

**HTTPS Token Binding with TLS Terminating Reverse Proxies
draft-ietf-tokbind-ttrp-09**

Abstract

This document defines HTTP header fields that enable a TLS terminating reverse proxy to convey information to a backend server about the validated Token Binding Message received from a client, which enables that backend server to bind, or verify the binding of, cookies and other security tokens to the client's Token Binding key. This facilitates the reverse proxy and backend server functioning together as though they are a single logical server side deployment of HTTPS Token Binding.

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1. Introduction

Token Binding over HTTP [[RFC8473](#)] provides a mechanism that enables HTTP servers to cryptographically bind cookies and other security tokens to a key generated by the client. When the use of Token Binding is negotiated in the TLS [[RFC5246](#)] handshake [[RFC8472](#)] the client sends an encoded Token Binding Message [[RFC8471](#)] as a header in each HTTP request, which proves possession of one or more private keys held by the client. The public portion of the keys are represented in the Token Binding IDs of the Token Binding Message and for each one there is a signature over some data, which includes the exported keying material [[RFC5705](#)] of the TLS connection. An HTTP server issuing cookies or other security tokens can associate them with the Token Binding ID, which ensures those tokens cannot be used successfully over a different TLS connection or by a different client than the one to which they were issued.

A fairly common deployment architecture for HTTPS applications is to have the backend HTTP application servers sit behind a reverse proxy

that terminates TLS connections from clients. The proxy is accessible to the internet and dispatches client requests to the appropriate backend server within a private or protected network. The backend servers are not directly accessible by clients and are only reachable through the reverse proxy. The details of such deployments are typically opaque to clients who make requests to the proxy server and see responses as though they originated from the proxy server itself. Although HTTPS is also usually employed between the proxy and the backend server, the TLS connection that the client establishes for HTTPS is between itself and the reverse proxy server.

Token Binding facilitates a binding of security tokens to a key held by the client by way of the TLS connection between that client and the server. In a deployment where TLS is terminated by a reverse proxy, however, the TLS connection is between the client and the proxy while the backend server is likely the system that will issue and validate cookies or other security tokens. Additional steps are therefore needed to enable the use of Token Binding in such deployment architectures. In the absence of a standardized approach, different implementations will address it differently, which will make interoperability between such implementations difficult or impossible without complex configurations or custom integrations.

This document standardizes HTTP header field names that a TLS terminating reverse proxy (TTRP) adds to requests that it sends to the backend servers. The headers contain information from the validated Token Binding Message sent by the client to the proxy, thus enabling the backend server to bind, or verify the binding of, cookies and other security tokens to the client's Token Binding key. The usage of the headers, both the TTRP adding the headers and the backend application server using the headers to bind cookies or other tokens, are to be configuration options of the respective systems as they will not always be applicable.

1.1. Requirements Notation and Conventions

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.

2. HTTP Header Fields and Processing Rules

2.1. Encoding

The field-values of the HTTP headers defined herein utilize the following encoded forms.

2.1.1. Token Binding ID

A Token Binding ID is represented as an "EncodedTokenBindingID", which is the base64url encoding of the TokenBindingID byte sequence (see [section 3 of \[RFC8471\]](#)) using the URL and filename safe alphabet described in [Section 5 of \[RFC4648\]](#), with all trailing pad characters '=' omitted and without the inclusion of any line breaks, whitespace, or other additional characters. ABNF [\[RFC5234\]](#) syntax for "EncodedTokenBindingID" is shown in Figure 1 below.

```
EncodedTokenBindingID = *( DIGIT / ALPHA / "-" / "_" )
```

```
DIGIT = <Defined in Section B.1 of \[RFC5234\]>
```

```
ALPHA = <Defined in Section B.1 of \[RFC5234\]>
```

Figure 1: Encoded Token Binding ID ABNF

2.1.2. Token Binding Type

A Token Binding type value (a single byte) can be represented as an "EncodedTokenBindingType", which is a case-insensitive hex encoding ([Section 8 of \[RFC4648\]](#)). The ABNF definition is shown in Figure 2 below.

```
EncodedTokenBindingType = 1*2HEXDIG
```

```
HEXDIG = <Defined in Section B.1 of \[RFC5234\]>
```

