

**A PRF API extension for the GSS-API
draft-ietf-kitten-gssapi-prf-05.txt**

Status of this Memo

By submitting this Internet-Draft, each author represents that any applicable patent or other IPR claims of which he or she is aware have been or will be disclosed, and any of which he or she becomes aware will be disclosed, in accordance with [Section 6 of BCP 79](#).

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>.

This Internet-Draft will expire on January 25, 2006.

Copyright Notice

Copyright (C) The Internet Society (2005).

Abstract

This document defines a Pseudo-Random Function (PRF) extension to the Generic Security Service Application Programming Interface (GSS-API) for keying application protocols given an established GSS-API security context. The primary intended use of this function is to key secure session layers that don't or cannot use GSS-API per-message MIC (message integrity check) and wrap tokens for session protection.

Table of Contents

| | | |
|---------------------|--|-------------------|
| 1. | Introduction | 3 |
| 1.1 | Conventions used in this document | 3 |
| 2. | GSS_Pseudo_random() | 3 |
| 2.1 | C-Bindings | 6 |
| 2.2 | Java Bindings | 6 |
| 3. | IANA Considerations | 6 |
| 4. | Security Considerations | 7 |
| 5. | References | 7 |
| 5.1 | Normative References | 7 |
| 5.2 | Informative References | 8 |
| | Author's Address | 8 |
| | Intellectual Property and Copyright Statements | 9 |

Williams

Expires January 25, 2006

[Page 2]

1. Introduction

A need has arisen for users of the GSS-API to key applications' cryptographic protocols using established GSS-API security contexts. Such applications can use the GSS-API for authentication, but not for transport security (for whatever reasons), and since the GSS-API does not provide a method for obtaining keying material from established security contexts such applications cannot make effective use of the GSS-API.

To address this need we define a pseudo-random function (PRF) extension to the GSS-API.

Though this document specifies an abstract API as an extension to the GSS-API version 2, update 1, and though it specifies the bindings of this extension for the C and Java programming languages, it does not specify a revision of the GSS-API and so does not address the matter of how portable applications detect support for and ensure access to this extension. We defer this matter to an expected, comprehensive update to the GSS-API.

1.1 Conventions used in this document

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](#)].

2. GSS_Pseudo_random()

Inputs:

- o context CONTEXT handle,
- o prf_key INTEGER,
- o prf_in OCTET STRING,
- o desired_output_len INTEGER

Outputs:

- o major_status INTEGER,
- o minor_status INTEGER,
- o prf_out OCTET STRING

Williams

Expires January 25, 2006

[Page 3]

Return major_status codes:

- o GSS_S_COMPLETE indicates no error.
- o GSS_S_NO_CONTEXT indicates that a null context has been provided as input.
- o GSS_S_CONTEXT_EXPIRED indicates that an expired context has been provided as input.
- o GSS_S_UNAVAILABLE indicates that the mechanism lacks support for this function or, if the security context is not fully established, that the context is not ready to compute the PRF with the given prf_key, or that the given prf_key is not available.
- o GSS_S_FAILURE indicates general failure, possibly due to the given input data being too large or of zero length, or due to the desired_output_len being zero; the minor status code may provide additional information.

This function applies the established context's mechanism's keyed pseudo-random function (PRF) to the input data ('prf_in'), keyed with key material associated with the given security context and identified by 'prf_key', and outputs the resulting octet string ('prf_out') of desired_output_len length.

The minimum input data length is one octet.

Mechanisms MUST be able to consume all the provided prf_in input data that is 2^{14} or fewer octets.

If a mechanism cannot consume as much input data as provided by the caller, then GSS_Pseudo_random() MUST return GSS_S_FAILURE.

The minimum desired_output_len is one.

Mechanisms MUST be able to output at least up to 2^{14} octets.

If the implementation cannot produce the desired output due to lack of resources then it MUST return GSS_S_FAILURE and MUST set a suitable minor status code.

The prf_key can take on the following values: GSS_C_PRF_KEY_FULL, GSS_C_PRF_KEY_PARTIAL or mechanism-specific values, if any. This parameter is intended to distinguish between the best cryptographic keys that may be available only after full security context establishment and keys that may be available prior to full security context establishment. For some mechanisms, or contexts, those two

Williams

Expires January 25, 2006

[Page 4]

prf_key values MAY refer to the same cryptographic keys; for mechanisms like the Kerberos V GSS-API mechanism [[RFC1964](#)] where one peer may assert a key that may be considered better than the others they MAY be different keys.

GSS_C_PRF_KEY_PARTIAL corresponds to a key that would be have been used while the security context was partially established, even if it is fully established when GSS_Pseudo_random() is actually called. Mechanism-specific prf_key values are intended to refer to any other keys that may be available.

The GSS_C_PRF_KEY_FULL value corresponds to the best key available for fully-established security contexts.

GSS_Pseudo_random() has the following properties:

- o its output string MUST be a pseudo-random function [[GGM1](#)] [[GGM2](#)] of the input keyed with key material from the given security context -- the chances of getting the same output given different input parameters should be exponentially small.
- o when successfully applied to the same inputs by an initiator and acceptor using the same security context, it MUST produce the same results for both, the initiator and acceptor, even if called multiple times (as long as the security context is not expired).
- o upon full establishment of a security context all cryptographic keys and/or negotiations used for computing the PRF with any prf_key MUST be authenticated (mutually, if mutual authentication is in effect for the given security context).
- o the outputs of the mechanism's GSS_Pseudo_random() (for different inputs) and its per-message tokens for the given security context MUST be "cryptographically separate;" in other words, it must not be feasible to recover key material for one mechanism operation or transform its tokens and PRF outputs from one to the other given only said tokens and PRF outputs. [This is a fancy way of saying that key derivation and strong cryptographic operations and constructions must be used.]
- o as implied by the above requirement, it MUST NOT be possible to access any raw keys of a security context through GSS_Pseudo_random(), no matter what inputs are given.

