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The Dynamic Host Configuration Protocol for IPv6 (DHCPv6) Client Fully Qualified Domain Name (FQDN) Option

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Abstract

This document specifies a new Dynamic Host Configuration Protocol for IPv6 (DHCPv6) option that can be used to exchange information about a DHCPv6 client's Fully Qualified Domain Name (FQDN) and about responsibility for updating DNS resource records (RRs) related to the client's address assignments.

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1. Introduction

DNS ([2], [3]) maintains (among other things) the information about mapping between hosts' Fully Qualified Domain Names (FQDNs) [10] and IPv6 addresses assigned to the hosts. The information is maintained in two types of Resource Records (RRs): AAAA and PTR [12]. The DNS update specification [4] describes a mechanism that enables DNS information to be updated over a network.

The Dynamic Host Configuration Protocol for IPv6 (DHCPv6) [5] provides a mechanism by which a host (a DHCPv6 client) can acquire certain configuration information, along with its stateful IPv6 address(es). This document specifies a new DHCPv6 option, the Client FQDN option, which can be used by DHCPv6 clients and servers to exchange information about the client's fully qualified domain name and about who has the responsibility for updating the DNS with the associated AAAA and PTR RRs.

2. Terminology

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 [1].

Familiarity with the DNS Update protocol [4] and with DHCPv6 and its terminology, as defined in [5], is assumed.

3. Models of Operation

When a DHCPv6 client acquires an address, a site's administrator may desire that the AAAA RR for the client's FQDN and the PTR RR for the acquired address be updated. Therefore, two separate DNS update transactions may occur. Acquiring an address via DHCPv6 involves two entities: a DHCPv6 client and a DHCPv6 server. In principle, each of these entities could perform none, one, or both of the DNS update transactions. However, in practice, not all permutations make sense. The DHCPv6 Client FQDN option is primarily intended to operate in the following two cases:

1. DHCPv6 client updates the AAAA RR; DHCPv6 server updates the PTR RR.

2. DHCPv6 server updates both the AAAA and the PTR RRs.

The only difference between these two cases is whether the FQDN-to-IPv6-address mapping is updated by a DHCPv6 client or by a DHCPv6 server. The IPv6-address-to-FQDN mapping is updated by a DHCPv6 server in both cases.

The reason these two are important, while others are unlikely, has to do with authority over the respective DNS domain names. A DHCPv6 client may be given authority over mapping its own AAAA RRs, or that authority may be restricted to a server to prevent the client from listing arbitrary addresses or associating its addresses with arbitrary domain names. In all cases, the only reasonable place for the authority over the PTR RRs associated with the address is in the DHCPv6 server that allocates the address.

Note: A third case is supported in which the client requests that the server perform no updates. However, this case is presumed to be rare because of the authority issues.

In any case, whether a site permits all, some, or no DHCPv6 servers and clients to perform DNS updates into the zones that it controls is entirely a matter of local administrative policy. This document does not require any specific administrative policy and does not propose one. The range of possible policies is very broad, from sites where only the DHCPv6 servers have been given credentials that the DNS servers will accept, to sites where each individual DHCPv6 client has been configured with credentials that allow the client to modify its own domain name. Compliant implementations MAY support some or all of these possibilities. Furthermore, this specification applies only to DHCPv6 client and server processes: it does not apply to other processes that initiate DNS updates.

