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# JSON Service Connect (JCX) Protocol

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### Abstract

JSON Service Connect (JCX) is a JSON/REST Web Service that may be used to establish and maintain a 'connection binding' of a device to an account held with a Web Service Provider. Multiple connection bindings may be established under the same account to support multiple devices and/or multiple users of a single device. A connection binding permits a device to securely connect to one or more services offered by the Web Service Provider with support for protocol and protocol version agility and fault tolerance.

The protocol is presented as a HTTP/JSON Web Service and uses the HTTP session continuation mechanism for authentication of transaction messages and supports negotiation of a HTTP session continuation mechanism context for the established endpoint connections.

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## 1. Definitions

### 1.1. 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].

## 2. Introduction and Purpose

JSON Service Connect (JCX) is a JSON/REST Web Service that may be used to establish and maintain a 'connection binding' of a device to an account held with a Web Service Provider (WSP).

A Connection Binding comprises a set of long term credentials used to authenticate interactions with the JCX service itself and a set of 'Service Connections' to specific services offered by the Web Service Provider.

Each service connection in turn comprises a collection of 'Instance Connections' which describe a specific instances of the Web Service.

For example Alice is a consumer and example.com a provider of a range of Web Services including anti-malware protection and management of home automation devices. Alice has 42 devices of different types that each make use of one or more of the Web Services provided by example.com. All the devices are enrolled in the same JCX account 'alice@example.com' but each device has a unique connection binding and different devices make use of different Web Services.

The centralized account provides Alice with a single point of control from which she can authorize the addition of new devices to the account or the removal of devices that are deactivated. This allows Alice to avoid the need to manage a device such as a network-enabled lightswitch through the lightswitch itself.

To ensure continuity of service in case of network failure or administration work, example.com provides multiple instances of its Web Services hosted on different machines. Different users MAY be granted access to a different collection of service instances according to their needs and the service tier they are subscribed to.

### 2.1. Establishing a Web Service Provider Account

The means by which the Web Service Provider Account is established is outside the scope of this document.

In a typical case the user would establish an account with their chosen Web Service Provider through the normal process of using a Web Browser to access the Web Service Provider's site and entering such data as the Web Service Provider requires into a HTML form.

Depending on the circumstances, the data provided by the applicant may require verification before the account is created.

[Default accounts for appliances that are going to be implicitly authenticated by reference to the network they are on.]

### 2.2. Establishing a Connection Binding

A connection binding represents a long term association between a device and an account at the Web Service Provider. The association includes the establishment of an authentication context between the device and the JCX service.

An authentication context consists of:

- A Context Identifier.

- An authentication algorithm.

- A secret key.

The context identifier is an opaque string assigned by the JCX service. Following the approach introduced in Kerberos, a JCX service MAY eliminate the need to store authentication context information by encoding the authentication algorithm and encrypted secret key in the context identifier.

The authentication context can ensure that future communications are secured against impersonation if and only if the original process of establishing a connection binding was secured against communication. Mutual authentication is therefore an essential requirement.

The means by which the connection binding is established depend on the affordances of the device in question. Establishing a connection binding to a device with a keyboard is easily accomplished through use of a one-time PIN code. But many embedded devices do not provide a keyboard or similar affordance.

The following modes of session establishment are supported:

- PIN Code Establishment.
- Out of Band Completion.
- QR Code Establishment.

### 2.2.1. PIN Code Establishment.

To establish a connection binding for a new mobile phone, Alice logs into her JCX account manager and requests a new PIN code. She then starts the application that makes use of a JCX account and selects 'create new binding'. She is prompted for and enters her account name (alice@example.com) and PIN.

The client connects to the JCX service and verifies that the TLS certificate presented is correct for example.com and has been issued in accordance with issue practices that ensure an appropriately high degree of trust (e.g. the CABForum Extended Validation requirements).

### 2.2.2. Out of Band Completion.

To establish a connection binding for her new toaster oven, Alice plugs the appliance into her local network and enters her account name into the device. Since she has not obtained a PIN code in advance, she leaves the entry blank.

To complete the process, Alice logs into her JCX account where she sees that a new device is available to add to the account. To help identify the correct device, there is a picture of the toaster oven, the model name and serial number.

