           Short-Lived Certificates for Secure Telephone Identity
                draft-peterson-stir-certificates-shortlived-05

Abstract

   When certificates are used as credentials to attest the assignment of
   ownership of telephone numbers, some mechanism is required to provide
   certificate freshness. This document specifies short-lived
   certificates as a means of guaranteeing certificate freshness for
   secure telephone identity (STIR), potentially relying on the
   Automated Certificate Management Environment (ACME) or similar
   mechanisms to allow signers to acquire certificates as needed.

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1. Introduction

   The STIR problem statement [RFC7340] discusses many attacks on the
   telephone network that are enabled by impersonation, including
   various forms of robocalling, voicemail hacking, and swatting. One
   of the most important components of a system to prevent impersonation
   is the implementation of credentials which identify the parties who
   control telephone numbers. The STIR certificates [RFC8226]
   specification describes a credential system based on [X.509] version
   3 certificates in accordance with [RFC5280] for that purpose. Those
   credentials can then be used by STIR authentication services
   [RFC8224] to sign PASSporT objects [RFC8225] carried in a SIP
   [RFC3261] request.

   The STIR certificates document specifies an extension to X.509 that
   defines a Telephony Number (TN) Authorization List that may be
   included by certificate authorities in certificates. This extension
   provides additional information that relying parties can use when
   validating transactions with the certificate: either in the form of
   Service Provider Codes (SPCs) or telephone numbers. Telephone
   numbers or number ranges are used in delegate STIR certificates
   [RFC9060]. When a SIP request arrives at a terminating
   administrative domain, for example, the calling number attested by

the SIP request can be compared to the TN Authorization List of the
delegate certificate that signed the request to determine if the
caller is authorized to use that calling number in SIP.

No specific recommendation is made in the STIR certificates document
for a means of determining the freshness of certificates with a TN
Authorization List. This document explores how short-lived
certificates could be used as a means of preserving that freshness.
Short-lived certificates also have a number of other desirable
properties that fulfill important operational requirements for
network operators. A mechanism such as the Automated Certificate
Management Environment (ACME) [RFC8555] could be leveraged to manage
these short-lived certificates, as well as various web-based
interfaces or other out-of-band mechanisms. The interaction of STIR
with ACME has already been explored in [RFC9448], so it provides a
potentially attractive way of delivering short-lived certificates.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
"OPTIONAL" in this document are to be interpreted as described in BCP
14 [RFC2119] [RFC8174] when, and only when, they appear in all
capitals, as shown here.

3. Short-lived certificates for STIR

While there is no easy definition of what constitutes a "short-lived"
certificate, the term typically refers to certificates that are valid
only for days or even hours, as opposed to the months or years common
in traditional public key infrastructures. When the private keying
material associated with a certificate with an expiry of months or
years is compromised by an adversary, the issuing authority must
revoke the certificate, which requires relying parties to review
certificate revocation lists or to access real-time status
information with protocols such as OCSP. Short-lived certificates
offer an alternative where, if compromised, certificates will shortly
expire anyway, and rather than revoking and reissuing the certificate
in response to a crisis, certificates routinely roll-over and cannot
be cached for a long term by relying parties, minimizing their value
to attackers.

One of the additional benefits of using short-lived certificates is
that they do not require relying parties to perform any certificate
freshness check. The trade-off is that the signer must acquire new
certificates frequently, so the cost of round-trip times to the
certificate authority is paid on the signer's side rather than the
verifier's side; however, in environments where many parties may rely

on a single certificate, or at least where a single certificate will
be used to sign many transactions during its short lifetime, the
overall architecture will incur fewer round-trip times to the
certificate authority and thus less processing delay.

