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Dynamic Host Configuration Protocol (DHCP) IPv4 and IPv6 Option for a Location Uniform Resource Identifier (URI)

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Abstract

This document creates a Dynamic Host Configuration Protocol (DHCP) Option for transmitting a client's geolocation Uniform Resource Identifier (URI), and another Option to explicitly indicate how long that location URI is to be considered valid. This Location URI can then be dereferenced in a separate transaction by the client or sent to another entity and dereferenced to learn physically where the client is located, but only while valid.

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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].

1. Introduction

This document creates a Dynamic Host Configuration Protocol (DHCP) Option for transmitting a client's geolocation Uniform Resource Identifier (URI), and another Option to explicitly indicate how long that location URI is to be considered valid. In this scenario, the DHCP client is a Geopriv Target (i.e., the entity whose geolocation is associated with the location URI). The DHCP implementation of the client can then make this location information available to other applications for their usage. This location URI points to a Location Server [RFC5808] which has the geolocation of the client (e.g., uploaded into a wiremap database when the client attached

wall-jack,or by means of 802.11 geolocation mechanisms).

Applications within the Target can then choose to dereference this location URI and/or transmit the URI to another entity as a means of conveying where the Target is located. Both Conveying and Dereferencing a location URI is described in [RFC6442]. Session Initiation Protocol (SIP) is not the only protocol that can dereference a location URI; there is also HTTP-Enabled Location Delivery (HELD) [RFC6753] and HTTP [RFC2616].

A Location Server (LS) stores the Target's location as a presence document, called a Presence Information Data Format - Location

Object (PIDF-LO), defined in RFC 4119 [RFC4119]. The Location Server is the entity contacted during the act of dereferencing a Target's location. If the dereferencing entity has permission, defined in [RFC6772], the location of the target will be received. The LS will grant permission to location inquiries based on the rules established by a Rule Holder [RFC3693]. The LS has the ability to challenge any request for a target's location, thereby providing additive security properties before location revelation.

Possessing a location URI has advantages over having a PIDF-LO, especially when a target's location changes. With a location URI, when a target moves, the location URI does not change (at least within the same domain). The location URI can still be given out as the reference to the Target's current location. The opposite is true if the location is conveyed by value in a message. Once the Target moves, the previously given location is no longer valid, and if the Target wants to inform another entity about its location, it has to send the PIDF-LO to the location recipient (again).

A problem exists within existing RFCs that provide location to the UA ([RFC6225] and [RFC4776]). Those DHCP Options for geolocation values require an update of the entire location information (LI) every time a client moves. Not all clients will move frequently, but some will. Refreshing location values every time a client moves does not scale in certain networks/environments, such as IP-based cellular networks, enterprise networks or service provider networks with mobile endpoints. An 802.11 based access network is one example of this. Constantly updating Location Configuration Information (LCI) to endpoints might not scale in mobile (residential or enterprise or municipal) networks in which the client is moving through more than one network attachment point,

perhaps as a person walks or drives with their client down a neighborhood street or apartment complex or a shopping center or through a municipality (that has IP connectivity as a service).

If the client was provided a location URI reference to retain and hand out when it wants or needs to convey its location (in a protocol other than DHCP), a location URI that would not change as the client's location changes (within a domain). Scaling issues would be significantly reduced to needing an update of the location URI only when a client changes administrative domains - which is much less often. This delivery of an indirect location has the added benefit of not using up valuable or limited bandwidth to the client with the constant updates. It also relieves the client from having to determine when it has moved far enough to consider asking for a refresh of its location.

In enterprise networks, if a known location is assigned to each individual Ethernet port in the network, a device that attaches to the network, such as a wall-jack (directly associated with a specific Ethernet Switch port) will be associated with a known location via a unique circuit-ID that's used by the Relay Agent

Information Option (RAIO) defined in RFC 3046 [RFC3046]. This assumes wall-jacks have an updated wiremap database. RFC 6225 [RFC6225] and RFC 4776 [RFC4776] would return an LCI value of location for either IPv4 or IPv6. This document specifies how a location URI is returned using DHCP. The location URI points to a PIDF-LO contained on an LS. Performing a dereferencing transaction, that Target's PIDF-LO will be returned. If local configuration has the requirement of only assigning unique location URIs to each client at the same attachment point to the network (i.e., same RJ-45 jack or same 802.11 Access Point - except when triangulation is used), then unique location URIs will be given out. They will all have the same location at the record, relieving the backend Sighter or LS from individually maintaining each location independently.

The location URI Option can be useful in IEEE 802.16e connected endpoints or IP cellular endpoints. The location URI Option can be configured on a router, such as a residential home gateway, such that the router receives this Location URI Option as a client with the ability to communicate to downstream endpoints as a server.

