

SASL GSSAPI mechanisms

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A revised version of this draft document will be submitted to the RFC editor as a Proposed Standard for the Internet Community. Discussion and suggestions for improvement are requested.

NOTE TO RFC EDITOR: Prior to publication as an RFC, the RFC Editor is directed to replace occurrences of "[THIS-DOC]" with the RFC number assigned to this document.

Internet DRAFT

GSSAPI SASL mechanisms

May 30, 2001

1. Abstract

The Simple Authentication and Security Layer [[SASL](#)] is a method for adding authentication support to connection-based protocols. This document describes the method for using the Generic Security Service Application Program Interface [[GSSAPI](#)] in the Simple Authentication and Security Layer [[SASL](#)].

This document replaces [section 7.2 of RFC 2222](#) [[SASL](#)], the definition of the "GSSAPI" SASL mechanism.

2. Conventions Used in this Document

The key words "MUST", "MUST NOT", "SHOULD", "SHOULD NOT", and "MAY" in this document are to be interpreted as defined in "Key words for use in RFCs to Indicate Requirement Levels" [[KEYWORDS](#)].

3. Introduction and Overview

Each and every GSSAPI mechanism used within SASL is implicitly registered by this specification.

For backwards compatibility with existing implementations of Kerberos V5 and SPNEGO under SASL, the SASL mechanism name for the Kerberos V5 GSSAPI mechanism [[GSSAPI-KERBEROS](#)] is "GSSAPI" and the SASL mechanism for the SPNEGO GSSAPI mechanism [[SPNEGO](#)] is "GSS-SPNEGO". The SASL mechanism name for any other GSSAPI mechanism is the concatenation of "GSS-" and the Base32 encoding of the first ten bytes of the MD5 hash [[MD5](#)] of the ASN.1 DER encoding [[ASN1](#)] of the GSSAPI mechanism's OID. Base32 encoding is described later in this document. The Base32 rules on padding characters and characters outside of the base32 alphabet are not relevant to this use of Base32.

SASL mechanism names starting with "GSS-" are reserved for SASL mechanisms which conform to this document.

The specification of all SASL mechanisms conforming to this document is in the "Specification common to all GSSAPI mechanisms" section of this document.

The IESG is considered to be the owner of all SASL mechanisms which conform to this document. This does NOT necessarily imply that the IESG is considered to be the owner of the underlying GSSAPI

mechanism.

[3.1](#) Example

The OID for the SPKM-1 mechanism [[SPKM](#)] is 1.3.6.1.5.5.1. The ASN.1 DER encoding of this OID is 06 06 2b 06 01 05 05 01. The MD5 hash of the ASN.1 DER encoding is 57 ee 81 82 4e ac 4d b0 e6 50 9f 60 1f 46 8a 30. The Base32 encoding of the first ten bytes of this is "K7XIDAS0VRG3BZSQ". Thus the SASL mechanism name for the SPKM-1 GSSAPI mechanism is "GSS-K7XIDAS0VRG3BZSQ".

[4.](#) SPNEGO

Use of the Simple and Protected GSS-API Negotiation Mechanism [[SPNEGO](#)] underneath SASL introduces subtle interoperability problems and security considerations. To address these, this section places additional requirements on implementations which support SPNEGO underneath SASL.

A client which supports, for example, the Kerberos V5 GSSAPI mechanism only underneath SPNEGO underneath the "GSS-SPNEGO" SASL mechanism will not interoperate with a server which supports the Kerberos V5 GSSAPI mechanism only underneath the "GSSAPI" SASL mechanism.

Since SASL is capable of negotiating amongst GSSAPI mechanisms, the only reason for a server or client to support the "GSS-SPNEGO" mechanism is to allow a policy of only using mechanisms below a certain strength if those mechanism's negotiation is protected. In such a case, a client or server would only want to negotiate those weaker mechanisms through SPNEGO. In any case, there is no down-negotiation security consideration with using the strongest mechanism and set of options the implementation supports, so for interoperability that mechanism and set of options MUST be negotiable without using the "GSS-SPNEGO" mechanism.

