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*ACLU*

# RFC 9216

## S/MIME Example Keys and Certificates

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### Abstract

The S/MIME development community benefits from sharing samples of signed or encrypted data. This document facilitates such collaboration by defining a small set of X.509v3 certificates and keys for use when generating such samples.

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Acknowledgements

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## 1. Introduction

The S/MIME ([RFC8551]) development community, in particular the email development community, benefits from sharing samples of signed and/or encrypted data. Often, the exact key material used does not matter because the properties being tested pertain to implementation correctness, completeness, or interoperability of the overall system. However, without access to the relevant secret key material, a sample is useless.

This document defines a small set of X.509v3 certificates ([RFC5280]) and secret keys for use when generating or operating on such samples.

An example RSA Certification Authority is supplied, and sample RSA certificates are provided for two "personas", Alice and Bob.

Additionally, an Ed25519 ([RFC8032]) Certification Authority is supplied, along with sample Ed25519 certificates for two more "personas", Carlos and Dana.

This document focuses narrowly on functional, well-formed identity and key material. It is a starting point that other documents can use to develop sample signed or encrypted messages, test vectors, or other artifacts for improved interoperability.

## 1.1. Terminology

"Certification Authority" (or "CA"): a party capable of issuing X.509 certificates

"End Entity" (or "EE"): a party that is capable of using X.509 certificates (and their corresponding secret key material)

"Mail User Agent" (or "MUA"): a program that generates or handles email messages ([RFC5322])

## 1.2. Prior Work

[RFC4134] contains some sample certificates as well as messages of various S/MIME formats. That older work has unacceptably old algorithm choices that may introduce failures when testing modern systems: in 2019, some tools explicitly marked 1024-bit RSA and 1024-bit DSS as weak.

This earlier document also does not use the now widely accepted Privacy-Enhanced Mail (PEM) encoding (see [RFC7468]) for the objects and instead embeds runnable Perl code to extract them from the document.

It also includes examples of messages and other structures that are greater in ambition than this document intends to be.

[RFC8410] includes an example X25519 certificate that is certified with Ed25519, but it appears to be self issued, and it is not directly useful in testing an S/MIME-capable MUA.

## 2. Background

### 2.1. Certificate Usage

These X.509 certificates ([RFC5280]) are designed for use with S/MIME protections ([RFC8551]) for email ([RFC5322]).

In particular, they should be usable with signed and encrypted messages as part of test suites and interoperability frameworks.

All end-entity and intermediate CA certificates are marked with Certificate Policies from [[TEST-POLICY](#)] indicating that they are intended only for use in testing environments. End-entity certificates are marked with policy 2.16.840.1.101.3.2.1.48.1 and intermediate CAs are marked with policy 2.16.840.1.101.3.2.1.48.2.

## 2.2. Certificate Expiration

The certificates included in this document expire in 2052. This should be sufficiently far in the future that they will be useful for a few decades. However, when testing tools in the far future (or when playing with clock-skew scenarios), care should be taken to consider the certificate validity window.

Due to this lengthy expiration window, these certificates will not be particularly useful to test or evaluate the interaction between certificate expiration and protected messages.

## 2.3. Certificate Revocation

Because these are expected to be used in test suites or examples, and we do not expect there to be online network services in these use cases, we do not expect these certificates to produce any revocation artifacts.

As a result, none of the certificates include either an Online Certificate Status Protocol (OCSP) indicator (see `id-ad-ocsp` as defined in the Authority Information Access X.509 extension in [Section 4.2.2.1](#) of [[RFC5280](#)]) or a Certificate Revocation List (CRL) indicator (see the CRL Distribution Points X.509 extension as defined in [Section 4.2.1.13](#) of [[RFC5280](#)]).

## 2.4. Using the CA in Test Suites

To use these end-entity certificates in a piece of software (for example, in a test suite or an interoperability matrix), most tools will need to accept either the example RSA CA ([Section 3](#)) or the example Ed25519 CA ([Section 6](#)) as a legitimate root authority.

Note that some tooling behaves differently for certificates validated by "locally installed root CAs" than for pre-installed "system-level" root CAs). For example, many common implementations of HTTP Public Key Pinning (HPKP) ([RFC7469](#)) only applied the designed protections when dealing with a certificate issued by a pre-installed "system-level" root CA and were disabled when dealing with a certificate issued by a "locally installed root CA".

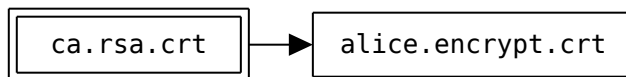
To test some tooling specifically, it may be necessary to install the root CA as a "system-level" root CA.

## 2.5. Certificate Chains

In most real-world examples, X.509 certificates are deployed with a chain of more than one X.509 certificate. In particular, there is typically a long-lived root CA that users' software knows about upon installation, and the end-entity certificate is issued by an intermediate CA, which is in turn issued by the root CA.

The example end-entity certificates in this document can be used either with a simple two-link certificate chain (they are directly certified by their corresponding root CA) or in a three-link chain.

For example, Alice's encryption certificate (`alice.encrypt.crt`; see [Section 4.3](#)) can be validated by a peer that directly trusts the example RSA CA's root cert (`ca.rsa.crt`; see [Section 3.1](#)):



*Figure 1: Validating Alice's encryption certificate directly when the issuing CA is a trust anchor*

And it can also be validated by a peer that only directly trusts the example Ed25519 CA's root cert (`ca.25519.crt`; see [Section 6.1](#)) via an intermediate cross-signed CA cert (`ca.rsa.cross.crt`; see [Section 3.3](#)):



*Figure 2: Validating Alice's cert from a different trust anchor via an intermediate cross-signed CA certificate*

By omitting the cross-signed CA certs, it should be possible to test a "transvalid" certificate (an end-entity certificate that is supplied without its intermediate certificate) in some configurations.

## 2.6. Passwords

Each secret key presented in this document is represented as a PEM-encoded PKCS #8 ([\[RFC5958\]](#)) object in cleartext form (it has no password).

As such, the secret key objects are not suitable for verifying interoperable password protection schemes.

However, the PKCS #12 ([\[RFC7292\]](#)) objects do have simple textual passwords, because tooling for dealing with passwordless PKCS #12 objects is underdeveloped at the time of this document.

## 2.7. Secret Key Origins

The secret RSA keys in this document are all deterministically derived using provable prime generation as found in [FIPS186-4] based on known seeds derived via SHA-256 ([SHA]) from simple strings. The validation parameters for these derivations are stored in the objects themselves as specified in [RFC8479].

The secret Ed25519 and X25519 keys in this document are all derived by hashing a simple string. The seeds and their derivation are included in the document for informational purposes and to allow recreation of the objects from appropriate tooling.

All RSA seeds used are 224 bits long (the first 224 bits of the SHA-256 digest of the origin string) and are represented in hexadecimal.

## 3. Example RSA Certification Authority

The example RSA Certification Authority has the following information:

Name: Sample LAMPS RSA Certification Authority

### 3.1. RSA Certification Authority Root Certificate

This certificate is used to verify certificates issued by the example RSA Certification Authority.

```
-----BEGIN CERTIFICATE-----
MIIDezCCAm0gAwIBAgITcBn0xb/zdaeCQlqp6yZUAGZUCDANBgkqhkiG9w0BAQ0F
ADBVMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEwhMQU1QUyBXRzExMC8GA1UEAxMo
U2FtcGx1IEExBTBVTIFJTQSBZDZXJ0aWZpY2F0aW9uIEF1dGhvcml0eTAGFw0xOTEx
MjAwNjU0MThaGA8yMDUyMDkyNzA2NTQxOFowVTENMAAsGA1UEChMESAUVURjERMA8G
A1UECxMITEFNUFUMgV0cxMTAvBgNVBAMTKFNhbXBsZSBMQU1QUyBSU0EgQ2VydGlm
aWNhdGlvbiBBdXR0b3JpdHkwggEiMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEKAoIB
AQC2GGPTEFVNdil0LsiQ79A0Mz2G+LRJlBx2vNo8STibAnyQ9VzFrGJHjUhrX/Omr
OP3rDCB2SYfBPVwd0CdC6z9qfJkcVxDc1hK+VS9vKncL0IPUYlkJwWuMpXa1Ielz
+zCuV+gjV83Uvn6wTn39MCmymu7nFPzihcu0nbMYOCdMmUbi1Dm8TX9P6itFR3hi
IHpSKMbkoXlM1837WafFx57kBIoIuNjKEyPIuK9wGUAeppc5QAHJg95PPEHNLmM
yhBzClmgkyozRSeSrKxq9XeJKU94lWGaZ0zb4karCur/eiMoCk3YNV8L3styvcmG
1qUDCAaKx6FZEF7hE9RN6L3bAgMBAAGjQjBAMA8GA1UdEwEB/wQFMAMBAf8wDgYD
VR0PAQH/BAQDAgEGMB0GA1UdDgQWBBSRMI58BxcMp/EJKGU2GmccaHb0WTANBgkq
hkiG9w0BAQ0FAAOCAQEACDXWlJGjzKadNMPcFlZInZC+Hl7RLrcBDR25jMCXg9yL
IwGVEcNp2fH4+YHTRTGLH81aPADMdUGHgpfcfqwjesavt/m00T0S0LjJ0RVm93fE
heSNUHUigVR9njTVw2EBz7e2p+v3t0sMnunvm6PIDgHxx0W6mJzMX7lG74bJfo+v
dx+jI/aXt+iih5pi7/2Yu9eTDVu+S52wsnF89BEJeV0r+EmGDxUv47D+5KuQpKM9
U/isXpwC6K/36T8RhhD0QXDq0Mt91TZ4dJTT0m3cmo80zzcxskMDStZH00zCBtBq
uIbwWw50a72o/Iwg9v+W0WkSBCWEadf/uK+cRicxrQ==
-----END CERTIFICATE-----
```

### 3.2. RSA Certification Authority Secret Key

This secret key material is used by the example RSA Certification Authority to issue new certificates.

```
-----BEGIN PRIVATE KEY-----
MIIE+wIBADANBqkqhkiG9w0BAQEFAASCBKggwggSkAgEAAoIBAQC2GGPTEFVNdi0L
siQ79A0Mz2G+LRJlbX2vNo8STibAnyQ9VzFrGJHjUhRX/OmrOP3rDCB2SYfBPVwd
0CdC6z9qfJkcVxDc1hK+VS9vKncL0IPUYlkJwWuMpXa1IeLz+zCuV+gjV83Uvn6w
Tn39MCmymu7nFPzihcu0nbMY0CdMmUbi1Dm8TX9P6itFR3hiIHpSKMbkoxLM1837
WafFx57kBIoIuNjKEyPIuK9wGUAeppc5QAHJg95PPEHNLmMyhBzClmgkyozRSeS
rkxq9XeJKU94lWGaz0zb4karCur/eiMoCk3YNV8L3styvcMG1qUDCAaKx6FZEf7h
E9RN6L3bAgMBAECggEAE3tFhsm7DpgDlro+1Sk1kjbHssR4s0BHb4zrPp6c18P0
6T8gWuBcj1Dz0zykNTzaMaDxAia4vuxVJB1mberkNHZTFqyb8bx3ceSE0CT3aoyq
5fiFpR0L6Ba1vgg8RTvNCAIApHNa4pVk0XD8Wq+h7m1UA0YGbie5U08/P2qWjC0z
+zcheyYXJS/iuu0t2/F0ihEWGcXBmoc8D++n7mKst2jkAHD4w1PN2MgVqnmagpBz
gobFNMczYzPDS+PPTtQZ1XvdGF5Sodc+Fz+jpWun1kqxDHE4UIZzDA/HAAbG0Rbm
aEzAVs0s9ZExeq0tqu2fPB7zF/1JKdRk4UJ0UxS00QKBgQDJwonP5Rwv00sYoCiw
zuFcYTmN/hI3R3viKuxr19CH6+mvuIU85ooIHF6TiouZwhk+6+Vv7rcXdS554DT4
2RbVrX/5i/M0zx8c8IIwoZJIasLz+vx8F4n6hyhV65bXN7AIBojMh2dt8tP2MZ/R
VEfsk4mNm06yKuzYAfjJziCnQKKBgQDnDH9UYUIPkq0PSvViKQFJFCB9BJPFhld2
pIgoziw/JZzM3W3IWU0KKG7UxS0T3xmn3IX6xmWW4vX1/088yb0bZWYP0edb61GM
I9DoI5ignDlGdwy0L2PFuZh5pqqc09DE+cpJW4nNoudqTNmCrjhmXNCGKgGjLD8z
/OkSccvyywKBgDd0ReajRUziEjDxjF2UbzKx8lzJsX4KIs22GIhHqSRCv1cy80Qa
5WN3ULNiyB350HCP69wDFMXym5rJoQjPvh6GIuhYKv4V8ffffkYv5kx5uWiXZVJ
7v2x+m8rMqlyv+pkYWLv8KKytHmdiBzD+oTWx7r4ueLjtaxngzxn93pAoGBAKpR
rR9PnroKHubSE/drUNZFLvnZwPDv6l08T978t0NL372pUT9KjR8eN31DaMpoQ0pc
BqvpSoQjBlT1nDysV2krI0RwMI0zAWc0E9C8RMvJ6+RdU50Q1BSyjlVgaKi5AAHk
PTk8cGYV01BCHG1X8p3XYfw0xQaHxtuVCV8eYgCvAoGBAIZeiVhc0YTJ0jUadz+0
vS0zA1arg5k2YPCGF7z+ijM5rbMk7jrYixD6WMjT0kVLHdsVxMBpbA7GhL7TKy5
cepBH1PVwxEI18dqN+UoeJeBpnHo/cjJ0iCR9/aMJzI+qiUo30MDR+UH99NIddKN
i75GRVLAeW0Izgt09EMEiD9joDsw0QYKKwYBBAGSCBIIATERMCKGCWCGSAFlAwQC
AgQcpcG3hHYU7WYaawUiNRQotLfnYzMotmTAt1i6Q==
-----END PRIVATE KEY-----
```

This secret key was generated using provable prime generation found in [\[FIPS186-4\]](#) using the seed `a5c1b7847614ed661a6b0522351428b4b7f09d8ccca2d99302dd62e9`. This seed is the first 224 bits of the SHA-256 ([\[SHA\]](#)) digest of the string `draft-lamps-sample-certs-keygen.ca.rsa.seed`.

