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GSS-API Extensions

Status of this Memo

This document provides information to the community regarding extensions to GSS-API as defined in RFC 2743 and RFC 2744.

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Abstract

This document describes extensions to RFC 2743, Generic Security Service Application Program Interface Version 2, Update 1. Extensions include: credential export and import; delegation at any time; credential extensions (e.g. restrictions) handling.

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1 Introduction

RFC 2743 defines the Generic Security Service Application Program Interface (GSS-API) Version 2, Update 1 [3, 4], as an API for portably adding authentication, delegation, and message protection to distributed computing applications.

In 1997, the Globus Project (www.globus.org) introduced the Grid Security Infrastructure (GSI), an implementation of a security mechanism for Grid computing that uses the GSS-API standard. This implementation uses public key protocols for use in programming Grid applications [2] -- that is, applications that run in dynamic, inter-domain distributed computing environments. Based on this implementation, a great deal of experience has been gained on the use of GSS-API in numerous real applications and middleware toolkits. While this experience has been overwhelmingly positive, it has also led to an understanding of some deficiencies in the existing GSS-API.

This document describes extensions to the GSS-API made by the Globus Project to address these deficiencies. These extensions are:

- *Credential export and import*: Processes need to be able, in a controlled and standard fashion, to export credentials to and import credentials from other processes. This includes processes that are not written to the GSS-API.
- *Delegation at any time*: GSS-API only allows for delegation during the initial context establishment, via an argument to `gss_init_sec_context`. This document extends GSS-API to also allow for delegation at any time after initial context establishment.
- *Credential extensions handling*: When delegating a credential, it is often useful to attach additional data, such as restriction policies, to that delegated credential which restricts its usage. This document defines extensions to the GSS-API to allow such extensions to be specified during delegation and to be extracted from a security context after authentication. However, the approach is neutral to the actual attached data.

Section 2 describes the GSS-API extensions.

Section 3 contains changes to existing GSS-API functions.

Section 4 contains discussions of problems with the existing GSS-API that the authors have found, but have not had time to work out solutions for.

Section 5 contains security considerations.

Section 6 contains C-bindings for the API extensions.

Section 7 contains the references.

Section 8 contains acknowledgements.

Section 9 contains the OIDs defined by this document.

Section 10 contains the change log for this document.

Section 11 contains contact information for the authors.

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This document was written under the auspices of the Global Grid Forum Grid Security Infrastructure Working Group. For more information on this and other related work, see http://www.gridforum.org/2_SEC/GSI.htm.

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 RFC-2119 [1]. While not a normative document, these terms are used to describe requirements for interoperability with the Globus Project implementation.

2 Extension Specifications

This section describes extensions to the GSS-API as defined in RFC 2743..

2.1 Credential Export and Import

These functions are intended to be used primarily by complex servers that must juggle multiple credentials, storing them for a time in files and/or passing them to other processes. In order to portably implement a reliable service that can accept delegated credentials from multiple clients, these functions are needed to allow the service to checkpoint and reload the delegated credential to and from permanent storage.

These functions also provide support for servers that need to pass a credential on to other processes, for example a secure shell daemon (SSHD) that accepts a delegated credential from a client and then wants to make that credential available to the spawned shell process.

Previously applications that needed this functionality were forced to use mechanism specific lower level routines, defeating the purpose of a generic interface.

The `gss_export_cred` function allows exporting credentials in one of two forms as selected by the `option_req` parameter:

When `option_req` is equal to 0, it exports an opaque buffer suitable for storage in memory or on disk or passing to another process, which can import the buffer with `gss_import_cred`.

This method of invocation will normally be used by applications that want to transfer a credential to another GSS application or save a credential to some storage medium so it can be loaded later (perhaps after a restart).

When `option_req` is equal to 1, it exports a buffer filled with mechanism-specific information that the calling application can use to pass the credential to another process that is not written to the GSS-API. This is intended to work with the existing Kerberos and GSI GSS implementations. These implementations normally store credentials by writing the credentials to a file and then storing the path to that file in an environment variable. In the case of these implementations this function stores the credential on disk and returns a buffer containing a string suitable for passing to `putenv(3)`. This method of invocation will normally be used by applications, such as SSHD, which accept a delegated GSS credential and then want to make this credential available to the shell process they spawn.

Note that in either case, you cannot pass the exported credential to another machine over the network and assume it will work. Passing a credential to another process may also fail if the process does not have the same privileges as the original process.

A credential can also expire between export and import. In this case the import of the credential SHOULD fail, returning an error.

The `gss_import_cred` function is the complimentary function to `gss_export_cred`. When called with the exported buffer and `option_req` set to the same value used in the `gss_export_cred` call it MUST return a credential handle suitable for use with other GSS-API functions. While this function is similar in function to `gss_acquire_cred`, there is no compatibility between the two (i.e. one cannot take a buffer from `gss_export_cred` and use `gss_acquire_cred` to import it).