If a client's policy is to first prefer GSSAPI mechanism X, then non-GSSAPI mechanism Y, then GSSAPI mechanism Z, and if a server

supports mechanisms Y and Z but not X, then if the client attempts to negotiate mechanism X by using the "GSS-SPNEGO" SASL mechanism, it may end up using mechanism Z when it should have used mechanism Y. For this reason, implementations MUST exclude from SPNEGO those GSSAPI mechanisms which are weaker than the strongest non-GSSAPI SASL mechanism advertised by the server.

5. Base32 encoding

The Base32 encoding is designed to represent arbitrary sequences of octets in a form that needs to be case insensitive but need not be humanly readable.

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A 33-character subset of US-ASCII is used, enabling 5 bits to be represented per printable character. (The extra 33rd character, "=", is used to signify a special processing function.)

The encoding process represents 40-bit groups of input bits as output strings of 8 encoded characters. Proceeding from left to right, a 40-bit input group is formed by concatenating 5 8bit input groups. These 40 bits are then treated as 8 concatenated 5-bit groups, each of which is translated into a single digit in the base32 alphabet. When encoding a bit stream via the base32 encoding, the bit stream must be presumed to be ordered with the most-significant-bit first. That is, the first bit in the stream will be the high-order bit in the first 8bit byte, and the eighth bit will be the low-order bit in the first 8bit byte, and so on.

Each 5-bit group is used as an index into an array of 32 printable characters. The character referenced by the index is placed in the output string. These characters, identified in Table 1, below, are selected from US-ASCII digits and uppercase letters.

Table 1: The Base32 Alphabet

Value	Encoding	Value	Encoding	Value	Encoding	Value	Encoding
0	A	9	J	18	S	27	3
1	B	10	K	19	T	28	4
2	C	11	L	20	U	29	5
3	D	12	M	21	V	30	6
4	E	13	N	22	W	31	7
5	F	14	O	23	X		

6 G	15 P	24 Y	(pad) =
7 H	16 Q	25 Z	
8 I	17 R	26 2	

Special processing is performed if fewer than 40 bits are available at the end of the data being encoded. A full encoding quantum is always completed at the end of a body. When fewer than 40 input bits are available in an input group, zero bits are added (on the right) to form an integral number of 5-bit groups. Padding at the end of the data is performed using the "=" character. Since all base32 input is an integral number of octets, only the following cases can arise: (1) the final quantum of encoding input is an integral multiple of 40 bits; here, the final unit of encoded output will be an integral multiple of 8 characters with no "=" padding, (2) the final quantum of encoding input is exactly 8 bits; here, the final unit of encoded output will be two characters followed by six "=" padding characters, (3) the final quantum of encoding input is exactly 16 bits; here, the final unit of encoded output will be four characters followed by four "=" padding characters, (4) the final

quantum of encoding input is exactly 24 bits; here, the final unit of encoded output will be five characters followed by three "=" padding characters, or (5) the final quantum of encoding input is exactly 32 bits; here, the final unit of encoded output will be seven characters followed by one "=" padding character.

Because it is used only for padding at the end of the data, the occurrence of any "=" characters may be taken as evidence that the end of the data has been reached (without truncation in transit). No such assurance is possible, however, when the number of octets transmitted was a multiple of 8 and no "=" characters are present.

Any characters outside of the base32 alphabet are to be ignored in base32-encoded data.

6. Specification common to all GSSAPI mechanisms

Each SASL mechanism which uses a GSSAPI mechanism uses the following specification.

The implementation MAY set any GSSAPI flags or arguments not mentioned in this specification as is necessary for the

implementation to enforce its security policy.

6.1. Client side of authentication protocol exchange

The client calls `GSS_Init_sec_context`, passing in `input_context_handle` of 0 (initially), `mech_type` of the GSSAPI mechanism for which this SASL mechanism is registered, `chan_binding` of NULL, and `targ_name` equal to `output_name` from `GSS_Import_Name` called with `input_name_type` of `GSS_C_NT_HOSTBASED_SERVICE` and `input_name_string` of "service@hostname" where "service" is the service name specified in the protocol's profile, and "hostname" is the fully qualified host name of the server. If the client will be requesting a security layer, it MUST also supply to the `GSS_Init_sec_context` a `mutual_req_flag` of TRUE, a `sequence_req_flag` of TRUE, and an `integ_req_flag` of TRUE. If the client will be requesting a security layer providing confidentiality protection, it MUST also supply to the `GSS_Init_sec_context` a `conf_req_flag` of TRUE. The client then responds with the resulting `output_token`. If `GSS_Init_sec_context` returns `GSS_S_CONTINUE_NEEDED`, then the client should expect the server to issue a token in a subsequent challenge. The client must pass the token to another call to `GSS_Init_sec_context`, repeating the actions in this paragraph.

