PLAID application specification

License Version 7.1

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1. Introduction

PLAID (Protocol for Light weight Authentication of ID) is a smartcard authentication protocol developed by Centrelink, which is cryptographically stronger, faster and more private for contactless applications than most or all equivalent protocols currently available either commercially or via existing standards.

There are significant advantages in efficiency and reduction in costs if a common, non-proprietary and standardised protocol of this type is available across common software, readers, building, key and card management systems particularly should multiple agencies or governments and their vendors support the same protocol.

Centrelink, an Australian Government Statutory Agency, has a consequent strategic interest in obtaining commercial off the shelf (COTS) product using PLAID. Since Centrelink obtains the greatest advantage by the broadest use of PLAID, Centrelink chooses to license the intellectual property developed by Centrelink to other agencies, government and commercial organisations on an open, free and non-discriminatory basis, and to propose it as a component of forward formal standards.

In order to facilitate the above, Centrelink has structured a program to;

Have PLAID evaluated by both respected cryptographic organisations, as well as the broader cryptographic community.

Generate interest and co-operation, from government agencies worldwide.

Develop, propose, socialise, agree and implement standardisation strategies in consultation with these agencies and industry.

Manage vendor access, feedback and licensing to ensure equality of access of PLAID intellectual property to all vendors and end-users that chose to support the protocol.

Ensure Intellectual Property (IP) is not lost, diluted or accidentally transferred to any single party, and is available to all potential user communities under reasonable, non-discriminatory and free licensing arrangements.

Encourage governments, their agencies, commercial end-users and vendors to implement PLAID within COTS product with the intention of using the scale of these implementations to drive down the cost and increase the availability of fit-for-purpose COTS product to all.

This specification forms an initial step in the standardisation strategy. It provides any interested party with a formal, stabilised and tested version of PLAID (Version 7) which has both been reviewed by respected cryptographic organisations and has been load tested on a significant range of smartcards and devices over a two year period.

This version incorporates various enhancements in response to issues identified by the Australian Defence Signals Directorate (DSD) and the US National Institute of Standards and Technology (NIST) as well as the internal Centrelink team.

This is the first version of PLAID to include a production licence which allows the re-distribution of PLAID IP without restriction and without the possibility of licence condition alteration. As such, manufacturers may choose to incorporate PLAID into their product offerings at no cost from this release.

1. PLAID Authentication Protocol

PLAID is a cryptographic and algorithmic method and associated source code which uses symmetric and/or asymmetric cryptography in a unique protocol to protect the communications between smartcard and terminal devices in such a way that strong authentication of objects on the smartcard is possible in a fast and highly secure fashion without the exposure of card or cardholder identifying information or any other information which is useful to an attacker.

The PLAID protocol uses standards-based cryptography commonly available on most programmable smartcards, computer systems and embedded devices and is consequently highly portable to existing cards and devices.

The PLAID protocol is optimised for a fast mutual authentication between the smartcard and devices or middleware using either contact or contactless smartcard implementations. In optimal configurations, with high-end cards and optimised environments, total transaction speeds range between 200 and 300 milliseconds (0.2 - 0.3 seconds). Slightly longer times are experienced when working with large access control objects such as biometric templates.

PLAID is highly resilient to the following threats:

ID-leakage – the leakage of individually identifiable, unique or determinable data or characteristic of the smartcard or card holder during authentication.

Private-data-leakage – availability of private data in the clear at interfaces accessible by other than the data owner or appropriately authorised parties.

Replay attack - an attack in which a valid data transmission from a smartcard is able to be repeated by a different smartcard or by a smartcard emulator and appear to be an authentic session.

Man-in-the-middle attack – an attack where an active emulator or similar device or devices insert themselves in the session between the real smartcard and the reader and maliciously modify data within the session in such a fashion that neither the smartcard nor reader detect the modified session.

PLAID supports either single- or dual-factor authentication, with support for authentication of the smartcard, the access control system record and (optionally) the cardholder’s PIN or biometric template.

PLAID version 7 supports the following new features;

Multiple key sets (255). Different keys may be used by purpose (i.e., perimeter, logical access, computer room and administrative key sets) and maintenance of keys is possible by rolling onto a spare un-used key set already stored on the smartcard.