2.1.1 `gss_export_cred` call

Inputs:

- `option_req` INTEGER – 0 = Export simple data good only for reuse with `gss_import_cred`, 1 = Export mechanism-specific data that can be passed to non-GSS applications (see following function description).
- `cred_handle` CREDENTIAL HANDLE – credential to be exported. The credential may be modified but is stable and usable after call.
- `desired_mech` OBJECT IDENTIFIER – desired mechanism for exported credential, may be NULL to indicate system default

Outputs:

- `major_status` INTEGER
- `minor_status` INTEGER

- `export_buffer` OCTET STRING – token to be used in future `gss_import_cred` call (if `option_req == 0`) or mechanism specific data (if `option_req == 1`). To be freed by caller using `gss_release_buffer`.
- `actual_mech` OBJECT_IDENTIFIER – actual mechanism of the exported credential

Returned `major_status` codes:

- `GSS_S_COMPLETE` indicates that the operation was successfully completed and `export_buffer` contains the requested data.
- `GSS_S_CREDENTIALS_EXPIRED` indicates the credential referred to by `cred_handle` has expired and cannot be exported.
- `GSS_S_UNAVAILABLE` indicates that the requested operation is not supported by the underlying mechanism.
- `GSS_S_BAD_MECH` indicates that the requested mechanism is unsupported.
- `GSS_S_FAILURE` indicates a failure unspecified at the GSS-API level.

`GSS_export_cred` is used to export a credential so that it can be passed to another process or reloaded by the same process after its use of a different credential in the interim.

If the caller passes in a value of 0 for `option_req` the returned data **MUST** be suitable for use in a call to `gss_import_cred` at a later date or in a different process. Note that the data may contain the actual credential itself or just a pointer to it (e.g. a filename). In any case it should be assumed that the returned buffer contains sensitive information and care should be taken to protect the privacy of its contents. This token **MUST** be encapsulated using the mechanism for an exported name object defined in RFC 2743 [3], Section 3.2, using the exported credential object in place of the name object and a token identifier value of hex 04 02.

If the caller passes in a value of 1 for `option_req` the return data **MUST** contain mechanism-specific data that the calling application can use to pass the credential to another process that does not use the GSS-API. The caller is responsible for understanding this data and knowing what to do with it. For example in the case of both Kerberos 5 and GSI the credential will be stored to a file and the returned data will be a string suitable for passing to `putenv(3)`. In this case the caller may need to change the ownership of the credential file.

In either case the data is returned in `export_buffer`, which the calling application is responsible for freeing using `gss_release_buffer`.

2.1.2 `gss_import_cred`

Inputs:

- `option_req` INTEGER – 0 = `import_buffer` is opaque data as created by `gss_export_cred` called with `option_req` = 0, 1 = `import_buffer` is handle to a credential as created by `gss_export_cred` called with `option_req` = 1 (e.g. strings of the form “KRB5CCNAME=FILE:filename”).
- `desired_mech` OBJECT IDENTIFIER – desired mechanism for the imported credential, may be NULL to indicate system default.
- `import_buffer` OCTET STRING – buffer containing data for import as created by a call to `gss_export_cred`.
- `lifetime_req` INTEGER – in seconds, 0 requests default.

Outputs:

- `major_status` INTEGER
- `minor_status` INTEGER
- `cred_handle` CREDENTIAL HANDLE – the returned credential handle. Resources associated with the credential handle must be released by the application after use with a call to `gss_release_cred`.
- `lifetime_rec` INTEGER – in seconds, with reserved value for INDEFINITE.
- `actual_mech` OBJECT_IDENTIFIER – actual mechanism of the imported credential.

Returned `major_status` codes:

- `GSS_S_COMPLETE` indicates that the operation was successful and `cred_handle` contains a handle to a usable credential.
- `GSS_S_BAD_MECH` indicates that the requested mechanism is unsupported.
- `GSS_S_DEFECTIVE_TOKEN` indicates the import buffer is unparsable.
- `GSS_S_NO_CRED` indicates that the imported credential is unusable or inaccessible.
- `GSS_S_CREDENTIALS_EXPIRED` indicates that the imported credential has expired.
- `GSS_S_FAILURE` indicates an error unspecified at the GSS-API level.

`gss_import_cred` is the complimentary function to `gss_export_cred` and is intended to be used to allow use of a credential that was passed from another process or read from storage.

The credential, or the handle to the credential, is read from `import_buffer`, which MUST be unmodified. A handle to the credential is returned in `cred_handle`.

