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ALTO Server Discovery Protocol
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Abstract

The goal of Application-Layer Traffic Optimization (ALTO) is to provide guidance to applications, which have to select one or several hosts from a set of candidates that are able to provide a desired resource.

Entities seeking guidance need to discover and possibly select an ALTO server to ask. This is called ALTO server discovery. This memo describes an ALTO server discovery mechanism based on several alternative mechanisms that are applicable in a diverse set of ALTO deployments.

Status of this Memo

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1. Introduction

The goal of Application-Layer Traffic Optimization (ALTO) is to provide guidance to applications, which have to select one or several hosts from a set of candidates, that are able to provide a desired resource [RFC5693]. The requirements for ALTO are itemized in [I-D.ietf-alto-reqs]. ALTO is realized by a client-server protocol. ALTO clients send queries to ALTO servers, in order to solicit guidance.

ALTO clients have to discover suitable ALTO servers. Therefore the output of the herein defined ALTO discovery procedure tells the ALTO client which ALTO servers to send the queries to. The ALTO discovery procedure, as part of the the ALTO client, can be embedded in the resource consumer, which will eventually access the desired resource. As an alternative, they can be embedded in a resource directory, which assists resource consumers in finding appropriate resource providers. In some specific peer-to-peer application protocols these resource directories are called "trackers". Finally the ALTO server discovery procedure can be embedded in the resource consumer, whereas the ALTO client is embedded in the resource directory. ALTO queries, which are issued by a resource directory on behalf of a resource consumer, are referred to as third-party ALTO queries. The various possibilities to place ALTO servers and the placement of ALTO clients is discussed in [I-D.stiemerling-alto-deployments]. [I-D.song-alto-server-discovery] compares different protocol options and identifies DHCP and DNS as two approaches for the ALTO server discovery without detailing on the exact solution.

No matter where ALTO server and client are located, clients have to first find out if there is an ALTO server deployed that is in charge for them, and second they have to get the contact information of that server, i.e., the IP address, port number, and probably transport protocol (which defaults to TCP for [I-D.ietf-alto-protocol]).

The goal of this memo is to propose a uniform mechanism for all types of ALTO client deployments that is implementable and deployable at a fast pace, i.e., without creating other deployment dependecies for ALTO. We propose to use a combination of DHCP and DNS to retrieve the URL of the resposnsible ALTO server.

Comments and discussions about this memo should be directed to the ALTO working group: alto@ietf.org.

1.1. Requirements

There is other related works on server discovery, for instance GEOPRIV has rather strong security requirements (for good reasons),

which are documented in [I-D.ietf-geopriv-lis-discovery]. However, these requirements do not apply for the ALTO server discovery, as ALTO as such has very different requirements (see [I-D.ietf-alto-reqs]).

The result of the guidance provided to the application via the ALTO protocol is input to improve the initial peer selection process for peer-to-peer applications, or any other application applicable. A missing ALTO server, i.e., no result returned as part of the ALTO server discovery procedure, does not prevent the application to operate. A wrong or forged guidance from the ALTO server may only impact the overall operational result of the peer-to-peer system for a limited time, as these systems fine-tune their behavior depending on the experience network behavior.

This means that a wrong, missing, or forged ALTO guidance will not cause damage to the application or peer-to-peer system. This is in sharp contrast to the GEOPRIV use case, where a failure may have severe impact, including loss of human life. This is not the case for ALTO, as it is intended to be used today and as it is explored right now from the networking community.

1.2. Pre-Conditions

The whole document assumes certain pre-conditions, such as:

- The ALTO server discovery procedure is executed on a per IP address base. Multiple IP addresses per interface or multiple IP addresses assigned to different IP interfaces require to repeat the procedure for every IP address. It may be fine to group IP addresses according their domain suffixes and to perfom the procedure for such a group. However, this is out of scope of this document.

- The ALTO server discovery procedure is executed on a per IP family base, i.e., seperate for IPv4 and IPv6. It is up to the ALTO client to decide which of the possible multiple results of different IP address families to use. The choice of whether to use IPv4 or IPv6 is out of scope of this document.

- A change of the IP address at an interface invalidates the result of the ALTO server discovery procedure. For instance, if the IP address assigned to a mobile host changes due to host mobility, it is required to run the ALTO server discovery procedure for the new IP address without relying on earlier gained information.

2. Protocol Overview

We define multiple alternatives to discover the IP address of the ALTO server, as there are a number of ways possible how such information can be provided to the ALTO client. The choice of method is up to the local network deployment. For instance, there can be deployments where the ALTO server in charge for ALTO client is provisioned by the network operator and communicated to the ALTO client's host via a DHCP option, while in other deployments no such means may exist.

