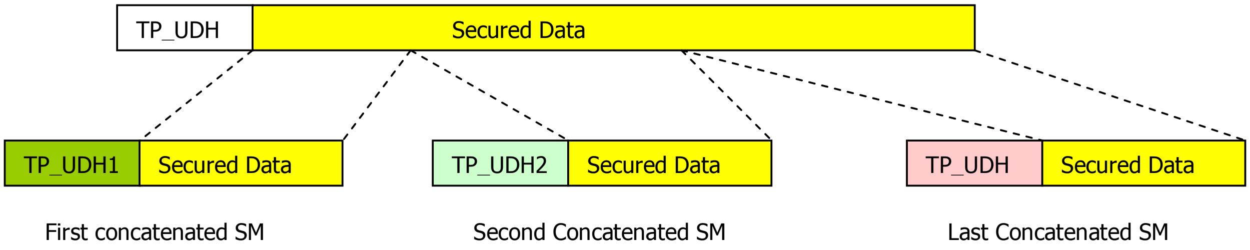


Figure 11 - The User Data Header in C-SM PP

SM specific elements	Generalised Command Packet	Comments
UDL		Indicates the length of the entire SM
UDHL		The first octet of the content or User Data part of the Short Message itself. Length of the total User Data Header includes the length of IEIa + IEIDLa + IEDa + IEIb + IEIDLb + IEDb + …
IEIa	'00', indicating concatenated short message	Identifies this Header as a concatenation control header defined in 3GPP TS 23.040.
IEIDLa	Length of Concatenation header	Length of the concatenation control header (= 3).
IEDa	3 octets containing data concerned with concatenation	These octets contain the reference number, sequence number and total number of messages in the sequence, as defined in 3GPP TS 23.040.
IEIb		Identifies this element as the Packet Identifier.

UDH for concatenated Short Message Point to Point

The Information Element Data field contains information set by the sending entity so that the receiving entity is able to re-assemble the short message in the correct order. The Information Element Data octets are coded as follows:

- Octet 1: Concatenated Short Message reference number: this reference number is constant within a concatenate session
- Octet 2: Maximum number of short message in the concatenate session: indicate the total number of short message within a concatenate session. The value is constant within a concatenate session
- Octet 3: Sequence number of the current message: indicate the sequence number of the short message within a concatenate session.

12.5.3 Structure of the Command Packet contained in Concatenated Short Message Point to Point

If a Command Packet is longer than 140 octets (including the Command Header), it is concatenated according to TS 23.040.

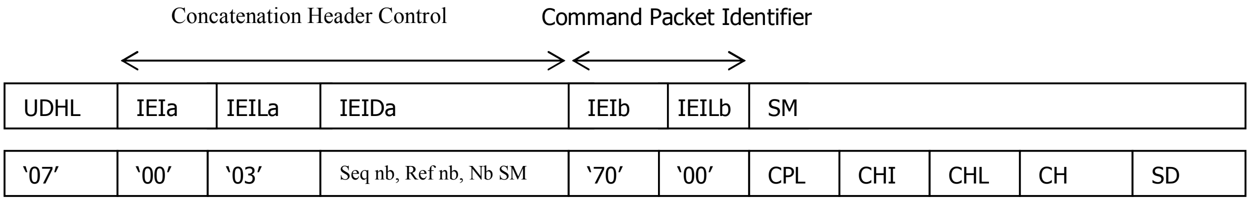
The structure of the Command Packet in a Concatenated Short Message is as defined in Structure of the Command Packet chapter.

The first Short Message contains:

- The Concatenation Control Header, as defined above,
- And the Command Packet Identifier (CPI) in the User Data Header.

In each subsequent Short Message only the Concatenation Control Header is present. The CPI, CPL and Command Header are not present.

First Short Message:



UDHL	IEIa	IEILa	IEIDa	IEIb	IEILb	SM				
‘07’	‘00’	‘03’	Seq nb, Ref nb, Nb SM	‘70’	‘00’	CPL	CHI	CHL	CH	SD

IEIa = ‘00’ indicates concatenate short message
IEIb = ‘70’ indicates CPI

Following Short Messages:

Concatenation Header Control

UDHL	IEIa	IEILa	IEIDa	SD
‘05’	‘00’	‘03’	Seq nb, Ref nb, Nb SM	SD

If data is ciphered, then they are ciphered before being split into individual concatenated Short Message. The Concatenation Control Header of the UDH in each Short Message is not ciphered.

The CPL fields and the CHL field are included in the RC/CC/DS calculation if used.

12.5.4 Structure of the Response Packet contained in Concatenated Short Message Point to Point

If a Response Packet is longer than 140 octets (including the Response Header), it is concatenated according to TS 23.040.

The structure of the Response Packet in a Concatenated Short Message is as defined in Structure of the Response Packet chapter.

The first Short Message contains:

- The Concatenation Control Header, as defined in General Structure of the User Data Header in Concatenated Short Message Point to Point chapter,
- And the Response Packet Identifier (RPI) in the User Data Header.

In each subsequent Short Message only the Concatenation Control Header is present. The RPI, RPL and Response Header are not present.

First Short Message:

Concatenation Header Control Command Packet Identifier

UDHL	IEIa	IEILa	IEIDa	IEIb	IEILb	SM				
‘07’	‘00’	‘03’	Seq nb, Ref nb, Nb SM	‘71’	‘00’	RPL	RHI	RHL	RH	SD

IEIa = ‘00’ indicates concatenate short message
IEIb = ‘71’ indicates RPI

Following Short Messages:

Concatenation Header Control

UDHL	IEIa	IEILa	IEIDa	SD
‘0’5	‘00’	‘03’	Seq nb, Ref nb, Nb SM	SD

If data is ciphered, then they are ciphered before being split into individual concatenated Short Message. The Concatenation Control Header of the UDH in each Short Message is not ciphered.

The RPL fields and the RHL field are included in the RC/CC/DS calculation if used.

12.5.5 Structure of the Concatenated Short Message Point to Point throw the USIM API

As for single Short Message, it is possible for card to receive multiple short messages via an ENVELOPE (SMS_PP_DOWNLOAD) APDU, or via an UPATE_RECORD EF_{SMS} APDU.
The received message can be:

- Formatted accordingly to identify explicitly a toolkit application (see chapter Structure of the Command Packet) and send the data to it
- Unformatted and send data to all registered toolkit application.

12.6 TLV structure for Envelopes (SMS-PP DOWNLOAD)

When Short Message are received concatenated, the USIM Toolkit framework re-assembles the original message before any further processing, and places in one SMS TPDU TLV (with TP-UDL field coded on one byte) included in the USAT `EnvelopeHandler`. The concatenation control headers used to re-assemble the short messages in the correct order are not present in the SMS TPDU.
The TP-elements of the SMS TPDU and the Address (TS-Service-Centre-Address) correspond to the ones in the last received Short Message (independently of the Sequence number of Information-Element-Data).

The minimum requirement for the USIM Toolkit Framework is to process a concatenated short message with the following properties:

- The Information Element Identifier is equal to the 8-bit reference number.
- It contains uncompressed 8 bit data and additionally the DCS shall be set to ‘Class 2’.

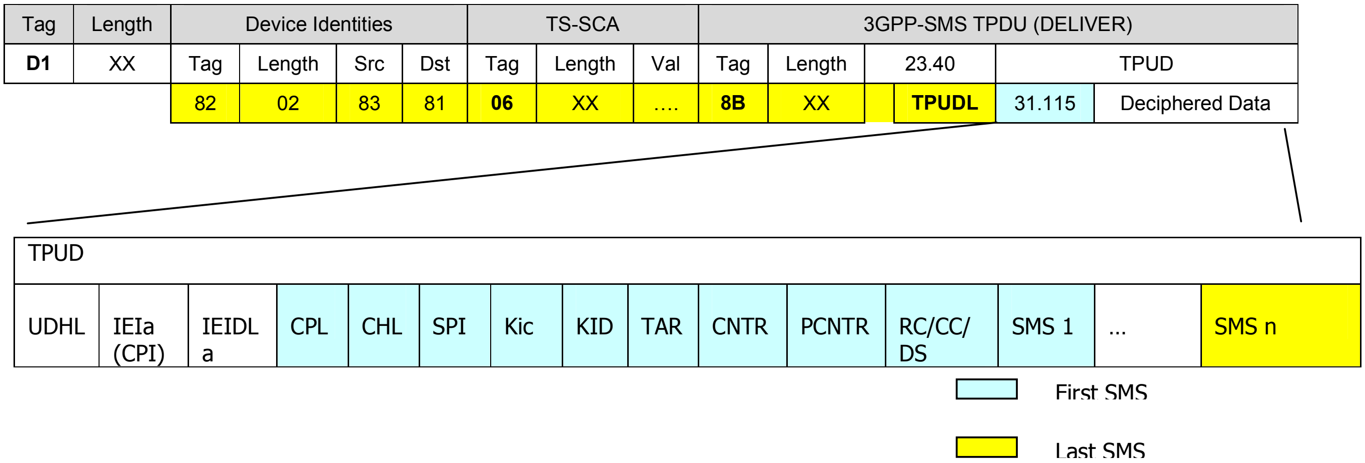
12.6.1 Formatted Short Message

In the case of envelope formatted short message, the USIM Toolkit framework:

- Verifies the security of the Short Message
- Re-assemble all the Short Message
- Trigger toolkit application registered to the *EVENT_FORMATTED_SMS_PP_ENV*, with the corresponding TAR,

When the toolkit applet is triggered, message data are deciphered though the `USATEnvelopeHandler.`

Structure of the `USATEnvelopeHandler`



Tag	Length	Device Identities				TS-SCA			3GPP-SMS TPDU (DELIVER)				
D1	XX	Tag	Length	Src	Dst	Tag	Length	Val	Tag	Length	23.40	TPUD	
		82	02	83	81	**06**	XX	….	**8B**	XX	**TPUDL**	31.115	Deciphered Data

TPUD														
UDHL	IEIa (CPI)	IEIDL a	CPL	CHL	SPI	Kic	KID	TAR	CNTR	PCNTR	RC/CC/ DS	SMS 1	…	SMS n

🟦 First SMS

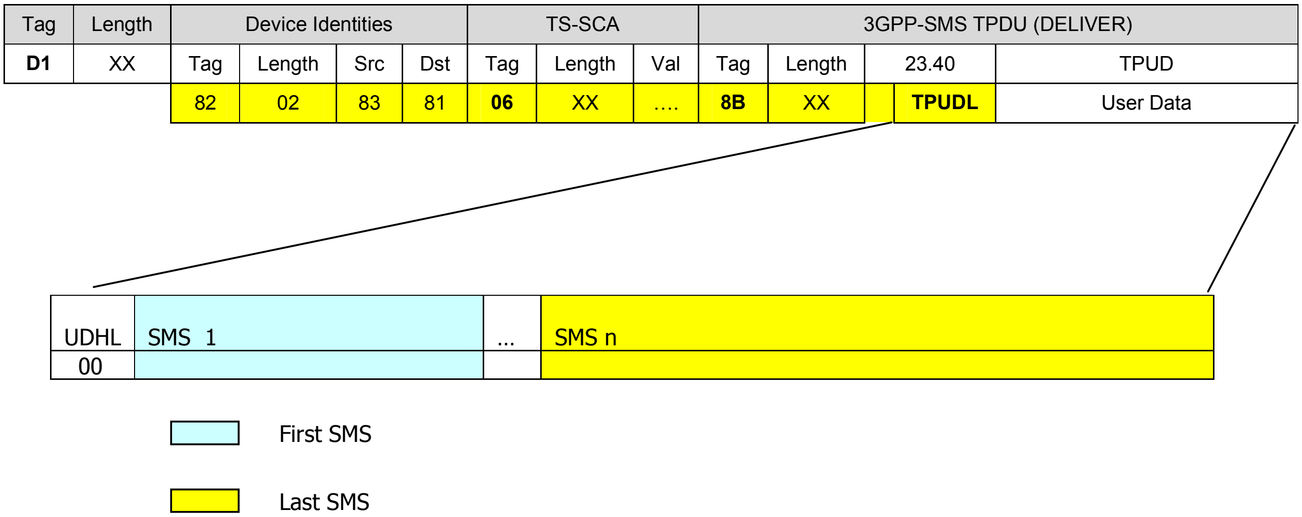
🟨 Last SMS

Figure 12 - The USAT Envelope Handler content in case of Formatted SM

12.6.1.1.1 Unformatted Short Message

After reassembles appropriately the different short message, the USIM toolkit framework trigger all applets registered to the EVENT_UNFORMATTED_SMS_PP_ENV.

Structure of the `USATEnvelopeHandler`



Tag	Length	Device Identities				TS-SCA			3GPP-SMS TPDU (DELIVER)			
D1	XX	Tag	Length	Src	Dst	Tag	Length	Val	Tag	Length	23.40	TPUD
		82	02	83	81	**06**	XX	….	**8B**	XX	**TPUDL**	User Data

UDHL	SMS 1	…	SMS n
00			

🟦 First SMS

🟨 Last SMS

12.6.2 TLV structure for Update Record

When formatted concatenated Short Message are sent via Update Record EF_{SMS} APDU, the USIM Toolkit framework:

- Updates the EF_{SMS} file with the data received,
- Verifies the security of the short message,
- Triggers the toolkit applet registered to *EVENT_FORMATTED_SMS_PP_UPD* and with corresponding TAR,
- Converts the Update Record EF_{SMS} into a TLV List:

Structure of the `USATEnvelopeHandler`

Tag	Length	Device Identities				TS-SCA			3GPP SMS TPDU (DELIVER)				
D1	XX	Tag	Length	Rcd No	Status	Tag	Length	Value	Tag	Length	23.40	TPUD	
		82	02	Absolute record nb		**86**	XX	….	**8B**	XX	**TPUDL**	31.115	Data

In the Device Identities field, Absolute Record Number and Record Status correspond to the last Update Record EF_{SMS} APDU received.
In the TS-SCA, fields correspond to the last Update Record EF_{SMS} APDU received.

An AID TLV can be present in the structure of the USAT, if EF_{SMS} file is under an ADF. The value of AID TLV is the AID of the ADF.

AID		
Tag	Length	Value
AF	XX	ADF AID

When receiving an unformatted UPDATE RECORD EF_{SMS}, the USIM Toolkit Framework:

- Updates the EF_{SMS} file with the data received;
- Converts the UPDATE RECORD EF_{SMS} APDU data into a TLV list as described for formatted Update Record,
- Triggers all toolkit applications registered to the `EVENT_UNFORMATTED_SMS_PP_UPD`.

12.6.3 Methods to retrieve UDL

To retrieve the length of the User Data, the `getUserDataLength` method must be used, as the value indicated in the TP-UDL field of the USAT `EnvelopeHandler` correspond at the last concatenated Short Message received. The `getUserDataLength` method will return the length from the UDHL to the last byte of the deciphered data.

12.7 Concatenated SMS and Interoperability issues

- The API handling of outgoing concatenated SMS is not standardized. Therefore it is up to the application to manage the sending of outgoing concatenated SMS.

- When the card is about to receive a concatenated SMS, which has not been entirely received, and the card receives during this process a concatenated SMS with a different reference number, and then the cards of the SIM Alliance members react differently, they are not interoperable at this point.

- The SIM Alliance members have set up different mechanisms in order to allocate space for concatenated SMS in memory. Therefore interoperability cannot be guaranteed for the method to allocate memory space for concatenated SMS. Nevertheless the SIM Alliance members guarantee that there are means available on each card to reserve a minimum memory space for the reception of concatenated SMS.

12.8 Short Message Cell Broadcast Description

12.8.1 Structure of the CBS page in the SMS-CB Message

The CBS page sent to the MS by the BTS (Base Transceiver Station) is a fixed block of 88 octets as coded in GSM 24.012. The 88 octets of CBS information consist of a 6-octet header and 82 user octets.
The 6-octet header is used to indicate the message content as defined in 3GPP TS 23.041. This header is required to be transmitted unsecured in order for the ME to handle the message in the correct manner (e.g. interpretation of the DCS).
General structure

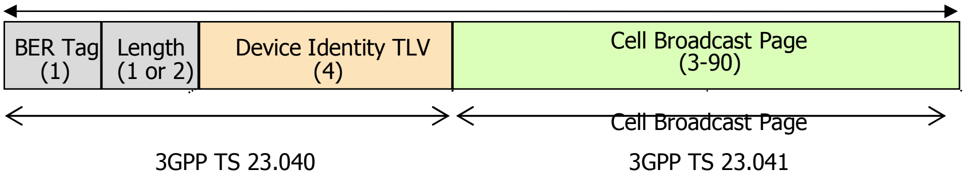


Figure 13 - The CBS pages

12.8.2 Cell Broadcast Page Parameters

Octet Number(s)	Field
1-2	Serial Number
3-4	Message Identifier
5	Data Coding Scheme
6	Page Parameter
7-88	Content of Message

12.8.2.1.1 Serial Number

This parameter is a 16-bit integer, which identifies a particular CBS message (which may be one to fifteen pages in length) from the source and type indicated by the Message Identifier and is altered every time the CBS message with a given Message Identifier is changed. For more detail refer to 3GPP TS 23.041.

12.8.2.1.2 Message Identifier

This parameter identifies the source and type of the CBS message. A number of CBS messages may originate from the same source and/or be of the same type. These will be distinguished by the Serial Number. The Message Identifier is coded in binary.
The ME shall attempt to receive the CBS messages whose Message Identifiers are in the "search list". This "search list" shall contain the Message Identifiers stored in the EF_{CBMI}, EF_{CBMID} and EF_{CBMIR} files on the SIM and any Message Identifiers stored in the ME in a "list of CBS messages to be received". If the ME has restricted capabilities with respect to the number of Message Identifiers it can search for, the Message Identifiers stored in the SIM shall take priority over any stored in the ME.
For SMS CB Message, the Message Identifier use the range:

1000 - 107F (hex):	for Cell Broadcast Data Download in "clear" (i.e. unsecured) to the USIM (see 3GPP TS 31.111). If a message Identifier from this range is in the "search list", the ME shall attempt to receive this CBS message.
1080 – 10FF (hex):	for Cell Broadcast Data Download secured according to 3GPP TS 31.115 to the SIM (see 3GPP TS 31.111). If a message Identifier from this range is in the "search list", the ME shall attempt to receive this CBS message.

12.8.2.1.3 Data Coding Scheme

This parameter indicates the intended handling of the CBS message at the MS, the alphabet/coding, and the language (when applicable). This is defined in 3GPP TS 23.038.

12.8.2.1.4 Page Parameter

This parameter is coded as two 4-bit fields. The first field (bits 0-3) indicates the binary value of the total number of pages in the CBS message and the second field (bits 4-7) indicates binary the page number within that sequence. The coding starts at 0001, with 0000 reserved. If a mobile receives the code 0000 in either the first field or the second field then it shall treat the CBS message exactly the same as a CBS message with page parameter 0001 0001 (i.e. a single page message).

12.8.2.1.5 Content of Message

This parameter is a copy of the 'CBS-Message-Information-Page' as sent from the CBC (Cell Broadcast Centre) to the BSC (Base Station Controller).
The content of the message is secured as defined in this document.