The `lifetime_rec` result MUST indicate the length of time for which the acquired credential will be valid, as an offset from the present. A mechanism MAY return a reserved value indicating INDEFINITE if no constraints on credential lifetime are imposed. A caller of `gss_import_cred` MAY request a length of time for which the acquired credential is to be valid (using the `lifetime_req` parameter), beginning at the present, or can request a credential with a default validity interval. Requests for postdated credentials are not supported within the GSS-API. Implementations MAY supply credential validity period specifiers at a point prior to invocation of the `gss_import_cred` call (e.g., in conjunction with user login procedures). As a result, callers requesting non-default values for `lifetime_req` MUST be prepared to accommodate the return of a credential with a different lifetime as indicated by `lifetime_rec`. The `lifetime_req` parameter should be viewed as advisory and no error should be returned if the lifetime request cannot be honored.

2.2 Delegation At Any Time

These functions are designed to allow more flexible protocols to be built on top of the GSS-API. They allow delegation to happen at times other than context initiation, in either direction regardless of the direction of context initiation (i.e. the acceptor in context initiation can be the delegator) and with a credential other than the credential used for context initiation.

These functions also allow the initiator and acceptor to attach extensions, such as restriction polices, to a delegated credential. These extensions are mechanism-specific and completely opaque to the GSS-API. See the following section on Credential Extension Handling for information about accessing the extension data.

Furthermore, these functions make it possible to delegate credentials associated with mechanisms other than the mechanism used for context establishment. Application may for example wish to delegate a Kerberos credential over a security context established using GSI.

The two functions for doing delegation are `gss_init_delegation` and `gss_accept_delegation`. These functions are used in a similar manner as `gss_init_sec_context` and `gss_accept_sec_context`; they should be called in a loop as long as they return `GSS_S_CONTINUE_NEEDED` and the tokens output by each should be passed into the other.

Note that mechanisms are not required to support intermingling of calls to other GSS-API functions (e.g. `gss_wrap`) with the sequence of calls needed to perform delegation of a credential. This also implies that if an application initiates a second delegation while a previous one has yet to complete, the results may be undefined.

2.2.1 `gss_init_delegation`

Inputs:

`meder@mcs.anl.gov`

- `context_handle` CONTEXT HANDLE – handle to existing security context.
- `cred_handle` CREDENTIAL HANDLE – handle to credential to be delegated. NULL (`GSS_C_NO_CREDENTIAL`) specifies the use of the default credential.
- `mech_type` OBJECT IDENTIFIER – NULL parameter specifies that the system default should be used.
- `lifetime_req` INTEGER - 0 specifies default lifetime
- `extension_oids` SEQUENCE OF OBJECT IDENTIFIER – identifiers for the type of data in the `extensions_buffers`. See description below for a discussion of this option.
- `extension_buffers` SEQUENCE OF OCTET STRINGS – opaque extension data to be applied to the delegated credential. See description below for a discussion of this option.
- `input_token` OCTET STRING – `GSS_C_NO_BUFFER` or token received from target.

Outputs:

- `major_status` INTEGER
- `minor_status` INTEGER
- `output_token` OCTET STRING – token to pass to target. May be empty. Caller must release with `gss_release_buffer`.

Returned `major_status` codes:

- `GSS_S_COMPLETE` indicates that delegation is complete and it is not necessary to call `gss_init_delegation` again. The returned `output_token` may have data to be sent to the target to successfully complete the delegation.
- `GSS_S_CONTINUE_NEEDED` indicates that the information in the returned `output_token` must be sent to the target and a reply must be received and passed as the `input_token` argument in a subsequent call to `gss_init_delegation`.
- `GSS_S_DEFECTIVE_TOKEN` – consistency checks on input token failed.
- `GSS_S_BAD_SIG` – bad integrity check on input token.
- `GSS_S_NO_CRED` – credential is invalid.
- `GSS_S_CREDENTIALS_EXPIRED` – provided credential has expired.
- `GSS_S_OLD_TOKEN` – `input_token` is too old.

- `GSS_S_DUPLICATE_TOKEN` – `input_token` is a duplicate.
- `GSS_S_BAD_MECH` – unsupported mechanism.
- `GSS_S_BAD_BINDINGS` – this indicates that the extensions provided were invalid (e.g. a mismatch of number of OIDs and buffers).
- `GSS_S_FAILURE` – error unspecified at the GSS-API level.

This routine is used by either side of a security context to perform a delegation to the peer. The credential being delegated MAY either be the same credential used to setup the context or MAY be a different credential.

Input parameters other than `input_token` MUST correspond to the same valid GSS-API structures during the delegation process.

The `extension_oids` and `extension_buffers` parameters can be used to specify a set of extensions for the delegated credential. There MUST be an identical number of OIDs and buffers, with each OID indicating what the type of data (e.g. policy language) its corresponding buffer contains. These values MAY be `GSS_C_NO_OID_SET` and `GSS_C_NO_BUFFER_SET`, respectively, to indicate that no extensions are to be applied to the credential.

