HTTP Alternative Services
draft-ietf-httpbis-alt-svc-01

Abstract

   This document specifies "alternative services" for HTTP, which allow
   an origin's resources to be authoritatively available at a separate
   network location, possibly accessed with a different protocol
   configuration.

Editorial Note (To be removed by RFC Editor)

   Discussion of this draft takes place on the HTTPBIS working group
   mailing list (ietf-http-wg@w3.org), which is archived at
   <http://lists.w3.org/Archives/Public/ietf-http-wg/>.

   Working Group information can be found at
   <http://tools.ietf.org/wg/httpbis/>; that specific to HTTP/2 are at
   <http://http2.github.io/>.

   The changes in this draft are summarized in Appendix A.

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1. Introduction

HTTP [HTTP-p1] conflates the identification of resources with their
location. In other words, "http://" (and "https://") URLs are used
to both name and find things to interact with.

In some cases, it is desirable to separate these aspects; to be able
to keep the same identifier for a resource, but interact with it
using a different location on the network.

For example:

o An origin server might wish to redirect a client to an alternative
   when it needs to go down for maintenance, or it has found an
   alternative in a location that is more local to the client.

o An origin server might wish to offer access to its resources using
   a new protocol (such as HTTP/2, see [HTTP2]) or one using improved
   security (such as Transport Layer Security (TLS), see [RFC5246]).

o An origin server might wish to segment its clients into groups of
   capabilities, such as those supporting Server Name Indication
   (SNI, see Section 3 of [RFC6066]) and those not supporting it, for
   operational purposes.

This specification defines a new concept in HTTP, "Alternative
Services", that allows a resource to nominate additional means of
interacting with it on the network. It defines a general framework
for this in Section 2, along with a specific mechanism for
discovering them using HTTP header fields in Section 3.

It also introduces a new status code in Section 5, so that origin
servers (or their nominated alternatives) can indicate that they are
not authoritative for a given origin, in cases where the wrong
location is used.

1.1. 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].

This document uses the Augmented BNF defined in [RFC5234] along with
the "OWS", "delta-seconds", "parameter", "port", "token", and "uri-
host" rules from [HTTP-p1], and uses the "#rule" extension defined in
Section 7 of that document.

[2](#). **Alternative Services Concepts**

   This specification defines a new concept in HTTP, the "alternative
   service". When an origin (see [[RFC6454](#)]) has resources that are
   accessible through a different protocol / host / port combination, it
   is said to have an alternative service.

   An alternative service can be used to interact with the resources on
   an origin server at a separate location on the network, possibly
   using a different protocol configuration. Alternative services are
   considered authoritative for an origin's resources, in the sense of
   [[HTTP-p1](#)], Section 9.1.

   For example, an origin:

   ("http", "www.example.com", "80")

   might declare that its resources are also accessible at the
   alternative service:

   ("h2", "new.example.com", "81")

   By their nature, alternative services are explicitly at the
   granularity of an origin; i.e., they cannot be selectively applied to
   resources within an origin.

   Alternative services do not replace or change the origin for any
   given resource; in general, they are not visible to the software
   "above" the access mechanism. The alternative service is essentially
   alternative routing information that can also be used to reach the
   origin in the same way that DNS CNAME or SRV records define routing
   information at the name resolution level. Each origin maps to a set
   of these routes -- the default route is derived from origin itself
   and the other routes are introduced based on alternative-protocol
   information.

   Furthermore, it is important to note that the first member of an
   alternative service tuple is different from the "scheme" component of
   an origin; it is more specific, identifying not only the major
   version of the protocol being used, but potentially communication
   options for that protocol.

   This means that clients using an alternative service will change the
   host, port and protocol that they are using to fetch resources, but
   these changes MUST NOT be propagated to the application that is using
   HTTP; from that standpoint, the URI being accessed and all
   information derived from it (scheme, host, port) are the same as
   before.

Importantly, this includes its security context; in particular, when
TLS [RFC5246] is in use, the alternative server will need to present
a certificate for the origin's host name, not that of the
alternative. Likewise, the Host header field is still derived from
the origin, not the alternative service (just as it would if a CNAME
were being used).

