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**Identification cards — Integrated circuit  
cards —**

Part 15:

**Cryptographic information application**

AMENDMENT 1: Examples of the use  
of the cryptographic information application

*Cartes d'identification — Cartes à circuit intégré —*

*Partie 15: Application des informations cryptographiques*

*AMENDEMENT 1: Exemples d'emploi de l'application des informations  
cryptographiques*

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## Foreword

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Amendment 1 to ISO/IEC 7816-15:2004 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 17, *Cards and personal identification*.

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## Identification cards — Integrated circuit cards —

Part 15:

### Cryptographic information application

#### AMENDMENT 1: Examples of the use of the cryptographic information application

*Insert the following new annex after Annex D.*

#### **Annex E** (informative)

### **Examples of the use of the cryptographic information application**

#### **E.1 Introduction**

The purpose of this informative annex is to provide practical examples of the use of the cryptographic information application. By providing sample program code for each example, programmers can see the programmatic connection between high-level ASN.1 representations and low-level BER representations and thus create more efficient and more compact software that uses the cryptographic information application.

Each clause in the annex is a free-standing example and consists of four paragraphs:

1. Description of the example
2. A specification of the example described in paragraph (1) in commented ISO/IEC 7816-15 ASN.1 constructs, using the formal value notation defined in ISO/IEC 8824-1.
3. Annotated code in the ISO/IEC 9899 TC2 C programming language for BER encoding and decoding according to the ASN.1 specification of paragraph (2).
4. BER encoding of the example as produced by the encoder of paragraph (3). Two examples also include graphic representations of the BER at the end of the Annex.
5. The source code provided in paragraph (3) was compiled and run to generate the output shown in paragraph (4).

A transcription of the ASN.1 encoding of the Cryptographic Information Application listed in Annex A above was used for all examples. A free, publically-available ASN.1 compiler was used to generate the BER encoders and decoders from this ASN.1.

#### **E.2 Encoding of a Private Key**

##### **E.2.1 Cryptographic Information Application Example Description**

This is an example of an ISO/IEC 7816-15 RSA private key.

## E.2.2 ASN.1 Encoding of an RSA Private Key

```

privateKeys objects { -- SEQUENCE OF --
  privateRSAKey { -- SEQUENCE --
    commonObjectAttributes { -- SEQUENCE --
      label '4b455931'H -- "KEY1" --,
      flags '80'H,
      authId '41444d'H -- "ADM" --,
      userConsent 1
    },
    classAttributes { -- SEQUENCE --
      id '9b'H,
      usage '2040'H,
      native TRUE,
      accessFlags '98'H,
      keyReference 10
    },
    subclassAttributes { -- SEQUENCE --
      keyIdentifiers { -- SEQUENCE OF --
        { -- SEQUENCE --
          idType 5,
          idValue '3132333435363738'H -- "12345678" --
        }
      }
    },
    typeAttributes { -- SEQUENCE --
      value indirect path { -- SEQUENCE --
        efidOrPath '3f004041'H
      },
      modulusLength 1024
    }
  }
}

```

## E.2.3 Code Encoding and Decoding BER from the ASN.1

```

/*
** Encoding of a Private Key as a Data Object in EF.OD
*/
void Part15PrivateKey(const char *label,
  unsigned char objectFlags,
  unsigned char *authId,
  unsigned int authIdLength,
  unsigned int userConsent,
  unsigned char native,
  unsigned char *id, unsigned int idLength,
  unsigned short usageFlags,
  unsigned char accessFlags,
  unsigned int keyReference,
  unsigned int identifierType,
  unsigned char *externalIdentifier,
  unsigned char *path, unsigned int pathLength,
  unsigned int modulusLength
)
{
  unsigned int l;
  CIOChoice *cio;
  PrivateKeyChoice *prk, **prkp;
  CredentialIdentifier *crid, **cridp;

  PrivateKeyObject_PrivateRSAKeyAttributes pattr = { 0 };
  CommonObjectAttributes commonObjAttr = { 0 };
  CommonKeyAttributes commonKeyAttr = { 0 };
  CommonPrivateKeyAttributes commonPrivateKeyAttr = { 0 };
  PrivateRSAKeyAttributes privateRSAKeyAttr = { 0 };
}

```

```

Path pathOctets                = { 0 };
AsnOcts issuerHash             = { 0 };

char commonObjectFlags[1] = { 0 };
AsnBits commonFlagsAsnBits = { 3, commonObjectFlags };

char keyUsage[2] = { 0 };
AsnBits keyUsageAsnBits = { 10, keyUsage };

char keyAccessFlags[1] = { 0 };
AsnBits keyAccessFlagsAsnBits = { 5, keyAccessFlags };

/*
** Section 8.3 The CIOChoice type
**
** "EF.OD shall contain the concatenation of 0, 1, or more DER-encoded CIOChoice values."
**
*/
cio = (CIOChoice *)calloc(1, sizeof(PrivateKeyChoice));

cio->choiceId = CIOCHOICE_PRIVATEKEYS;

/*
** "It is expected that an EF.OD entry will usually reference a separate file (the path
** choice of PathOrObjects) containing CIOs of the indicated type. An entry may, however,
** hold CIOs directly (the objects choice of PathOrObjects), if the objects and the EF.OD
** file have the same access control requirements."
**
** PathOrObjects{PrivateKeyChoice}
**
*/
cio->a.privateKeys = (PrivateKey *)calloc(1, sizeof(PrivateKey));
cio->a.privateKeys->choiceId = PATHOROBJECTS_PRIVATEKEYCHOICE_OBJECTS;
cio->a.privateKeys->a.objects = AsnListNew(sizeof(void*));

/*
** Section 8.4.1 PrivateKeyChoice
**
** "This type contains information pertaining to a private key. Each value
** consists of attributes common to any object, any key, any private key,
** and attributes particular to the key."
**
*/
prkp = (PrivateKeyChoice **)AsnListAppend(cio->a.privateKeys->a.objects);

*prkp = prk = calloc(1, sizeof(PrivateKeyChoice));

prk->choiceId = PRIVATEKEYCHOICE_PRIVATERSAKEY;

prk->a.privateRSAKey = &patrr;

patrr.commonObjectAttributes = &commonObjAttr;
patrr.classAttributes        = &commonKeyAttr;
patrr.subClassAttributes     = &commonPrivateKeyAttr;
patrr.typeAttributes         = &privateRSAKeyAttr;

/*
** Section 8.2.8 CommonObjectAttributes
**
** "This type is a container for attributes common to all CIOs."
**
*/
commonObjAttr.label.octs = _strdup(label);
commonObjAttr.label.octetLen = strlen(label);

commonObjectFlags[0] = objectFlags;
commonObjAttr.flags = commonFlagsAsnBits;

commonObjAttr.authId.octetLen=authIdLength;
commonObjAttr.authId.octs = authId;

commonObjAttr.userConsent = &userConsent;

/*
** Section 8.2.9 CommonKeyAttributes
**
** "The iD field shall be unique for each key information object, except when a public
** key information object and its corresponding private key object are stored on
** the same card. In this case, the information objects shall share the same
** identifier (which may also be shared with one or several certificate information