Figure 2: Encoded Token Binding Type ABNF

2.2. Token Binding ID HTTP Header Fields

The Token Binding Protocol [\[RFC8471\]](#) recommends that implementations make Token Binding IDs available to the application as opaque byte sequences, enabling those applications to use the Token Binding IDs when generating and verifying bound tokens. In the context of a TLS terminating reverse proxy (TTRP) deployment, the TTRP makes the Token Binding ID(s) available to the backend application with the following header fields.

Sec-Provided-Token-Binding-ID

The Token Binding ID of the provided Token Binding represented as an "EncodedTokenBindingID".

Sec-Referred-Token-Binding-ID

The Token Binding ID of the referred Token Binding represented as an "EncodedTokenBindingID".

Sec-Other-Token-Binding-ID

Additional Token Bindings that are sent by the client and validated by the TTRP are represented as a comma-separated list of the concatenation of the "EncodedTokenType", a period (".") character, and the "EncodedTokenBindingID" of each.

Both "Sec-Provided-Token-Binding-ID" and "Sec-Referred-Token-Binding-ID" are single HTTP header field-valued as defined in [Section 3.2 of \[RFC7230\]](#), which MUST NOT have a list of values or occur multiple times in a request.

All header fields defined herein are only for use in HTTP requests and MUST NOT to be used in HTTP responses.

2.3. Processing Rules

This section defines the applicable processing rules for a TLS terminating reverse proxy (TTRP) and backend server(s) to provide server side support of Token Binding over HTTP [\[RFC8473\]](#) using the HTTP headers described in [Section 2.2](#). Use of the technique is to be a configuration or deployment option and the processing rules described herein are for servers operating with that option enabled.

A TTRP negotiates the use of Token Binding with the client, such as is described in [\[RFC8472\]](#) and validates the Token Binding Message as defined in The Token Binding Protocol [\[RFC8471\]](#) and Token Binding over HTTP [\[RFC8473\]](#) for each HTTP request on the underlying TLS connection. Requests with a valid Token Binding Message (and meeting any other authorization or policy requirements of the TTRP) are dispatched to the backend server with the following modifications.

1. The "Sec-Token-Binding" header in the original incoming request MUST be removed from the request that is dispatched to the backend server.
2. The Token Binding ID of the provided Token Binding of the Token Binding Message MUST be placed in the "Sec-Provided-Token-Binding-ID" header field of the dispatched request using the format defined in [Section 2.2](#).
3. If the Token Binding Message contains a referred Token Binding, the referred Token Binding ID MUST be placed in the "Sec-Referred-Token-Binding-ID" header field of the dispatched request using the format defined in [Section 2.2](#). Otherwise, the "Sec-

Referred-Token-Binding-ID" header field MUST NOT be present in the dispatched request.

4. If the Token Binding Message contains any additional validated Token Bindings, they are placed in the "Sec-Other-Token-Binding-ID" header field using the format defined in [Section 2.2](#). If the Token Binding Message contains no additional valid Token Bindings, the "Sec-Referred-Token-Binding-ID" header field MUST NOT be present in the dispatched request.
5. Any occurrence of the "Sec-Provided-Token-Binding-ID", "Sec-Referred-Token-Binding-ID", and "Sec-Other-Token-Binding-ID" headers in the original incoming request MUST be removed or overwritten before forwarding the request.

Requests made over a connection where the use of Token Binding was not negotiated MUST be sanitized by removing any occurrences of the "Sec-Provided-Token-Binding-ID", "Sec-Referred-Token-Binding-ID", and "Sec-Other-Token-Binding-ID" header fields prior to dispatching the request to the backend server.

Forward proxies and other intermediaries MUST NOT add the "Sec-Provided-Token-Binding-ID", "Sec-Referred-Token-Binding-ID", or "Sec-Other-Token-Binding-ID" header to requests.