### 2.2.3. QR Code Preauthorization.

Alice decides to remodel the kitchen completely and plans to install a dozen new network enabled LED light fixtures. Using an application on the mobile phone she enabled earlier, Alice scans a QR code attached to each fixture before the devices are installed. When the fixtures are installed and powered, the connection binding is preauthorized.

## 3. Example Uses

### 3.1. PIN code establishment

Alice buys a new laptop computer which she wishes to use with the malware protection service provided by example.com. Alice has an existing account 'alice' with this Web Service Provider and obtains a pin code Q80370-1RA606-F04B from the Web Service Provider Web site.

Alice enters the values alice@example.com and Q80370-1RA606-F04B into the Web Service client she wishes to use with the Web Service Provider on the new laptop.

The client obtains the JCX service for example.com using DNS SRV discovery. The client establishes a TLS connection to the service and verifies that the certificate provided has a valid certificate path, has not been revoked and meets the validation criteria of the client. Since the purpose of this particular Web Service client is to provide security, the client requires that an Extended Validation certificate be presented.

Having established a TLS connection to the JCX Service, the client sends the following HTTP request:

```
Post / HTTP/1.1
Host: example.com
Cache-Control: no-store
Content-Type: Application/json;charset=UTF-8
Content-Length: 470
```

```
{
  "OpenRequest": {
    "Encryption": ["HS256",
      "HS384",
      "HS512",
      "HS256T128"],
    "Authentication": ["A128CBC",
      "A256CBC",
      "A128GCM",
      "A256GCM"],
    "Account": "alice",
    "Domain": "example.com",
    "HavePasscode": true,
    "HaveDisplay": true,
    "Challenge": "d2gdVeQesS3UT0gtK4JSEg==",
    "DeviceID": "Serial:0002212",
    "DeviceURI": "http://comodo.com/dragon/v3.4",
    "DeviceName": "Comodo Dragon"}}}
```

To prevent man in the middle attack, the client does not send the PIN code in the initial request. The PIN code is only sent after the service responds with a challenge nonce to be used to prevent replay attack.

The service receives the request, determines that it meets its access control policy and selects a set of cryptographic parameters from the set proposed by the client. In this case the service prefers the use of AES128CBC for encryption and the HS256 Message Authentication Code for authentication.

The service determines that a PIN code has been issued for the account and uses the value of that PIN to generate a response to the challenge presented by the client. A new challenge is generated to test the client knowledge of the PIN.

[TBS: Is there a need for the service to be able to support multiple outstanding PIN codes for the same account? This could be supported by providing the last 2 significant characters of the PIN code to the service which could use it as an index. This would enable several hundred simultaneous outstanding requests which should be enough for most applications. Large volume applications would need to use a different scheme.]

The service sends the following response to the client:

```
HTTP/1.1 203 Passcode
Content-Type: application/json;charset=UTF-8
Content-Length: 500

{ "Status" : "Authenticate",
  "OpenResponse": {
    "Status": 203,
    "StatusDescription": "Passcode",
    "Cryptographic": [{
      "Secret": "11bmdFi9Et7KIUg8aeN2AQ==",
      "Encryption": "A128CBC",
      "Authentication": "HS256",
      "Ticket":
        "TUMnor00SjHHS7D2uFcG1RYJ0Hd3eibwe0ogptoNMQuCYmCHfHAJcJlyvi
        j8WoXDg1TS0kctnmoBz18W0NLS1cgSyZcmsAyows8y1Rn2Z102WBgoWrFIO
        qPa4oB29dgs/ei6ieINZtmvXNCm2NUkWA==" }],
    "Challenge": "a1X8aAWH6acSq03FTT94HA==",
    "ChallengeResponse": "enT5myMw8w2hV4H32Ntx/g==" }}}
```

To complete the transaction, the client sends a TicketRequest message to the service containing a response to the PIN challenge sent by the service (ChallengeResponse).

The TicketRequest message is authenticated using HTTP Session authentication under the shared secret specified in the OpenResponse message:

```
Post / HTTP/1.1
```

```

Host: example.com
Cache-Control: no-store
Content-Type: Application/json;charset=UTF-8
Content-Length: 78
Session:
  Value=cjkMkfnnYP8JYWZAbRLvtpqImmOK3rsrOT1XcvAgHDk=;
  Id=TUMnor00SjHHS7D2uFcG1RYJ0Hd3eibwe0ogptoNMQuCYmCHfHAJcJlyvi
    j8WoXDg1TS0kctnmoBz18W0NLS1cgSyZcmsAyoWs8y1Rn2Z102WBgoWrFI0qPa4
    oB29dgs/ei6ieINZtmvXNCm2NUkWA==

{
  "TicketRequest": {
    "ChallengeResponse": "TctLOG74cwpm26YNpEibcQ=="}}

```

The service checks the value of ChallengeResponse against the known PIN and if the result is correct establishes parameters for the Connection Binding for the device.

