JSON Web Service Binding Version 1.0
draft-hallambaker-json-web-service-01

Abstract

   The JSON Web Binding (JWB) describes a standardized approach to
   implementing Web Services. Services are advertised using the DNS SRV
   and HTTP Well Known Service conventions. Messages may be
   authenticated or authenticated and encrypted at the message layer in
   addition to any transport and/or network layer security. Service
   messages are encoded in JSON using Internet time format for Date-Time
   fields and Base64urlencoding for binary objects.

   This document specifies Version 1.0 of JWB which uses HTTP/1.1 for
   transport. Use of the multiple stream capabilities of HTTP version 2
   is outside the scope of this document.

Status of This Memo

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

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   This Internet-Draft will expire on July 25, 2016.

1. Introduction

The JSON Web Binding (JWB) specifies one approach to using DNS
Discovery [RFC1035], the HTTP [RFC7230] protocol and the JSON data
encoding [RFC7159] in a Web Service.

JWB is not the only approach possible, but developing a standard
means making choices that don't matter to developers that build on
it. While there are infinitely many ways that a Web Service might
employ HTTP and JSON to implement a Web Service, a client and a
server can only interoperate if they both agree to use the same one.

Discovery Beginning with a DNS address of the service (e.g.
   example.com), the client identifies a specific HTTP URL at
   which to access the service. The DNS SRV record [RFC2782] and
   Well Known Service [RFC5785] mechanisms are used for this
   purpose.

Authentication and Encryption Web Services MAY require
   authentication and encryption services at the message level
   even if transport layer security (e.g. TLS [RFC5264]) is used.
   Use of such enhancements is signaled using the HTTP Content-
   Encoding header.

Content Mapping The mapping of data types described in the
   specification (integer, string, etc.) to JSON data types.
   [RFC3339] Date time encoding and BASE64-url encoding [RFC4648]
   are used to map date-time and binary data types to JSON
   encoding values.

A key architectural principle that guides the design of JWB is that
the Web Service application should be as independent of the HTTP
presentation layer as is possible. Thus:

Message semantics are not affected by HTTP headers or the request
line URL.

The use of HTTP response codes is limited to reporting errors and
warnings that arise from the HTTP transport.

If message layer authentication or authenticated encryption are used, this is applied within the HTTP content payload and not through a combination of payload and header data.

This specification describes a mechanism for accessing a collection of hosts as a single undifferentiated service with provision for load balancing and fault tolerance. This has important consequences for state management. Web Services typically involve some form of stateful interaction or real world side effect. Otherwise, it is likely that the Web Service would be better written as a traditional Web interaction mapping the stateless resources to URIs.

The mechanism described in this specification is intended for the initial discovery of a host with which to engage in a Web Service transaction which may or may not consist of a series of message exchanges. Since sharing state between hosts supporting a virtual service requires resources and typically introduces latency, a service specification MAY require that a transaction begun on one host be completed with the same host and the time period in which a transaction that is accepted by one host will be regarded as 'final' by the virtual service.

For example, a file upload protocol for a photograph sharing service might have separate messages for checking that there is space to store the photograph 'Check', uploading the file 'Store' and reporting that the data is safely stored at multiple locations. When responding to the Check command, the host is reporting that there is space at that local node. It is obviously undesirable for a client to verify that host1 has enough space to store the file and then attempt to upload the file to host2. Equally, having uploaded the file to host1, it might be minutes, hours or even days before the photograph could be retrieved through host2. Such questions are left for the Web Service protocol designer to address.

2. Definitions

2.1. Requirements Language

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 RFC 2119 [RFC2119].

3. Service Discovery

Service discovery is the process of resolving the address of a Web Service to a Web Service Endpoint, a URI [RFC3986] at which the service is provided.

A JWB Web Service is specified by giving the DNS Address of the
service <domain>, and Well Known Service name <service>.

3.1. Host Identification

The first step in service discovery is to resolve the <domain> and
<service> identifiers to the IP address of a host that provides that
service.

3.1.1. SRV Lookup

A client attempting to connect to the service first attempts to
locate an SRV record [RFC2782] for the specified service:

_<service>._tcp._<domain> SRV <priority> <weight> <port> <mapping>

Where <priority> and <weight> are the SRV priority and weight
parameters specified in [RFC2782], <port> is the TCP port number and
<mapping> is the DNS name of the host for which the service
advertisement is made. Standard A/AAAA/CNAME resolution is used to
obtain the IP address of the host from <mapping>.