12.8.3 A Command Packet contained in a SMS-CB message

The relationship between the Command Packet and its inclusion in the SMS-CB message structure is indicated in the table above.

Command Packet in CBS page of an SMS-CB message:

SMS-CB specific elements	**Generalised Command Packet Elements**	**Comments**
SN		Refer to 3GPP TS 23.041. Coded on 2 octets containing the ID of a particular message.
MID	CPI='1080' to '109F'	Coded on 2 octets containing the source and type of the message. The Command Packet Identifier range is reserved in 3GPP TS 23.041. (see note)
DCS		Refer to 3GPP TS 23.041. Coded on 1 octet containing the alphabet coding and language as defined in GSM 23.038.
PP		Refer to 3GPP TS 23.041. Coded on 1 octet to indicate the page number and total number of pages.
Content of Message	CPL	Length of the Command Packet, coded over 2 octets, and shall not be coded according to ISO/IEC 7816-6.
	CHI	The Command Header Identifier. Null field.
	CHL	This shall indicate the number of octets from and including the SPI to the end of the RC/CC/DS field. Binary coded over 1 octet.
	SPI to RC/CC/DS in the Command Header	The remainder of the Command Header.
	Secured Data	Application Message, including possible padding octets.

NOTE: Generally, the CPI is coded on 1 octet, as specified in Structure of Command Packet Chapter. However, the CPI for the SMS-CB message is coded on 2 octets as the values reserved in 3GPP TS 23.041 to identify the Command Packet are MID values which are coded on 2 octets.

12.8.4 Structure of the Response Packet for a SMS-CB Message

As there is no response mechanism defined for SMS-CB, there is no defined structure for the (Secured) Response Packet.
However, if a (Secured) Response Packet is sent via another bearer the structure shall be defined by the Receiving Application.

12.8.5 Structure of Short Message Cell Broadcast throw the USIM API

A received Cell Broadcast Message, via en ENVELOPE (CELL BROASCAST DOWNLOAD) APDU can be either:

- Formatted according Command Packet contained in a SMS-CB message chapter,
- Unformatted.

12.8.5.1.1 Formatted Short Message Cell Broadcast (1 Page):

When the card receives a formatted Short Message Cell Broadcast page, the USIM Toolkit application:

- Verifies the security of the message,
- Triggers the toolkit applet registered to *EVENT_FORMATTED_SMS_CB*, with the corresponding TAR.

Structure of the `USATEnvelopeHandler`:

Tag	Len	Device Identities				Cell Broadcast Page						3GPP TS 31.115			
D2	xx	Tag	Len	Src	Dst	Tag	Len	SN	MI	DCS	PP	CPL	CHL	SPI to RC/CC/DS	Secured datc (note1)
		82	02	83	81	**8C**	xx	xx xx	10 80	56	00				

Note: data are deciphered, as it is required in 3GPP TS 31.115.

12.8.5.1.2 Unformatted Short Message Cell Broadcast (1 Page):

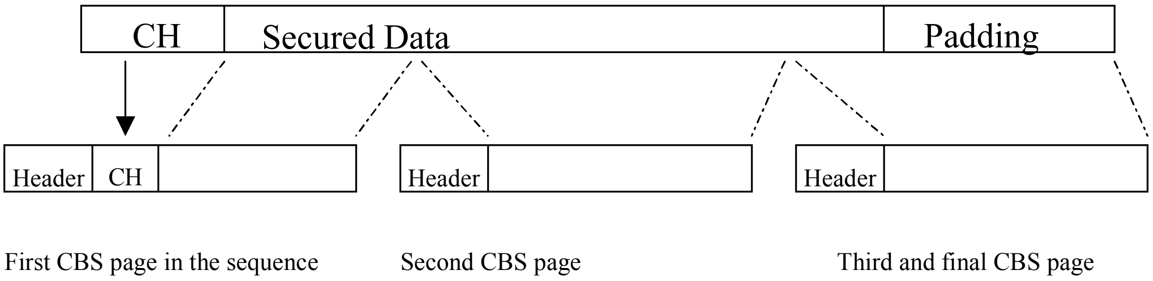
When the card receives an unformatted Short Message Cell Broadcast page, the USIM Toolkit application triggers all toolkit applets registered to *EVENT_UNFORMATTED_SMS_CB*.

Structure of the `USATEnvelopeHandler`:

Tag	Len	Device Identities				Cell Broadcast Page								
D2	xx	Tag	Len	Src	Dst	Tag	Len	SN		MI		DCS	PP	data
		82	02	83	81	**8C**	xx	xx	xx	10	00	56	00	

12.9 Multiple Short Message Cell Broadcast Description

It is possible to send more than 82 octets with Short Message CBC. The Command Packet is then split over a sequence of SMS_CB pages.



In the above figure, Header = 6 Octet header as defined in TS 23.041 [6] (i.e. SN, MID, DCS and PP) and CH = Command Header includes here the CPL, CHL, SPI to RC/CC/DS.

Figure 14 - CBS structure with Secured Data

Securing of the complete CBS message is done by the Sending Entity. The Secured CBS message is formatted in accordance with 3GPP TS 31.115 and transmitted to the MS as CBS pages. The CBS pages are received by the ME and sent directly to the USIM Toolkit Application, by analyzing the MID value.

12.9.1 Structure of Multiple Short Messages Cell Broadcast throw the USIM API

When the Cell Broadcast Message is received as multiple pages, the USIM Toolkit application reassembles the global message before any further processing.

12.9.1.1.1 Formatted Multiple Short Message Cell Broadcast:

When the card receives formatted multiple Short Message Cell Broadcast, the Toolkit:

- Verifies the security of the message,
- Decrypts the message,
- Triggers the toolkit applet registered to `EVENT_FORMATTED_SMS_CB`, with the corresponding TAR.

Structure of the `USATEnvelopeHandler`:

Tag	Len	Device Identities				Cell Broadcast Page								3GPP TS 31.115					
D2	xx	Tag	Len	Src	Dst	Tag	Len	SN		MI		DCS	PP	CPL	CHL	SPI to RC/CC/DS	Secured data		
		82	02	83	81	**8C**	xx	xx	xx	10	80	56	22				Sm1	..	Sm n

🟨 First SM CB

🟦 Last SM CB

Figure 15 – USAT Envelope Handler in case of formatted CB

12.9.1.1.2 Unformatted Multiple Short Message Cell Broadcast:

When the card receives unformatted multiple Short Message Cell Broadcast, the USIM Toolkit application triggers all toolkit applets registered to *EVENT_UNFORMATTED_SMS_CB*.

Structure of the USAT Envelope Handler:

Tag	Len	Device Identities				Cell Broadcast Page										
D2	xx	Tag	Len	Src	Dst	Tag	Len	SN		MI		DCS	PP	data		
		82	02	83	81	**8C**	xx	xx	xx	10	00	56	00	Sm1	…	Sm n

🟨 First SM CB

🟦 Last SM CB

Figure 16 – USAT Envelope Handler in case of unformatted CB

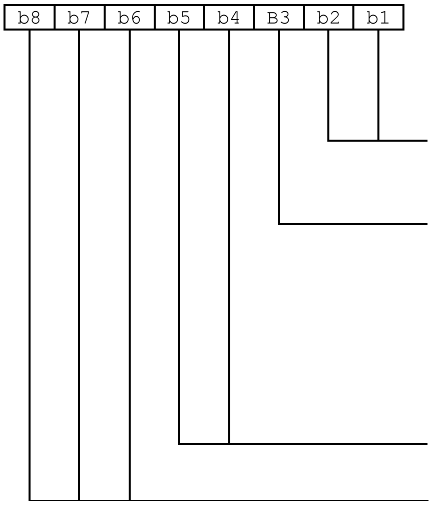
13 Security Parameters Description for Secure Packets

13.1 Coding of the SPI: Security Parameter Indicator

These two bytes defined the security level applied to the input and output message. This includes whether counter verification and a PoR (Proof of Receipt) are required along with the associated security level.

If the SPI indicates that a specific field is unused, the Sending Entity shall set the contents of this field to zero, and the Receiving Entity shall ignore the contents.
If the SPI indicates that no RC, CC or DS is present in the Command Header, the RC/CC/DS field shall be of zero length.

First Octet:



00: No RC, CC or DS
01: Redundancy Check
10: Cryptographic Checksum
11: Digital Signature

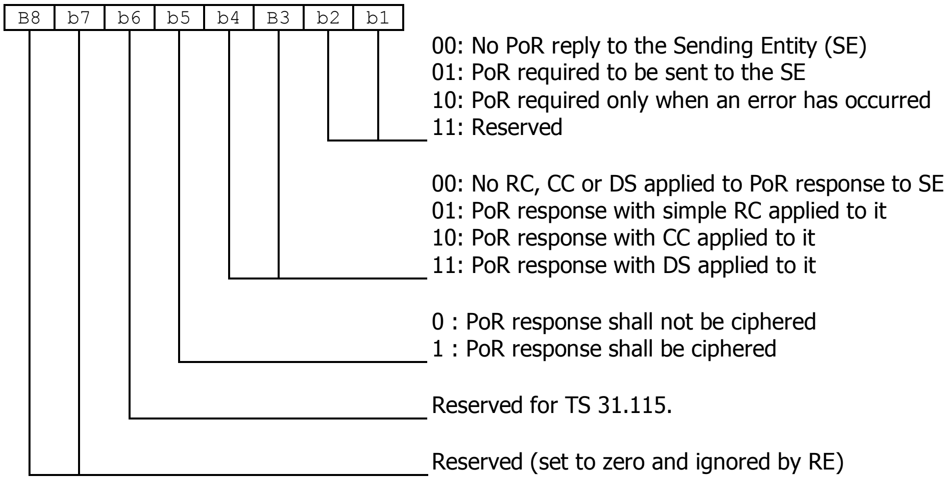
0 : No Ciphering
1 : Ciphering

00: No counter available (note 1)
01: Counter available; no replay or sequence checking (note 2)
10: Process if and only if counter value is higher than the value in the RE (note 3)
11: Process if and only if counter value is one higher than the value in the RE (note 4)

Reserved (set to zero and ignored by RE)

NOTE 1: In this case the counter field is present in the message.
NOTE 2: In this case the counter value is used for information purposes only, (e.g. date or time stamp). If the Command Packet was successfully unpacked, the counter value can be forwarded from the Receiving Entity to the Receiving Application. This depends on proprietary implementations and happens in an application dependent way.
NOTE 3: The counter value is compared with the counter value of the last received Command Packet. This is tolerant to failures on the transport level (i.e. losses of Command Packets). A possible scenario is a global update.
NOTE 4: This provides strict control in addition to security indicated in note 3.

Second Octet:



B8	b7	b6	b5	b4	B3	b2	b1

b2 b1:
00: No PoR reply to the Sending Entity (SE)
01: PoR required to be sent to the SE
10: PoR required only when an error has occurred
11: Reserved

b4 b3:
00: No RC, CC or DS applied to PoR response to SE
01: PoR response with simple RC applied to it
10: PoR response with CC applied to it
11: PoR response with DS applied to it

b5:
0 : PoR response shall not be ciphered
1 : PoR response shall be ciphered

b6:
Reserved for TS 31.115.

B8 b7:
Reserved (set to zero and ignored by RE)

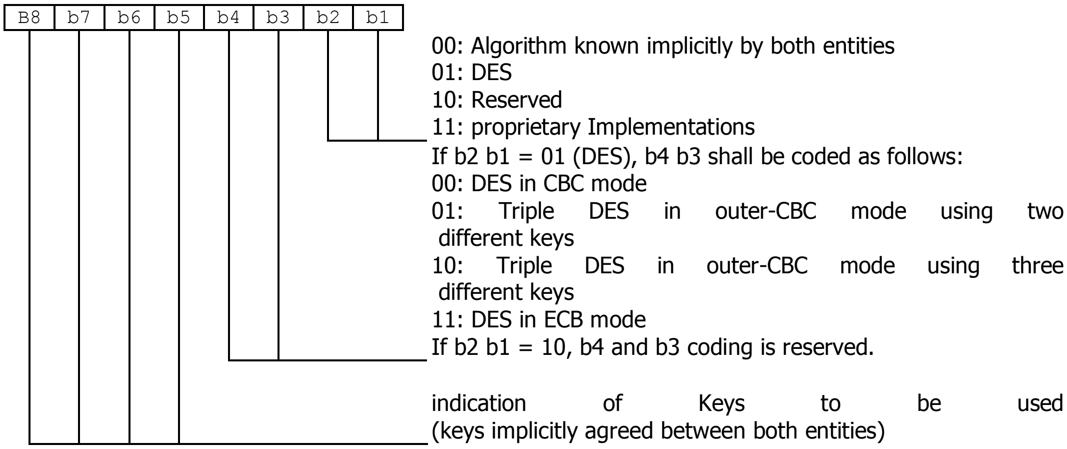
If RC, CC or DS is applied to the Command Packet i.e. SPI1.b2b1 is different from '00' and if RC, CC or DS is applied to the Response Packet i.e. SPI2.b4b3 is different from ‘00’, then SPI2.b4b3 shall be set to the same value as SPI1.b2b1.

> **Interoperability issue**
> There is no definition, and so interoperability, about the Digital Signature functionality in the RC/CC/DS field.

13.1.1 Coding of the Kic field

The Kic byte indicates the algorithm and the key to be used to decrypt the Command Packet if encryption is used, and encrypt Response Packet if specified in the bits5 of the SPI2.

The KIc is coded as below.



B8	b7	b6	b5	b4	b3	b2	b1

b2 b1:
00: Algorithm known implicitly by both entities
01: DES
10: Reserved
11: proprietary Implementations

b4 b3:
If b2 b1 = 01 (DES), b4 b3 shall be coded as follows:
00: DES in CBC mode
01: Triple DES in outer-CBC mode using two different keys
10: Triple DES in outer-CBC mode using three different keys
11: DES in ECB mode
If b2 b1 = 10, b4 and b3 coding is reserved.

B8 b7 b6 b5:
indication of Keys to be used (keys implicitly agreed between both entities)

DES is the algorithm specified as DEA in ISO 8731-1.
DES in CBC mode is described in ISO/IEC 10116.
Triple DES in outer-CBC mode is described in clause 15.2 of ISBN 0-471-12845-7.
DES in ECB mode is described in ISO/IEC 10116.

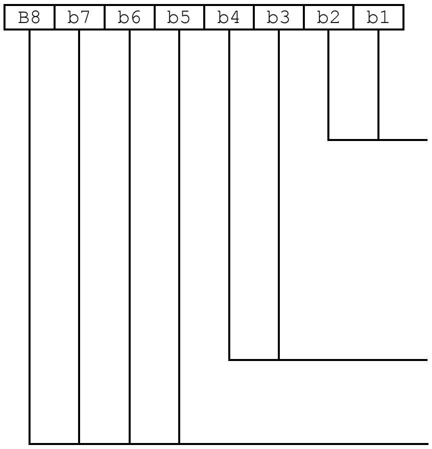
The initial chaining value for CBC modes shall be zero.
For GlobalPlatform security architecture compliant cards see § 18.

13.1.2 Coding of the KID field

KID byte indicates the algorithm and key to be used if Cryptographic Checksum or Redundancy Check has to be checked on the Command Packet or performed on the Response Packet.

13.1.3 Coding of the KID for Cryptographic Checksum

If b2b1= '10' (Cryptographic Checksum) in the first byte of SPI, KID is coded as following:



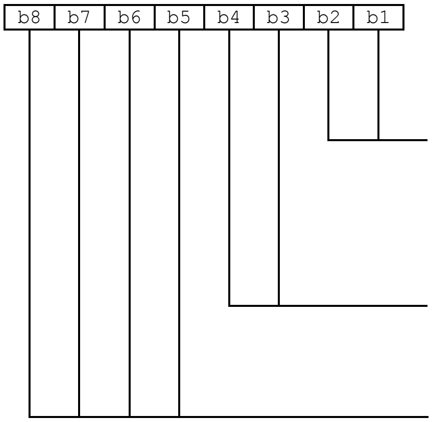
00: Algorithm known implicitly by both entities
01: DES
10: Reserved
11: proprietary Implementations
If b2 b1 = 01 (DES), b4 b3 shall be coded as follows:
00: DES in CBC mode
01: Triple DES in outer-CBC mode using two different keys
10: Triple DES in outer-CBC mode using three different keys
11: Reserved
If b2 b1 = 10, b4 and b3 coding is reserved.

indication of Keys to be used (keys implicitly agreed between both entities)

DES is the algorithm specified as DEA in ISO 8731-1.
DES in CBC mode is described in ISO/IEC 10116.
Triple DES in outer-CBC mode is described in clause 15.2 of ISBN 0-471-12845-7.
The initial chaining value for CBC modes shall be zero.
If padding is required, the padding octets are coded hexadecimal '00'. These octets are not be included in the secured data.

13.1.4 Coding of the KID for Redundancy Check

If b2b1= '01' (Redundancy Check) in the first byte of SPI, KID is coded as follows:



00: Algorithm known implicitly by both entities
01: CRC
10: Reserved
11: proprietary Implementations

If b2b1=01 (CRC), b4b3 shall be coded as follows:
00: CRC 16
01: CRC 32
10 to 11: Reserved
If b2b1 = 10, b4 and b3 coding is reserved.

For Proprietary use or
For GlobalPlatform security architecture compliant cards: indication of Keys to be used

CRC algorithm is specified in ISO/IEC 10239.
The generator polynomial used for CRC 16 is X^16+X^12+X^5+1.
The generator polynomial used for CRC 32 is X^32 +X^26 +X^23 +X^22 +X^16 +X^12 +X^11 +X^10 +X^8 +X^7 +X^5 +X^4 +X^2 +X +1.
The least significant bit of the first byte to be included in the checksum represents the most significant term of the input polynomial.
The least significant term of the output polynomial represents the most significant bit of the first byte of the RC/CC/DS field.
The initial value of the register is 'FFFF' for CRC 16 and 'FFFFFFFF' for CRC 32.
The CRC result is obtained after an XOR operation of the final register value with ‘FFFFFFFF’ for CRC 32 or 'FFFF' for CRC 16.

13.2 Counter Field and Management

If in the first SPI byte b4b5=00 (No counter available) the five byte counter must be present in the command packet, but it is ignored by the RE and the RE does not update the counter.

If b5 of the first SPI byte is equal to 1 then the following rules shall apply to counter management, with the goal of preventing replay and synchronization attacks:

- The SE sets the counter value. It is only incremented.
- The RE shall update the counter to its next value upon receipt of a Command Packet after the corresponding security checks (i.e. RC/CC/DS and CNTR verification) have been passed successfully.
- The next counter value is the one received in the incoming message.
- When the counter value reaches its maximum value the counter is blocked.

If there is more than one SE, care has to be taken to ensure that the counter values remain synchronized between the SE's to what the RE is expecting, irrespective of the transport mechanism employed.
The level of security is indicated via the proprietary interface between the Sending/Receiving Application and Sending/Receiving Entity. Application designers should be aware that if the Sending Application requests "No RC/CC/DS" or "Redundancy Check" and "No Counter Available" from the SE, no security is applied to the Application Message and therefore there is an increased threat of malicious attack.

