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# Resource Public Key Infrastructure (RPKI) Trust Anchor Locator
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## Abstract

This document defines a Trust Anchor Locator (TAL) for the Resource Public Key Infrastructure (RPKI). TALs allow Relying Parties in the RPKI to download the current Trust Anchor (TA) CA certificate from one or more locations, and verify that the key of this self-signed certificate matches the key on the TAL. Thus, Relying Parties can be configured with TA keys, but allow these TAs to change the content of their CA certificate. In particular it allows TAs to change the set of IP Address Delegations and/or Autonomous System Identifier Delegations included in the RFC3779 extension of their certificate.

This document obsoletes the previous definition of Trust Anchor Locators in RFC 7730 by adding support for RFC3986 Uniform Resource Identifiers (URIs) that use HTTPS as the scheme.

## Status of This Memo

Copyright Notice

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## 1. Introduction

This document defines a Trust Anchor Locator (TAL) for the Resource Public Key Infrastructure (RPKI) [RFC6480]. This format may be used to distribute trust anchor material using a mix of out-of-band and online means. Procedures used by Relying Parties (RPs) to verify RPKI signed objects SHOULD support this format to facilitate interoperability between creators of trust anchor material and RPs. This document obsoletes [RFC7730] by adding support for HTTPS URIs [RFC7230] in a TAL.

### 1.1. 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.

### 1.2. Changes from RFC7730

The TAL format defined in this document differs from the definition in [RFC7730] in that:

- it allows for the use of the HTTPS scheme in URIs [RFC7230]; and

- it allows for the inclusion of an optional comment section.

Note that current Relying Parties may not support this new format yet. Therefore it is RECOMMENDED that a Trust Anchor operator maintains a [RFC7730] TAL file for a time as well until they are satisfied that RP tooling has been updated.

## 2. Trust Anchor Locator

### 2.1. Trust Anchor Locator Motivation

This document does not propose a new format for trust anchor material. A trust anchor in the RPKI is represented by a self-signed X.509 Certification Authority (CA) certificate, a format commonly used in PKIs and widely supported by RP software. This document specifies a format for data used to retrieve and verify the authenticity of a trust anchor in a very simple fashion. That data is referred to as the TAL.

The motivation for defining the TAL is to enable selected data in the trust anchor to change, without needing to redistribute the trust anchor per se.

In the RPKI, certificates contain an RFC3779 extension, that can contain a set of IP Address Delegations and/or Autonomous System Identifier Delegations. In this document we refer to these delegations as the Internet Number Resources (INR) contained in an RPKI certificate.

The set of INRs associated with an entity acting as a trust anchor is likely to change over time. Thus, if one were to use the common PKI convention of distributing a trust anchor to RPs in a secure fashion, then this procedure would need to be repeated whenever the INR set

for the entity acting as a trust anchor changed. By distributing the TAL (in a secure fashion), instead of distributing the trust anchor, this problem is avoided, i.e., the TAL is constant so long as the trust anchor's public key and its location do not change.

The TAL is analogous to the TrustAnchorInfo data structure specified in [RFC5914], which is on the Standards Track. That specification could be used to represent the TAL, if one defined an rsync or HTTPS URI extension for that data structure. However, the TAL format was adopted by RPKI implementors prior to the PKIX trust anchor work, and the RPKI implementer community has elected to utilize the TAL format, rather than define the requisite extension. The community also prefers the simplicity of the ASCII encoding of the TAL, versus the binary (ASN.1) encoding for TrustAnchorInfo.

### 2.2. Trust Anchor Locator File Format

In this document we define a Trust Anchor URI as a URI that can be used to retrieved a current Trust Anchor certificate. This URI MUST be either an rsync URI [RFC5781], or an HTTPS URI [RFC7230].