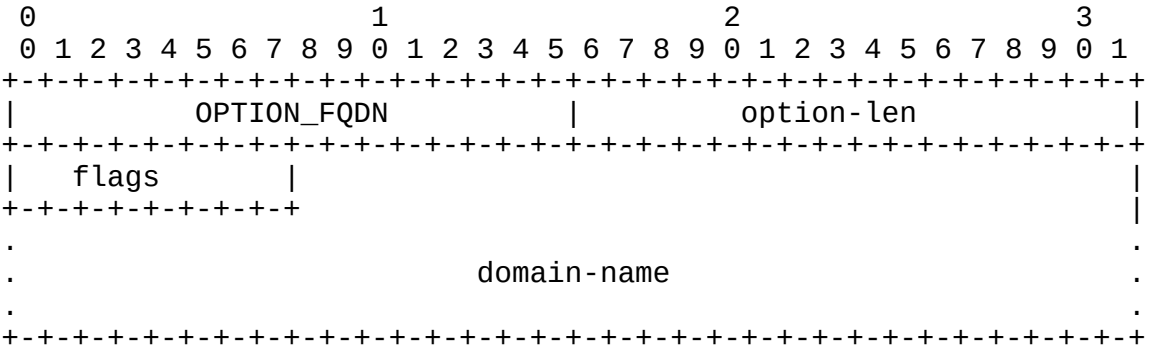
This document describes a new DHCPv6 option that a client can use to convey all or part of its domain name to a DHCPv6 server. Site-specific policy determines whether or not DHCPv6 servers use the names that clients offer, and what DHCPv6 servers do in cases where clients do not supply domain names.

4. The DHCPv6 Client FQDN Option

To update the IPv6-address-to-FQDN mapping, a DHCPv6 server needs to know the FQDN of the client for the addresses for the client's IA_NA bindings. To allow the client to convey its FQDN to the server, this document defines a new DHCPv6 option called "Client FQDN". The Client FQDN option also contains Flags that DHCPv6 clients and servers use to negotiate who does which updates.

The code for this option is 39. Its minimum length is 1 octet.

The format of the DHCPv6 Client FQDN option is shown below:

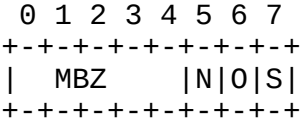


option-code	OPTION_CLIENT_FQDN (39)
option-len	1 + length of domain name
flags	flag bits used between client and server to negotiate who performs which updates
domain-name	the partial or fully qualified domain name (with length option-len - 1)

The Client FQDN option MUST only appear in a message's options field and applies to all addresses for all IA_NA bindings in the transaction.

4.1. The Flags Field

The format of the Flags field is:



The "S" bit indicates whether the server SHOULD or SHOULD NOT perform the AAAA RR (FQDN-to-address) DNS updates. A client sets the bit to 0 to indicate that the server SHOULD NOT perform the updates and 1 to indicate that the server SHOULD perform the updates. The state of the bit in the reply from the server indicates the action to be taken by the server; if it is 1, the server has taken responsibility for AAAA RR updates for the FQDN.

The "O" bit indicates whether the server has overridden the client's preference for the "S" bit. A client MUST set this bit to 0. A server MUST set this bit to 1 if the "S" bit in its reply to the client does not match the "S" bit received from the client.

The "N" bit indicates whether the server SHOULD NOT perform any DNS updates. A client sets this bit to 0 to request that the server SHOULD perform updates (the PTR RR and possibly the AAAA RR based on the "S" bit) or to 1 to request that the server SHOULD NOT perform any DNS updates. A server sets the "N" bit to indicate whether the server SHALL (0) or SHALL NOT (1) perform DNS updates. If the "N" bit is 1, the "S" bit MUST be 0.

The remaining bits in the Flags field are reserved for future assignment. DHCPv6 clients and servers that send the Client FQDN option MUST clear the MBZ bits, and they MUST ignore these bits.

4.2. The Domain Name Field

The Domain Name part of the option carries all or part of the FQDN of a DHCPv6 client. The data in the Domain Name field MUST be encoded as described in Section 8 of [5]. In order to determine whether the FQDN has changed between message exchanges, the client and server MUST NOT alter the Domain Name field contents unless the FQDN has actually changed.

A client MAY be configured with a fully qualified domain name or with a partial name that is not fully qualified. If a client knows only part of its name, it MAY send a name that is not fully qualified, indicating that it knows part of the name but does not necessarily know the zone in which the name is to be embedded.