```

```

** objects ..."
*/
commonKeyAttr.id.octs = id;
commonKeyAttr.id.octetLen = idLength;

keyUsage[0] = (unsigned char)(usageFlags>>8);
keyUsage[1] = (unsigned char)(usageFlags);
commonKeyAttr.usage = keyUsageAsnBits;

keyAccessFlags[0] = accessFlags;
commonKeyAttr.accessFlags= keyAccessFlagsAsnBits;

commonKeyAttr.native = &native;

commonKeyAttr.keyReference = &keyReference;

/*
** Section 8.2.10 CommonPrivateKeyAttributes
**
** "The name field, when present, names the owner of the key, as specified in a
** corresponding certificate's subject field.
**
** Values of the keyIdentifiers field can be matched to identifiers from external
** messages or protocols to select the appropriate key to a given operation."
**
*/
commonPrivateKeyAttr.keyIdentifiers =
    (CommonPrivateKeyAttributesSeqOf *)AsnListNew(sizeof (void*));

cridp = (CredentialIdentifier **)AsnListAppend(commonPrivateKeyAttr.KeyIdentifiers);
*cridp = crid = (CredentialIdentifier *)calloc(1, sizeof(CredentialIdentifier));

issuerHash.octs = _strdup(externalIdentifier);
issuerHash.octetLen = strlen(externalIdentifier);

crid->idType = identifierType;
crid->idValue.value = &issuerHash;
SetAnyTypeByInt(&(crid->idValue), identifierType);

/*
** Section 8.4.2 Private RSA Key Attributes
**
** "PrivateRSAKeyAttributes.value: The value shall be a path to a file containing
** a private RSA key. If there is no need to specify a path to a file, the path
** value may be set to the empty path."
**
*/
privateRSAKeyAttr.value = (ObjectValue *)calloc(1, sizeof(ObjectValue));
privateRSAKeyAttr.value->choiceId = OBJECTVALUE_INDIRECT;
privateRSAKeyAttr.value->a.indirect =
    (ReferencedValue *)calloc(1, sizeof(ReferencedValue));

privateRSAKeyAttr.value->a.indirect->choiceId = REFERENCEDVALUE_PATH;

pathOctets.efidOrPath.octs = (char *)calloc(1, pathLength);
memcpy(pathOctets.efidOrPath.octs, path, pathLength);
pathOctets.efidOrPath.octetLen = pathLength;
privateRSAKeyAttr.value->a.indirect->a.path = &pathOctets;

privateRSAKeyAttr.modulusLength = modulusLength;

/*
** Print the Private Key Data Object
**
*/
PrintCIOChoice(stdout, cio, 3);

/*
** BER Encode the Private Key Data Object
**
*/
BERLength = BEncCIOChoiceContent(gb, cio);
}

/*
** Decoding of a Private Key as a Data Object in EF.OD
**
*/
PrivateKeyObject_PrivateRSAKeyAttributes *PrivateKey(unsigned char *BER, unsigned int BERLength)
{

```

```

SBuf b;
GenBuf *gb;
unsigned int bytesDecoded = 0;
ENV_TYPE env;
CIOChoice *cio;
AsnTag tagId0;
AsnLen elmtLen0;

if(setjmp(env) != 0) exit(0);

cio = calloc(1, sizeof(CIOChoice));

SBufInstallData(&b, BER, BERLength);
SBufToGenBuf(&b, &gb);

tagId0 = BDecTag(gb, &bytesDecoded, env);
elmtLen0 = BDecLen(gb, &bytesDecoded, env);

/*
** Decode the RSA Private Key Data Object
*/
BDecCIOChoiceContent(gb, tagId0, elmtLen0, cio, &bytesDecoded, env);

return ((PrivateKeyChoice *) (cio->a.privateKeys->a.objects->first->data))->a.privateRSAKey;
}

```

## E.2.4 BER Encoding

```

<EF_OD>
0xa0,0x51,0xa0,0x4f,0x30,0x4d,0x30,0x12,0x0c,0x04,0x4b,0x45,0x59,0x31,0x03,0x02,
0x05,0x80,0x04,0x03,0x41,0x44,0x4d,0x02,0x01,0x01,0x30,0x12,0x04,0x01,0x9b,0x03,
0x03,0x06,0x20,0x40,0x01,0x01,0xff,0x03,0x02,0x03,0x98,0x02,0x01,0x0a,0xa0,0x13,
0x30,0x11,0xa0,0x0f,0x30,0x0d,0x02,0x01,0x05,0x04,0x08,0x31,0x32,0x33,0x34,0x35,
0x36,0x37,0x38,0xa1,0x0e,0x30,0x0c,0x30,0x06,0x04,0x04,0x3f,0x00,0x40,0x41,0x02,
0x02,0x04,0x00
</EF_OD>

```

Table E.1 is a diagrammatic representation of this BER encoding.

Table E.1 — EF.PrKD of RSA private Key

		Data Type			
A0	51	CIOChoice: Private key data object			
A0	4F	PrivateKeyChoice: Private RSA Key			
	30	Private RSA Key object			
	4D				
	30	Common object Attribute			
	12				
	0C		04 label	4B, 45, 59, 31	UTF8String
	03		02 flags	05, 80	BIT STRING
	04		03 auth Id	41, 44, 44	OCTET STRING
	02	01 userConsent	01	INTEGER	
	30	Common Key Attribute			
	12				
	04		01 iD	9B	OCTET STRING
	03		03 usage	06, 20, 40	BIT STRING
	01		01 native	FF	BOOLEAN
	03	02 accessFlags	03, 98	BIT STRING	
	02	01 keyReference	0A	INTEGER	

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Table E.1 (continued)

A0	13	Common Private Key Attribute				
	30	11	Sequence			
	A0	0F	keyIdentifier			
	30	0D	Sequence			
		02	01	idType	05	INTEGER
		60	08	idValue	31, 32, 33, 34, 35, 36, 37, 38	OpenType
A1	0e	Private RSA key attribute				
	30	0C	Sequence			
		30	06	Path		
		04	04	efidOrPath	3F, 00, 40, 41	OCTET STRING
		02	02	modulusLength	04, 00	INTEGER

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## E.3 Encoding of a Protected Data Container

### E.3.1 Cryptographic Information Application Example Description

A data container object with two security conditions, one for READ and one for UPDATE. The data in the data container is a BER-TLV. The secret key SK-1 must be verified in order to change password AO-1.

### E.3.2 ASN.1 Encoding of the Protected Data Container Object

```

dataContainerObjects objects { -- SEQUENCE OF --
  iso7816DO { -- SEQUENCE --
    commonObjectAttributes { -- SEQUENCE --
      label '444f2d31'H -- "DO-1" --,
      flags '40'H,
      accessControlRules { -- SEQUENCE OF --
        { -- SEQUENCE --
          accessMode '80'H,
          securityCondition or { -- SEQUENCE OF --
            authId '414f2d31'H -- "AO-1" --,
            authId '414f2d32'H -- "AO-2" --
          }
        },
        { -- SEQUENCE --
          accessMode '40'H,
          securityCondition and { -- SEQUENCE OF --
            authId '414f2d31'H -- "AO-1" --,
            authId '414f2d32'H -- "AO-2" --
          }
        }
      },
    },
    classAttributes { -- SEQUENCE --
    },
    typeAttributes direct '80020102'H
  }
}

authObjects objects { -- SEQUENCE OF --
  pwd { -- SEQUENCE --
    commonObjectAttributes { -- SEQUENCE --
      label '414f2d31'H -- "AO-1" --,
      flags '40'H
    },
    classAttributes { -- SEQUENCE --
      authId '414f2d31'H -- "AO-1" --,
      authReference 1,
      seIdentifier 2
    },
    typeAttributes { -- SEQUENCE --
      pwdFlags '0400'H,
      pwdType 1,
      minLength 4,
      storedLength 12,
      maxLength 8,
      padChar 'ff'H -- " " --,
      path { -- SEQUENCE --
        efidOrPath '3f004045'H
      }
    }
  }
}

```

```

    }
  }
}

secretKeys objects { -- SEQUENCE OF --
  genericSecretKey { -- SEQUENCE --
    commonObjectAttributes { -- SEQUENCE --
      label '534b2d31'H -- "SK-1" --,
      flags '40'H,
      authId '414f2d31'H -- "AO-1" --
    },
    classAttributes { -- SEQUENCE --
      id '534b2d31'H -- "SK-1" --,
      usage '0200'H,
      native TRUE,
      accessFlags '10'H,
      keyReference 10
    },
    subclassAttributes { -- SEQUENCE --
      keyLen 64
    },
    typeAttributes { -- SEQUENCE --
      keyType {2 8},
      keyAttr '58'H
    }
  }
}
}