Multiple access control system records authenticated by purpose (255). Depending on the record required by the reader, the protocol will provide an authenticated record of just the type required for the particular environment. These records could for example be all of; a Weigand number; a US Federal FASC-N staff number; a FIPS 201 CHUID or Centrelink

CSIC record; an ISO/IEC 7812 card number; a biometric template or any other numbering system required by the environment.

A 256 bit AES session key is provided for the next smartcard operation. PLAID may be used as a bootstrap protocol to set up the card with a secure session to support subsequent higher level protocols or operations. This might for example be used to protect a public certificate accessed in the next operation from exposure of its otherwise publically available attributes.

A usage counter is maintained by the card for analysis of successful authentications and comparison to back-office data in order to assist in identification of attempted attacks.

A failed attempt counter is maintained by the smartcard for its analysis of failed authentications and to shut access to the application down in the instance of multiple failed authentications.

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**User** means the entity that accesses, uses, reproduces, downloads or otherwise deals with PLAID.

1. Scope

The scope of this document is to describe the PLAID authentication protocol in sufficient detail to allow any two or more implementations to be interoperable given that the implementations independently agree on the PLAID keys used and the values of keys, as well as the ACS record structures and any biometric template formats supported.

This document does not address key management, ACS record structures or biometric templates as these are logically described in other standards or specifications or should be determined by implementers.

Further to this scope, and to assist in interoperability, a reference implementation is made available by Centrelink to support this document. This implementation is freely available from the Commonwealth of Australia via Centrelink as both source and objects code under the same licence applicable to this document and set out in section 4.

1. Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 7816 Parts 3, 4, Identification cards — Integrated circuit cards with contacts

ISO/IEC 14443 (all parts), Information technology — Identification cards – Contactless integrated circuit(s) cards – Proximity cards

ISO/IEC 18033 (all parts), Information technology — Security techniques — Encryption algorithms

FIPS 197 AES – Announcing the Advanced Encryption Standard

FIPS 180 SHA – Introducing the Secure Hash Standard

1. Terms and Definitions

For the purposes of this document, the following terms and definitions, apply.

7.1 ACS record (ACSrecord)

A unique record per Card Holder and Operational Mode that is authenticated by the PLAID AP for the purpose of PACS or LACS access.

7.2 Card Holder

The person to whom a PLAID-capable smartcard is issued by the Issuer and whose differential identity is the target of the PLAID Authentication Protocol.

7.3 Diversification Data (DivDat)

A number which the Issuer sets that is unique per smartcard for use by the key diversification algorithm to ensure that breach of an individual card symmetric key cannot result in a breach of the systems master keys.

7.4 Issuer

The entity, system or role which issues a PLAID-capable smartcard and owns the PLAID keys.

7.5 ID-Leakage

A constant subset of data that is static for each authentication exchange between a specific ICC and IFD. This subset (even when encrypted) could allow for identification of an individual smartcard, and therefore indirectly the cardholder. This attribute can be a superset of private data-leakage.

7.6 Keyset Identifier

An identifier which uniquely identifies a key set.

7.7 LACS record

Logical access control system record, see ACS record.

7.8 Man-in-the-middle attack

An attack where an active emulator or similar device or devices insert themselves in the session between the real ICC and the IFD and maliciously modify data within the session in such a fashion that neither the ICC nor IFD detect the modified session.

7.9 Operation mode identifier (OpModeID)

An identifier sent to the ICC in the in the P1 parameter of the Initial Authenticate command that determines which PACS/LACS record type is served up by the final authentication step.

7.10 PACS record

Physical access control system record, see ACS record.

7.11 Private data leakage

The availability of private data in the clear at interfaces accessible by other than the data owner or appropriately authorised parties. This attribute is a subset of ID-Leakage.

7.12 Replay attack

An attack in which a valid data transmission from an ICC is able to be repeated by a different ICC or by an ICC emulator and appear to be an authentic session as viewed from an IFD.