To send a fully qualified domain name, the Domain Name field is set to the DNS-encoded domain name including the terminating zero-length label. To send a partial name, the Domain Name field is set to the DNS-encoded domain name without the terminating zero-length label.

A client MAY also leave the Domain Name field empty if it desires the server to provide a name.

Servers SHOULD send the complete fully qualified domain name in Client FQDN options.

5. DHCPv6 Client Behavior

The following describes the behavior of a DHCPv6 client that implements the Client FQDN option.

A client MUST only include the Client FQDN option in SOLICIT, REQUEST, RENEW, or REBIND messages.

A client that sends the Client FQDN option MUST also include the option in the Option Request option if it expects the server to include the Client FQDN option in any responses.

5.1. Client Desires to Update AAAA RRs

If a client that owns/maintains its own FQDN wants to be responsible for updating the FQDN-to-IPv6-address mapping for the FQDN and address(es) used by the client, the client MUST include the Client FQDN option in the SOLICIT with Rapid Commit, REQUEST, RENEW, and REBIND message originated by the client. A client MAY choose to include the Client FQDN option in its SOLICIT messages. The "S", "O", and "N" bits in the Flags field in the option MUST be 0.

Once the client's DHCPv6 configuration is completed (the client receives a REPLY message and successfully completes a final check on the parameters passed in the message), the client MAY originate an update for the AAAA RRs (associated with the client's FQDN) unless the server has set the "S" bit to 1. If the "S" is 1, the DHCPv6 client SHOULD NOT initiate an update for the name in the server's returned Client FQDN option Domain Name field. However, a DHCPv6 client that is explicitly configured with a FQDN MAY ignore the state of the "S" bit if the server's returned name matches the client's configured name.

5.2. Client Desires Server to Do DNS Updates

A client can choose to delegate the responsibility for updating the FQDN-to-IPv6-address mapping for the FQDN and address(es) used by the client to the server. In order to inform the server of this choice, the client SHOULD include the Client FQDN option in its SOLICIT with Rapid Commit, REQUEST, RENEW, and REBIND messages and MAY include the Client FQDN option in its SOLICIT. The "S" bit in the Flags field in the option MUST be 1, and the "O" and "N" bits MUST be 0.

5.3. Client Desires No Server DNS Updates

A client can choose to request that the server perform no DNS updates on its behalf. In order to inform the server of this choice, the client SHOULD include the Client FQDN option in its SOLICIT with

Rapid Commit, REQUEST, RENEW, and REBIND messages and MAY include the Client FQDN option in its SOLICIT. The "N" bit in the Flags field in the option MUST be 1, and the "S" and "O" bits MUST be 0.

Once the client's DHCPv6 configuration is completed (the client receives a REPLY message and successfully completes a final check on the parameters passed in the message), the client MAY originate its DNS updates provided the server's "N" bit is 1. If the server's "N" bit is 0, the server MAY perform the PTR RR updates; it MAY also perform the AAAA RR updates if the "S" bit is 1.

5.4. Domain Name and DNS Update Issues

As there is a possibility that the DHCPv6 server is configured to complete or replace a domain name that the client sends, the client MAY find it useful to send the Client FQDN option in its SOLICIT messages. If the DHCPv6 server returns different Domain Name data in its ADVERTISE message, the client could use that data in performing its own eventual AAAA RR update, or in forming the Client FQDN option that it sends in its subsequent messages. There is no requirement that the client send identical Client FQDN option data in its SOLICIT, REQUEST, RENEW, or REBIND messages. In particular, if a client has sent the Client FQDN option to its server, and the configuration of the client changes so that its notion of its domain name changes, it MAY send the new name data in a Client FQDN option when it communicates with the server again. This MAY cause the DHCPv6 server to update the name associated with the PTR records and, if the server updated the AAAA record representing the client, to delete that record and attempt an update for the client's current domain name.