14 BIP commands and events

14.1 Introduction to the Bearer Independent Protocol (BIP)

According to TS 102 223, the Bearer Independent Protocol (BIP) is a mechanism by which the terminal provides the UICC with access to the data bearers supported by the terminal and the network. This feature enables a UICC to establish a data channel through the handset to a remote server in the network. Depending on UICC / ME capabilities BIP can handle up to 7 open data channels at the same time.

BIP is a set of USAT commands that defines an interface between the (U)SIM and the mobile phone for high-speed data exchange. With an open channel command the UICC has to give information to the mobile about its preferred bearer type (e.g. CSD, Packet Data Service or local bearer) and also its preferred terminal interface transport level (e.g. TCP or UDP for GPRS). The definition of this terminal interface transport level which is used between the mobile and the server is out scope for BIP and not described in TS 31.111.

BIP does not reflect reliability and security of the transferred data which must be handled by additional protocols (e.g. CAT-TP).. Please refer to section § Reliability and Security using BIP for details.

Following graphic shows the BIP protocol stack (using the GPRS bearer):

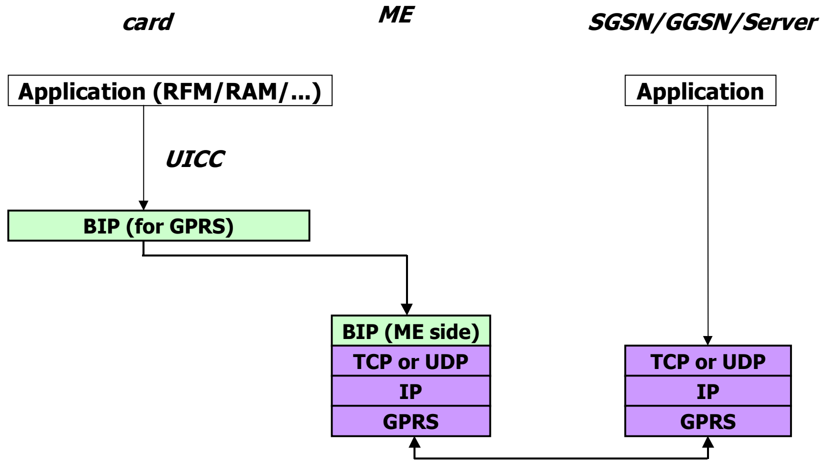


Figure 17 –BIP Protocol stack

- SGSN: Serving GPRS Support Node
- GGSN: Gateway GPRS Support Node

As defined in TS 102 223 (Annex A) the BIP commands and events are separated into different classes "e" and "f". This categorization is also reflected in the Terminal Profile sections, as seen in the following section.

- The following USAT table reflect the standard BIP command/event-set (class "e"):

Proactive command: OPEN CHANNEL
Proactive command: CLOSE CHANNEL
Proactive command: RECEIVE DATA
Proactive command: SEND DATA
Proactive command: GET CHANNEL STATUS
Event download: Data available
Event download: Channel status

- Some additional commands and events (class "f") relevant to BIP are used for local bearers mainly (e.g. Bluetooth, IrDA):

Proactive command: SERVICE SEARCH
Proactive command: GET SERVICE INFORMATION
Proactive command: DECLARE SERVICE
Event download: Local connection event

The BIP commands and events are available for 2G and 3G with following bearers:

Network Bearers:

- CSD and HSCSD bearer
  Circuit Switched Data bearer, this is a „regular" data call used in a 2G network
  High Speed Circuit Switched Data bearer, this is an optional high speed data call used in a 2G network

- Packet Data Service
  GPRS (General Packet Radio Service) for packet oriented connection used in 2G networks, or UTRAN for packet oriented connection used in 3G networks

Local Bearers:
e.g. Bluetooth and IrDA links

14.2 BIP Commands description

14.2.1 OPEN CHANNEL

This command enables the SIM to open a data channel. The UICC has to provide all necessary information to the ME related to the desired bearer (e.g. APN for GPRS, Address for CSD, etc.).
It is up to the ME to allocate send/receive buffers for the data transfer, allocate a channel Id for the UICC/ME data exchange and open the data channel.
The ME informs the UICC about the connection status either via the TERMINAL RESPONSE (after execution of the OPEN CHANNEL command) or via an Envelope Command (EVENT DOWNLOAD - Channel Status).
The following list summarizes the different modes of the OPEN CHANNEL command:

14.2.2 OPEN CHANNEL related to Circuit Switched bearer

The UICC indicates whether the terminal should establish the link immediately or upon receiving the first transmitted data (on demand).

The UICC provides to the terminal a list of parameters necessary to establish a link.

The UICC may request the use of an automatic reconnection mechanism. The UICC may also request an optional maximum duration for the reconnection mechanism. The terminal shall attempt at least one link establishment set-up.

The UICC may also request an optional maximum duration for the terminal to automatically release the link if no data is exchanged.

If the Fixed Dialing Number service is enabled, the address included in the OPEN CHANNEL proactive command will not be checked against those of the FDN list.

If the terminal supports the Last Number Dialed service, the terminal does not store the channel set-up details (called party number and associated parameters) sent by this UICC command in EF_{LND}.

14.2.2.1 OPEN CHANNEL related to packet data service bearer

The UICC indicates whether the terminal should establish the link immediately, in background mode or upon receiving the first transmitted data (on demand).

The UICC provides to the terminal a list of parameters necessary to activate a packet data service.

The terminal will attempt at least one packet data service activation.

> **Example of GPRS Open channel:**
>
> If "immediate packet data service activation" is requested, the ME allocates buffers, activates the PDP (Packet data protocol) context, informs the SIM and reports the channel Id using TERMINAL RESPONSE (Command performed successfully).
>
> If "on demand" PDP packet data service activation is requested, the ME allocates buffers, informs the SIM and reports the channel identifier using TERMINAL RESPONSE (Command performed successfully).
>
> If "background mode" packet data service activation is requested, the ME does the same steps as under "on demand PDP".
> At the end of activation (which can take a longer time depending on the network) the terminal sends a channel status event (Link Established) to the UICC.
>
> **Developer Tip:**
> In case of an error in opening a channel in background mode the ME sends a Channel Status Event „Link not established - no further info".

14.2.2.2 OPEN CHANNEL related to local bearer

This command is used to establish a connection using a local bearer (Bluetooth, IrDA, RS232, USB). The UICC can act as a server or a client. In the server use case, the UICC performs an OPEN CHANNEL only after having received a Local Connection event from the terminal.

Upon receiving this command, the ME decides if it is able to execute the command. The UICC indicates whether the ME should establish the link immediately or upon receiving the first transmitted data (on demand).

The UICC provides to the terminal a list of parameters necessary to establish a link.

The UICC may request the use of an automatic reconnection mechanism. The UICC may also request an optional maximum duration for the reconnection mechanism. The terminal attempts at least one link establishment set-up.

The UICC may also request an optional maximum duration for the terminal to automatically release the link if no data is exchanged.

14.2.2.3 OPEN CHANNEL related to Default (network) Bearer

The UICC indicates whether the terminal should establish the link immediately or upon receiving the first transmitted data (on demand).

The terminal is responsible for providing the parameters necessary to establish the connection (e.g. APN for GPRS, Address for CSD, etc.).

Upon receiving this command, the terminal decides if it is able to execute the command. Example behaviours are listed in clauses for the selected bearer.

> **Developer Tip:**
> This functionality needs to be handled carefully, because the result is extremely linked to the terminal configuration.

14.2.2.4 OPEN CHANNEL comparison of parameters

The following table shows all parameters of the different OPEN CHANNEL commands:

Description	CS bearer	packet data service bearer	local bearer	default (network) bearer
Proactive UICC command Tag	M	M	M	M
Length (over following parameters)	M	M	M	M
Command details	M	M	M	M
Device identities	M	M	M	M
Alpha identifier	O	O	O	O
Icon identifier	O	O	O	O
Address	M	-	-	-
Subaddress	O	-	-	-
Duration 1 (present if Duration 2 is present)	C	-	C	-
Duration 2	O	-	O	-
Bearer description	M	M	M	M
Buffer size	M	M	M	M
Network Access Name	-	O	-	-
Other address (local address)	O	O	-	O
Text String (User login)	O	O	-	O
Text String (User password)	O	O	O	O
UICC/terminal interface transport level	O	O	O	O
Data destination address (requested when a UICC/terminal interface transport is present)	C	C	C	C
Remote Entity Address	-	-	O	-
Text Attribute (may be present only if the Alpha Identifier is present)	C	C	C	C
Frame Identifier	O	O	O	O

Legend:

M	=	Mandatory
C	=	Conditional (dependency described in brackets)
O	=	Optional
-	=	not available

14.2.3 CLOSE CHANNEL

This command requests the ME to close the channel corresponding to the Channel identifier.

The ME releases the data transfer, discards the remaining data in the buffer, and informs the UICC that the command has been successfully executed, using TERMINAL RESPONSE;

14.2.4 SEND DATA

Once a channel has been successfully opened, this command requests the ME to send data through the previously set up data channel corresponding to a dedicated Channel identifier. Upon receiving this command, the ME either immediately sends data or stores provided data into the Tx buffer corresponding to the Channel identifier.

14.2.5 RECEIVE DATA

This command requests the ME to return data from a dedicated Channel identifier according to the number of bytes specified by the UICC.
Then, upon receiving this command, if the requested number of bytes is available in the buffer, the ME informs the UICC that the command has been successfully executed, using TERMINAL RESPONSE and returns the requested data and the number of bytes remaining in the channel buffer (or FF if more than the maximum bytes remain).

14.2.6 GET CHANNEL STATUS

This command requests the ME to return a Channel status for each dedicated Channel identifier using TERMINAL RESPONSE.
Channel Status information contains e.g. Channel Identifier, Link establishment status, Link dropping.

14.2.7 SERVICE SEARCH

This command is used to search for the availability of a local service in the environment of the terminal, such as Bluetooth or IrDA.
The UICC may provide a Device Filter. The devices responding to the service search are then part of the set given by Device Filter. If the Device Filter parameter is not present, no filter on the type of equipment is done by the terminal.
The UICC provides a Service Search parameter. The devices responding to the service search then support the requested service.

14.2.8 GET SERVICE INFORMATION

This proactive command is used to look for the complete service record related to a service. By service record, it is meant all information that allows the UICC to define precisely the service (e.g. protocol stacks).
The UICC provides the Attribute Information parameter which indicates which detailed information is required.

If the terminal is able to execute the command the terminal performs the search for the service details and informs the UICC using TERMINAL RESPONSE (command performed successfully, Service Record). The Service Record is then used as argument of an Open Channel proactive command.

If the CAT application already has all information concerning the service, it may directly try to connect the service performing an OPEN CHANNEL, and bypass the GET SERVICE INFORMATION step.

14.2.9 DECLARE SERVICE

This command allows the UICC to download into the terminal service database the services that the card provides as a server. The declaration is to be made on a service by service basis, at the set-up (e.g. after the profile download). The UICC indicates whether the terminal is required to add a new service in the terminal service database or to remove a service from the terminal service database.
When adding a new service, the UICC provides a Service Record that the terminal is required to register into its local service database. When removing a service, the UICC provides the Service Identifier which uniquely identifies the service to be deleted from the database.

If the terminal is able to execute the command the terminal informs the UICC that the command has been successfully performed using TERMINAL RESPONSE.

Note that a service can be coded using a coding type issued from a specific local bearer technology (e.g. Bluetooth or IrDA); however this service is considered by the terminal as available for any bearer.

14.3 BIP Events description

14.3.1 EVENT DOWNLOAD (DATA AVAILABLE):

If the applet is registered to this event (through the `ToolkitRegistry.setEvent` method), and once the targeted channel buffer is empty when new data arrives in it, the ME informs the UICC that this has occurred, by using the ENVELOPE (EVENT DOWNLOAD – Data available).

14.3.2 EVENT DOWNLOAD (CHANNEL STATUS)

The Channel Status event is sent from the ME to the UICC if

- the link was established or establishing failed (after an OPEN CHANNEL in background mode); or
- a link enters an error condition; or
- any other error.

The event is only sent, if the error condition is not resulting from the execution of a proactive command and if the Channel Status event is part of the current SET UP EVENT LIST.

From Rel. 6 on the structure of the Envelope (Event Download - Channel Status) contains a Bearer description data object, which is only present after an OPEN CHANNEL in background mode.

See example in Annex I in TS 102 223

14.3.3 EVENT DOWNLOAD LOCAL CONNECTION

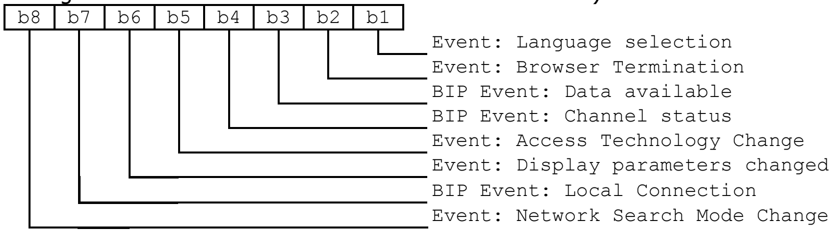
This event notifies the card that a local event has been set up, indicates the Remote Entity Address and Interface Transport Level (UDP, TCP).

14.3.4 Terminal Profile indication for BIP

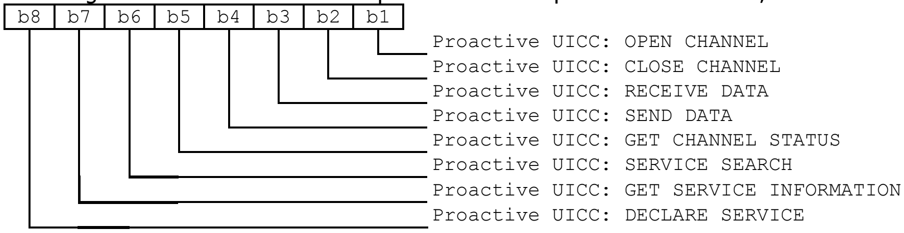
The ME indicates support of the BIP commands and events as well as the relevant network capabilities in its Terminal Profile.

According to TS 102 223 the BIP commands are separated into 2 classes, class "e" and "f", which can be found in the Terminal Profile Bytes of the ME:

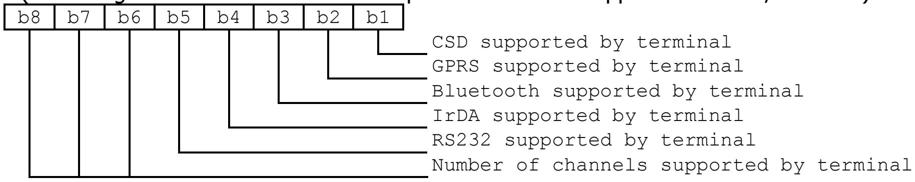
Sixth byte: (According to TS 102 223: Event driven information extensions)


b8
b7
b6
b5
b4
b3
b2
b1
Event: Language selection
Event: Browser Termination
BIP Event: Data available
BIP Event: Channel status
Event: Access Technology Change
Event: Display parameters changed
BIP Event: Local Connection
Event: Network Search Mode Change

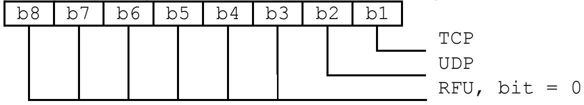
Twelfth byte: (According to TS 102 223: Bearer Independent Protocol proactive commands, class "e" and "f")


b8
b7
b6
b5
b4
b3
b2
b1
Proactive UICC: OPEN CHANNEL
Proactive UICC: CLOSE CHANNEL
Proactive UICC: RECEIVE DATA
Proactive UICC: SEND DATA
Proactive UICC: GET CHANNEL STATUS
Proactive UICC: SERVICE SEARCH
Proactive UICC: GET SERVICE INFORMATION
Proactive UICC: DECLARE SERVICE

Thirteenth byte: (According to TS 102 223: Bearer Independent Protocol supported bearers, class "e")


b8
b7
b6
b5
b4
b3
b2
b1
CSD supported by terminal
GPRS supported by terminal
Bluetooth supported by terminal
IrDA supported by terminal
RS232 supported by terminal
Number of channels supported by terminal

Seventeenth byte: (According to TS 102 223: Bearer Independent Protocol supported transport interface, class "e")



14.4 Java-API for BIP

The UICC specification defines a BIP Java-API supporting BIP tags, events and methods.

The following specifications contain the BIP Java-API for Release 5 and Release 6 of the UICC:
Rel. 5: 3GPP TS 43.019
Rel. 6: ETSI/SCP TS 102 241

According to some API-extensions from Rel. 5 to Rel. 6 the following tables show which API-items are only available from Rel. 6 on ("x" = supported, "-" = not supported):

Proactive BIP command Tags:

BIP command tags	Rel. 5	Rel. 6
PRO_CMD_OPEN_CHANNEL	x	x
PRO_CMD_GET_CHANNEL_STATUS	x	x
PRO_CMD_SEND_DATA	x	x
PRO_CMD_RECEIVE_DATA	x	x
PRO_CMD_CLOSE_CHANNEL	x	x
PRO_CMD_DECLARE_SERVICE	-	x
PRO_CMD_GET_SERVICE_INFORMATION	-	x
PRO_CMD_SERVICE_SEARCH	-	x

BIP Envelope TAG to get field value:

BIP envelope tags	Rel. 5	Rel. 6
TAG_CHANNEL_DATA_LENGTH	x	x
TAG_CHANNEL_DATA	x	x
TAG_REMOTE_ENTITY_ADRESS	-	x
TAG_SERVICE_RECORD	-	x
TAG_SERVICE_SEARCH	-	x
TAG_SERVICE_AVAILABILITY	-	x
TAG_CHANNEL_STATUS	x	x

On reception of BIP envelope, trigger applet registered to the event:

BIP events	Rel. 5	Rel. 6
EVENT_EVENT_DOWNLOAD_DATA_AVAILABLE	x	x
EVENT_EVENT_DOWNLOAD_CHANNEL_STATUS	x	x
EVENT_EVENT_DOWNLOAD_LOCAL_CONNECTION	-	x

Methods:

BIP methods	Rel. 5	Rel. 6
`initClosechannel`	x	x
`copyChannelData`	x	x
`getChannelIdentifier`	x	x
`allocateServiceIdentifier`	-	x
`releaseServiceIdentifier`	-	x
`getChannelStatus`	-	x

General Result Constant:

BIP result code	Rel. 5	Rel. 6
RES_ERROR_BEARER_INDEPENDENT_PROTOCOL_ERROR	-	x

Moreover as specified in TS 102 241 the Toolkit Framework assures a minimum behavior for managing BIP events and dedicated channels:

In order to allow the toolkit applet to be triggered by the BIP related events, the Toolkit Framework must have previously issued a SET UP EVENT LIST proactive command.

When a toolkit applet changes one or more of these requested events of its registry object, the Toolkit Framework dynamically updates the event list stored in the ME during the current card session.

For the events DOWNLOAD DATA AVAILABLE, DOWNLOAD CHANNEL STATUS and DOWNLOAD LOCAL CONNECTION (new in Release 6) the framework only triggers the applet registered to these events with the appropriate channel or service identifier.