2.2.2 `gss_accept_delegation`

Inputs:

- `sec_context` CONTEXT HANDLE – handle to existing security context.
- `input_token` OCTET STRING – token received from initiator.
- `extension_oids` SEQUENCE OF OBJECT IDENTIFIER – identifiers for the type of data in the `extension_buffers`. See description below for a discussion of this option.
- `extension_buffers` SEQUENCE OF OCTET STRINGS – requested data for extensions to be applied to the delegated credential. See description below for a discussion of this option.
- `lifetime_req` INTEGER - in seconds, 0 requests default

Outputs:

- `delegated_cred` CREDENTIAL HANDLE – on completion this will contain a handle to the delegated credential. The caller must release with `gss_release_cred`.

- `lifetime_rec` INTEGER - in seconds, or reserved value for INDEFINITE
- `output_token` OCTET STRING – token to pass to initiator. MAY be empty. Caller must release with `gss_release_buffer`.
- `mech_type` OBJECT_IDENTIFIER – mechanism corresponding to delegated credential; read only, caller should not attempt to release.

Return `major_status` codes:

- `GSS_S_COMPLETE` indicates that the delegation has been successful and `delegated_cred` contains a handle to a usable credential.
- `GSS_S_CONTINUE_NEEDED` indicates that the information in the returned `output_token` must be sent to the initiator and a reply must be received and passed as the `input_token` argument in a subsequent call to `gss_accept_delegation`.
- `GSS_S_DEFECTIVE_TOKEN` – malformed token.
- `GSS_S_BAD_SIG` – integrity check failed.
- `GSS_S_OLD_TOKEN` – token too old.
- `GSS_S_NO_CONTEXT` – bad context.
- `GSS_S_BAD_MECH` – unsupported mechanism for the delegated credential.
- `GSS_S_BAD_BINDINGS` – this indicates that the extensions provided were invalid (e.g. a mismatch of number of OIDs and buffers).
- `GSS_S_FAILURE` – Error unspecified at the GSS-API level.

This routine is used by either side of a security context to accept a delegation being performed by `gss_init_delegation`. The credential being delegated MAY be either the same credential used to setup the context or MAY be a different credential.

Input parameters other than `input_token` MUST correspond to the same valid GSS-API structures during the delegation process.

The `lifetime_rec` parameter, on successful completion, MUST contain the remaining lifetime, in seconds, of the delegated credential. A mechanism May return a reserved value indicating INDEFINITE if no constraints on credential lifetime are imposed. A caller of `gss_accept_delegation` MAY also request that the delegated credential be valid for a specified period of time (via the `lifetime_req` argument), but MUST be prepared to handle a delegated credential with shorter than requested lifetime.

The `extension_oids` and `extension_buffers` parameters MAY be used to request extensions to be applied to the delegated credential. There MUST be an identical number of OIDs and buffers with each OID indicating the type of data (e.g. policy language) its corresponding buffer contains. See `gss_init_delegation` for a discussion of these OIDs. Note that depending on the mechanism, the initiator MAY decide to ignore the extensions requested by the acceptor. These values MAY be `GSS_C_NO_OID_SET` and `GSS_C_NO_BUFFER_SET`, respectively, to indicate that no extensions are requested in the credential.

2.3 Extended Credential Inquiry

Applications wanting to make more complex authorization decisions require more information about a client's credential than just the client's identity. In order to provide this information the `gss_inquire_sec_context_by_oid` and `gss_inquire_cred_by_oid` functions were added. These functions give applications a means to retrieve arbitrary data about a context or credential.

The `gss_inquire_sec_context_by_oid` and `gss_inquire_cred_by_oid` functions are called with an object identifier identifying the information that the application is interested in. This object identifier will either be one of a number of generic OIDs or may be mechanism-specific.

2.3.1 `gss_inquire_sec_context_by_oid` call

Inputs:

- `sec_context` CONTEXT HANDLE – handle to existing security context.
- `desired_object` OBJECT IDENTIFIER – OID of desired object.

Outputs:

- `major_status` INTEGER
- `minor_status` INTEGER
- `data_set` SET OF OCTET STRING – zero or more pieces of data corresponding to the data associated with the `desired_object` OID. To be freed by caller using `gss_release_buffer_set`.

Return `major_status` codes:

- `GSS_S_COMPLETE` indicates that the function completed successfully and data was returned.
- `GSS_S_CONTINUE_NEEDED` indicates that there are more data items to be returned (see following description).

- `GSS_S_NO_CONTEXT` indicates that no valid context was recognized for the input context handle provided.
- `GSS_S_FAILURE` indicates that the requested operation failed for reasons unspecified at the GSS-API level.