### 3.3. RSA Certification Authority Cross-Signed Certificate

If an email client only trusts the Ed25519 Certification Authority Root Certificate found in [Section 6.1](#), they can use this intermediate CA certificate to verify any end-entity certificate issued by the example RSA Certification Authority.



```
-----BEGIN CERTIFICATE-----
MIIC5zCCApmgAwIBAgITcTQnnf8DUsvAdvkX7mUemYos7DAFBgMrZXAwWTENMA5G
A1UEChMESUVURjERMA8GA1UECzMITEFNUFMgV0cxNTAzBgNVBAMTLFNhbXBsZSBM
QU1QUyBFZDI1NTE5IENlcnRpZm1jYXRpb24gQXV0aG9yaXR5MCAXDTIwMTIxNTIx
MzU0NFoYDzIwNTIwOTI3MDY1NDE4WjBVMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQL
EwhMQU1QUyBXRzExMC8GA1UEAxMoU2FtcGx1IEExBTVBtIFJTSBDZXXJ0aWZpY2F0
aW9uIEF1dGhvcml0eTCCASIwDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBALYY
Y9MQVU12LQuyJDv0DQzPYb4tEmVtfa82jxJ0JsCfJD1XMW5YkeNSFFf86as4/esM
IHZJh8E9XB3QJ0LrP2p8mRxXENzWEr5VL28qdwvQg9RiWQnBa4yldrUh6XP7MK5X
6CNXzdS+frB0ff0wKbKa7ucU/OKFy46dsxg4J0yZRuLU0bxNf0/qK0VHeGIge1Io
xuSheUzXzftZoV/HnuQEigi42MoTI8i4r3AZQB6mlz1AAcmD3k88Qc0eWYzKEHMK
WaCTKjNFJ5KuTGr1d4kpT3iVYZpnTNviRqsK6v96IygKTdg1Xwvey3K9wwbWpQMI
BorHoVkr/uET1E3ovdsCAwEAAN8MHowDwYDVR0TAQH/BAUwAwEB/zAXBgNVHSAE
EDA0MAwGCmCGSAFlAwIBMAIwDgYDVR0PAQH/BAQDAgEGMB0GA1UdDgQWBBSRMI58
BxcMp/EJKGU2GmccaHb0WTAfBgNVHSMEGDAWgBRropV9uhSb5C0E0Qek0YLkLmuM
tTAFBgMrZXADQQBnQ+0eFP/BBKz8bVELVEPw9WFXwIGnyH7rrmLQJSE5GJmm7cYX
FFJBGyc3NWz1xxyfJLsh0yYh04dxdM8R5hcD
-----END CERTIFICATE-----
```

## 4. Alice's Sample Certificates

Alice has the following information:

Name: Alice Lovelace

Email Address: `alice@smime.example`

### 4.1. Alice's Signature Verification End-Entity Certificate

This certificate is used for verification of signatures made by Alice.

```
-----BEGIN CERTIFICATE-----
MIIDzzCCAregAwIBAgITN0EFee11f0Kpolw69Phqzpp1zANBggkqhkiG9w0BAQ0F
ADBVMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEwhMQU1QUyBXRzExMC8GA1UEAxMo
U2FtcGx1IEExBTvBTIFJTQSBdZXJ0aWZpY2F0aW9uIEF1dGhvcml0eTAwFw00TEEx
MjAwNjU0MThaGA8yMDUyMDkyNzA2NTQxOFowOzENMAsGA1UEChMESAUVURjERMA8G
A1UECxMITEFNUFMgV0cxZmFzAVBgNVBAMTDkFsaWNlIEExvdmVsYWNlMIIBIjANBgkq
hkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAtPSJ6Fg4Fj5Nmn9PkrYo0jTkfCv4TfA/
pd0/KLpZbJOAER0sI7Aja07B1GuMUFJeSTulamNfCwDcDkY63PQWl+DILs7GxVwX
urhYdZlaV5hcUqVackPvedDBc/3rz4D/esFfs+E7QMFtmd+K04s+A8TCN012DRVB
DpbP4JFD9hsc8prDtpGmFk7rd0q8gqnhxBW2RZAeLqzJOMayCQtws1q7ktnBR2w
ZX5ICjecF1YJFhX4jrnHwp/iELGqqaNXd3/Y0pG7QFecN7836IPPdfTMSiPR+peC
rhJZwLSebwXlJe3VMvbvQjoBMpEYlaJBUIKk01zQ1Pq90njlsJL0wIDAQABo4Gv
MIGsMAwGA1UdEwEB/wQCMAAwFwYDVR0gBBAwDjAMBgpghkgBZQMCAATABM4GA1Ud
EQQXMBWBE2FsaWNlQHNtaW1lLmV4YW1wbGUwEwYDVR0lBAwwCgYIKwYBBQUHAWQw
DgYDVR0PAQH/BAQDAgBAMB0GA1UdDgQWBBS79syyLR0GEhyXrilqkBDTIGZmczAf
BgNVHSMEGDAWgBSRMI58BxcMp/EJKGU2GmccaHb0WTANBgkqhkiG9w0BAQ0FAAOC
AQEAc4miNqf0qaBpI3f+CpJDhxtuZ2P9HjQEQ+v6BdP7GKJ19naIs3BjJ0d64roA
KHAp+c284VvyVXWJ99FMX8q2ZUQMxH+xh6oAfzcozmnd6XaVWHg4eHIjSo27PmhK
E1oAJKKhDbdbEcZXL2+x1V+duGymWtaD01DZZukKYr7agyHahixRn/C9cy31wbqN
sy9x0fjPQg6+DqatiQpMz9Eiae6aCHHBh0iPU7IPkazgPYgkLD59fk4PGHnYxs1F
hd06zZk9E8zwlclALgZa/iSbczsqckN3qGehD2s16jMhwFXLJtBiN+uCDgNG/D0
qyTbY4fgKieUHx/tHuzUssZxJg==
-----END CERTIFICATE-----
```

## 4.2. Alice's Signing Private Key Material

This private key material is used by Alice to create signatures.

```
-----BEGIN PRIVATE KEY-----
MIIE+gIBADANBgkqhkiG9w0BAQEFAASCBCkwggSjAgEAAoIBAQC09InoWDgWPK2a
f0+StijSNOR8K/hN8D+l078oullsk4ASvSwjsCNo7sHUa4xQU15J06VqY18LANw0
Rjrc9BaX4MguzsbFXBe6uFh1mVpXmFxSpUByQ+950MFz/evPgP96wV+z4TtAwW2Z
34rTiz4DxMI07XYNFUE0ls/gkUP2Gxzys02kaYWTut3SryCqeHEFbZFkB4urMk4
xrIJC3CzWruS2Q0FHbBlfkgKN5wXVgkWFfi0ucfCn+IQsaqpo1d3f9jSkbtAV5w3
vzfog8919MxKI9H614KuElnAtJ7BtZcsl7dUy9u9C0gEykRiVokFQgqQ7XNDU+r3
Se0Wwks7AgMBAAECggEAFKD2DG9A1u77q3u3p2WDH3zueTtiqgaT8u8X0+jh0I/+
HzoX9eo8DIJ/b/G3brwHyfh17JFvLH1zbgsn5bghJTz3r+JcZZ513srqMV8t8zjI
JEH0KC3szH8gYVKWrIgbaQ0t1H9Ti8J2oKk2aymqBFr3ZXpBUCTWpEz2s3FMBUUI
qCEsAJqsdEch+kt43X5kvAom7LC1DHiE6RKfhMEub/LGNHSwY4dmzhaG6p95FJ1h
s8HoURI2ReVpsTadaKd3KoYNc1lcfmwdZs/hFs7xmmwXKMmlonh1mzHqD1/BqeJ
Hc8MP4ueDdyVgIe/uVtLQ9NcRQbuokkDyDYMYV6hzQKBgQD75ahYGFZznRKtSE3
w/2rUqTYIwxx2PQz5G58PcsTZM89Hj4aZ0oLmudHbrTQHluRNcHoXEI62rs0cVPs
D7IILZ0Lfs+SSTeNEXxD57mjyyufpV650cNc1mSJAmMX2jWQ8ndn0uWPcc5J6fNvT
au0a7ZB0aeKHnA8XXL3GYiLM9QKBgQC35xKi7f2JmGtsYY21tfRuDum6EjhmW6b7
GWnI9IXF8TGj15s7oDEYvqSPTJdB6PAB/tZwdbj9mB4qj176x1kB/N7G097408UP
/PdHkU7duyf5nRq1mrI+yGFHVSGD313rc+akYdKcC207e6IRMST1ZFoznC6qNgpi
nNTuDz4ZbwKBgA5Dd9/dKKm77gvY690bjn6oBFuUs05VaaaSlcsFOL2VZMLCNqQJ
+NLFZ7k8xJJQVcEIOT2uE7X/csBKdoUUcnL5nnsqVZQPQwI5G937KQgugy1MZLte
WmFXlX/w5qzKXtWr3ox9JPFzveSfs1bqZBi1QQmfp0skhBo/jyNvpYUNAOGAMNkw
GhcdQW87GY7QFXQ/ePw0mV49lgrCT/BwKPKDK1815ZgvfL/ddEzWQgH/XraoyHT2T
uEuM18+QM73hfLt26RBCHGXK1CUMMZL+fAQc7sjH1YXlkleFASg4rrpqrKqoR+KB
YSiayNhAK4yrf+WN66C8VPknbA7us0L1TEbA0AECgYEAtwRiiQwk3BlqENFypyc8
0Q1pxp3U7ciHi8mni0kNcTqe57Y/2o8nY9ISnt1GffMs79YQfRXTRdEm2St6oChI
9Cv5j74LHZXkgEVff02Nq/uwSzTZkePk+HoPJJo4WtAdokZgRAYyH10gEae8R189e
yBX7dut0NALjRZFTrg18Cueg0zA5BgorBgEEAZIIEggBMSsWkQYJYIZIAWUDBAIC
BBySyJ1DMNPY4x1P3pudD+bp/BQhQd1lpF5bQ28F
-----END PRIVATE KEY-----
```

This secret key was generated using provable prime generation found in [FIPS186-4] using the seed 92c89d4330d3d8e31d4fde9b9d0fe6e9fc142141dd65a45e5b436f05. This seed is the first 224 bits of the SHA-256 ([SHA]) digest of the string draft-lamps-sample-certs-keygen.alice.sign.seed.

### 4.3. Alice's Encryption End-Entity Certificate

This certificate is used to encrypt messages to Alice.

```
-----BEGIN CERTIFICATE-----
MIIDzZCCAgAwIBAgITDy01vRE5l0rOQlSHoe49NAaKtDANBgkqhkiG9w0BAQ0F
ADBVMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLewhMQU1QUyBXRzExMC8GA1UEAxMo
U2FtcGx1IEExBTVBtIFJTSBDZlXJ0aWZpY2F0aW9uIEF1dGhvcml0eTAuFw00TEEx
MjAwNjU0MThaGA8yMDUyMDkyNzA2NTQxOFowOzENMAAsGA1UEChMESAUVURjERMA8G
A1UECxMITEFNUFMgV0cxZmVzAVBGNVBAmtDkFsaWNlIEExvdmVsYWNlMIIBIjANBgkq
hkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAmPUp+ovBou0P6AFQJ+Rpwp0DxxzY60n1
lJ53pTeNSiJlWkwtw/cxQq0t4uD2vWYB8g0UH/CVt2Zp1c+auzPKJ2Zu5mY6kHm+
hVB+IthjLeI7Htg6rNeuXq50/TuTSxX5R1I1EXGt8p6hAQVeA5oZ2afHg4b97enV
8gozR0/Nkug4AkXmbk7THNc8vvjMUJanZ/VmS4TgDqXjWShplcI3lcvvBZMswt41
/0HJvmsWsqpS6oQcAx3Weag0yCNj1V9V9yu/3DjcYbwW2lJf5NbMHbM1LY4X5chWf
NEbkN6hQury/zxnlsukgn+fHbqvDhJLAgFpW/jA/EB/WI+whUpqtQIDAQABo4Gv
MIGsMAwGA1UdEwEB/wQCMAAwFwYDVR0gBBAwDjAMBgpghkgBZQMCAATABMB4GA1Ud
EQQXMBWBE2FsaWNlQHNtaW1lLmV4YW1wbGUwEwYDVR0lBAwwCgYIKwYBBQUHAwQw
DgYDVR0PAQH/BAQDAgUGMB0GA1UdDgQWBBSiU0HVrdyAKRV8ASPw546vzfn3DzAf
BgNVHSMEGDAWgBSRMI58BxcMp/EJKGU2GmccaHb0WTANBgkqhkiG9w0BAQ0FAAOC
AQEAgU14oJyxMpwWpAyl0vK6NEbM1gD5H14EC4Muxq1u0q2XgX0SBHI6DFX/4LD
sfx7fSIus8gWVY3WqMeu0A7IizkBD+GDEu8uKveERRXZncxGwy2MfbH1Ib3U8QzT
jqB8+dz2AwYeMx0DWq9opwtA/lT0kRg8uuivZfg/m5fFo/QshlHNaatDVEXsU4Ps
98Hm/3gznbvhdjFbZbi4oZ3tAadRlE5K9JiQaJYOnUmGpfb8PPwDR6chMZeeGSA
W++OIKqHrg/WEh4yiuPfqmAvX2hZkPpivNJYdTPUXTS07K459CyqbqG+sN0o2kc1
nTXl85RHNRVKQK+L0YWY1Q+hWA==
-----END CERTIFICATE-----
```

#### 4.4. Alice's Decryption Private Key Material

This private key material is used by Alice to decrypt messages.

```
-----BEGIN PRIVATE KEY-----
MIIE+gIBADANBgkqhkiG9w0BAQEFAASCBCwggSjAgEAAoIBAQCalsn6i8Gi44/o
AVAn5Gnck4PHHNjrSfWUnnelN41KImVaTC3D9zFCrS3i4Pa9ZgHyA5Qf8JW3ZmnV
z5q7M8onZm7mZjqQeb6FUH4i2GMt4jse2Dqs165ernT905NLfFlHUjURca3ynqEB
BV4DmhnZp8eDhv3t6dXyCjNHT82S6DgCRZuTtMc1zy++MxQLqdn9WZLh0A0peNZ
KGmVwjeVy+8FkyzC3jX/Qcm+ZLCq1LqhbWdHdZ5qDTII2PVX1X3K7/cONxhvBbaU
l/k1swdszUtjhflyFZ80RuQ3qFC6vL/PGeWy6SCf58duq/AOEksCAW1b+MD8QH9Y
j7CFsmq1AgMBAAECggEADgxoWEDDRE5yEZ+s7TMw+WH2o+3X00rryqnsLb0yv34I
wAAUWK7qZyjd9rSD0AtB0gFhQNXyHwZ1T+0iHsLCIfqJMZ8wy1iFHBCIphoMSWs5
/D+idXrUef5Y23rClBxXH0g1UnSGXnpUH4ehV6p1lvZMh40JKEoMC4cpyd1SzXrw
+VGCc1+pXv/tTW3Rb2qoW09JoWY+Epccsrw5N80FIF0Dh4QfbLN6pVTt28aQ4pf/
1KhLoapjFzXSYp/jrcNjYJ9qRdSAbZsK0J2yZ0yqjLHDCDipFty+W0pkUZcJhsgu
Cg1Stt7tKgSvAV/nEjN8e/vA91/AACKBCNcLzEoLgQKBgQC4eTM6BDCzLusXJBK4
SRC/WwUthJZzf0k2Gmwr0DCTRYhWQSDjBfiQNboazH0bVPz45qP10f0t2iPEHeX+
VWAXTNRn69M9lEzxygA3s76lAejBR3FbLWkzLYqPB3oZwSIE7CrWHTXJipFWZv+X
FG1R418fnRCUMJ4j85qem5iyqQKBgQDWhQMJu7FC02fr83qsIdLwqhiDtTpwUN3j
qfp7JoEZ0xbm3TgM1xPAkrQTUgfr2ZhXGtUwsuKHyifxQEycrTkB0g0ggAfG0fnv
ybyXK6/guctHJQiy64lL39kPuvQkKB+Y060B/oF6zbyFvqanoKXjpsp0bN3i3yBU
X5/E0u/LLQKBgQCUVhWwEAgSg+pgBx9jG0nPK4h0CkznRJ7qyuo37Tv+E317lFf
vYFv1Ysd4CJmmiUCkZTvk3FkL7HrFo/HwSeQFQEt7aDkN8jX9bPPFv8K+UoNgkGp
LA8YVFrDQSPyadfnVYvsuXhzJLZSYGjP0GHgI5JufYLDZ4UDK/T97ekQYQKBgDDM
ORCxxvXTyGiW2USVU3EkaqFDtnMmH27G6LNxuudc/dco2cFWbZ0bbGFN8yYiBCwJl
fDGDv7wb5FIgykypqtn4lpvjHUHA6hX90gShT3TTTsZ0SjJJGgZEeV/2qyq+ZdF/
Ya+ecV26BzR1Vfuzs4jBnCuS4DaHgxcuWW2N6pZRAoGAWTovk3xdtE0TZvDerxUY
l8hX+vwJGy7uZjegi4cFecSk0R4iekVxrEvEGhpNdEB2GqdLgp6Q6GPdalCG2wc4
7poj/0inc4RtRRf3nZHaTy00bnSe/0y+t00UbkRmTxhnViVhCc0t6BUcsHupbu2
Adub72Klk+gvASDduatGjqg0zA5BgorBgEEAZIIEggBMSswKQYJYIZIAWUDBAIC
BBwc90hJ90RfRmxCciUfX5a3f6Bpiz6Ys/Hugge/
-----END PRIVATE KEY-----
```

This secret key was generated using provable prime generation found in [\[FIPS186-4\]](#) using the seed `1cf74849f7445f466c4272251f5f96b77fa0698b3e98b3f1ee8207bf`. This seed is the first 224 bits of the SHA-256 ([\[SHA\]](#)) digest of the string `draft-lamps-sample-certs-keygen.alice.encrypt.seed`.