In this case the server uses the Session Id parameter to encode permissions associated with the request as described in [Appendix TBS]. Accordingly the server must replace the Session Id whenever the associated permissions change. Accordingly, the server replaces the cryptographic parameters specified in the OpenResponse request for use in future JCX service requests. In this case the server returns three connections, each offering a different transport protocol option. Each connection specifies its own set of cryptographic parameters (or will when the code is written for that).

The service also returns a service connection the malware protection service the client requested access to. This service connection specifies three different service instances. Each service instance has its own set of cryptographic parameters for use with HTTP session authentication. In this case the three different service instances offer different means of accessing the same service: as a JSON Web Service over HTTP, using a binary encoding over a UDP transport and tunnelling via DNS.

```

HTTP/1.1 200 Complete
Content-Type: application/json;charset=UTF-8
Content-Length: 1907
Session:
  Value=nKhjR1r2eYPga0rmDfHT4H0vgQ+EuUoQPwzI10bt1js=;
  Id=TUMnor00SjHHS7D2uFcG1RYJ0Hd3eibwe0ogptoNMQuCYmCHfHAJcJlyvi
    j8WoXDg1TS0kctnmoBz18W0NLS1cgSyZcmsAyoWs8y1Rn2Z102WBgoWrFI0qPa4
    oB29dgs/ei6ieINZtmvXNCm2NUkWA==

{ "Status" : "Success",
  "TicketResponse": {
    "Status": 200,
    "StatusDescription": "Complete",
    "Cryptographic": [{
      "Protocol": "OBPConnection",
      "Secret": "HQuQg4GkzTwTVoGxar0EXg==",
      "Encryption": "A128CBC",
      "Authentication": "HS256",
      "Ticket":
        "0ulMVMmfY/pLHZ0FlIy2zDnNycYz9Znvs3JJYQG1Z+dWaxMNxm/jLEsJd/
        0qsAc5qp8fjBoMN49V9DkDgM4UYJxVriqfr64RyTTgug2taHY="}],
    "Service": [{
      "Name": "obp1.example.com",
      "Port": 443,
      "Address": "10.1.2.3",
      "Priority": 1,
      "Weight": 100,
      "Transport": "WebService",
      "Cryptographic": {
        "Protocol": "OBPQuery",
        "Secret": "kezeXxhkzXgxY7vpkHUb1g==",
        "Encryption": "A128CBC",
        "Authentication": "HS256",
        "Ticket":
          "jpbXvI7/0WTmwI2NN4n7Vvw96nbS9LpSsSNMIkdapiUoLikSkjpgMrtb

```

```

    VKz5lH0Pl0CgAyZXxfZpQRsp4oPY4BcRaMw6F5na62IHnBVDeXg="}}},
  {
    "Name": "dns1.example.com",
    "Port": 53,
    "Address": "10.1.2.2",
    "Priority": 1,
    "Weight": 100,
    "Transport": "DNS",
    "Cryptographic": {
      "Protocol": "OBPQuery",
      "Secret": "Wk3m7DlL/GStBBm3xUjyzg==",
      "Encryption": "A128CBC",
      "Authentication": "HS256",
      "Ticket":
        "Q9r4hXefHhLvgpKHVg3w2p7VptVH9qidGiIa4Nw3Zp5hZR816h9+PRj5
        sye1jmIhy4sYA/jfK/g40rSngK9xW07Qg3/iQ+YTAchKQjdJtN4="}}},
  {
    "Name": "udp.example.com",
    "Port": 5000,
    "Address": "10.1.2.2",
    "Priority": 1,
    "Weight": 100,
    "Transport": "UDP",
    "Cryptographic": {
      "Protocol": "OBPQuery",
      "Secret": "wBiguG9FGj08nS/c/njp4Q==",
      "Encryption": "A128CBC",
      "Authentication": "HS256",
      "Ticket":
        "F8LPKTL+XaAX0eJsM22fdJ37BRS816dKXD66UbD8NAVK0g0u556uS8WW
        AMj+dJbJaErUzo/vw7tY0icCu1bw8qHm004gzhbSbD4Nga2EAU4="}}]}
}

```

## 3.2. Unbinding

After a year of use, Alice decides to replace the laptop with a new one. Before selling the old laptop on eBay, she tells the Web Service client to cancel the connection to the Web Service Provider.