In the STIR context, the TN Authorization List defined in [RFC8226]
adds a new wrinkle to the behavior of short-lived certificates,
especially when the List is populated with telephone numbers or
number ranges instead of Service Provider Codes (SPCs). A subject
may have authority over multiple telephone numbers, but a particular
short-lived certificate issued to that subject could attest the
authority over all, some, or just one of those telephone numbers.
Short-lived certificates permit a more on-demand certification
process, where subjects acquire certificates as needed, potentially
in reaction to calls being placed. A STIR authentication service
could even acquire a new certificate on a per-call basis that can
only sign for the calling party number of the call in question, as it
would expire immediately thereafter. At the other end of the
spectrum, a large enterprise service provider could acquire a
certificate valid for millions of numbers, but expire the certificate
after a very short duration - on the order of hours - to reduce the
risk that the certificate would be compromised.

This inherent flexibility in the short-lived certificate architecture
would also permit authentication services to implement very narrow
policies for certificate usage. A large service provider who wanted
to avoid revealing which phone numbers they controlled, for example,
could provide no information in the certificate that signs a call
other than just the single telephone number that corresponds to the
calling party's number. How frequently the service provider feels
that they need to expire that certificate and acquire a new one is
entirely a matter of local policy. This makes it much harder for
entities monitoring signatures over calls to guess who owns which
numbers, and provides a much more complicated threat surface for
attackers trying to compromise the service.

4. Certificate conveyance with 'x5c'

In order to reduce the burden on verification services, an
authentication service could also piggyback a short-lived certificate
onto the PASSporT, so that no network lookup and consequent round-
trip delay would be required on the terminating side to acquire the
new certificate. In particular, the poor cacheability of short-lived
certificates may require frequent fetches of certificates via the
"x5u" PASSporT header element when relying parties validate
PASSporTs.

As an optimization, this specification permits the conveyance of the
certificate chain for a short-lived certificate via the "x5c" JWS
header element ([RFC7515] Section 4.1.6). The "x5c" element contains
a base64 encoded DER representation of the certificate chain. STIR
Verification service implementations compliant with this
specification MUST support the "x5c" element; authentication services
SHOULD use the "x5c" format for PASSporTs signed by certificates with
an expiry shorter than one week. The presence of x5y creates
PASSporT objects that are considerable larger than typical RFC8225
tokens, and the longer the certificate chain, the larger the PASSporT
header will be. But provided the certificate chain leads to a
trusted certification authority, "x5u" precludes the need for a
round-trip time before validation at the STIR verification service.

