

## **LIPKEY - A Low Infrastructure Public Key Mechanism Using SPKM**

### Status of this Memo

This document is an Internet-Draft and is in full conformance with all provisions of [Section 10 of RFC2026](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at <http://www.ietf.org/ietf/1id-abstracts.txt>

The list of Internet-Draft Shadow Directories can be accessed at <http://www.ietf.org/shadow.html>.

### Abstract

This memorandum describes a method whereby one can use GSS-API [[RFC2078](#)] to supply a secure channel between a client and server, authenticating the client with a password, and server with a public key certificate. As such, it is analogous to the common low infrastructure usage of the Transport Layer Service (TLS) protocol [[RFC2246](#)].

The method leverages the existing Simple Public Key Mechanism (SPKM) [[RFC2025](#)], and is specified as a separate GSS-API mechanism (LIPKEY) layered on top of SPKM.

## Table of Contents

<a href="#">1.</a>	<a href="#">Introduction . . . . .</a>	<a href="#">4</a>
<a href="#">2.</a>	<a href="#">LIPKEY's Requirements of SPKM . . . . .</a>	<a href="#">5</a>
<a href="#">2.1.</a>	<a href="#">Mechanism Type . . . . .</a>	<a href="#">5</a>
<a href="#">2.2.</a>	<a href="#">Name Type . . . . .</a>	<a href="#">6</a>
<a href="#">2.3.</a>	<a href="#">Algorithms . . . . .</a>	<a href="#">6</a>
<a href="#">2.3.1.</a>	<a href="#">MANDATORY Algorithms . . . . .</a>	<a href="#">6</a>
<a href="#">2.3.2.</a>	<a href="#">RECOMMENDED Integrity Algorithms (I-ALG) . . . . .</a>	<a href="#">9</a>
<a href="#">2.4.</a>	<a href="#">Context Establish Tokens . . . . .</a>	<a href="#">9</a>
<a href="#">2.4.1.</a>	<a href="#">REQ-TOKEN Content Requirements . . . . .</a>	<a href="#">9</a>
<a href="#">2.4.1.1.</a>	<a href="#">algId and req-integrity . . . . .</a>	<a href="#">10</a>
<a href="#">2.4.1.2.</a>	<a href="#">Req-contents . . . . .</a>	<a href="#">10</a>
<a href="#">2.4.1.2.1.</a>	<a href="#">Options . . . . .</a>	<a href="#">10</a>
<a href="#">2.4.1.2.2.</a>	<a href="#">Conf-Algs . . . . .</a>	<a href="#">10</a>
<a href="#">2.4.1.2.3.</a>	<a href="#">Intg-Algs . . . . .</a>	<a href="#">10</a>
<a href="#">2.4.2.</a>	<a href="#">REP-TI-TOKEN Content Requirements . . . . .</a>	<a href="#">10</a>
<a href="#">2.4.2.1.</a>	<a href="#">algId . . . . .</a>	<a href="#">11</a>
<a href="#">2.4.2.2.</a>	<a href="#">rep-ti-integ . . . . .</a>	<a href="#">11</a>
<a href="#">2.5.</a>	<a href="#">Quality of Protection . . . . .</a>	<a href="#">11</a>
<a href="#">3.</a>	<a href="#">How LIPKEY Uses SPKM . . . . .</a>	<a href="#">12</a>
<a href="#">3.1.</a>	<a href="#">Tokens . . . . .</a>	<a href="#">12</a>
<a href="#">3.2.</a>	<a href="#">Initiator . . . . .</a>	<a href="#">12</a>
<a href="#">3.2.1.</a>	<a href="#">GSS_Import_name . . . . .</a>	<a href="#">12</a>
<a href="#">3.2.2.</a>	<a href="#">GSS_Acquire_cred . . . . .</a>	<a href="#">12</a>
<a href="#">3.2.3.</a>	<a href="#">GSS_Init_sec_context . . . . .</a>	<a href="#">13</a>
<a href="#">3.2.3.1.</a>	<a href="#">LIPKEY Caller Specified anon_req_flag as TRUE . . . . .</a>	<a href="#">13</a>
<a href="#">3.2.3.2.</a>	<a href="#">LIPKEY Caller Specified anon_req_flag as FALSE . . . . .</a>	<a href="#">14</a>
<a href="#">3.2.4.</a>	<a href="#">Other operations . . . . .</a>	<a href="#">15</a>
<a href="#">3.3.</a>	<a href="#">Target . . . . .</a>	<a href="#">15</a>
<a href="#">3.3.1.</a>	<a href="#">GSS_Import_name . . . . .</a>	<a href="#">15</a>
<a href="#">3.3.2.</a>	<a href="#">GSS_Acquire_cred . . . . .</a>	<a href="#">15</a>
<a href="#">3.3.3.</a>	<a href="#">GSS_Accept_sec_context . . . . .</a>	<a href="#">15</a>
<a href="#">4.</a>	<a href="#">LIPKEY Description . . . . .</a>	<a href="#">16</a>
<a href="#">4.1.</a>	<a href="#">Mechanism Type . . . . .</a>	<a href="#">16</a>
<a href="#">4.2.</a>	<a href="#">Name Types . . . . .</a>	<a href="#">16</a>
<a href="#">4.3.</a>	<a href="#">Token Formats . . . . .</a>	<a href="#">16</a>
<a href="#">4.3.1.</a>	<a href="#">Context Tokens . . . . .</a>	<a href="#">16</a>
<a href="#">4.3.1.1.</a>	<a href="#">Context Tokens Prior to SPKM-3 Context Establishment . . . . .</a>	<a href="#">17</a>
<a href="#">4.3.1.2.</a>	<a href="#">Post-SPKM-3 Context Establishment Token . . . . .</a>	<a href="#">17</a>
<a href="#">4.3.2.</a>	<a href="#">Tokens from GSS_GetMIC and GSS_Wrap . . . . .</a>	<a href="#">18</a>
<a href="#">4.4.</a>	<a href="#">Quality of Protection . . . . .</a>	<a href="#">18</a>
<a href="#">5.</a>	<a href="#">Security Considerations . . . . .</a>	<a href="#">18</a>
<a href="#">5.1.</a>	<a href="#">Password Management . . . . .</a>	<a href="#">18</a>
<a href="#">5.2.</a>	<a href="#">Certification Authorities . . . . .</a>	<a href="#">19</a>
<a href="#">5.3.</a>	<a href="#">HMAC-MD5 and MD5 Weaknesses . . . . .</a>	<a href="#">19</a>
<a href="#">5.4.</a>	<a href="#">Security of cast5CBC . . . . .</a>	<a href="#">19</a>
	<a href="#">References . . . . .</a>	<a href="#">20</a>

