                  Federated Filesystem Security Addendum
              draft-cel-nfsv4-federated-fs-security-addendum-02

Abstract

   This document addresses critical security-related items that are
   missing from existing FedFS proposed standards.

Requirements Language

   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].

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1. Introduction

   Requirements for federated filesystems are described in [RFC5716].
   Specification of the protocol used by administrators to configure
   fileservers and construct namespaces is provided in [FEDFS-ADMIN].
   Specification of the protocol allowing fileservers to store namespace
   information is provided in [FEDFS-NSDB].

   These documents are now immutable. However, some security-related
   concerns have arisen that should be addressed immediately rather than
   waiting for another version of these protocols to be ratified.

1.1. Problem Statement: GSSAPI service name for ADMIN

   After IESG review, the Security Considerations chapter of
   [FEDFS-ADMIN] now specifically requires that implementations of this
   protocol support GSSAPI security mechanisms.

   ADMIN protocol clients must use a service principal to establish a
   GSS context shared with an ADMIN server. To construct the service
   principal, clients need to know a priori the protocol's GSSAPI
   service name. The form of that service name is described in section
   4.1 of [RFC2743].

Also according to the final paragraph of section 4.1, requesting an addition to the "GSSAPI/Kerberos/SASL Service Names" registry requires a specification. Because [FEDFS-ADMIN] cannot be changed, a new specification must be provided.

1.2. Problem Statement: GSSAPI service name for NSDB

[FEDFS-NSDB] specifies that NSDB services must be based on the LDAP protocol [RFC4511]. [FEDFS-NSDB] and [FEDFS-ADMIN] already specify a mechanism to protect NSDB connections using x.509 [RFC4513].

In some cases, it is inconvenient for domain administrators to provide x.509 certificates for NSDBs. One reason might be that administrators have no access to a public trusted Certificate Authority. If a Kerberos TGT service is available locally, for example, that could be a more logical choice than x.509 for managing NSDB server identity.

The RPC [RFC5531] and LDAP protocols have GSSAPI in common. The present document clarifies the use of existing SASL GSSAPI mechanisms when deployed with NSDBs. It does not address how the ADMIN protocol can specify SASL GSSAPI in NSDB connection parameters.

1.3. Problem Statement: Compromised NSDBs

The FedFS ADMIN RPC protocol provides a mechanism for provisioning NSDBs on remote fileservers. The operations it provides are FEDFS_SET_NSDB_PARAMS, FEDFS_GET_NSDB_PARAMS, and FEDFS_GET_LIMITED_NSDB_PARAMS.

FEDFS_SET_NSDB_PARAMS specifies the name of an NSDB and the security mode to use when connecting to this NSDB. The fileserver connects to an NSDB in order to resolve a FedFS junction. The ADMIN protocol specification further says:

    On success, this operation returns FEDFS_OK. When the operation returns, the new connection parameters SHOULD be used for all subsequent LDAP connections to the given NSDB. Existing connections MAY be terminated and re-established using the new connection parameters. The connection parameters SHOULD be durable across fileserver reboots.

There are two security modes defined in the protocol specification: FEDFS_SEC_NONE, which does not authenticate the LDAP server; and FEDFS_SEC_TLS, which uses START_TLS (RFC 4513) to authenticate the LDAP server.

When FEDFS_SEC_TLS is specified with the FEDFS_SET_NSDB_PARAMS
operation, an x.509v3 certificate chain is also provided to the
fileserver. The fileserver uses the provided certificate to
authenticate subsequent connections to this NSDB. The
FEDFS_SET_NSDB_PARAMS operation can change the connection security
used by a fileserver to connect to a particular NSDB from NONE to TLS
or TLS to NONE.

Over time, domain administrators add NSDB connection parameters to
each of their fileservers to enable FedFS junction resolution. The
specified NSDB may be the domain's own, or it might be an NSDB in a
foreign domain.

Many junctions on multiple fileservers can be created that use a
particular NSDB. There is no way to find such junctions without an
exhaustive search. Since filesystem namespace topology can evolve
arbitrarily over time, a recorded pathname of any junction is almost
guaranteed to become stale.

Now suppose we have two FedFS domains: example.net and
university.edu. Suppose university.edu fileservers have a number of
junctions that refer to locations maintained by example.net, and thus
university.net's fileservers are configured to resolve junctions on
example.net's NSDB.

One day Mallory compromises example.net's NSDB, but the domain
administrator there is on a long vacation. The administrator at
university.net discovers the compromise immediately, but has no
control over the foreign NSDB and cannot create a fresh x.509
certificate or verify that the contents of the NSDB are unmolested.
The only choice is to find and remove every junction in the
university.edu domain that contains the compromised NSDB.

If university.edu is using a good implementation of FedFS, the
administrative tools it provides might allow an administrator to
simply visit each of its fileservers and mark the example.net NSDB as
compromised. Any junction resolution that attempts to use that NSDB
would fail, but all junctions remain in place. When example.net's
administrator gets back from holiday and cleans up the mess, the
university.edu administrator can then update each of her fileservers
with fresh connection parameters for that NSDB.

However, none of this can be done remotely using the FedFS ADMIN
protocol. It does not have a mechanism for removing NSDB connection
parameters or for fencing a compromised NSDB.