An example PASSporT header with an "x5c" element with three
certificates in its chain might look as follows:

```
{ "typ":"passport",
  "ppt":"div",
  "alg":"ES256",
  "x5c":
  [ "MIIE3jCCA8agAwIBAgICAwEwDQYJKoZIhvcNAQEFBQAwYzELMAkGA1UEBhMCVVM
    xITAfBgNVBAoTGFRoZSBHbyBEYWRkeSBHcm91cCwgSW5jLjExMC8GA1UECxMoR2
    8gRGFkZHkgQ2xhc3MgMiBDZXJ0aWZpY2F0aW9uIEF1dGhvcml0eTAeFw0wNjExM
    TYwMTU0MzdaFw0yNjExMTYwMTU0MzdaMIHKMQswCQYDVQQGEwJVUzEQMA4GA1UE
    CBMHQXJpem9uYTETMBEGA1UEBxMKU2NvdHRzZGFsZTEaMBgGA1UEChMRR29EYWR
    keS5jb20sIEluYy4xMzAxBgNVBAsTKmh0dHA6Ly9jZXJ0aWZpY2F0ZXMuZ29kYW
    RkeS5jb20vcmVwb3NpdG9yeTEwMC4GA1UEAxMnR28gRGFkZHkgU2VjdXJlIENlc
    nRpZmljYXRpb24gQXV0aG9yaXR5MREwDwYDVQQFEwgwNzk2OTI4NzCCASIwDQYJ
    KoZIhvcNAQEBBQADggEPADCCAQoCggEBAMQt1RWMnCZM7DI161+4WQFapmGBWTt
    wY6vj3D3HKrjJM9N55DrtPDAjhI6zMBS2sofDPZVUBJ7fmd0LJR4h3mUpfjWoqV
    Tr9vcyOdQmVZWt7/v+WIbXnvQAjYwqDL1CBM6nPwT27oDyqu9SoWlm2r4arV3aL
    GbqGmu75RpRSgAvSMeYddi5Kcju+GZtCpyz8/x4fKL4o/K1w/O5epHBp+YlLpyo
    7RJlbmr2EkRTcDCVw5wrWCs9CHRK8r5RsL+H0EwnWGu1NcWdrxcx+AuP7q2BNgW
    JCJjPOq8lh8BJ6qf9Z/dFjpfMFDniNoW1fho3/Rb2cRGadDAW/hOUoz+EDU8CAw
    EAAaOCATIwggEuMB0GA1UdDgQWBBT9rGEyk2xF1uLuhV+auud2mWjM5zAfBgNVH
    SMEGDAWgBTSxLDSkdRMEXGzYcs9of7dqGrU4zASBgNVHRMBAf8ECDAGAQH/AgEA
    MDMGCCsGAQUFBwEBBCcwJTAjBggrBgEFBQcwAYYXaHR0cDovL29jc3AuZ29kYWR
    keS5jb20wRgYDVR0fBD8wPTA7oDmgN4Y1aHR0cDovL2NlcnRpZmljYXRlcy5nb2
    RhZGR5LmNvbS9yZXBvc2l0b3J5L2dkcm9vdC5jcmwwSwYDVR0gBEQwQjBABgRVH
    SAAMDgwNgYIKwYBBQUHAgEWKmh0dHA6Ly9jZXJ0aWZpY2F0ZXMuZ29kYWRkeS5j
    b20vcmVwb3NpdG9yeTAOBgNVHQ8BAf8EBAMCAQYwDQYJKoZIhvcNAQEFBQADggE
    BANKGwOy9+aG2Z+5mC6IGOgRQjhVyrEp0lVPLN8tESe8HkGsz2ZbwlFalEzAFPI
    UyIXvJxwqoJKSQ3kbTJSMUA2fCENZvD117esyfxVgqwcSeIaha86ykRvOe5GPLL
    5CkKSkB2XIsKd83ASe8T+5o0yGPwLPk9Qnt0hCqU7S+8MxZC9Y7lhyVJEnfzuz9
    p0iRFEUOOjZv2kWzRaJBydTXRE4+uXR21aITVSzGh6O1mawGhId/dQb8vxRMDsx
    uxN89txJx9OjxUUAiKEngHUuHqDTMBqLdElrRhjZkAzVvb3du6/KFUJheqwNTrZ
    EjYx8WnM25sgVjOuH0aBsXBTWVU+4=",
```