How an LS responds to a dereference request can vary, and a policy established by a Ruleholder [RFC3693] for a Location Target as to

what type of challenge(s) is to be used, how strong a challenge is used or how precise the location information is given to a Location Recipient (LR). This document does not provide mechanisms for the LS to tell the client about policies or for the client to specify a policy for the LS. While an LS should apply an appropriate access-control policy, clients must assume that the LS will provide location in response to any request (following the possession model [RFC5808]). For further discussion of privacy, see the Security Considerations.

This document IANA-registers the new IPv4 and IPv6 DHCP Options for a location URI and Valid-For.

2. Format of the DHCP LocationURI Option

2.1 Overall Format of LocationURI Option in IPv4

The LocationURI Option format for IPv4 is as follows:

```
  0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |   Code XXX    |   Length=XX   |                             .....
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.....                        LocationURI...                    .....
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.....                                                           |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```


Figure 1. IPv4 Fields for this LocationURI Option

Code XXX: The code for this DHCPv4 option (IANA assigned).

Length=XX: The length of this option, counted in bytes - not counting the Code and Length bytes. This is a variable length Option, therefore the length value will change based on the length of the URI within the Option.

LocationURI: Location URI - This field, in bytes, is the URI pointing at the location record where the PIDF-LO for the Location Target resides. The LocationURI is always

represented in ASCII.

2.2 Overall Format of LocationURI Option in IPv6

The LocationURI Option format for IPv6 is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          option-code          |           option-len          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          LocationURI...                    .....
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.....                                                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2. IPv6 fields of this LocationURI Option

option-code: The code for this DHCPv6 option (IANA assigned).

option-len: The length of this option, counted in bytes - not counting the option-code and option-len bytes. This is a variable length Option, therefore the length value will change based on the length of the URI within the Option.

LocationURI: see Section 2.1

2.3 Overall Format of Valid-For Option in IPv4

The Valid-For Option format for IPv4 is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Code XXX    |                   Valid-For                .....
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```



```
.....           |
+-+-+-+-+-+-+-+-+
```

Figure 1. IPv4 Fields for this Valid-For Option

Code XXX: The code for this DHCPv4 option (IANA assigned).

Valid-For: Valid-For - The time, in seconds, the LocationURI - received in the same DHCP message - is to be considered valid for dereferencing. The Valid-For is always represented as a four-byte unsigned integer.

2.4 Overall Format of Valid-For Option in IPv6

The Valid-For Option format for IPv6 is as follows:

```
  0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |          option-code          |           Valid-For          .....
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
.....      Valid-For (Cont'd)     |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2. IPv6 fields of this Valid-For Option

option-code: The code for this DHCPv6 option (IANA assigned).

Valid-For: see Section 2.3

2.5 Rules for both LocationURI and Valid-For Options

The LocationURI and Valid-For Options have the following rules:

- o Implementation of the Location URI Option is mandatory on the DHCP server and client, per this specification.
- o Implementation of the Valid-For Option is OPTIONAL on the DHCP server and client, per this specification.
- o The Location URI Option MUST be sent from a server, and received by a client with or without an accompanying Valid-For Option.

The Valid-For Option offers no meaningful information to a client without an accompanying Location URI Option, and might be misunderstood or misapplied, therefore

- o The Valid-For Option MUST NOT be sent from a server, and received by a client, without an accompanying Location URI Option.

o A client receiving a Valid-For Option without a Location URI Option MUST ignore the Valid-For Option.

o The Valid-For Option MUST only be considered in relation to the Location URI Option. It has no other purpose in DHCP then in relation to the Location URI (i.e., there is no other Option in DHCP to which it has meaning).

o The Valid-For Option MUST NOT cause any error in handling the Location URI, i.e., if not understood, it MUST be ignored.

A client uses the Location URI (value) until the Valid-For value reaches zero. If there is no Valid-For Option value, then the counter did not ever start (a null value), and the client continues to use the Location URI value until given a new Location URI Option (with or without a Valid-For value) which overwrites any previous Location URI and Valid-For Option values.

o Servers MUST assume that clients will overwrite any existing, previously sent values of Location URI Option and/or Valid-For Option.

o Clients MUST overwrite any existing, previously sent values of Location URI Option and/or Valid-For Option when receiving the next instance of either Option.

o If a client receives a new Location URI Option without also receiving a new Valid-For Option - with the previous Valid-For Option timer not reaching zero, the Valid-For timer MUST be set to zero upon reception of this new Location URI Option.

The choice of the Valid-For value is a policy decision for the operator of the DHCP server. Like location URIs themselves, it can be statically configured on the DHCP server or provisioned dynamically (via an out-of-band exchange with a Location Information Server) as requests for location URIs are received.

o Clients receiving both a Location URI and Valid-For Options start the Valid-For timer upon receipt of the DHCP message containing both Options.

o Applications MUST NOT make use of a location URI after it becomes invalid (i.e., after the Valid-For timer expires).