A client that delegates the responsibility for updating the FQDN-to-IPv6-address mapping to a server will not receive any indication (either positive or negative) from the server as to whether the server was able to perform the update. The client MAY use a DNS query to check whether the mapping is up to date. However, depending on the load on the DHCPv6 and DNS servers and the DNS propagation delays, the client can only infer success. If the information is not found to be up to date in DNS, the authoritative servers might not have completed the updates or zone transfers, or caching resolvers may yet have updated their caches.

If a client releases an address prior to the expiration of the valid lifetime and the client is responsible for updating its AAAA RR, the client SHOULD delete the AAAA RR associated with the address before sending a RELEASE message. Similarly, if a client is responsible for updating its AAAA RRs, but is unable to renew the lifetimes for an address, the client SHOULD attempt to delete the AAAA RR before the

lifetime on the address is no longer valid. A DHCPv6 client that has not been able to delete an AAAA RR that it added SHOULD attempt to notify its administrator, perhaps by emitting a log message.

A client SHOULD NOT perform DNS updates to AAAA RRs for its non-Global Unicast addresses [7] or temporary addresses [6].

6. DHCPv6 Server Behavior

The following describes the behavior of a DHCPv6 server that implements the Client FQDN option when the client's message includes the Client FQDN option.

Servers MUST only include a Client FQDN option in ADVERTISE and REPLY messages if the client included a Client FQDN option and the Client FQDN option is requested by the Option Request option in the client's message to which the server is responding.

The server examines its configuration and the Flag bits in the client's Client FQDN option to determine how to respond:

- The server sets to 0 the "S", "O", and "N" bits in its copy of the option it will return to the client.
- If the client's "N" bit is 1 and the server's configuration allows it to honor the client's request for no server-initiated DNS updates, the server sets the "N" bit to 1.
- Otherwise, if the client's "S" bit is 1 and the server's configuration allows it to honor the client's request for the server to initiate AAAA RR DNS updates, the server sets the "S" to 1. If the server's "S" bit does not match the client's "S" bit, the server sets the "O" bit to 1.

The server MAY be configured to use the name supplied in the client's Client FQDN option, or it MAY be configured to modify the supplied name or to substitute a different name. The server SHOULD send its notion of the complete FQDN for the client in the Domain Name field. The server MAY simply copy the Domain Name field from the Client FQDN option that the client sent to the server.

6.1. When to Perform DNS Updates

The server SHOULD NOT perform any DNS updates if the "N" bit is 1 in the Flags field of the Client FQDN option in the REPLY messages (to be) sent to the client. However, the server SHOULD delete any RRs that it previously added via DNS updates for the client.

The server MAY perform the PTR RR DNS update (unless the "N" bit is 1).

The server MAY perform the AAAA RR DNS update if the "S" bit is 1 in the Flags field of the Client FQDN option in the REPLY message (to be) sent to the client.

The server MAY perform these updates even if the client's message did not carry the Client FQDN option. The server MUST NOT initiate DNS updates when responding with an ADVERTISE message to the client.

The server MAY complete its DNS updates (PTR RR or PTR and AAAA RR) before or after sending the REPLY message to the client.

If the server's AAAA RR DNS update does not complete until after the server has replied to the DHCPv6 client, the server's interaction with the DNS server MAY cause the DHCPv6 server to change the domain name that it associates with the client. This can occur, for example, if the server detects and resolves a domain-name conflict [8]. In such cases, the domain name that the server returns to the DHCPv6 client would change between two DHCPv6 exchanges.

If the server previously performed DNS updates for the client and the client's information has not changed, the server MAY skip performing additional DNS updates.

When a server receives a RELEASE or DECLINE for an address, detects that the valid lifetime on an address that the server bound to a client has expired, or terminates a binding on an address prior to the binding's expiration time (for instance, by sending a REPLY with a zero valid lifetime for an address), the server SHOULD delete any PTR RR that it associated with the address via DNS update. In addition, if the server took responsibility for AAAA RRs, the server SHOULD also delete the AAAA RR.