When `GSS_Init_sec_context` returns `GSS_S_COMPLETE`, the client examines the context to ensure that it provides a level of protection permitted by the client's security policy. If the context is

acceptable, the client takes the following actions: If the last call to `GSS_Init_sec_context` returned an `output_token`, then the client responds with the `output_token`, otherwise the client responds with no data. The client should then expect the server to issue a token in a subsequent challenge. The client passes this token to `GSS_Unwrap` and interprets the first octet of resulting cleartext as a bit-mask specifying the security layers supported by the server and the second through fourth octets as the network byte order maximum size `output_message` to send to the server (if the resulting cleartext is not 4 octets long, the client fails the negotiation). The client then constructs data, with the first octet containing the bit-mask specifying the selected security layer, the second through fourth octets containing in network byte order the maximum size `output_message` the client is able to receive, and the remaining octets containing the UTF-8 encoded [UTF8] authorization identity.

The authorization identity is not NUL-terminated. The client passes the data to GSS_Wrap with `conf_flag` set to FALSE, and responds with the generated `output_message`. The client can then consider the server authenticated.

6.2. Server side of authentication protocol exchange

The server passes the initial client response to GSS_Accept_sec_context as `input_token`, setting `input_context_handle` to 0 (initially), `mech_type` of the GSSAPI mechanism for which this SASL mechanism is registered, `chan_binding` of NULL, and `acceptor_cred_handle` equal to `output_cred_handle` from GSS_Acquire_cred called with `desired_name` equal to `output_name` from GSS_Import_name with `input_name_type` of GSS_C_NT_HOSTBASED_SERVICE and `input_name_string` of "service@hostname" where "service" is the service name specified in the protocol's profile, and "hostname" is the fully qualified host name of the server. If GSS_Accept_sec_context returns GSS_S_CONTINUE_NEEDED, the server returns the generated `output_token` to the client in challenge and passes the resulting response to another call to GSS_Accept_sec_context, repeating the actions in this paragraph.

When GSS_Accept_sec_context returns GSS_S_COMPLETE, the server examines the context to ensure that it provides a level of protection permitted by the server's security policy. If the context is acceptable, the server takes the following actions: If the last call to GSS_Accept_sec_context returned an `output_token`, the server returns it to the client in a challenge and expects a reply from the client with no data. Whether or not an `output_token` was returned (and after receipt of any response from the client to such an `output_token`), the server then constructs 4 octets of data, with the first octet containing a bit-mask specifying the security layers supported by the server and the second through fourth octets

containing in network byte order the maximum size `output_token` the server is able to receive. The server must then pass the plaintext to GSS_Wrap with `conf_flag` set to FALSE and issue the generated `output_message` to the client in a challenge. The server must then pass the resulting response to GSS_Unwrap and interpret the first octet of resulting cleartext as the bit-mask for the selected security layer, the second through fourth octets as the network byte order maximum size `output_message` to send to the client, and the

remaining octets as the authorization identity. The server must verify that the `src_name` is authorized to authenticate as the authorization identity. After these verifications, the authentication process is complete.

[6.3.](#) Security layer

The security layers and their corresponding bit-masks are as follows:

- 1 No security layer
- 2 Integrity protection.
Sender calls `GSS_Wrap` with `conf_flag` set to `FALSE`
- 4 Confidentiality protection.
Sender calls `GSS_Wrap` with `conf_flag` set to `TRUE`

Other bit-masks may be defined in the future; bits which are not understood must be negotiated off.

Note that SASL negotiates the maximum size of the `output_message` to send. Implementations can use the `GSS_Wrap_size_limit` call to determine the corresponding maximum size `input_message`.

[7.](#) IANA Considerations

The IANA is advised that SASL mechanism names starting with "GSS-" are reserved for SASL mechanisms which conform to this document. The IANA is directed to place a statement to that effect in the `sasl-mechanisms` registry.