#### 4.5. PKCS #12 Object for Alice

This PKCS #12 ([\[RFC7292\]](#)) object contains the same information as presented in Sections [3.3](#), [4.1](#), [4.2](#), [4.3](#), and [4.4](#).

It is locked with the simple five-letter password `alice`.

-----BEGIN PKCS12-----

MIIX+AIBAZCCF8AGCSqGSIB3DQEHAaCCF7EEghetMIIXqTCCBI8GCSqGSIB3DQEH  
BqCCBIAwggR8AgEAMIIEdQYJKoZIhvcNAQcBMBwGCiqGSIB3DQEMAQMwDgQIWIQKs  
PyUaB9YCAhTCGIIESCsrTOUty394FyrjkeCBSV1dw7I3o9oZN7N6Ux2KyIamsWiJ  
77t7RL1/VsXSBLjVV8Sn5+/o3mFjr5NkyQbWuky33ySVy3HZUdZc2RTooyFEdRi8  
x82dzEaVmab7pW4zpoG/IVR60TizcWJ0ooGoE00Rim6y2G+iRZ3ePBUq0+8eSNYW  
+jIWov9abdFqj9j1bQKj/Hrdje2TCd16a9sS1TFYvIxBWUdPLZDwvCQqwiCwmXeI  
6T9EpZldksDjr5N+zFhSLoRwABGRU8jXSU9AEsem9DFxoqZq8VsQcegQFY6aJcZ0  
Xe17IECIAgK8nZlKCTzyNVALxeFw0ijWnW41tDaqcC6GepmuINiqqdD94YA0HxRL  
1lKU4mLknSJ36W4T7vaI4fp98sK0nGpaDzQheu6BbQ+dVd44q52MDwvqvD0Y7UjF  
IVEP3V9EbfN641CR0mIcVCUynxb3aaKjhgBKTGbYsKtPue974rDPIArMs2Heo8y3  
cq+f7Jce0IVCglRatN6rSyJBF8JlBQW5pZGco8AwTM1pK3RrdIDziheA8DIBB+KT  
4JZB06UprlcZ5wBY6ncXWa5E4feb57Cd3bB+zJuubBX9f4yG/J0cSF59w92c/6Qb  
i4EFk6tAiz19PxuLLWjco71e69Jiav19Ph/WJpf/XCEurw7K+VAeZALFW41G/D30  
WIBRC2shisHB3j8+3fNPcvi4Fy3EkZNW41rZFAjBbtloCcx5rcfRS7vxucAvC5X9  
4bm0xEcd0ysnuplH77u+CWWxjCk414S1KZTUbcw1a0B6yRDvojUMZkdZmqsxyYjn  
JG5QhMFQrTyALwCgJsP/rAf5xPhG2p+9Qul0yiBIIzWvKNKRQKL+YLCvYvTh1bhj  
rUflYzzvviyXCY9LcX2GBop9yBFJzIcmKfL0MGua6WIKWX2BIjhGTtu6VThmRHuf  
0sqNg/ZrNCTYa7e1D6gWP5uFRecSZdAsf+0XTe6M7e/vaN4Go4A3H8+d53SYQP6n  
pTt/a0DTHzY77aNMh+mzkIHC1W3zUdlS48tUyJMiAN3Tt+RfhHZfgloJ7IdcYdM2  
01U+UD/5L9ghxN8dh13Fi3rDyn6Y5xB1xFuZ0mLjoEI+3Pr1+B9Kgf+o/hxFttfx  
1uP1XcHt0a4gBr6g7fWGNssfw5S6g6hS9UDTAY0pVLaatil2TZmeYZzj19ssv36  
kr1VaRV9xcQCbY05ucD+buymFXPn/rhVdxhgIydmv0tdzDozy0WFDtvgjUBNeRnC  
eMVD6AlWdW0lmBq0cILJS0aY2FWm8Kju62XZA8YIRowlLysuq3zIqDmzmqJFKwuA  
mRMZmUVhophMEN86rwob3Z87gNbyy1U/dXi+s6Vybx/kiwDXjfyhWBnhn1gkghiv  
oOhGtt+yAliCVuHQLEloQeQN04C5QTU0d1W0j489Ft6wvpm0tqcL6NpnRYUhbCoF  
XhFr4wswggR3BqkqkhiG9w0BBwagggRoMIIEZAIADCCBF0GCSqGSIB3DQEHAATAc  
BgoqkhiG9w0BDAEDMA4ECPoEFEHQGB9dAgIU5oCCBDA0rGHYn47xktt1J1VvWQZN  
BYIMFzLn6p2/zKotGf7EMdgSdwlxkhKTWxunfoP/gfRD6boXTAA7ukJDsHXZrfXF  
KjI4HI2oa/NihwqctphcLonBJXcofuv+loP9MPLtwu3Mo1wsWTiHpf5XmxMoZQw  
fbrp2ohLugJ01ZRB9RfAUpaAhtFg91pL0tXEpz7GULEy0nYh9R8iu9bSel8bp14S  
+AoxzXD4gYiEU6Yi0/47aRstd3H4u3ERDnUKSoqVstslRSKk/WrGYUwoy7kNDwy  
DBitfosMY0rpWEe5rXTBwJkBodcl3LbPDbNzdbRZw+e+y0bJ9zfrlMpl0xVfoiji  
q9UbrdgN2yo0RKwF6c63V2RdF5tjQHnNIM3K3tC9zEis11jgn9Le0LB9Cd1qyE4P  
WfmHN0gwgDF1eX96TmUipmYM63H6jcbnSc6p7eIZtCrqGjhsTqFwcMg04WaxWeHD  
ffLXSZdzIUB+zfc8tftUUE0UX3tX411oU7K8uAuQTSK/AXwUj+MbQVhlz8te4FVr  
w4ulZ184IYqhD3VdIOxXiZkFskChRz8/7QacrXFvfkrcrxS2iHMoxhoJ7WETnTI  
slW5R5runj61r50VT4HCFNFQfGBbTtV9AdP7yka9aQDwXPCoXFgeb1Q01F/BigzW  
02Jp5Lcrrw7ia0y88QbTzWhi57d4he50Ip0wHUiGPh7s792mlltvuSprKJk0XWv6h  
qAj5AsBB8JNvgXP71Ytx2vMdjw6gqzCcxASJ4UHqg0CxmioDLUP+FHAY1CPNSjBR  
pHrTi1Ufi/+9hYneQci++qPvkCqMuGHVxamd40LanGJN1NxE1DyMeduapX5rXuPn  
g66LPey9GQuE3SBNC2dmju0y7d8fWXEzqhqltPfsuwVzdnWb1uAcjRfQPNo+uWe4  
zihYisXK3lqA557dRqdSv+6GL6/OZQOCTaYMyZIWD9jS2gU6T3q2j8uk1LNC19n8  
aSpQ5xWspBXpzXo39fG6CMeqzZ1FCqrVQwYhdXbtxn90x/pimmW0lcqAxv+xythW  
BMx+i11JEdbCj015wjmsCWNPWlM4AVSholpZhs9Mq6rvqBXi1HJgjD0DpSLCE0xh  
/GNoXo0X3LrxfCIDEhT8LyZ2NE59yh3t6pm88soFzaAghdjb1Fkc79nBbc14NLKq  
SmL/7GktkxEzn0iSYfnfJ905kjZC08d8RnoGfrDDUWD2ZiHbbx0Cq4E3E0Zt13aH  
JOXRBOZLC9L2JNeSniBZZGykh+Pi4TsIZXL2UPQ+dy4DDaEf8yamyY04dlhFsnhD  
qr94Y9E30/rpF0yUb2gCehEgT9nppVuMeridsCkHqemmgVr/52Xv/XK9dx4+YBjL  
4/3Id0/yVJURqDIHH8o4ogF4rflkz0alrZ9nJFugP0UM8oNysal9yr7/Dli1juV0  
MIIDZwYJKoZIhvcNAQcGoIIDWCCA1QCAQAwggNNBqkqkhiG9w0BBwEwHAYKKoZI  
hvcNAQwBAZA0BAidIqBxZFwvagICFCKAggMgTzrUv4/12Jqnv3AL+P6990uX1ybZ  
NcTWC+hMRV0Ho0FuAAybzdsRBAaZch1+8GheU8yz7IYWmLn1PNHxLZ8inIYfmTfk  
Pa34Rk8s/RxJIE8LMYL1qjk/FMq/Fpgc0S65S6bXvJ69Hb8gtAoGW8P1b0dd9bvG  
NbAk00h5r+IWiH4U8zGpcqWDWRgieGICsY00Hvx4KKMv6FIjFVCTZevORVoyzmSX  
ZZgxqrbjw4CZqOWReHPI3aEt5xVX3BihRGi4EiYia6yU10V0ZTGBKqWUeKm0A5Gw  
SX3mH/kLiya3gwwGvdq1ncXcl7V1STN1HFyp4ebGKg4CsZ6NkWjocwq2PwM/Tqoz