[2.4. Examples](#)

Extra line breaks and whitespace have been added to the following examples for display and formatting purposes only.

[2.4.1. Provided Token Binding ID](#)

The following "Sec-Token-Binding" header is from an HTTP request made over a TLS connection between the client and the TTRP where the use of Token Binding has been negotiated. The base64url-encoded representation of the exported keying material for that connection is "AYVUayPTP9RmELNpGjFl6Ykm2CUx7pUMxe35yb11dgU", which can be used to validate the Token Binding Message. The encoded Token Binding Message has the provided Token Binding that the client uses with the server.

```
Sec-Token-Binding: AIkAAgBBQKzyIrmcY_YcTHVoSHBut69vrGfFdy1_YKTZfFJv
6BjrZsKD9b9FRzSBxDs1twTqnAS71M1RBumuihhI9xqxXKkAQEtxe4jeUJU0Wezx1Q
XWVSBFeHxFmdXRBIH_LKOSAUSM0J0XEw1Q8DE248qk0iRKzw3KdSNYukYEPm021bQi
3YAAAA
```

Figure 3: Header in HTTP Request to TTRP

After validating the Token Binding Message, the TTRP removes the "Sec-Token-Binding" header and adds the following "Sec-Provided-Token-Binding-ID" header with the provided Token Binding ID to the request that is dispatched to the backend server.

```
Sec-Provided-Token-Binding-ID: AgBBQKzyIrmcY_YCtHVoSHBut69vrGfFdy1_
YKTZfFJv6BjrZsKD9b9FRzSBxDs1twTqnAS71M1RBumuihhI9xqxXKk
```

Figure 4: Header in HTTP Request to Backend Server

2.4.2. Provided and Referred Token Binding IDs

The following "Sec-Token-Binding" header is from an HTTP request made over a TLS connection between the client and the TTRP where the use of Token Binding has been negotiated. The base64url-encoded representation of the exported keying material for that connection is "wEWWCP1KPxfq-QL4NxYII_P4ti_9YYqrTpGs28BZEqE", which can be used to validate the Token Binding Message. The encoded Token Binding Message has the provided Token Binding that the client uses with the server as well as the referred Token Binding that it uses with a different server.

```
Sec-Token-Binding: ARIAAGBBQCfsI1D1sTq5mVT_2H_dihNIvuHJCHGjHPJchPav
NbGrOo26-2JgT_IsbvZd4daDFbirYBIwJ-TK1rh8FzrC-psAQMyYIqXj7djGPev1dk
jV9XxLYGcyqOrBVEtBHRMUCeo22ymLg30iFcl_fmOPxJbjxI6lKcF0lyfy-dSQmPIe
zQ0AAAEECAEFARPIiuZxj9gK0dWhIcG63r2-sZ8V3LX9gpN18Um_oG0tmwoP1v0VHNI
HEOzW3B0qcBLvUzVEG6a6KGEj3GrFcqQBAHQm0pzigUTXKLRamuKE1pmmP9I3UBVpoe
1DBCe9H2l1VPpsImakUa6crAqZ-0CGBmji7bYzQogpKcyxTTFk5zdwAA
```

Figure 5: Header in HTTP Request to TTRP

After validating the Token Binding Message, the TTRP removes the "Sec-Token-Binding" header and adds the following "Sec-Provided-Token-Binding-ID" and "Sec-Referred-Token-Binding-ID" headers, with the provided and referred Token Binding IDs respectively, to the request that is dispatched to the backend server.

```
Sec-Provided-Token-Binding-ID: AgBBQCfsI1D1sTq5mVT_2H_dihNIvuHJCHGj
HPJchPavNbGrOo26-2JgT_IsbvZd4daDFbirYBIwJ-TK1rh8FzrC-ps
Sec-Referred-Token-Binding-ID: AgBBQKzyIrmcY_YCtHVoSHBut69vrGfFdy1_
YKTZfFJv6BjrZsKD9b9FRzSBxDs1twTqnAS71M1RBumuihhI9xqxXKk
```