The IANA is directed to modify the existing registration for "GSSAPI" in the "sasl-mechanisms" so that RFC [THIS-DOC] is listed as the published specification. Add the descriptive text "This mechanism is for the Kerberos V5 mechanism of GSSAPI. Other GSSAPI mechanisms use other SASL mechanism names, as described in this mechanism's published specification."

The IANA is directed to modify the existing registration for "GSS-SPNEGO" as follows.

SASL mechanism name: GSS-SPNEGO

Published Specification: RFC [THIS-DOC]

Intended usage: LIMITED USE

Author/Change controller: iesg@ietf.org

8. References

- [ASN1] ISO/IEC 8824, "Specification of Abstract Syntax Notation One (ASN.1)"
- [GSSAPI] Linn, J., "Generic Security Service Application Program Interface Version 2, Update 1", [RFC 2743](#), January 2000
- [GSSAPI-KERBEROS] Linn, J., "The Kerberos Version 5 GSS-API Mechanism", [RFC 1964](#), June 1996
- [IMAP4] Crispin, M., "Internet Message Access Protocol - Version 4", [RFC 1730](#), University of Washington, December 1994.
- [KEYWORDS] Bradner, "Key words for use in RFCs to Indicate Requirement Levels", [RFC 2119](#), March 1997
- [MD5] Rivest, R., "The MD5 Message-Digest Algorithm", [RFC 1321](#), April 1992
- [SASL] Myers, J., "Simple Authentication and Security Layer (SASL)", [RFC 2222](#), October 1997
- [SPKM] Adams, C., "The Simple Public-Key GSS-API Mechanism (SPKM)", [RFC 2025](#), October 1996
- [SPNEG0] Baize, E., Pinkas., D., "The Simple and Protected GSS-API Negotiation Mechanism", [RFC 2478](#), December 1998
- [UTF8] Yergeau, F., "UTF-8, a transformation format of ISO 10646", [RFC 2279](#), January 1998

9. Security Considerations

Security issues are discussed throughout this memo.

When a server or client supports multiple authentication mechanisms, each of which has a different security strength, it is possible for an active attacker to cause a party to use the least secure mechanism supported. To protect against this sort of attack, a client or server which supports mechanisms of different strengths should have a configurable minimum strength that it will use. It is not sufficient for this minimum strength check to only be on the server, since an active attacker can change which mechanisms the client sees as being supported, causing the client to send authentication credentials for its weakest supported mechanism.

The client's selection of a SASL mechanism is done in the clear and

may be modified by an active attacker. It is important for any new SASL mechanisms to be designed such that an active attacker cannot obtain an authentication with weaker security properties by modifying the SASL mechanism name and/or the challenges and responses.

SPNEGO [[SPNEGO](#)] has protection against many of these down-negotiation attacks, SASL does not itself have such protection. The section titled "SPNEGO" mentions considerations of choosing negotiation through SASL versus SPNEGO.

The integrity protection provided by the security layer is useless to the client unless the client also requests mutual authentication. Therefore, a client wishing to benefit from the integrity protection of a security layer MUST pass to the GSS_Init_sec_context call a `mutual_req_flag` of TRUE.

Additional security considerations are in the SASL [[SASL](#)] and GSSAPI [[GSSAPI](#)] specifications.

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[Appendix A](#). Sample code

The following is an example program which converts mechanism OIDs (of the form "1.3.6.1.5.5.1") to SASL mechanism names. This sample program uses the reference MD5 implementation in [\[MD5\]](#).

```
#include <stdio.h>
#include "md5.h"

static const
struct compat_map {
    const unsigned char oid[15];
    const char *saslname;
} compat_map[] = {
    { { 0x06, 0x05, 0x2b, 0x05, 0x01, 0x05, 0x02 }, "GSSAPI" },
    { { 0x06, 0x09, 0x2a, 0x86, 0x48, 0x86, 0xf7, 0x12, 0x01, 0x02, 0x02 },
      "GSSAPI" }, /* old Kerberos V5 OID */
    { { 0x06, 0x06, 0x2b, 0x06, 0x01, 0x05, 0x05, 0x02 }, "GSS-SPNEGO" },
};

static unsigned long parsenum(char **ptr)
{
    unsigned long rval = 0;
    while (**ptr >= '0' && **ptr <= '9') {
        rval = rval * 10 + *(*ptr)++ - '0';
    }
    return rval;
}

static void asn1encode(unsigned long val, unsigned char **buf)
```

```

    int noctets = 1;
    for (tmpval = val; tmpval >= 128; tmpval >>= 7) noctets++;
    while (--noctets) {
        *(*buf)++ = ((val >> (7 * noctets)) & 0x7f) | 0x80;
    }
    *(*buf)++ = val & 0x7f;
}

static char basis_32[] = "ABCDEFGHIJKLMNOPQRSTUVWXYZ234567";

/*
 * Convert the GSSAPI mechanism 'oid' of length 'oidlen', placing
 * the result into 'retbuf', which must be of size 21
 */
void oidToSaslMech(const unsigned char *oid, unsigned oidlen, char *retbuf)
{