1. Symbols (and Abbreviated Terms)

| **Symbol** | **Meaning** |
| --- | --- |
| | | logical concatenation of bit strings (Pipe) |
| ⊕ | Logical exclusive OR operator (XOR) |
| AES | advanced encryption standard (as defined in FIPS-197) |
| AID | application identifier |
| AP | authentication protocol |
| APDU | application protocol data unit |
| COTS | commercial off the shelf |
| CRT | Chinese remainder theorem |
| DivDat | diversification data – salt data used in cryptographic operations |
| DOS | denial of service (attack) |
| ECB | electronic code book |
| FA | final authenticate |
| IA | initial authenticate |
| ICC | integrated circuit card, logically equivalent in this specification to PICC |
| IFD | interface device |
| KeySetID | A 2-byte value specifying which key set the protocol will negotiate or use |
| LACS | logical access control system |
| OID | object identifier |
| OpModeID | A 2-byte value specifying which operational mode the protocol will use |
| PACS | physical access control system |
| PICC | proximity integrated circuit card, logically equivalent in this specification to ICC |
| PIN | personal identification number |
| PKCS | public key cryptography standards |
| PLAID | protocol for lightweight authentication of identity |
| ROM | read-only memory |
| RSA | Rivest, Shamir and Adleman asymmetric cryptographic algorithm |
| SHA | secure hash algorithm (as defined in FIPS-180) |
| SW | status word |
| TRNG | true random number generator |

1. Revisions History

PLAID version 7.1 does not provide backwards compatible extensions to PLAID version 7. All of these extensions are designed to ensure precise definition of function and logic and optimisations implemented in the PLAID version 7 reference implementation source code. Consolidated details of the differences to previous versions are set out in the table below.

| **Revision Ref No** | **Change** | **Rationale for change** | **Document Locations** |
| --- | --- | --- | --- |
| 7.1.1 | New section and explanatory paragraph | New section and paragraph setting out an overview of changes | This section, Revisions History |
| 7.1.2 | Add new options to FA command to distinguish between one, two factor PIN or biometric-based authentication | For a one-factor (default) authentication, there is no sense in passing the PIN hash if it is not going to be used by the IFD. In this circumstance the FA payload only needs to include the diversification data and the ACS record.  For a two-factor authentication the FA payload needs to additionally include the PIN hash.  For a biometric-based two-factor authentication minutia data is required rather than PIN hash.  This change discriminates between these scenarios using the P2 parameter of the FA command and the PLAID ICC application should adjust the payload based on this scenario.  This option also improves performance and security since sending superfluous payload information no longer occurs.  Modified and new P2 definitions for the FA command are:  FA\_1FACTOR = 0x00 (Default)  FA\_2FACTOR\_PIN = 0x01  FA\_2FACTOR\_MINUTIAE =0x02 | Four new rows in section 11, table 2, Data dictionary. New definition for “Minutiae” and three new FA\_xxx objects defined.  One modified and two new rows under the FA Commmand in section 15, command set table 3  Two new rows for Minutiae under the set and get data Command in section 15, command set table 3 |
| 7.1.3 | Removed the LUCount from the FA payload returned by the ICC | This field was designed to be used to correlate the usage of the card with the usage recorded by backend systems and need not be collected for each authentication. This field can be retrieved after the PLAID authentication has been completed through a “GET DATA” command when an audit is required. | LUcount concatenation removed from step 6F of section 12 and from related Figure 1 |
| 7.1.4 | Remove VersionNo from SetData command set | Version number should be set at ICC application instantiation and should only be readable after this point. | Remove VersionNo row from Set Data command set in Section 15, table 3 |
| 7.1.5 | Add new status word (error message) SW\_OUT\_OF\_KEYSTORES | This status word allows an implementation to handle the situation where all of the key slots allocated by the implantation on an ICC have been populated with keys, and as administrator attempts to add a new key. The new SW is:  SW\_OUT\_OF\_KEYSTORES – 0x69f7 | New row added to section 16, table 4 |
| 7.1.6 | Remove three status words (error messages) SW\_DATA\_INVALID  SW\_INCORRECT\_P1P2  SW\_CONDITION\_NOT\_SATISFIED | The error messages have been found to be unnecessary since a failure induced by an attacker should NOT be provided with information confirming a failure. The correct response to as attack is to return seemingly good but incorrect data and for the ICC application to “play along” with the attacker. | Row removed from section 16, table 4 |
| 7.1.7 | Change value of status word values (error messages) | Values chosen for status words were consistent with ISO/IEC 14443-3 but not to ISO/IEC 7816-3 which mandates status word values must start with either a 6 or a 9 hexidecimal value.  The values are changed to:  SW\_PLAID\_LOCKED = 0x69f1  SW\_PLAID\_TERMINATED = 0x69FD | Values modified in section 16, table 4 |
| 7.1.8 | Remove section “States of the Application” | This section has been moved from this specification to the documentation associated with the reference implementation as the content was implementation-specific. | Remove section “States of the Application” |
| 7.1.9 | Section 12, Figure 1 PLAID 7.1 Graphic Overview updated | Diagram updated and supporting text boxes numbered to improve clarity | Diagram updated |
| 7.1.10 | Section 18, Session Key Generation | Second paragraph, second sentence, deleted words “of the key” since correctly it is actually the data that is padded | Deleted words “of the key” |
| 7.1.11 | Add informative annex regarding key lengths and algorithms | Informative annex added to clarify the requirement to specify key lengths and algorithms and algorithm options | Add Annex “Suggested Key Lengths and Algorithms” |