The following figure illustrates the different protocols that are used to find the URI of a suitable ALTO server.

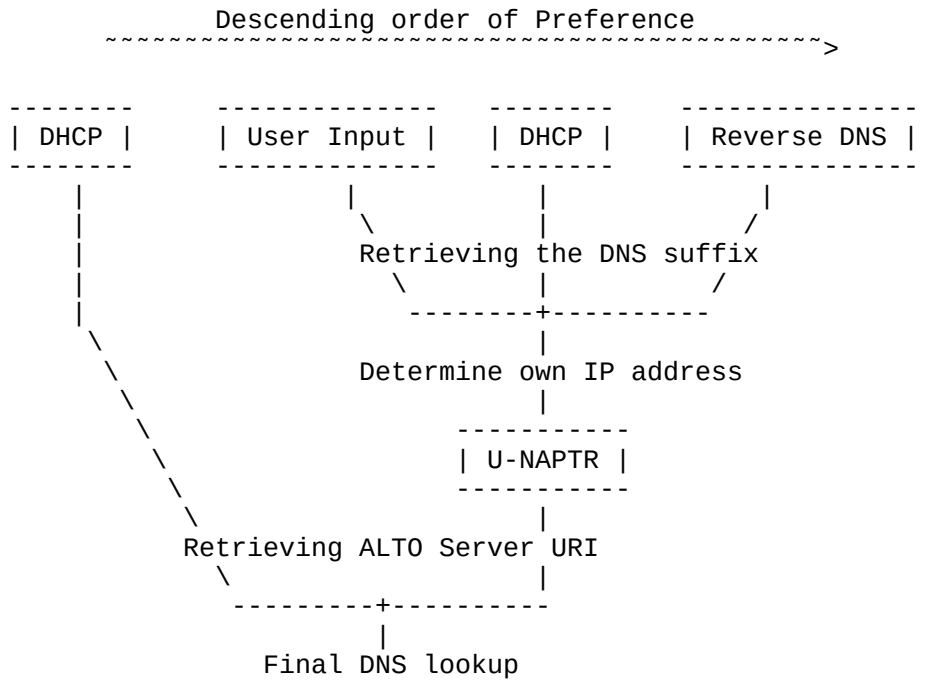

Figure 1: Protocol Overview

One option to retrieve the URI directly from the access network provider is DHCP. However for DHCP there are problems with residential gateways or broadband routers with NAT. If the network operator gives information about ALTO serves to the residential gateway via DHCP, the residential gateway would have to forward this information to the hosts with the (P2P) applications within the local network. This is not supported by already deployed residential gateways. Also DHCP poorly supports third-party ALTO server

discovery, i.e., in scenarios where the ALTO client is co-located with a resource directory ("tracker"), which is located in a different administrative domain than the client which will eventually access the ressource.

Thus in deployment scenarios where DHCP is not possible, we specify a U-NAPTR based resolution process as a second option to retrieve the URL. As a precondition for resolution the U-NAPTR process needs the right domain name as input. This domain name is determined by the IP address of the client and the DNS suffix of the access network where the client is registered in. In order to retrieve the DNS suffix we specify three options:

User input: a user may manually specify the DNS suffix on its own, either to access a 3rd party ALTO service provider or as it does know such information.

DHCP: a network provider provides the DNS suffix through a DHCP option.

Reverse DNS: the DNS system can be used to retrieve the DNS suffix through reverse lookup of an FQDN associated with an IP address. This is the last resort if all other options failed.

3. Retrieving the URI by DHCP

One way of directly configuring the ALTO server URI for an access network provider is the DHCP protocol. The ALTO server URI consists of a domain name and the protocol the client should use to contact the server. While the domain name can vary and is configured by DHCP, the protocol is always HTTP.

For example a client may retrieve the domain name altoserver.example.com by the DHCP option as described in the remaining section. The client uses this domain name to contact the ALTO server under

http://altoserver.example.com/

3.1. ALTO Server Domain Name Encoding

This section describes the encoding of the domain name used in the DHCPv4 option shown in Section 3.2 and also used in the DHCPv6 option shown in Section 3.3.

The domain name is encoded according to Section 3.1 of [RFC1035] whereby each label is represented as a one-octet length field followed by that number of octets. Since every domain name ends with the null label of the root, a domain name is terminated by a length byte of zero. The high-order two bits of every length octet MUST be zero, and the remaining six bits of the length field limit the label to 63 octets or less. To simplify implementations, the total length of a domain name (i.e., label octets and label length octets) is restricted to 255 octets or less.