Expires: May 2000

[Page 2]

Acknowledgments . . . . . [22](#)  
Author's Address . . . . . [22](#)

## 1. Introduction

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [[RFC2119](#)].

This memorandum describes a new security mechanism under the GSS-API called the Low Infrastructure Public Key Mechanism (LIPKEY). GSS-API provides a way for an application protocol to implement authentication, integrity, and privacy. TLS is another way. While TLS is in many ways simpler for an application to incorporate than GSS-API, there are situations where GSS-API might be more suitable. Certainly this is the case with application protocols that run over connectionless protocols. It is also the case with application protocols such as ONC RPC [[RFC1831](#)] [[RFC2203](#)], which have their own security architecture, and so do not easily mesh with a protocol like TLS that is implemented as a layer that encapsulates the upper layer application protocol. GSS-API allows the application protocol to encapsulate as much of the application protocol as necessary.

Despite the flexibility of GSS-API, it compares unfavorably with TLS with respect to the perception of the amount of infrastructure required to deploy it. The better known GSS-API mechanisms, Kerberos V5 [[RFC1964](#)] and SPKM require a great deal of infrastructure to set up. Compare this to the typical TLS deployment scenario, which consists of a client with no public key certificate accessing a server with a public key certificate. The client:

- \* obtains the server's certificate,
- \* verifies that it was signed by a trusted Certification Authority (CA),
- \* generates a random session symmetric key,
- \* encrypts the session key with the server's public key, and
- \* sends the encrypted session key to the server.

At this point, the client and server have a secure channel. The client can then provide a user name and password to the server to authenticate the client. For example, when TLS is being used with the http protocol, once there is a secure channel, the http server will present the client with an html page that prompts for a user name and password. This information is then encrypted with the session key and sent to the server. The server then authenticates the client.

Note that the client is not required to have a certificate to

Expires: May 2000

[Page 4]

identify and authenticate it to the server. The only security infrastructure required, other than a TLS implementation, is a public key certificate and password database on the server. Most operating systems that the http server would run on already have a native password database, so the net additional infrastructure is a server certificate. Hence the term "low infrastructure security model" to identify this typical TLS deployment scenario.

By using unilateral authentication, and using a mechanism resembling the SPKM-1 mechanism type, SPKM can offer many aspects of the previously described low infrastructure security model. An application that uses GSS-API is certainly free to use GSS-API's GSS\_Wrap() routine to encrypt a user name and password and send them to the server, for it to decrypt and verify.

Applications often have application protocols associated with them, and there might not be any provision in the protocol to specify a password. Layering a thin GSS-API mechanism over a mechanism resembling SPKM-1 can mitigate this problem. This can be a useful approach to avoid versioning applications that have already bound to GSS-API, assuming the applications have not been written to statically bind to specific GSS-API mechanisms. The remainder of this memorandum defines the thin mechanism: the Low Infrastructure Public Key Mechanism (LIPKEY).

## **2. LIPKEY's Requirements of SPKM**

SPKM-1 with unilateral authentication is close to the desired low infrastructure model described earlier. This section describes some additional changes to how SPKM-1 operates in order to realize the low infrastructure model. These changes include some minor changes in semantics. While it would be possible to implement these semantic changes within an SPKM-1 implementation (including using the same mechanism type Object Identifier (OID) as SPKM-1), the set of changes stretch the interpretation of [RFC 2025](#) to the point where compatibility would be in danger. A new mechanism type, called SPKM-3, is warranted. LIPKEY requires that the SPKM implementation support SPKM-3. SPKM-3 is equivalent to SPKM-1, except as described in the remainder of this section.

### **2.1. Mechanism Type**

SPKM-3 has a different mechanism type OID from SPKM-1. The SPKM-3 mechanism type's OID is not yet defined.

Expires: May 2000

[Page 5]



## 2.2. Name Type

[RFC 2025](#) defines no required name types of SPKM. LIPKEY requires that the SPKM-3 implementation support all the mechanism independent name types in [RFC 2078](#).

## 2.3. Algorithms

### 2.3.1. MANDATORY Algorithms

[RFC 2025](#) defines various algorithms for integrity, confidentiality, key establishment, and subkey derivation. Except for md5WithRSAEncryption, the REQUIRED Key Establishment (K-ALG), Integrity (I-ALG) and One-Way Functions for Subkey Derivation (O-ALG) algorithms listed in [RFC 2025](#) continue to be REQUIRED.