1. Purpose

This specification defines the PLAID version 7.1 authentication protocol including all elements required to create an operational implementation of the AP. The specification is intended as the reference documentation required for implementers to build generic and interoperable PLAID version 7.1 ICCs, IFDs and systems. This document is intended to stand in place of formal standards documentation until such time as formal standardisation is complete, at which point this document will be withdrawn, and a reference to the formal standard provided in its place.

1. Data Dictionary

The following table sets out the size and details of PLAID data objects;

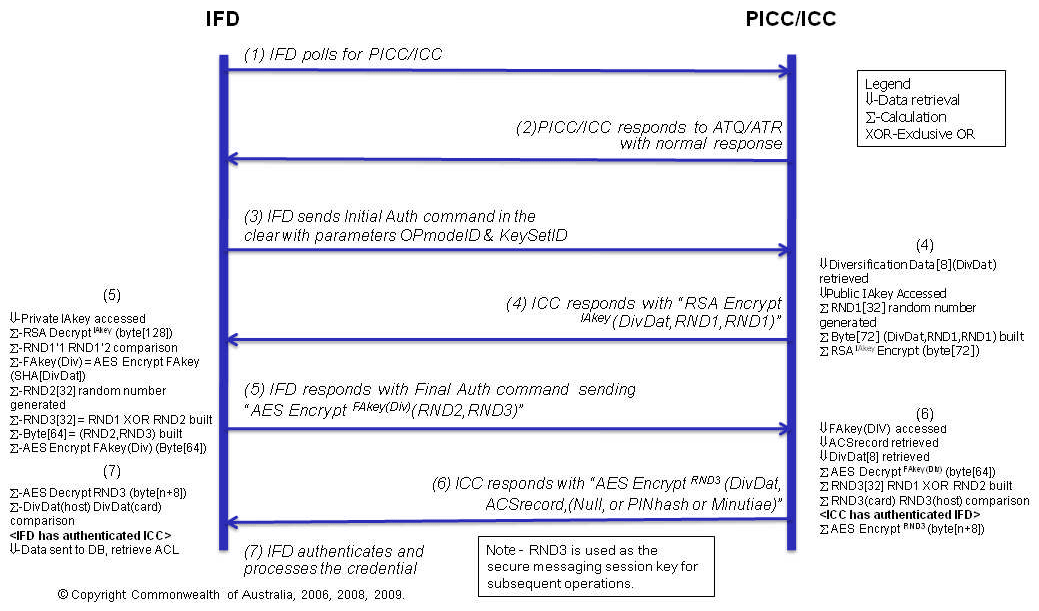
Table 2: Data Dictionary

| **Object Name** | **Purpose** | **Size Bytes** | **Data type** | **Comments** |
| --- | --- | --- | --- | --- |
| ACSrecord | Access Control System Record | varies | Alpha-Numeric | The data returned by the Final Authenticate command. The exact structure of this data is determined by the implementation. |
| DivDat | Symmetric Key Diversification Data | 8 | Binary | Diversification data fixed at card issuance via a random method and guaranteed unique by the issuance system for any one scheme. |
| FA\_1Factor | Final authenticate default command option (one factor) | 8 | Binary | When the FA command P2 value is set to 0x00 the command returns the binary concatenation DivDat|ACSrecord |
| FA\_2Factor\_PIN | Final authenticate two-factor factor with PIN command option | 8 | Binary | When the FA command P2 value is set to 0x01 the command returns the binary concatenation DivDat|ACSrecord|PINhash |
| FAkey(DIV) | Diversified Final Authenticate Key | 32 | Binary | The current Final Authenticate key that has been diversified based on the appropriate key set and key diversification algorithm and per ICC diversification data. |
| FAkey(KeySetID) | Administrative Final Authenticate Key | 32 | Binary | Administrative FAkey where KeySetID is always decimal zero. |
| FAkey(KeySetID) | Final Authenticate Key | 32 | Binary | An AES symmetric key shared by the smartcard and by the host system. One instance of FAkey will exist for each KeySetID. |
| IAkey(KeySetID) | Administrative Initial Authenticate Key | 32 | Binary | An RSA Key pair used to secure the Initial Authenticate command. One instance of IAkey will exist for each KeySetID with the public key stored on the ICC and the private key stored on the IFD or back office. |
| IAkey(KeySetID) | Initial Authenticate Key | 32 | Binary | An RSA Key pair used to secure the Initial Authenticate command. One instance of IAkey will exist for each KeySetID with the public key stored on the ICC and the private key stored on the IFD or back office. |
