

# Opportunistic Security for HTTP/2

## Abstract

This document describes how `http` URIs can be accessed using Transport Layer Security (TLS) and HTTP/2 to mitigate pervasive monitoring attacks. This mechanism not a replacement for `https` URIs; it is vulnerable to active attacks.

## Status of this Memo

This document is not an Internet Standards Track specification; it is published for examination, experimental implementation, and evaluation.

This document defines an Experimental Protocol for the Internet community. This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Not all documents approved by the IESG are a candidate for any level of Internet Standard; see Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at <http://www.rfc-editor.org/info/rfc8164><sup>1</sup>.

## Copyright Notice

Copyright © 2017 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust's Legal Provisions Relating to IETF Documents (<http://trustee.ietf.org/license-info><sup>2</sup>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

<sup>1</sup> <http://www.rfc-editor.org/info/rfc8164>

<sup>2</sup> <http://trustee.ietf.org/license-info>

## Table of Contents

<b>1 Introduction</b> .....	<b>3</b>
1.1 Goals and Non-goals.....	3
1.2 Notational Conventions.....	3
<b>2 Using HTTP URIs over TLS</b> .....	<b>4</b>
2.1 Alternative Server Opt-In.....	4
2.2 Interaction with "https" URIs.....	5
2.3 The "http-opportunistic" Well-Known URI.....	5
<b>3 IANA Considerations</b> .....	<b>6</b>
<b>4 Security Considerations</b> .....	<b>7</b>
4.1 Security Indicators.....	7
4.2 Downgrade Attacks.....	7
4.3 Privacy Considerations.....	7
4.4 Confusion regarding Request Scheme.....	7
4.5 Server Controls.....	7
<b>5 References</b> .....	<b>8</b>
5.1 Normative References.....	8
5.2 Informative References.....	9
<b>Authors' Addresses</b> .....	<b>11</b>

## 1. Introduction

This document describes a use of HTTP Alternative Services [RFC7838] to decouple the URI scheme from the use and configuration of underlying encryption. It allows an `http` URI [RFC7230] to be accessed using HTTP/2 and Transport Layer Security (TLS) [RFC5246] with Opportunistic Security [RFC7435].

This document describes a usage model whereby sites can serve `http` URIs over TLS, thereby avoiding the problem of serving Mixed Content (described in [W3C.CR-mixed-content-20160802]) while still providing protection against passive attacks.

Opportunistic Security does not provide the same guarantees as using TLS with `https` URIs, because it is vulnerable to active attacks, and does not change the security context of the connection. Normally, users will not be able to tell that it is in use (i.e., there will be no "lock icon").

### 1.1. Goals and Non-goals

The immediate goal is to make the use of HTTP more robust in the face of pervasive passive monitoring [RFC7258].

A secondary (but significant) goal is to provide for ease of implementation, deployment, and operation. This mechanism is expected to have a minimal impact upon performance and require trivial administrative effort to configure.

Preventing active attacks (such as man-in-the-middle attacks) is a non-goal for this specification. Furthermore, this specification is not intended to replace or offer an alternative to `https`, since `https` both prevents active attacks and invokes a more stringent security model in most clients.

### 1.2. Notational Conventions

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. Using HTTP URIs over TLS

An origin server that supports the resolution of `http` URIs can indicate support for this specification by providing an alternative service advertisement [RFC7838] for a protocol identifier that uses TLS, such as `h2` [RFC7540]. Such a protocol **MUST** include an explicit indication of the scheme of the resource. This excludes `HTTP/1.1`; `HTTP/1.1` clients are forbidden from including the absolute form of a URI in requests to origin servers (see Section 5.3.1 of [RFC7230]).

A client that receives such an advertisement **MAY** make future requests intended for the associated origin [RFC6454] to the identified service (as specified by [RFC7838]), provided that the alternative service opts in as described in Section 2.1.

A client that places the importance of protection against passive attacks over performance might choose to withhold requests until an encrypted connection is available. However, if such a connection cannot be successfully established, the client can resume its use of the cleartext connection.

A client can also explicitly probe for an alternative service advertisement by sending a request that bears little or no sensitive information, such as one with the `OPTIONS` method. Likewise, clients with existing alternative services information could make such a request before they expire, in order minimize the delays that might be incurred.

Client certificates are not meaningful for URLs with the `http` scheme; therefore, clients creating new TLS connections to alternative services for the purposes of this specification **MUST NOT** present them. A server that also provides `https` resources on the same port can request a certificate during the TLS handshake, but it **MUST NOT** abort the handshake if the client does not provide one.