If a match is found, the client uses the mechanism specified in
[RFC2782] to choose hosts and attempts to contact each host in turn
until a successful HTTP connection is established or the maximum
number of attempts threshold is reached.

3.1.2. DNS Fallback

Despite the fact that SRV records have been a part of the DNS
standard for 20 years, it is not uncommon for network intermediaries
to implement SRV record resolution incorrectly or block it entirely.

If no SRV record is found, a client MAY perform fallback discovery if
explicitly authorized to do so by the corresponding Web Service
protocol specification. The client attempts to connect to the host
<service>.<domain> using the standard A/AAAA/CNAME resolution rules
to obtain the IP address of the host.

3.2. HTTP host processing

Having identified the IP address, the client performs a HTTP or HTTPS
Web Service POST request at the default Web Service Endpoint
specified by the Well Known Service name and the original DNS address
of the service.

http://<domain>:<port>/.well-known/<service>

Note that a given host MAY provide multiple instances of a Web
Service under different discovery addresses. Therefore it is
essential to use the original <domain> value rather than the
<mapping> returned in the SRV record.

3.2.1. Use of TLS transport

The use of TLS transport is indicated by the SRV port number as
follows:

If the SRV port number is 80, 8000, 8080 or greater than 32,767
HTTP over TCP is used.

Otherwise HTTP over TLS Transport (HTTPS) is used.

If an authenticated DNS resolution protocol (e.g. DNSSEC
[RFC4033]) is used to resolve the SRV record, these rules permit
deployments to achieve 'secure on first contact' transport
security without the need to resolve additional records (e.g.
TLSA [RFC6698]. Note however that while the use of TLS is
mandated, the criteria for evaluating the TLS certificate chain
presented by the server is left to local site policy.

A service presented on a port for which HTTP is indicated MAY
specify a redirect to require use of HTTPS protocol.

3.2.2. Fallback Processing Rules

If a client's attempt to connect to a host selected from an SRV
connection redirection results in a HTTP (3xx), Client error (4xx) or
Server error (5xx) code, the client MUST process the HTTP error
response and not simply attempt a connection to a different host. If
a client request is rejected for lack of authentication (511) or
because the request is too large (413) at one host, the client should
assume that the request will be rejected for the same reason at
another. If the attempt to create a TCP connection fails or the
server returns Service Unavailable (503), the client MAY use the SRV
fallback rules to select an alternative host.

3.2.3. Service Continuation

Once the initial service discovery mechanism has been used to
establish contact with a host, the service protocol MAY specify that
further interactions be directed to another host and/or using a
different protocol. Such mechanisms are outside the scope of this
specification.

3.3. **Example**

   The Mathematical Mesh has the Well Known Service name of 'MMM'.
   Accounts used in the Mathematical Mesh follow the [RFC5822] format of
   <user>@<domain>.

   Alice has the account alice@example.com and the DNS configuration
   file for example.com has the following entries:

   _mmm._tcp.example.com SRV host1.example.com 0 10 80 host1.example.com
   _mmm._tcp.example.com SRV host2.example.com 0 40 80 host2.example.com
   mmm.example.com   CNAME host3.example.com
   host1.example.com   A 10.0.1.1
   host2.example.com   A 10.0.1.2
   host3.example.com   A 10.0.1.1
   host3.example.com   A 10.0.1.2

   The client attempts to resolve the address alice@example.com as
   follows:

   Client attempts to resolve SRV record for _mmm._tcp.example.com

   DNS resolver returns two entries.

   Client makes a random selection between host1 (20% weighting) and
   host2 (80% weighting). Chooses host1.

   Client resolves A/AAAA for host1.example.com

   DNS resolver returns 10.0.1.1

   Client attempts to POST Web Service request to
   http://example.com/.well-known/mmm at host address 10.0.1.1

   The host at 10.0.1.1 returns 503 Service Unavailable

   Client resolves A/AAAA for host2.example.com

   DNS resolver returns 10.0.1.2

   Client attempts to POST Web Service request to
   http://example.com/.well-known/mmm at host address 10.0.1.2

   Request succeeds, session proceeds.

   If the same client is used in a network location where the SRV record
   resolution fails due to a faulty firewall configuration, the
   resolution proceeds as follows:

Client attempts to resolve SRV record for _mmm._tcp.example.com

DNS resolver returns 'not found'

Client attempts to resolve A and AAAA record

DNS resolver returns 10.0.1.1, 10.0.1.2

Client makes a random selection between 10.0.1.1 (50% weighting) and
10.0.1.2 (50% weighting). Chooses host1.