| KeySetID | Administrative Key Set Identifier | 1 | Binary, Value=0 decimal | Key set identifier for the administrative key set, which must exist and be key set decimal zero. |
| KeySetID | Key Set Identifier | 1 | Binary, Range 1-255 decimal | Key set identifier provided by the IFD to the ICC to support multi-issuer and multi-key set environments. |
| LTcount | Logical Try Counter | 1 | Binary | Logs failed logical authentication attempts for all KeySetIDs other than the Administrative key set. Reset to zero with successful attempt. |
| LTcountAdm | Logical Try Counter for the Admin Key Set | 1 | Binary | Logs failed logical authentication attempts for the Administrative KeySetID. Reset to zero with successful attempt. |
| LUcount | Logical Usage Counter | 2 | Binary | Logs total successful logical authentications for all KeySetIDs other than the Administrative key set. |
| LUcountAdm | Logical Usage Counter for the Admin Key Set | 3 | Binary | Logs total successful logical authentications for the Administrative key set. |
| Minutiae | Fingerprint Minutiae data stored on-card | Variable up to 224 bytes | Binary | Minutiae template is extracted as raw data and evaluated by the IFD. At this version we are looking to understand if this is sufficient data for operational systems. We are explicitly seeking comment as to whether additional minutiae data should be designed into the specification or whether minutiae should be by individual finger etc. |
| OpModeID | Administrative Operating Mode Identifier | 1 | Binary, Value=0 decimal | Operating mode identifier for the administrative mode, which must exist and be set to decimal zero. |
| OpModeID | Operating Mode Identifier | 1 | Binary, Range 1-255 decimal | Operating mode identifier provided by the CAD to the ICC to support multiple operating modes. |
| PIN | PIN | 8 | Alpha-Numeric | The PIN Global to the ICC. |
| PINhash | PIN Hash | 20 | Binary | When retrieving the PIN value, the SHA-1 hash value of the PIN is the only value transmitted. |
| RND1 | Random Number one | 32 | Binary | Random number generated by the smartcard using its TRNG. |
| RND2 | Random Number two | 32 | Binary | Random number generated by the smartcard using its TRNG. |
| RND3 | Random Number three | 32 | Binary | String generated by the IFD and ICC separately calculating RND1 ⊕RND2. |
| SecureICC | Secure the ICC | 1 | Binary | Flag to hold initial state of the PLAID application 0=unsecured 1=secured. |
| SessionKey | Session Key | 32 | Binary | String generated by the IFD and ICC separately calculating RND3. |
| VersionNo | Version number | 1 | Binary | Implementation version number, starting at zero and incrementing by one for each release. |

1. Authentication Protocol Description

The following is a step-by-step description of the steps involved in the PLAID mutual authentication involving a PACS or LACS record.