The client sends the following message to the provider:

```

Post / HTTP/1.1
Host: example.com
Cache-Control: no-store
Content-Type: Application/json;charset=UTF-8
Content-Length: 25
Session:
  Value=bZU61eCOW4nVnfdJNS719HL4IsNVxtoTgoRt+mqLbWY=;
  ID=0u1MVMmfY/pLHZ0FlIy2zDnNycYz9Znvs3JJYQG1Z+dWaxMNxm/jLEsJd/
  0qsAc5qp8fjBoMN49V9DkDgM4UYJxVriqfr64RyTTgug2taHY=

{
  "UnbindRequest": {}
}

```

The Session ID specifies the connection binding. Since the Unbind Request is only valid for that connection binding, there is no need to specify the connection binding further in the request.

The server verifies that the request was authenticated and returns a successful response:

```

HTTP/1.1 200 Complete
Content-Type: application/json;charset=UTF-8
Content-Length: 26
Session:
  Value=9P1FmroeFU7y9qHgXdSFXH2qSImh0cQpaSgZrx5IswM=;
  Id=0u1MVMmfY/pLHZ0FlIy2zDnNycYz9Znvs3JJYQG1Z+dWaxMNxm/jLEsJd/
  0qsAc5qp8fjBoMN49V9DkDgM4UYJxVriqfr64RyTTgug2taHY=

```

```
{ "Status" : "Success",  
  "UnbindResponse": {}}
```

[TBS: Add in the status response back into the JSON message. ]

### 3.3. Out of Band Completion

Alice purchases an Internet enabled coffee pot. The installer configures the coffee pot in her kitchen but does not have access to Alice's JCX account or a PIN code to configure it.

The installer configures the coffee pot to use the JCX account specified by Alice. The coffee pot does not have a psscode to enter but does have a link to an image of the coffee pot.

The client sends the following request:

[TBS: non pin code example]

Since the client does not have a PIN code, there is no need to return a challenge. Instead the service returns the status "OOB" to indicate that the transaction will be completed out of band.

[TBS: non pin code example]

By default the coffee pot attempts to complete the JCX connection at ten second intervals for the first ten minutes, every thirty seconds for the next hour, every five minutes for the following 24 hours and once an hour thereafter.

The client sends the following request to check the status of the request:

[TBS: should add in a parameter 'don't call again for x seconds']

The first service response tells the coffee pot not to ask again until five minutes have elapsed:

[TBS: non pin code example]

The installer calls Alice to tell her that the coffee pot is ready to connect. Alice authorizes the connection remotely via the Web Service Provider's Web site. Alice identifies the request to connect the coffee pot by means of the image provided. She can also use the same image to help determine which connection to cancel when the coffee pot is replaced.

The next time the coffee pot requests a status update, the service responds with the connection binding parameters:

[TBS: non pin code example]

## 4. OBPCConnection

### 4.1. Message: Message

### 4.2. Message: Response

Status : Integer [0..1]

Application layer server status code

StatusDescription : String [0..1]

Describes the status code (ignored by processors)

### 4.3. Message: ErrorResponse

An error response MAY be returned in response to any request.

Note that requests MAY be rejected by the code implementing the transport binding before application processing begins and so a server is not guaranteed to provide an error response message.

## 4.4. Message: Request

Ticket : Binary [1..1]

Opaque ticket issued by the server that identifies the cryptographic parameters for encryption and authentication of the message payload.

## 4.5. Structure: Cryptographic

Parameters describing a cryptographic context.

Protocol : Label [0..1]

OBP tickets MAY be restricted to use with either the management protocol (Management) or the query protocol (Query). If so a service would typically specify a ticket with a long expiry time or no expiry for use with the management protocol and a separate ticket for use with the query protocol.

Secret : Binary [1..1]

Shared secret

Encryption : Label [1..1]

Encryption Algorithm selected

Authentication : Label [1..1]

Authentication Algorithm selected

Ticket : Binary [1..1]

Opaque ticket issued by the server that identifies the cryptographic parameters for encryption and authentication of the message payload.