The changes MAY, however, be made visible in debugging tools,
consoles, etc.

Formally, an alternative service is identified by the combination of:

o An Application Layer Protocol Negotiation (ALPN) protocol, as per
   [I-D.ietf-tls-applayerprotoneg]

o A host, as per [RFC3986], Section 3.2.2

o A port, as per [RFC3986], Section 3.2.3

Additionally, each alternative service MUST have:

o A freshness lifetime, expressed in seconds; see Section 2.2

There are many ways that a client could discover the alternative
service(s) associated with an origin.

2.1. Host Authentication

Clients MUST NOT use alternative services with a host other than the
origin's without strong server authentication; this mitigates the
attack described in Section 7.2. One way to achieve this is for the
alternative to use TLS with a certificate that is valid for that
origin.

For example, if the origin's host is "www.example.com" and an
alternative is offered on "other.example.com" with the "h2" protocol,
and the certificate offered is valid for "www.example.com", the
client can use the alternative. However, if "other.example.com" is
offered with the "h2c" protocol, the client cannot use it, because
there is no mechanism in that protocol to establish strong server
authentication.

Furthermore, this means that the HTTP Host header field and the SNI
information provided in TLS by the client will be that of the origin,
not the alternative.

2.2. Alternative Service Caching

Mechanisms for discovering alternative services can associate a
freshness lifetime with them; for example, the Alt-Svc header field
uses the "ma" parameter.

Clients MAY choose to use an alternative service instead of the
origin at any time when it is considered fresh; see Section 2.4 for
specific recommendations.

Clients with existing connections to alternative services are not
required to fall back to the origin when its freshness lifetime ends;
i.e., the caching mechanism is intended for limiting how long an
alternative service can be used for establishing new requests, not
limiting the use of existing ones.

To mitigate risks associated with caching compromised values (see
Section 7.2 for details), user agents SHOULD examine cached
alternative services when they detect a change in network
configuration, and remove any that could be compromised (for example,
those whose association with the trust root is questionable). UAs
that do not have a means of detecting network changes SHOULD place an
upper bound on their lifetime.

2.3. Requiring Server Name Indication

A client MUST only use a TLS-based alternative service if the client
also supports TLS Server Name Indication (SNI) ([RFC6066], Section
3). This supports the conservation of IP addresses on the
alternative service host.

2.4. Using Alternative Services

By their nature, alternative services are optional; clients are not
required to use them. However, it is advantageous for clients to
behave in a predictable way when they are used by servers (e.g., for
load balancing).

Therefore, if a client becomes aware of an alternative service, the
client SHOULD use that alternative service for all requests to the
associated origin as soon as it is available, provided that the
security properties of the alternative service protocol are
desirable, as compared to the existing connection.

When a client uses an alternate service, it MUST emit the Service
header field (Section 4) on every request using that alternate
service.

The client is not required to block requests; the origin's connection
can be used until the alternative connection is established.
However, if the security properties of the existing connection are
weak (e.g. cleartext HTTP/1.1) then it might make sense to block
until the new connection is fully available in order to avoid
information leakage.

Furthermore, if the connection to the alternative service fails or is
unresponsive, the client MAY fall back to using the origin. Note,
however, that this could be the basis of a downgrade attack, thus
losing any enhanced security properties of the alternative service.

3. **The Alt-Svc HTTP Header Field**

An HTTP(S) origin server can advertise the availability of
alternative services to clients by adding an Alt-Svc header field to
responses.

```
Alt-Svc     = 1#( alternative *( OWS ";" OWS parameter ) )
alternative = protocol-id "=" port
protocol-id = token ; percent-encoded ALPN protocol identifier
```

ALPN protocol names are octet sequences with no additional
constraints on format. Octets not allowed in tokens ([HTTP-p1],
Section 3.2.6) MUST be percent-encoded as per Section 2.1 of
[RFC3986]. Consequently, the octet representing the percent
character "%" (hex 25) MUST be percent-encoded as well.