The `desired_object` parameter **MUST** contain an OID that references information the application is interested in. This may, for example, be an OID that identifies an extension used in the delegation routines

If the requested data is not present, `major_status` **MUST** be set to `GSS_S_COMPLETE` and 0 objects **MUST** be returned in `data_set`.

Note that there is disagreement between the current GSS-API RFC [3] and the RFC specifying the C-language bindings [4]. While the GSS-API RFC states that functions that functions of this nature should not iterate using `GSS_S_CONTINUE_NEEDED`, the RFC specifying language bindings does so. Applications **SHOULD** be prepared to handle this function returning only a single piece of data per call and call it iteratively if it returns `GSS_S_CONTINUE_NEEDED`.

2.3.2 `gss_inquire_cred_by_oid` call

Inputs:

- `cred_handle` CREDENTIAL HANDLE - handle to existing credential.
- `desired_object` OBJECT IDENTIFIER - OID of desired object.

Outputs:

- `major_status` INTEGER
- `minor_status` INTEGER
- `data_set` SET OF OCTET STRING - zero or more pieces of data corresponding to the data associated with the `desired_object` OID. To be freed by caller using `gss_release_buffer_set`.

Return `major_status` codes:

- `GSS_S_COMPLETE` indicates that the function completed successfully and data was returned.
- `GSS_S_CONTINUE_NEEDED` indicates that there are more data items to be returned (see following description).

- `GSS_S_NO_CRED` indicates there was no valid credential
- `GSS_S_FAILURE` indicates that the requested operation failed for reasons unspecified at the GSS-API level.

The `desired_object` parameter **MUST** contain an OID that references information the application is interested in. This may for example correspond to an OID used in the extended delegation routines. The OID `id-gss-ext-inquire-cred-restrictions`, as defined in Section 9, **MAY** be used to request restrictions on the use of the credential. This allows restrictions that may be encoded in a mechanism-specific manner to be requested independent of the mechanism.

If the requested data is not present, `major_status` **MUST** be set to `GSS_S_COMPLETE` and 0 objects will be returned in `data_set`.

Note there is disagreement between the current GSS-API RFC [3] and the RFC specifying the C-language bindings [4]. While [3] states that functions of this nature should not iterate using `GSS_S_CONTINUE_NEEDED`, [4] does so. Applications **SHOULD** be prepared to handle this function returning only a single piece of data per call and call it iteratively if it returns `GSS_S_CONTINUE_NEEDED`.

2.4 Context options

Currently there is no method for passing flags into the `gss_accept_sec_context` call. Instead of changing the arguments to this function we define a method that allows us to set options on a security context and then pass the context into a first call of `gss_accept_sec_context` or `gss_init_sec_context`. This provides the means for an application to achieve more fine-grained control of the underlying GSS-API mechanism.

The options are identified with OIDS, which may be mechanism specific or one of the generic options defined below.

Generic options, OIDs are defined in Section 9:

`id-gss-ext-context-opts-disallow-encryption` – Setting this option to 1 **MUST** cause the underlying GSS library to disallow any encryption of application data.

`id-gss-ext-context-opts-fail-expiration` – Setting this option to 1 **MUST** cause the underlying GSS library to fail if any message protection operation is attempted after the security context has expired. The underlying mechanism **SHOULD** allow this option to be set to 0 after such an error is returned so that an application can finish an ongoing process before returning an error to the user. For example, an application may wish to complete a file transfer already in progress before refusing to start another transfer. Note that some implementations may not be able to perform message protection after security context expiration.

`id-gss-ext-context-opts-app-check-exts` – Setting this option to a list of OIDs (using the SET OF OBJECT IDENTIFIER data type) will inform the underlying GSSAPI library that the

application will take responsibility for checking any extensions in the peer credential identified by these OIDs . If the GSS mechanism encounters an extension during context establishment that the application has not declared its responsibility for, then the GSS mechanism may choose to fail the authentication. The reason for this is that without the knowledge that the application is aware of and taking responsibility for handling the extensions the GSSAPI mechanism cannot be assured they will be respected and must take the safe course of failure.

2.4.1 gss_set_sec_context_option call

Inputs:

- `sec_context CONTEXT HANDLE` – handle to security context. NULL specifies that a new security context should be created.
- `option OBJECT IDENTIFIER` – OID of desired option.
- `value OCTET STRING` – value of option.

Outputs:

- `major_status INTEGER`
- `minor_status INTEGER`

Return `major_status` codes:

- `GSS_S_COMPLETE` indicates that the function completed successfully.
- `GSS_S_FAILURE` indicates that the requested operation failed for reasons unspecified at the GSS-API level. This includes an attempt to change an immutable option.

The `sec_context` parameter **MUST** either be an existing security context or NULL, indicating a new security context should be initialized and the specified option set on the new context.

The option parameter **MUST** contain an OID that references the option that the application wishes to set.