When a Toolkit Applet has sent an OPEN CHANNEL proactive command and received a successful TERMINAL RESPONSE, the framework registers the received channel identifier for the calling Toolkit Applet.

When a Toolkit Applet has sent a CLOSE CHANNEL proactive command and received a successful TERMINAL RESPONSE or at card reset, the framework releases the channel identifier contained in the command.

The Toolkit Framework prevents a toolkit applet to issue a SEND DATA, RECEIVE DATA and CLOSE CHANNEL proactive commands using a channel identifier, which is not allocated to it. If an applet attempts to issue such a command the Toolkit Framework throws an exception (command not allowed).

The Toolkit Framework prevents a toolkit applet to issue a DECLARE SERVICE (add, delete) proactive commands using a service identifier, which is not allocated to it. If an applet attempts to issue such a command the Toolkit Framework throws an exception (command not allowed).

In case of the maximum number of allocated Services is exceeded the Toolkit Framework throws a Toolkit Exception (no service id available).

The Toolkit Framework prevents a toolkit applet to issue an OPEN CHANNEL proactive command if it exceeds the maximum number of channel allocated to this applet during the INSTALL [install]. If an applet attempts to issue such a command the Toolkit Framework throws an exception (command not allowed).

14.5 Reliability and Security using BIP

As BIP is just a set of USAT commands to establish a channel from the ME to a remote server, there is no guarantee of reliable data exchange or end-to-end security, especially if a packet oriented bearer like GPRS is used together with UDP as transport interface where UDP-packets may get lost without notice. Reliability and security have to be achieved by additional protocols which are referenced here:

Protocols to ensure reliability:
TCP: If this protocol is supported by the ME, it ensures that the data packages are fully transmitted and have the correct order.

CAT_TP: This protocol is defined in TS102 127. It must be implemented on the UICC and is based on the UDP-support of mobiles. If the server also supports CAT_TP it ensures full packet delivery and correct packet order. CAT_TP also provides an identification of the UICC to the server.

Protocol to ensure security:
UICC secure packages: this protocol is defined in TS 102 225 and describes the use of secure protocol on a UICC (originally derived from the GSM 03.48 standard). It also includes the use of CAT_TP for secure packet exchange.

14.6 Applet Developer tips

- The registration to the event DOWNLOAD DATA AVAILABLE and event DOWNLOAD CHANNEL STATUS is effective once the toolkit applet has issued a successful OPEN CHANNEL proactive command, and valid till the first successful CLOSE CHANNEL or the end of the card session.

- The registration to the event DOWNLOAD LOCAL CONNECTION is effective once the toolkit applet has issued a successful DECLARE SERVICE (add) proactive command, and valid till the first successful DECLARE SERVICE (delete) or the end of the card session.

- A successful TERMINAL RESPONSE means that the result of the proactive command execution belongs to command performed category (i.e. General Result ='0x').

- Without using an additional transport layer or security mechanism on top of BIP (e.g. CAT_TP), each applet developer has to make sure that these issues are addressed by the applet. The ME will manage the data from or to the UICC via TCP protocol, in order to ensure the data transmission to the remote entity.

- BIP is fully integrated in the USAT specification TS 31.111 and therefore has no influence on the existing USIM / USAT communication between UICC and Handset.

- A BIP connection is always started by the UICC and it can not be started by the server. However the server can request a BIP application for opening a channel using a remote command like PUSH as described in TS 102226.

An example of a BIP APDU exchanges is available in the Annex I of the TS 102 223.

An example of an Applet using BIP API and BIP functionalities is available in Annex D of the 43.019 (Rel. 5)

15 Card Remote Management

The TS 102 226 specification defines the Card Remote Management by OTA including the Remote File Management and the Remote Applet Management. This specification first defines the data formats used to send a remote management request in a Command Packet and to retrieve the result of this request or card data in the Additional Response data of a Response Packet. This specification then defines the commands available for the Remote File Management and for the Remote Applet Management.

15.1 Remote Management Application data formats

Two different data formats are supported by Remote Management Applications.
The Compact Data Format allows the Remote Management Application to execute several commands but can send back to the server only one response to an APDU command, i.e. only one outgoing command can be included in the script. While the Expanded allows the card to send back to the server several responses to the APDU commands, i.e several outgoing commands can be included in the script.
The Compact and Expanded data formats are distinguished by different TAR.

15.1.1 Compact Remote Management Application data format

In the Compact Data format, each command packet contains a sequence of commands.

Commands are concatenated in the command packet according to the following format:

Class byte (CLA)	Instruction code (INS)	P1	P2	P3	Data (optional)

To retrieve the Response parameters/data of a case 4 command the GET RESPONSE command has to be issued.
The GET RESPONSE and any case 2 command (e.g. READ BINARY, READ RECORD) shall only occur once in a command string and, if present, must be the last command in the string.
For all case 2 commands and for the GET RESPONSE command, if P3='00', then the card sends back all available response parameters/data e.g. if a READ RECORD command has P3='00' the whole record shall be returned. The limitation of 256 bytes does not apply for the length of the response data. In case the data is truncated in the response, the status words shall be set to '62 F1'.

15.1.2 Compact Remote response structure

If a proof of Receipt is required by the sending entity, the Additional Response Data sent by the Remote Management Application shall be formatted as follows:

Length	Name
1	Number of commands executed within the command script (see note)
2	Last executed command status word
X	Last executed command response data if available (i.e. if the last command was an outgoing command)
NOTE:	This field shall be set to '01' if one command was executed within the command script, '02' if two commands were executed, etc.

15.1.3 Expanded Remote Management Application data format

The Expanded Remote Application data format is a more flexible protocol capable of containing several outgoing commands in the same Command Packet.

15.1.4 Expanded Remote Commands

Each Command Session is included in a BER-TLV (Command Scripting template); one Command Script can be present in one single Command Packet as follows:

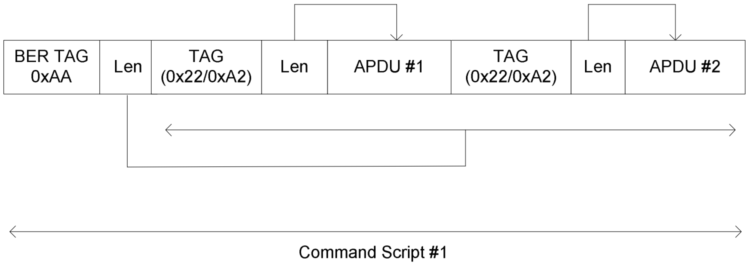


Figure 18 – Expanded Remote Format

A command session (or command script) is made of a sequence of C-APDU commands, each of them coded as a C-APDU TLV as follows:

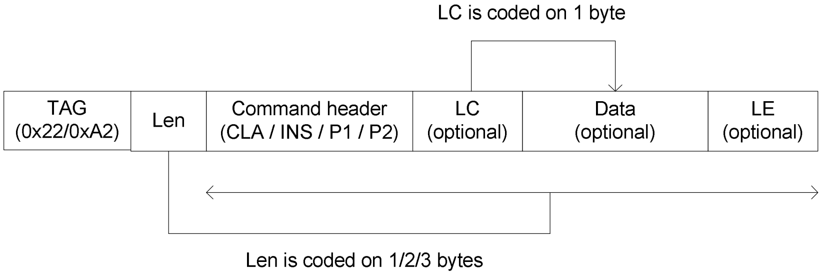


Figure 19 – Format of a Command Session TLV

Note: the presence of the Comprehension Requirement bit is irrelevant for the card.

The LC parameter represents the APDU input data and it is present only for Case 3 / Case 4 commands; in these cases, also the Data field is present; a LC value of ‘00’ means 256 bytes.

The LE parameter represents the APDU output data and it is present only for Case 2 / Case 4 commands. A LE value of ‘00’ means “all data available”, that is the whole amount of data to be returned without the constraint of 256 bytes.

The total size of a single C-APDU TLV can be up to 262 bytes.

Command sessions are independent of each other, e.g. in case of Remote File Management, at the beginning of each command session the root directory is selected (the root is the MF in case of a UICC RFM, or is the ADF in case of a USIM RFM).

When the first command results in an error, command packet execution is aborted and this C-APDU becomes the last executed command and the R-APDU is part of the Response Scripting Template.

15.1.5 Expanded Remote Responses

The Response Session is included in a BER TLV (Response Scripting Template). Only for Case 2 / Case 4 C-APDU TLV the relevant R-APDU TLV is present, with the exception of the last C-APDU TLV as the corresponding R-APDU is always present.

The format of the Response Scripting Template is as follows:

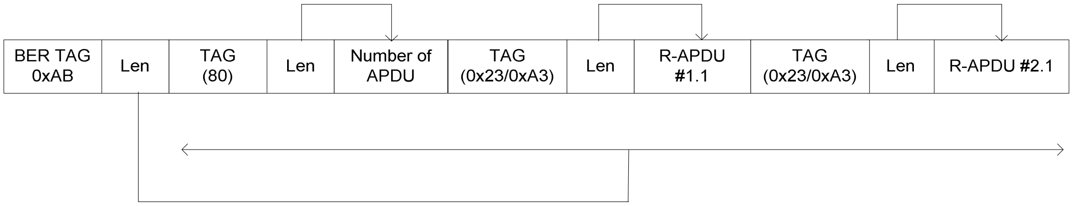


Figure 20 – Response Scripting Template structure

For each R-APDU, returned data size is only limited by the maximum data length returnable by a single Response Packet that may vary with the transport layer (e.g., SMS, BIP…).

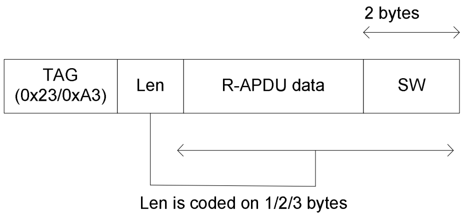


Figure 21 – R-APDU TLV structure

If the returned data is larger than the transport layer capacity, a warning Status Word is returned ('62 F1') with all the fitting data and no other command is executed.

16 Remote File Management Architecture

Remote file management applications on the UICC/USIM provide Remote file access in accordance to the new UICC/USIM architecture.

16.1 Remote File Access for UICC

If an application provides access to the shared file system structure over the air, it is called “UICC Shared File System Remote File Management” (UICC RFM). It allows file management of the EFs and the DFs stored under the MF, but it can not access any ADF so the execution of **Select by path** or **Select by FID** with File IDentifier 0x7FFF contained in the Command Data fails. **Select by name** is also not supported.

16.2 Remote File Access for ADF

As on the card several applications can be present, each of them is the owner and the manager of a different ADF. There can be also several RFM applications to manage ADF via OTA. Each RFM application is also able to manage the EFs and DFs under the MF.

The implicitly selected ADF is the current directory at the beginning of a Command "session". It is possible to reselect the ADF root from another DF by using the FID 0x7FFF.

With an USIM RFM it is not possible to access files stored under other ADFs (e.g. another USIM).

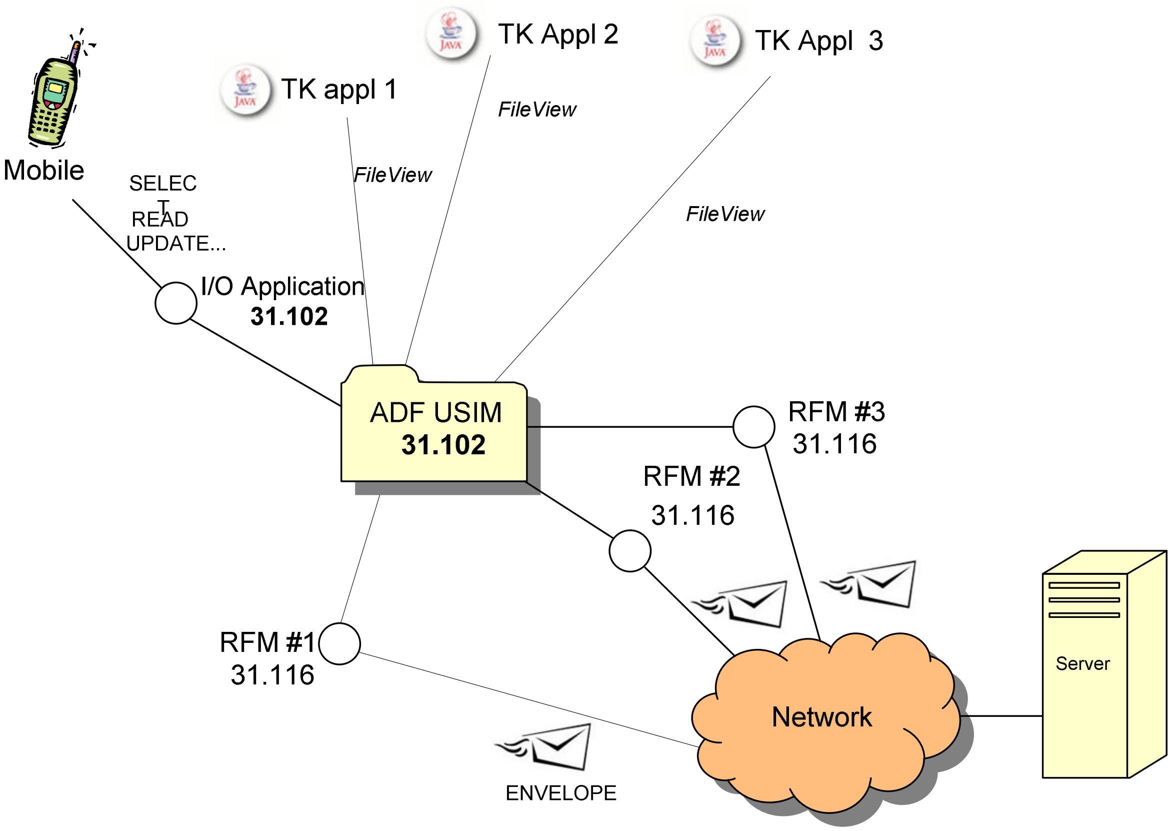


Figure 22 – The ways of accessing an ADF

16.3 Remote File Application Parameters

Even though each RFM application can manage just one ADF, several RFM applications managing the same ADF can be present. As different Remote Files Management applications are independent from each other, they can be installed with different parameters, such as:

- Access Domain, coded according to 'Remote Applet Management' Chapter.
- Minimum Security Level, coded according to 'Remote Applet Management' Chapter.
- Related ADF
- TAR value(s)

By changing these parameters different access rights and different security levels can be defined for the different applications.

> **Interoperability Issue:**
> The way Remote File Application parameters are configured is not specified in 102 226 standards. SIM Alliance members provide proprietary mechanisms to configure those parameters.

16.4 Remote File Management AID and TAR

The following TARs must be used to address the RFM applications, as specified in TS 101.220:

Remote File Management Applications	
UICC Shared File System	'B0 00 00' and 'B0 00 02' to 'B0 00 0F'
USIM File Systems	'B0 00 01' and 'B0 00 20 to 'B0 01 1F'

It is worth to note that these bytes are independent from the USIM AID. The Compact and Expanded Remote Application data formats are distinguished by different TAR values.

16.4.1 RFM Commands

RFM available commands
SELECT
UPDATE BINARY
UPDATE RECORD
SEARCH RECORD
INCREASE
VERIFY PIN
CHANGE PIN
DISABLE PIN
ENABLE PIN
UNBLOCK PIN
DEACTIVATE FILE
ACTIVATE FILE
READ BINARY
READ RECORD
CREATE FILE
DELETE FILE
RESIZE FILE

SELECT

The SELECT command supports all the selection modes when selecting a DF or an EF by FID or by path; the FID 0x7FFF, dedicated to select the current ADF, cannot be used in cases of UICC RFM.

The SELECT by DF Name can not be used in the RFMs because it is used to select a different ADF and each USIM RFM manages just one ADF.

Warning: If a file is declared as not shareable, the file selection status can prevent the file from being selected in other contexts (I/O, toolkit applets). In this case, if the file is currently selected by User Equipment or by a Toolkit Applet, it can not be selected by RFM and vice versa.

READ BINARY, UPDATE BINARY,
READ RECORD, UPDATE RECORD,
SEARCH RECORD, INCREASE,
ACTIVATE FILE, DEACTIVATE FILE,
CREATE FILE, DELETE FILE, RESIZE FILE

The operations are allowed only if a Security Condition (SC) related to the relevant Access Mode (AM) is granted by the RFM application Access Domain.

The access rights granted to an application by its Access Domain is independent from the access rights granted at the UICC/Terminal interface. This implies in particular that the status of a secret code (e.g. disabled PIN1, blocked PIN2, etc.) at the UICC/Terminal interface does not affect the access rights granted to an application.

Security Condition and Access Mode are indicated in EF_{ARR} (see [102 221]).

VERIFY PIN, CHANGE PIN,

ENABLE PIN, DISABLE PIN,
UNBLOCK PIN

The PIN related commands affect the PIN value or the PIN blocking status both in RFM sessions and in I/O sessions: presenting a wrong PIN value for three times, the PIN is blocked also for the I/O session; changing PIN value via OTA affects PIN value also for the I/O session, and so on.

> **Interoperability Issue:**
> SIM Alliance members are not interoperable about the PIN verification during an OTA sessions: it may or may not change the set of operations granted to the RFM application in the current session.

17 Remote Application Management

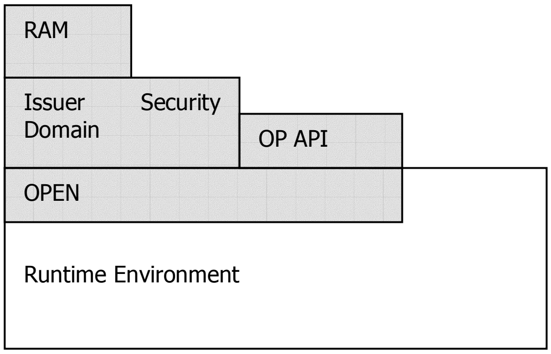


Figure 23 – Remote Application Management Architecture

Remote Application Management on a card includes the ability to load, install and remove applications. It is performed using commands defined in the GlobalPlatform Specification (see GP 2.1.1).

17.1 Remote Application Management Architecture

The Issuer Security Domain is the representative entity of the card issuer. It provides support for control, security and communication requirements of the card issuer. It has the capability of loading, installing, and deleting applications that belong either to the Card Issuer or to other Application Providers.

Security Domains support security services such as key handling, encryption, decryption, digital signature generation and verification for their owners (Card Issuer, Application Provider or Controlling Authority) applications.

Remote Application Management applications are OTA interfaces to the Issuer Security Domain and other Security Domains.

The GlobalPlatform API provides services to Applications (e.g. cardholder verification, personalization, or security services). It also provides Card Content management services (e.g. card locking or application Life Cycle State update) to Applications.

> **Interoperability Issue:**
> SIM Alliance members don't guarantee that the GlobalPlatform API is available on any smartcard product.

The main responsibilities of the GlobalPlatform Environment (OPEN) are to provide an API to Applications, command dispatch, Application selection, and Card Content management.