SPKM is designed to be extensible with regard to new algorithms. In order for LIPKEY to work correctly and securely, the following algorithms MUST be implemented in SPKM-3:

\* Integrity algorithms (I-ALG)

NULL-MAC

Because the initiator may not have a certificate for itself, nor for the target, it is not possible for it to calculate an Integrity value in the initiator's REQ-TOKEN that is sent to the target. So we define, in ASN.1 [\[CCITT\]](#) syntax, a null I-ALG that returns a zero length bit string regardless of the input passed to it:

```
NULL-MAC OBJECT IDENTIFIER ::= {
    -- OID to be defined
}
```

id-dsa-with-sha1

This is the signature algorithm as defined in [Section 7.2.2 of \[RFC2459\]](#). As noted in [RFC 2459](#), the ASN.1 OID used to identify this signature algorithm is:

```
id-dsa-with-sha1 OBJECT IDENTIFIER ::= {
    iso(1) member-body(2) us(840) x9-57(10040)
    x9cm(4) 3
}
```

Expires: May 2000

[Page 6]

Note that there is a work-in-progress [[PKIX](#)] to obsolete [RFC 2459](#). However that work-in-progress does not change the definition of id-dsa-with-sha1.

#### HMAC-MD5

A consequence of the SPKM-3 initiator not having a certificate is that it cannot use a digital signature algorithm like md5withRSAEncryption, id-dsa-with-sha1, or sha1withRSAEncryption once the context is established. Instead, a message authentication code (MAC) algorithm is required. DES-MAC is specified as recommended in [[RFC2025](#)]. Since the security of 56 bit DES has been shown to be inadequate [[EFF](#)], SPKM-3 needs a stronger MAC. Thus, SPKM-3 MUST support the HMAC-MD5 algorithm [[RFC2104](#)], with this OID [[IANA](#)]:

```
HMAC-MD5 OBJECT IDENTIFIER ::= {
    iso(1) org(3) dod(6) internet(1) security(5)
        mechanisms(5) ipsec(8) isakmpOakley(1)
    1
}
```

The reference for the algorithm OID of HMAC-MD5 is [[IANA](#)].  
The reference for the HMAC-MD5 algorithm is [[RFC2104](#)].

The HMAC-SHA1 algorithm is not a mandatory SPKM-3 I-ALG MAC because SHA-1 is about half the speed of MD5 [[Young](#)]. A MAC based on an encryption algorithm like cast5CBC, DES EDE3, or RC4 is not mandatory because MD5 is 31 percent faster than the fastest of the three encryption algorithms [[Young](#)].

#### \* Confidentiality algorithm (C-ALG).

[RFC 2025](#) does not have a MANDATORY confidentiality algorithm, and instead has RECOMMENDED a 56 bit DES algorithm. Since the LIPKEY initiator needs to send a password to the target, and since 56 bit DES has been demonstrated as inadequate [[EFF](#)], LIPKEY needs stronger encryption. Thus, SPKM-3 MUST support this algorithm:

```
cast5CBC OBJECT IDENTIFIER ::= {
    iso(1) memberBody(2) usa(840) nt(113533) nsn(7)
        algorithms(66) 10
}
```

```
Parameters ::= SEQUENCE {
    iv OCTET STRING DEFAULT 0, -- Initialization vector
    keyLength INTEGER          -- Key length, in bits
}
```

Expires: May 2000

[Page 7]

```
}

```

The reference for the OID and description of the cast5CBC algorithm is [[RFC2144](#)]. The keyLength in the Parameters MUST be set 128 bits.

A triple DES (DES EDE3) algorithm is not a mandatory SPKM-3 C-ALG because it is much slower than cast5CBC. One set of measurements [[Young](#)] on a Pentium Pro 200 mega hertz processor using the SSLeay code, showed that DES EDE3 performed as high as 1,646,210 bytes per second, using 1024 byte blocks. The same test bed yielded performance of 7,147,760 bytes per second for cast5CBC, and 22,419,840 bytes per second for RC4. Most TLS sessions negotiate the RC4 cipher. Given that LIPKEY is targeted at environments similar to that where TLS is deployed, selecting a cipher that is over 13 times slower (and over 13 times more CPU intensive) than RC4 would severely impede the usefulness of LIPKEY. For performance reasons, RC4 would be the preferred mandatory algorithm for SPKM-3. Due to intellectual property considerations with RC4 [[Schneier](#)], the combination of cast5CBC's reasonable performance, and its royalty-free licensing terms [[RFC2144](#)] make cast5CBC the optimal choice among DES EDE3, RC4, and cast5CBC.

\* Key Establishment Algorithm (K-ALG)

[RFC 2025](#) lists dhKeyAgreement [[PKCS-3](#)] as an apparently optional algorithm. As will be described later, the RSAEncryption key establishment algorithm is of no use for a low infrastructure security mechanism as defined by this memorandum. Hence, in SPKM-3, dhKeyAgreement is a REQUIRED key establishment algorithm:

```
dhKeyAgreement OBJECT IDENTIFIER ::= {
    iso(1) member-body(2) US(840) rsadsi(113549) pkcs(1)
    pkcs-3(3) 1
}
```

\* One-Way Function for Subkey Derivation Algorithm (O-ALG)

[RFC 2025](#) lists MD5 as a mandatory algorithm. Since MD5 has been found to have weaknesses when used as a hash [[Dobbertin](#)], id-sha1 is a MANDATORY O-ALG in SPKM-3:

```
id-sha1 OBJECT IDENTIFIER ::= {
    iso(1) identified-organization(3) oiw(14)
    secsig(3) algorithms(2) 26
}
```

Expires: May 2000

[Page 8]

The reference for the algorithm OID of id-sha1 is [[RFC2437](#)]. The reference for SHA-1 algorithm corresponding to id-sha1 is [[FIPS](#)].