Client attempts to POST Web Service request to
http://example.com/.well-known/mmm at host address 10.0.1.1

The host at 10.0.1.1 returns 503 Service Unavailable

Client attempts to POST Web Service request to
http://example.com/.well-known/mmm at host address 10.0.1.2

Request succeeds, session proceeds.

Note that the main difference between these two scenarios is that the
use of the SRV record allows the service configuration to account for
load balancing with tiers of fallback support while the use of round
robin A/AAAA records does not.

4. HTTP Messages

JWB messages are exchanged as HTTP POST transactions. Support for
and use of HTTP/1.1 [RFC7230] is REQUIRED unless otherwise specified
by the Web Service Specification.

While the use of HTTP/2 [RFC7540] offers the potential benefit of
multiple concurrent transaction streams, the means of making use of
such capabilities is outside the scope of JWB v1.0 but is likely to
be the main incentive for defining a revision.

In contrast to other approaches to the design of Web Services, the
only use made of the HTTP transport is to distinguish between
different services on the same host using the Host header and .well-
known convention and for message framing.

In particular no use is made of the URI request line to identify
commands, nor are the caching or proxy capabilities of HTTP. One of
the main design objectives of JWB is to enable message level
authentication. Since HTTP headers are mutable and may be changed by
intermediaries, any attempt to make use of HTTP features requires a
mechanism to canonicalize or duplicate the headers. Furthermore, the

implementation of authentication and encryption features at the
message level is liable to be incompatible with the HTTP caching
model and any attempt to implement caching is moot when TLS is in
use.

4.1. Request

The HTTP request MAY contain any valid HTTP header specified in
[RFC7230].

   Request Line URI   /well-known/<service>

   Request Line Method POST

   Host: Header   <domain>

   Content-Encoding As specified in section yy below.

   Content-Type As specified in section zz below.

   Content-Length or Transfer-Encoding As specified in [RFC7230].

   Payload The content payload as specified in section XX below.

Example: The HTTP request for the mmm service in the previous example
would be:

```
POST /.well-known/mmm HTTP/1.1
Host: example.com
Content-Type: application/json
Content-Length: 16

{ ?hello? : {} }
```

4.2. Response

The response MAY contain any HTTP response header. However since JWB
services do not make use of HTTP caching and messages are not
intended to be modified by HTTP intermediaries, only a limited number
of headers have significance.

   Response Code The HTTP response code. This is processed as
      described in section zz below.

   Content-Type As specified in section zz below.

   Content-Length or Transfer-Encoding As specified in [RFC7230].

   Cache-Control Since the only valid HTTP method for a JWB request
      is POST, JWB responses are not cacheable. The use of the
      cache-control header is therefore unnecessary. However
      experience suggests that reviewers find it easier to understand
      protocol specifications if they are reminded of the fact that
      caching is neither supported nor desired.

   Example: The HTTP response for the mmm service in the previous
   example would be:

   HTTP/1.1 200 OK
   Content-Type: application/json
   Connection: keep-alive
   Cache-Control: no-store
   Content-Length: 43

   { ?hello-response? : { ?Version? : ?1.0? }}

5. Error handling and response codes

   A JWB Web Service is effectively using a three layer protocol stack
   with the potential for an error to occur at any of the three layers:

   Transport Layer

   HTTP Layer

   Web Service Layer

   Services SHOULD always attempt to return error codes at the highest
   level possible. However it is clearly impossible for a connection
   that is refused at the Transport layer to return an error code at the
   HTTP layer. It is however possible for a HTTP layer error response
   to contain a content body.

   In the case that a JWB response contains both a HTTP response code
   and a well formed JWB payload containing a response, the JWB payload
   response SHALL have precedence.

6. Content Encoding

   The HTTP Content-Encoding header specifies transformations performed
   on the content before the HTTP Transfer encoding was applied. This
   is commonly used for specifying compression. In JWB the Content-

Encoding header MAY be used to specify that the content that follows
contains a payload that is either authenticated [RFC7515] or
authenticated and encrypted [RFC7516] using the JOSE specification.

6.1. Direct Encoding

If the Content-Encoding header is absent or empty, the HTTP content
is the message payload as specified by the Content-Type header.