5i02tqvOeR8lX7LrSegxGH81Kw3nMV4dH5txoVt9hddZCKKGcJ5Z8F1zxFP4BFuF  
7h0mRpUPdxiahJ/GkXDVIaw6BJKd4Q9e6sjJYxTeq4u0P6V4PMuDU7F98X/d9sEx  
2X3b1cJxuA7xt0nKAPsWEyWBg98B+CKG6Kw05s8TlZVmlk15FCUjvFoKCiWIKF4N  
vGLiW0IP/jJ9N6Gqp4gNbm51zNFGZ7gZAtvsBSGQSOUpgfZcx2mRxpBmcX8tm5YJ  
hmY9EDK13umUUGKrP0rG8c7/MVAQegSKqQuXSfMK6KknXGe7jwjs7xaQaRm9fFHS  
0KbGU3MsLxRGjW/jzjUNAewDiSYPCVo8E/kd8LETvjAowF772y9o0X1ZzcP7Hwcl  
oYc0/WSSh4e+FAbgqLo/8KIkgZJ23BAcdx8XAtxzUZhRdHaItnwaJsFtr4TCwq8C  
XxJG5u44/z6imqRv0aXQfvk6sSNGdG62TkacYg2K63D9hcg+TbZPPVSStWxyj8S  
N84anzT0xb1yx6aw6IL+uBLC4jISgNFijaF5pwjLSbgTs5Z7skZdCam80xYmdJV0  
ES/uqFCQFUSamXXNbotviQk8jWuJFz+BXzPYJN3t+3mp6SmgTZ2zP8FUQEE4GbSH  
DqYV621DcWRo/mao8xzX/mvkKm4ddGBldiusoHZaL4gdo2A1qThSMnMBsciC+jEj  
Dq0r70XhHccTDW8wggWUBgkqhkiG9w0BBWgggWFBIIIFgTCCBX0wggV5Bgsqhkig  
9w0BDAoBAqCCBSYwggUiMBwGCiqGSIb3DQEMAQMWdGQIehcRLmVUAPMCAhQ0BIIF  
AHb5dXZKzCeRUo2ZSj0yufS3zQ5HhKyfapsyCqbYCKv/lSzNYWvuda7xfau0M7  
/wCB9sWdz0MTpaBMHwx9hvibZiY65oM+ry4tTuKkQ0Jl370snjB0dSNTKszsI3fa  
PUjslxqIH3aC1shD70qhIRGZzRjK44PJyWv626oQrgVtTYR9NYTdee+SbBZbkEt/  
EpWipwftWXR6tSYJQn99e09Vih8HyQvWipidUhp3pCF0low4VZyAqIWOHcw9TAjB  
XNv+qfdH7fiX9wM5/GvnQReIsqjXUoc6pSQIAqD/f+I/d1F2ZmqM7KwX0LGRER9  
OWZGyF734pN9GLbNetWm6rKxmlSI/5m6+2Jxxfann16P+vBSEgWJ/I8GnJAdzIbB  
Tyfjog4Gi2+lmrPzK7+C79ntM9nfsr4xvzy/BknwZiaJksd4Vv0GkS9nfm6shtBJ  
B9uR+GJfthtsvIVUHN0kz2r/lvZMSRb0g9yR53hv1H/nXCmUjWz/BvobmoaVBcCm  
m0nnYZTHMnARIVYdLQFif5ZLH7WV/XVEVioRntNRiKsK96VAHm5XboWQGCqL0heh  
IX3Nily1genGm1aFlSQNMvLDko1ILDTRkInVpmjG/WFoLntpJFPtYZsooT1jjXLw  
3VTSodtgKQNDpY0EidSjwqIS87fzrCB2Wmwys0iGfdsuNhsaqNqa0dM06FiW2fku  
x7H+w7SX1/n9YeZUNL0cewLcC7E8IA1IarjglZE1L6Yb2ldXxV9q3PP0wKuGnah0  
TKnd6mLn5BIG0GTzF1VspXRrJhFrcLe+xsJR1r6niI3bcMWXXy7gbm1X/CRE902I  
ynx1oDR+xZ6rjPwDJP7kVf4GvA8trCGrot4pbJbmwlBeMIylScdQoHEnyqren0n  
RMmXZaKzL3njtq7Wk78qoJq0a6Vh/sde0Kc0PFkyTZdMB1Tztm0K2VJU3jUVzPLM  
0WY2fyGDoA89ol+/MiNsgiaEghGybXBYip0ex+p7j1GIRN/CKmpWsqjZnB78kyXm  
Z6AE1vC6ned/7zANInDkzXiun6ic72LoBX3JGiCSuM6hIPJ0AcDwlzTDu0H2rCQN  
w+ativJ2v4KbgeKoc6beQb5fZhs7VsWHikIcpwqB5ngwt34wHgFG0nTS41ZmvzSJ7  
FMRVmsDYkdTzZgN0axiUBQMcEvxNIE3nAmA+dvB7w6XRQVSUsL+vBFhHiWVGZ7h  
k5sCeHElewXK0SyJADgfflYq3EfeGz13h4wtoSfbBVtzbbyg2LNegUCLfIJKc7fm  
T7X7JSxbj0gndMHEeMdVb+NFxbgsXYrYD8rC2A8l5cQzZrsxb1bvgybEJz+NU/52  
UgGrPmdjJKuGBK/V2zor6qPvKyId1Gb4QQuIoyClwhZ+qk9nE4Eft84y7ISgMywH  
+lw87HrSHKfpqzQhCxlRlu53IYK/4PhE7BYC9Q4tvIsZXSGZ+nju4tyzERSlaNe5  
njUeIENr4B/+kXULwVDcvMFHqUFJmKfai8FUga7gyipZ+654clGgJjnNB01va8Jc  
dtdPRRW4gwdrVn8u8J78KBzt6ChkrpKRV8VeWKBk9lhcT0ZNPJnNqhDrkfzHBqP0  
Uo133I7P7C+h9sNDI153W6IOIodyQE0Av1WxHo4y/1d1VeGDaB7h0SDq9ZMpm9n1  
En7F6/1/s4IUZHja/qRrK9hD4M0Xq0LhFXuUzuiPo490MUawGQYJKoZihvcNAQkU  
MQweCgBhAGwAaQBjAGUwIwYJKoZihvcNAQkVMRYEFKJTQdVEPIApFXwBI/Dnjq/N  
83cPMIIFlAYJKoZihvcNAQcBoIIFhQSCBYEwggV9MIIFeQYLKoZihvcNAQwKAQKq  
ggUmMIIFIjAcBgoqhkiG9w0BDAEDMA4ECKq4DtyiaY0yAgIUpQSCBQAKQtkPOS4s  
LE60s7nP4RaJWBuyXl27V/o6TusBRBgQoPzP+aC+099wgisEKedyB47bAzc04sba  
4q8UkERAsYHcEhdD2hGRCL7ou9jTtrr4RgZpa5V9CJcB00t4bqy2lUef0pm6no+R  
X840uyM4q5Q+cfH1rTQ1a/a+gLglbptoEkH/4dfR3ELYiXcM5UrBYTJ0HcyME8c+  
TXbpf7kiplTtIsrlZyU5zrWcxngrBxwFA+085W/uVR3QZSW+EGx/VCYwGruZlNyt  
BvBYjsYsnC+yKYXbqL81Dg0ePy+eh6VX64SwBLXcWcY+NK2EZrhzrUFj1+PXFky3  
IVVPJhTE9o7gJA0hZvAan0luWXozD3/WPQaXhyIJDwM2mjznjL2MBydpy9K8Cio7  
XaV6PX8DszIZkfi4DAz5f7G7WbwUq3IjPPPwiUv+JsR+dnqzWDJ22Sxc+AdQP2sK  
qMvP8g0pH0sVlXXE76c5rUcZCZD+gGv1av07YttWqbDqLj6oQEIJ8LX0Qvwd0YEh  
etE0bJ5uv2njhQDhLkH/JIbmFSgJZEm8dtKHb8f5wZc2B+nXGB+TFboGzSuP7gaW  
u1vKsJNqT/J/FYEqcamI2F+td7z1sGfbr9ckAcxXeb2uPVbCJ1a50gRlZ9qVm5Hb  
5f53X7aoQqP3F3LDGQmJ+GFQ/oXXwabqn4TvN09KdHxpGcMMU9RnugUfNU9GBec0  
vfrzmVKZdmJ36H0mMnLvgRakRhCV3kGABXY83hwUv17E1qASLKcAWIachCCGpBG  
yGtP2IOZTn7PsLJR1BzKnePa7MgFcgocToIpdQnCTtAsalmbm1s480LN3GB5ojeG  
bQvNf9TAvia0tg5VuT4/048V6uYSJsIZsawm3tGA/LjxyfV1aLddQT5Zf5ZX9BX+  
K/PB4oYAFxtUpMK/aL5G1MvppUJ9CjqAtnoKE+EkdQmyZ1VoD09ih44zuRx6XV4A

```

EYafNB8ygjRHGsvPW0/M0Es0w16wzJHTuf/15fD/nH7Xh5MzhCF0CtvLn8v+S1Po
i2/4006pS2byjUFRbeCpzEpRxdv90LCb9ALdy0yG9u41W3yInKNFnaWBulf0PFCe
ZT92M1BgwJA8ZcydtiunRNAH5iWLSPl0Up0D1v6En+rat+PoyRXIy2fLHBL25aw
LhABoZPgRsCiLsiNiohfyngksrQKeRg0laBMT92J8r1E4sUKirQlc0diWBE6vmBS
XzyN/twvfgPNIXgr0rw6c7VhS+hNTrsttg/xcfvJ/bftDbKm+RZL+yQo0kkAf9R
5tizzyMdMBlaMrpfrBxvNtMiykbZ88SYoA70Trwab2aHQLuVhs80jXGBE0qmSudcS
dV1EhBpo9HBsDZZi0IwOp5/B9fCHdnThCTiUm80eQ6mX2/DB9L1Nh7gH0yLL3azT
m12D0ZpZNaXyxLzdiRiAdwpWZmmeg00G70yi0D5eIxh6cbnBU6Ygdp+pFFVYHfA
vc5Czpn20PhXX2k00kbwawr9AfrFjIfAEmBFx5GBGr/lSiUQSkbUC/s209Yga0g
WTYt3KXPzrThJJGZnnXZRTGfIi6vp8RsnPX35+Dxe/Lp3gXDdIJeWG6XVA8t3fsp
coTqPkm/XGNMm0Z81KX/ReVdP+dC93sov2DuDZbYGPmH1D47b00iA68GD64DEuNt
Q8MhWk8VRR1FqcuwB0T0bc+SIKEINKvYmDFAMBkGCSqGSIB3DQEJFDEMHgoAYQBs
AGkAYwBlMCMGCSqGSIB3DQEJFTEWBBS79syyLR0GEhyXrilqkBDTIGZmczAvMB8w
BwYFKw4DAh0EFO/nnMx9hi1oZ0S+JkJAu+H3/jPzBAj10QCgvaJQwQICKAA=
-----END PKCS12-----

```

## 5. Bob's Sample

Bob has the following information:

Name: Bob Babbage

Email Address: bob@smime.example

### 5.1. Bob's Signature Verification End-Entity Certificate

This certificate is used for verification of signatures made by Bob.

```

-----BEGIN CERTIFICATE-----
MIIDyJCCARkGAWIBAgITaqOkD33fBy/kGaVsmPv8LghbwzANBqkqhkiG9w0BAQ0F
ADBVMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEwhMQU1QUyBXRzExMC8GA1UEAxMo
U2FtcGx1IEExBTBVTIFJTQSBDZSJ0aWZpY2F0aW9uIEF1dGhvcml0eTAGFw0x0TE
MjAwNjU0MThaGA8yMDUyMDkyNzA2NTQxOFowODENMAsGA1UEChMESUVURjERMA8G
A1UECxMITEFNUFMgV0cxFDASBGNVBAAMTC0JvYiBCYWJiYWdlMIIBIjANBqkqhkiG
9w0BAQEFAAOCAQ8AMIIBCgKCAQEAA5nAF0glRof9NjBKke6g+7RLrOgRfwQjch+2z
m0Af67FJRNrEwTuOutlWamUA3p9+wb7XqizVH0QhVesjwgp8Pjpo8Adm8ar84d2t
tey10VdxaCJuNe7SjJfrwShB6NvAm7S8CDG3+Eapk09fzn2pWwaREQ6twWthi1QT
51PduRtiQ1oqsuJk8LBDgUMZlKUsaXfF8GKzJlGuaLR15/3Kfr9+b6VkcDuxTZYL
Zxt6+a3/QkaC3I9m2ygPubtHFJB5P5+s8boROSKm10B1gsLow8eF9S70tcGGeeoZ
JiJUQCR14NaU5bIyfKEZV2YStXwdztoEJJ2fRURIK+8Ynw1B3QIDAQABo4GtMIGq
MAwGA1UdEwEB/wQCMAAFwYDVR0gBBADjAMBgpghkgBZQMCAATABMBwGA1UdEQQV
MBOBEWJvYkZzbWltZS5leGFtcGxlMBMGA1UdJQMMAoGCCsGAQUFBwMEMA4GA1Ud
DwEB/wQEAwIGwDAdBgNVHQ4EFgQUF8WEE9Cn73aQ0Lizbwi8krWeK5QwHwYDVR0j
BBgwFoAUKTCOfAcXDKfxCSHlNhpnHGh29FkwDQYJKoZIhvcNAQENBQADggEBAG7e
QY6Px7WZC5vCbF5hj0itxoz3oyM+LRcSTGwoYXdm1wsNUzy31pE3dtADvevRtsP8
uN7xyfK6XZBzhShA/BtkkqYGiFvXDplu0xWmqC0WPmc1PNK2mHil+pGMfvnUwnxd
6gKcHED5p+bUhDyIH2fy9hGye0Us8nvi+7/HwBipN+nA/PfsPn+aU411K6qDoG/i
kwyuiWcFFlc5yE5rkAe2J0/a4+HtzNmTK4jB/4GbyI6xlUszPlEqKE+Es10Xut/y
UWL5nKkaqRRd07Pq371MpFQs2+zXt4fGheKzZU3XXrIPcAPyJjWiyU1DzpqgSJM
OIp/HtXdfScHb9+Qic8=
-----END CERTIFICATE-----

```



## 5.2. Bob's Signing Private Key Material

This private key material is used by Bob to create signatures.

```
-----BEGIN PRIVATE KEY-----
MIIE+wIBADANBqkqhkiG9w0BAQEFAASCBKgwggSkAgEAAoIBAQDmcAXSCVGH/02M
EqR7qD7tEus6BF/BCNwf7b0bQB/rsU1E2sTB04662VZqZQDen37BvteqLNUc5CFV
6yPCCnw8mmjwB2bxqvzh3a217LU5V3FoIm417tImN+vBKEHo28CbtLwIMbf4RqmQ
71/OfalbBpERDq3Ba0eLVBPNu925G2JDWiQy4mTwsE0BQxmUpSxpd8XwYrMmUa5o
tGXn/cp+v35vpWQIO7FNlgtng3r5rf9CRoLcj2bbKA+5u0cUkHk/n6zxuhE5IqBU
4HWCwujDx4X1Ls61wYZ6ihkmILRAJHXg1pTlsjJ8oRLXZhK1fB302gQknZ9FREgr
7xifCUHdAgMBAAECggEABcQg1fTtieZ+0/aNdU149NK0qx97GLTBjIguQEDDBVFK
2lu4PhBg9AdgAUqLH1PE+eq65JaGZwvFH8X1Ms2AKiRzYsPOQIoJ4n1hc69uiEN9
Ykcv4QH0vvqtCtWYjJyb5By9WPeLH6QynJ6FLBoSqxhURSWyYfTuwqt10HEhsUuH
d3N5BmbFiRBNj4aIA9zz+i5xL0m33kMKai/Ajj3sI0AJsZ5ZVAhYbC8sCt1Xevb6
i41p9S6GSwGC19by+1y9WC1QGtb5GDotvChMvmZS/03NeDc6xC/LZoQcHNvgiZd7
f1g6iEkJLCYK+D7xsd7Y630w75Haj0vnlhiJ0bSA+wKBgQDxv8jP2D6IVRGgYfaC
nUU3Mg70wagX1fgPH09Sk6e9c8Cg0Rh2uWjptawu88xBGFyZ+xnWqr7GCNsltas
3m94ri4A4R94+5uL8+o0LC26gMDfzATd1Q3k/h919YLk89tonQEUBCFZJdphThEb
vg2W+nNsEVcQGUClzhX0AyGMswKBgQD0BYk3sdGQbBA/hYD1EYsZfYebUiYv2lTt
VGRgTohKfclRAW0tGP9YRbKyEVkBLhjgkXzS9xGqKywP71z9Iny+zDGbzk8E1B/g
lS7GFGX50TG0ISfaFWTYdxt4mN9pduZE2b1T/26uyU8DXCEBhF/OqhwQjJqKTYTT
Rl3Ara5fLwKBgQDQyVtjIyD2q8naY2D8c4mo3vHtzyc21tQzcUD8Z4vSYps1hbos
KN/48qJmRv3tjP+o+SXasYKsFE/4pIroLxTVNNkbQm6ektfttp01yPG8340wLk
97HvW0ig/tX6m0Wg1yBsm+q9TKTrvm1pRGlme6BQgSYyy4r504u3VlnYwKBgQC1
B4FvWyDhTVQHwaAfHUg3av/k+T++KSg6gVKJF1Nw1x8ZW5kvnbc3pAlgTnyZFyK
s5n5iwI1VZEtdbKt1kqKCP8tqAV9p9AYWQKrgzxUJs0uUwCzC+X3aWEf87IIPNe
iQKfXiZaQuZ23T2tKvsoZz8nqg9x7U8hG3uYLV26HQBKGC0J/C21yW25NwZ5Fudh
PsQmVH7+YydJaLzHS/c7Pr0gQFRMdejvAku/eYJbKbUv7qsJFIG4i/IG0CfVmu/B
ax5fbfYZtoB/0zxWaLkIEStVWaKrSKRdTrNzTA0reeJKsY4RNp6rvmpgojbmIGA1
Tg8Mup0xQ8F4d28rtUeynHxzoDsw0QYKKwYBBAGSCBIIATERMCKGCWCGSAF1AwQC
AgQc9K+qy7VHPzy0Bqwy4AGI/kFzrhXJm88E0ouPbg==
-----END PRIVATE KEY-----
```

This secret key was generated using provable prime generation found in [FIPS186-4] using the seed f4afaacbb5473f360e06ac32e00188fe4173ae15c99bcf043a8b8f6e. This seed is the first 224 bits of the SHA-256 ([SHA]) digest of the string draft-lamps-sample-certs-keygen.bob.sign.seed.