### **2.3.2. RECOMMENDED Integrity Algorithms (I-ALG)**

#### md5WithRSAEncryption

The md5WithRSAEncryption integrity algorithm is listed in [[RFC2025](#)] as mandatory. Due to intellectual property considerations [[RSA-IP](#)], SPKM-3 implementations cannot be required to implement it. However, given the proliferation of certificates using RSA public keys, md5WithRSAEncryption is strongly RECOMMENDED. Otherwise, the opportunities for LIPKEY to leverage existing public key infrastructure will be limited.

#### sha1WithRSAEncryption

For reasons similar to that for md5WithRSAEncryption, sha1WithRSAEncryption is a RECOMMENDED algorithm. The sha1WithRSAEncryption algorithm is listed in addition to md5WithRSAEncryption due to weaknesses in the MD5 hash algorithm [[Dobbertin](#)]. The OID for sha1WithRSAEncryption is:

```
sha1WithRSAEncryption OBJECT IDENTIFIER ::= {
    iso(1) member-body(2) US(840) rsadsi(113549) pkcs(1)
    pkcs-1(1) 5
}
```

The reference for the algorithm OID and description of sha1WithRSAEncryption is [[RFC2437](#)].

## **2.4. Context Establish Tokens**

[RFC 2025](#) sets up a context with an initiator first token (REQ-TOKEN), a target reply (REP-TI-TOKEN), and finally an initiator second token (REP-IT-TOKEN) to reply to the target's reply. Since LIPKEY uses SPKM-3 with unilateral authentication, the REP-IT-TOKEN is not used. LIPKEY has certain requirements on the contents of the REQ-TOKEN and REP-TI-TOKEN, but the syntax of the SPKM-3 tokens is not different from [RFC 2025](#)'s SPKM-1 tokens.

### **2.4.1. REQ-TOKEN Content Requirements**

Expires: May 2000

[Page 9]



#### **2.4.1.1. algId and req-integrity**

If the SPKM-3 initiator cannot calculate a req-integrity field due to the lack of a target certificate, it MUST use the NULL-MAC I-ALG described earlier in this memorandum. This will produce a zero length bit string in the Integrity field.

#### **2.4.1.2. Req-contents**

Because [RFC 2025](#) requires that the RSAEncryption K-ALG be present, SPKM-1 must be able to map the target (targ-name) to its public key certificate, and thus SPKM can use the RSAEncryption algorithm to fill in the key-estb-req field. Because LIPKEY assumes a low infrastructure deployment, SPKM-3 MUST be prepared to be unable to map the targ-name field of the Req-contents field. This is a contradiction which is resolved by requiring SPKM-3 to support the dhKeyAgreement algorithm. Note that if an SPKM-3 implementation tries to map the target to a certificate, and succeeds, it is free to use the RSAEncryption K-ALG algorithm. It is also free to use an algID other than NULL-MAC in the REQ-TOKEN type.

##### **2.4.1.2.1. Options**

SPKM-3 implementations MUST set the target-certif-data-required bit to 1 if the only K-ALG in the key-estb-set field of Req-contents is dhKeyAgreement. This would normally occur if the SPKM-3 implementation cannot resolve the target name to a certificate.

##### **2.4.1.2.2. Conf-Algs**

If the SPKM-3 implementation supports an algorithm weaker than cast5CBC, cast5CBC MUST be listed before the weaker algorithm to encourage the target to negotiate the stronger algorithm.

##### **2.4.1.2.3. Intg-Algs**

Because the initiator will be anonymous (at the SPKM-3 level) and will not have a certificate for itself, the initiator cannot use an integrity algorithm that supports non-repudiation; it must use a MAC algorithm. If the SPKM-3 implementation supports an algorithm weaker than HMAC-MD5, HMAC-MD5 MUST be listed before the weaker algorithm to encourage the target to negotiate the stronger algorithm.

#### **2.4.2. REP-TI-TOKEN Content Requirements**

With the previously described requirements on REQ-TOKEN, the contents of SPKM-3's REP-TI-TOKEN can for the most part be derived from the specification in [RFC 2025](#). The exceptions are the algId and rep-ti-

Expires: May 2000

[Page 10]

integ fields.

**2.4.2.1. algId**

The SPKM-3 target MUST NOT use a NULL-MAC I-ALG; it MUST use a signature algorithm like id-dsa-with-sha1, md5WithRSAEncryption, or sha1WithRSAEncryption.

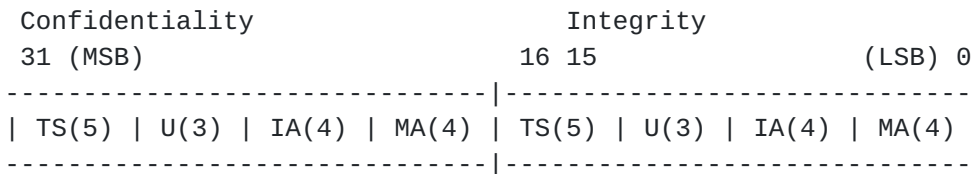
**2.4.2.2. rep-ti-integ**

If the req-token has an algId of NULL-MAC, then the target MUST compute the rep-ti-integ on the concatenation of the req-contents and rep-ti-contents.

**2.5. Quality of Protection**

The SPKM-3 initiator and target negotiate the set of algorithms they mutually support, using the procedure defined in Section 5.2 of [RFC 2025](#). If a QOP of zero is specified, then the initiator and target will use the first C-ALG (privacy), and I-ALG (integrity) algorithms negotiated.

SPKM breaks the QOP into several fields, as reproduced here from [Section 5.2 of RFC 2025](#):



The MA subfields enumerate mechanism-defined algorithms. Since this memorandum introduces a new mechanism, SPKM-3, within the SPKM family, it is appropriate to add algorithms to the MA subfields of the respective Confidentiality and Integrity fields.