In order to have precisely one way to represent any ALPN protocol
name, the following additional constraints apply:

1. Octets in the ALPN protocol MUST NOT be percent-encoded if they
    are valid token characters except "%", and

2. When using percent-encoding, uppercase hex digits MUST be used.

With these constraints, recipients can apply simple string comparison
to match protocol identifiers.

For example:

```
Alt-Svc: http2=8000
```

This indicates that the "http2" protocol on the same host using the
indicated port (in this case, 8000).

Examples for protocol name escaping:

```
+-------------------+------------+--------------------+
| ALPN protocol name | protocol-id | Note              |
+-------------------+------------+--------------------+
| http2             | http2      | No escaping needed |
+-------------------+------------+--------------------+
| w=x:y#z           | w%3Dx%3Ay#z | "=" and ":" escaped |
+-------------------+------------+--------------------+
| x%y               | x%25y      | "%" needs escaping |
+-------------------+------------+--------------------+
```

Alt-Svc MAY occur in any HTTP response message, regardless of the status code.

Alt-Svc does not allow advertisement of alternative services on other hosts, to protect against various header-based attacks.

It can, however, have multiple values:

Alt-Svc: h2c=8000, h2=443

The value(s) advertised by Alt-Svc can be used by clients to open a new connection to one or more alternative services immediately, or simultaneously with subsequent requests on the same connection.

Intermediaries MUST NOT change or append Alt-Svc field values.

3.1. Caching Alt-Svc Header Field Values

When an alternative service is advertised using Alt-Svc, it is considered fresh for 24 hours from generation of the message. This can be modified with the 'ma' (max-age) parameter;

Alt-Svc: h2=443;ma=3600

which indicates the number of seconds since the response was generated the alternative service is considered fresh for.

ma = delta-seconds

See Section 4.2.3 of [HTTP-p6] for details of determining response age.

For example, a response:

```
HTTP/1.1 200 OK
Content-Type: text/html
Cache-Control: 600
Age: 30
Alt-Svc: h2c=8000; ma=60
```

indicates that an alternative service is available and usable for the
next 60 seconds. However, the response has already been cached for
30 seconds (as per the Age header field value), so therefore the
alternative service is only fresh for the 30 seconds from when this
response was received, minus estimated transit time.

When an Alt-Svc response header field is received from an origin, its
value invalidates and replaces all cached alternative services for
that origin.

See Section 2.2 for general requirements on caching alternative
services.

Note that the freshness lifetime for HTTP caching (here, 600 seconds)
does not affect caching of Alt-Svc values.

4. **The Service HTTP Header Field**

The Service HTTP header field is used in requests to indicate the
identity of the alternate service in use, just as the Host header
field identifies the host and port of the origin.

Service = uri-host [":" port]

Service is intended to allow alternate services to detect loops,
differentiate traffic for purposes of load balancing, and generally
to ensure that it is possible to identify the intended destination of
traffic, since introducing this information after a protocol is in
use has proven to be problematic.

When using an Alternate Service, clients MUST include a Service
header in all requests.

For example:

```
GET /thing
Host: origin.example.com
Service: alternate.example.net
User-Agent: Example/1.0
```

5. The 421 Not Authoritative HTTP Status Code

The 421 (Not Authoritative) status code indicates that the current
origin server (usually, but not always an alternative service; see
Section 2) is not authoritative for the requested resource, in the
sense of [HTTP-p1], Section 9.1.

Clients receiving 421 (Not Authoritative) from an alternative service
MUST remove the corresponding entry from its alternative service
cache (see Section 2.2) for that origin. Regardless of the
idempotency of the request method, they MAY retry the request, either
at another alternative server, or at the origin.

421 (Not Authoritative) MAY carry an Alt-Svc header field.

This status code MUST NOT be generated by proxies.

A 421 response is cacheable by default; i.e., unless otherwise
indicated by the method definition or explicit cache controls (see
Section 4.2.2 of [HTTP-p6]).

[[apr: This really ought to be 420.]]