       "MIIE+zCCBGSgAwIBAgICAQ0wDQYJKoZIhvcNAQEFBQAwgbsxJDAiBgNVBAcTG1Z
       hbGlDZXJ0IFZhbGlkYXRpb24gTmV0d29yazEXMBUGA1UEChMOVmFsaUNlcnQsIE
       luYy4xNTAzBgNVBAsTLFZhbGlDZXJ0IENsYXNzIDIgUG9saWN5IFZhbGlkYXRpb
       24gQXV0aG9yaXR5MSEwHwYDVQQDExhodHRwOi8vd3d3LnZhbGljZXJ0LmNvbS8x
       IDAeBgkqhkiG9w0BCQEWEWluZm9AdmFsaWNlcnQuY29tMB4XDTA0MDYyOTE3MDY
       yMFoXDTI0MDYyOTE3MDYyMFowYzELMAkGA1UEBhMCVVMxITAfBgNVBAoTGFRoZS
       BHbyBEYWRkeSBHcm91cCwgSW5jLjExMC8GA1UECxMoR28gRGFkZHkgQ2xhc3MgM
       iBDZXJ0aWZpY2F0aW9uIEF1dGhvcml0eTCCASAwDQYJKoZIhvcNAQEBBQADggEN
       ADCCAQgCggEBAN6d1+pXGEmhW+vXX0iG6r7d/+TvZxz0ZWizV3GgXne77ZtJ6XC
       APVYYYwhv2vLM0D9/AlQiVBDYsoHUwHU9S3/Hd8M+eKsaA7Ugay9qK7HFiH7Eux
       6wwdhFJ2+qN1j3hybX2C32qRe3H3I2TqYXP2WYktsqbl2i/ojgC95/5Y0V4evLO
       tXiEqITLdiOr18SPaAIBQi2XKVlOARFmR6jYGB0xUGlcmIbYsUfb18aQr4CUWWo
       riMYavx4A6lNf4DD+qta/KFApMoZFv6yyO9ecw3ud72a9nmYvLEHZ6IVDd2gWMZ
       Eewo+YihfukEHU1jPEX44dMX4/7VpkI+EdOqXG68CAQOjggHhMIIB3TAdBgNVHQ
       4EFgQU0sSw0pHUTBFxs2HLPaH+3ahq1OMwgdIGA1UdIwSByjCBx6GBwaSBvjCBu
       zEkMCIGA1UEBxMbVmFsaUNlcnQgVmFsaWRhdGlvbiBOZXR3b3JrMRcwFQYDVQQK
       Ew5WYWxpQ2VydCwgSW5jLjE1MDMGA1UECxMsVmFsaUNlcnQgQ2xhc3MgMiBQb2x
       pY3kgVmFsaWRhdGlvbiBBdXRob3JpdHkxITAfBgNVBAMTGGh0dHA6Ly93d3cudm
       FsaWNlcnQuY29tLzEgMB4GCSqGSIb3DQEJARYRaW5mb0B2YWxpY2VydC5jb22CA
       QEwDwYDVR0TAQH/BAUwAwEB/zAzBggrBgEFBQcBAQQnMCUwIwYIKwYBBQUHMAGG
       F2h0dHA6Ly9vY3NwLmdvZGFkZHkuY29tMEQGA1UdHwQ9MDswOaA3oDWGM2h0dHA
       6Ly9jZXJ0aWZpY2F0ZXMuZ29kYWRkeS5jb20vcmVwb3NpdG9yeS9yb290LmNybD
       BLBgNVHSAERDBCMEAGBFUdIAAwODA2BggrBgEFBQcCARYqaHR0cDovL2NlcnRpZ
       mljYXRlcy5nb2RhZGR5LmNvbS9yZXBvc2l0b3J5MA4GA1UdDwEB/wQEAwIBBjAN
       BgkqhkiG9w0BAQUFAAOBgQC1QPmnHfbq/qQaQlpE9xXUhUaJwL6e4+PrxeNYiY+
       Sn1eocSxI0YGyeR+sBjUZsE4OWBsUs5iB0QQeyAfJg594RAoYC5jcdnplDQ1tgM
       QLARzLrUc+cb53S8wGd9D0VmsfSxOaFIqII6hR8INMqzW/Rn453HWkrugp++85j
       09VZw==",
       "MIIC5zCCAlACAQEwDQYJKoZIhvcNAQEFBQAwgbsxJDAiBgNVBAcTG1ZhbGlDZXJ
       0IFZhbGlkYXRpb24gTmV0d29yazEXMBUGA1UEChMOVmFsaUNlcnQsIEluYy4xNT
       AzBgNVBAsTLFZhbGlDZXJ0IENsYXNzIDIgUG9saWN5IFZhbGlkYXRpb24gQXV0a
       G9yaXR5MSEwHwYDVQQDExhodHRwOi8vd3d3LnZhbGljZXJ0LmNvbS8xIDAeBgkq
       hkiG9w0BCQEWEWluZm9AdmFsaWNlcnQuY29tMB4XDTk5MDYyNjAwMTk1NFoXDTE
       5MDYyNjAwMTk1FowgbsxJDAiBgNVBAcTG1ZhbGlDZXJ0IFZhbGlkYXRpb24gTm
       V0d29yazEXMBUGA1UEChMOVmFsaUNlcnQsIEluYy4xNTAzBgNVBAsTLFZhbGlDZ
       XJ0IENsYXNzIDIgUG9saWN5IFZhbGlkYXRpb24gQXV0aG9yaXR5MSEwHwYDVQQD
       ExhodHRwOi8vd3d3LnZhbGljZXJ0LmNvbS8xIDAeBgkqhkiG9w0BCQEWEWluZm9
       AdmFsaWNlcnQuY29tMIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQDOOnHK5a
       vIWZJV16vYdA757tn2VUdZZUcOBVXc65g2PFxTXdMwzzjsvUGJ7SVCCSRrCl6zf
       N1SLUzm1NZ9WlmpZdRJEy0kTRxQb7XBhVQ7/nHk01xC+YDgkRoKWzk2Z/M/VXwb
       P7RfZHM047QSv4dk+NoS/zcnwbNDu+97bi5p9wIDAQABMA0GCSqGSIb3DQEBBQU
       AA4GBADt/UG9vUJSZSWI4OB9L+KXIPqeCgfYrx+jFzug6EILLGACOTb2oWH+heQ
       C1u+mNr0HZDzTuIYEZoDJJKPTEjlbVUjP9UNV+mWwD5MlM/Mtsq2azSiGM5bUMM
       j4QssxsodyamEwCW/POuZ6lcg5Ktz885hZo+L7tdEy8W9ViH0Pd"]