PLAID 7.1 Authentication Protocol



(Figure 1 PLAID 7.1 Graphic Overview)

The following sets out the explicit steps required in order to carry out a mutual authenticate using the PLAID Authentication Protocol.

1. IFD begins polling
   * In the case of contactless PICC the IFD polls for the PICC, waits for card presence, completes the ISO/IEC 14443-3 anti-collision procedure and then sends the answer to query (ATQ) command.
2. ICC responds to ATRATQ
   * The ICC responds with the ICC normal response to the ATR/ATQ command.
   * If the PLAID application is NOT the ICC default application then the ISO/IEC 7816-4 select application command shall be called by the IFD.
3. The IFD sends the IA command
   * The IFD sends an IA request to the ICC in order to obtain the Diversification Data (DivDat).
   * The IA request incorporates the OpModeID value (in P1) and KeySetID value (in P2) identifying respectively which information the device is expecting to be returned and which cryptographic key set should be used to perform the authentication.
4. The ICC responds to the IA command
   * The ICC retrieves the cryptographic key value as identified by the KeySetID value in P2 of the IA command.
   * Authentication fails if the key is not found, in which case an equivalent but random string is returned, without ANY indication of the error condition.
   * The ICC Generates a random value (RND1) using its TRNG.
   * The ICC Creates the bit string STR1: (DivDat) | RND1 | RND1.
   * The ICC Computes the bit string ESTR1 where ESTR1 = RSA Encrypt IAkey (STR1).
   * Note that the ICC shall incorporate only the modulus and the public exponent values to perform the encryption.
   * The ICC Transmits the ESTR1 string to the IFD.
5. The IFD responds to the IA response
   * The IFD calculates STR1 where STR1 = RSA Decrypt IAkey(ESTR1).
   * The IFD compares the two copies of RND1 - Authentication fails if they do not match, in which case an equivalent but random string is returned, without ANY indication of the error condition.
   * The IFD extracts the cards diversification data from STR1.
   * The IFD generates a random 256-bit value (RND2) using its TRNG.
   * The IFD calculates RND1RND2; the result is denoted as RND3.
   * The IFD uses the diversification data (DivDat) and calculates the diversified final authenticate key FAkey(Div) where FAkey(Div) = AES Encrypt FAkey(DivDat, DivDat, DivDat, DivDat).
   * The IFD generates the bit string denoted STR2 where STR2 = RND2 | RND3.
   * The IFD calculates ESTR2 where ESTR2 = AES Encrypt FAkey(Div) (STR2).
   * The IFD transmits the final authenticate string ESTR2 to the ICC.
6. The ICC responds to the FA command
   * The ICC calculates STR2 where STR2 = AES Decrypt FAkey(Div) (ESTR2).
   * The ICC Calculates RND1RND2 and compares it with RND3. Authentication fails if they do not match, in which case an equivalent but random string is returned, without ANY indication of the error condition.
   * The ICC updates the internal LUcount.
   * The ICC calculates the PIN hash from the ICC global PIN.
   * Based on the OpModeID flag set in P1 of the IA command, the ICC retrieves the appropriate PLAID ACSrecord from secure memory.
   * The ICC concatenates the string STR3 where STR3 = DivDat | ACSrecord | (then either null or PIN Hash or Minutiae depending on the P2 value of the FA command).
   * The ICC Calculates ESTR3 where ESTR3 = AES Encrypt RND3(STR3).
   * The ICC Transmits ESTR3 to the IFD.
7. The IFD processes the credential
   * The IFD calculates STR3 where STR3 = AES Decrypt RND3(ESTR3).
   * The IFD compares the transmitted DivDat with the IFD copy received in the Initial Authenticate command. Authentication fails if they do not match.
   * If PIN authentication is required then the IFD will have the cardholders PINhash in STR3 and compares a SHA-1 hash of the PIN from the card holder with the SHA-1 PINhash retrieved from STR3. Authentication fails if they do not match.
   * If biometric authentication is required then the IFD has the cardholders Minutiae in STR3 and should biometrically compare minutiae from the card holder with minutiae retrieved from STR3. Authentication fails if they do not match.
   * The ACSrecord is extracted from STR3 and can now be considered to have been authenticated. The ACSrecord can now be passed to whichever back office system is appropriate to open a door or to be part of a further logon process.
   * Further authentication protocols or card access protocols may optionally use the generated session key RND3 as a secure messaging or encryption key in subsequent sessions.
8. Operational Modes and Key Sets