6. IANA Considerations

6.1. The Alt-Svc Message Header Field

This document registers Alt-Svc in the Permanent Message Header
Registry [RFC3864].

o Header Field Name: Alt-Svc

o Application Protocol: http

o Status: standard

o Author/Change Controller: IETF

o Specification Document: [this document]

o Related Information:

6.2. The Service Message Header Field

This document registers Alt-Svc in the Permanent Message Header
Registry [RFC3864].

o   Header Field Name: Service

o   Application Protocol: http

o   Status: standard

o   Author/Change Controller: IETF

o   Specification Document: [this document]

o   Related Information:

[6.3](#). The 421 Not Authoritative HTTP Status Code

This document registers the 421 (Not Authoritative) HTTP Status code
in the Hypertext Transfer Protocol (HTTP) Status Code Registry
([HTTP-p2], Section 8.2).

   Status Code: 421

   Short Description: Not Authoritative

   Specification: Section 5 of this document

[7](#). Security Considerations

[[anchor1: Identified security considerations should be enumerated in
the appropriate documents depending on which proposals are accepted.
Those listed below are generic to all uses of alternative services;
more specific ones might be necessary.]]

[7.1](#). Changing Ports

Using an alternative service implies accessing an origin's resources
on an alternative port, at a minimum. An attacker that can inject
alternative services and listen at the advertised port is therefore
able to hijack an origin.

For example, an attacker that can add HTTP response header fields can
redirect traffic to a different port on the same host using the Alt-
Svc header field; if that port is under the attacker's control, they
can thus masquerade as the HTTP server.

This risk can be mitigated by restricting the ability to advertise
alternative services, and restricting who can open a port for
listening on that host.

7.2. Changing Hosts

   When the host is changed due to the use of an alternative service, it
   presents an opportunity for attackers to hijack communication to an
   origin.

   For example, if an attacker can convince a user agent to send all
   traffic for "innocent.example.org" to "evil.example.com" by
   successfully associating it as an alternative service, they can
   masquerade as that origin. This can be done locally (see mitigations
   above) or remotely (e.g., by an intermediary as a man-in-the-middle
   attack).

   This is the reason for the requirement in Section 2.1 that any
   alternative service with a host different to the origin's be strongly
   authenticated with the origin's identity; i.e., presenting a
   certificate for the origin proves that the alternative service is
   authorized to serve traffic for the origin.

   However, this authorization is only as strong as the method used to
   authenticate the alternative service. In particular, there are well-
   known exploits to make an attacker's certificate appear as
   legitimate.

   Alternative services could be used to persist such an attack; for
   example, an intermediary could man-in-the-middle TLS-protected
   communication to a target, and then direct all traffic to an
   alternative service with a large freshness lifetime, so that the user
   agent still directs traffic to the attacker even when not using the
   intermediary.

   As a result, there is a requirement in Section 2.2 to examine cached
   alternative services when a network change is detected.

7.3. Changing Protocols

   When the ALPN protocol is changed due to the use of an alternative
   service, the security properties of the new connection to the origin
   can be different from that of the "normal" connection to the origin,
   because the protocol identifier itself implies this.

   For example, if a "https://" URI had a protocol advertised that does
   not use some form of end-to-end encryption (most likely, TLS), it
   violates the expectations for security that the URI scheme implies.

   Therefore, clients cannot blindly use alternative services, but
   instead evaluate the option(s) presented to assure that security
   requirements and expectations (of specifications, implementations and

end users) are met.

8. Acknowledgements

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for their feedback and suggestions.

The Alt-Svc header field was influenced by the design of the
Alternative-Protocol header field in SPDY.

9. References

9.1. Normative References

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                                   August 2008.

Appendix A. Change Log (to be removed by RFC Editor before publication)

A.1. Since draft-nottingham-httpbis-alt-svc-05

   This is the first version after adoption of
   draft-nottingham-httpbis-alt-svc-05 as Working Group work item. It
   only contains editorial changes.

A.2. Since draft-ietf-httpbis-alt-svc-00

   Selected 421 as proposed status code for "Not Authoritative".

   Changed header field syntax to use percent-encoding of ALPN protocol

names (<https://github.com/http2/http2-spec/issues/446>).

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