```

### E.3.3 Code from the ASN.1 for Encoding and Decoding BER

```

/*
** Encoding of a Protected Data Object
*/
void DataObject(unsigned char *label,
               unsigned char objectFlags,
               unsigned char *password1,
               unsigned char *password2
              )
{
  CIOChoice *cio;
  DataContainerObjectChoice *dco, **dco;
  AccessControlRule *acr, **acrp;
  SecurityCondition *sc, **scp;

  SecurityCondition securityCondition1;
  SecurityCondition securityCondition2;
  AsnOcts authId1;
  AsnOcts authId2;

  CommonObjectAttributes commonObjectAttr = { 0 };
  CommonDataContainerObjectAttributes commonDataContainerObjectAttributes = { 0 };
  ISO7816DOAttributes iso7816DOAttributes = { 0 };

  DataContainerObject_ISO7816DOAttributes patrr = { 0 };

  CredentialIdentifier credentialIdentifier = { 0 };
  Path pathOctets = { 0 };
  AsnOcts dataObjectValue1 = { sizeof(doValue1), doValue1 };
}

```

```

char commonObjectFlags[1]                = { 0 };
AsnBits commonFlagsAsnBits               = { 2, commonObjectFlags };

char accessControlRuleFlags1[1]          = { 0 };
AsnBits accessControlRuleAsnBits1       = { 4, accessControlRuleFlags1 };
char accessControlRuleFlags2[1]          = { 0 };
AsnBits accessControlRuleAsnBits2       = { 4, accessControlRuleFlags2 };

char usageFlagBits[2]                   = { 0 };
AsnBits usageFlagsAsnBits               = { 10, usageFlagBits };

authId1.octetLen = strlen(password1);
authId1.octs = strdup(password1);

authId2.octetLen = strlen(password2);
authId2.octs = strdup(password2);

/*
** Data Object Choice
*/
cio = (CIOChoice *)calloc(1, sizeof(DataContainerObjectChoice));
cio->choiceId = CIOCHOICE_DATACONTAINEROBJECTS;
cio->a.dataContainerObjects = (DataContainerObjects *)calloc(1, sizeof(DataContainerObjects));
cio->a.dataContainerObjects->a.objects = AsnListNew(sizeof (void*));
cio->a.dataContainerObjects->choiceId = PATHROBJECTS_DATACONTAINEROBJECTCHOICE_OBJECTS;

dco = (DataContainerObjectChoice **)AsnListAppend(cio->a.dataContainerObjects->a.objects);

*dco = dco = calloc(1, sizeof(DataContainerObjectChoice));

dco->choiceId = DATACONTAINEROBJECTCHOICE_ISO7816D0;

dco->a.iso7816D0 = &pattr;

pattr.commonObjectAttributes = &commonObjectAttr;
pattr.classAttributes        = &commonDataContainerObjectAttributes;
pattr.subClassAttributes     = NULL;
pattr.typeAttributes         = &iso7816D0Attributes;

/*
** Common Object Attributes
*/
commonObjectAttr.label.octetLen = strlen(label);
commonObjectAttr.label.octs = label;

commonObjectFlags[0] = objectFlags;
commonObjectAttr.flags = commonFlagsAsnBits;

commonObjectAttr.accessControlRules = AsnListNew(sizeof (void*));

acrp = (AccessControlRule **)AsnListAppend(commonObjectAttr.accessControlRules);
*acrp = acr = calloc(1, sizeof(AccessControlRule));
accessControlRuleFlags1[0] = (unsigned char)(READ_FLAG);
acr->accessMode = accessControlRuleAsnBits1;
securityCondition1.choiceId = SECURITYCONDITION_SEACOS_OR;
securityCondition1.a.seacos_or = AsnListNew(sizeof (void*));
scp = (SecurityCondition **)AsnListAppend(securityCondition1.a.seacos_or);
*scp = sc = calloc(1, sizeof(SecurityCondition));
sc->choiceId = SECURITYCONDITION_AUTHID;
sc->a.authId = &authId1;

```

```

scp = (SecurityCondition **)AsnListAppend(securityCondition1.a.seacos_or);
*scp = sc = calloc(1, sizeof(SecurityCondition));
sc->choiceId = SECURITYCONDITION_AUTHID;
sc->a.authId = &authId2;
acr->securityCondition = &securityCondition1;

acrp = (AccessControlRule **)AsnListAppend(commonObjectAttr.accessControlRules);
*acrp = acr = calloc(1, sizeof(AccessControlRule));
accessControlRuleFlags2[0] = (unsigned char)(UPDATE_FLAG);
acr->accessMode = accessControlRuleAsnBits2;
securityCondition2.choiceId = SECURITYCONDITION_SEACOS_AND;
securityCondition2.a.seacos_and = AsnListNew(sizeof(void*));
scp = (SecurityCondition **)AsnListAppend(securityCondition2.a.seacos_and);
*scp = sc = calloc(1, sizeof(SecurityCondition));
sc->choiceId = SECURITYCONDITION_AUTHID;
sc->a.authId = &authId1;
scp = (SecurityCondition **)AsnListAppend(securityCondition2.a.seacos_and);
*scp = sc = calloc(1, sizeof(SecurityCondition));
sc->choiceId = SECURITYCONDITION_AUTHID;
sc->a.authId = &authId2;
acr->securityCondition = &securityCondition2;

/*
** Common Data Container Object Attributes
*/

/*
** ISO/IEC 7816 Data Object Attributes
*/
iso7816DOAttributes.choiceId = OBJECTVALUE_DIRECT;

iso7816DOAttributes.a.direct.value = &dataObjectValue1;
SetAnyTypeByInt(&(iso7816DOAttributes.a.direct), issuerKeyHash);

/*
** Print the Data Object
*/
PrintCIOChoice(stdout, cio, 3);

/*
** BER Encode the Data Object
*/
BERLength += BEncCIOChoiceContent(gb, cio);
}

void Password(const char *label,
              unsigned char objectFlags,
              unsigned char *authId,
              unsigned int authReference,
              unsigned int seReference,
              unsigned char *id,
              unsigned char *path, unsigned int pathLength,
              unsigned short pwdFlags,
              unsigned int pwdType,
              unsigned int minimumLength,
              unsigned int storedLength,
              unsigned int maximumLength,
              unsigned char paddingCharacter
              )
{

```

```

CIOChoice *cio;
AuthenticationObjectChoice *auth, **authp;

AuthenticationObject_PasswordAttributes pattr                = { 0 };

CommonObjectAttributes commonObjAttr                        = { 0 };
CommonAuthenticationObjectAttributes commonAuthenticationObjectAttr = { 0 };
PasswordAttributes passwordAttributes                      = { 0 };

Path pathOctets                                            = { 0 };
AsnOcts padChar                                           = { 0 };

char commonObjectFlags[1]                                  = { 0 };
AsnBits commonFlagsAsnBits                                = { 2, commonObjectFlags };
char passwordFlags[2]                                     = { 0 };
AsnBits passwordFlagsBits                                 = { 12, passwordFlags };

/*
** Authentication Object Choice
*/
cio = (CIOChoice *)calloc(1, sizeof(AuthenticationObjectChoice));
cio->choiceId = CIOCHOICE_AUTHOBJECTS;
cio->a.authObjects = (AuthObjects *)calloc(1, sizeof(AuthObjects));
cio->a.authObjects->choiceId = PATHROBJECTS_AUTHENTICATIONOBJECTCHOICE_OBJECTS;
cio->a.authObjects->a.objects = AsnListNew(sizeof(void*));

authp = (AuthenticationObjectChoice **)AsnListAppend(cio->a.authObjects->a.objects);

*authp = auth = calloc(1, sizeof(AuthenticationObjectChoice));

auth->choiceId = AUTHENTICATIONOBJECTCHOICE_PWD;

auth->a.pwd = &pattr;

pattr.commonObjectAttributes = &commonObjAttr;
pattr.classAttributes        = &commonAuthenticationObjectAttr;
pattr.subClassAttributes     = (AsnNull *)NULL;
pattr.typeAttributes         = &passwordAttributes;

/*
** Common Object Attributes
*/
commonObjAttr.label.octs = _strdup(label);
commonObjAttr.label.octetLen = strlen(label);

commonObjectFlags[0] = objectFlags;
commonObjAttr.flags = commonFlagsAsnBits;

/*
** Common Authentication Object Attributes
*/
commonAuthenticationObjectAttr.authId.octs = iD;
commonAuthenticationObjectAttr.authId.octetLen = strlen(iD);

commonAuthenticationObjectAttr.authReference = &authReference;
commonAuthenticationObjectAttr.seIdentifier = &seReference;

/*
** Password Attributes
*/