The value parameter **MUST** contain the value the option should be set to. The size of the octet string will vary depending on the option being set (analogous to the UNIX `setsockopt` function).

2.5 Buffer Set Functions

These functions are needed to support other new functions added in this section.

2.5.1 gss_create_empty_buffer_set

Inputs:

- None

Outputs:

- `buffer_set` SET OF OCTET STRING To be freed by caller using `gss_release_buffer_set`.
- `major_status` INTEGER
- `minor_status` INTEGER

Return `major_status` codes:

- `GSS_S_COMPLETE` indicates that the function completed successfully.
- `GSS_S_FAILURE` indicates that the requested operation failed for reasons unspecified at the GSS-API level.

Creates an empty buffer set, to which members may subsequently be added using the `gss_add_buffer_set_member` routine.

2.5.2 gss_add_buffer_set_member call

Inputs:

- `member_buffer` OCTET_STRING
- `buffer_set` SET OF OCTET STRING

Outputs:

- `major_status` INTEGER
- `minor_status` INTEGER

Return `major_status` codes:

- `GSS_S_COMPLETE` indicates that the function completed successfully.
- `GSS_S_FAILURE` indicates that the requested operation failed for reasons unspecified at the GSS-API level.

This function adds a buffer to a buffer set. The `member_buffer` argument may be released after the completion of this call.

2.5.3 gss_release_buffer_set call

Inputs:

- buffer_set SET OF OCTET STRING

Outputs:

- major_status INTEGER
- minor_status INTEGER

Return major_status codes:

- GSS_S_COMPLETE indicates that the function completed successfully and data was returned.
- GSS_S_FAILURE indicates that the requested operation failed for reasons unspecified at the GSS-API level.

This function allows callers to release the storage associated with a SET OF OCTET STRING allocated by another GSS-API call. This call's specific behavior depends on the language and programming environment within which a GSS-API implementation operates, and is therefore detailed within applicable bindings specifications; in particular, implementation and invocation of this call may be superfluous (and may be omitted) within bindings where memory management is automatic.

3 Changes to existing functions

This section contains changes to the behavior of the existing GSSAPI functions.

3.1 `gss_accept_sec_context`

The `gss_accept_sec_context` call MUST now accept a non-NULL security context, as created by the `gss_set_sec_context_option` call, on initial call.

3.2 `gss_init_sec_context`

The `gss_init_sec_context` call MUST now accept a non-NULL security context, as created by the `gss_set_sec_context_option` call, on initial call.

3.3 `gss_getMIC`, `gss_verifyMIC`, `gss_wrap`, `gss_unwrap`

If the `GSS_PROTECTION_FAIL_ON_CONTEXT_EXPIRATION` option has been set to 1 by the `gss_set_sec_context_option` call then these functions MUST fail if the security context being used has expired.

If the `GSS_PROTECTION_FAIL_ON_CONTEXT_EXPIRATION` option is set to 0 then functions SHOULD continue to function as long as they possibly can regardless of the expiration of security context. Some implementation may not be able to continue functioning after security context expiration.

4 Additional Desired Functionality

The following sections describe shortcomings in the GSSAPI and propose possible schemes for modifying the API to address these but do not lay out a specific proposal for change.

4.1 Token Framing

One major shortcoming in the GSS-API specification is that it does not prescribe or recommend a standard mechanism independent way of framing tokens generated by GSS-API functions.

We feel that the absence of a framing mechanism negates the utility of the `mech_type` and similar parameters, since demultiplexing tokens based on mechanism without said framing becomes nearly impossible.

We realize that almost all mechanisms used to implement the GSS-API provide their own framing mechanism and may not want to add additional framing since this may hinder interoperability with non-GSS-API using applications. Thus any proposed framing should not be mandatory.

It is our opinion that any proposed framing mechanism should at the bare minimum allow for the following:

1. A mechanism for determining the length of the token
2. A way of determining the mechanism that produced the token
3. A mechanism for identifying the token type, where token type indicates the origin (e.g. context establishment, application data ...) of the token

Finally, it may be argued that framing could and should be done at the application level, but even in this case a recommendation would give the benefit of greater interoperability between mechanisms which implement framing at the GSSAPI level.

4.2 Different levels of verbosity with `gss_display_status`

It is desirable to have different levels of error message verbosity at different times. When returning an error message to a user, simplicity is often the best course. Users tend to want a simple description of the error and maybe a little guidance on how to fix the problem. Long error messages tend to scare them away.

On the other hand, if a developer or other user seriously interested in debugging is reading the error message, the more information the better.

The `gss_display_status` call currently offers no way to select different levels of verbosity in the messages it returns. Some possible ways of implementing this are:

- Add a way of passing in a flag to the `gss_display_call` perhaps by defining more values for status type.
- Defining a predefined string at the beginning of all strings returned by `gss_display_status` to indicate the verbosity level of the string. This has the advantage that the server can send these strings over the network to a client that can decide the level of verbosity without involving the server.
- Defining a new call, `gss_display_status_ext`, that has an option to specify verbosity level.