The complete set of Confidentiality MA algorithms is thus:

- 0001 (1) = DES-CBC
- 0010 (2) = cast5CBC

Where "0001" and "0010" are in base 2. An SPKM peer that negotiates a confidentiality MA algorithm value of "0010" MUST use a 128 bit key, i.e. set the keyLength values in the cast5CBC Parameters to 128 bits.

The complete set of Integrity MA algorithms is thus:

Expires: May 2000

[Page 11]

0001 (1) = md5WithRSAEncryption  
0010 (2) = DES-MAC  
0011 (3) = id-dsa-with-sha1  
0100 (4) = HMAC-MD5  
0101 (5) = sha1WithRSAEncryption

Where "0001" through "0101" are in base 2.

Adding support for cast5CBC, id-dsa-with-sha1, HMAC-MD5, and sha1WithRSAEncryption in the above manner to SPKM-1 and SPKM-2 does not impair SPKM-1 and SPKM-2 backward compatibility because, as noted previously, SPKM negotiates algorithms. An older SPKM-1 or SPKM-2 that does not recognize MA values for cast5CBC, id-dsa-with-sha1, or HMAC-MD5 will not select them.

### **3. How LIPKEY Uses SPKM**

#### **3.1. Tokens**

LIPKEY will invoke SPKM-3 to produce SPKM tokens. Since the mechanism that the application uses is LIPKEY, LIPKEY will wrap some of the SPKM-3 tokens with LIPKEY prefixes. The exact definition of the tokens is described later in this memorandum.

#### **3.2. Initiator**

##### **3.2.1. GSS\_Import\_name**

The initiator uses GSS\_Import\_name to import the target's name, typically, but not necessarily, using the GSS\_C\_NT\_HOSTBASED\_SERVICE name type. Ultimately, the output of GSS\_Import\_name will apply to an SPKM-3 mechanism type because a LIPKEY target is an SPKM-3 target.

##### **3.2.2. GSS\_Acquire\_cred**

The initiator calls GSS\_Acquire\_cred. The credentials that are acquired are LIPKEY credentials, a user name and password. How the user name and password is acquired is dependent upon the operating environment. A application that invokes GSS\_Acquire\_cred() while the application's user has a graphical user interface running might trigger the appearance of a pop up window that prompts for the information. A application embedded into the operating system, such as an NFS [[Sandberg](#)] client implemented as a native file system might broadcast a message to the user's terminals telling him to invoke a command that prompts for the information.

Expires: May 2000

[Page 12]

### **3.2.3. GSS\_Init\_sec\_context**

When a program invokes `GSS_Init_sec_context` on the LIPKEY mechanism type, if the context handle is NULL, the LIPKEY mechanism will in turn invoke `GSS_Init_sec_context` on an SPKM-3 mechanism implemented according to the requirements described previously. This call to SPKM-3 MUST have the following attributes:

- \* `claimant_cred_handle` is NULL
- \* `mutual_req_flag` is FALSE
- \* `anon_req_flag` is TRUE
- \* `input_token` is NULL
- \* `mech_type` is the OID of the SPKM-3 mechanism

Keep in mind the above attributes are in the `GSS_Init_sec_context` call from the LIPKEY mechanism down to the SPKM-3 mechanism. There are no special restrictions placed on the application invoking LIPKEY's `GSS_Init_sec_context` routine. All other arguments are derived from the LIPKEY `GSS_Init_sec_context` arguments.

The call to the SPKM-3 `GSS_Init_sec_context` will create an SPKM-3 context handle. The remainder of the description of the LIPKEY `GSS_Init_sec_context` call depends on whether the caller of the LIPKEY `GSS_Init_sec_context` sets `anon_req_flag` to TRUE or FALSE.

#### **3.2.3.1. LIPKEY Caller Specified `anon_req_flag` as TRUE**

If the caller of LIPKEY's `GSS_Init_sec_context` sets `anon_req_flag` to TRUE, it MUST return to the LIPKEY caller all the outputs from the SPKM-3 `GSS_Init_sec_context` call, including the `output_context_handle`, `output_token`, and `mech_type`. In this way, LIPKEY now "gets out of the way" of GSS-API processing between the application and SPKM-3, because nothing in the returned outputs relates to LIPKEY. This is necessary, because LIPKEY context tokens do not have provision for specifying anonymous initiators. This is because SPKM-3 is sufficient for purpose of supporting anonymous initiators in a low infrastructure environment.

Clearly, when the LIPKEY caller desires anonymous authentication, LIPKEY does not add any value, but it is simpler to support the feature, than to insist the caller directly use SPKM-3.

If all goes well, the caller of LIPKEY will be returned a major status of `GSS_S_CONTINUE_NEEDED` via SPKM-3, and so the caller of

Expires: May 2000

[Page 13]



LIPKEY will send the `output_token` to the target. The caller of LIPKEY then receives the response token from the target, and directly invokes the SPKM-3 `GSS_Init_sec_context`. Upon return, the major status should be `GSS_S_COMPLETE`.

#### **3.2.3.2. LIPKEY Caller Specified `anon_req_flag` as `FALSE`**

The LIPKEY mechanism will need to allocate a context handle for itself, and record in the LIPKEY context handle the SPKM-3 context handle that was returned in the `output_context_handle` parameter from the call to the SPKM-3 `GSS_Init_sec_context` routine. The LIPKEY `GSS_Init_sec_context` routine will return in `output_context_handle` the LIPKEY context handle, and in `mech_type`, the LIPKEY mechanism type. The `output_token` is as defined later in this memorandum, in the subsection entitled "Context Tokens Prior to SPKM-3 Context Establishment." All the other returned outputs will be those that the SPKM-3 `GSS_Init_sec_context` routine returned to LIPKEY. If all went well, the SPKM-3 mechanism will have returned a major status of `GSS_S_CONTINUE_NEEDED`.