```

```

passwordFlags[0] = (unsigned char) (pwdFlags>>8);
passwordFlags[1] = (unsigned char) (pwdFlags);
passwordAttributes.pwdFlags = passwordFlagsBits;

passwordAttributes.pwdType      = pwdType;
passwordAttributes.minLength    = minimumLength;
passwordAttributes.storedLength = storedLength;
passwordAttributes.maxLength    = (AsnInt *)calloc(1, sizeof(AsnInt));
*passwordAttributes.maxLength  = maximumLength;

padChar.octetLen = 1;
padChar.octs = (char *)calloc(1,1);
padChar.octs[0] = paddingCharacter;
passwordAttributes.padChar = padChar;

pathOctets.efidOrPath.octs = path;
pathOctets.efidOrPath.octetLen = pathLength;
passwordAttributes.path = &pathOctets;

/*
** Print the Authentication Data Object
*/
fprintf(stdout, "\n\n");
PrintCIOChoice(stdout, cio, 3);

/*
** BER Encode the Authentication Data Object
*/
BERLength += BEncCIOChoiceContent(gb,cio);
}

void SecretKey(const char *label,
               unsigned char objectFlags,
               unsigned char *authId,
               unsigned short usageFlags,
               unsigned int keyReference,
               unsigned char *id,
               unsigned int keyLength
              )
{
    CIOChoice *cio;
    SecretKeyChoice *sk, **skp;

    SecretKeyObject_GenericKeyAttributes pattr = { 0 };

    CommonObjectAttributes commonObjAttr = { 0 };
    CommonKeyAttributes commonKeyAttr = { 0 };
    CommonSecretKeyAttributes commonSecretKeyAttr = { 0 };
    GenericKeyAttributes genericKeyAttr = { 0 };

    Path pathOctets = { 0 };
    AsnOcts keyOidOcts = { 0 };
    AsnOcts keyAttrOcts = { 0 };
    AsnOid keyOid = { 0 };
    char commonObjectFlags[1] = { 0 };
    AsnBits commonFlagsAsnBits = { 2, commonObjectFlags };
    char keyUsage[2] = { 0 };
    AsnBits keyUsageAsnBits = { 9, keyUsage };
    char keyNativeAsnBool = FALSE;
    char keyAccessFlags[1] = { 0 };
    AsnBits keyAccessFlagsAsnBits = { 4, keyAccessFlags };

```

```

/*
** Secret Key Choice
*/
cio = (CIOChoice *)calloc(1, sizeof(SecretKeyChoice));
cio->choiceId = CIOCHOICE_SECRETKEYS;
cio->a.secretKeys = (SecretKeys *)calloc(1, sizeof(SecretKeys));
cio->a.secretKeys->choiceId = PATHROBJECTS_SECRETKEYCHOICE_OBJECTS;
cio->a.secretKeys->a.objects = AsnListNew(sizeof (void*));

skp = (SecretKeyChoice **)AsnListAppend(cio->a.secretKeys->a.objects);

*skp = sk = calloc(1, sizeof(SecretKeyChoice));

sk->choiceId = SECRETKEYCHOICE_GENERICSECRETKEY;

sk->a.genericSecretKey = &pattr;

pattr.commonObjectAttributes = &commonObjAttr;
pattr.classAttributes         = &commonKeyAttr;
pattr.subClassAttributes      = &commonSecretKeyAttr;
pattr.typeAttributes          = &genericKeyAttr;

/*
** Common Object Attributes
*/
commonObjAttr.label.octs = label;
commonObjAttr.label.octetLen = strlen(label);

commonObjAttr.authId.octetLen = strlen(authId);
commonObjAttr.authId.octs = authId;

commonObjectFlags[0] = objectFlags;
commonObjAttr.flags = commonFlagsAsnBits;

/*
** Common Key Attributes
*/
commonKeyAttr.iD.octs = iD;
commonKeyAttr.iD.octetLen = strlen(iD);

keyUsage[0] = (unsigned char)(usageFlags>>8);
keyUsage[1] = (unsigned char)(usageFlags);
commonKeyAttr.usage = keyUsageAsnBits;

keyNativeAsnBool = TRUE;
commonKeyAttr.native = &keyNativeAsnBool;

keyAccessFlags[0] = NEVEREXTRACTABLE_FLAG;
commonKeyAttr.accessFlags= keyAccessFlagsAsnBits;

commonKeyAttr.keyReference = &keyReference;

/*
** Common Secret Key Attributes
*/
commonSecretKeyAttr.keyLen = (AsnInt *)calloc(1, sizeof(AsnInt));

*commonSecretKeyAttr.keyLen = keyLength;

/*

```

```

** Generic Secret Key Type
*/
keyOidOcts.octetLen = 1;
keyOidOcts.octs = (char *)calloc(1,1);
keyOidOcts.octs[0] = 88;
genericKeyAttr.keyType = keyOidOcts;

SetAnyTypeByInt(&genericKeyAttr.keyAttr, subjectKeyId);
keyAttrOcts.octetLen = 1;
keyAttrOcts.octs = (char *)calloc(1,1);
keyAttrOcts.octs[0] = 88;
genericKeyAttr.keyAttr.value = &keyAttrOcts;

/*
** Print the Secret Key Data Object
*/
fprintf(stdout, "\n\n");
PrintCIOChoice(stdout, cio, 3);

/*
** BER Encode the Secret Key Data Object
*/
BERLength += BEncCIOChoiceContent(gb,cio);
}

/*
** Finding the Authentication Object that Protects a Data Object
*/
void Access_Condition_for_Data_Object(unsigned char *DOBER, unsigned int DOBERLength,
                                     unsigned char *AOBER, unsigned int AOBERLength)
{
    ENV_TYPE env;
    CIOChoice *cioDO, *cioAO;
    SBuf dob, aob;
    GenBuf *dogb, *aogb;
    unsigned int bytesDecoded = 0;
    AsnTag tagId0;
    AsnLen elmtLen0;
    DataContainerObjectChoice *dataObject;
    AuthenticationObjectChoice *authenticationObject;
    AuthenticationObject_PasswordAttributes* pwd;
    AccessControlRule *accessControlRule;
    SecurityCondition *securityCondition, *securityConditionAuthID;
    AsnOcts *authId1;

    if(setjmp(env) != 0) exit(0);

    /*
    ** Retrieve the access rule for reading from the Data Object
    */
    cioDO = (CIOChoice *)calloc(1, sizeof(DataContainerObjectChoice));

    SBufInstallData(&dob, DOBER, DOBERLength);
    SBufToGenBuf(&dob, &dogb);

    tagId0 = BDecTag(dogb, &bytesDecoded, env);
    elmtLen0 = BDecLen(dogb, &bytesDecoded, env);

    BDecCIOChoiceContent(dogb, tagId0, elmtLen0, cioDO, &bytesDecoded, env);

```

```

dataObject = (DataContainerObjectChoice *) (cioDO->a.dataContainerObjects->a.objects->first->data);

FOR_EACH_LIST_ELMT(accessControlRule, dataObject->a.iso7816DO->commonObjectAttributes-
>accessControlRules)
{
    if(accessControlRule->accessMode.bits && READ_FLAG)
        break;
}

if(accessControlRule == NULL)
    exit(0);

securityCondition = accessControlRule->securityCondition;

if(securityCondition->choiceId != SECURITYCONDITION_SEACOS_OR)
    exit(0);

securityConditionAuthID = (SecurityCondition *) (securityCondition->a.seacos_or->first->data);

if(securityConditionAuthID->choiceId != SECURITYCONDITION_AUTHID)
    exit(0);

authId1 = (AsnOcts *) securityConditionAuthID->a.authId;

/*
** Find the Authentication Object associated with the first term in the OR
*/
cioAO = (CIOChoice *) calloc(1, sizeof(AuthenticationObjectChoice));

SBufInstallData(&aob, AOBER, AOBERLength);
SBufToGenBuf(&aob, &aogb);

tagId0 = BDecTag(aogb, &bytesDecoded, env);
elmLen0 = BDecLen(aogb, &bytesDecoded, env);

BDecCIOChoiceContent(aogb, tagId0, elmLen0, cioAO, &bytesDecoded, env);

FOR_EACH_LIST_ELMT(authenticationObject, cioAO->a.dataContainerObjects->a.objects)
{
    if(authenticationObject->choiceId == AUTHENTICATIONOBJECTCHOICE_PWD)
    {
        pwd = authenticationObject->a.pwd;
        if((authId1->octetLen == pwd->commonObjectAttributes->label.octetLen) &&
            memcmp(authId1->octets, pwd->commonObjectAttributes->label.octets, authId1->octetLen) == 0)
        {
            /*
            ** Found the AO that goes with the first term in the OR
            ** condition associated with the READ access mode of the DO
            */
            break;
        }
    }
}
}