This specification allows for up to 255 key sets. For each key set, the value for IAkey and FAkey can be different. This allows that different levels of trust can be applied depending on the business requirements of the implementation. These might be building, role or function based, or some combination of these or other factors.

This specification allows for up to 255 operational modes. For each mode, the ACS record returned in the final authenticate can be different, and allows that a distinct ACS record can then be passed to the IFD or backend systems depending on the business requirements of the implementation.

For **example**, a system might utilise the following key sets and/or operational modes:

**Old buildings** - only authenticates weigand number for older buildings

**New Buildings** - authenticates using ISO/IEC 7812 based numbering

**Administration** - modify the cards PLAID contents such as off-line keys or ACS records

**Logical Access** - access to system login, printer access, etc

**Physical Access** - perimeter access

**Computer room** - computer room access and highly secure areas

**Offline** - physical network connection is not possible

**Shared** - shared public areas of government buildings – trusted persons can enter outer perimeter

***Note:*** there may or may not be a one-one correspondence between OpModeID and KeySetID in any one implementation. For instance; during transition there may be a single KeySetID utilised for building access, but new buildings might use one OpModeID whilst old buildings use another in order to transition from their use of the older weigand based numbering.

There is always an administrative key set and operational mode; these are denoted by the value contained in OpModeID and KeySetID being set to decimal zero for the related objects; KeySetID,

OpModeID, IAkey(KeySetID) and FAkey(KeySetID).

1. Application Identification

The PLAID application shall be selected either by;

making the PLAID authentication application the default application;

calling the AID registered by the Australian Commonwealth (Centrelink) directly at "A0 00

67 6D 61 66"; or

registering an appropriate AID for a specific scheme.

PLAID supports multiple implementations under different AIDs, therefore more than one implementation may be supported per card or reader as long as the appropriate AID is explicitly called or set as the default AID.

1. Command Set

The following are the specific commands required to comply with this specification. These commands are based on commands specified in ISO/IEC 7816 part 4 including the provision within the standard for the introduction of new commands for specific purposes such as PLAID. Within ISO/IEC 7816-4 there is provision for the passing of parameter via the P1 and P2 structures. The P1 structure is used to pass the operational mode parameter and the P2 structure is utilised to pass the key-set identifier from the IFD to the ICC. These parameters are sent in the clear by the IFD in the Initial Authenticate command.