Expires : DateTime [0..1]

Date and time at which the context will expire

## 4.6. Structure: ImageLink

Algorithm : Label [0..1]

Image encoding algorithm (e.g. JPG, PNG)

Image : Binary [0..1]

Image data as specified by algorithm

## 4.7. Structure: Connection

Contains information describing a network connection.

Name : Name [0..1]

DNS Name. Since one of the functions of an OBP service is name resolution, a DNS name is only used to establish a connection if connection by means of the IP address fails.

Port : Integer [0..1]

TCP or UDP port number.

Address : String [0..1]

IPv4 (32 bit) or IPv6 (128 bit) service address

Priority : Integer [0..1]

Service priority. Services with lower priority numbers SHOULD be attempted before those with higher numbers.

Weight : Integer [0..1]

Weight to be used to select between services of equal priority.

Transport : Label [0..1]

OBP Transport binding to be used valid values are HTTP, DNS and UDP.

Expires : DateTime [0..1]

Date and time at which the specified connection context will expire.

## 4.8. Bind

Binding a device is a two step protocol that begins with the Start Query followed by a sequence of Ticket queries.

## 4.9. Message: BindRequest

The following parameters MAY occur in either a StartRequest or TicketRequest:

Encryption : Label [0..Many]

Encryption Algorithm that the client accepts. A Client MAY offer multiple algorithms. If no algorithms are specified then support for the mandatory to implement algorithm is assumed. Otherwise mandatory to implement algorithms MUST be specified explicitly.

Authentication : Label [0..Many]

Authentication Algorithm that the client accepts. If no algorithms are specified then support for the mandatory to implement algorithm is assumed. Otherwise mandatory to implement algorithms MUST be specified explicitly.

## 4.10. Message: BindResponse

The following parameters MAY occur in either a StartResponse or TicketResponse:

Cryptographic : Cryptographic [0..Many]

Cryptographic Parameters.

Service : Connection [0..Many]

A Connection describing an OBP service point

## 4.11. Message: OpenRequest

The OpenRequest Message is used to begin a device binding transaction. Depending on the authentication requirements of the service the transaction may be completed in a single query or require a further Ticket Query to complete.

If authentication is required, the mechanism to be used depends on the capabilities of the device, the requirements of the broker and the existing relationship between the user and the broker.

If the device supports some means of data entry, authentication MAY be achieved by entering a passcode previously delivered out of band into the device.

The OpenRequest specifies the properties of the service (Account, Domain) and Device (ID, URI, Name) that will remain constant throughout the period that the device binding is active and parameters to be used for the mutual authentication protocol.

Account : String [0..1]

Account name of the user at the OBP service

Domain : Name [0..1]

Domain name of the OBP broker service

HavePasscode : Boolean [0..1] Default =False

If 'true', the user has entered a passcode value for use with passcode authentication.

HaveDisplay : Boolean [0..1] Default =False

Specifies if the device is capable of displaying information to the user or not.

Challenge : Binary [0..1]

Client challenge value to be used in authentication challenge

DeviceID : URI [0..1]

Device identifier unique for a particular instance of a device such as a MAC or EUI-64 address expressed as a URI

DeviceURI : URI [0..1]

Device identifier specifying the type of device, e.g. an xPhone.

DeviceName : String [0..1]

Descriptive name for the device that would distinguish it from other similar devices, e.g. 'Alice's xPhone'.

## 4.12. Message: OpenResponse

An Open request MAY be accepted immediately or be held pending completion of an inband or out-of-band authentication process.

The OpenResponse returns a ticket and a set of cryptographic connection parameters in either case. If the

Challenge : Binary [0..1]

Challenge value to be used by the client to respond to the server authentication challenge.

ChallengeResponse : Binary [0..1]

Server response to authentication challenge by the client

VerificationImage : ImageLink [0..Many]

Link to an image to be used in an image verification mechanism.

## 4.13. Message: TicketRequest

The TicketRequest message is used to (1) complete a binding request begun with an OpenRequest and (2) to refresh ticket or connection parameters as necessary.

ChallengeResponse : Binary [0..1]

The response to a server authentication challenge.

## 4.14. Message: TicketResponse

The TicketResponse message returns cryptographic and/or connection context information to a client.

## 4.15. Unbind

Requests that a previous device association be deleted.