17.1.1 Application Loading and Installation Process

The loading and installation process enables an applet to be downloaded on to a card and made available for use.
The first step is to load a package containing an applet byte code onto the card. Then the applet must be installed from the package before it can be used. Applet installation involves creating an applet instance (object) in the card memory. Two commands are used to perform the process: INSTALL and LOAD.
A loading session consists of the sequence of commands as described in the following diagram:

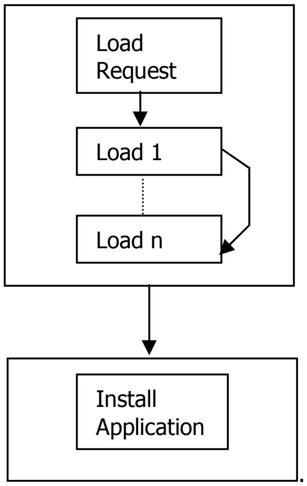


Figure 24 – Loading and installing an application

The INSTALL command must be sent first with the *Load* option. Several LOAD commands are then sent to the card; they include the package byte code, which is sent to the card, block by block. Each block is numbered and the last block is clearly identified. Depending on the applet size, several bearer message entities might be used for loading the package.

An applet is installed via the INSTALL command sent with the Install option. Installation does not necessarily occur during the same session as the package loading phase.

17.1.2 Application Life Cycle States

The life cycle states of an application comply with the GlobalPlatform 2.1.1 specification (see GP 2.1.1):

- INSTALLED
- SELECTABLE
- LOCKED

The commands to manage the different life cycle states of an application are INSTALL, GET STATUS and SET STATUS.

When an applet is locked, it cannot be triggered or selected and all its menu entries are disabled (in other words: removed from the SET UP MENU proactive command).

When an applet is in the state SELECTABLE, it can be triggered by the Toolkit Framework. Moreover it is able to maintain its own application specific states, but these are out of scope for the Remote Application Management.

The applet's life cycle state starts with the successful execution of the INSTALL(install) command.

17.2 Description of the IN/OUT Commands

The list of commands supported for Remote Application Management is specified in the table below.

Operational Command	Additional Features in ETSI TS 102 226 and 3GPP TS 31.116 Compared to GP 2.1.1
DELETE Load File	No additional features
DELETE Application	No additional features
SET STATUS	No additional features
INSTALL [for load]	No additional features
INSTALL [for install]	Specifies the Install Parameter field including the System Parameters field. This enables you to specify: the memory space required for installation the toolkit application specific parameters (including access domain and information to manage the toolkit

	card resources as menus)
INSTALL [for make selectable]	No additional features
LOAD	Defines an additional requirement concerning the used algorithm for cards supporting DAP verification
PUT KEY	Only Key Version Numbers from '01' to '0F' and Key Identifiers from '01' to '03' are used for the secured packet structure according to ETSI TS 102 225. Key Version Number '11' is used for the calculation of the UICC Toolkit Parameters DAP and Access Domain DAP. Definition of the key identifier which has to be used for the ciphering of the key values which are provided in the PUT KEY command. Clarification of the version of the transport key DEK used when replacing or creating a key set.
GET STATUS	Extended to retrieve the SCP Registry Data (if bit2 of P2 is set)
GET DATA	Extended to retrieve: 'FF 1F' – menu parameters (see 3GPP TS 23 048) 'FF 20' – card resources (see 3GPP TS 23 048) 'FF 21' – information on the card resources used and available 'FF 22' to 'FF 3F' – reserved for allocation in ETSI TS 102 226

Interoperability Issues
The SIM Alliance members do not guarantee that the SELECT, STORE DATA, DELETE Key, INSTALL [for personalization] and INSTALL [for extradition] commands as defined in GP 2.1.1 are supported by the Remote Application Management on each card.

Concerning the GlobalPlatform commands used via OTA the SIM Alliance members do not guaranty the interoperability concerning the status word sent in the additional data of the response packet.

The SIM Alliance members recommend using the GET DATA with 'FF 21' to retrieve the card resources instead of using 'FF 20'. Furthermore they recommend to use the GET STATUS to retrieve the menu parameters instead of using GET DATA with 'FF 1F'.

17.2.1 LOAD Command

The SIM Alliance members state that a card supporting DAP verification supports at least DES scheme for Load File Data Block Signature computation according to GlobalPlatform Card Specification GP 2.1.1.

17.2.2 INSTALL (load) Command

A card supporting DAP verification supports the Load File Data Block Hash according to GlobalPlatform Card Specification GP 2.1.1.

Interoperability Issue
If present, the Load Parameter Field of the INSTALL [for load] command shall be coded according to GlobalPlatform Card Specification GP 2.1.1.
If the System Specific parameters "Non volatile code space limit" (Tag 'C6'), "Volatile data space limit" (Tag 'C7') and "Non volatile data space limit" (Tag 'C8') are available, the SIM Alliance members state that the UICC is able to handle them.

When these parameters are available, they are used to determine whether it is possible to load the application on the card or not by checking the available memory versus the specified one.

17.2.3 INSTALL(Install) Command

The SIM Alliance members state that they all support the combined [for install and make selectable] within the same INSTALL command.

SIM and UICC file access and toolkit parameters are not allowed to be contained simultaneously in the INSTALL command.
SIM file access and toolkit parameters shall be used for `sim.toolkit.ToolkitInterface` and UICC file access and toolkit parameters apply to the `uicc.toolkit.ToolkitInterface` and the according `FileView`.

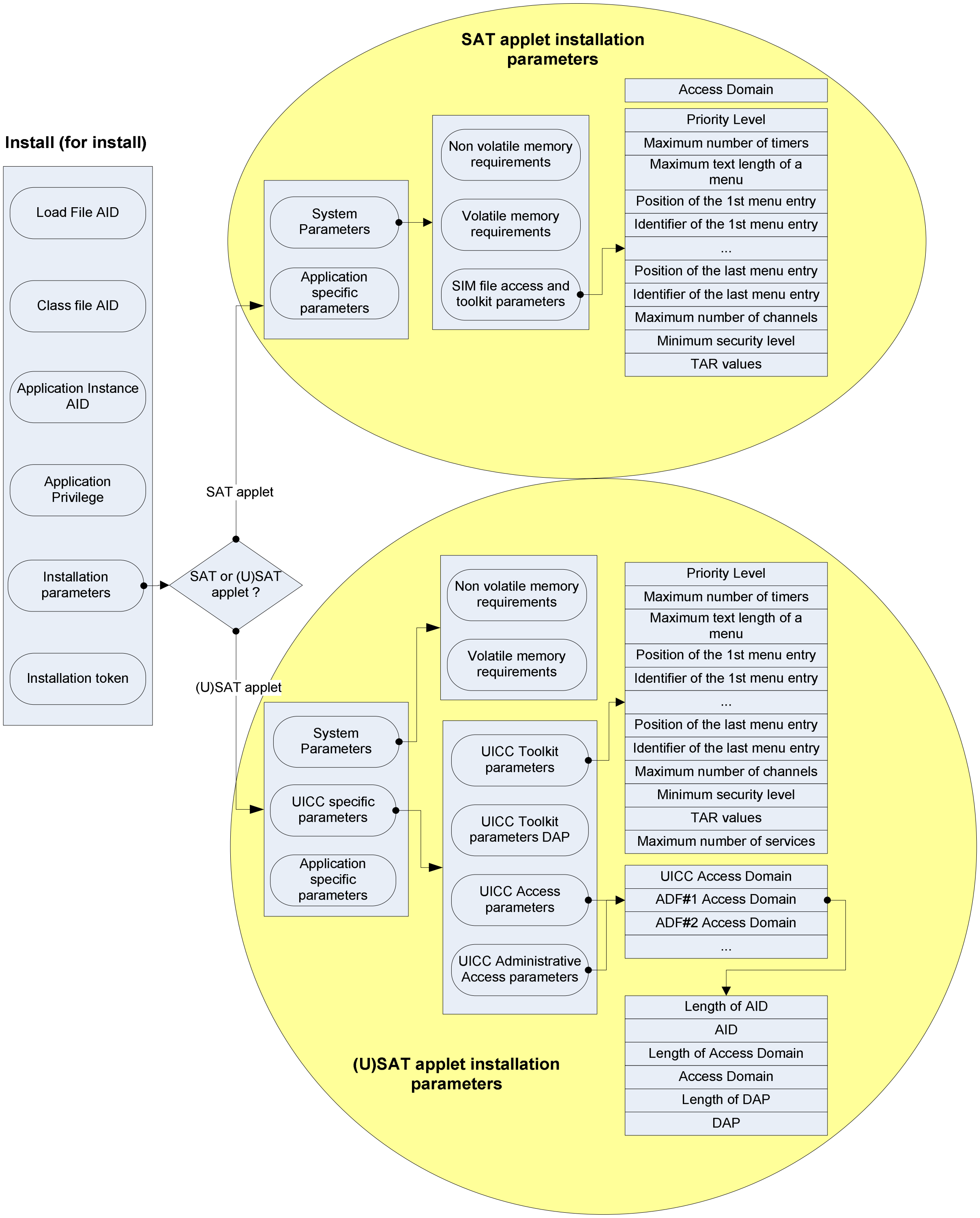

SAT applet installation parameters
Install (for install)
Load File AID
Class file AID
Application Instance AID
Application Privilege
Installation parameters
Installation token
SAT or (U)SAT applet ?
SAT applet
(U)SAT applet
System Parameters
Application specific parameters
Non volatile memory requirements
Volatile memory requirements
SIM file access and toolkit parameters
Access Domain
Priority Level
Maximum number of timers
Maximum text length of a menu
Position of the 1st menu entry
Identifier of the 1st menu entry
...
Position of the last menu entry
Identifier of the last menu entry
Maximum number of channels
Minimum security level
TAR values
System Parameters
UICC specific parameters
Application specific parameters
Non volatile memory requirements
Volatile memory requirements
UICC Toolkit parameters
UICC Toolkit parameters DAP
UICC Access parameters
UICC Administrative Access parameters
Priority Level
Maximum number of timers
Maximum text length of a menu
Position of the 1st menu entry
Identifier of the 1st menu entry
...
Position of the last menu entry
Identifier of the last menu entry
Maximum number of channels
Minimum security level
TAR values
Maximum number of services
UICC Access Domain
ADF#1 Access Domain
ADF#2 Access Domain
...
Length of AID
AID
Length of Access Domain
Access Domain
Length of DAP
DAP
(U)SAT applet installation parameters

Figure 25 – SAT and USAT toolkit install parameters

The INSTALL command for install mode is formatted as follows when installing an applet with SIM file access and toolkit specific parameters:

Presence	Length	Description
M	1	Length of the load file AID
M	5-16	Load file AID
M	1	Length of the class file AID
M	5-16	Class file AID
M	1	Length of the application instance AID
M	5-16	Application instance AID
M	1	Length of the application privilege
C	0 or 1	Application privilege
M	1	Install parameter length
M	≥14	Install parameter field (TLV formatted)

Presence	Length	Description
M	1	Tag of the System Parameters field: EFh
M	1	Length of the System Parameters field
M	≥10	System Parameters field (TLV formatted)

Presence	Length	Description
M	1	Tag of the non-volatile memory required: C8h
M	1	Length of the non-volatile memory required for the installation field
M	2	Non-volatile memory required for the installation field (in bytes)
M	1	Tag of the volatile memory required: C7h
M	1	Length of the volatile memory required for the installation field
M	2	Volatile memory required for the installation field (in bytes)
O	1	Tag of the SIM file access and toolkit applications specific parameter field: CAh
C	1	Length of the SIM file access and toolkit applications specific parameter field
C	6-n	SIM file access and toolkit applications specific parameter field

Presence	Length	Description
M	1	Tag of the Applet-Specific Parameters field: C9h
M	1	Length of the Applet-Specific Parameters field
C	0-o	Applet-Specific Parameters

Presence	Length	Description
M	1	Length of the install token
C	0-n	The Install Token is mandatory for Delegated Management. The install token shall not be present if Delegated Management is not used.

M – Mandatory; C – conditional; O – optional

> **Note**
> The memory space required indicates the minimum size to be available on the card when downloading the application. The USIM must prevent the applet from being installed if the required size is not available on the card.

The INSTALL command for install mode is formatted as follows when installing an applet with UICC System specific parameters:

Presence	Length	Description
M	1	Length of the load file AID
M	5-16	Load file AID
M	1	Length of the class file AID
M	5-16	Class file AID
M	1	Length of the application instance AID
M	5-16	Application instance AID

M	1					Length of the application privilege
C	0 or 1					Application privilege
M	1					Install parameter length
M	≥14					Install parameter field (TLV formatted)
		Presence	Length			Description
		M	1			Tag of the System Parameters field: EFh
		M	1			Length of the System Parameters field
		M	≥10			System Parameters field (TLV formatted)
				Presence	Length	Description
				M	1	Tag of the non-volatile memory required: C8h
				M	1	Length of the non-volatile memory required for the installation field
				M	2	Non-volatile memory required for the installation field (in bytes)
				M	1	Tag of the volatile memory required: C7h
				M	1	Length of the volatile memory required for the installation field
				M	2	Volatile memory required for the installation field (in bytes)
		O	1			Tag of the UICC System specific parameters field: EAh
		C	1			Length of the UICC System specific parameters constructed field
		C	0-m			UICC System specific parameters constructed value field
		M	1			Tag of the Applet-Specific Parameters field: C9h
		M	1			Length of the Applet-Specific Parameters field
		C	0-o			Applet-Specific Parameters
M	1					Length of the install token
C	0-n					The Install Token is mandatory for Delegated Management. The install token shall not be present if Delegated Management is not used.

Interoperability Issue

- The memory space required on the card is not a physical memory reservation. The physical memory size actually used on the card depends on the card manufacturer. There is currently no interoperability in this respect and you are advised to use the value ranges provided by the card manufacturers.
- If the installation of an application fails all allocated resources are freed but the claiming of the resources might differ depending on the card manufacturer.

17.2.3.1 SIM File Access And Toolkit Application Specific Parameters

The SIM File Access and Toolkit Application Specific Parameters are mandatory for applications using the `sim.toolkit.ToolkitInterface` or `sim.access.SIMView` interface specified as defined in 3GPP TS 43 019.

The SIM File Access and Toolkit Application Specific Parameters are used to specify the resources that the application instance can use. These resources include the timers and menu items for the SET UP MENU proactive command. The network operator or service provider can also define the menu position and the menu identifier of the menus activating the application. The following format is used to code the application parameters:

Presence	Length	Name
M	1	Length of the Access Domain field
M	1-q	Access Domain
M	1	Priority level for the Toolkit application instance
M	1	Maximum number of timers allowed for the application instance
M	1	Maximum text length for a menu entry
M	1	Maximum number of menu entries allowed for this application instance
C	1	Position of the first menu entry ('00' means last position)
C	1	Identifier of the first menu entry ('00' means that the identifier is not

		significant)
...	...	...
C	1	Position of the last menu entry (‘00’ means last position)
C	1	Identifier of the last menu entry (‘00’ means that the identifier is not significant)
O	0 or 1	Maximum number of BIP channels for this application instance
O	0 or 1	Length of the Minimum Security Level field
C	0-r	Minimum Security Level (MSL)
O	0 or 1	Length of the TAR Value(s) field (= 3*t)
C	3*t	TAR Value(s) of the Toolkit application instance

M – Mandatory; C – conditional; O – optional

Refer to ETSI TS 102 226 for further details on these parameters (including default values for optional parameters).

Access Domain field: Some values are mandatory whereas others are optional.
SIM Alliance members support the following values:

- 00h – full access
- 01h – APDU access (reserved for 2G; see 3GPP TS 31 116)
- 02h – UICC access (reserved for 3G; see description below)
- FFh – no access

If an optional parameter is included, then all the previous parameters in the table above shall be included also.
If no parameter is set in the “Maximum number of channels” field, a default value is allocated for the application instance by the card.

> **Interoperability Issue**
> The default parameter for the “Maximum number of channels” is card manufacturer dependent.

17.2.3.2 UICC System Specific Parameters

The UICC System Specific Parameters value field of the INSTALL [for install] command shall be coded as follows:

<table>
<tr><th>Presence</th><th>Length</th><th>Name</th></tr>
<tr><td>O</td><td>1</td><td>Tag of UICC Toolkit Application specific parameters field: 80h</td></tr>
<tr><td>C</td><td>1</td><td>Length of the UICC Toolkit Application specific parameters field</td></tr>
<tr><td>C</td><td>n</td><td>UICC Toolkit Application specific parameters</td></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Length</th><th>Name</th></tr>
<tr><td>1</td><td>Priority Level of the Toolkit Application instance</td></tr>
<tr><td>1</td><td>Maximum number of timers allowed for this application instance</td></tr>
<tr><td>1</td><td>Maximum text length for a menu entry</td></tr>
<tr><td>1</td><td>Maximum number of menu entries allowed for this application instance</td></tr>
<tr><td>1</td><td>Position of the first menu entry</td></tr>
<tr><td>1</td><td>Identifier of the first menu entry (‘00’ means do not care)</td></tr>
<tr><td>...</td><td>...</td></tr>
<tr><td>1</td><td>Position of the last menu entry</td></tr>
<tr><td>1</td><td>Identifier of the last menu entry (‘00’ means do not care)</td></tr>
<tr><td>1</td><td>Maximum number of BIP channels for this application instance</td></tr>
<tr><td>1</td><td>Length of the Minimum Security Level field</td></tr>
<tr><td>0-r</td><td>Minimum Security Level (MSL)</td></tr>
<tr><td>1</td><td>Length of the TAR Value(s) field (= t)</td></tr>
<tr><td>t</td><td>TAR Value(s) of the Toolkit application instance</td></tr>
<tr><td>1</td><td>Maximum number of services for this application instance</td></tr>
</table>
</td></tr>
<tr><td>O</td><td>1</td><td>Tag of UICC Toolkit parameters DAP: C3h</td></tr>
<tr><td>C</td><td>1</td><td>Length of UICC Toolkit parameters DAP</td></tr>
<tr><td>C</td><td>o</td><td>UICC Toolkit parameters DAP</td></tr>
<tr><td>O</td><td>1</td><td>Tag of UICC Access Application specific parameters field: 81h (see Note 1)</td></tr>
<tr><td>C</td><td>1</td><td>Length of UICC Access Application specific parameters field</td></tr>
</table>

C	p	UICC Access Application specific parameters

Presence	Length	Name
O	1	Length of UICC file system AID (= ‘0x00’)
O	0	Empty UICC file system AID
O	1	Length of Access Domain for UICC file system
O	m	Access Domain for UICC file system
O	1	Length of Access Domain DAP
O	0 or n	Access Domain DAP
O	1	Length of ADF #1 AID
O	5-16	ADF #1 AID
O	1	Length of Access Domain for ADF #1
O	o	Access Domain for ADF #1
O	1	Length of Access Domain DAP #1
O	0 or p	Access Domain DAP # 1
…	…	…
O	1	Length of ADF #q AID
O	5-16	ADF #q AID
O	1	Length of Access Domain for ADF #q
O	o	Access Domain for ADF #q
O	1	Length of Access Domain DAP #q
O	0 or p	Access Domain DAP #q

O	1	Tag of UICC Administrative Access Application specific parameters field: 82h (see Note 1)
C	1	Length of UICC Administrative Access Application specific parameters field
C	p	UICC Administrative Access Application specific parameters

Presence	Length	Name
O	1	Length of UICC file system AID (= ‘0x00’)
O	0	Empty UICC file system AID
O	1	Length of Administrative Access Domain for UICC file system
O	m	Administrative Access Domain for UICC file system
O	1	Length of Administrative Access Domain DAP
O	0 or n	Administrative Access Domain DAP
O	1	Length of ADF #1 AID
O	5-16	ADF #1 AID
O	1	Length of Administrative Access Domain for ADF #1
O	o	Administrative Access Domain for ADF #1
O	1	Length of Administrative Access Domain DAP #1
O	0 or p	Administrative Access Domain DAP # 1
…	…	…
O	1	Length of ADF #q AID
O	5-16	ADF #q AID
O	1	Length of Administrative Access Domain for ADF #q
O	o	Administrative Access Domain for ADF #q
O	1	Length of Administrative Access Domain DAP #q
O	0 or p	Administrative Access Domain DAP #q

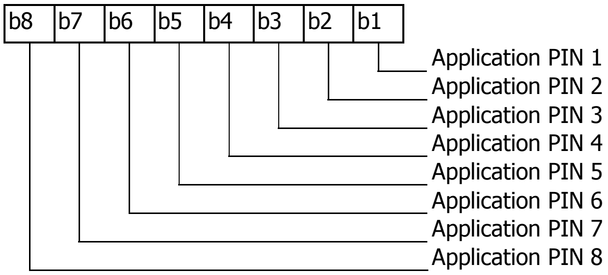
> **Note**
> The UICC access application specific parameters and UICC administrative access application specific parameters are also applicable for non-Toolkit applets which want to access the file system.

