
**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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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 = (PrivateKeys *)calloc(1, sizeof(PrivateKeys));
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 = &pattr;

pattr.commonObjectAttributes = &commonObjAttr;
pattr.classAttributes        = &commonKeyAttr;
pattr.subClassAttributes     = &commonPrivateKeyAttr;
pattr.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.octets = 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.octets = _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.octets = (char *)calloc(1, pathLength);
memcpy(pathOctets.efidOrPath.octets, 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 *PrivateRSAKey(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	4D	Private RSA Key object		
30	12	Common object Attribute		
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	12	Common Key Attribute		
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

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;

dcop = (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*));
*acr = (AccessControlRule **)AsnListAppend(commonObjectAttr.accessControlRules);
*acr = 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 = PATHOROBJECTS_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;
        }
    }
}
}

```

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,0xa0,0x05,
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, **atadvsos;
  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->contextList = (Context **)AsnListAppend(atadvssp->contextList);
*atadvssp->contextList = atadvssp->contextList = (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	81	Certificate				
	E1					
A0	81	Certificate Choice: X.509 certificate				
	DE					
30	81	X.509 certificate Object				
	DB					
30	19	Common Object Attributes				
0C	0D		Label	43, 65, 72, 74, 69, 66, 69, 63, 61, 74, 65, 20, 31	UTF8String	
03	02		Flags	05 40	BIT STRING	
04	01		authid	17	OCTED STRING	
02	01		userConsent	05	INTEGER	
30	58	Common Certificate Attributes				
04	03		iD	41, 44, 4D	OCTET STRING	
01	01		Authority	00	BOOLEAN	
30	0D		Identifier			
	02		01	idType	00	INTEGER
	60		08	idValue	31, 32, 33, 34, 35, 36, 37, 38	OpenType
A0	22		certHash			

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Table E.2 (continued)

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

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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 '5369676e6174757265204170706c6963617469666e'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,

```