Figure 6: Headers in HTTP Request to Backend Server

2.4.3. Provided and Other Token Binding IDs

The following "Sec-Token-Binding" header is from an HTTP request made over a TLS connection between the client and the TTRP where the use of Token Binding has been negotiated. The base64url-encoded representation of the exported keying material for that connection is "Zr_1DESCcDoaltcZCK613UrEWHRf2B3w9i3bwcxpacc", which can be used to validate the Token Binding Message. The encoded Token Binding Message has the provided Token Binding and two other Token Bindings.

```
Sec-Token-Binding: AZsAAgBBQA35hcCjI5GEHLLAZ0i2l2ZvQe-bSPAP7jovkZJM
4wYHgmmXNd1aRpnQmXK9ghUmrDtS6p_e2uS1MXIVK0IwgysAQJ-TKyVGF37XUXMy79
ybwJyPpfCG9Iq6fdIxLX_yJn-L__Z3p_WIL3g17K00H3XZmJS3qZNNEVu_8HmPN-d9
hGMAAE0CAEFAR68GbdIQyrHqkorJF0sekYJvf8iV03obGxbawBqAEJetsYxprB6c3M
x5KDHBGZjsFbeFW5Xec_EaxX0Hw3RmJwBA-Fu22kokRbB7G0D0g6_sdCHTbczSCmm
6rqP1x7kRIij_kJNCcwMMFzbsBTXcm5fJrRdBtcsqiiqYD6aJ1SgAACwIAQUCDqt
6m63By8b1lvhN-n90sQThoLomzKpMicSZGwR166jplhbkjrFshzdNqzLFFEhCT9s0p
Xrcbp0HsZnpRSkmhAEBf0wxjK3Y9E0eMrqjo0IUhmurW2EgtSRBjDwc0r-rDT231Zv
_f1oePB8Pkd1kgAtgKX5EDiemfo1YER3_I2cv3AAA
```

Figure 7: Header in HTTP Request to TTRP

After validating the Token Binding Message, the TTRP removes the "Sec-Token-Binding" header and adds the following "Sec-Provided-Token-Binding-ID" and "Sec-Other-Token-Binding-ID" headers to the request that is dispatched to the backend server.

```
Sec-Provided-Token-Binding-ID: AgBBQA35hcCjI5GEHLLAZ0i2l2ZvQe-bSPAP
7jovkZJM4wYHgmmXNd1aRpnQmXK9ghUmrDtS6p_e2uS1MXIVK0Iwgys
Sec-Other-Token-Binding-ID: 4d.AgBBQEevBm3SEMqx6pKKyRdLHpGCb3_IldN6
Gxsw2lm6gBCXrbGMAawenNzMeSgxwRmY7BW3hVuV3nPxGsV9B8N0Zic,B.AgBBQIO
q3qbrchLxvWw-E36f06xB0GguibMqkyJxJkbBHXrqOmWfU0s0swfN02rMsUUSEJP2
zSletxuk4exmelFKSaE
```

Figure 8: Headers in HTTP Request to Backend Server

3. TLS Versions and Best Practices

TLS 1.2 [[RFC5246](#)] is cited in this document because, at the time of writing, it is the latest version that is widely deployed. However, this document is applicable with other TLS versions that allow for negotiating the use of Token Binding. Token Binding for Transport Layer Security (TLS) Version 1.3 Connections [[I-D.ietf-tokbind-tls13](#)], for example, describes Token Binding with TLS 1.3 [[RFC8446](#)]. Implementation security considerations for TLS, including version recommendations, can be found in Recommendations for Secure Use of Transport Layer Security (TLS) and Datagram Transport Layer Security (DTLS) [[BCP195](#)].

4. Security Considerations

The headers described herein enable a reverse proxy and backend server to function together as though they are a single logical server side deployment of HTTPS Token Binding. Use of the headers outside that intended use case, however, may undermine the protections afforded by Token Binding. Therefore steps **MUST** be taken to prevent unintended use, both in sending the headers and in relying on their value.