```

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### E.3.4 BER Encoding

```

<EF_DO>
0xa7,0x46,0xa0,0x44,0xa0,0x42,0x30,0x34,0x0c,0x04,0x44,0x4f,0x2d,0x31,0x03,
0x02,0x06,0x40,0x30,0x28,0x30,0x12,0x03,0x02,0x04,0x80,0xa2,0x0c,0x04,0x04,
0x41,0x4f,0x2d,0x31,0x04,0x04,0x41,0x4f,0x2d,0x32,0x30,0x12,0x03,0x02,0x04,
0x40,0xa1,0x0c,0x04,0x04,0x41,0x4f,0x2d,0x31,0x04,0x04,0x41,0x4f,0x2d,0x32,
0x30,0x00,0xa1,0x08,0xa0,0x06,0x60,0x04,0x80,0x02,0x01,0x02
</EF_DO>

<EF_AO>
0xa8,0x3e,0xa0,0x3c,0x30,0x3a,0x30,0x0a,0x0c,0x04,0x41,0x4f,0x2d,0x31,0x03,0x02,
0x06,0x40,0x30,0x0c,0x04,0x04,0x41,0x4f,0x2d,0x31,0x02,0x01,0x01,0x80,0x01,0x02,
0xa1,0x1e,0x30,0x1c,0x03,0x03,0x04,0x04,0x00,0x0a,0x01,0x01,0x02,0x01,0x04,0x02,
0x01,0x0c,0x02,0x01,0x08,0x04,0x01,0xff,0x30,0x06,0x04,0x04,0x3f,0x00,0x40,0x45
</EF_AO>

<EF_SK>
0xa3,0x3b,0xa0,0x39,0xaf,0x37,0x30,0x10,0x0c,0x04,0x53,0x4b,0x2d,0x31,0x03,0x02,
0x06,0x40,0x04,0x04,0x41,0x4f,0x2d,0x31,0x30,0x14,0x04,0x04,0x53,0x4b,0x2d,0x31,
0x03,0x02,0x02,0x00,0x01,0x01,0xff,0x03,0x02,0x04,0x10,0x02,0x01,0x0a,0x05,
0x30,0x03,0x02,0x01,0x40,0xa1,0x06,0x30,0x04,0x06,0x01,0x58,0x58
</EF_SK>

```

## E.4 Encoding of a Certificate

### E.4.1 Cryptographic Information Application Example Description

A description of an X.509 certificate.

### E.4.2 ASN.1 Encoding of an X.509 Certificate

```

certificates objects { -- SEQUENCE OF --
  x509Certificate { -- SEQUENCE --
    commonObjectAttributes { -- SEQUENCE --
      label '43657274696669636174652031'H -- "Certificate 1" --,
      flags '40'H,
      authId '17'H,
      userConsent 5
    },
    classAttributes { -- SEQUENCE --
      id '41444d'H -- "ADM" --,
      authority FALSE,
      identifier { -- SEQUENCE --
        idType 0,
        idValue '3132333435363738'H -- "12345678" --
      },
      certHash { -- SEQUENCE --
        hashAlg { -- SEQUENCE --
          algorithm {0 17 34 51},
          parameters '332211'H
        },
        certId { -- SEQUENCE --
          issuer ipAddress 'c0a82d01'H,
          serialNumber 13107
        },
        hashVal '998877'H
      },
    },
  },
}

```

```

trustedUsage { -- SEQUENCE --
  keyUsage '2000'H
},
identifiers { -- SEQUENCE OF --
  { -- SEQUENCE --
    idType 5,
    idValue '616263'H -- "abc" --
  },
  { -- SEQUENCE --
    idType 5,
    idValue '78797a'H -- "xyz" --
  }
},
typeAttributes { -- SEQUENCE --
  value indirect path { -- SEQUENCE --
    efidOrPath '3f004042'H -- "? @B" --
  },
  subject rdnSequence { -- SEQUENCE OF --
    { -- SET OF --
      { -- SEQUENCE --
        type {1 11 68},
        value NULL,
        valuesWithContext { -- SET OF --
          { -- SEQUENCE --
            distingAttrValue '5577'H,
            contextList { -- SET OF --
              { -- SEQUENCE --
                contextType {2 40 86},
                contextValues { -- SET OF --
                  '876543'H
                },
                fallback TRUE
              }
            }
          }
        }
      }
    }
  },
  issuer rdnSequence { -- SEQUENCE OF --
    { -- SET OF --
      { -- SEQUENCE --
        type {2 5 102},
        value NULL,
        valuesWithContext { -- SET OF --
          { -- SEQUENCE --
            distingAttrValue '8899'H,
            contextList { -- SET OF --
              { -- SEQUENCE --
                contextType {2 40 86},
                contextValues { -- SET OF --
                  '785634'H
                },
                fallback TRUE
              }
            }
          }
        }
      }
    }
  }
}

```

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```

    },
    serialNumber 22376
  }
}
}

```

### E.4.3 Code from the ASN.1 for Encoding and Decoding BER

```

/*
** Example of Code for Encoding the BER
*/
void X509Certificate(unsigned char *label,
                    unsigned char objectFlags,
                    unsigned char *iD, unsigned int iDLength,
                    unsigned char authority,
                    unsigned short usageFlags,
                    unsigned int externalIdentifierType,
                    unsigned char *externalIdentifier,
                    unsigned char *path, unsigned int pathLength,
                    unsigned char *BER, unsigned int *BERLength) // Output
{
  unsigned int l;
  SBuf b;
  GenBuf *gb;
  unsigned char buffer[1024];

  CIOChoice *cio;
  CertificateChoice *prk, **prkp;
  AccessControlRule *acr, **acrp;
  SecurityCondition *sc, **scp;
  CredentialIdentifier *cid, **cidp;
  RelativeDistinguishedName *rdn, **rdnp;
  AttributeTypeAndDistinguishedValue *atadv, **atadvp;
  AttributeTypeAndDistinguishedValueSetOfSeq *atadvsos, **atadvsosp;
  Context *atadvso, **atadvso;
  AsnAny *any, **anyp;

  SecurityCondition securityCondition1;
  SecurityCondition securityCondition2;
  AsnOcts authId11 = { sizeof(AuthId11), AuthId11 };
  AsnOcts authId12 = { sizeof(AuthId12), AuthId12 };
  AsnOcts authId21 = { sizeof(AuthId21), AuthId21 };
  AsnOcts authId22 = { sizeof(AuthId22), AuthId22 };

  CertificateObject_X509CertificateAttributes pattr = { 0 };
  CommonObjectAttributes commonObjAttr = { 0 };
  CommonCertificateAttributes commonCertificateAttr = { 0 };
  X509CertificateAttributes x509CertificateAttr = { 0 };

  CredentialIdentifier credentialIdentifier = { 0 };
  Path pathOctets = { 0 };
  AsnOcts issuerHash = { 0 };
  AsnOcts issuerHash1 = { sizeof(identifier1), identifier1 };
  AsnOcts issuerHash2 = { sizeof(identifier2), identifier2 };

  AsnOcts asnATADVvalue = { sizeof(ATADVvalue), ATADVvalue };
  AsnOcts asnATADVdistvalue = { sizeof(ATADVdistvalue), ATADVdistvalue };
  AsnOcts asnATADVvalueIssuer = { sizeof(ATADVvalueIssuer), ATADVvalueIssuer };

```