The Valid-For timer is used only at the application layer, as an indication of when the URI can be used to access location. It is

independent of the DHCP lease timer, and in no way related to the DHCP state machine.

o Clients MUST NOT trigger an automatic DHCP refresh on expiry of the Valid-For timer; rather, they SHOULD follow normal DHCP

mechanics.

Server operators should consider the relation between the Valid-For time and the lease time. Clients typically request a lease refresh when half the lease time is up. If the Valid-For time is less than the typical refresh rate (i.e., half the lease time), then for the remaining interval, clients will run the risk of not having a usable location URI for applications. If the Valid-For time is less than half the typical refresh rate, it is a near certainty clients will not have a usable location URI for the interval between the Valid-For time and the typical refresh time for applications. For example, if a lease is set to 24 hours, the typical refresh request is set to initiate at the 12 hour mark. If the Valid-For timer is set to less than 24 hours, but more than 12 hours (in this example), the client might not be refreshed at the 12 hour mark and runs the risk of not have a location URI for applications that request it. If, on the other hand, the Valid-For timer is less than 12 hours (in this example, which is before a typical client would ask for a refresh, applications will be without a usable location URI until the full refresh has been received.

3. DHCP Option Operation

The [RFC3046] RAIO can be utilized to provide the appropriate indication to the DHCP Server where this DISCOVER or REQUEST message came from, in order to supply the correct response.

Caution SHOULD always be used involving the creation of large Options, meaning that this Option MAY need to be in its own INFORM, OPTION or ACK message.

It is RECOMMENDED to avoid building URIs, with any parameters, larger than what a single DHCP response can be. However, if a message is larger than 255 bytes, concatenation is allowed, per RFC 3396 [RFC3396].

Per [RFC2131], subsequent LocationURI Options, which are

non-concatenated, overwrite the previous value.

Location URIs MUST NOT reveal identity information of the user of the device, since DHCP is a cleartext delivery protocol. For example, creating a location URI such as

    sips:34LKJH534663J54@example.com

is better than a location URI such as

    sips:aliceisat123mainstatlantageorgiaus@example.com

The username portion of the first example URI provides no direct identity information (in which 34LKJH534663J54 is considered to be a

random number in this example).

In the <presence> element of a PIDF-LO document, there is an 'entity' attribute that identifies what entity *this* presence document (including the associated location) refers to. It is up to the PIDF-LO generator, either Location Server or an application in the endpoint, to insert the identity in the 'entity' attribute. This can be seen in [RFC4119]. The considerations for populating the entity attribute value in a PIDF-LO document are independent from the considerations for avoiding exposing identification information in the username part of a location URI.

This Option is used only for communications between a DHCP client and a DHCP server. It can be solicited (requested) by the client, or it can be pushed by the server without a request for it. DHCP Options not understood MUST be ignored [RFC2131]. A DHCP server supporting this Option might or might not have the location of a client. If a server does not have a client's location, but needs to provide this Location URI Option to a client (for whatever reason), an LS is contacted. This server-to-LS transaction is not DHCP, therefore it is out of scope of this document. Note that this server-to-LS transaction could delay the DHCP messaging to the client. If the server fails to have location before it transmits its message to the client, location will not be part of that DHCP message. Any timers involved here are a matter of local configuration.

The dereference of a target's location URI would not involve DHCP, but an application layer protocol, such as SIP or HTTP, therefore

dereferencing is out of scope of this document.

In the case of residential gateways being DHCP servers, they usually perform as DHCP clients in a hierarchical fashion up into a service provider's network DHCP server(s), or learn what information to provide via DHCP to residential clients through a protocol, such as PPP. In these cases, the location URI would likely indicate the residence's civic address to all wired or wireless clients within that residence.

3.1 Architectural Assumptions

The following assumptions have been made for use of this LocationURI Option for a client to learn its location URI (in no particular order):

- o Any user control (what [RFC3693] calls a 'Ruleholder') for access to the dereferencing step is assumed to be out of scope of this document. An example authorization policy is in [RFC6772].

- o The authorization security model vs. possession security model discussion can be found in [RFC5606], describing what is expected

in each model of operation. It should be assumed that a location URI attained using DHCP will operate under an possession model by default. An authorization model can be instituted as a matter of local policy. An authorization model means possessing the location URI does not give that entity the right to view the PIDF-LO of the target whose location is indicated in a presence document. The dereference transaction will be challenged by the Location Server only in an authorization model. The nature of this challenge is out of scope of this document.

- o This document does not prevent some environments from operating in an authorization model, for example - in less tightly controlled networks. The costs associated with authorization vs. possession models are discussed in Section 3.3.2 of [RFC5606].