Coding of the Access Domain Data for UICC access mechanism
The UICC access mechanism is coded as follows:

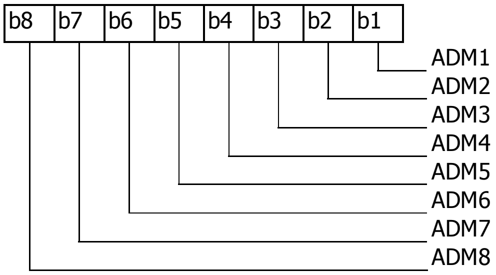
Byte 1: ‘02’ for UICC access

Byte 2: ‘03’ the length of the following data

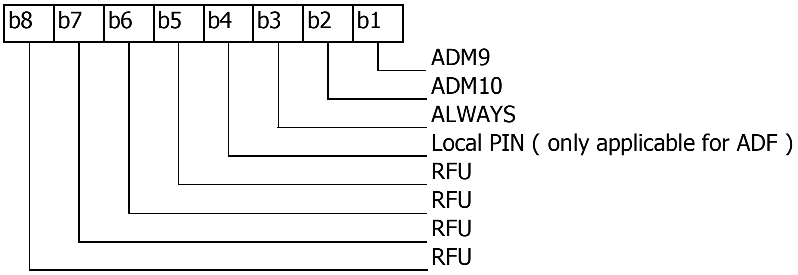
Byte 3:



Byte 4:



Byte 5:



These access rights are checked against SE ID 01 access rules as defined in ETSI TS 102 221 (see § 6.4.1 of the present document).

> **Note**
> The Administrative Access Domains are coded the same way as the Access Domains.

The UICC access parameters are applicable to applications using the `uicc.access.FileView` defined in ETSI TS 102 241.

The UICC Administrative access application specific parameters field is used to specify the access rights for the application instance to administrate the file system.
The UICC Administrative access parameters are applicable to applications using the `uicc.access.fileadministration.AdminFileView` defined in ETSI TS 102 241, also for operations inherited from `uicc.access.FileView` (e.g. `readBinary(..)`).

17.2.4 DELETE Command

The following description is taken from the ETSI TS 102 226:

The removal of Applications, Executable Load Files and of Executable Load Files and its related Applications shall be supported.

SIM Alliance members agree that they all provide mechanisms to recover memory space after deleting an application. Note that these mechanisms can be different for the SIM Alliance members.

Interoperability Issue
The SIM Alliance members do not guaranty that the warning status word '62 00' (Application has been logically deleted) is supported.

Applet Developer Tip
As it is not possible in Javacard 2.2.1 to delete an applet owning an object stored in a static field, use the `AppletEvent.uninstall` method to release such references.

17.2.5 GET DATA command

The SIM Alliance members agree that they all support the class byte value '80' for the GET DATA command.

17.2.5.1 Extended Card Resources Tag

Extended Card Resources		
Length	Description	Value
1	Number of installed applications tag	'81'
1	Number of installed applications length	X
X	Number of installed applications	
1	Free non volatile memory tag	'82'
1	Free non volatile memory length	Y
Y	Free non volatile memory	
1	Free volatile memory tag	'83'
1	Free volatile memory length	Z
Z	Free volatile memory	

Note
SIM Alliance members recommend using the GET DATA for the Extended Card Resources instead of the GET DATA for the Card Resources as it is limited to 64kb regarding the free memory size returned.

17.2.6 GET STATUS command

If bit 2 of the P2 parameter is set, the returned GlobalPlatform Registry Data TLV includes a SCP Registry data TLV which includes a Menu Parameters TLV for Issuer Security Domain, Security Domains and Applications.

SCP Registry Data		
Tag	Length	Value
'EA'	Length of following data	SCP Registry Data
'80'	Length of Menu parameters	Menu parameters
	Length	Value
	1	First menu entry position
	1	First menu entry identifier
	1	First menu entry state
	...	...
	1	Last menu entry position
	1	Last menu entry identifier
	1	Last menu entry state

The menu entry identifiers and positions are the ones provided in the Menu Entries list defined in ETSI TS 102 241 and are returned regardless of the menu entry state as well as regardless of the Application life cycle state (e.g. Selectable/Locked, etc.).
The menu entry state is defined as follows:

'00':	menu entry is disabled
'01':	menu entry is enabled
other values	RFU

Interoperability Issue

The LOGICALLY DELETED life cycle state as known from the OP 2.0.1 is not supported by all card manufacturers as this life cycle state is not defined in the GP 2.1.1.

The SIM Alliance members advise to use only combinations of P1 as defined in the GP 2.1.1 as other combinations defined in previous versions of the GlobalPlatform might not be supported by all card manufacturers.

17.2.7 PUT KEY command

For a detailed explanation see § 18.

18 Security domain and Key Management

18.1 Security Domains on UICC Java Cards

18.1.1 Introduction

The GP security architecture introduces the role of the card issuer and the application provider. It further defines four specific on-card entities: the *Card Manager*, the *Card Runtime Environment*, *Applications*, and *Security Domains*.

The Issuer Security Domain and the Global Platform Environment (OPEN) are always created by the Card Issuer, but applications may also be created by application providers. To ensure a secure way of communication between on-card applications and off-card entities, keys are needed to encrypt / decrypt messages and calculate checksums.

Physically, a SD is a special application that supports a secure communication between an Application Provider's application and off-card entities during its personalization phase and runtime. For this purpose, a SD manages its own keys.
It is desirable to limit the access to such keys, so that not every application provider knows the Card Issuer's keys, and a Card Issuer knows not the keys of any application provider. To grant such an access control, GP introduces the concept of Security Domains (SD): every application is associated with a SD, there is a default SD on each card, the Issuer Security Domain.
All applications of provider A can be associated with A's SD, all applications of provider B with B's SD etc.

GP defines additional privileges for Security Domains such as DAP verification, Delegated Management, the mutual authentication process, the secure channel management and an API to manage the access of applications to a SD.
Parts of this functionality may be covered in future ETSI specifications and will then be introduced in this document.

18.1.2 Security Domains in non-OTA communication

In non-OTA communication, a security domain may provide means of establishing a secure channel between the application and the outside world, as shown in the picture below. At minimum, the security domain has to provide access to keys that can be utilized by applications for cryptographic purposes. Access to keys and secure channels is granted via methods in the GP API.
Refer to GP card implementation specification for more details on security in non-OTA communication. This topic is only covered here for reasons of understandability. It depends on the card manufacturer to which extend the non-OTA part of GP is implemented.

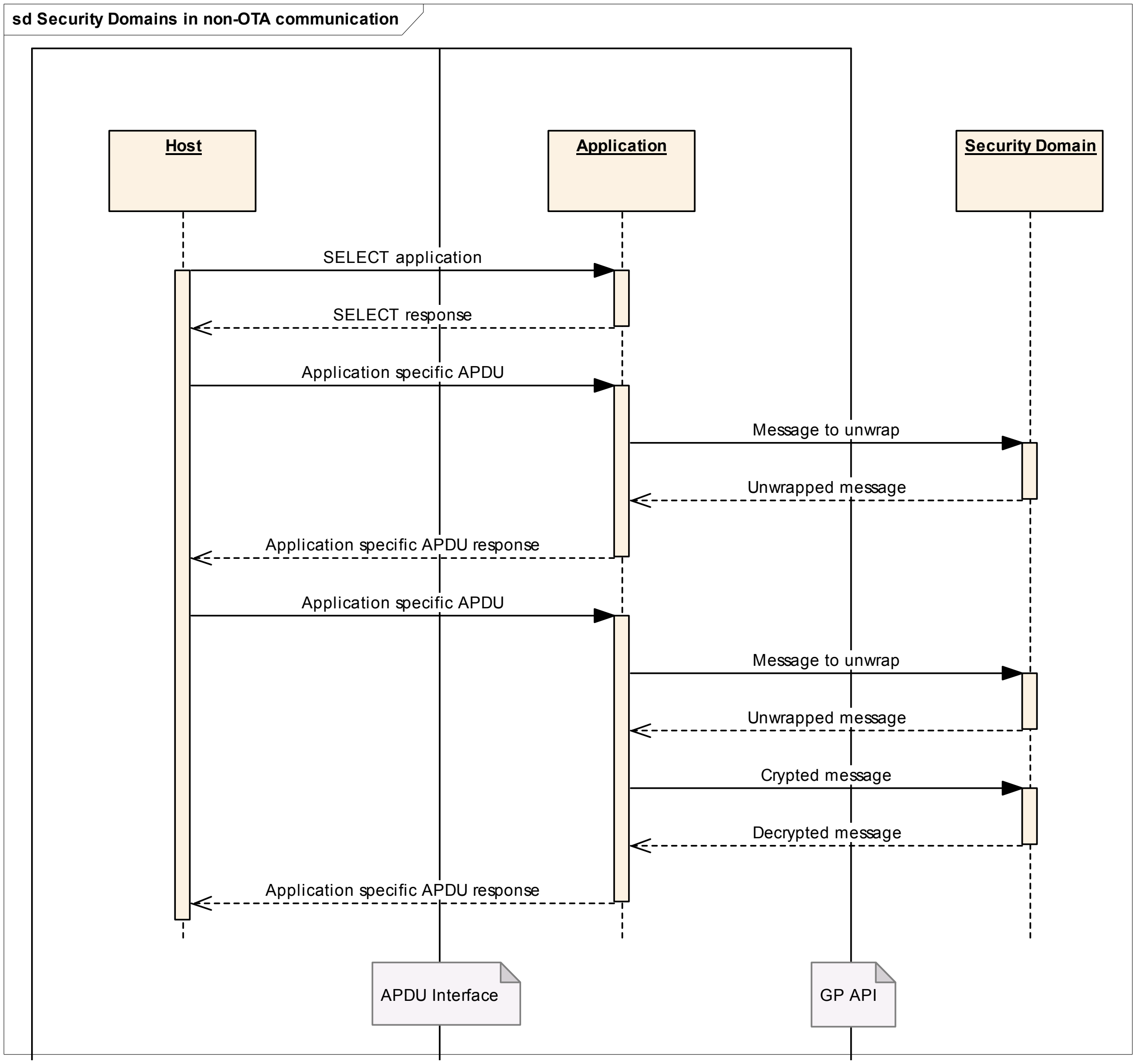


Figure 26 – Security Domains in non-OTA communications

18.2 Security Domains in OTA-communication

It is specified in ETSI TS 102 225 that on every card that implements the GP security architecture, a SD must perform the OTA security actions (i.e. RC/CC/DS, ciphering/deciphering, counter management). So in the case that there is an application on a card that is associated with a SD and a secured OTA-message arrives for it, the message is unwrapped and decrypted by the SD and not by the Toolkit Framework. In any case, applications get message data in plain format as specified for the corresponding events (like the event EVENT_FORMATTED_SMS_PP_ENV).

18.2.1 Key Management

A SD manages its own keys. Like any other application, a SD is identified by a TAR.
PUT KEY command by OTA is allowed to change and create keys.

> **Developer Tip**
> The usage of the PUT KEY command to create key sets over-the-air is not recommended as the PoR handling in the existing networks is not reliable enough.

The PUT KEY is either issued via a secure channel or via OTA, in the latter case the TAR is evaluated by the Toolkit Framework to channel the command to the right Security Domain.
According to the GP specification, keys have to be associated with a certain algorithm and length. In the PUT KEY command, an algorithm identifier together with length information is sent to the card together with the key data.
Keys can be updated by using the PUT KEY command, but the key deletion command may not be supported by each card.
Keys are always organized in Key Sets. According to GP, a Key Set may contain one to many keys. The ETSI TS 102 225 precises the definition to three keys per key sets (KID, KIc and DEK see also § 12.2.2) and an additional counter.
A maximum of 15 key sets for OTA transportation is allowed for the ISD. SIM Alliance members support up to 15 key sets for OTA transportation for each security domain.
Key Sets are identified with a version number that is unique within its SD. Keys within key sets are identified by a unique index within the key set. Key Set versions and key indices have to be specified in the PUT KEY command.

The key used for ciphering the key values (e.g. KIc, KID or DEK) of the PUT KEY command is the key with identifier 3 (i.e. DEK). It is a static key.
When replacing or adding key(s) within the same key set, or when updating the key version number of a key set, the encrypting key to be used is the DEK of the same key version number as the changed key(s).
When creating key set(s), the encrypting key to be used is the DEK of the same key version number as KIc and KID in the Command Packet containing the PUT KEY command.
The key version number of KIc and KID used to secure the Response Packet is the same as the key version number indicated in the Command Packet.
The transport security keys (i.e. KIc/KID) used to secure the Response Packet are the same as the ones of the Command Packet containing the PUT KEY command.

18.2.2 Set Up of Security Domains

The implementation and installation of a SD depends very much on the card implementation and is proprietary for each manufacturer.

18.2.3 Interoperability regarding Security Domains and GP security

In summary, the following points apply for the interoperability of Security Domains on UICC Java Cards:
SIM Alliance members are interoperable:

- All SIM Alliance members support Security Domains (other than the Issuer Security Domain) for OTA
- The addressed application gets the message in plain format.
- All SIM Alliance members support key management as specified is above.
- All applications must be associated with the ISD or with one other security domain.
- For applications associated with an SD, the keys of the SD are taken for OTA security.

> **Interoperability Issue**
> The interface between Card Manager and Security Domains is open. The way to implement security in a SD is not standardized. The implementation is proprietary and as a consequence it is not possible to load and install Security Domains in an interoperable way.

18.3 Key Management

18.3.1 Algorithm

The algorithm to be used depends on the DES algorithm specified as DEA in ISO 8731-1.
The algorithm to be used is defined as follows:

- DES in CBC mode is described in ISO/IEC 10116

- Triple DES in outer-CBC mode is described in "Applied Cryptography: Protocols, Algorithms, and Source Code in C, 2nd Edition"
- DES in ECB mode is described in ISO/IEC 10116

The initial chaining value for CBC modes is zero.

SIM Alliance members support DES and triple DES in CBC/ECB mode for ciphering and in CBC mode for cryptographic checksum.

The length of the keys to be used depends on the algorithm used.

If a DES in CBC or ECB mode is used, the key should have a length of eight bytes.

To ensure interoperability, you are advised to use a:

- 16-byte key divided into two keys of eight bytes if triple DES using two different keys is used
- 24-byte key divided into three keys of eight bytes if triple DES using three different keys is used

18.3.2 Key Set Version

The key set version to be used in the KIc and KID bytes refers to a Global Platform key set version number. The key set version 0 is reserved. Therefore the key set version is then between '01' and '0F'.

The key set version '11' is used for UICC Toolkit Parameters DAP and Access Domain DAP verification. The number of key sets, as well as the number of security domains, may be defined at the personalization step, according to operators' requirements.

Each package, applet, and instance of an applet loaded on a Java card must be assigned a unique identifier, known as an application identifier (AID). An AID is a string of between 5 and 16 hexadecimal bytes.

The first five bytes of an AID (the RID) uniquely identify the applet provider, that is, the company supplying the package or applet. An applet provider must apply for a registered

RID from ISO; examples for RID could be found in chapter § A.2.

The remaining bytes (up to 11) of an AID contain the Proprietary Identifier eXtension (PIX). The PIX uniquely identifies a package, applet, or applet instance. The PIX is assigned by the applet provider.

The TAR (Toolkit Application Reference) is a 3-byte code used to uniquely identify a second level application (e.g. Toolkit Application). It is used when targeting an applet instance with an OTA message. Prior to the standard specification Release 6, an applet instance could have only one TAR; the value of which is defined by the 13th, 14th and 15th byte of the AID. The standard specification Release 6 allows you to define a list of TARs that are associated with an applet instance. The TAR list is defined when installing the applet instance; if the TAR list is not defined, then the 13th, 14th and 15th byte of the AID are used as the unique TAR of the instance.

If the TAR of an applet is not defined (no TAR list defined and the length of the applet instance's AID is less than 15 bytes), the applet cannot be triggered by OTA.

> **Developer Tip**
> The SIM Alliance members suggests to not define a TAR value (TAR length of less than 15 bytes or no TAR list) if it is not functionally required by the application (e.g. no OTA triggering).

A AID and TARs (annex)

A.1 AID Format

This section provides a basic description of the AID data format used in Java Card technology. For full details, refer to ISO 7816-5, AID Registration Category 'D' Format.

The AID format used by the Java Card platform is an array of bytes that can be interpreted as two distinct parts, as shown in Figure 1. The first part is a five-byte value known as a RID (Registered application provider identifier). The second part is a variable length value known as PIX (proprietary identifier extension). PIX may have a length between 0 and 11 bytes. Therefore, an AID may have a total length between 5 and 16 bytes.

<--------------------------- Application IDentifier (AID) ------------------------------>	
Registered application provider IDentifier (RID)	Proprietary application Identifier eXtension (PIX)
<--------------- 5 bytes ---------------->	<--------------- 0 - 11 bytes -------------->

ISO controls the assignment of RIDs to companies, with each company obtaining its own unique RID. Companies assign PIXs for AIDs using their own RIDs.