6.2. Content-Encoding: jose-jwb

The Content-Encoding type jose-jwb is a serialization format for JSON
Web Signature and JSON Web Encryption objects. Each message consists
of the following sequence:

Preamble: A JSON object in UTF-8 encoding

ASCII Record Separator Character (%x1E)

Payload

ASCII Record Separator Character (%x1E)

Postscript: A JSON object in UTF-8 encoding

The payload data consists of all the data that appears between the
first and the last occurrence of the record separator character %x1E
in the HTTP content. Since the UTF-8 encoding does not permit the
octet %0x1E to occur within a well formed JSON object, the use of
this character as a record separator is unambiguous even if the
character occurs within the payload (as is possible with a binary
content-type or if the payload is encrypted).

The contents of the Preamble, Payload and Postscript vary according
to whether the message is authenticated or authenticated and
encrypted.

6.3. Authenticated

Authenticated messages are signed using Jose Web Signature [RFC7515].
The Preamble, Payload and Postscript are formed as follows:

Preamble A JSON Object containing the JWS Protected Header

Payload The binary data over which the signature value is
    calculated

      Postscript The JWS Signature header

   Note that a jsoe-jwb message is only permitted to have a single
   header and there is no provision for providing data that is not
   integrity protected.

6.4. Authenticated Encryption

   Authenticated messages are signed using Jose Web Signature [RFC7515].
   The Preamble, Payload and Postscript are formed as follows:

      Preamble A JSON Object containing the JWS Protected Header

      Payload The binary data over which the signature value is
         calculated

      Postscript The JWS Signature header

   Note that a jsoe-jwb message is only permitted to have a single
   header and there is no provision for providing data that is not
   integrity protected.

7. Content Type

   The Content Type header specifies the plaintext payload media type as
   specified in [RFC6838].

   For version1.0 of this specification, the only supported payload
   media type is application/json as specified in [RFC7159].

   Future versions of this specification may include support for binary
   encodings such as JSON-B [draft-hallambaker-jsonbcd] and/or CBOR
   [rfc7049].

8. JSON Data Bindings

   Note that this is the only part of this specification that is
   strictly limited to JSON encoding. The rest of the specification is
   equally applicable to Web Services using XML and/or CBOR encoding.

8.1. Request Message

   Each JWBv1.0 request contains exactly one Web Service Command.
   [Future versions MAY specify a mechanism that permits multiple
   commands to be sent in parallel]

The request payload contains a JSON object that contains exactly one member whose name is the name of the command that is requested and whose value is an object that contains the command parameters (if any).

{ ?hello? : {} }

8.2. Response Message

The response payload contains a JSON object that contains the members specified by the Web Service specification.

Future versions of this specification MAY reserve particular fields in the response payload for particular purposes (e.g. returning status values).

{ ?hello-response? : { ?Version? : ?1.0? }}

8.3. Data Fields

JSON was originally developed to provide a serialization format for the JavaScript programming language [ECMA-262]. While this approach is generally applicable to the type systems of scripting programming languages, it is less well matched to the richer type systems of modern object oriented programming languages such as Java and C#. Moreover

Working within a subset of the capabilities of JSON allows a Web Service protocol to be accessed with equal ease from either platform type. In particular the following capabilities of JSON are avoided:

The ability to use arbitrary strings as field names.

The use of JSON objects to define maps directly

The following data field types are used:

    Integer   Integer values are encoded as JSON number values.

    String   Test strings are encoded as JSON text strings.

    Boolean   Boolean values are encoded as JSON 'false', 'true' or
        'null' tokens according to value.

    Sequence   Sequences of data items that are encoded as JSON arrays

Object of known type Objects whose type is known to the receiver
   are encoded as JSON objects

Object of variable type Objects whose type is not known to the
   receiver are encoded as JSON objects containing a single field
   whose name describes the type of the object value and whose
   value contains the value.

Binary Data Byte sequences are converted to BASE64-url encoding
   [RFC4648] and encoded as JSON string values.

Date Time Date Time values are converted to Internet time format
   as described in [RFC3339] and encoded as JSON string values.

9. Security Considerations

A fuller treatment of the security considerations will follow.

9.1. Integrity

9.1.1. DNS Spoofing

9.1.2. TLS Downgrade

9.1.3. TLS Service Impersonation

9.1.4. Request Replay Attack

9.1.5. Response Replay Attack

9.2. Confidentiality

9.2.1. Side Channel Attack

9.2.2. Session Key Leakage

10. IANA Considerations

The following registrations are required:

HTTP Content Coding Registry jose-jwb

Well-Known URIs /.well-known/srv/

   [Or change registry to FCFS]

11. References

11.1. Normative References

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11.2. Informative References

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