3.2 Harmful URIs and URLs

There are, in fact, some types of URIs that are not good to receive, due to security concerns. For example, any URLs that can have

scripts, such as "data:" URLs, and some "HTTP:" URLs that go to web pages that have scripts. Therefore,

o URIs received via this Option MUST NOT be automatically sent to a general-browser to connect to a web page, because they could have harmful scripts.

o This Option MUST NOT contain "data:" URLs, because they could contain harmful scripts.

o Section 3.3 IANA registers acceptable location URI schemes (or types) for use by this specification. Clients MUST reject URI schemes not currently registered in IANA.

3.3 Valid Location URI Schemes or Types

This section specifies which URI types are acceptable as a location URI scheme (or type) for this DHCP Option:

1. sip:
2. sips:
3. pres:
4. http:
5. https:

URIs using the "pres" scheme are dereferenced using the presence event package for SIP [RFC3856], so they will reference a PIDF-LO document when location is available. Responses to requests for URIs with other schemes ("sip", "sips", "http", and "https") MUST have MIME type 'application/pidf+xml'. Alternatively, HTTP and HTTPS URIs MAY refer to information with MIME type 'application/held+xml',

in order to support HELD dereferencing [RFC6753]. Clients can indicate which MIME types they support using the "Accept" header field in SIP [RFC3261] or HTTP [RFC2616].

See RFC 3922 [RFC3922] for using the "pres:" URI with XMPP.

It is RECOMMENDED that implementers follow Section 4.6 of RFC 6442 [RFC6442] as guidance regarding which Location URI schemes to provide in DHCP. That document discusses what a receiving entity does when receiving a URI scheme that is not understood. Awareness to the two URI types there is important for conveying location, if

SIP is used to convey a Location URI provided by DHCP.

4. IANA Considerations

4.1 The IPv4 Option number for the Location URI Option

This document IANA registers the Location URI IPv4 Option number XXX (to be assigned by IANA once this document becomes an RFC).

4.2 The IPv6 Option-Code for the Location URI Option

This document IANA registers the Location URI IPv6 Option-Code XXX (to be assigned by IANA once this document becomes an RFC).

4.3 The IPv4 Option number for the Valid-For Option

This document IANA registers the Valid-For IPv4 Option number XXX (to be assigned by IANA once this document becomes an RFC).

4.4 The IPv6 Option-Code for the Valid-For Option

This document IANA registers the Valid-For IPv6 Option-Code XXX (to be assigned by IANA once this document becomes an RFC).

5. Security Considerations

Where critical decisions might be based on the value of this location URI option, DHCP authentication as defined in "Authentication for DHCP Messages" [RFC3118] and "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)" [RFC3315] SHOULD be used to protect the integrity of the DHCP options.

A real concern with RFC 3118 or RFC 3315 is that neither is widely deployed because each requires pre-shared keys to successfully work (i.e., in the client and in the server). Most implementations do not accommodate this.

DHCP, initially, is a broadcast request (a client looking for a

server), and a unicast response (answer from a server) type of protocol. There is no privacy protection for DHCP messages, an eavesdropper who can monitor the link between the DHCP server and requesting client can discover the Location URI.

Once a client has a Location URI, it needs information on how the location server will control access to dereference requests. A client might treat a tightly access-controlled URI differently from one that can be dereferenced by anyone on the Internet (i.e., one following the "possession model"). Since the client does not know what policy will be applied during this validity interval, clients MUST handle location URIs as if they could be dereferenced by anybody until they expire. For example, such open location URIs should only be transmitted in encrypted channels. Nonetheless, location servers SHOULD apply appropriate access control policies, for example by limiting the number of queries that any given client can make, or limiting access to users within an enterprise.

Extensions to this option, such as [ID-POLICY-URI] can provide mechanisms for accessing and provisioning policy. Giving users access to policy information will allow them to make more informed decisions about how to use their location URIs. Allowing users to provide policy information to the LS will enable them to tailor access control policies to their needs (within the bounds of policy that the LS will accept).

As to the concerns about the location URI itself, as stated in the document (see Section 3), it MUST NOT have any user identifying information in the URI user-part/string itself. The location URI also needs to be hard to guess that it belongs to a specific user.

In some cases a DHCP server may be implemented across an uncontrolled network. In those cases, it would be appropriate for a network administrator to perform a threat analysis (see RFC 3552) and take precautions as needed.

Link-layer confidentiality and integrity protection may also be employed to reduce the risk of location disclosure and tampering.

6. Acknowledgements

Thanks to James Winterbottom, Marc Linsner, Roger Marshall and Robert Sparks for their useful comments. And to Lisa Dusseault for her concerns about the types of URIs that can cause harm. To Richard Barnes for inspiring a more robust Security Considerations section, and for offering the text to incorporate HTTP URIs. To Hannes Tschofenig and Ted Hardie for riding me to comply with their concerns, including a good scrubbing of the nearly final doc.

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