## 5.3. Bob's Encryption End-Entity Certificate

This certificate is used to encrypt messages to Bob.

```
-----BEGIN CERTIFICATE-----
MIIDYjCCArKgAwIBAgITMHxHQA+GJjocYtLrgy+WwNeG1DANBgkqhkiG9w0BAQ0F
ADBVMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEwhMQU1QUyBXRzExMC8GA1UEAxMo
U2FtcGx1IExBTVBTIFJTQSBZDZXJ0aWZpY2F0aW9uIEF1dGhvcml0eTAqFw0xOTEx
MjAwNjU0MThaGA8yMDUyMDkyNzA2NTQxOFowODENMAsGA1UEChMESAUVURjERMA8G
A1UECxMITEFNUFMgV0cxFDASBgNVBAMTC0JvYiBCYWJiYXN0eWw1dGhvcml0eWw1
9w0BAQEFAAOCAQ8AMIIBCgKCAQEAtHAlBNMiBIk8iJqwHk/yDoFWwj8P9Z1uYdq
1aqIuofvjoAyjdA8TbsBRGdmvaIOSQ0epsNjW1ko71E8H1Ds9JHn1E+tzH3mKfn+
G2erY+alkMJTXPvMAUdCA8+e10J7k91gYXDpzIWRP3Kc0xTlsJ8tGJ6mhydJX3wP
0/HuyHpfKQqfDusPH8S5yidPciWuB7Wj0X4xY1pUAz2rSSAlnGvhEzKFbW43BPjY
XPUrWMTxFya1dj6Eb9M/klbhdZheDLLsjLUSXYU70r9VXGM/qcjd/NhWYphCeB
cqsWam5mXLYdm0mFmqoecF62mUE0DiNdhwKTtnefd0cll+D3FQIDAQABo4GtMIGq
MAwGA1UdEwEB/wQCMAAwFwYDVR0gBBADjAMBgpghkgBZQMCAATABMBwGA1UdEQQV
MBOBEWJvYkZzbWltZS5leGFtcGx1MBMGA1UdJQMMAoGCCsGAQUFBwMEMA4GA1Ud
DwEB/wQEAwIFIDAdBgNVHQ4EFgQUSr0sMVMCSZxN42554CVh1T6IYiUwHwYDVR0j
BBgwFoAUKTC0fAcXDKfxCShlNhpHGH29FkwDQYJKoZIhvcNAQENBQADggEBAC2c
Y8FgaxgB+Dx9gAFj35ae1vgzYiWI3Ax3FSxogo/GzpK//LB4215oeBuKXbm0ixBn
4nojxD7PM1M0i+i1AvVNJNaHY9TtgIqq8V/C0C7vL8SdB01e5ZRI764ohu9ivYv
Ixxvt7gzvSTpe+NUT1i09xNgsC8v19WB/BwkqMAGDqMxqCxt4fyrvVwpxNBke75j
E6Q3xCjfd0WYcfMLK7EsTSgimYuonZjN7v/yqTdjn/iVH+agL/2M1SfiU36w/Yf1
7EM09uKGH/Javh+2Vjd0j8rE/q2Iaac5VI91M6xz5oDZUknycBKKinR+nJWMT5AK
UAaL2Mj13YtrUGBpxxY=
-----END CERTIFICATE-----
```

#### 5.4. Bob's Decryption Private Key Material

This private key material is used by Bob to decrypt messages.

```
-----BEGIN PRIVATE KEY-----
MIIE/AIBADANBqkqhkiG9w0BAQEFAASCBBkwggSlAgEAAoIBAQCq0cCUE0yIEiTy
ImrAeT/IOgVbCPw/1nW5h2rVqoi6h++0gDKN0DxNuwFEZ2a9og5JA56mw2NbWSju
UTweU0z0kefUT63MfeYp+f4bZ6tj5qWQwLnc+8wBR0IDz57U4nuT3WBhcOnMhas/
cpzTF0Wwny0YnqaHJ0lffA/T8e7Ie18pBB806w8fxLnKJ09yJa4HtaPrfjFjWlQD
PatJICWca+ETMoVtbjce+Nhc9SdFYy1cXJrV20roRv0z+SVuF1mF4MsuyMtrJdhT
vSv1VcYz+pyN382FZimEJ4FyqzBozmZcth2bSYWaqh5wXraZQTQOI12HAp02d593
RyWX4PcVAgMBAAECggEAEvPt6aAQjEJzHfiKnqt1U7p4UKb5Ef4yFrE7PdTLkeK2
RjncIhb6MeevVs8g06co7Zn8tuUT95U3c0XLhV0WTVaHYeurTXaknICz3Ie0oS18
skiVZko70uJ8pR6asWUlr/z0j1EwZ7RnEUWet97oM0YeA07LDFDkF7eUq//6bfzT
ewr/QfDDsv+erwJBh+9CRH0JyTuDH1WeGxYV8VK3M6VhdTjFxxFhrQ4pBe5J/UA
17Bd2GM8Urg6VYzVo6x4ajnc1H/ezYLdc459poTffv6Fg2trqFVAj2IrQ1Aeqjda
lemsa6Np801mUGknq3fjKS13RYGBv/48rCH0T8eRgQKBgQDM5TuS4ANQj0Yo0gtF
xoVjbVlnd0o+SmdFkZihzQHxcblY9HXe5H1bLf1IMXz/nERxl+SmYuuJk0EdiM9r
HOCcHRLfBmC7t0GdVvLDHSAX8Ec47LbtKZqyM1U9dn7Z+5q4iywqpaP8pP3+oY57
cgtQax1jle3xhRAj65c11RBmQQKBgQDVBtLqK6wKDFsdZuMZGUt0Y0rtamBDCgEU6
rEqBAyCPy5NpF1pomUFcYKWT/wbReFqtuyq20yiATB0yHHMko46BUtN7qX/m/skt
DHWXVws1+G4IgEMVokM9jjrkgdY5grrJ68sagKC+bgv35BizHPIqgQu06qnPSrM9
bevwbQEj1QKBgQCiPE/zeBSnzyjeaTdLxGkR1R+ZX2WqdNdYqnQkiWmkflaSmt5J
4raEj+GhLC5BZsZ6+z480M6XXFW0wSkbMv5WH1824KHvgKcfoh00iR1EVyjN1gDx
wk0QvjycMhs3FpXn0arjCczS2wGSGPEpUR4JJhpcfaF6kphZsWDWzVLAQKBgQC2
ivbKltNhj4w2q1m7EGC3F5bz15j0I1QTKQXYbspM8zww6KuFR3+1+Wvlt30ncJ9u
dOXFU7gCdBeMotTBA7uBVUxZ0tKQy19bTorNU1wNn1zNnJbETDLi1WH9zCdkrTIC
PtFK67WQ6yMfDwzC1gEy5YjzRjbTe/rukbP5weH1uQKBgQC+WfachEmQ3NcxSjbR
kUxCcida8REewWh4AldU8U0gFcFxF6YwQI8I7ujtnCK2RKTECG9HCyaDXgMwfArV
zf17a9xDJL2LQKrJ9ATeSo34o9zIkpjLJ0NCHHoc0qYdHU+V02ZE4Gu8DKk3siVH
XAaJ/RJSEqAIM0gwfGuH0hhto6A7MDkGCisGAQQBkggSCAExKzApBglghkgBZQMq
AgIEHJjImYZS1Ykp6InjQZ87/Q7f4KyhXaMGDe34oeg=
-----END PRIVATE KEY-----
```

This secret key was generated using provable prime generation found in [\[FIPS186-4\]](#) using the seed 98c8998652958929e889e3419f3bfd0edfe0aca15da3060dedf8a1e8. This seed is the first 224 bits of the SHA-256 ([\[SHA\]](#)) digest of the string `draft-lamps-sample-certs-keygen.bob.encrypt.seed`.

## 5.5. PKCS #12 Object for Bob

This PKCS #12 ([\[RFC7292\]](#)) object contains the same information as presented in Sections [3.3](#), [5.1](#), [5.2](#), [5.3](#), and [5.4](#).

It is locked with the simple three-letter password bob.

-----BEGIN PKCS12-----

MIIX6AIBAZCCF7AGCSqGSIB3DQEHAaCCF6EEghedMIIXmTCCBIcGCSqGSIB3DQEH  
BqCCBHGwggrQ0AgEAMIEbQYJKoZIhvcNAQcBMBwGCiqGSIB3DQEAMAQMDGQIe/d6  
qDQ/28QCAhQGgIIEQJKA5kzRVm9d6rEwC/0RyBSgpPuSR0UQTjspt6EhBZlgHc3u  
FTCPa05P/vpeWaCnBRarGFn3DmqA3JT+59bmRpGdiP3ZrIk2EbHi0yrd2P3UFDnX  
qRkKI+7pf6e0HWJRntJA+KJS8v3tZ/hpiEKAeav/Mq0IFNFyEiZpCkbKcX5auDb1  
p5c3J2MNg/WNBfpGJUHKVIZuIF3H+8LffGayRsDsppoUMffR+GmdL8nxLiqhraHD  
+Iqr3LpEroNi/iZQWUTFTUlaePf/2KMqaH0uy41IVvcH1jIcLXHGNaa66S8AP/Hj2  
TJPPg/lve76DVAgDExn4QJd4pBFQac90zmxuU1HZrvzubK9t4e5lr80wpd2djvZK  
wSLzUgtQZXq8pSs1r85vrb3KItdYGF6SZpX029FS7rY3uYth5SYVUQWduYYY3S0/  
nsaLg4MCWU04Sh7nYJZL5Ijkk9LS7JhmwKvizHRRTXbLyRDH06e+jCRgLcU2WSUq  
1bEr9Jy0ucK8zNPTf8HWBTS0ubvy4Jf03mVp4REX/8ozXlLztWGb1FGbyaJ9Y4ga  
LM3JpKxMtb1UTxoAyj3iFwGLGZFGKBlWp1r+0dkKkC4dloFE22IINfLdRNLV9mP0  
aGZhsDheB8iV0tN01u91B1U68Q7AL1ryXWUSjouKGRSU6uMDLZ7rw0wLZC1m4oLG  
BF8Cm04ELmb0ci78fBs/qDXlf3BJazcNtciamEsQPYRGkHASBRYtoDfVY6mTT40o  
obdrZigcvCwttDBu7RtynAQVZ8DvKzxFGhe2p2Yc9H5A5ML7IwqNtYzheduBAQTE  
jAU2jMqwnZN5wULEnH2TF6KAQNRKdtBYMBqkToKgxf5Zf+cJZbyQq7WM6nVfOM7g  
kcFdeHDn/CWoSNHI1+JA3wSDM06zkU5HMD2MpT1RLTsaemImUKCAGYieJmwNQxR9  
aYHBBw5BNBw1XRB7WRka2Uah0Xq/wAgaI/o9L+mShDRFJjFi+t8AV3KR0WWWg020  
9qchX7P5H3Sy/tq8yUQIoI+hRiRjKfi9qy6AxIRttrK4WbW4scUtBZSk9uFkTVU  
ybnV6WvBpn2SrnwF/E1ueKARVMouWJ/7fiLJXk6wVvVtuBZw2gE5QGfucwQ0PQsC  
xPx8MhNl1KZYDVCgsyUr/LMHeKNc31S2HLGQK7kh/o+QQazafiJocQ+krB51VX1D  
nQlIhz4zvKsBgZhpoe3wQcfAY5sp2ubepsZ5T/YHkmroBmvA4g1vi7nlCetgxXrh  
2V60XvaZ+BnfsYxJeUZGnNMNEDFlzS7xB18ojtT5JN0o+9tLsdikdikl69IsVv+2  
eCv9Go+wh19cSAL24rkzdKVuiIAXS7tzel3eWGjdKoq3Ke+tfJtobSGrB39xgLVr  
3ho63hd+qTUyjcAhVL3hAJinv+/KT0jR8fq+CDsXMnCEWugHhWb+66N0r876MIEE  
bwYJKoZIhvcNAQcGoIIEYDCCBFwCAQAwggRVBggkqhkiG9w0BBwEwHAYKKoZIhvcN  
AQwBAZA0BAjGuDskfG4UwICFLWAggQogyL08hPtU152dk0+BVimcGXW3FmDrT0D  
gU3Drd0P76kZyZd2lLuGb9dx84wx0XnFxiXBM4F3QSDbCK4t0uJ6JRaEeUoCAyZd  
XyHtLjVeuozt2xHBDUgQVE01dZHtk1VUgzLScha1rXjcwpa4+8xqqoVM3C15uBh6  
QLUNey8Z3YlKlk018Tdge600Urg72BPKppNfJlN4Tn0FwMVMA/qHAJl4pL1YDpmc  
5BZm4tMg0HvPiz96uwjEhw1GZFG0gZIogevJuqCNiZPDjCFEDgnCw6sciS5Bi+dX  
Km0VUdamSr93e2eEPLbzxZR0E0A3Ic0j66iHuZpU9YhKzsAIhLMxT8kF81I0ZZzj  
8N+P1hnkjdVWuJLg77pkXxQJyvuT0e2oc9r/DCHjckneen3+E66IKsYbib7sX4g6  
2oFBJs+7xQopy69pC8jCn3fx61t7AFx2RiVvVHY/eU4sXoWkJNqQ3Vxj2SPWKjzJ  
4IiVwVxIFiQjj0tDFdGYPGukJXn62Lbb8CFgam9s4jDKnr0LHIngVeUIgi4wkvva  
QzZTzXfUApezQgQy4x+ogdiYF1U0a00aqvrGRiiJlMdRi0/MDy+jzkX5cULhXkF  
vdbNCirv+3zBaiJ5Eu6q0zP5Cxi2qXhSbehZqvTPB4dD/vu9yxHpZmUCvzm7H213  
Tdrb9WxH0c92ZpBzsfICA1smVwTDFVga/kqN6noPw0qWZANIk27/+apsTkBYaVpa  
jpf9eydi5eV2+pEQV08fh40JfIKbHS0L2E3Gp/rPm9lVgmCmjBWh+Di1k4qgF/f  
lsxWgzXN0xPntpohnM6AZDxW9Sk+BE1DLYS4WFwUg679BsJG6hQqAZKvG/8agSH2  
k+TKKYUbXbFVCB0+iuNZIwgf4qxGzvI5+Iok+0cxuGCqw0u30QbfECEG01QbKETn  
ic3kMiZ5Cxt7NQsuyEYAQ/AmvM4qo0x7Tw1r7tR8BcAEF6fGxd2VXIV8Tr/pXG02  
HL+0iIHs+0b67z1Thr7wUB4tCp9LC3IiWdsr7KcSRNEMXpUIFI0etCjNgCU3iR  
9152150fWNGxQfaXTEyMVNaT1HpwihIisSb9QHbagaRLbYmqJ+ILSECADYQPEwf+  
LT01tc0hkIb6BiwVWUu00qNj6ILJM2XvmknATyUj9MYcd77x0JzMrJE5VtaM5BVT  
oRpc0LfhY0mihceGSEqXX5golKqfLUze7zls1NWMYTTLw6tC6I+c/IUIWJnZT4m2  
RbTQ0krfPn94zbTjrG42HS5+Ke3ySV6Fv8MZ+s93yY1v9iB6cVPEuteLRc+C7e7t  
lw0bQ2+MyAkjenS5Td+3tC71R4202CSfy2Sa0sRv+EaYjTGzf9F3TM706o5+VZrM  
gtIKtw2okRcjRhaKDFhui6jo46YYzWbrgOS3vzc60VcwggNnBgkqhkiG9w0BBwag  
ggNYMIIDVAIBADCCA00GCSqGSIB3DQEHAATAcBgoqhkiG9w0BDAEDMA4ECEyHXPVs  
ncxTAgIUQ4CCAYDSB1YeFnsa4vtKApbLnd9FENDYeYqkKmj0lkDagMqHC22/nQ9v  
gz2l0o5FQJoaJx/WSorQt0Jny1QP9vZd2t+bkfoaXOR0MtmFY5S0tYEudJp1rCz+  
ZEw8JlePJP0Q3lNwEiSk5NnXLRWNzurIeuyZEd1VbTvi/rF22sRWlM335L67zj  
P1sPeXkBPiYCLHw8E4rkaC8G1ko5wyrnhuqL4Itzhv00RvgRaDflpP9WTj9LVUv  
FD5D59zgb0ptaW0jIw4Jp1IGXIEZiynW4KfkWy2YJvsXiuLHvN3Z8qL6VtxNGk1s  
g340uKkUULzmtDJqT9RVkoYBXxN7KYesbStt0NhpWdv/MxHrEo8TGHZAvbmwgfT