The caller of the LIPKEY `GSS_Init_sec_context` routine will see a major status of `GSS_S_CONTINUE_NEEDED`, and so the caller of LIPKEY will send the `output_token` to the target. The caller of LIPKEY then receives the target's response token, and invokes the LIPKEY `GSS_Init_sec_context` routine for a second time. LIPKEY then invokes the SPKM-3 `GSS_Init_sec_context` for a second time and upon return, the major status should be `GSS_S_COMPLETE`.

While SPKM-3's context establishment is now complete, LIPKEY's context establishment is not yet complete, because the initiator must send to the target the user name and password that was passed to it via the `claimant_cred_handle` on the first call to the LIPKEY `GSS_Init_sec_context` routine. LIPKEY uses the established SPKM-3 context handle as the input to `GSS_Wrap` (with `conf_req_flag` set to `TRUE`) to encrypt what the `claimant_cred_handle` refers to (user name and password), and returns that as the output token to the caller of LIPKEY (provided the `conf_state` output from call to the SPKM-3 `GSS_Wrap` is `TRUE`), along with a major status of `GSS_S_CONTINUE_NEEDED`.

The caller of LIPKEY sends its second token to the target, and waits for either a `GSS_S_COMPLETE` response from the target, indicating that the user name and password was accepted, or an error indicating rejection of the user name and password (`GSS_S_NO_CRED`), or some other appropriate error.

The SPKM-3 context remains established while the LIPKEY context is established. If the SPKM-3 context expires before the LIPKEY context

Expires: May 2000

[Page 14]

is destroyed, the LIPKEY implementation should expire the LIPKEY context and return the appropriate error on the next GSS-API operation.

#### **3.2.4. Other operations**

For other operations, the LIPKEY context acts as a pass through to the SPKM-3 context. Operations that affect or inquire context state, such as `GSS_Delete_sec_context`, `GSS_Export_sec_context`, `GSS_Import_sec_context`, and `GSS_Inquire_context` will require a pass through to the SPKM-3 context and a state modification of the LIPKEY context.

### **3.3. Target**

#### **3.3.1. GSS\_Import\_name**

As with the initiator, the imported name will be that of the target.

#### **3.3.2. GSS\_Acquire\_cred**

The acceptor calls the LIPKEY `GSS_Acquire_cred` routine to get a credential for an SPKM-3 target, via the SPKM-3 `GSS_Acquire_cred` routine. The `desired_name` is the `output_name` from `GSS_Import_name`.

#### **3.3.3. GSS\_Accept\_sec\_context**

When a program invokes `GSS_Accept_sec_context` on the LIPKEY mechanism type, if the context handle is `NULL`, the LIPKEY mechanism will in turn invoke `GSS_Accept_sec_context` on an SPKM-3 mechanism implemented according the requirements described previously. This call to SPKM-3 is no different than what one would expect for a layered call to `GSS_Accept_sec_context`.

If all goes well, the SPKM-3 `GSS_Accept_sec_context` call succeeds with `GSS_S_COMPLETE`, and the LIPKEY `GSS_Accept_sec_context` call returns the `output_token` to the caller, but with a major status of `GSS_S_CONTINUE_NEEDED` because the LIPKEY initiator is still expected to send the user name and password.

Once the SPKM-3 context is in a `GSS_S_COMPLETE` state, the next token the target receives will contain the user name and password, wrapped by the output of an SPKM-3 `GSS_Wrap` call. The target invokes the LIPKEY `GSS_Accept_sec_context`, which in turn invokes the SPKM-3 `GSS_Unwrap` routine. The LIPKEY `GSS_Accept_sec_context` routine then compares the user name and password with its user name and password database. If the initiator's user name and password are

Expires: May 2000

[Page 15]

valid, GSS\_S\_COMPLETE is returned to the caller. Otherwise GSS\_S\_NO\_CRED is returned. In either case, a zero length output\_token is returned to the caller. The target should send the major status to the initiator and expect no more context tokens for that context.

## **4. LIPKEY Description**

### **4.1. Mechanism Type**

The OID for LIPKEY is to be defined.

### **4.2. Name Types**

LIPKEY uses only the mechanism independent name types defined in [RFC 2078](#). All the name types defined in [RFC 2078](#) are REQUIRED.

### **4.3. Token Formats**

#### **4.3.1. Context Tokens**

GSS-API defines the context tokens as:

```
InitialContextToken ::=
-- option indication (delegation, etc.) indicated within
-- mechanism-specific token
[APPLICATION 0] IMPLICIT SEQUENCE {
    thisMech MechType,
    innerContextToken ANY DEFINED BY thisMech
    -- contents mechanism-specific
    -- ASN.1 structure not required
}

SubsequentContextToken ::= innerContextToken ANY
-- interpretation based on predecessor InitialContextToken
-- ASN.1 structure not required
```

The contents of the innerContextToken depend on whether the SPKM-3 context is established or not.