The TAL is an ordered sequence of:

1. an optional comment section consisting of one or more lines each starting with the '#' character, followed by human readable informational UTF-8 text, conforming to the restrictions defined in section 2 of [RFC5198], and ending with a line break,

2. a URI section, that is comprised of one or more ordered lines, each containing a Trust Anchor URI, and ending with a line break,

3. a line break,

4. a subjectPublicKeyInfo [RFC5280] in DER format [X.509], encoded in Base64 (see Section 4 of [RFC4648]). To avoid long lines, line breaks MAY be inserted into the Base64-encoded string.

Note that line breaks in this file can use either "<CRLF>" or "<LF>".

### 2.3. TAL and Trust Anchor Certificate Considerations

Each Trust Anchor URI in the TAL MUST reference a single object. It MUST NOT reference a directory or any other form of collection of objects. The referenced object MUST be a self-signed CA certificate that conforms to the RPKI certificate profile [RFC6487]. This certificate is the trust anchor in certification path discovery [RFC4158] and validation [RFC5280] [RFC3779].

The validity interval of this trust anchor is chosen such that the "notBefore" time predates the moment that this certificate is published, and the "notAfter" time is after the planned time of re-issuance of this certificate.

The INR extension(s) of this trust anchor MUST contain a non-empty set of number resources. It MUST NOT use the "inherit" form of the INR extension(s). The INR set described in this certificate is the set of number resources for which the issuing entity is offering itself as a putative trust anchor in the RPKI [RFC6480].

The public key used to verify the trust anchor MUST be the same as the subjectPublicKeyInfo in the CA certificate and in the TAL.

The trust anchor MUST contain a stable key which does not change when the certificate is reissued due to changes in the INR extension(s), when the certificate is renewed prior to expiration.

Because the public key in the TAL and the trust anchor MUST be stable, this motivates operation of that CA in an offline mode. In that case a subordinate CA certificate containing the same INRs, or in theory any sub-set of INRs, can be issued for online operations. This allows the entity that issues the trust anchor to keep the corresponding private key of this certificate offline, while issuing all relevant child certificates under the immediate subordinate CA. This measure also allows the Certificate Revocation List (CRL) issued by that entity to be used to revoke the subordinate CA certificate in the event of suspected key compromise of this online operational key pair that is potentially more vulnerable.

The trust anchor MUST be published at a stable URI. When the trust anchor is reissued for any reason, the replacement CA certificate MUST be accessible using the same URI.

Because the trust anchor is a self-signed certificate, there is no corresponding CRL that can be used to revoke it, nor is there a manifest [RFC6486] that lists this certificate.

If an entity wishes to withdraw a self-signed CA certificate as a putative trust anchor, for any reason, including key rollover, the entity MUST remove the object from the location referenced in the TAL.

Where the TAL contains two or more Trust Anchor URIs, then the same self-signed CA certificate MUST be found at each referenced location. In order to increase operational resilience, it is RECOMMENDED that the domain name parts of each of these URIs resolve to distinct IP addresses that are used by a diverse set of repository publication

points, and these IP addresses be included in distinct Route Origin Authorizations (ROAs) objects signed by different CAs.

### 2.4. Example

```
        # This TAL is intended for documentation purposes only.
        # Do not attempt to use this in a production setting.
        rsync://rpki.example.org/rpki/hedgehog/root.cer
        https://rpki.example.org/rpki/hedgehog/root.cer

        MIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAovWQL2lh6knDx
        GUG5hbtCXvvh4AOzjhDkSHlj22gn/1oiM9IeDATIwP44vhQ6L/xvuk7W6
        Kfa5ygmqQ+xOZOwTWPcrUbqaQyPNxokuivzyvqVZVDecOEqs78q58mSp9
        nbtxmLRW7B67SJCBSzfa5XpVyXYEgYAjkk3fpmefU+AcxtxvvHB5OVPIa
        BfPcs80ICMgHQX+fphvute9XLxjfJKJWkhZqZ0v7pZm2uhkcPx1PMGcrG
        ee0WSDC3fr3erLueagpiLsFjwwpX6F+Ms8vqz45H+DKmYKvPSstZjCCq9
        aJ0qANT9OtnfSDOS+aLRPjZryCNyvvBHxZXqj5YCGKtwIDAQAB
```

### 3. Relying Party Use

In order to use the TAL to retrieve and validate a (putative) trust anchor, an RP SHOULD:

1. Retrieve the object referenced by (one of) the Trust Anchor URI(s) contained in the TAL.

2. Confirm that the retrieved object is a current, self-signed RPKI CA certificate that conforms to the profile as specified in [RFC6487].