1.4. Scope Of This Document

   This document specifies additional requirements for the FedFS ADMIN
   protocol specified in [FEDFS-ADMIN], which is a standards track
   specification.

2. GSSAPI Service Name for the FedFS ADMIN protocol

   Section 6 of [FEDFS-ADMIN] requires a FedFS ADMIN server to support
   the RPCSEC_GSS framework [RFC2203]. The present document specifies
   the GSSAPI service name, as described in Section 4.1 of [RFC2743], to
   be used for the FedFS ADMIN protocol.

   Regardless of what security mechanism under RPCSEC_GSS is in use, a
   FedFS ADMIN server MUST identify itself in GSSAPI via a
   GSS_C_NT_HOSTBASED_SERVICE name type. GSS_C_NT_HOSTBASED_SERVICE
   names are of the form:

        service@hostname

   For the ADMIN protocol, the "service" element is

        fedfs-admin

   Implementations of security mechanisms will convert fedfs-
   admin@hostname to various different forms. For Kerberos V5, the
   following form is RECOMMENDED:

        fedfs-admin/hostname

   This service name SHOULD NOT be used to authenticate other GSSAPI
   services.

3. GSSAPI Service Name for the FedFS NSDB protocol

   Section 5.2.1.1 of [RFC4513] specifies the GSS service name for LDAP.
   LDAP servers acting as NSDBs MUST use this service name, which is of
   the form:

        service@hostname

   When accessing an NSDB service, the "service" element is

        ldap

   Implementations of security mechanisms will convert ldap@hostname to
   various different forms. For Kerberos V5, the following form is
   RECOMMENDED:

ldap/hostname

FedFS-enabled file servers act as NSDB clients when resolving FedFS
junctions. In order to access NSDBs via SASL GSSAPI, such clients
would first authenticate to a KDC. To avoid a requirement for human
interaction (say, to enter a Kerberos password), such clients should
utilize a key stored in a keytab. Clients MAY use nfs/hostname, but
MUST NOT use fedfs-admin/hostname.

3.1. Cross-realm considerations

Note that the target NSDB's REALM is not specified above. When
authenticating a GSSAPI service, NSDB clients typically have a
service name (in this case "ldap") and the fully qualified domain
name of the NSDB server. The underlying LDAP client library will
either:

1. Find the server's REALM based on local configuration, or

2. Request a referral from the local KDC if the NSDB server's FQDN
    is not registered in the default REALM.

Therefore, a pre-existing trust relationship must exist between the
REALM of a FedFS-enabled file server and the REALMs containing
foreign NSDBs containing junctions that file server wants to resolve.
In this instance, an x.509 certificate may be a preferrable approach.

4. Fencing Compromised NSDBs

An NSDB is considered "foreign" relative to a particular FedFS domain
if that domain's administrator has no administrative access to that
NSDB.

When a FedFS domain administrator is faced with a foreign NSDB that
is compromised or otherwise unusable, and in the absense of an
implementation-provided mechanism for fencing an NSDB, the
administrator can fence that NSDB using the following technique.

1. The administrator locally generates a new certificate for the
    compromised foreign NSDB. The certificate can be self-signed, or
    signed by the administrator's local certificate authority.

2. The administrator distributes this certificate to all of her
    domain's fileservers using the FedFS ADMIN protocol or some other
    secure means. The connection security for the foreign NSDB is
    set to FEDFS_SEC_TLS on each of the local domain's fileservers.

3. The administrator requests fresh certificate material from the
    administrator of the foreign NSDB.

4. When the threat has passed and the foreign NSDB is safe to use
    again, the administrator can distribute the new valid certificate
    material to her domain's fileservers.

No change to the ADMIN protocol as specified in [FEDFS-ADMIN] is
required to fence a compromised NSDB. Step 2 guarantees that, on
fileservers in the administrator's local FedFS domain, resolving a
junction that references the compromised foreign NSDB will fail until
updated certificate material is provided.

5. Security Considerations

When deploying FedFS, the use of security mechanisms that maintain
the confidentiality of all network communications is recommended.
This includes the use of any pseudoflavor that supports the
rpc_gss_svc_privacy service for the FedFS ADMIN protocol, and the use
of TLS message encryption for the NSDB protocol.

When creating x.509 certificates for authenticating NSDBs,
implementations should utilize keys that are as large as practical,
especially if certificate lifetimes are long.

Operational security is further enhanced by ensuring that all
hardware entropy sources are verified for cryptographic use. This
recommendation applies to the creation of x.509 certificate material,
random-variant UUIDs, and handshake keys used to secure transports,
for example.

Information stored in fedfsDescr and fedfsAnnotation attributes are
readable by any unauthenticated user of an NSDB, and therefore should
contain no sensitive information.

6. IANA Considerations

In accordance with Section 4.1 of [RFC2743], the service name "fedfs-
admin" will be registered in the GSSAPI Service Name registry at
http://www.iana.org/assignments/gssapi-service-names/ gssapi-service-
names.xml

The new entry should reference the present document as the
specification.

7. Acknowledgements

   The author of this document gratefully acknowledges the contributions
   of Simo Sorce, Nico Williams, Robert Thurlow, Spencer Shepler, Tom
   Haynes, and David Noveck.

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8.1. Normative References

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