7. DNS RR TTLs

RRs associated with DHCP clients may be more volatile than statically configured RRs. DHCP clients and servers that perform dynamic updates should attempt to specify resource record TTLs that reflect this volatility, in order to minimize the possibility that answers to DNS queries will return records that refer to DHCP IP address assignments that have expired or been released.

The coupling among primary, secondary, and caching DNS servers is 'loose'; that is a fundamental part of the design of the DNS. This looseness makes it impossible to prevent all possible situations in which a resolver may return a record reflecting a DHCP-assigned IP

address that has expired or been released. In deployment, this rarely, if ever, represents a significant problem. Most DHCP-managed clients are infrequently looked up by name in the DNS, and the deployment of IXFR [13] and NOTIFY [14] can reduce the latency between updates and their visibility at secondary servers.

We suggest these basic guidelines for implementers. In general, the TTLs for RRs added as a result of DHCP IP address assignment activity SHOULD be less than the initial lifetime. The RR TTL on a DNS record added SHOULD NOT exceed 1/3 of the lifetime, but SHOULD NOT be less than 10 minutes. We recognize that individual administrators will have varying requirements: DHCP servers and clients SHOULD allow administrators to configure TTLs and upper and lower bounds on the TTL values, either as an absolute time interval or as a percentage of the lease lifetime.

While clients and servers MAY update the TTL of the records as the lifetime is about to expire, there is no requirement that they do so as this puts additional load on the DNS system with likely little benefit.

8. DNS Update Conflicts

This document does not resolve how a DHCPv6 client or server prevent name conflicts. This document addresses only how a DHCPv6 client and server negotiate the fully qualified domain name and who will perform the DNS updates.

Implementers of this work will need to consider how name conflicts will be prevented. If a DNS updater needs a security token in order to successfully perform DNS updates on a specific name, name conflicts can only occur if multiple updaters are given a security token for that name. Or, if the fully qualified domains are based on the specific address bound to a client, conflicts will not occur. Or, a name conflict resolution technique as described in "Resolving Name Conflicts" [8]) SHOULD be used.

9. IANA Considerations

The IANA has assigned DHCPv6 option code 39 for the Client FQDN option.

10. Security Considerations

Unauthenticated updates to the DNS can lead to tremendous confusion, through malicious attack or through inadvertent misconfiguration. Administrators need to be wary of permitting unsecured DNS updates to zones that are exposed to the global Internet. Both DHCPv6 clients and servers SHOULD use some form of update request origin authentication procedure (e.g., Secure DNS Dynamic Update [11]) when performing DNS updates.

Whether a DHCPv6 client is responsible for updating an FQDN-to-IPv6-address mapping or whether this is the responsibility of the DHCPv6 server is a site-local matter. The choice between the two alternatives is likely based on the security model that is used with the DNS update protocol (e.g., only a client may have sufficient credentials to perform updates to the FQDN-to-IPv6-address mapping for its FQDN).

Whether a DHCPv6 server is always responsible for updating the FQDN-to-IPv6-address mapping (in addition to updating the IPv6-to-FQDN mapping), regardless of the wishes of an individual DHCPv6 client, is also a site-local matter. The choice between the two alternatives is likely based on the security model that is being used with DNS updates. In cases where a DHCPv6 server is performing DNS updates on behalf of a client, the DHCPv6 server SHOULD be sure of the DNS name to use for the client, and of the identity of the client.

Depending on the presence of or type of authentication used with the Authentication option, a DHCPv6 server may not have much confidence in the identities of its clients. There are many ways for a DHCPv6 server to develop a DNS name to use for a client, but only in certain circumstances will the DHCPv6 server know for certain the identity of the client.

It is critical to implement proper conflict resolution, and the security considerations of conflict resolution apply [8].

11. Acknowledgements

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