3.2. ALTO Server DHCPv4 Option

The ALTO server DHCPv4 option carries a DNS ([RFC1035]) fully-qualified domain name (FQDN) to be used by the ALTO client to locate a ALTO server.

The DHCP option for this encoding has the following format:

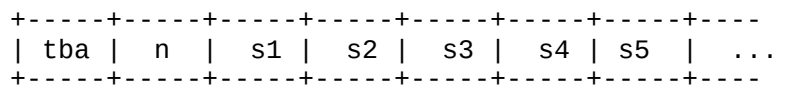

Figure 2: ALTO FQDN DHCPv4 Option

The values s1, s2, s3, etc. represent the domain name labels in the domain name encoding. Note that the length field in the DHCPv4

option represents the length of the entire domain name encoding, whereas the length fields in the domain name encoding (see Section 3.1) is the length of a single domain name label.

Code: to be assigned by IANA

Len: Length of the 'ALTO Server Domain Name' field in octets; variable.

ALTO Server Domain Name: The domain name of the ALTO server for the client to use.

A DHCPv4 client MAY request a ALTO server domain name in a Parameter Request List option, as described in [RFC2131].

The encoding of the domain name is described in Section 3.1.

This option contains a single domain name and, as such, MUST contain precisely one root label.

3.3. ALTO Server DHCPv6 Option

This section specifies the DHCP option for IPv6 (DHCPv6) to carry the domain name of the ALTO server. It is similar formatted to the DHCPv4 option

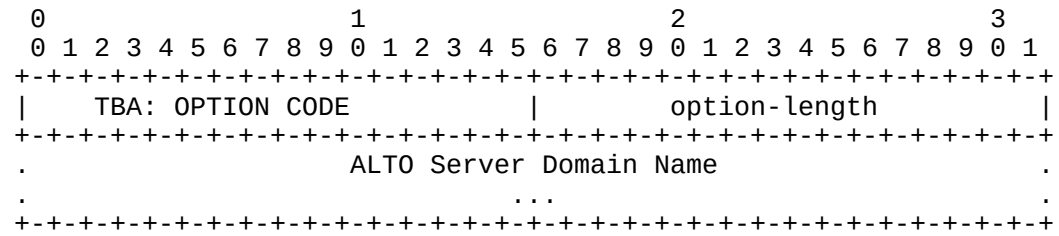

Figure 3: ALTO Server Domain Name DHCPv4 Option

option-code: to be assigned by IANA

option-length: The length of the 'ALTO Server Domain Name' field in octets; variable.

ALTO Server Domain Name: The domain name of the ALTO server for the client to use.

A DHCPv6 client MAY request a ALTO server domain name in an Options Request Option (ORO), as described in [RFC3315].

The encoding of the domain name is described in Section 3.1.

This option contains a single domain name and, as such, MUST contain precisely one root label.

4. Retrieving the URI by U-NAPTR

As already described a direct DHCP configuration may not always be possible, for example due to deployment restrictions of the access network. Alternatively the ALTO server URI can be discovered by a U-NAPTR resolution process, as specified in this section.

The section is devided in two parts: Section 4.1 describes the U-NAPTR resolution process itself. As a precondition this process requires the domain name of the access network where the resouce consumer is registered in. How the client identifies this DNS suffix is described in Section 4.2.

4.1. U-NAPTR Resolution

ALTO servers are identified by U-NAPTR/DDDS (URI-Enabled NAPTR/ Dynamic Delegation Discovery Service) [RFC4848] application unique strings, in the form of a DNS name. An example is 'altoserver.example.com'.

Clients need to use the U-NAPTR [RFC4848] specification described below to obtain a URI (indicating host and protocol) for the applicable ALTO service. In this document, only the HTTP and HTTPS URL schemes are defined. Note that the HTTP URL can be any valid HTTP URL, including those containing path elements.

The following two DNS entries show the U-NAPTR resolution for "example.com" to the HTTPS URL https://altoserver.example.com/secure or the HTTP URL http://altoserver.example.com, with the former being preferred.

```
example.com.

IN NAPTR 100  10   "u"    "ALTO:https"
     "!.*!https://altoserver.example.com/secure!"  ""

IN NAPTR 200  10   "u"    "ALTO:http"
     "!.*!http://altoserver.example.com!"  ""
```

4.2. Retrieving the Domain Name

The U-NAPTR resolution process requires a domain name as input. The algorithm that is applied to determine this domain name is described in this section. We specify three different options. In option 1 the user manually configures a specific ALTO service instance that he wants to use. Option 2 defines a DHCP option to allow the network service provider a remote configuration of the client. In option 3

the client tries to get the domain name by performing a reverse DNS lookup on its IP address.