5 Security Considerations

5.1 Credential export and import

Since exported credential buffers may contain sensitive information (e.g. the credential itself) care must be taken to maintain the privacy of this information. Precautions should include:

- Storing the exported credential only in files with carefully controlled access policies
- Not sending the exported credential over the network in the clear (unencrypted)
- Being careful which processes are given access to the credential

5.2 Delegation at any time and restricted delegation handling

Applications delegating credentials need to be sure that they are delegating credentials only to other processes and systems that can be trusted. Since credentials are often stored on disk, compromises of systems can lead to stolen credentials from trusted processes.

The use of restrictive policies is encouraged for this reason as it can greatly limit the use of any stolen credential.

6 C-Bindings

The following are the C-bindings for the API extensions:

```
typedef gss_buffer_set_desc_struct {
    size_t          count;
    gss_buffer_desc * elements;
} gss_buffer_set_desc, *gss_buffer_set_t;
```

```
OM_uint32
gss_create_empty_buffer_set(
    OM_uint32 *      minor_status,
    gss_buffer_set_t * buffer_set)
```

```
OM_uint32
gss_add_buffer_set_member(
    OM_uint32 *      minor_status,
    const gss_buffer_t member_buffer,
    gss_buffer_set_t * buffer_set)
```

```
OM_uint32
gss_release_buffer_set(
    OM_uint32 *      minor_status,
    gss_buffer_set_t buffer_set)
```

```
OM_uint32
gss_export_cred(
    OM_uint32 *      minor_status,
    const gss_cred_id_t cred_handle,
    const gss_OID     desired_mech,
    gss_OID *         actual_mech,
    OM_uint32         option_req,
    gss_buffer_t       export_buffer);
```

```
OM_uint32
gss_import_cred(
    OM_uint32 *      minor_status,
    gss_cred_id_t *  output_cred_handle,
    const gss_OID     desired_mech,
    gss_OID *         actual_mech,
    OM_uint32         option_req,
    const gss_buffer_t import_buffer,
    OM_uint32         time_req,
    OM_uint32 *       time_rec);
```

```
OM_uint32
```

```
gss_init_delegation(
    OM_uint32 *          minor_status,
    const gss_ctx_id_t   context_handle,
    const gss_cred_id_t   cred_handle,
    const gss_OID         desired_mech,
    const gss_OID_set     extension_oids,
    const gss_buffer_set_t extension_buffers,
    const gss_buffer_t    input_token,
    OM_uint32            time_req,
    gss_buffer_t          output_token);
```

```
OM_uint32
gss_accept_delegation(
    OM_uint32 *          minor_status,
    const gss_ctx_id_t   context_handle,
    const gss_OID_set     extension_oids,
    const gss_buffer_set_t extension_buffers,
    const gss_buffer_t    input_token,
    OM_uint32            time_req,
    OM_uint32 *          time_rec,
    gss_cred_id_t *       delegated_cred_handle,
    gss_OID              mech_type,
    gss_buffer_t          output_token);
```

```
OM_uint32
gss_inquire_sec_context_by_oid(
    OM_uint32 *          minor_status,
    const gss_ctx_id_t   context_handle,
    const gss_OID         desired_object,
    gss_buffer_set_t     data_set);
```

```
OM_uint32
gss_inquire_cred_by_oid(
    OM_uint32 *          minor_status,
    const gss_cred_id_t   cred_handle,
    const gss_OID         desired_object,
    gss_buffer_set_t *     data_set);
```

```
OM_uint32
gss_set_sec_context_option(
    OM_uint32 *          minor_status,
    gss_ctx_id_t *       context_handle,
    const gss_OID         option,
    gss_buffer_t          value);
```

7 References

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- [2] Foster, I., C. Kesselman, and S. Tuecke, "The Anatomy of the Grid: Enabling Scalable Virtual Organizations," *International Journal of Supercomputer Applications*, 2001.
- [3] Linn, J., "Generic Security Service Application Program Interface, Version 2, Update 1," RFC 2743, January 2000.
- [4] Wray, J., "Generic Security Service API Version 2, C-bindings," RFC 2744, January 2000.