hOUrc/WVtUopPEs4QgrsA8d0MrSd51VtPW0XPsBPEnLuh7dqAlmgztYlP4Yztk2/  
 JJ+E4MosmRjBkZM2N5WuG1DC5m9KF/5JjNVwQ7e8gMeUv/3gizgCG/4Mgng0VGG  
 IxGzzBoQXPWCKdT3sLQVyt4/pqPBpZYnPO9bmkkY/UIa1unNB+WWpL0kKSzD5wRv  
 /2xmN02D37DnHwTFYC51Zb1Kz7FGjOgCwG95VPc8NQ8aG5rqpQ+muq/Ji15mXgNw  
 IDeM4bawa01UKEzqTGQub3gsJMGiV0hgt0rBi09Kx/2PJoLUuwZGcbo4oGSVR7KH  
 lLgIuC8aIQDyFURVYRCNw0w5U7JN5arkvZ4ty0/qk5UbJxQuDkF8o6ZdVi0310Do  
 C+6zvncDx4HvUd6uQ+u/kZfr8qfwM5o6D2qXhS/ZHskq2xwIzb47uUUqaeg3yOZJ  
 ++na7gC+ibthXXnNsHUvPbpCn9qViFhzilcQZYq0tZxDKa0E/pzEP/IA4IG24wEL  
 GnyuUIHXBS9T0MchTx17Bglyc0PRDnFKzMQfUXY1rAeRk76cs3y4VQDbfYDi0zsa  
 1qqMAPIX4i/qKfDRvDuLxtZQbVA/rNumm40LPUQ50vEngIESA74G+//YQbVjbMjP  
 y+hm7/15q5LRo9YxCS49KGlz4NG1QMWjnfkp0CNVZVpaQ7TPG0IYzBL6kTCCBzGg  
 CSqGSIB3DQEHAaCCBYkEggWFMIIIFgTCCBX0GCyqGSIB3DQEMCGeCoIIFLjCCBSow  
 HAYKKoZiHvcNAQwBAZA0BAi0/0ICbTbZLQICF0wEggUIFwT/JI8UjJQPfYTFonJE  
 o8zEbpYWXKboqW6/zZsMGmAnUPgQNQDxyuLVpr5jUc437kVB2M3F0x8DjmEpeb  
 tHfIoYjoXF7jdnA4EF38tss0K1nMPmSgl02iYZt0qs0vBpfe05Hj40vhi26J9Pz  
 TwPcg13QQPqfWv7CwgGVn4/hntBARIpSE4gAlfAcqkxtJBm01QwDoAds0K0MsYnt  
 gWajpr1J3Hm+34NPL04Usf10pcesPUJ4CBxNyLXxjjs0zD78WVvKY+N+j89xTsyT  
 z5Y0fEkFqrcl8pgBQxH72jBwScm5YwHz3BhWQgr2bpWJ1f2LWcVsnrN9tx6RhQtA  
 AkcyNgX/ksp5Ew4JTo+o6oXLRhXIYauRrUrisMY++b8ZJTp6C1t0RW2QdqqMZghS  
 ZgaW6FSC6Dy2Dd/ezdkYUCgiEtq8eSxF/8WDw6Va2iGVSnt4/p/0J97yN5y0J0K1  
 g0hATebU+I3E74PQ9RK84FfJvyHDBC6fvYZW/ouMccg3YmAF+dTm74Hq88X4daV+  
 /UPYf/cvpyiwcBTg6H3jkrks0yKoWLIfrIvMNBeeKZ+f12Enw1MFzkLI4VGD/UEr  
 wrbhN0SHkh51IGtu0yRTf6msYQpkw+jr7QwJIIdQyrAoaVaRotVyvgT0LLHw8r6  
 o7v36yoNov3kDPW7DfbSVTWX51IyQn8NqMwa4N1c1WT8ukfZXSaYykFSqF3w5za1  
 a4iIhu03GjDcfiWLMULYVAUcvSmcIULE1oW7FKiJc80adeIu0JBySRSEvf7B3w81  
 eYUs+u/h1ptrZZKhe1JdAtlszvHJ0DD0kMqA6Ig4yomscGSol/sRUqpecIQwVZTC  
 RRq9dJOFJkKhKD5Eo9E0Z2snp01fpUF5qlMeBjpYgkX7jhyFyvq+qDqBAY8izvkc  
 ruE69WooBVyorqKHURjWtY+rhzcB4+HL72wZKzLnY3iUjJ1UANxM8mC9fpD1NJt/  
 7epqzPyZ2Kd4GJVYi8sQpFKf4tRHDr0tI5iUB78qj1EBp1w4qvRn/jC4ii7+Bas8  
 mz/AJ25QeviC44Vj+eT2YyXafDivrmoeBuVMIBbD066YnuBC2CeKydnWdiARzc3I  
 fhcuHvWq7riotYfyDqd4e0Jy7Y57pbwv4Qwz1yCxRjSwiFQ7/fRa2Cx8xtxKcC/A  
 4LGNXAKISy+uNbDWA7AYaP6RmGgMCaNiXy3F1zvxNE3bv68tXRF9vjuEChUq56N6  
 992qhoBuHP0J/mRItw+JoI4m/0FnEUGT3bNyxpEFyA7aXBE91aQdSX14a97nCO/R  
 SFH/frWPFYgxr3XdCif3Cw5PDs25YNsXWCsDCVeJWMFroZmDwa8sBkY270+rGv7  
 6qXvb/uGD3M2C+DySVy55Zd42wjghSezgY6taT0tqKfLOS6V14ELU78Q6va2o8M1  
 cUdi343t0i60MZgCDUwPP8TjKZINh8u1KNhZgpwNLz1gE0dd20013bbzdZ6uio3R  
 52WQWRck17Z9lUesCJavytcAi0mMefMxBPM0dnUi608TPDRA0mcohBE5rybwDXAo  
 B/VUbwgM0/qCpZ7VcSKN1lUuoE9+Kho0NK/gyMEvntMxGNNI8arV8UkeFollPhrt  
 umvdwqbVCeN8Tbj5vXo6Hu+eKB7AVwjbk/rRHpZxnnVGXbm8HzM+kjib2cY1dius  
 VRJ/1+Q9GXuo135tQbobgcMzAmqAqZp9kDE8MBUGCSqGSIB3DQEFDEIHgYAYgBv  
 AGIwIwYJKoZiHvcNAQkVMRYEFeqzrDFTAkmcTeNueeALYZU+iGIILMIIFkAYJKoZI  
 hvCNAQcBoIIFgQSCBX0wggV5MIIFdQYLKozIhvcNAQwKAQKgggUmMIIFIjAcBgoq  
 hkiG9w0BDAEDMA4ECCNi2K1bMEiBAGIUdGSCBQDLIXo4ExcyE8+4aiZij/Wnh/SV  
 VVR0n7s4PGCbxt+Vr0HD9YzTuUicAqIcHH62dv7NSy+fgqZG7SmVR1IodadFe+5u  
 sAzXoyyhhEe2c+ToeVbr5rs+vBvQUyh6X5XTV5QV0AkWsyKGjyfydy86x1Q8cL2D2  
 BM+Rpkm1cFtjgWcB46U6S6w50sG7X0KSCMI4a6rnHPVgPPdXMrj3VSPJY8bhBqED  
 PVTnfSHf/wKZrIi5403F33B5jt6Cm9+9m9Fed8n+81w59rRom72CY9Xii/ULER9T  
 Hwjx0Z0Q+dIm123Kauwexu0Gjii0UR8MeM/A0n7UNys+bZTulgdpWW/mDhJ+eLAT  
 nhJw5ro/AWA6YVXG+t5k9LjdJ1ZmqS4bJxvBwilpEGoh0MM6Yp0dr1XM4mT/E0JM  
 WD458Ngs05CuCpwAUXGdQmgrVsFrrV0HTyHeVLDhe43J3GI6HCWJV0eDQzZma03A  
 M+IooRDkThnJMaxUXphKTag5+f/smNYEhzVjZeIc8GFZ36eSI4BNGHSXFACwLu2T  
 hkzpxMmg50JAUHBYxqE/fVevLUH4JPLgz869wk8gRlUBo6ihQGrnsx7Z05IsYahE  
 Yjz0N05PVPJYMLSyMovG9i+LpzQ49gIBzPu2fdLR41u5n505mG1Y4aJ70CJxMORY  
 hWHuctHdGdpJsgiq8+1iiUwmfyCfb0ZL3ePMU+W0zkAsyn22aK8jDBLLVZ1v0ZIV  
 qR3Gx4QFPsk6qCMQ0E58VkmUMxYvClzTwSeEMu66eND/AKTE+XXV/d9bmSmWGk7Y  
 8XrDKLkfmRdr1IeondVJv5mk12YKxBPQGeUqK5XJUa2dzH9zvfxEX8iYzdt4281QC  
 iXJ3qwmBT+8Ro0Lbt4Ky0s2e2ZSznjrL9004oUsHI0yEfjwnWoLhKbkmun8GJxoB  
 2yCzTawVqf9/qIUXaSzcp23AV6Lf1k90f79HYPW3cQJAtjf6XBVE1xVZPkfTuC3y

```

VLuf1js2ed/ctpHg9nuId/xHFH7t4HbmU3/ZufE1GHnsRQ3kbnqA5WXerd9UzeoD
aVDjFXGrITp8env08GXyvwWGxLL150l0DuJSv1E+1yww86SNjBYUTx0r0CJjTk2
7vIUhAYUEA+J71IeifqQPKYXnrCdUEajbfEdek30WiLR+ChEvEp48M1a6UVTLm/
mjiwbsxm5QlGccmz13e32RiyrfseB+RyllmzeJtydP2IHkWK7pww9y01PK0QtZs
66IGZKqeXrWBk9QFYDX42gAy/xTfglco4K07akhp3UzTIQyTXnt+0s0Scc+ArVm/
dwC1m+Zxybt0cVyadjpKWydyfAr3aTkGxX6RmHrEWr1R9BnMGPyEsDs+yeVNs1Qd
Dhff/bQLwCLXdGLWwLe6kitUiyi8F3bdfPjR7R61lEUvJrBm7YlmgdxRCJ02LFLG
n09iSMNe5vminAKiuzfb4Dp9dqEMhmJfdsTURagfJIyqULoe08EIIozahivbzoWV
A6oPAkk2D8DnTiMegX4IZ/Zb3LPxJKAeX03Ys1YQrNSNZ3B2ZISBapzGzhFzFRVz
POMXhN53pDh1xkw0btkKb1YA9CvP+kzgwekzCy/Mlq/Hb038CV1NKzay3yg4nteh
J+v9/k7gaqKmo3ZWMGk0WGBv/GFxYhmeNd14Y65D9TlypM/zrXSYGo0qZgSA6H1A
gogzwwSaGwx9n/o6czE8MBUGCSqGSIB3DQEJFDEIHgYAYgBvAGIwIwYJKoZiHvcN
AQkVMRYEFBfFhVvQp+92kDi4s28IvJK1niuUMC8wHzAHBguUrDgMCGgQUgwafFeGu
n9Q1raAUCgw+KWxk+8EECJ1vqXe6ro0FAgioAA==
-----END PKCS12-----

```

## 6. Example Ed25519 Certification Authority

The example Ed25519 Certification Authority has the following information:

Name: Sample LAMPS Ed25519 Certification Authority

### 6.1. Ed25519 Certification Authority Root Certificate

This certificate is used to verify certificates issued by the example Ed25519 Certification Authority.

```

-----BEGIN CERTIFICATE-----
MIIBtzCCAwmGAWIBAgITH59R65FuWGNFHoyc0N3iWesrXzAFBgMrZXAwWTENMAsG
A1UECHMESUVURjERMA8GA1UECxMITEFNUFmgV0cxNTAzBgNVBAMTLFNhbXBsZSBM
QU1QUyBFZDI1NTE5IENlcnRpZmljYXRpb24gQXV0aG9yaXR5MCAXDTEwMTIxNTIx
MzU0NFoYDzIwNTIxMjE1MjEzNTQ0WjBZMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQL
EwhMQU1QUyBXRzE1MDMGA1UEAxMsU2FtcGx1IEExBTVBTEIEVkmjU1MTkgQ2VydGlm
aWNhdGlvbiBBdXR0b3JpdHkwKjAFBgMrZXADIQCEgUZ9yI/rkX/82DihqzVIZQZ+
RKE3URyp+eN2TxJDBKNCMEAwDwYDVR0TAQH/BAUwAwEB/zA0BgNVHQ8BAf8EBAMC
AQYwHQYDVR00BBYEFGuilX26FJvklQTRB6TRguQua4y1MAUGAytlcANBAFAJr1Wo
Qjzwt0ph7rXe023x3GaLPMXMwQI20f+apkdG2mH9ID6PE1bu3gRRqIH5w2tyS+xF
Jw0ouxcJyAyXEQ4=
-----END CERTIFICATE-----

```

### 6.2. Ed25519 Certification Authority Secret Key

This secret key material is used by the example Ed25519 Certification Authority to issue new certificates.

```

-----BEGIN PRIVATE KEY-----
MC4CAQAwBQYDK2VwBCIEIAt889xRDvxNT8ak53T7tzKuSn6CQDe8fIdjrCiSFRcp
-----END PRIVATE KEY-----

```

This secret key is the SHA-256 ([SHA]) digest of the ASCII string `draft-lamps-sample-certs-keygen.ca.25519.seed`.