    }

    [TBD - certificate above is the example from RFC7515]

A potential alternative approach would be that [RFC8224] already
provides a way of pointing to a certificate in a MIME body associated
with the SIP request. For out-of-band uses of STIR, however, having
the certificate embedded in the PASSporT itself is a superior option.

5. Certificate Acquisition with ACME

One of the primary challenges facing short-lived certificates is
building an operational system that allows signers to acquire new
certificates and put them to immediate use. ACME [RFC8555] is
designed for exactly this purpose. After a client registers with an
ACME server, and the authority of the client for the names in
question is established (through means such as [RFC9448]), the client
can at any time apply for a certificate to be issued by sending an
appropriate JSON request to the server. That request will contain a
CSR [RFC2986] indicating the intended scope of authority as well the
validity interval of the certificate in question. Ultimately, this
will enable the client to download the certificate from a certificate
URL designated by the server.

ACME is based on the concept that clients establish accounts at an
ACME server, and that through challenges, the server learns which
identifiers it will issue for certificates requested for an account.
Any given certificate issued for an account can be for just one of
those identifiers, or potentially for more: this is determined by the
CSR that an ACME client creates for a particular order. Thus, a
service provider with authority for millions of identifiers - that
is, millions of telephone numbers - could create a CSR for an ACME
order that requests a certificate only associated with one of those
telephone numbers if it so desired. The same would be true of
certificates based on Service Provider Codes (SPCs) as described in
[RFC8226]: a service provider might have just one SPC or perhaps
many. ACME thus puts needed flexibility into the hands of the
clients requesting certificates to determine how much of their
authority they want to invest in any given certificate.

[RFC9448] uses the ATC framework of [RFC9447] to generate tokens that
are provided to the CA in response to ACME challenges. For a usage
with short-term certificates, it may make sense for the ATC tokens to
have a relatively long expiry, so that the ACME client does not have
to constantly return to the Token Authority for new tokens. This
could potentially be used with the ACME STAR [RFC8739] mechanism as
well.

6. IANA Considerations

This document contains no actions for the IANA.

7. Privacy Considerations

   Short-lived certificates provide attractive privacy properties when
   compared to real-time status query protocols like OCSP, which require
   relying parties to perform a network dip that can reveal a great deal
   about the source and destination of communications. For STIR, these
   problems are compounded by the presence of the TN Authorization List
   extension to certificates. Short-lived certificates can minimize the
   data that needs to appear in the TN Authorization List, and
   consequently reduce the amount of information about the caller leaked
   by certificate usage to an amount equal to what is leaked by the call
   signaling itself.

8. Security Considerations

   This document is entirely about security. For further information on
   certificate security and practices, see [RFC5280], in particular its
   Security Considerations. The Security Considerations of [RFC8555]
   are relevant to the use of ACME to acquire short-lived certificates.

9. Acknowledgments

   Stephen Farrell, Jack Richard and Chris Wendt provided key input to
   the discussions leading to this document.

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