A.2 Registered application provider IDentifier (RID)

The RIDs dealt with in the present document, as registered by ISO/IEC according to ISO/IEC 7816-5, are:

	RID
ETSI	'A000000009'
3GPP	'A000000087'
Axalto	‘’
Gemplus	‘A0 00 00 00 18’
Giesecke & Devrient	‘D2 76 00 01 18’
Incard	‘A0 00 00 00 95’
Oberthur Card Systems	‘A0 00 00 00 77’
Orga Kartensysteme GmbH	‘D2 76 00 00 28’

A.3 Proprietary application Identifier eXtension (PIX)

The PIX is used at the discretion of ETSI and can contain between 7 and 11 bytes of information. The PIX is coded in hexadecimal. In all cases, bytes 13, 14 and 15 are reserved for the Toolkit Application Reference (TAR).

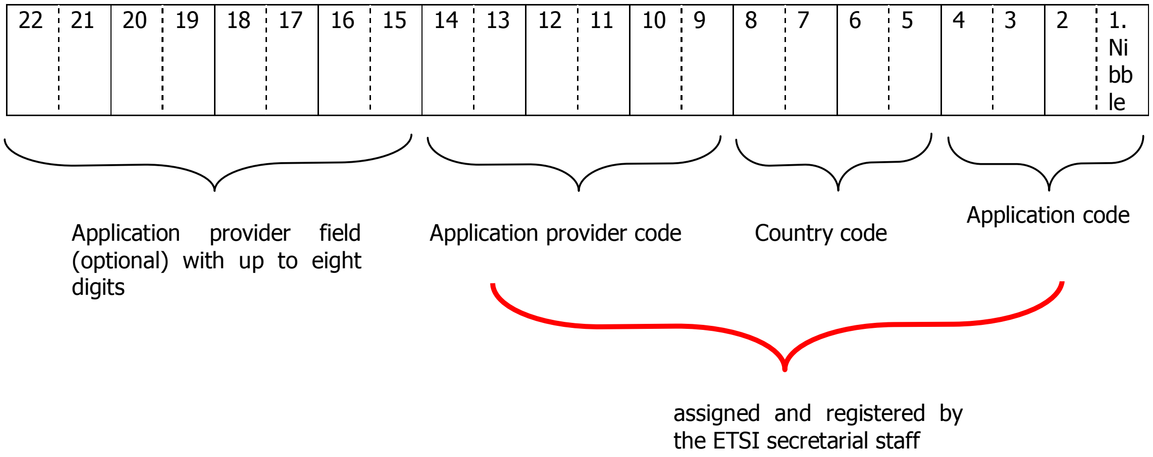

22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1. Nibble
Application provider field (optional) with up to eight digits
Application provider code
Country code
Application code
assigned and registered by the ETSI secretarial staff

Figure 27 – Structure of an AID

For further details, refer to technical specification TS 101 220.

A.4 PIX Coding for different Applications

Application Code

Allocated from ETSI:

Application	**RID**	**ETSI Application Code**	**Document**
GSM	'A000000009'	'0001'	TS 151.011
GSM SIM toolkit	'A000000009'	'0002'	TS 101.267
API Application			
GSM SIM API for Java™ Card	'A000000009'	'0003'	TS 143.019
UICC API for Java Card™	'A000000009'	"0005"	TS 102 241

Allocated from 3GPP:

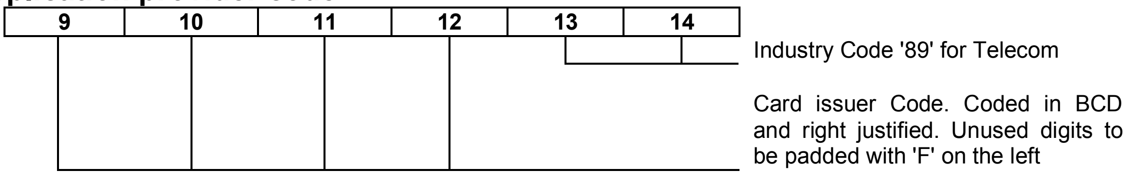
Application	**RID**	**3GPP Application Code**	**Document**
3GPP UICC	'A000000087'	'1001'	TS 131.101
3GPP USIM	'A000000087'	'1002'	TS 131.102
3GPP USIM toolkit	'A000000087'	'1003'	TS 131.111
3GPP ISIM	'A000000087'	'1004'	TS 131.103
API Application			
3GPP (U)SIM API for Java Card™	'A000000087'	'1005'	TS 31.130

Country Code

To indicate the country of the application provider of the ETSI or 3G standardized application. List of actual country codes is published by ITU.

In case of API Country Code is not used and set to 'FF FF'

Application provider code


9
10
11
12
13
14
Industry Code '89' for Telecom
Card issuer Code. Coded in BCD and right justified. Unused digits to be padded with 'F' on the left

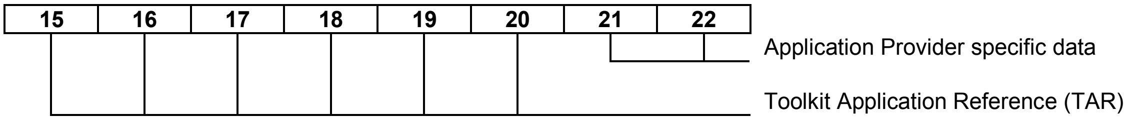
In case of API, Digit 9-12 is not used and set to 'FF FF'

Application provider field - 8 digits

The use of this field is entirely up to the application provider. It may, for instance, be used to indicate "local" versions, revisions, etc. of the ETSI or 3G standardized applications. According to ISO/IEC 7816-5, if the AID is 16 bytes long, then the value 'FF' for the least significant byte (digits 21 and 22) is reserved for future use.

For 2G Applications:

It's used for the following applications: GSM ('0001'), GSM SIM toolkit ('0002') or GSM SIM API for Java™ Card ('0003')


15
16
17
18
19
20
21
22
Application Provider specific data
Toolkit Application Reference (TAR)

Toolkit Application Reference (TAR) as specified in TS 102 226, is managed by the application provider (i.e. operator in that case) except for TAR values beginning with hexadecimal value 'B' (most significant bits of digit 15) which are reserved for future use by the 3GPP and the TAR value '000000' which is reserved for the Issuer Security Domain (see TS 102 226).

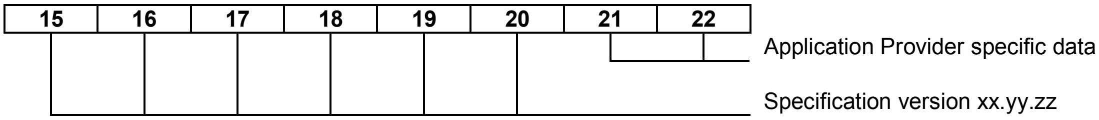
Application Provider specific data is used for application administration purposes.

For 3GPP Applications:

It's used for the following applications: 3GPP UICC ('1001'), 3GPP USIM ('1002') or 3GPP ISIM ('1004')
Digit 15 to 20, coded in BCD, refer to the specification version xx.yy.zz. The coding of xx, yy, and zz is right justified and padded with '0' on the left.

> **Example**
> If the version is 6.5.0 then specification version is '06 05 00'.

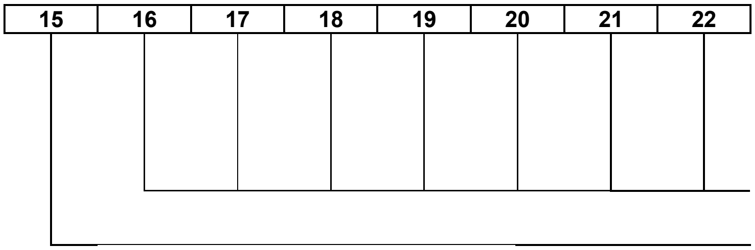
Digit 21 to 22 are coded in hexadecimal


15
16
17
18
19
20
21
22
Application Provider specific data
Specification version xx.yy.zz

Application Provider specific data: for application administration purposes.

For Java Card™ APIs:

It's used for the following APIs: SIM API ('0003'), UICC API('0005') or 3GPP (U)SIM API ('1005')



If Digit 15 = '1', for relevant Application Code:
‘0003’ defined in TS 143 019
‘0005’ defined in TS 102 241
‘1005’ defined in 3GPP TS31.130

API Type, '1' for Java Card

A.5 Toolkit Application Reference (TAR)

The Toolkit Application Reference (TAR) is used to uniquely identify a second level application (e.g. Toolkit Application).

To be addressed, the Toolkit Application needs a first level application (e.g. GSM, USIM application) running.

A second level application may have several TAR values assigned.

Allocation of TAR values

Application	TAR	Document
Issuer Security Domain		
Issuer Security Domain	'00 00 00'	ETSI TS 102 226
1st level application issuer specific values		
Allocated by the 1st level application issuer	'00 00 01' to 'AF FF FF'	
Allocated by the 1st level application issuer	'C0 00 00' to 'FF FF FF'	
Remote File Management Applications		
UICC Shared File System	'B0 00 00' and 'B0 00 02' to 'B0 00 0F'	ETSI TS 102 226
SIM File System	'B0 00 10' to 'B0 00 1F'	3GPP TS 31.116
USIM File Systems (may include UICC Shared file system)	'B0 00 01' and 'B0 00 20 to 'B0 01 1F'	3GPP TS 31.116
RFU	'B0 01 20' to 'B0 FF FF'	
Payment Applications		
RFU	'B1 00 00' to 'B1 FF FF'	
	USAT Interpreter Application	
USAT Interpreter Application	'B2 00 00' to 'B2 00 FF'	TS 131.114
Reserved for future categories		
RFU	'B2 01 00' to 'BF FE FF'	
Proprietary toolkit application		
Proprietary toolkit application	'BF FF 00' to 'BF FF FF'	

A.6 Telecom API Package Version Management

The package AID coding is defined in TS 101.220. The SIM API packages' AID is not modified by changes to Major or Minor Version.

The major version is incremented if a change to the specification leads to byte code incompatibility with the previous version.

The minor version is incremented if a change to the specification does not lead to byte code incompatibility with the previous version.

A.7 SIM API package version management

The following table describes the relationship between each 3GPP TS 43.019 specification version, the SIM API package AID, and the major and minor versions defined in the export files.

TS 03.19/ 43.019 version	sim.access package		sim.toolkit package	
	AID	Major, Minor	AID	Major, Minor
5.5.0	A000000009 0003FFFFFFFF8910710001	2.2	A000000009 0003FFFFFFFF8910710002	2.6

A.8 UICC API package version management

The following table describes the relationship between each TS 102 241 specification version and its UICC API packages AID and Major, Minor versions defined in the export files.

TS 102 241	**uicc.access package**		**uicc.toolkit package**	
	AID	**Major, Minor**	**AID**	**Major, Minor**
latest version!	A0 00 00 00 09 00 05 FF FF FF FF 89 11 00 00 00	1.0	A0 00 00 00 09 00 05 FF FF FF FF 89 12 00 00 00	1.0

TS 102 241	**uicc.system package**	
	AID	**Major, Minor**
	A0 00 00 00 09 00 05 FF FF FF FF 89 13 00 00 00	1.0

TS 102 241	**uicc.access.fileadministration package**	
	AID	**Major, Minor**
	A0 00 00 00 09 00 05 FF FF FF FF 89 11 01 00 00	1.0

A.9 USIM API for Java Cards package version management

The following table describes the relationship between each TS 31.130 specification version and its packages AID and Major, Minor versions defined in the export files.

TS 31.130	**uicc.usim.access package**		**uicc.usim.toolkit package**	
	AID	**Major, Minor**	**AID**	**Major, Minor**
latest version!	A0 00 00 00 87 10 05 FF FF FF FF 89 13 10 00 00	1.0	A0 00 00 00 87 10 05 FF FF FF FF 89 13 20 00 00	1.0

The package `uicc.usim.access` contains only constants, therefore it may not be loaded on the UICC.

A.10 Java Card API Packages

The following table shows the AIDs of the packages described in the Java Card Specification 2.2.1:

Package	AID
`java.lang`	A0 00 00 00 62 00 01
`javacard.framework`	A0 00 00 00 62 01 01
`javacard.security`	A0 00 00 00 62 01 02
`javacardx.crypto`	A0 00 00 00 62 02 01

B TLV Coding (annex)

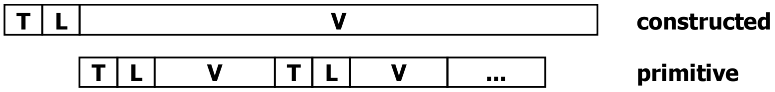
The specification TS 101.220 is no longer updated with corrections or clarifications, it will be done in the Release 7 version of this document only; therefore this document refers to the Rel. 7 rather than Rel. 6 version of the 101.220 specification.

In the ETSI specifications data-objects are used to capsulate information and code it in a Tag-Length-Value construction.

The data transmitted in a TLV data object structure is formatted as follows:

Byte(s)	Description	Length
1 to T	TLV Tag	1 ≤ T ≤ 3
T+1 to T+L	TLV Length	1 ≤ L ≤ 4
T+L+1 to T+L+X	TLV Value	X

There are constructed and primitive TLVs existing where the value part of the constructed TLV-Object again can hold several constructed or primitive TLV-objects.



B.1 Tag coding

According to TS 101.220 the following table shows the encoding of the components for each of the recognized forms of TLV (see also Note below):

Name of TLV	Encoding of tag field	Encoding of length field	Encoding of value field
BER-TLV	ISO 8825-1	see § B.2	ISO 8825-1
COMPACT-TLV	ISO 7816-4	ISO 7816-4	ISO 7816-4
COMPREHENSION-TLV	TS 101 220, section 7.1.1	see section § B.4	ISO 7816-4

Examples for

- BER-TLV: tags for several templates, like the FCP template, Security attribute template, PIN Status Template
- COMPACT-TLV: historical bytes of the ATR
- COMPREHENSION-TLV: card application toolkit data-objects (proactive commands, envelopes, etc)

A summary of assigned TLV tag-values can be found under TS 101 220, section 7.2. All unassigned tag values are reserved for future use.

B.2 BER-TLVs

The coding of a BER-TLV tag field depends on the usage of the TLV-object. Following table explains the tag encoding scheme:

Table: First byte of BER-TLV tag fields according to ISO 7816-4

b8/b7	b6	b5-b1	
00			universal class
01			application class
10			context specific class
11			private class
	0		primitive encoding
	1		constructed encoding
		xxxxx	tag number from zero to thirty (short tag field, e.g. consisting of a single byte)
		11111	tag number greater than thirty (long tag field, e.g. consisting of 2 or 3 bytes)

B.3 COMPACT-TLVs

According to TS 101.220 the COMPACT-TLV data objects are used for the historical bytes of the ATR only.
The COMPACT-TLV data objects are deduced from interindustry BER-TLV data objects with tag field '4X' and length field '0Y'. The coding is 'XY' followed by a value field of 'Y' bytes fixing one or more data elements. In this clause, quartet 'X' is referred to as the compact tag and quartet 'Y' as the compact length.

B.4 COMPREHENSION-TLVs

The COMPREHENSION-TLV data objects are not encoded as BER-TLV tag fields. They are primitive data objects defined in [101 220 R7] for the specific purpose of indicating the Comprehension Required Flag (CR) in the tag.

The value of the first byte identifies the format used.

First byte value	Format
'00'	Not used
'01' to '7E'	Single byte
'7F'	Three-byte
'80'	Reserved for future use
'81' to 'FE'	Single byte
'FF'	Not used

The specification [101 220 R7] defines only COMPREHENSION-TLVs with one byte length.
The same value in the different formats represents the same data object.
Unless otherwise stated, for COMPREHENSION-TLV it is the responsibility of the UICC application and the terminal to decide the value of the Comprehension Required (CR) flag for each data object in a given command.
Handling of the CR flag is the responsibility of the receiving entity.

CR	Value
Comprehension required	1
Comprehension not required	0

Single byte format

The tag is coded over one byte.

8	7	6	5	4	3	2	1
CR	Tag value						

CR: Comprehension required for this object.

Three-byte format

The tag is coded over three bytes.

Byte 1	Byte 2								Byte 3
	8	7	6	5	4	3	2	1	
Tag value format = '7F'	CR	Tag value							

Tag value format: Byte 1 equal to '7F' indicates that the tag is in the three-byte format.

- **CR:** Comprehension required for this object. Use and coding is the same as in single byte format.
- **Tag value:** Coded over 15 bits, with bit 7 of byte 2 as the most significant bit. Range from '00 01' to '7F FF'.

B.5 Length coding

The length of the TLV objects is coded on one to four bytes, depending on the amount of bytes coded in the value-part.

As defined in section 7.2 of TS 101.220 seperate rules apply for the length-coding of :

- COMPACT-TLV:
  The maximum length of the value part is limited to 65535 bytes and therefore maximum 3 lengths bytes are allowed according to ISO 7816-4.

- BER-TLV and COMREHENSION-TLV
  For BER-TLV and COMPREHENSION-TLV data-objects a maximum number of 4 length-bytes is allowed.

Length	Byte 1	Byte 2	Byte 3	Byte 4
0-127	length ('00' to '7F')	not present	not present	not present
128-255	'81'	length ('80' to 'FF')	not present	not present
256-65535	'82'	length ('01 00' to 'FF FF')		not present
65536 - 16777215	'83'	length ('01 00 00' to 'FF FF FF')		

Note:
Even if TS 101.220 refers to BER coding with this table, the correct naming would be DER (distinguished encoding rules) coding, which is a subset of BER. With DER it is mandatory to use the shortest possible length coding. E.g. if you want to code T=C0, V= AA BB CC, following rules apply:

- C0 81 03 AA BB CC(valid BER coding according to ISO 7816-4 but not allowed for TS 101.220)
- C0 03 AA BB CC (valid DER coding according to ISO 8825-1, mandated in TS 101.220)

B.6 Value coding

The value of a TLV is defined in the appropriate section of the ETSI specification, where the functionality or the tag-field is described.

C Administrative Commands (annex)

This document gives a functional description of the administrative commands, their respective responses, associated status words, error codes and their coding supported by any smart-card manufacturer that is a SIMAlliance member. These new commands allow in particular creating, deleting and resizing a file in an application since the Release 6 of the 3GPP specifications.

C.1 CREATE FILE

Definition and scope

This function allows the creation of a new file or directory under the current directory. The application that calls the CREATE FILE function is supposed to have fulfilled the access condition of the current directory for the CREATE FILE function.

When creating an EF with linear fixed or cyclic structure the UICC creates directly as many records as allowed by the requested file size. The memory space is allocated for the created file and filled with FF (other behaviours are proprietary and to define using tags '85' or 'A5').

After the creation of a DF, the current directory will be the newly created file. In case of an EF creation, the current EF will be the newly created file too and the current directory is unchanged.

After creation of an EF with linear fixed structure, the record pointer is not defined. After creation of an EF with cyclic structure, the current record pointer is on the last created record. After creation of an EF with BER TLV structure, the current tag pointer is undefined.

Once the file is created, some data may have to be updated to take into account this new file creation. For example, an EF creation may require updating the EF_{ARR} with the access conditions of the file just created.

> **Interoperability issue**
> SIMAlliance members cannot guarantee that ADF creation can be performed by this command.

Command message

As an UICC command, the CREATE FILE is coded according to table 1.

Table 1: CREATE FILE command message

Code	Value
CLA	0x
INS	E0
P1	'00'
P2	'00'
Lc	Length of the subsequent data field
Data field	Data sent to the UICC
Le	Not present

Data field (TLV) needed in the command message

The input parameters of the create file are included in a TLV "0x62" + Length that encapsulates the whole File Control Parameters.