### 2.1. Alternative Server Opt-In

For various reasons, it is possible that the server might become confused about whether requests' URLs have an `http` or `https` scheme (see Section 4.4). To ensure that the alternative service has opted into serving `http` URLs over TLS, clients are required to perform additional checks before directing `http` requests to it.

Clients **MUST NOT** send `http` requests over a secured connection, unless the chosen alternative service presents a certificate that is valid for the origin as defined in [RFC2818]. Using an authenticated alternative service establishes "reasonable assurances" for the purposes of [RFC7838]. In addition to authenticating the server, the client **MUST** have obtained a valid "http-opportunistic" response for an origin (as per Section 2.3) using the authenticated connection. An exception to the latter restriction is made for requests for the "http-opportunistic" well-known URI.

For example, assuming the following request is made over a TLS connection that is successfully authenticated for those origins, the following request/response pair would allow requests for the origins "`http://www.example.com`" or "`http://example.com`" to be sent using a secured connection:

```
HEADERS
+ END_STREAM
+ END_HEADERS
:method = GET
:scheme = http
:authority = example.com
:path = /.well-known/http-opportunistic

HEADERS
:status = 200
content-type = application/json

DATA
+ END_STREAM
[ "http://www.example.com", "http://example.com" ]
```

This document describes multiple origins, but only for operational convenience. Only a request made to an origin (over an authenticated connection) can be used to acquire the "http-opportunistic" resource for that origin. Thus, in the example, the request to "http://example.com" cannot be assumed to also provide a representation of the "http-opportunistic" resource for "http://www.example.com".

## 2.2. Interaction with "https" URIs

Clients **MUST NOT** send `http` and `https` requests on the same connection. Similarly, clients **MUST NOT** send `http` requests for multiple origins on the same connection.

## 2.3. The "http-opportunistic" Well-Known URI

This specification defines the "http-opportunistic" well-known URI [RFC5785]. A client is said to have a valid "http-opportunistic" response for a given origin when:

- The client has requested the well-known URI from the origin over an authenticated connection and a 200 (OK) response was provided,
- That response is fresh [RFC7234] (potentially through revalidation [RFC7232]),
- That response has the media type "application/json",
- That response's payload, when parsed as JSON [RFC7159], contains an array as the root, and
- The array contains a string that is a case-insensitive, character-for-character match for the origin in question, serialized into Unicode as per Section 6.1 of [RFC6454].

A client **MAY** treat an "http-opportunistic" resource as invalid if values it contains are not strings.

This document does not define semantics for "http-opportunistic" resources on an `https` origin, nor does it define semantics if the resource includes `https` origins.

Allowing clients to cache the "http-opportunistic" resource means that all alternative services need to be able to respond to requests for `http` resources. A client is permitted to use an alternative service without acquiring the "http-opportunistic" resource from that service.

A client **MUST NOT** use any cached copies of an "http-opportunistic" resource that was acquired (or revalidated) over an unauthenticated connection. To avoid potential errors, a client can request or revalidate the "http-opportunistic" resource before using any connection to an alternative service.

Clients that use cached "http-opportunistic" responses **MUST** ensure that their cache is cleared of any responses that were acquired over an unauthenticated connection. Revalidating an unauthenticated response using an authenticated connection does not ensure the integrity of the response.

### 3. IANA Considerations

This specification registers the following well-known URI [\[RFC5785\]](#):

- URI Suffix: http-opportunistic
- Change Controller: IETF
- Specification Document(s): [Section 2.3](#) of RFC 8164
- Related Information:

## 4. Security Considerations

### 4.1. Security Indicators

User agents **MUST NOT** provide any special security indicators when an `http` resource is acquired using TLS. In particular, indicators that might suggest the same level of security as `https` **MUST NOT** be used (e.g., a "lock device").

### 4.2. Downgrade Attacks

A downgrade attack against the negotiation for TLS is possible.

For example, because the `Alt-Svc` header field [RFC7838] likely appears in an unauthenticated and unencrypted channel, it is subject to downgrade by network attackers. In its simplest form, an attacker that wants the connection to remain in the clear need only strip the `Alt-Svc` header field from responses.

### 4.3. Privacy Considerations

Cached alternative services can be used to track clients over time, e.g., using a user-specific hostname. Clearing the cache reduces the ability of servers to track clients; therefore, clients **MUST** clear cached alternative service information when clearing other origin-based state (i.e., cookies).

### 4.4. Confusion regarding Request Scheme

HTTP implementations and applications sometimes use ambient signals to determine if a request is for an `https` resource; for example, they might look for TLS on the stack or a server port number of 443.