### 6.3. Ed25519 Certification Authority Cross-Signed Certificate

If an email client only trusts the RSA Certification Authority Root Certificate found in [Section 3.1](#), they can use this intermediate CA certificate to verify any end-entity certificate issued by the example Ed25519 Certification Authority.

```
-----BEGIN CERTIFICATE-----
MIICvzCCAaegAwIBAgITR49T5oAgYhF5+eBYQ3ZBZIMuujANBgkqhkiG9w0BAQsF
ADBVMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEwhMQU1QUyBXRzExMC8GA1UEAxMo
U2FtcGx1IEExBTvBTIFJTQSBdZXJ0aWZpY2F0aW9uIEF1dGhvcml0eTAGFw0yMDEy
MTUyMTM1NDRaGA8yMDUyMDkyNzA2NTQxOFowWTENMA8GA1UEChMESAUVURjERMA8G
A1UECxMITEFNUFUMGV0cXNTAzBgNVBAMTLFNhbXBsZSBMQU1QUyBFZDI1NTE5IEN1
cnRpZmljYXRpb24gQXV0aG9yaXR5MCAwBQYDK2VwAyEAhIFGfciP65F//Ng4oas1
SGUGfkShN1Ecqfnjdk8SQwSjFDB6MA8GA1UdEwEB/wQFMAMBAf8wFwYDVR0gBBAw
DjAMBgpghkgBZQMCATACMA4GA1UdDwEB/wQEAwIBBjAdBgNVHQ4EFgQUa6KVfboU
m+QtBNEHpNGC5C5rjLUwHwYDVR0jBBgwFoAUKTC0fAcXDKfxCShlNhpnHGh29Fkw
DQYJKoZIhvcNAQELBQADggEBAGV0x0EzgLKixMcztiikxxJDbmRat1pcipD15
1n8kiBoGhsT4fNZJVoL00QBa/WTMntL+qcAk2itqZCNIEZeGklUljXBAz5tkDRAF
f/v99LEcsZTcuIbnJqz35danQkp4/upG4hPkfx+nbc1bsVylrITwIG0pnGhz7z3m
VCk03DFE3Qt4w9mlv9yuMse33nmsBGXog/XZvM2JRY0iKt0xksQqQD9uYm7MoMeH
qQs30t7EaoPj54xyWvy42run6TLUye64D94SNjB/q/wjL96bsVIKGrRn10T1ybCh
4F5HD00hQZgP15D1b1rg+vskN8MSk5nuD+6z1VsugioW0+k=
-----END CERTIFICATE-----
```

## 7. Carlos's Sample Certificates

Carlos has the following information:

Name: Carlos Turing

Email Address: carlos@smime.example

### 7.1. Carlos's Signature Verification End-Entity Certificate

This certificate is used for verification of signatures made by Carlos.

```

-----BEGIN CERTIFICATE-----
MIICBzCCAbmgAwIBAgITP14fVCTRtAFDeA9zwYoXhR52lJAFBgMrZXAwWTENMAsg
A1UEChMESUVURjERMA8GA1UECXMITEFNUFMgV0cxNTAzBgNVBAMTLFNhbXBsZSBM
QU1QUyBFZDI1NTE5IENlcnRpZm1jYXRpb24gQXV0aG9yaXR5MCAXDTEwMTIxNTIx
MzU0NFoYDzIwNTIxMjE1MjEzNTQ0WjA6MQ0wCwYDVQKKEwRJRVRGMREwDwYDVQQL
EwhMQU1QUyBXRzEwMBQGA1UEAxMNQ2FybG9zIFR1cm1uZzAqMAUGAyt1cAMhAMLO
gDIS3mHITYRNYO+RnOedr5/HuQHxSPyAKaS98ito4GwMIGtMAwGA1UdEwEB/wQC
MAAwFwYDVR0gBBADjAMBgpghkgBZQMCATAMB8GA1UdEQQYMBaBFGNhcmxvc0Bz
bWltZS5leGFtcGx1MBMGA1UdJQMMMAoGCCsGAQUFBwMEMA4GA1UdDwEB/wQEAwIG
wDAdBgNVHQ4EFgQUZIXj05wdWs3mC7oafwi+xJzMhD8wHwYDVR0jBBgwFoAUa6KV
fboUm+QtBNEHpNGC5C5rjLUwBQYDK2VwA0EAwVgQWbdy6FQIPtFsaWvG2/US2fnS
6B+BzgCrkGQKWX1WgkTj4ME0qL+0cFXLr7ZQ2DQUo2iXyTAu58BR6btcCQ==
-----END CERTIFICATE-----

```

## 7.2. Carlos's Signing Private Key Material

This private key material is used by Carlos to create signatures.

```

-----BEGIN PRIVATE KEY-----
MC4CAQAwBQYDK2VwBCIEILvvxL741LFX+Ep3Iyye3Cjr4JmONIVYhZPM4M9N1IH
-----END PRIVATE KEY-----

```

This secret key is the SHA-256 ([SHA]) digest of the ASCII string `draft-lamps-sample-certs-keygen.carlos.sign.25519.seed`.

## 7.3. Carlos's Encryption End-Entity Certificate

This certificate is used to encrypt messages to Carlos. It contains an SMIMECapabilities extension to indicate that Carlos's MUA expects Elliptic Curve Diffie-Hellman (ECDH) with the HMAC-based Key Derivation Function (HKDF) using SHA-256, and that it uses the AES-128 key wrap algorithm, as indicated in [RFC8418].

```

-----BEGIN CERTIFICATE-----
MIICNDCCAeagAwIBAgITfz0Bv+b10MAT79aCh3arViNvhDAFBgMrZXAwWTENMAsg
A1UEChMESUVURjERMA8GA1UECXMITEFNUFMgV0cxNTAzBgNVBAMTLFNhbXBsZSBM
QU1QUyBFZDI1NTE5IENlcnRpZm1jYXRpb24gQXV0aG9yaXR5MCAXDTEwMTIxNTIx
MzU0NFoYDzIwNTIxMjE1MjEzNTQ0WjA6MQ0wCwYDVQKKEwRJRVRGMREwDwYDVQQL
EwhMQU1QUyBXRzEwMBQGA1UEAxMNQ2FybG9zIFR1cm1uZzAqMAUGAyt1bGhAMhAC5o
MczTIMiddTUYTc/WymEqXw8hZm1QbIz2xX2gFDx0o4HdMIHaMcsGCSqGSIb3DQEJ
DwQeMBwwGgYLKozIhvcNAQkQAxMwCwYJYIZIAWUDBAEFMAwGA1UdEwEB/wQCMAAw
FwYDVR0gBBADjAMBgpghkgBZQMCATAMB8GA1UdEQQYMBaBFGNhcmxvc0BzbWlt
ZS5leGFtcGx1MBMGA1UdJQMMMAoGCCsGAQUFBwMEMA4GA1UdDwEB/wQEAwIDCDAd
BgNVHQ4EFgQUgSmg+i0gSyCMDXgA3u3aFss0JbkwHwYDVR0jBBgwFoAUa6KVfboU
m+QtBNEHpNGC5C5rjLUwBQYDK2VwA0EAzss75UzFuADPfd4hQdo5jyAQ3GvkyvI
BdBgnWtJ1eT1WuMaIMhi1rH4vPGPd9scwW+sqd9fG+pv3MShl+zKAQ==
-----END CERTIFICATE-----

```



## 7.4. Carlos's Decryption Private Key Material

This private key material is used by Carlos to decrypt messages.

```
-----BEGIN PRIVATE KEY-----  
MC4CAQAwBQYDK2VuBCIEIIH5782H/otrLy9Dtvzt79ffsvpcVXgdUczTdUvSQsK  
-----END PRIVATE KEY-----
```

This secret key is the SHA-256 ([[SHA](#)]) digest of the ASCII string `draft-lamps-sample-certs-keygen.carlos.encrypt.25519.seed`.

## 7.5. PKCS #12 Object for Carlos

This PKCS #12 ([[RFC7292](#)]) object contains the same information as presented in Sections [6.3](#), [7.1](#), [7.2](#), [7.3](#), and [7.4](#).

It is locked with the simple five-letter password `carlos`.

-----BEGIN PKCS12-----

MIICZgIBAZCCCpYGCsQGSIB3DQEHAaCCOCocEggqDMIIFzCCAvCGCSqGSIB3DQEH  
BqCCAUGwggLkAgEAMIIC3QYJKoZIhvcNAQcBMBwGCiqGSIB3DQEAMQWdGQIwS3R  
pT1mkyMCAhS7gIICsGKkBM0nci9VHfQxOTWy/lkKyQeF5bwsF/9gZrqUym1KtHZF  
a4rSJIPUctmzqVnhGmfW9m+LEi7Em9rRmUIQbDZt4kQDG5eDk7AdhyDnB3uZDG1W  
4cAeUVXJMzGfnwtzy5TZBZzEo5nnVX74Al+PDW9wdpbv2TIRiL0m29fBT+7HVS9F  
Z/95XokSwbb6mmCYeGiPpNEaoueUeuU4zrh/k+JJqDuqNsU66I30wH0CFmk3aarBV  
3LkEeCjKfKngzMOZqiKZu8D2hEUjsGQ9ALsRn7P+hIWNFIgjqvqgcCMTF8fLK1C/8  
vYGD+H0pnn23nLele4b/qpFYx5kJ0b0K1Zo1SpGUQ7Bu6gectUcey0gi7CjRScuV  
ew7918ZY0ugyYoIWAT0kecPM0TFtxAn19JPXo4jBYAlwUtx7GYAlDkgZCb/0dbkv  
4L+PAeJK4kVDREDQ6ch/6/hlqU8xHeNzdagEWYL6FxDiHebASxIvZzqkLd7RV9m  
dL1FXst9R9G74j0s0WMMFmd9toy0hD0q6G19cat0rolCVS/CKaC0CucsJfiKrlJ/  
duQkt/JwcELveu0g60u2uaGKUqHmFhd3+6omk+wNB0Y+0D5MmBZ/xnrVELGmzp94  
q0f/HfZPT6sXkYBGU2eUA/qr/zimNG3TuGVch/MdnduuVhvAYLyh1gbA8yRm+I/  
zGCVuAqhsHITTx7Fqc3tyVp/mLyu00QuwmgAw6NhzWkZf5N+tR0DZGcgw8rZpeJA  
yTxVfcjzXvoShxog7RroR9Nc4FwJhWI4B02410HFEiQZeRk8vzI8WIFXnn6t42/q  
j1mV7Ba42zxPEGoY3m0bKwjR6rDp6KwmmfkgHPwMPU3qP2/ASV8WT1+9GIYHc5Am  
9CmS0TiQMluW70Ra2k5ZMlwnbKNyMRbjUB/yHwwwggKvBgkqhkiG9w0BBWagggKg  
MIICnAIBADCCApUGCSqGSIB3DQEHAATAcBgoqhkiG9w0BDAEDMA4ECOMzXMste/8a  
AgIULICCAmgXa+q2JhTLvWsj5SKLdMninTk5uB6Hh0sDKYR9GDg/cABqUFxycROG  
JeJueWIRkJhsfdXJi+TSRtnQ0ppyVM9oRUdxcbGuCI98fEbLmVyr7KF8GudTgC+b  
eaLjn6HYkWpv71WdvsFG8BEy6Jqi3/tP9PgNvpCYgVVM7yx6SX8QArCLsQkxbTsv  
Ae0iN18H89W9x0HEz4Z2qHYyb7f0pPHrmpTGC6qmtvo1gNRsKTF0wYeQ5Sy/9U3f  
oM6bIcr0vHDksaco4+5n0zeySDETY8W4m01K0uC/t0oT0ScYGBerhVr0DQapZGT/  
Ej5LpgjX0uosAoT3IKnMwK3C00Z8oBzcvGSpeAa/V/OTKDPzB22yq6sEaHAPoUqb  
cKRJmB6HC5mdLs3n0uP1vLZuYsHu7Evt0Uhs9pbkLJDICgM+4SFgKTRbd6Xt8bf  
GHkWnmpv4pQL7jjzA3epP2DHyC8MJaDvleWY7Z3t/IEtkzVxfLLo8kt21edz12cm  
uFVK9i1MW3eJuyiRyFXFPgVsuNi/HFNijXFgxzAncP7FFP5MCs0o6daiEjJjemKf  
J3D+HdD60gFih/ex9V+tG14y7/jtxCRA/54mit4sCy3LC0++1Ep9AtFwGYrDw825  
uGj27a7mE26qgGdGXdzT9UJ8FfUsIoRPrG38Q4mhS10pTarNucW0GjkftZiKJLay  
rFMRf3HYxOI/7iupfxYLK/4/FODijaHzAfSdQf2Bo7csPaz2HQkK/0ny0+tt68S9  
pUCjEfV6Liy22tang/jXxPFbBDK/P68Mnmgr8C3PcYhPJCo/K0JR2/8F8pVVEqd5  
MIIDPwYJKoZIhvcNAQcGoIIDMDCCAYwCAQAwggMlBgkqhkiG9w0BBWewHAYKKoZI  
hvcNAQwBAZA0BAho9g0tQyYTvwICFIGAgg43SpNCoshZX3ikmK1m0IJP2Ah8Xv  
94S/5NA8kwHtaNXpLrjYr3CyRL93USm55uvGAtECR/Eb10N9zeo2p0gK2JPSbDr6  
/1oovo7UoZNRoRBZ8pUegVWJswNwjqvzVu5JIRmpD05XjVDKHbFqiXAqtj9/w3q0  
Qq/p/M9UrLWD93hyLNdIppWr2KR2it9mASTKEHX9dqXcTOG0Kp2GmrfGNteGL02j  
qVKZaZyYI8gkSxhVLS9zzgf10ynAkzYQsoo+GKhDAW1fJECemAyPc3L+eeARw/SY  
q1d5QVwxKfYpIJ2wiiavdeRVNBWiwV7Ti+P9PtPx/hV22NNLwMhvnJcHaSS1Pa0i  
SjoxFJ1EJWGES0QwcdwM8iN3oVuqT5HU/edMgx9TLNTiE1g2GEq59I/RwBtCL8Dh  
OzKnUb4PU1Z81+HimV3KPI8g3cduhYaBR4HfqAhMnc+w5HXI6J3C1NtAE/izZ1Y2  
0d71+GTJfjPgZiy0hjfqfbMt8uU9D9aPr2XjN0WoKRSojae16v8bLx+dFn6RMxFUS  
g3nLEZ6EDpyrJfpGPm6mPgZKSXtvnHuFcbS+utkRuVAtqu07r2XpkGBIJLNVIRHU  
5gLACbtj9TPcAce6RLoaYSDgOuFK0YZMdwzhsAI0YMPyHsUEZpQ5tjWSB6ENbvF  
7+QhmDnf6N3Bj+vxUtGS40pVsYCGbM0D7UM5QpUxIgvKpPrfRok0Zs/fi9sW+Xy6  
eQ2Brbn3t9C2TAs0RYzFbuBwuTCqFW/rXHS6iffJpx2eAg3DCqaUAJjptSV/yzj4  
vxiX1DB3fMRcpNd5Je7DoHS4axuj7SLHdpNoUhs+qQsG6yDM5BEuXWGxo/L9sGhe  
XQRUnkZ4m4g01sfGT0FDNurXx/oP0ym+B50q6nLUWv0tYZpmCVil358dIEGPPSMY  
AMXh05tIPFDYSJ3WLS0cxy5X4sXZ15w16Pzeb9SF5topqRUB5PDTfVr2bQUMwTbp  
99Fc0Qf6cg8HXyT+8b4qKp9WyjCBxAYJKoZIhvcNAQcBoIG2BIGzMIgWMIgtBgsq  
hkiG9w0BDAoBAqBaMfGwHAYKKoZIhvcNAQwBAZA0BAgNhF0DEdzSrQICFF0E0CEq  
Fie1peicS90SXNQjLwbN3k081YM2HqeSZoEKJ4JSF1V1kWW3xwfu5aZKrGEYBfGM  
d8renRijMUIwGwYJKoZIhvcNAQkUMQ4eDABjAGEAcgBsAG8AczAjBgkqhkiG9w0B  
CRUxFgQUgSmg+i0gSyCMDXgA3u3aFss0JbkwgcQGCSqGSIB3DQEHAaCBtGSBsZCB  
sDCBrQYLKoZIhvcNAQwKAQKgwjBYMBwGCiqGSIB3DQEAMQWdGQINFcQIEMfd9UC  
AhS1BDgZruEsSaBY+Cm9WKR8HhH3JXh+AoMSrwdCKytWt+MNIXB0jY2QZHDn3U  
Fn7qHw06MDthnKniazFCMBsGCSqGSIB3DQEFDEOHgWYwBhAHIAbABvAHMwIwYJ

```
KoZIhvcNAQkVMRYEFGSF4zuchVrN5gu6Gn8IvsSczIQ/MC8wHzAHBgUrDgMCGgQU
8n0YIWrnJVXEur957K5cCV3jx5cECJDjaZkfy4FnAgIoAA==
-----END PKCS12-----
```