Mechanisms MAY limit the output of the PRF, possibly in ways related to the types of cryptographic keys available for the PRF function, thus the prf_out output of GSS_Pseudo_random() MAY be smaller than

Williams

Expires January 25, 2006

[Page 5]

requested.

2.1 C-Bindings

```
#define GSS_C_PRF_KEY_FULL 0
#define GSS_C_PRF_KEY_PARTIAL 1

OM_uint32 gss_pseudo_random(
    OM_uint32          *minor_status,
    gss_ctx_id_t       context,
    int                prf_key,
    const gss_buffer_t prf_in,
    ssize_t            desired_output_len,
    gss_buffer_t        prf_out
);
```

Additional major status codes for the C-bindings:

- o GSS_S_CALL_INACCESSIBLE_READ
- o GSS_S_CALL_INACCESSIBLE_WRITE

See [[RFC2744](#)].

2.2 Java Bindings

For Java `GSS_Pseudo_random()` maps to a method, 'prf', of the class that implements the `GSSContext` interface. Note that this document does not modify any Java interfaces and does not specify a method by which portable Java applications detect support for this GSS-API extension -- we leave that to a subsequent, comprehensive update to the GSS-API.

```
public static final int GSS_C_PRF_KEY_FULL = 0
public static final int GSS_C_PRF_KEY_PARTIAL = 1

public byte[] prf(int prf_key, byte inBuf[], int outlen)
    throws GSSException
```

See [[RFC2853](#)].

3. IANA Considerations

This document has no IANA considerations currently. If and when a relevant IANA registry of GSS-API symbols is created then the generic and language-specific function names, constant names and constant values described above should be added to such a registry.

Williams

Expires January 25, 2006

[Page 6]

4. Security Considerations

Care should be taken in properly designing a mechanism's PRF function.

GSS mechanisms' PRF functions should use a key derived from contexts' authenticated session keys and should preserve the forward security properties of the mechanisms' key exchanges.

Some mechanisms may support the GSS PRF function with security contexts that are not fully established, but applications **MUST** assume that authentication, mutual or otherwise, has not completed until the security context is fully established.

Callers of GSS_Pseudo_random() should avoid accidentally calling it with the same inputs. One useful technique is to prepend to the prf_in input string, by convention, a string indicating the intended purpose of the PRF output in such a way that unique contexts in which the function is called yield unique inputs to it.

Pseudo-random functions are, by their nature, capable of producing only limited amounts of cryptographically secure output. The exact amount of output that one can safely use, unfortunately, varies from one PRF to another (which prevents us from recommending specific numbers). Because of this we recommend that unless you really know what you are doing (i.e. you are a cryptographer and are qualified to pass judgement on cryptographic functions in areas of period, presence of short cycles, etc), you limit the amount of the PRF output used to the necessary minimum.

For some mechanisms the computational cost of computing GSS_Pseudo_random() may increase significantly as the length of the prf_in data and/or the desired_output_length increase. This means that if an application can be tricked into providing very large input octet strings and requesting very long output octet strings then that may constitute a denial of service attack on the application; therefore applications **SHOULD** place appropriate limits on the size of any input octet strings received from their peers without integrity protection.

5. References

5.1 Normative References

- [GGM1] Goldreich, O., Goldwasser, S., and S. Micali, "How to Construct Random Functions", October 1986.
- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate

Williams

Expires January 25, 2006

[Page 7]

Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.

[RFC2743] Linn, J., "Generic Security Service Application Program Interface Version 2, Update 1", [RFC 2743](#), January 2000.

[RFC2744] Wray, J., "Generic Security Service API Version 2 : C-bindings", [RFC 2744](#), January 2000.

[RFC2853] Kabat, J. and M. Upadhyay, "Generic Security Service API Version 2 : Java Bindings", [RFC 2853](#), June 2000.

[5.2](#) Informative References

[GGM2] Goldreich, O., Goldwasser, S., and S. Micali, "On the Cryptographic Applications of Random Functions", 1985.

[RFC1750] Eastlake, D., Crocker, S., and J. Schiller, "Randomness Recommendations for Security", [RFC 1750](#), December 1994.

[RFC1964] Linn, J., "The Kerberos Version 5 GSS-API Mechanism", [RFC 1964](#), June 1996.

Author's Address

Nicolas Williams
Sun Microsystems
5300 Riata Trace Ct
Austin, TX 78727
US

Email: Nicolas.Williams@sun.com

Intellectual Property Statement

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in [BCP 78](#) and [BCP 79](#).

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at <http://www.ietf.org/ipr>.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at ietf-ipr@ietf.org.

Disclaimer of Validity

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Copyright Statement

Copyright (C) The Internet Society (2005). This document is subject to the rights, licenses and restrictions contained in [BCP 78](#), and except as set forth therein, the authors retain all their rights.

Acknowledgment

Funding for the RFC Editor function is currently provided by the Internet Society.