```

```

    int i;
    MD5_CTX md5ctx;
    unsigned char md5buf[16];
    char *out;
    unsigned char *in;
    unsigned char *p;
    int len;

    /* See if it has a backwards-compatibility SASL mechanism name */
    for (i = 0; i < (sizeof(compat_map) / sizeof(compat_map[0])); i++) {
        if (memcmp(compat_map[i].oid, oid, oidlen) == 0) {
            strcpy(retbuf, compat_map[i].saslname);
            return;
        }
    }

    MD5Init(&md5ctx);
    MD5Update(&md5ctx, (unsigned char *)oid, oidlen);
    MD5Final(md5buf, &md5ctx);

    printf("MD5 hash:          ");
    for (p = md5buf; p < md5buf + 16; p++) {
        printf("%02x ", *p);
    }
    printf("\n");

```

```

in = md5buf;
strcpy(retbuf, "GSS-");
out = retbuf + strlen(retbuf);
len = 10;
while (len) {
    *out++ = basis_32[in[0] >> 3];
    *out++ = basis_32[((in[0] & 7) << 2) | (in[1] >> 6)];
    *out++ = basis_32[(in[1] & 0x3f) >> 1];
    *out++ = basis_32[((in[1] & 1) << 4) | (in[2] >> 4)];
    *out++ = basis_32[((in[2] & 0xf) << 1) | (in[3] >> 7)];
    *out++ = basis_32[(in[3] & 0x7f) >> 2];
    *out++ = basis_32[((in[3] & 3) << 3) | (in[4] >> 5)];
    *out++ = basis_32[(in[4] & 0x1f)];
    in += 5;
    len -= 5;
}
*out++ = '\\0';
}

main(int argc, char **argv)
{
    char *oidstr;

```

```

unsigned long val1, val2;
unsigned char asn1buf[1024];
unsigned char *asn1start = asn1buf + 4;
unsigned char *asn1next = asn1start;
unsigned char *asn1lennext;
unsigned char *p;
MD5_CTX md5ctx;
unsigned char md5buf[16];
char saslmechbuf[21];
int i;

if (argc != 2) {
    fprintf(stderr, "usage: %s oid\n", argv[0]);
    exit(1);
}

oidstr = argv[1];
val1 = parsenum(&oidstr);

```

```

if (*oidstr++ != '.') goto badoid;
val2 = parsenum(&oidstr);
if (*oidstr && *oidstr++ != '.') goto badoid;
*asn1next++ = val1 * 40 + val2;

while (*oidstr) {
    val1 = parsenum(&oidstr);
    if (*oidstr && *oidstr++ != '.') goto badoid;

    asn1encode(val1, &asn1next);
}

/* Now that we know the length of the OID, generate the tag
 * and length
 */
asn1lennext = asn1next;
*asn1lennext++ = 6;
asn1encode(asn1next - asn1start, &asn1lennext);

/* Copy tag and length to beginning */
memcpy(asn1start - (asn1lennext - asn1next), asn1next,
    asn1lennext - asn1next);
asn1start -= asn1lennext - asn1next;

printf("ASN.1 DER encoding: ");
for (p = asn1start; p < asn1next; p++) {
    printf("%02x ", *p);
}
printf("\n");

```

```

oidToSaslMech(asn1start, asn1next - asn1start, saslmechbuf);
printf("SASL mechanism name: %s\n", saslmechbuf);

exit(0);

badoid:
    fprintf(stderr, "bad oid syntax\n");
    exit(1);
}

```


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