## 4.16. Message: UnbindRequest

Since the ticket identifies the binding to be deleted, the only thing that the unbind message need specify is that the device wishes to cancel the binding.

## 4.17. Message: UnbindResponse

Reports on the success of the unbinding operation.

If the server reports success, the client SHOULD delete the ticket and all information relating to the binding.

A service MAY continue to accept a ticket after an unbind request has been granted but MUST NOT accept such a ticket for a bind request.

## 5. Mutual Authentication

A Connection Service MAY require that a connection request be authenticated. Two authentication mechanisms are defined.

PIN Code: The client and server demonstrate mutual knowledge of a PIN code previously exchanged out of band.

Out of Band Confirmation: The request for access is confirmed out of band.

In addition, services MAY accept the use of any message or transport layer authentication scheme.

For example HTTP Session Continuation or Transport Layer Security with client authentication.

## 5.1. PIN Authentication

PIN code authentication provides users with a simple and often familiar mechanism for authenticating the connection request. The means by which the user obtains the PIN code is outside the scope of this document. Possible methods for distributing the PIN code include obtaining the code from an account management Web site provided by the Web Service Provider, letter post, email and in person.

Although the PIN value is never exposed on the wire in any form, the protocol considers the PIN value to be text encoded in UTF8 encoding.

To encourage readability, the use of space (0x20) and hyphen (0x2D) characters to arrange PIN characters into groups of four to seven characters is encouraged. To avoid the risk of this practice introducing user error, space and hyphen characters are ignored when processing the PIN value.

Support for the full UNICODE character set in PIN codes is intended to facilitate provision of PIN codes in the user's native language. Web Service Providers MAY make use of any UNICODE characters they choose but capricious choices are likely to cause users difficulty. For example a PIN code MAY contain the ZAPF Dingbats thick tick mark (U+2704) but users would almost certainly find it difficult to enter and may confuse it with the similar thin tick mark (U+2703).

Servers that support PIN Authorization SHOULD offer the choice of a PIN that only uses numeric digits ('0', '1', '2', '3', '4', '5', '6', '7', '8', '9'). Clients that support PIN Authorization MUST allow entry of PINS that only contain numeric digits.

The PIN Mechanism is a three step process:

The client sends an OpenRequest message to the Service containing a challenge value CC.

The service returns an OpenResponse message containing to the client a server challenge value SV and a server response value SR.

The client sends a TicketRequest message to the service containing a client response value CR.

Since no prior authentication key has been established the OpenRequest and OpenResponse messages are sent without message authentication.

The Challenge values CC, and SC are cryptographic nonces. The nonces SHOULD be generated using an appropriate cryptographic random source. The nonces MUST be at least as long as 128 bits, MUST be at least the minimum key size of the authentication algorithm used and MUST NOT more than 640 bits in length (640 bits should be enough for anybody).

The server response and client response values are generated using an authentication algorithm selected by the server from the choices proposed by the client in the OpenRequest message.

The algorithm chosen may be a MAC algorithm or an encrypt-with-authentication (EWA) algorithm. If an EWA is specified, the encrypted data is discarded and only the authentication value is used in its place.

Let  $A(d,k)$  be the authentication value obtained by applying the authentication algorithm with key  $k$  to data  $d$ .

To create the Server Response value, the UTF8 encoding of the PIN value 'P' is first pre-processed to remove space and hyphen characters, then converted into a symmetric key KPC by using the Client challenge value as the key truncating if necessary and then applied to the of the OpenRequest message:

$$\begin{aligned} \text{KPC} &= A(\text{PIN}, \text{CC}) \\ \text{SR} &= A(\text{Secret} + \text{SC} + \text{OpenRequest}, \text{KPC}) \end{aligned}$$

In the Web Service Binding, the Payload of the message is the HTTP Body as presented on the wire. The Secret and Server Challenge are presented in their binary format and the '+' operator stands for simple concatenation of the binary sequences.

This protocol construction ensures that the party constructing SR:

Knows the PIN code value (through the construction of KPC).

Is responding to the Open Request Message (SR depends on OpenRequest).

Has knowledge of the secret key which MUST be used to authenticate the following TicketRequest/TicketResponse interaction that will establish the actual connection.

Does not provide an oracle the PIN value. That is, the protocol does not provide a service that reveals the (since the value SR includes the value SC which is a random nonce generated by the server and cannot be predicted by the client).