Expires: May 2000

[Page 16]

#### 4.3.1.1. Context Tokens Prior to SPKM-3 Context Establishment

In a LIPKEY InitialContextToken, thisMech will be the Object identifier for LIPKEY. However, as long as LIPKEY has not established the SPKM-3 mechanism, the innerContextToken for both the InitialContextToken and the SubsequentContextToken will be the output of an SPKM-3 GSS\_Init\_sec\_context or GSS\_Accept\_sec\_context. So the LIPKEY innerContextToken would be either:

- \* An InitialContextToken, with thisMech set to the object identifier for SPKM-3, with innerContextToken defined to be an SPKMInnerContextToken, as defined in [RFC 2025](#).
- \* A SubsequentContextToken, with innerContextToken defined to be SPKMInnerContextToken

#### 4.3.1.2. Post-SPKM-3 Context Establishment Token

Once the SPKM-3 context is established, there is just one token sent from the initiator to the target, and no token returned to initiator. This token is the result of a GSS\_Wrap (conf\_req is set to TRUE) of a user name and password by the SPKM-3 context. This is the SPKM-WRAP token and is partially reproduced here from [RFC 2025](#):

```

SPKM-WRAP ::= SEQUENCE {
    wrap-header    Wrap-Header,
    wrap-body     Wrap-Body
}

Wrap-Body ::= SEQUENCE {
    int-cksum     BIT STRING,
                -- Checksum of header and data,
                -- calculated according to
                -- algorithm specified in int-alg
                -- field of wrap-header
    data         BIT STRING
                -- encrypted data.
}

```

The "data" field of Wrap-Body is contains the result of a GSS\_Wrap operation on this type:

```

UserName-Password ::= SEQUENCE {
    user-name     OCTET STRING,
                -- each octet is an octet of a
                -- UTF-8 [RFC2279] string
    password     OCTET STRING
                -- each octet is an octet of a

```

Expires: May 2000

[Page 17]



```
    }
    -- UTF-8 [RFC2279] string
```

#### **4.3.2. Tokens from GSS\_GetMIC and GSS\_Wrap**

[RFC 2078](#) defines the token emitted by GSS\_GetMIC and GSS\_Wrap as:

```
PerMsgToken ::=
  -- as emitted by GSS_GetMIC and processed by GSS_VerifyMIC
  -- ASN.1 structure not required
  innerMsgToken ANY

SealedMessage ::=
  -- as emitted by GSS_Wrap and processed by GSS_Unwrap
  -- includes internal, mechanism-defined indicator
  -- of whether or not encrypted
  -- ASN.1 structure not required
  sealedUserData ANY
```

As one can see, there are no mechanism independent prefixes in PerMSGToken or SealedMessage, and no explicit mechanism specific information either. Since LIPKEY does not add any value to GSS\_GetMIC and GSS\_Wrap other than passing the message to the SPKM-3 GSS\_GetMIC and GSS\_Wrap, LIPKEY's PerMsgToken and SealedMessage tokens are exactly what SPKM-3's GSS\_GetMIC and GSS\_Wrap routines produce.

#### **4.4. Quality of Protection**

LIPKEY, being a pass through for GSS\_Wrap and GSS\_GetMIC to SPKM-3, does not interpret or alter the QOPs passed to the aforementioned routines or received from their complements, GSS\_Unwrap, and GSS\_VerifyMIC. Thus, LIPKEY supports the same set of QOPs as SPKM-3.

### **5. Security Considerations**

#### **5.1. Password Management**

LIPKEY sends the clear text password encrypted by 128 bit cast5CBC so the risk in this approach is in how the target manages the password after it is done with it. The approach should be safe, provided the target clears the memory (primary and secondary, such as disk) buffers that contained the password, and any hash of the password immediately after it has verified the user's password.

Expires: May 2000

[Page 18]

## **5.2. Certification Authorities**

The initiator must have a list of trusted Certification Authorities in order to verify the checksum (rep-ti-integ) on the SPKM-3 target's context reply token. If it encounters a certificate signed by an unknown and/or untrusted certificate authority, the initiator MUST NOT silently accept the certificate. If it does wish to accept the certificate, it MUST get confirmation from the user running the application that is using GSS-API.

## **5.3. HMAC-MD5 and MD5 Weaknesses**

While the MD5 hash algorithm has been found to have weaknesses [[Dobbertin](#)], the weaknesses do not impact the security of HMAC-MD5 [[Dobbertin](#)].

## **5.4. Security of cast5CBC**

The cast5CBC encryption algorithm is relatively new compared to established algorithms like triple DES, and RC4. Nonetheless, the choice of cast5CBC as the MANDATORY C-ALG for SPKM-3 is advisable. The cast5CBC algorithm is a 128 bit algorithm that the 256 bit cast6CBC [[RFC2612](#)] algorithm is based upon. The cast6CBC algorithm was judged by the U.S. National Institute of Standards and Technology (NIST) to have no known major or minor "security gaps," and to have a "high security margin" [[AES](#)]. NIST did note some vulnerabilities related to smart card implementations, but many other algorithms NIST analyzed shared the vulnerabilities, and in any case, LIPKEY is by definition not aimed at smart cards.

Expires: May 2000

[Page 19]