Then the mandatory sub TLV objects are:

- **Tag 0x82:** File Descriptor that specifies if the file to create is shareable or not, if it is an EF, a DF or an ADF and the type of the file (transparent, linear fixed, cyclic, BER-TLV). In case of linear fixed and cyclic files, the record length must be present
- **Tag 0x83:** File ID (2 bytes)

> **Interoperability issue**
> It's not specified, and so not interoperable, meaning of this parameter in case of ADF creation.

- **Tag 0x84:** ADF name / AID, only present in case of ADF creation

- **Tag 0x8A:** Life Cycle Status Information, it defines the status of the file after creation (the status of a file object is linked to the Activate/Deactivate commands)
- **Tag 0x8C, 0xAB or 0x8B:** Security attributes that respectively mean compact, expanded or referenced. SIMAlliance members guarantee the support of referenced security attributes tag '8B' that uses EF_{ARR} in one of the parent DF of the current location. See 6.3.2 for further details.

Interoperability issue
Mechanisms to specify 2G security attributes (i.e. the access conditions valid when the card is put in a 2G mobile) are not specified by ETSI specification and so they are not interoperable.

- **Tag 0x80/0x81:** Size of the EF (Tag 0x80) or DF/ADF (Tag 0x81). It doesn't include the size of the structural information for the created object. It is the size returned in the FCP information provided in a response to a SELECT APDU command and labeled "Reserved File Size" for EF. For DF creation, the tag '81' may be ignored.
- **Tag 0xC6:** PIN status template data object needed only in case of DF creation

Interoperability issue
SIMAlliance members cannot guarantee that cards behavior is interoperable for this TLV. However it is recommended to include it in the CREATE command as it is a mandatory field. This tag may be ignored too.

- **Tag 'A5':** Proprietary tags can be used to define how to fill created EFs (), to specify the BER-TLV maximum file size, to define a specific file information or other proprietary behaviors that may vary from supplier to supplier.

Limitations:

The maximum number of EF for a given DF is 255 (limitation from the answer to a select).
The maximum size of an EF is 32k as the read binary cannot access to more than 32k (due to SFI in P1P2 parameters).

TLV graphic representation

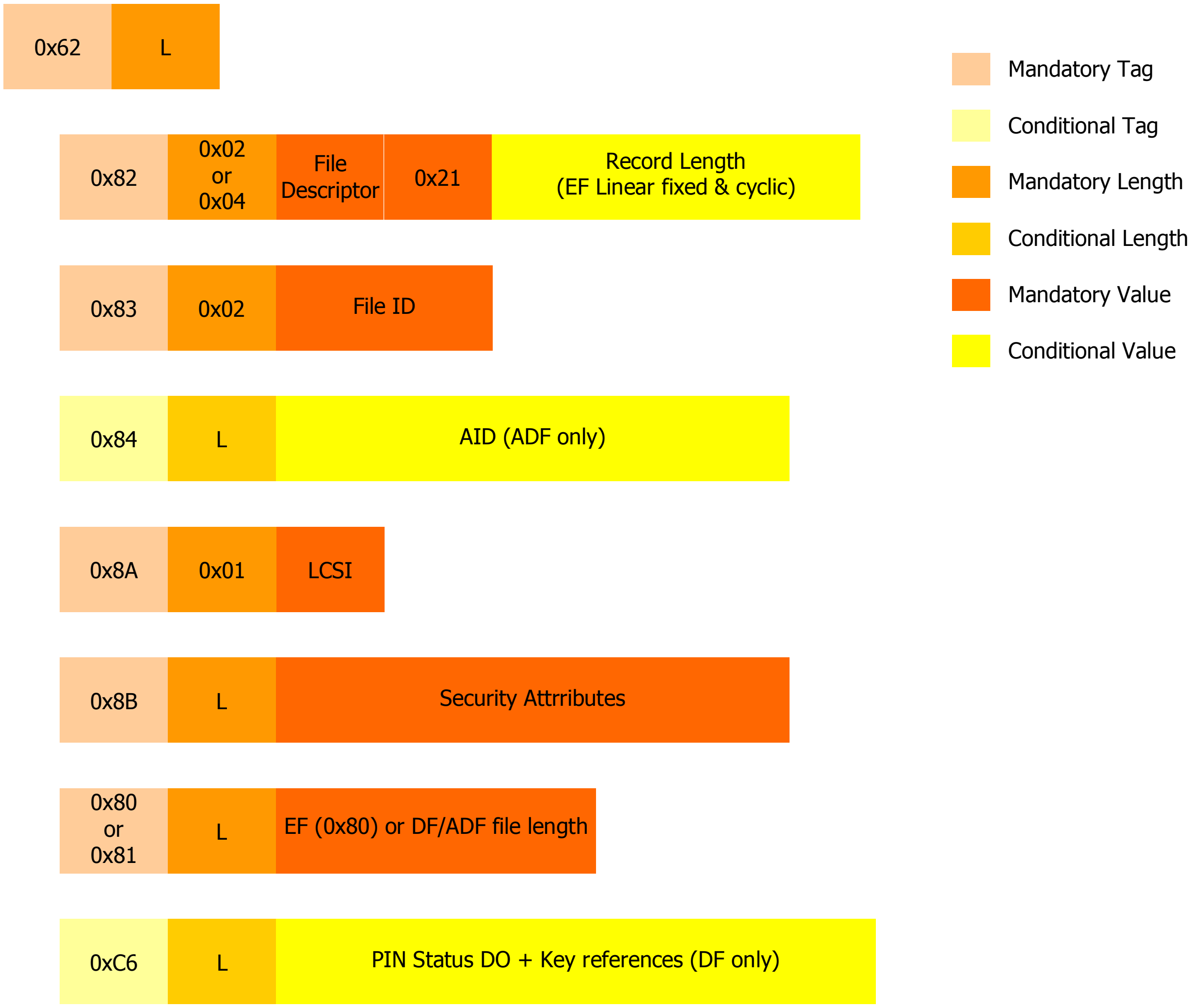


Figure 28 – TLV structure for the CREATE command

C.2 DELETE FILE

Definition and scope

This command performs the deletion of an EF immediately under the current DF, or of a DF with its complete sub-tree.

- Prior to the execution of a DELETE FILE command by the application, it is supposed to have fulfilled the access condition "DELETE FILE" of the object to be deleted. After successful completion, the current directory is unchanged and no EF is selected in case of an EF deletion.
- If a DF is to be deleted, the application is supposed to have fulfilled the access condition "DELETE FILE (self)" of the DF to be deleted. After successful completion the parent directory is selected and no EF is selected.
- If an ADF is to be deleted, the application is supposed to have fulfilled the access condition "DELETE FILE (self)" of the ADF to be deleted and the ADF cannot be currently selected on another logical channel. After successful completion the MF is selected and no EF is selected.

Interoperability issue
SIMAlliance members cannot guarantee that ADF deletion can be performed by this command.

If a file is indicated as not-shareable and is the current file of one application, then another application cannot delete it. If a file is indicated as shareable then it can be deleted by one application independently of whether or not the file is the current file of any other application. So in this case, if another application is using concurrently the deleted file, the processing by the application may fail. If a DF is shareable and an application, having the appropriate rights, requests to delete it, the whole DF including all EFs can be deleted whatever shareable status they have.

> **Interoperability issue:**
> SIMAlliance members cannot guarantee that deletion of shareable EF/DF will result in the same final file context for other applications.
>
> SIMAlliance members cannot guarantee that deletion of mapped files is interoperable.

After successful completion of this command, the deleted file can no longer be selected. The resources held by the file are released and the memory used by this file is set to the logical erased state. It is not possible to interrupt this process in such a way that the data can become recoverable.

Command message

The DELETE FILE command message is coded according to table 2.

Table 2: DELETE FILE command message

Code	Value
CLA	0x
INS	E4
P1	'00'
P2	'00'
Lc	Not present or length of the subsequent data field
Data field	Data sent to the UICC (optional file ID on 2 bytes)
Le	Not present

FID is mandatory in the JAVA API.
When not present, the current selected EF/DF/ADF on the considered logical channel is deleted.

C.3 RESIZE FILE

Definition and scope

This command allows modifying the memory space allocated to the MF, a DF/ADF, a transparent file, a linear fixed file or a BER-TLV structured EF under the current directory (MF, DF/ADF). This command is not allowed for a cyclic file. If the RESIZE FILE command is used for an ADF, this ADF can only be the ADF of the current active application on this logical channel. MF or DF/ADF resizing operation may not be supported.

The RESIZE FILE access condition is indicated in the access rules of the targeted object after the AM_DO tag '84'. If this TLV object contains the value D4, then the RESIZE FILE command can be applied on this object.

In case of successful execution of the command, the current file or directory on which the command was applied is selected. If the RESIZE FILE command was performed on a linear fixed file the record pointer is undefined and on a BER-TLV structured EF the tag pointer is undefined. The Total File Size, if applicable, and the File Size TLV object defined in the FCP template of the modified file is updated accordingly. The allocated memory space is updated according to the new data size. Note that for a linear fixed file, the RESIZE FILE command modifies the number of records but doesn't change the record length.

After an unsuccessful execution of the command, the current selected file and directory remains the same as prior to the execution. In this case, the card restores the previous context (the resize command is an atomic operation).

In case the size of a linear fixed or transparent EF is increased:

- the extension data is appended to the end of the existing data
- the data contained in the previously allocated memory space are not modified by the RESIZE FILE command

- the newly allocated memory space is initialized with 'FF' unless another value is specified in a proprietary TLV object '85' or 'A5'.

In case the size of a linear fixed or transparent EF is decreased:

- the removed data are deleted and removed from the end of the existing data and
- the remaining data already contained in the previously allocated memory space are not modified by the RESIZE FILE command

For a BER-TLV structured EF, the Reserved File Size or the Maximum File Size or both can be resized. If the Maximum File Size is decreased and the new size conflicts with the used size, then depending on the mode chosen in P1 parameter, the command is rejected or all objects in the file are deleted.

Command message

The RESIZE FILE command message is coded according to table 3.

Table 3: RESIZE command message

Code	Value
CLA	8x
INS	D4
P1	00 (or 01 for BER-TLV EF – mode selection)
P2	'00'
Lc	Length of the subsequent data field
Data Field	Data sent to the ICC
Le	Not present

Data field sent in the command message

There is at most one occurrence of the following Tags.

- **Tag '83':** It contains the File ID of the object (MF, ADF, DF or EF) to resize. If the resize operation target is the current ADF of the application, the FID '7FFF' can be used.
- **Tag '80':** File Size (Reserved File Size). This TLV is needed only in case of EF resize operation. It contains the New File Size for this EF. This size is the new number of bytes allocated for the body of the EF (i.e., like in the Create File command, it does not include structural information). In the case of an EF with linear fixed structure, the new File Size is the record length multiplied by the number of records of the EF; otherwise the command is rejected (see previous note). This New File Size low limit is at least the size needed by one record. For transparent files, if this size is set to '00', all the content of the EF is removed but the EF is not deleted (it is then exactly as if the EF was created with a size set to '00') and the structural information is still available. For BER-TLV structured EF, if File Size is present, it indicates the minimum number of bytes reserved for the body of the file. The value includes administrative overhead (if any) that is required to store TLV objects, but not the structural information for the file itself. The current content of the file remains still the same whatever is the new reserved file size value (in case of increase of the current file size, below is the decrease case).
- **Tag '81':** Total File Size. This TLV is only used in case of MF or a DF/ADF resize operation. It contains the New Total File Size for the MF or this DF/ADF. This size is the new amount of physical memory allocated for the MF or a DF/ADF (i.e. it does not include structural information) for card not implementing dynamic allocation of memory. The amount of EFs or DFs which may be created is implementation dependent. The MF or DF/ADF can be resized to '00' only if it does not contain any file. In this case, the structural information is still available for the MF or DF/ADF. For an ADF, the resizing to '00' does not affect EF_{DIR} and any other information necessary to administer an application.
- **After tag 'A5',** there can be some other optional or proprietary TLV objects, for example to define with which pattern use to fill the created space resizing an object with a higher size. The full support of these features may vary from a card supplier to another.
- About the optional sub TLV object with **tag '86'** (Maximum File Size for a BER-TLV structured EF located inside the TLV beginning by 'A5'), this TLV object will only be provided if a BER-TLV structured EF is resized. The Maximum File Size indicates the new maximum number of bytes that can be allocated for the body of the file. As previously, this value includes administrative overhead (if any) that is required to store TLV objects, but not the structural information for the file itself.

In case the New Maximum File Size is decreased and the size used by the existing TLV is greater than the New Maximum File Size:

- If P1 indicates Mode 0, all existing TLV objects are deleted (the file itself is not deleted). The New Maximum File Size is assigned to the file.
- If P1 indicates Mode 1, no action is performed and it returns an error telling the conditions of use are not satisfied.

D SIM Alliance Interoperable Loader (annex)

Description of SIM Alliance Tools Implementing Interoperability

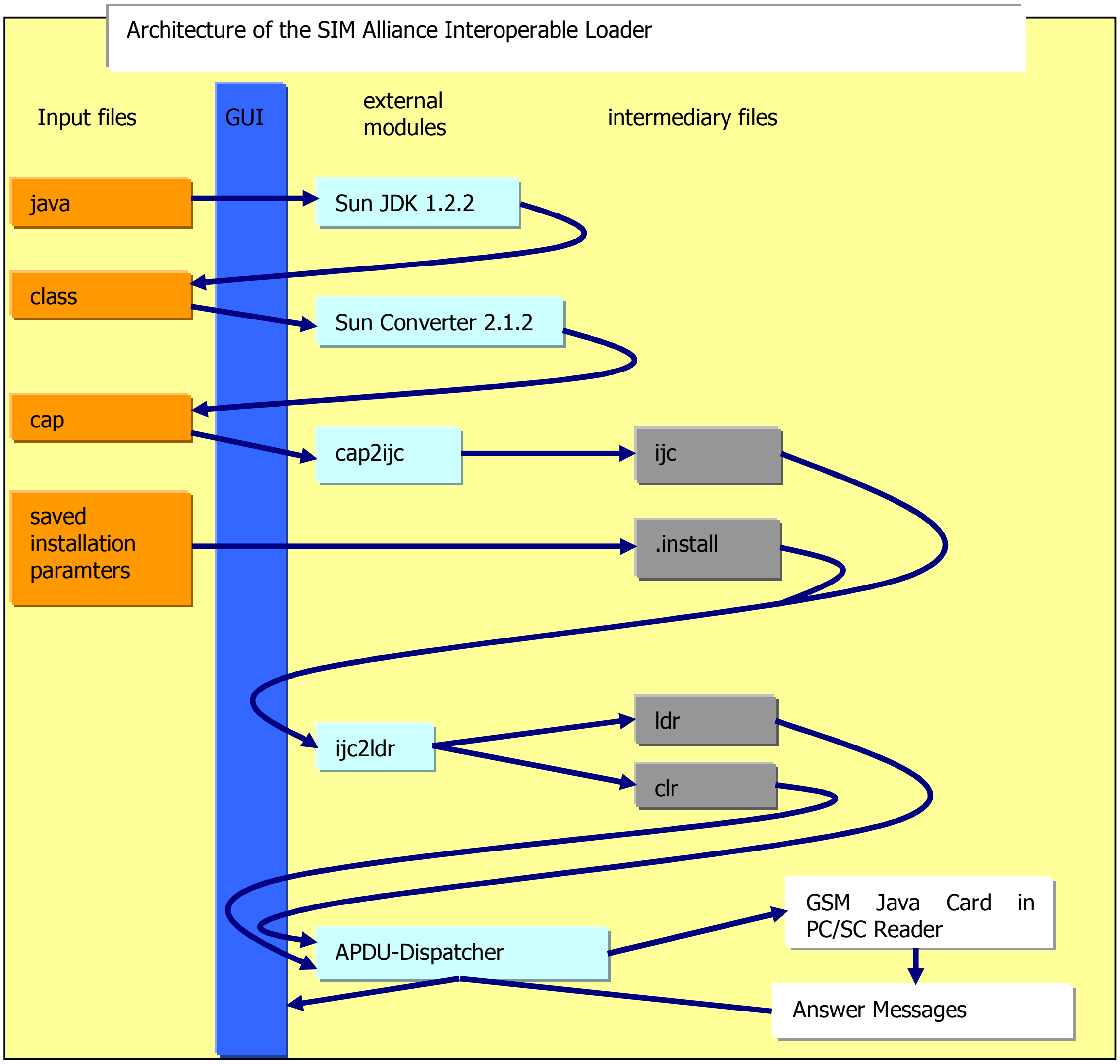


Figure 29 – SIM Alliance Interoperable Loader Architecture

The SIM Alliance Interoperable Loader is a tool designed by the members of the SIM Alliance Working Group on Java Interoperability to provide an interoperable way of downloading a SIM Toolkit application into a GSM Java Card by the means of OTA. Especially the second version of the loader tool is meant to be the implementation of an interoperable interpretation of the ETSI 102 225 specification.

The first step in the Interoperable Loader tool chain is the production of a Sun compliant .cap file. The tool is capable of processing .java or .class files. Java source code is compiled to give .class files with the use of Sun's JDK. For reasons of interoperability we recommend to use the JDK 1.4.1. Cap files are produced from class files with the help of the converter 2.2.1 from Sun Microsystems. The second version of the loader also accepts .cap as input and extracts the corresponding AIDs directly from the file.

In the second step of the Interoperable Loader tool chain, the cap file is converted to a .ijc file (interoperable java cap file) by the cap2ijc converter. In this conversion step, the standard Sun cap is merely reorganized to give a stream of bytes that can be loaded on to any Java Card.

The last part of the Interoperable Loader tool chain is the ijc2ldr-converter, which packs the stream of bytes contained in .ijc-files into Open Platform commands as demanded by the ETSI 102 226 specification and the underlying Global Platform specification 2.1, and the Open Platform commands into ETSI 131.115 conforming SMS envelopes. In its second version, the tool supports the minimum security level demanded by ETSI, which includes encoding of a MAC with an 8 Byte simple DES key in CBC mode. The DES key and the number of the corresponding key set on the card are directly entered in the user interface of the loader. It is also possible to demand a Proof of Receipt to which no security is applied. The second version of the loader is still capable of loading without any security the same way the first version worked, but this procedure is not standardized and therefore not interoperable. The APDU sequence resulting from the last step of the Tool Chain is stored in a .ldr-file. Also, a corresponding .clr-file is created which contains the command sequence to de-install the applet.

After all relevant command sequences have been created and stored, the loader tool uses the PC/SC middleware architecture for passing the commands to the GSM Java Card. Therefore, a PC/SC compliant reader has to be used and the corresponding PC/SC services of the operating system must be installed and activated. All answers from the card are passed back to the user interface and a log of the exchanged APDUs can be viewed and stored.

E Change History (annex)

This annex lists all changes made to the present document since its initial approval.

Meeting	VERS	REL	SUBJECT	Resulting Version
16/01/06	1.00	6	First issue of the Stepping Stones Rel6	1.00