```

AsnOcts asnATADVdistvalueIssuer = { sizeof(ATADVdistvalueIssuer), ATADVdistvalueIssuer };

char commonObjectFlags[1]                = { 0 };
AsnBits commonFlagsAsnBits                = { 2, commonObjectFlags };

char accessControlRuleFlags1[1]          = { 0 };
AsnBits accessControlRuleAsnBits1        = { 4, accessControlRuleFlags1 };
char accessControlRuleFlags2[1]          = { 0 };
AsnBits accessControlRuleAsnBits2        = { 4, accessControlRuleFlags2 };

char usageFlagBits[2]                    = { 0 };
AsnBits usageFlagsAsnBits                = { 10, usageFlagBits };

CertHash certHash = { 0 };
AlgorithmIdentifier algoId = { 0 };
AsnOcts parameters = { 0 };

CertId certId = { 0 };
GeneralName issuer;

Usage usage = { 0 };

AsnAny contextValue1;
AsnOcts contextValue1Octs = { sizeof(ContextValue1Octs), ContextValue1Octs };
AsnAny contextValue1Issuer;
AsnOcts contextValue1OctsIssuer = { sizeof(ContextValue1OctsIssuer), ContextValue1OctsIssuer };

InitAnyCryptographicInformationFramework();
InitAnyInformationFramework2();

SBufInit(&b, buffer, sizeof(buffer));
SBufResetInWriteRvsMode(&b);
SBufToGenBuf(&b, &gb);

/*
** Section 8.3 The CIOChoice type
**
** "EF.OD shall contain the concatenation of 0, 1, or more DER-encoded CIOChoice values."
**
**
**
*/
cio = (CIOChoice *)calloc(1, sizeof(CertificateChoice));
cio->choiceId = CIOCHOICE_CERTIFICATES;

/*
** "It is expected that an EF.OD entry will usually reference a separate file (the path
** choice of PathOrObjects) containing CIOs of the indicated type. An entry may, however,
** hold CIOs directly (the objects choice of PathOrObjects), if the objects and the EF.OD
** file have the same access control requirements."
**
** PathOrObjects{CertificateChoice}
**
*/
cio->a.certificates = (P15Certificates *)calloc(1, sizeof(P15Certificates));
cio->a.certificates->choiceId = PATHOROBJECTS_CERTIFICATECHOICE_OBJECTS;
cio->a.certificates->a.objects = AsnListNew(sizeof(void*));

/*
** Section 8.4.1 CertificateChoice
**
** "This type contains information pertaining to a private key. Each value

```

```

** consists of attributes common to any object, any key, any private key,
** and attributes particular to the key."
*/
prkp = (CertificateChoice **)AsnListAppend(cio->a.certificates->a.objects);

*prkp = prk = calloc(1, sizeof(CertificateChoice));

prk->choiceId = CERTIFICATECHOICE_X509CERTIFICATE;

prk->a.x509Certificate = &pattr;

pattr.commonObjectAttributes = &commonObjAttr;
pattr.classAttributes        = &commonCertificateAttr;
pattr.subClassAttributes     = NULL;
pattr.typeAttributes         = &x509CertificateAttr;

/*
** Section 8.2.8 CommonObjectAttributes
**
** "This type is a container for attributes common to all CIOs."
**
*/
commonObjAttr.label.octs = label;
commonObjAttr.label.octetLen = strlen(label);

commonObjAttr.flags[0] = objectFlags;
commonObjAttr.flags = commonFlagsAsnBits;

commonObjAttr.authId.octetLen = sizeof(authId);
commonObjAttr.authId.octs = authId;

commonObjAttr.userConsent = &one;

/*
** Section 8.2.15 CommonCertificateAttributes
**
** "When a public key in a certificate referenced by a certificate
** information object corresponds to a private key referenced by a
** private key information object, then the information objects
** shall share the same value for the id field. This requirement
** will simplify searches for a private key corresponding to a
** particular certificate and vice versa. Multiple certificates
** for the same key shall share the same value for the id."
*/
commonCertificateAttr.id.octetLen = idLength;
commonCertificateAttr.id.octs = id;
commonCertificateAttr.authority = &authority;

issuerHash.octs = externalIdentifier;
issuerHash.octetLen = strlen(externalIdentifier);
credentialIdentifier.idValue.value = &issuerHash;
SetAnyTypeByInt(&(credentialIdentifier.idValue), externalIdentifierType);

commonCertificateAttr.identifier = &credentialIdentifier;

/* Cert Hash */
commonCertificateAttr.certHash = &certHash;
certHash.hashAlg = &algoId;
algoId.algorithm.octetLen = sizeof(algoId);

```

```

algoId.algorithm.octs = algoId;

parameters.octetLen = sizeof(algo1Pm);
parameters.octs = algo1Pm;
algoId.parameters.value = &parameters;
SetAnyTypeByInt(&algoId.parameters, externalIdentifierType);

/* Cert Identifier */
certHash.certId = &certId;
certId.issuer = &issuer;
issuer.choiceId = GENERALNAME_IPADDRESS;
issuer.a.iPAddress = (AsnOcts *)calloc(1, sizeof(AsnOcts));
issuer.a.iPAddress->octetLen = sizeof(issuerIPAddress);
issuer.a.iPAddress->octs = issuerIPAddress;
certId.serialNumber = 0x3333;

/* Cert Hash */
certHash.hashVal.bitLen = 8*sizeof(hashbits);
certHash.hashVal.bits = hashbits;

/* Usage */
commonCertificateAttr.trustedUsage = &usage;
usageFlagBits[0] = (unsigned char)(usageFlags>>8);
usageFlagBits[1] = (unsigned char)(usageFlags);
usage.keyUsage = usageFlagsAsnBits;

/* Identifiers */
commonCertificateAttr.identifiers = AsnListNew(sizeof(void*));
cidp = (CredentialIdentifier **)AsnListAppend(commonCertificateAttr.identifiers);
*cidp = cid = calloc(1, sizeof(CredentialIdentifier));
cid->idType = externalIdentifierType;
cid->idValue.value = &issuerHash1;
SetAnyTypeByInt(&(cid->idValue), externalIdentifierType);

cidp = (CredentialIdentifier **)AsnListAppend(commonCertificateAttr.identifiers);

*cidp = cid = calloc(1, sizeof(CredentialIdentifier));

cid->idType = externalIdentifierType;
cid->idValue.value = &issuerHash2;
SetAnyTypeByInt(&(cid->idValue), externalIdentifierType);

/*
** Section 8.7.2 X509 Certificate Attributes
**
** "X509CertificateAttributes.value: The value shall be a ReferencedValue
** either identifying a file containing a DER encoded certificate at the
** given location, or a URL pointing to some location where the certificate can be found.
**
** "X509CertificateAttributes.subject, X509CertificateAttributes.issuer and
** X509CertificateAttributes.serialNumber: The semantics of these fields is the
** same as for the corresponding fields in ISO/IEC 9594-8:1998. The values of these
** fields shall be exactly the same as for the corresponding fields in the certificate itself.
** The reason for making them optional is to provide some space-efficiency, since they already
** are present in the certificate itself."
*/
x509CertificateAttr.value = (ObjectValue *)calloc(1, sizeof(ObjectValue));

x509CertificateAttr.value->choiceId = OBJECTVALUE_INDIRECT;
x509CertificateAttr.value->a.indirect = (ReferencedValue *)calloc(1, sizeof(ReferencedValue));

```