3. Confirm that the public key in the TAL matches the public key in the retrieved object.

4. Perform other checks, as deemed appropriate (locally), to ensure that the RP is willing to accept the entity publishing this self-signed CA certificate to be a trust anchor. These tests apply to the validity of attestations made in the context of the RPKI relating to all resources described in the INR extension of this certificate.

An RP SHOULD perform these functions for each instance of TAL that it is holding for this purpose every time the RP performs a resynchronization across the local repository cache. In any case, an RP also SHOULD perform these functions prior to the expiration of the locally cached copy of the retrieved trust anchor referenced by the TAL.

In the case where a TAL contains multiple Trust Anchor URIs, an RP MAY use a locally defined preference rule to select the URI to retrieve the self-signed RPKI CA certificate that is to be used as a trust anchor. Some examples are:

- Using the order provided in the TAL
- Selecting the Trust Anchor URI randomly from the available list
- Creating a prioritized list of URIs based on RP-specific parameters, such as connection establishment delay

If the connection to the preferred URI fails, or the retrieved CA certificate public key does not match the TAL public key, the RP SHOULD retrieve the CA certificate from the next URI, according to the local preference ranking of URIs.

## 4. URI Scheme Considerations

Please note that the RSYNC protocol provides neither transport security nor any means by which the Relying Party can validate that they are connected to the proper host. There it is RECOMMENDED that HTTPS is used as the preferred scheme.

Note that, although a Man in the Middle (MITM) cannot produce a CA certificate that would be considered valid according to the process described in Section 3, this attack can prevent that the Relying Party learns about an updated CA certificate.

Relying Parties MUST do TLS certificate and host name validation when they fetch a CA certificate using an HTTPS URI on a TAL. RPs SHOULD log any TLS certificate or host name validation issues found, so that an operator can investigate the cause.

It is RECOMMENDED that Relying Parties and Repository Servers follow the Best Current Practices outlined in [RFC7525] on the use of HTTP over TLS (HTTPS) [RFC7230]. Relying Parties SHOULD do TLS certificate and host name validation using subjectAltName dNSName identities as described in [RFC6125]. The rules and guidelines defined in [RFC6125] apply here, with the following considerations:

- Relying Parties and Repository Servers SHOULD support the DNS-ID identifier type. The DNS-ID identifier type SHOULD be present in Repository Server certificates.
- DNS names in Repository Server certificates SHOULD NOT contain the wildcard character "*".

- A Common Name (CN) field may be present in a Repository Server certificate's subject name but SHOULD NOT be used for authentication within the rules described in [RFC6125].

- This protocol does not require the use of SRV-IDs.

- This protocol does not require the use of URI-IDs.

## 5. Security Considerations

Compromise of a trust anchor private key permits unauthorized parties to masquerade as a trust anchor, with potentially severe consequences. Reliance on an inappropriate or incorrect trust anchor has similar potentially severe consequences.

This TAL does not directly provide a list of resources covered by the referenced self-signed CA certificate. Instead, the RP is referred to the trust anchor itself and the INR extension(s) within this certificate. This provides necessary operational flexibility, but it also allows the certificate issuer to claim to be authoritative for any resource. Relying parties should either have great confidence in the issuers of such certificates that they are configuring as trust anchors, or they should issue their own self-signed certificate as a trust anchor and, in doing so, impose constraints on the subordinate certificates.

## 6. IANA Considerations

This document has no actions for IANA.