Table 3: Command Set

| **Operation** | **CLA** | **INS** | **Object** | **P1 Value** | **P2 Value** | **Lc/Le** | **Comments** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Initial Authenticate | 0x80 | 0x8A | IA | <OpModeID> | <KeySetId> | N/A  N/A | Only available when card application security state is “PLAID\_SECURED”. |
| Administrative Initial Authenticate | 0x80 | 0x8A | IA | 0x00 | 0x00 | N/A | Only available when card application security state is “PLAID\_SECURED” and when administrative KeySetID(0) is selected |
| Final Authenticate | 0x80 | 0x8C | FA\_1FACTOR | 0x00 | 0x00 | Lc=0x40 | Only available when card application security state is “PLAID\_SECURED” and the corresponding “INITIAL AUTHENTICATE” command has been successfully completed. |
| FA\_2FACTOR\_PIN | 0x00 | 0x01 | Lc=0x40 |
| FA\_2FACTOR\_MINUTIAE | 0x00 | 0x02 | Lc=0x40 |
| Set Data | 0x80 | 0xDB | DivDat | 0x01 | 0x00 | Lc=0x10 | Only available when card is state is PLAID\_UNSECURED” or  “FINAL\_AUTHENTICATE” and after Administration has been successfully completed.  The length of the APDU body must be padded with null(s) (0x00) until the length is equal to the specified Lc when the ICC is in the state “PLAID\_UNSECURED”.  The data value of the command must be encrypted with the session key when the smartcard is in the state “PLAID\_SECURED”. |
| ACSrecord | 0x02 | 0x00 | Lc=Variable per scheme |
| PIN | 0x03 | 0x00 | Lc=0x20 |
| SecureICC | 0x04 | 0x00 | Lc=0x10 |
| Minutiae | 0x06 | 0x00 | Lc=0xE0 |
| IAkey | 0x07 | <KeySetID> | Lc=0x20 |
| FAkey | 0x08 | <KeySetID> | Lc=0x20 |
| LTcount | 0x0A | 0x00 | Lc=0x10 |
| Get Data | 0x80 | 0xCB | ACSrecord | 0x02 | 0x00 | Le=Variable per scheme | Only available when card security state is “PLAID\_SECURED” and “FINAL\_AUTHENTICATE” (User or Administration) has been successfully completed.  Note: The smartcard response will be encrypted with the session key  Note: The decrypted response will be padded with null(s) (0x00) up to the length specified in Lc. |
| PINhash | 0x03 | 0x00 | Le=0x20 |
| VersionNo | 0x05 | 0x00 | Le=0x10 |
| Minutiae | 0x06 | 0x00 | Le=0xE0 |
| LTcount | 0x0A | 0x00 | Le=0x10 |
| LTcountAdm | 0x0B | 0x00 | Le=0x10 |
| LUcount | 0x0C | 0x00 | Le=0x10 |
| LUcountAdm | 0x0D | 0x00 | Le=0x10 |

1. Error Codes (Status Words)

In addition to the standard error status conditions supported by ISO/IEC 7816 and ISO/IEC 14443, the following are the status words required in order to support the full range of PLAID error conditions.

Table 4: PLAID Error Codes (Status Words)

| **Error Code Name** | **Status Word Value** | **Origin** |
| --- | --- | --- |
| SW\_WRONG\_LENGTH | 0x6700 | ISO/IEC 7816-4 |
| SW\_COMMAND\_NOT\_ALLOWED | 0x6986 | ISO/IEC 7816-4 |
| SW\_INS\_NOT\_SUPPORTED | 0x6D00 | ISO/IEC 7816-4 |
| PLAID\_LOCKED | 0x69F1 | This specification |
| PLAID\_TERMINATED | 0x69FD | This specification |
| SW\_OUT\_OF\_KEYSTORES | 0x69F7 | This specification |

1. Key Diversification

PLAID utilises key diversification to ensure that the system remains secure should an individual ICC be compromised and its secret keys determined. The algorithm used to diversify the FAKey is as follows:

*FAkey (DIV) = AES Encrypt FAkey(DivDat,DivDat,DivDat,DivDat)*

1. Session Key Generation

PLAID results in the generation of a 256 bit (32 byte) session key in the final steps.

It is then possible for all subsequent communications between the ICC and the IFD or back office to have the body of the APDU encrypted with this key within a secure messaging session. Since AES uses 128 bit (16 byte) blocks for encryption/decryption, padding may be required up to the next block. The process used to generate the session key is as follows:

*SessionKey (RND3) = RND1* ⊕*RND2*

1. Access Control System Record

The detailed structure of the ACS record or credential shall be determined by the issuers’ specific specification or standards and use case. This is outside the scope of this specification.

PLAID supports multiple concurrent types of ACS record which are selected via the OpModeID parameter.

Since multiple ACS records may be stored and selected, these may for example include existing record numbers such as weigand building access numbers (for transition purposes), biometric templates or any other appropriate or standardised personnel number/s or strings which require authentication.

Annex A: Reference Implementation (Informative)

A reference implementation for PLAID 8 will be made available to assist in the comprehensive understanding of how to implement this specification.

The reference implementation may be downloaded from the following link:

[GovDex](https://www.govdex.gov.au)

Select **Centrelink PLAID** from the list of Public GovDex Communities.