```

x509CertificateAttr.value->a.indirect->choiceId = REFERENCEDVALUE_PATH;

pathOctets.efidOrPath.octs = (char *)calloc(1, pathLength);
memcpy(pathOctets.efidOrPath.octs, path, pathLength);
pathOctets.efidOrPath.octetLen = pathLength;
x509CertificateAttr.value->a.indirect->a.path = &pathOctets;
/* Subject */
x509CertificateAttr.subject = (Name *)calloc(1, sizeof(Name));
x509CertificateAttr.subject->choiceId = NAME_RDNSEQUENCE;
x509CertificateAttr.subject->a.rdnSequence = AsnListNew(sizeof (void*));
rdnp = (RelativeDistinguishedName **)AsnListAppend(x509CertificateAttr.subject->a.rdnSequence);
*rdnp = rdn = AsnListNew(sizeof (void*));
atadvp = (AttributeTypeAndDistinguishedValue **)AsnListAppend(rdn);
*atadvp=atadv=
    (AttributeTypeAndDistinguishedValue*)
        calloc(1, sizeof (AttributeTypeAndDistinguishedValue));
atadv->type.octetLen = sizeof (ATADVtype);
atadv->type.octs = ATADVtype;

atadv->value.value = &asnATADVvalue;
SetAnyTypeByOid(&(atadv->value), &noRevAvail);

atadv->valuesWithContext = AsnListNew(sizeof (void*));
atadvssp = (AttributeTypeAndDistinguishedValueSetOfSeq **)AsnListAppend(atadv->valuesWithContext);
*atadvssp=atadvssp=
    (AttributeTypeAndDistinguishedValueSetOfSeq *)
        calloc(1, sizeof (AttributeTypeAndDistinguishedValueSetOfSeq));

atadvssp->distingAttrValue.value = &asnATADVdistvalue;
SetAnyTypeByInt(&(atadvssp->distingAttrValue), externalIdentifierType);

atadvssp->contextList = AsnListNew(sizeof (void*));
atadvssp = (Context **)AsnListAppend(atadvssp->contextList);
*atadvssp = atadvssp = (Context *)calloc(1, sizeof (Context));
atadvssp->contextType.octetLen = sizeof (contextTypeIssuer);
atadvssp->contextType.octs = contextTypeIssuer;
atadvssp->contextValues = AsnListNew(sizeof (void*));
anyp = (AsnAny **)AsnListAppend(atadvssp->contextValues);
contextValue1.value = &contextValue1Octs;
SetAnyTypeByInt(&(contextValue1), externalIdentifierType);
*anyp = any = &contextValue1;

atadvssp->fallback = &True;

atadv->primaryDistinguished = FALSE;

/* Issuer */
x509CertificateAttr.issuer = (Name *)calloc(1, sizeof (Name));
x509CertificateAttr.issuer->choiceId = NAME_RDNSEQUENCE;
x509CertificateAttr.issuer->a.rdnSequence = AsnListNew(sizeof (void*));
rdnp = (RelativeDistinguishedName **)AsnListAppend(x509CertificateAttr.issuer->a.rdnSequence);
*rdnp = rdn = AsnListNew(sizeof (void*));
atadvp = (AttributeTypeAndDistinguishedValue **)AsnListAppend(rdn);
*atadvp=atadv=
    (AttributeTypeAndDistinguishedValue *)
        calloc(1, sizeof (AttributeTypeAndDistinguishedValue));
atadv->type.octetLen = sizeof (ATADVtypeIssuer);
atadv->type.octs = ATADVtypeIssuer;

atadv->value.value = &asnATADVvalueIssuer;

```

```

SetAnyTypeByOid(&(atadv->value), &noRevAvail);

atadv->valuesWithContext = AsnListNew(sizeof (void*));
atadvssosp= (AttributeTypeAndDistinguishedValueSetOfSeq **)AsnListAppend(atadv->valuesWithContext);
*atadvssosp=atadvssos=
    (AttributeTypeAndDistinguishedValueSetOfSeq *)
        calloc(1, sizeof(AttributeTypeAndDistinguishedValueSetOfSeq));
atadvssos->distingAttrValue.value = &asnATADVdistvalueIssuer;
SetAnyTypeByInt(&(atadvssos->distingAttrValue), externalIdentifierType);

atadvssos->contextList = AsnListNew(sizeof (void*));
atadvssosop = (Context **)AsnListAppend(atadvssos->contextList);
*atadvssosop = atadvssosso = (Context *)calloc(1, sizeof(Context));
atadvssosso->contextType.octetLen = sizeof(contextTypeIssuer);
atadvssosso->contextType.octs = contextTypeIssuer;
atadvssosso->contextValues = AsnListNew(sizeof (void*));
anyp = (AsnAny **)AsnListAppend(atadvssosso->contextValues);
contextValue1Issuer.value = &contextValue1OctsIssuer;
SetAnyTypeByInt(&(contextValue1Issuer), externalIdentifierType);
*anyp = any = &contextValue1Issuer;

atadvssosso->fallback = &True;

atadv->primaryDistinguished = FALSE;

x509CertificateAttr.serialNumber = &certSerialNumber;

/*
** Print the Certificate Data Object
*/
PrintCIOChoice(stdout, cio, 3);

/*
** BER Encode the Certificate Data Object
*/
*BERLength = BEncCIOChoiceContent (gb,cio);
GenBufResetInReadMode (gb);

l = 0;
memcpy(BER, GenBufGetSeg (gb, &l), *BERLength);
}

/*
** Example of Code for Decoding the BER
*/
Path_to_X509_Certificate(unsigned char *BER, unsigned int BERLength)
{
    SBuf b;
    GenBuf *gb;
    unsigned int bytesDecoded = 0;
    ENV_TYPE env;
    AsnTag tagId0;
    AsnLen elmtLen0;
    CIOChoice *cio;
    CertificateChoice *certificate;
    CertificateObject_X509CertificateAttributes* x509Certificate;
    X509CertificateAttributes* typeAttributes;
    ObjectValue* value;
    unsigned int i, pathLength;
    unsigned char *path;

```

```

if(setjmp(env) != 0) exit(0);

cio = calloc(1, sizeof(CIOChoice));

SBufInstallData(&b, BER, BERLength);
SBufToGenBuf(&b, &gb);
tagId0 = BDecTag(gb, &bytesDecoded, env);
elmtLen0 = BDecLen(gb, &bytesDecoded, env);

/*
** Decode the X.509 Certificate
*/
BDecCIOChoiceContent(gb, tagId0, elmtLen0, cio, &bytesDecoded, env);

/*
** Find the path to the certificate
*/
certificate = (CertificateChoice *) (cio->a.certificates->a.objects->first->data);

x509Certificate = certificate->a.x509Certificate;

typeAttributes = x509Certificate->typeAttributes;

value = typeAttributes->value;

printf("Path to Certificate: ");
pathLength = value->a.indirect->a.path->efidOrPath.octetLen;
path = value->a.indirect->a.path->efidOrPath.octs;
for(i = 0; i < pathLength; i+=2)
    printf("0x%02x%02x ", path[i], path[i+1]);
printf("\n");
}

```

#### E.4.4 BER Encoding