The resource consumer may have private IP addresses and public IP addresses and depending on the deployment it might be necessary to determine for all IP addresses the ALTO server in charge of. To determine its public IP address the resource consumer may need to use STUN[RFC5389] or BEP24[bep24]. For the following examples we assume that the IP address of the resource consumer is a.b.c.d.

4.2.1. Option 1: User input

A user may want to use a third party ALTO service instance. Therefore we allow the user to specify a DNS suffix on its own, for example in a config file option. The DNS suffix given by the user is combined with the IP address of the resource consumer to allow the third party ALTO service to direct the client to a suitable ALTO server based on the location of the client. A possible DNS suffix entered by the user may be:

myaltoprovider.org

This DNS suffix is prepended with the IP address of the resource consumer in reverse order to compose the domain name used for the final U-NAPTR lookup Section 4.1. In case there are multiple ALTO servers deployed, the third party ALTO service instance can direct the ALTO client to the ALTO server closest to the client based on the IP address.

Multiple lookups with different domain names might be necessary to complete the U-NAPTR resolution process. If there is no response for a lookup the domain name is shortened by one part for the succeeding lookup, until a lookup is successful, as for example

d.c.b.a.myaltoprovider.org.

c.b.a.myaltoprovider.org.

b.a.myaltoprovider.org.

a.myaltoprovider.org.

myaltoprovider.org.

4.2.2. Option 2: DHCP

As a second option network operators can configure the domain name to be used for service discovery within an access network. RFC 5986[RFC5986] defines DHCP IPv4 and IPv6 access network domain name options that identify a domain name that is suitable for service discovery within the access network. The ALTO server discovery procedure uses these DHCP options to retrieve the domain name as an input for the U-NAPTR resolution. One example could be:

example.com

4.2.3. Option 3: Reverse DNS Lookup

The last option to get the domain name is to use a DNS PTR query for the IP address of the resource consumer. The local DNS server resolves the IP address to the FQDN that also contains the DNS suffix for the respective IP address. A possible answer for a PTR lookup for d.c.b.a.in-addr.apra might be, for example:

d-c-b-a.dsl.westcoast.myisp.net

This domain name can be used for the final U-NAPTR lookup Section 4.1. Again, if there is no response to the lookup the domain name is shortened by one part for the succeeding lookup. The domain names used for the example as described above are:

d-c-b-a.dsl.westcoast.myisp.net.

dsl.westcoast.myisp.net.

westcoast.myisp.net.

myisp.net.

5. Applicability

This section discusses the applicability of the proposed solution with respect to the resource consumer server discovery and the third party deployment scenarios. Each section discusses the proposed steps that are needed to determine the ALTO Server URI.

5.1. Applicability for Resource Consumer Server Discovery

In this scenario the ALTO server discovery procedure is performed by the resource consumer, for example a peer in a P2P system. After the discovery the peer does the ALTO query on its own, or it might share the ALTO server contact information with a third party, for example a tracker, which then does the ALTO query on behalf of the peer.

The access network provider has two options based on DHCP to remotely configure the ALTO client to use its ALTO server. The first option is to provide the ALTO server URI directly by a DHCP option as described in Section 3, the second option is to provide the access network domain name as described in Section 4.2.2. It is up to the access network provider to choose one of both options.

To complete the ALTO server discovery process the resource consumer first SHOULD try to retrieve the ALTO server URI by the DHCP option as described in Section 3. In case this is successful the discovery process is finished, in case it fails, either as the access network provider has not configured the specified option or through deployment restrictions, the resource consumer SHOULD subsequently check whether the user has provider the domain name through manual configuration. If this is also not the case the next step SHOULD be to check for the access network domain name DHCP option (Section 4.2.2). Finally the client SHOULD try to retrieve the domain name by the last option, the DNS reverse lookup on its IP address as described in Section 4.2.3.

In case the ALTO discovery client has determined the domain name through one of the described options it proceedes with the U-NAPTR lookup as described in Section 4.1.

If the ALTO server URI could not be retrieved either through direct configuration by the access network provider through DHCP nor through the U-NAPTR lookup the discovery process fails.