## 7. Acknowledgements

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## 8. References

### 8.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC3779] Lynn, C., Kent, S., and K. Seo, "X.509 Extensions for IP Addresses and AS Identifiers", RFC 3779, DOI 10.17487/RFC3779, June 2004, <https://www.rfc-editor.org/info/rfc3779>.

[RFC4648] Josefsson, S., "The Base16, Base32, and Base64 Data Encodings", RFC 4648, DOI 10.17487/RFC4648, October 2006, <https://www.rfc-editor.org/info/rfc4648>.

[RFC5198] Klensin, J. and M. Padlipsky, "Unicode Format for Network Interchange", RFC 5198, DOI 10.17487/RFC5198, March 2008, <https://www.rfc-editor.org/info/rfc5198>.

[RFC5280] Cooper, D., Santesson, S., Farrell, S., Boeyen, S., Housley, R., and W. Polk, "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", RFC 5280, DOI 10.17487/RFC5280, May 2008, <https://www.rfc-editor.org/info/rfc5280>.

[RFC5781] Weiler, S., Ward, D., and R. Housley, "The rsync URI Scheme", RFC 5781, DOI 10.17487/RFC5781, February 2010, <https://www.rfc-editor.org/info/rfc5781>.

[RFC6125] Saint-Andre, P. and J. Hodges, "Representation and Verification of Domain-Based Application Service Identity within Internet Public Key Infrastructure Using X.509 (PKIX) Certificates in the Context of Transport Layer Security (TLS)", RFC 6125, DOI 10.17487/RFC6125, March 2011, <https://www.rfc-editor.org/info/rfc6125>.

[RFC6480] Lepinski, M. and S. Kent, "An Infrastructure to Support Secure Internet Routing", RFC 6480, DOI 10.17487/RFC6480, February 2012, <https://www.rfc-editor.org/info/rfc6480>.

[RFC6487] Huston, G., Michaelson, G., and R. Loomans, "A Profile for X.509 PKIX Resource Certificates", RFC 6487, DOI 10.17487/RFC6487, February 2012, <https://www.rfc-editor.org/info/rfc6487>.

[RFC7230] Fielding, R., Ed. and J. Reschke, Ed., "Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing", RFC 7230, DOI 10.17487/RFC7230, June 2014, <https://www.rfc-editor.org/info/rfc7230>.

[RFC7525] Sheffer, Y., Holz, R., and P. Saint-Andre, "Recommendations for Secure Use of Transport Layer Security (TLS) and Datagram Transport Layer Security (DTLS)", BCP 195, RFC 7525, DOI 10.17487/RFC7525, May 2015, <https://www.rfc-editor.org/info/rfc7525>.

[RFC7730] Huston, G., Weiler, S., Michaelson, G., and S. Kent, "Resource Public Key Infrastructure (RPKI) Trust Anchor Locator", RFC 7730, DOI 10.17487/RFC7730, January 2016, <https://www.rfc-editor.org/info/rfc7730>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/info/rfc8174>.

[X.509] ITU-T, "The Directory: Public-key and attribute certificate frameworks", October 2012.

## 8.2. Informative References

[RFC4158] Cooper, M., Dzambasow, Y., Hesse, P., Joseph, S., and R. Nicholas, "Internet X.509 Public Key Infrastructure: Certification Path Building", RFC 4158, DOI 10.17487/RFC4158, September 2005, <https://www.rfc-editor.org/info/rfc4158>.

[RFC5914] Housley, R., Ashmore, S., and C. Wallace, "Trust Anchor Format", RFC 5914, DOI 10.17487/RFC5914, June 2010, <https://www.rfc-editor.org/info/rfc5914>.

[RFC6486] Austein, R., Huston, G., Kent, S., and M. Lepinski, "Manifests for the Resource Public Key Infrastructure (RPKI)", RFC 6486, DOI 10.17487/RFC6486, February 2012, <https://www.rfc-editor.org/info/rfc6486>.

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