This might be due to expected limitations in the protocol (the most common HTTP/1.1 request form does not carry an explicit indication of the URI scheme, and the resource might have been developed assuming HTTP/1.1), or it may be because of how the server and application are implemented (often, they are two separate entities, with a variety of possible interfaces between them).

Any security decisions based upon this information could be misled by the deployment of this specification, because it violates the assumption that the use of TLS (or port 443) means that the client is accessing an HTTPS URI and operating in the security context implied by HTTPS.

Therefore, server implementers and administrators need to carefully examine the use of such signals before deploying this specification.

### 4.5. Server Controls

This specification requires that a server send both an alternative service advertisement and host content in a well-known location to send HTTP requests over TLS. Servers **SHOULD** take suitable measures to ensure that the content of the well-known resource remains under their control. Likewise, because the "Alt-Svc" header field is used to describe policies across an entire origin, servers **SHOULD NOT** permit user content to set or modify the value of this header.

## 5. References

### 5.1. 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>>.
- [RFC2818] Rescorla, E., "[HTTP Over TLS](#)", RFC 2818, [DOI 10.17487/RFC2818](#), May 2000, <<https://www.rfc-editor.org/info/rfc2818>>.
- [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>>.
- [RFC5785] Nottingham, M. and E. Hammer-Lahav, "[Defining Well-Known Uniform Resource Identifiers \(URIs\)](#)", RFC 5785, [DOI 10.17487/RFC5785](#), April 2010, <<https://www.rfc-editor.org/info/rfc5785>>.
- [RFC6454] Barth, A., "[The Web Origin Concept](#)", RFC 6454, [DOI 10.17487/RFC6454](#), December 2011, <<https://www.rfc-editor.org/info/rfc6454>>.
- [RFC7159] Bray, T., Ed., "[The JavaScript Object Notation \(JSON\) Data Interchange Format](#)", RFC 7159, [DOI 10.17487/RFC7159](#), March 2014, <<https://www.rfc-editor.org/info/rfc7159>>.
- [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>>.
- [RFC7232] Fielding, R., Ed. and J. Reschke, Ed., "[Hypertext Transfer Protocol \(HTTP/1.1\): Conditional Requests](#)", RFC 7232, [DOI 10.17487/RFC7232](#), June 2014, <<https://www.rfc-editor.org/info/rfc7232>>.
- [RFC7234] Fielding, R., Ed., Nottingham, M., Ed., and J. Reschke, Ed., "[Hypertext Transfer Protocol \(HTTP/1.1\): Caching](#)", RFC 7234, [DOI 10.17487/RFC7234](#), June 2014, <<https://www.rfc-editor.org/info/rfc7234>>.
- [RFC7540] Belshe, M., Peon, R., and M. Thomson, Ed., "[Hypertext Transfer Protocol Version 2 \(HTTP/2\)](#)", RFC 7540, [DOI 10.17487/RFC7540](#), May 2015, <<https://www.rfc-editor.org/info/rfc7540>>.
- [RFC7838] Nottingham, M., McManus, P., and J. Reschke, "[HTTP Alternative Services](#)", RFC 7838, [DOI 10.17487/RFC7838](#), April 2016, <<https://www.rfc-editor.org/info/rfc7838>>.



## 5.2. Informative References

- [RFC7258] Farrell, S. and H. Tschofenig, "[Pervasive Monitoring Is an Attack](#)", BCP 188, RFC 7258, [DOI 10.17487/RFC7258](#), May 2014, <<https://www.rfc-editor.org/info/rfc7258>>.
- [RFC7435] Dukhovni, V., "[Opportunistic Security: Some Protection Most of the Time](#)", RFC 7435, [DOI 10.17487/RFC7435](#), December 2014, <<https://www.rfc-editor.org/info/rfc7435>>.
- [W3C.CR-mixed-content-20160802] West, M., "[Mixed Content](#)", World Wide Web Consortium CR CR-mixed-content-20160802, August 2016, <<https://www.w3.org/TR/2016/CR-mixed-content-20160802>>.

## Acknowledgements

Mike Bishop contributed significant text to this document.

Thanks to Patrick McManus, Stefan Eissing, Eliot Lear, Stephen Farrell, Guy Podjarny, Stephen Ludin, Erik Nygren, Paul Hoffman, Adam Langley, Eric Rescorla, Julian Reschke, Kari Hurtt, and Richard Barnes for their feedback and suggestions.

## Authors' Addresses

**Mark Nottingham**

E-Mail: [mnot@mnot.net](mailto:mnot@mnot.net)

URI: <https://www.mnot.net/>

**Martin Thomson**

Mozilla

E-Mail: [martin.thomson@gmail.com](mailto:martin.thomson@gmail.com)