## 8. Dana's Sample Certificates

Dana has the following information:

Name: Dana Hopper

Email Address: dna@smime.example

### 8.1. Dana's Signature Verification End-Entity Certificate

This certificate is used for verification of signatures made by Dana.

```
-----BEGIN CERTIFICATE-----
MIICAzCCAbWgAwIBAgITaWZI+hVtn8pQZviAmPmBXzWfnjAFBgMrZXAwWTENMAsg
A1UEChMESUVURjERMA8GA1UECzMITEFNUFMgV0cxNTAzBgNVBAMTLFNhbXBsZSBM
QU1QUyBFZDI1NTE5IENlcnpZmljYXRpb24gQXV0aG9yaXR5MCAXDTIwMTIxNTIx
MzU0NFoYDzIwNTIxMjE1MjEzNTQ0WjA4MQ0wCwYDVQQKEwRJRVRGMREwDwYDVQL
EwhMQU1QUyBXRzEUMBIGA1UEAxMLRGFuYSBib3BwZXIwKjAFBgMrZXADIQCy2h3h
hkaKDY67PuCuNLnrQiHdSWYpPlgFs0if85vrq0BrjCBqzAMBgNVHRMBAf8EAjAA
MBcGA1UdIAQMA4wDAYKYZIAWUDAgEwATAdBgNVHREEFjAUGRjKjYw5hQHNTaW1l
LmV4YW1wbGUwEwYDVR0lBAwwCgYIKwYBBQUHAWQwDgYDVR0PAQH/BAQDAgbAMB0G
A1UdDgQWBRIA4bBabh4ba7e88wGsD0sVzLdljAFBgNVHSMEGDAWgBRropV9uhSb
5C0E0Qek0YLkLmuMtTAFBgMrZXADQDpORBZitzXGYUjxnoKVLICWL5xner97it5
VKxEf8E7AeAp96POPEu//2jXnh4qAT40ymW0wrqxU1NT8WW/dSgC
-----END CERTIFICATE-----
```

### 8.2. Dana's Signing Private Key Material

This private key material is used by Dana to create signatures.

```
-----BEGIN PRIVATE KEY-----
MC4CAQAwBQYDK2VwBCIEINZ8GPfmQh2AMp+uNIzZMbzyvT0ltwvEt13usjnUaW4N
-----END PRIVATE KEY-----
```

This secret key is the SHA-256 ([[SHA](#)]) digest of the ASCII string `draft-lamps-sample-certs-keygen.dana.sign.25519.seed`.

### 8.3. Dana's Encryption End-Entity Certificate

This certificate is used to encrypt messages to Dana. It contains an SMIMECapabilities extension to indicate that Dana's MUA expects ECDH with HKDF using SHA-256, and that it uses the AES-128 key wrap algorithm, as indicated in [[RFC8418](#)].

```
-----BEGIN CERTIFICATE-----
MIICMDCCAeKgAwIBAgITDksKNqnvupya02gkj1IIdwN7zpzAFBgMrZXAwWTENMAsg
A1UEChMESUVURjERMA8GA1UECzMITEFNUFMgV0cxNTAzBgNVBAMTLFNhbXBsZSBM
QU1QUyBFZDI1NTE5IENlcnRpZmljYXRpb24gQXV0aG9yaXR5MCAXDTIwMTIxNTIx
MzU0NFoYDzIwNTIxMjE1MjEzNTQ0WjA4MQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQL
EwhMQU1QUyBXRzEUMBIGA1UEAxMLRGFuYSBib3BwZXIwKjAFBgMrZW4DIQDgMaI2
AWkU9LG8CvaRHgDSEY9d72Y8ENZEmwibPugkVK0B2zCB2DARBgkqhkiG9w0BCQ8E
HjAcMBoGCyqGSIb3DQEJEAMTMAsgCWCgsAF1AwQBBTAMBgNVHRMBAf8EAjAAMBcG
A1UdIAQQMA4wDAYKYIZIAWUDAgEwATAdBgNVHREEFjAUGRjKjYW5hQHNTaW11LmV4
YW1wbGUwEwYDVR0lBAwwCgYIKwYBBQUHAWQwDgYDVR0PAQH/BAQDAgMIMB0GA1Ud
DgQWBBSd303UBe+a7GCGvCdtB0n0WtyPpDAfBgNVHSMEGDAWgBRropV9uhSb5C0E
0Qek0YLkLmuMtTAFBgMrZXADQQD6f7DCCxXzpnY3BwmrIuf/SNQSf//Otri7USkd
9GF+VthGS+9KJ4HTBCh0ZGuHIU9EgnfgdSL1UR3WUkL7tv8A
-----END CERTIFICATE-----
```

## 8.4. Dana's Decryption Private Key Material

This private key material is used by Dana to decrypt messages.

```
-----BEGIN PRIVATE KEY-----
MC4CAQAwBQYDK2VuBCIEIGxZt8L71Y480Eq4gs/smQ4weDhRNM1YHG21StivPfz3
-----END PRIVATE KEY-----
```

This seed is the SHA-256 ([SHA]) digest of the ASCII string `draft-lamps-sample-certs-keygen.dana.encrypt.25519.seed`.

## 8.5. PKCS #12 Object for Dana

This PKCS #12 ([RFC7292]) object contains the same information as presented in Sections 6.3, 8.1, 8.2, 8.3, and 8.4.

It is locked with the simple four-letter password `dana`.

-----BEGIN PKCS12-----

MIIKtGIBAzCCcn4GCSqGSIb3DQEHAaCCcm8EggprMIIKZzCCAu8GCSqGSIb3DQEH
BqCCAuAwggLcAgEAMIIC1QYJKoZIhvcNAQcBMBwGCiqGSIb3DQEMAQMDgQIZNqH
TA2APx0CAhQXgIICqK+HFHF6dF5qwlWM6MRCXw11VKrcYBff65iLABPyGvWENnVM
TTPpDLqbGm6Yd2eLntPZvJoVe5Sf2+DW4q3BZ9aKuEdneBBk8mDJ6/Lq1+wFXY5k
WaBHTA6LNml/NkM3za/fr4abKFQnu6DZgZDGBzh2BsgCMM09TeHgZyepsh3WP4Z0
aYdVSD0LiEzerDP10BgjYahcNLjv/Dn/dFxt003or010TTUoQCqehJ0oq3hJtSI+
8n0iXk6gtf1/ROj6JRt/3Aqz/mLMIhuxIg/5K1wxY9AwFT4oyflapNJoZGg9qwGi
PWVtEy3QDNvAs3bDfiNqQAFJ0EHv2z3Ran7sYuz3vE0FnPFA81oWbazlydjB0P/B
0Q+s6VLbsAosnZq9jv2ZVrCDaDA1/g7oD7fY8qmaC602q5/Z3KusfMt+r9En2v8I
H2vjgrpxnDIXjYuLZdrnNE/slRtqad0GR/WQ358RG+yUmRUbHYHGnkjn9f0GLasI
ZUV0aowivcWyF/kr7QV3VVexgqJMX6k1vzSXR0J/tnA+1/WPWy1mCJeljG0gYqSV
txtVB61Qmc2XP48F7wyaQZvdAU9zfe11/tHAaKKJWBpE11IuAEkGtIP6ozYJBFjH
I11tBA8fijTnug+S40vSgjtSRV/+kSEiW4F+pwE8RuTYfUu7q+Ew0LYdLgkH50yE
sn0b62UFpR/E1D9exWzohrFbIdUCbjtssXucruAqPNhW/abT0zicWu5nvf+Pniow
2VxvhwoGt5jZ+lkaR5Z+1/GpbMgq47EUyGCgKv+5GAcJxUxINZqLbACJ/MhlfYPB
eJrXz8f5Cigm1wZLisYCqnuc8cGCXjNqNkUlqtzodM8xv4gcgT/zILxmJZP2q4n
YA4yBQx5/n2G2dZC+pf3kAFbXcp0MIICpWYJKoZIhvcNAQcGoIICmDCCAPQCAQAw
ggKNBbkqhkIG9w0BBwEwHAYKKoZIhvcNAQwBAZA0BAjxuoiaSZDbnwICFH+AggJg
k2hcNYt00+15uLqXdiNhr5Q0JkYcrHdo0wR6G5AgLmwI+TYi+P8EZUjDIJ4TJ3b4
6xv7+3pT8cbEFF6PXcfs8/sCfM7FaV3SpLACLZbBJV520KE0CAGALZ0LIZ5mGVU
tWI2h1x587KeIv5GRPIxumDebT3Gmkkp9Qoi55hjTgn68o1SgDaJF8o5wnf0DhKS
o110a3x90wkJSN1AXfmBfj33KnT8Dc4bTfAZy1S5o1zCtaEqnct2Urb4Pe03LfHB
ErBsvY8HE4D7qh6P5ftXHQHax/b3hbU8jQP1tR0N90h0SiLi//ebCeGXWQRdVjL5
+VQrh1QF5d4Kz9Zx79oC36g7C2BxCQomur/F9TT12NPzPpaEGGo6ljB6myAHnYw9
rCxbSxBvbtEtLgJnxxb1Y5Q4ukgyjzK6431Bwq2+iNL0vGc9o2c5ELUPU9zGeLBZ
tXWvdX27a0HjusPFDZL70C5zHiYs1FU6Tkn9Aotc424Q3d2IRTTcYnnjs1VSi1Sr
4bRyB8zBAQmdQrniBW++7eJm3m/E0U0Yy0noUT169m8KNJrmSspMvKS6pyiYHR4I
BvAIkRIjvdtQJdQJ+Uyr+HH5daE6golW1917b2bXj/41mvXYkJY6W8x0km1RYhH
QZphWlvNcrHko46Unk48Qc/5J5tI+6UDTXFr//V34vcpQ2ktp0MAK11rBH549ef
CsGQTGoq8XHPksehEEMRm0JDeKTVkKx8xNhbwb395yFCIXff2NHeDLXP+JyW+nH
Iy2fnBDlyTiPF7YXyGiPjPAGk8LS8GUE+Zq2rWqrGNkwwgM/BgkqhkIG9w0BBwag
ggMwMIIDLAIADCCAYUGCSqGSIb3DQEHAATAcBgoqhkIG9w0BDAEDMA4ECofJ/s3Y
f5bgAgIUnYCCAavi4NaYP4lpAtuXtE02Zqgl9aLFwsj9B/rikBo601ZR/lSryJ4PJ
VGYy6NyBPjG67glJVMYiI3Hge+j66FXKXD/AaiMVD21ZmfrH935S14ZUKS9tpTJL
QDw3eJpDEDqJUFJZJ/ybgpRAKoNjhce3B7F7+WMI8Pr70M1Fbw7ytUCAj0f18sIW
prUA8f809dLiGgiWyjE5HMzSXEib5IMRpq5x4Q28pBrT8rVYgoQSSyVkfHtU7LDi
Bm68RfBgEl7jIqLdrt2kKxHC3/LC4xXQcFNXeQ056aRp8Yu4VpoRwraVLU03tJk+
pf1zFfmUei/JtiFlC6uf0PvC2B5h6kAZocE11LxGIDFH7fTdT6dzP7qTDbU0+uEk3
qsgktT2pcoVnxTanvQmTCEZM9ZKX5/z7Gkm+z83LGLDDU9oNyRSrxHrRBIvgH4w
3aGH1v6kfY0WwwwaghQOQIZFyzGVRKXsP7AslL+n4ti831TxqSUZX2qy9LpI4Tjp
5A/NLMko3uqmHF1TLnnYUqoppe88FNY8T/LXnHp0KTkuXFmdKJtp1/ydqh18jBk7
nflcQFdf1R/5okysblRtaMujlhelymT7MoM8u5C8ceIO7uWX8NI5B/IB+Yn2BvzZ
9LXoSia/wHjTu7UK610o7W0q9qTYei1i1x+HsmJa0C6hpaQh6b33VWDrHJb17c/4Z
tvQ9qAzqkqIhFWMRXNK+32jFVAgXrD8U1QHW2ip5s7W/Xtm1AegrhG1nSQgJezY1
OnE/t2PDWuPeW94kr0uv1fnsh6plLyZyF/BaqhoGCHsa/ipD86viVSZDgJ8ASVLF
eLUK3HYFMhJ+MLEzZJffYZA0nbYoyNPnc0vc7dpbk+ZMnlb5bDFcMCpm7+fW0jsC
nsNNL9nqQLNHHCJRKgux05rujftbPM7R3GLT9d/u5e9YY5cX0RiDLxomFffl2Yh
uRoyX+8WzEST98I/KmAraWKXnx0P1FEWajtnCrnGCezDK03xEHTQhECpg+z704mj
MjN6MIHABgkqhkIG9w0BBwGggBIega8wgawwgakGCyqGSIb3DQEMcGECofowWDac
BgoqhkIG9w0BDAEDMA4ECL2Bz1vW+YZkAgIUugQ4Y0yEjke53NDvCFR0ciUHZ7re
f9/wPx5TgV3qzGhfr4bP2rdpi0t9hAHVK5cmUAR7+wjAJiYdLUQxPjAXBgkqhkIG
9w0BCRQxCh4IAGQAYQBuaGEwIwYJKoZIhvcNAQkVMRYEFJ3fTdqF75rsYIa8J20E
6c5a3I+kMIHABgkqhkIG9w0BBwGggBIega8wgawwgakGCyqGSIb3DQEMcGECofow
WDacBgoqhkIG9w0BDAEDMA4ECFw78Uk8K64uAgIU+gQ4id0jRb3JyEM5fdpaeQR+
YEeMn+Y5KavplVD5HtgQQY9hhppbQqG4af7KY+MT6xus6oNEQeJAE5wxPjAXBgkq
hkiG9w0BCRQxCh4IAGQAYQBuaGEwIwYJKoZIhvcNAQkVMRYEFEGDhsFpuHhtrt7z

```
zAawM6xXMt2WMC8wHzAHBgUrDgMCGgQUzSoHpcIerV21CvC0jAe5ZVhs2M8ECC5D
kkz12M1tAgIoAA==
-----END PKCS12-----
```

## 9. Security Considerations

The keys presented in this document should be considered compromised and insecure, because the secret key material is published and therefore not secret.

Any application that maintains a deny list of invalid key material should include these keys in its list.

## 10. IANA Considerations

This document has no IANA actions.

## 11. References

### 11.1. Normative References

- [RFC5280] Cooper, D., Santesson, S., Farrell, S., Boeyen, S., Housley, R., and W. Polk, "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", RFC 5280, DOI 10.17487/RFC5280, May 2008, <<https://www.rfc-editor.org/info/rfc5280>>.
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