5.2. Applicability for Third Party Server Discovery

In case of the third party server discovery deployment scenario the entity performing the ALTO server discovery process is different from the resource consumer. Typically the resource consumer is a peer

whereas the ALTO client is a resource directory which seeks for ALTO guidance on behalf of the peer. Another use case for the third party discovery is an application that looks for ALTO guidance transparently for the resource consumer, for example a CDN.

Here the ALTO server discovery process can also retrieve guidance through one of the DHCP options or manual user configuration, but only if the provided discovery information is forwarded by the resource consumer to the third party entity. In this case, additional mechanisms for the forwarding of this discovery information need to be specified. However these mechanisms are out of scope of this doument.

If the third party entity cannot obtain this discovery information, the ALTO server discovery process relies on retrieving the domain name used as input to the U-NAPTR lookup through reverse DNS lookup of the IP address of the resource consumer as described in Section 4.2.3. Usually the third party entity already knows the IP address of the resource consumer which was used to establish the initial connection. In general this IP address is a public address, either of the resource consumer or of the last NAT on the path to the ALTO client. This makes the IP address a good candidate for the DNS PTR query. Thus, we expect that the DNS query will be successfully resolved to the FQDN of the domain where the resource consumer is registered in.

In case the resource consumer needs guidance for a different IP address, for example one from a private network, we recommend that the resource consumer discovers the server itself and forwards the ALTO server contact information directly to the third party entity, which in turn can then do the third party ALTO query. Again, forwarding the contact information from the resource consumer to the third party entity is out of scope of this document.

6. IANA Considerations

This document registers the following U-NAPTR application service tag:

Application Service Tag: ALTO

Defining Publication: The specification contained within this document.

This document registers the following U-NAPTR application protocol tags:

- Application Protocol Tag: http

  Defining Publication: RFC 2616 [RFC2616]

- Application Protocol Tag: https

  Defining Publication: RFC 2818 [RFC2818]

7. Security Considerations

7.1. General

This is still to be done in later revision of this draft, as the draft evolves heavily right now.

7.2. For U-NAPTR

The address of an ALTO server is usually well-known within an access network; therefore, interception of messages does not introduce any specific concerns.

The primary attack against the methods described in this document is one that would lead to impersonation of a ALTO server since a device does not necessarily have a prior relationship with a ALTO server.

An attacker could attempt to compromise ALTO discovery at any of three stages:

1. providing a falsified domain name to be used as input to U-NAPTR

2. altering the DNS records used in U-NAPTR resolution

3. impersonation of the ALTO

This document focuses on the U-NAPTR resolution process and hence this section discusses the security considerations related to the DNS handling. The security aspects of obtaining the domain name that is used for input to the U-NAPTR process is described in respective documents, such as [I-D.ietf-geopriv-lis-discovery].

The domain name that is used to authenticated the ALTO server is the domain name in the URI that is the result of the U-NAPTR resolution. Therefore, if an attacker were able to modify or spoof any of the DNS records used in the DDDS resolution, this URI could be replaced by an invalid URI. The application of DNS security (DNSSEC) [RFC4033] provides a means to limit attacks that rely on modification of the DNS records used in U-NAPTR resolution. Security considerations specific to U-NAPTR are described in more detail in [RFC4848].

An "https:" URI is authenticated using the method described in Section 3.1 of [RFC2818]. The domain name used for this authentication is the domain name in the URI resulting from U-NAPTR resolution, not the input domain name as in [RFC3958]. Using the domain name in the URI is more compatible with existing HTTP client software, which authenticate servers based on the domain name in the URI.

An ALTO server that is identified by an "http:" URI cannot be authenticated. If an "http:" URI is the product of the ALTO discovery, this leaves devices vulnerable to several attacks. Lower layer protections, such as layer 2 traffic separation might be used to provide some guarantees.

8. Open Issues

Here are a few open issues to be clarified:

Handling of reverse DNS lookups for IPv6: Refer to [RFC4472] for a discussion about the issues.

Missing reverse DNS entries for an IP address: There may be cases where the reverse DNS lookup does not yield any result. However, this will leave the ALTO client with no choice, other than giving up. This needs better documentation.

How to handled multiple results: For instance, a host behind a NAT that yields an ALTO server in the private IP address domain and one in the public IP address domain. Whom to ask?

Suffix Issues Document issues with suffix information provided by DHCP or by other means. For instance, a host behind a NAT may have a configured DNS suffix ".local". This suffix is not usuable for the server discovery procedure.

9. Conclusion

This document describes a general ALTO server discovery process and discusses how the process can be applied in different deployment scenarios, including the resouce consumer discovery as well as the third party discovery.

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Appendix A. Acknowledgments

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