## References

- [AES] Nechvatal, J., Barker, E., Dodson, D., Dworkin, M., Foti, J., Roback, E. (Undated, but no later than 1999). "Status Report on the First Round of the Development of the Advanced Encryption Standard."  
<http://csrc.nist.gov/encryption/aes/round1/r1report.htm>
- [CCITT] CCITT (1988). "Recommendation X.208: Specification of Abstract Syntax Notation One (ASN.1)."
- [Dobbertin] Dobbertin, H. (1996). "The Status of Md5 After a Recent Attack," RSA Laboratories' CryptoBytes, Volume 2, Number 2.  
<ftp://ftp.rsasecurity.com/pub/cryptobytes/crypto2n2.pdf>
- [EFF] Electronic Frontier Foundation, John Gilmore (Editor) (1998). "Cracking Des: Secrets of Encryption Research, Wiretap Politics & Chip Design," O'Reilly & Associates, ISBN 1565925203.
- [FIPS] National Institute of Standards and Technology (1995). "Secure Hash Standard" (SHA-1).  
<http://www.itl.nist.gov/fipspubs/fip180-1.htm>
- [IANA] Internet Assigned Numbers Authority (1999). "Network Management Parameters."  
<http://www.isi.edu/in-notes/iana/assignments/smi-numbers>
- [PKCS-3] RSA Laboratories (1993). "PKCS #3: Diffie-Hellman Key-Agreement Standard, Version 1.4."  
<ftp://ftp.rsa.com/pub/pkcs/ascii/pkcs-3.asc>
- [PKIX] Housley, R., Ford, W., Polk, W., Solo, D. (1999). "Internet X.509 Public Key Infrastructure Certificate and CRL Profile."
- [RFC1831] Srinivasan, R. (1995). "RPC: Remote Procedure Call Protocol Specification Version 2," [RFC 1831](#).  
<http://www.ietf.org/rfc/rfc1831.txt>
- [RFC1832] Srinivasan, R. (1995). "XDR: External Data Representation Standard," [RFC 1832](#).  
<http://www.ietf.org/rfc/rfc1832.txt>
- [RFC1964] Linn, J. (1996). "The Kerberos Version 5 GSS-API Mechanism," [RFC 1964](#).

Expires: May 2000

[Page 20]

<http://www.ietf.org/rfc/rfc1964.txt>

- [RFC2203] Eisler, M., Chiu, A., Ling L. (1997). "RPCSEC\_GSS Protocol Specification," [RFC 2203](#).  
<http://www.ietf.org/rfc/rfc2203.txt>
- [RFC2025] Adams, C. (1996). "The Simple Public-Key GSS-API Mechanism (SPKM)," [RFC 2025](#).  
<http://www.ietf.org/rfc/rfc2025.txt>
- [RFC2078] Linn, J. (1997). "Generic Security Service Application Program Interface, Version 2," [RFC 2078](#).  
<http://www.ietf.org/rfc/rfc2078.txt>
- [RFC2104] Krawczyk, H, Bellare, M., Canetti, R. (1997). "HMAC: Keyed-Hashing for Message Authentication," [RFC 2104](#).  
<http://www.ietf.org/rfc/rfc2104.txt>
- [RFC2119] Bradner, S. (1997). "Key words for use in RFCs to Indicate Requirement Levels," [RFC 2119](#).  
<http://www.ietf.org/rfc/rfc2119.txt>
- [RFC2144] Adams, C. (1997). "The CAST-128 Encryption Algorithm," [RFC 2144](#).  
<http://www.ietf.org/rfc/rfc2144.txt>
- [RFC2246] Dierks, T., Allen, C. (1999). "The TLS Protocols Version 1.0," [RFC 2246](#).  
<http://www.ietf.org/rfc/rfc2246.txt>
- [RFC2279] Yergeau, F. (1998). "UTF-8, a transformation format of ISO 10646," [RFC 2279](#).  
<http://www.ietf.org/rfc/rfc2279.txt>
- [RFC2437] Kaliski, B., Staddon, J. (1998). "PKCS #1: RSA Cryptography Specifications Version 2.0," [RFC 2437](#).  
<http://www.ietf.org/rfc/rfc2437.txt>
- [RFC2459] Housley, R., Ford, W., Polk, W., Solo, D. (1999). "Internet X.509 Public Key Infrastructure Certificate and CRL Profile," [RFC 2459](#).  
<http://www.ietf.org/rfc/rfc2459.txt>
- [RFC2612] Adams, C., Gilchrist, J. (1999). "The CAST-256 Encryption Algorithm," [RFC 2612](#).  
<http://www.ietf.org/rfc/rfc2612.txt>
- [RSA] S/MIME Editor, RSA Data Security, Inc. (1995). "S/MIME

Expires: May 2000

[Page 21]



Implementation Guide Interoperability Profile, Version 1."  
<ftp://ftp.rsa.com/pub/S-MIME/smimeimp.txt>

[RSA-IP] Unidentified member of IETF's Public-Key Infrastructure (X.509) Working Group (Undated, but no later than 1999). "RSA's unofficial statement pertaining to PKIX."  
<http://www.ietf.org/ietf/IPR/PKIX-RSA>

[Sandberg]  
Sandberg, R., Goldberg, D., Kleiman, S., Walsh, D., Lyon, B. (1985). "Design and Implementation of the Sun Network Filesystem," Proceedings of the 1985 Summer USENIX Technical Conference.

[Schneier]  
Schneier, B. (1996). "Applied Cryptography," John Wiley & Sons, Inc., ISBN 0-471-11709-9.

[Young] Young, E.A. (1997). "Index of /archives/net/Crypto/libeay."  
<http://ring.crl.go.jp/archives/net/Crypto/libeay/>

#### Acknowledgments

The author thanks and acknowledges:

- \* Jack Kabat for his patient explanation of the intricacies of SPKM, excellent suggestions, and review comments.
- \* Denis Pinkas for his review comments.
- \* Carlisle Adams for his review comments.
- \* This memorandum includes ASN.1 definitions for GSS-API tokens from [RFC 2078](#), which was authored by John Linn.
- \* This memorandum includes ASN.1 definitions and other text from the SPKM definition in [RFC 2025](#), which was authored by Carlisle Adams.

#### Author's Address

Address comments related to this memorandum to:

cat-ietf@mit.edu

Mike Eisler  
Sun Microsystems, Inc.  
5565 Wilson Road

Expires: May 2000

[Page 22]

Colorado Springs, CO 80919

Phone: 1-719-599-9026

E-mail: mre@eng.sun.com