8 Acknowledgments

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9 List of OIDs Defined in this Document

This section lists the OIDs used in this document.

id-gss-ext-inquire-cred-restrictions:	1.3.6.1.4.1.6757.1.1.1.1
iso.org.dod.internet.private.enterprise.grid.security.gss-extensions.inquire-cred.restrictions	
id-gss-ext-context-opts-disallow-encryption:	1.3.6.1.4.1.6757.1.1.2.1
iso.org.dod.internet.private.enterprise.grid.security.gss-extensions.context-options.disallow-encryption	
id-gss-ext-context-opts-fail-expiration:	1.3.6.1.4.1.6757.1.1.2.2
iso.org.dod.internet.private.enterprise.grid.security.gss-extensions.context-options.fail-on-context-expiration	
id-gss-ext-context-opts-app-check-exts:	1.3.6.1.4.1.6757.1.1.2.3
iso.org.dod.internet.private.enterprise.grid.security.gss-extensions.context-options.application-checked-extensions	

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Appendix A. Change Log (To be removed by GGF editor prior to publication)

Changes between version 0.11 and 0.12

Corrections from Olle Mulmo:

1. Cleaned up text in intro to Section 2.
2. Section 2.1: Capitalized SSHD
3. Section 2.2.2: Clarified “MAY” for contents of output_token.
4. Section 2.3.2: Added missing “be” in last sentence of first paragraph.
5. Section 2.4: Fixed typo “error in returned” -> “error is returned”

Changes in regards to making this an experimental document:

6. A number of changes of “defines” -> “describes” in Abstract, Section 1, Section 2. Associated minor wording changes. Removed references to “normative” and “non-normative”,
7. Section 1: Added text explaining that while RFC 2119 terms are still used, they are for interoperability with the Globus implementation.

Changes between version 0.10 and 0.11

1. Moved change log to Appendix
2. Corrected number of previous entry in change log
3. Sections 2.1 and 6: Removed protection_key argument from gss_export_cred and gss_import_cred functions.

Changes between version 0.9 and 0.10

(See http://www-unix.gridforum.org/mail_archive/security-wg/2003/11/msg00010.html)

4. Section 1: Clarified relationship of GSI to GSSAPI
5. Clarified normative nature of paragraphs 7 and 8
6. Fixed typos in 2.1, 2.1.2, 2.2, 5.1
7. 2.3.1 and 2.3.2: In description of “desired_object” changed “objects” to “object”

Changes between version 0.8 and 0.9

1. Section 2.1.1: specify encapsulation for export credential.

Changes between version 0.7 and 0.8

1. Added GGF Oids to document, including new section 9 listing OIDs.
2. Clarified section 4 is non-normative.
3. Corrected section numbers in introduction.
4. Changed a number of instances of "this document proposes" to "this document defines" and similar text in normative sections 2 and 3.
5. Changed a number of instances of "this function will" to "this function MUST".

Changes between version 0.6 and 0.7

1. Added protection_key parameter to gss_import_cred() and gss_export_cred() functions.

Changes between version 0.5 and 0.6

1. Updated section on token framing
2. Added lifetime_req parameter to gss_accept_delegation
3. Changed formatting to comply with GGF standard

4. Added `actual_mech` parameter to `gss_export_cred` and `gss_import_cred`
5. Updated C bindings

Changes between version 0.4 and 0.5:

1. Renamed delegation restrictions to more generic delegation extensions.
2. Added `gss_create_empty_buffer_set()` and `gss_add_buffer_set_member()`
3. Added `gss_inquire_cred_by_oid()`

Changes between version 0.3 and 0.4:

1. Added `time_req` argument to `gss_init_delegation()`.
2. NULL credential to `gss_init_delegation()` means to use the default credential.
3. Oids and buffers in calls to `init_delegation` and `accept_delegation` are now sequences and not sets.
4. Added text to 2.2 stating essentially that only one delegation is allowed to be in progress at a given time.
5. Revised text in 2.2.1 and 2.2.2 to attempt to clarify restriction oids specify policy languages in restriction buffers.
6. Added text to 2.3 about generic oids for retrieving information from the credential and in particular an oid for policies inserted by `gss_init_delegation()`.
7. Added `lifetime_rec` output to `gss_accept_delegation()`.
8. Added `lifetime_req` and `lifetime_rec` parameters to `gss_import_context()`.
9. Added section 2.4: `gss_set_sec_context_option()`. Deleted section in section 3 that talked about wanting to do this.
10. Added new section 3 discussing changes to existing functions with renumbering elsewhere in the document.
11. Added section 2.5, Housekeeping functions, with subsection 2.5.1 describing the `gss_release_buffer_set` call.
12. Message protection behavior on context expiration is now defined by sections 2.4 and 3.3.
13. Added section 4.2 on the need for verbosity levels in `gss_display_status`.
14. In Section 5.1 now use credential singular consistently
15. In 2.2.1 and 2.2.2 renamed `restrictions_oid` to `restrictions_oid` and `restrictions_buffers` to `restriction_buffers`. Also indicated these may be `GSS_C_NO_OID_SET` and `GSS_C_NO_BUFFER_SET` respectively.
16. 2.2.1 `input_token`: `GSS_C_NO_BUFFER` instead of NULL
17. 2.2.1 and 2.2.2 `output_token`: May be empty instead of NULL