Producing and consuming the headers **SHOULD** be a configurable option, respectively, in a reverse proxy and backend server (or individual application in that server). The default configuration for both should be to not use the headers thus requiring an "opt-in" to the functionality.

Backend servers **MUST** only accept the headers from trusted reverse proxies. And reverse proxies **MUST** sanitize the incoming request before forwarding it on by removing or overwriting any existing instances of the headers. Otherwise arbitrary clients can control the header values as seen and used by the backend server.

The communication between a reverse proxy and backend server needs to be secured against eavesdropping and modification by unintended parties.

The configuration options and request sanitization are necessarily functionally of the respective servers. The other requirements can be met in a number of ways, which will vary based on specific deployments. The communication between a reverse proxy and backend server, for example, might be over a mutually authenticated TLS with the insertion and consumption headers occurring only on that connection. Alternatively the network topology might dictate a private network such that the backend application is only able to accept requests from the reverse proxy and the proxy can only make requests to that server. Other deployments that meet the requirements set forth herein are also possible.

Employing the "Sec-" header field prefix for the headers defined herein denotes them as forbidden header names (see [[fetch-spec](#)]), which means they cannot be set or modified programmatically by script running in-browser.

5. IANA Considerations

5.1. HTTP Message Header Field Names Registration

This document specifies the following new HTTP header fields, registration of which is requested in the "Permanent Message Header Field Names" registry defined in [[RFC3864](#)].

- o Header Field Name: "Sec-Provided-Token-Binding-ID"
- o Applicable protocol: HTTP
- o Status: standard
- o Author/change Controller: IETF
- o Specification Document(s): [[this specification]]

- o Header Field Name: "Sec-Referred-Token-Binding-ID"
- o Applicable protocol: HTTP
- o Status: standard
- o Author/change Controller: IETF
- o Specification Document(s): [[this specification]]

- o Header Field Name: "Sec-Other-Token-Binding-ID"
- o Applicable protocol: HTTP
- o Status: standard
- o Author/change Controller: IETF
- o Specification Document(s): [[this specification]]

6. References

6.1. Normative References

- [BCP195] 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, <<http://www.rfc-editor.org/info/bcp195>>.
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- [RFC5234] Crocker, D., Ed. and P. Overell, "Augmented BNF for Syntax Specifications: ABNF", STD 68, [RFC 5234](#), DOI 10.17487/RFC5234, January 2008, <<https://www.rfc-editor.org/info/rfc5234>>.

- [RFC5246] Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.2", [RFC 5246](#), DOI 10.17487/RFC5246, August 2008, <<https://www.rfc-editor.org/info/rfc5246>>.
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- [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>>.
- [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>>.
- [RFC8471] Popov, A., Ed., Nystroem, M., Balfanz, D., and J. Hodges, "The Token Binding Protocol Version 1.0", [RFC 8471](#), DOI 10.17487/RFC8471, October 2018, <<https://www.rfc-editor.org/info/rfc8471>>.
- [RFC8472] Popov, A., Ed., Nystroem, M., and D. Balfanz, "Transport Layer Security (TLS) Extension for Token Binding Protocol Negotiation", [RFC 8472](#), DOI 10.17487/RFC8472, October 2018, <<https://www.rfc-editor.org/info/rfc8472>>.
- [RFC8473] Popov, A., Nystroem, M., Balfanz, D., Ed., Harper, N., and J. Hodges, "Token Binding over HTTP", [RFC 8473](#), DOI 10.17487/RFC8473, October 2018, <<https://www.rfc-editor.org/info/rfc8473>>.

6.2. Informative References

- [fetch-spec]
WhatWG, "Fetch", Living Standard , <<https://fetch.spec.whatwg.org/>>.
- [I-D.ietf-tokbind-tls13]
Harper, N., "Token Binding for Transport Layer Security (TLS) Version 1.3 Connections", [draft-ietf-tokbind-tls13-01](#) (work in progress), May 2018.
- [RFC3864] Klyne, G., Nottingham, M., and J. Mogul, "Registration Procedures for Message Header Fields", [BCP 90](#), [RFC 3864](#), DOI 10.17487/RFC3864, September 2004, <<https://www.rfc-editor.org/info/rfc3864>>.

[RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", [RFC 8446](#), DOI 10.17487/RFC8446, August 2018, <<https://www.rfc-editor.org/info/rfc8446>>.

[Appendix A](#). Acknowledgements

The author would like to thank the following people for their various contributions to the specification: Vinod Anupam, Dirk Balfanz, John Bradley, William Denniss, Nick Harper, Jeff Hodges, Subodh Iyengar, Leif Johansson, Michael B. Jones, Yoav Nir, James Manger, Andrei Popov, Eric Rescorla, Piotr Sikora, Martin Thomson, and Hans Zandbelt

[Appendix B](#). Document History

[[to be removed by the RFC Editor before publication as an RFC]]

[draft-ietf-tokbind-ttrp-09](#)

- o Publishing with no changes from -07/-08 to have a non expired version up while still awaiting the shepherd writeup.

[draft-ietf-tokbind-ttrp-08](#)

- o Avoid impending expiration (while awaiting the shepherd writeup) by publishing with no changes from -07.

[draft-ietf-tokbind-ttrp-07](#)

- o Update TLS 1.3 reference to [RFC 8446](#).
- o Update the references to the core token binding specs, which are now RFCs 8471, 8472, and 8473.

[draft-ietf-tokbind-ttrp-06](#)

- o Move TLS Versions and Best Practices out of Security Considerations to its own top-level section.

[draft-ietf-tokbind-ttrp-05](#)

- o Editorial updates.
- o Change one character in the last example to help emphasize the case-insensitivity of hex.
- o Add a TLS Versions and Best Practices section with [BCP195](#) and also mention of `ietf-tokbind-tls13` and `ietf-tls-tls13`.

[draft-ietf-tokbind-ttrp-04](#)

- o Add an example with Sec-Other-Token-Binding-ID.
- o Use the HEXDIG core ABNF rule for EncodedTokenBindingType and mention case-insensitive in the text.
- o Minor editorial fixes.
- o Add to the Acknowledgements and remove the 'and others' bit.

[draft-ietf-tokbind-ttrp-03](#)

- o Add a header to allow for additional token binding types other than provided and referred to be conveyed.
- o Reword the Abstract somewhat for (hopefully) improved readability.
- o Minor editorial and formatting updates.

[draft-ietf-tokbind-ttrp-02](#)

- o Add to the Acknowledgements.
- o Update references for Token Binding negotiation, protocol, and https.
- o Use the boilerplate from [RFC 8174](#).
- o Reformat the "HTTP Header Fields and Processing Rules" section to make the header names more prominent and move the encoding definitions earlier.

[draft-ietf-tokbind-ttrp-01](#)

- o Prefix the header names with "Sec-" so that they are denoted as forbidden header names by Fetch <https://fetch.spec.whatwg.org/>
- o Removed potentially confusing sentence from Security Considerations per <https://mailarchive.ietf.org/arch/msg/unbearable/00IpppyyEqMrQjEkyEi8p8CeBGA>
- o Editorial fixes.

[draft-ietf-tokbind-ttrp-00](#)

- o Initial WG draft from [draft-campbell-tokbind-ttrp](#).

[draft-campbell-tokbind-ttrp-01](#)

- o Minor editorial fixes.
- o Add to the Acknowledgements.

[draft-campbell-tokbind-ttrp-00](#)

- o Initial draft based on 'consensus to work on the problem' from the Seoul meeting [[1](#)][[2](#)] and reflecting the consensus approach from discussions at the Chicago meeting [[3](#)].

[1] <https://www.ietf.org/proceedings/97/minutes/minutes-97-tokbind-01.txt> (minutes from Seoul)

[2] <https://www.ietf.org/proceedings/97/slides/slides-97-tokbind-reverse-proxies-00.pdf> (slides from Seoul)

[3] https://mailarchive.ietf.org/arch/msg/unbearable/_ZHI8y2Vs5wMP8VMRr7zroo_sNU (summary of discussion)

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