```

<BER>
0xa4,0x81,0xe1,0xa0,0x81,0xde,0x30,0x81,0xdb,0x30,0x19,0x0c,0x0d,0x43,0x65,0x72,
0x74,0x69,0x66,0x69,0x63,0x61,0x74,0x65,0x20,0x31,0x03,0x02,0x06,0x40,0x04,0x01,
0x17,0x02,0x01,0x05,0x30,0x58,0x04,0x03,0x41,0x44,0x4d,0x01,0x01,0x00,0x30,0x0d,
0x02,0x01,0x00,0x60,0x08,0x31,0x32,0x33,0x34,0x35,0x36,0x37,0x38,0xa0,0x22,0xa0,
0x0c,0x30,0x0a,0x06,0x03,0x11,0x22,0x33,0x60,0x03,0x33,0x22,0x11,0xa1,0x0c,0x30,
0x0a,0x87,0x04,0xc0,0xa8,0x2d,0x01,0x02,0x02,0x33,0x33,0x03,0x04,0x00,0x99,0x88,
0x77,0xa1,0x05,0x03,0x03,0x06,0x20,0x00,0xa2,0x14,0x30,0x08,0x02,0x01,0x05,0x60,
0x03,0x61,0x62,0x63,0x30,0x08,0x02,0x01,0x05,0x60,0x03,0x78,0x79,0x7a,0xa1,0x64,
0x30,0x62,0x30,0x06,0x04,0x04,0x3f,0x00,0x40,0x42,0x30,0x28,0x31,0x26,0x30,0x24,
0x06,0x02,0x33,0x44,0x60,0x02,0x44,0x33,0x31,0x1a,0x30,0x18,0xa0,0x04,0x60,0x02,
0x55,0x77,0x31,0x10,0x30,0x0e,0x06,0x02,0x78,0x56,0x31,0x05,0x60,0x03,0x87,0x65,
0x43,0x01,0x01,0xff,0xa0,0x2a,0x30,0x28,0x31,0x26,0x30,0x24,0x06,0x02,0x55,0x66,
0x60,0x02,0x66,0x77,0x31,0x1a,0x30,0x18,0xa0,0x04,0x60,0x02,0x88,0x99,0x31,0x10,
0x30,0x0e,0x06,0x02,0x78,0x56,0x31,0x05,0x60,0x03,0x78,0x56,0x34,0x01,0x01,0xff,
0x02,0x02,0x57,0x68
</BER>

```

Table E.2 is a diagrammatic representation of the BER encoding.

Table E.2 — EF.CD of X.509 Certificate

		Data Type
A4	CIOChoice: Certificate	
81	E1	
A0	Certificate Choice: X.509 certificate	
81	DE	
30	X.509 certificate Object	
81	DB	
30	19 Common Object Attributes	
0C	0D Label	43, 65, 72, 74, 69, 66, 69, 63, 61, 74, 65, 20, 31
03	02 Flags	05 40
04	01 authId	17
02	01 userConsent	05
30	58 Common Certificate Attributes	
04	03 iD	41, 44, 4D
01	01 Authority	00
30	0D Identifier	
	02 01 idType	00
	60 08 idValue	31, 32, 33, 34, 35, 36, 37, 38
A0	22 certHash	

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Table E.2 (continued)

A0	0C	hashAlg										
		30	0A									
A1	0C	06	03	Algorithm		11, 22, 33				OID		
				60	03	parameters		33, 22, 11				OpenType
A1	0C	certID										
		30	0A									
A1	05	87	04	Issuer(iPAddress)		C0, A8, 2D, 01				OCTET STRING		
				02	02	serialNumber		33, 33				INTEGER
						hashVal		00, 99, 88, 77				INTEGER
trustUsage												
A2	14	03	03	keyUsage		06, 20, 00				BIT STRING		
				identifiers								
A2	08	CredentialIdentifier										
		02	01	idType		05				INTEGER		
				60	03	idValue		61, 62, 63				OpenType
CredentialIdentifier												
A2	08	02	01	idType		05				INTEGER		
				60	03	idValue		78, 79, 7A				OpenType

Table E.2 (continued)

A1	64	X509CertificateAttributes	
		30	62
		Choice	
		30	06
		Value	
		04	04
		efidOrPath	
		3F, 00, 40, 42	
		OCTET STRING	
		30	28
		subject (RDNSeuence)	
		34	26
		rdnSequence	
		30	24
		AttributeTypeAndDispinguishedValue	
		06	02
		Type	
		33, 44	
		OID	
		60	02
		Value	
		44, 33	
		OpenType	
		31	1A
		SET valuesWithContext	
		30	18
		SEQUENCE	
		A0	04
		SupportedAttributes	
		60	02
		55, 77	
		OpenType	
		31	10
		contextList	
		30	0E
		SEQUENCE	
		06	02
		contextType	
		OID	
		31	05
		SET	
		60	03
		Context	
		87, 65, 43	
		OpenType	
		01	01
		fallback	
		FF	
		BOOLEAN	

Table E.2 (continued)

A0	2A	Issuer (RDNSequence)	30 28		Choice :	31 26		SET of AttributeTypeAndValue		30 24		06 02		Type	55, 66	OID
			30 28			31 26		SET of AttributeTypeAndValue		30 24		60 02		Value	66, 77	OpenType
			30 28			31 26		SET of AttributeTypeAndValue		30 24		31 1A		SET valuesWithContext		
			30 28			31 26		SET of AttributeTypeAndValue		30 24		30 18		SEQUENCE		
			30 28			31 26		SET of AttributeTypeAndValue		30 24		A0 04		SupportedAttributes		
			30 28			31 26		SET of AttributeTypeAndValue		30 24		60 02		88, 99		OpenType
			30 28			31 26		SET of AttributeTypeAndValue		30 24		31 10		SET contextList		
			30 28			31 26		SET of AttributeTypeAndValue		30 24		30 0E		SEQUENCE		
			30 28			31 26		SET of AttributeTypeAndValue		30 24		06 02		contextType	78, 56	OID
			30 28			31 26		SET of AttributeTypeAndValue		30 24		31 05		SET Cotext		
			30 28			31 26		SET of AttributeTypeAndValue		30 24		60 03		Context	78, 56, 34	
			30 28			31 26		SET of AttributeTypeAndValue		30 24		01 01		fallback	FF	BOOLEAN
02	02	serial Number	57, 68													INTEGER

## E.5 Encoding of the ESIGN Cryptographic Information Application

### E.5.1 Cryptographic Information Application Example Description

The encoding is an example of a Cryptographic Information Application for the ESIGN as described in Section 16 of CWA 14890-1:2004

### E.5.2 ASN.1 Encoding of the IAS Cryptographic Information Application

```

{ -- SEQUENCE OF --
  privateKeys path { -- SEQUENCE --
    efidOrPath '4001'H
  },
  publicKeys path { -- SEQUENCE --
    efidOrPath '4002'H
  },
  certificates path { -- SEQUENCE --
    efidOrPath '4005'H
  },
  trustedCertificates path { -- SEQUENCE --
    efidOrPath '4004'H
  },
  dataContainerObjects path { -- SEQUENCE --
    efidOrPath '4006'H
  },
  authObjects path { -- SEQUENCE --
    efidOrPath '4003'H
  }
}

cardInfo { -- SEQUENCE --
  version 2,
  serialNumber '0102030405060708'H,
  manufacturerID '41434d45'H -- "ACME" --,
  label '5369676e617475726520417070666963617469666e'H -- "Signature Application" --,
  cardflags '60'H,
  seInfo { -- SEQUENCE OF --
    { -- SEQUENCE --
      se 1,
      aid 'a000000167455349474e'H
    },
    { -- SEQUENCE --
      se 2,
      aid 'a000000167455349474e'H
    }
  },
  supportedAlgorithms { -- SEQUENCE OF --
    { -- SEQUENCE --
      reference 1,
      algorithm 544,
      parameters 'H -- "" --,
      supportedOperations '02'H,
      objId {0 1 3 14 3 2 26},
      algRef 16
    },
    { -- SEQUENCE --
      reference 2,
      algorithm -2147483648,
      parameters 'H -- "" --,

```

```

        supportedOperations '40'H,
        objId {0 1 3 36 3 4 3 2 1},
        algRef 17
    },
    { -- SEQUENCE --
        reference 3,
        algorithm 544,
        parameters 'H -- "" --,
        supportedOperations '40'H,
        objId {0 1 2 72 113 37 1 1 5},
        algRef 18
    },
    { -- SEQUENCE --
        reference 4,
        algorithm -2147483647,
        parameters 'H -- "" --,
        supportedOperations '50'H,
        objId {0 1 3 36 7 2 1 1},
        algRef 23
    },
    { -- SEQUENCE --
        reference 5,
        algorithm -2147483646,
        parameters 'H -- "" --,
        supportedOperations '10'H,
        objId {0 1 3 36 3 4 3 2 1}
    }
},
issuerId '4d61696e205374726565742042616e6b'H -- "Main Street Bank" --,
holderId '53616c6c7920477265656e'H -- "Sally Green" --,
lastUpdate generalizedTime '31393835313130363231303632372e335a'H -- "19851106210627.3Z" --,
preferredLanguage '4573706572616e746f'H -- "Esperanto" --
}

AuthenticationObjects { -- SEQUENCE OF --
    pwd { -- SEQUENCE --
        commonObjectAttributes { -- SEQUENCE --
            label '476c6f62616c2050617373776f7264'H -- "Global Password" --,
            flags '40'H,
            authId '03'H,
            accessControlRules { -- SEQUENCE OF --
                { -- SEQUENCE --
                    accessMode '20'H,
                    securityCondition authReference { -- SEQUENCE --
                        authMethod 'c0'H,
                        seIdentifier 2
                    }
                }
            }
        },
        classAttributes { -- SEQUENCE --
            authId '01'H,
            authReference 1,
            seIdentifier 2
        },
        typeAttributes { -- SEQUENCE --
            pwdFlags '08'H,
            pwdType 0,
            minLength 4,
            storedLength 0,

```