To create the Client Response value, secret key is applied to the PIN value and server Challenge:

$$CR = A (PIN + SC + OpenRequest, Secret)$$

Note that the server can calculate the value of the Client Response token at the time that it generates the Server Challenge. This minimizes the amount of state that needs to be carried from one request to the next in the Ticket value when using the stateless server implementation described in section [Appendix A](#)

This protocol construction ensures that the generator of CR

Knows the PIN value.

Is responding to the OpenResponse generated by the server.

Note that while disclosure of an oracle for the PIN value is a concern in the construction of CR, this is not the case in the construction of SR since the client has already demonstrated knowledge of the PIN value.

## 5.2. Example: Latin PIN Code

The Connection Request example of section [Section 3](#) demonstrates the use of an alphanumeric PIN code using the Latin alphabet.

The PIN code is [Q80370-1RA606-F04B] and the authentication algorithm is [HS256]. The value KP is thus:

[TBS]

The data over which the hash value is calculated is Secret + SC + OpenRequest:

[TBS]

Applying the derived key to the data produces the server response:

The data for the client response is PIN + SC:

[TBS]

Applying the secret key to the data produces the client response:

[TBS]

## 5.3. Example: Cyrillic PIN Code

If the PIN code in the earlier example was [] the value KP would be:

[TBS]

The Server Response would be:

[TBS]

The rest of the protocol would then continue as before.

## 5.4. Out of Band Confirmation

The Out Of Band Confirmation mechanism is a three step process in which:

The client makes an OpenRequest message to the service and obtains an OpenResponse message.

The connection binding is authorized through an out of band process.

The client makes a TicketRequest to the service and obtains a TicketResponse message to complete the exchange.

Since no prior authentication key has been established the OpenRequest and OpenResponse messages are sent without authentication.

The principal concern in the Out Of Band Confirmation mechanism is ensuring that the party authorizing the request is able to identify which party originated the request they are attempting to identify.

If a device has the ability to display an image it MAY set the HasDisplay=true in the OpenRequest message. If the broker receives an OpenRequest with the HasDisplay value set to true, the OpenResponse MAY contain one or more VerificationImage entries specifying image data that is to be displayed to the user by both the client and the confirmation interface.

Before confirming the request, the user SHOULD verify that the two images are the same and reject the request in the case that they are not.

Many devices do not have a display capability, in particular an embedded device such as a network switch or a thermostat. In this case the device MAY be identified by means of the information provided in DeviceID, DeviceURI, DeviceImage and DeviceName.

## 6. Acknowledgements

[List of contributors]

## 7. Security Considerations

### 7.1. Denial of Service

### 7.2. Breach of Trust

### 7.3. Coercion

## 8. IANA Considerations

[TBS list out all the code points that require an IANA registration]

## 9. Normative References

- [RFC1035]** Mockapetris, P., "[Domain names - implementation and specification](#)", STD 13, RFC 1035, November 1987.
- [RFC2119]** Bradner, S., "[Key words for use in RFCs to Indicate Requirement Levels](#)", BCP 14, RFC 2119, March 1997.
- [RFC4366]** Blake-Wilson, S., Nystrom, M., Hopwood, D., Mikkelsen, J. and T. Wright, "[Transport Layer Security \(TLS\) Extensions](#)", RFC 4366, April 2006.
- [X.509]** International Telecommunication Union , "ITU-T Recommendation X.509 (11/2008): Information technology - Open systems interconnection - The Directory: Public-key and attribute certificate frameworks ", ITU-T Recommendation X.509, November 2008.
- [X.680]** International Telecommunication Union , "ITU-T Recommendation X.680 (11/2008): Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation ", ITU-T Recommendation X.680, November 2008.

## Appendix A. Stateless server

The protocol is designed to permit but not require the server to store connection binding state in the Session ID of the HTTP Session Continuation authentication mechanism.

The Session IDs are opaque as far as the client is concerned. The client receives the Session ID from the service and returns it with each request. The internal structure of the Session ID is therefore outside the scope of this specification but is provided here to assist implementers.

In the PIN Authentication example, two SessionIDs are issued by the server:

A temporary ID in response to the initial client OpenRequest.

A connection binding ID when the client PIN confirmation is accepted and the connection binding is created.

## **A.1. Temporary ID**

[TBS]

## **A.2. Connection Binding ID**

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