Flow-based Cost Query

draft-gao-alto-fcs-06

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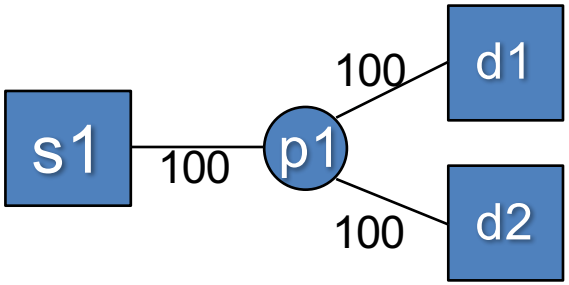
Updates: Overview

- Changes since -05 revision:
  - Major updates
    - Added flow-specific information announcement in the flow-based filter.
    - Introduced transmission-type="multicast" as a supported flow-specific information announcement.
  - Minor updates
    - Revised examples to better illustrate new features.
    - Renamed the address type "Domain Name" to "Internet Domain Name" to distinguish it with the "Domain Name" in the draft-ietf-alto-unified-props-new.

New Requirements

- Some novel network traffic optimization frameworks may involve multicast flows to improve the throughput. Previous revision (-05 and before) can only support the query for unicast flows.
- Unicast flows query may conduct inaccurate result in some cases:



If request availbw for unicast flows:
f1 (s1 -> d1): [ane1, ane2]
f2 (s1 -> d2): [ane1, ane3]
ane1.availbw = 100
ane2.availbw = 100
ane3.availbw = 100

f1.bw + f2.bw <= 100

If request availbw for multicast flows:
f0 (s1 -> p1): [ane1]
f1 (p1 -> d1): [ane2]
f2 (p1 -> d2): [ane3]
ane1.availbw = 100
ane2.availbw = 100
ane3.availbw = 100

f0.bw, f1.bw, f2.bw <= 100

- Additional Requirement: The ALTO server SHOULD allow the ALTO client to specify different data transmission types (unicast/multicast) for transmissions in the query space.

Flow-Specific Announcement

- This document proposes a general solution to query flows:
  - Extended Endpoint Address (ipv4/ipv6 -> eth, tcp, udp, …)
  - Flow-based Filter (cross-product -> arbitrary end-to-end pairs)
  - Flow-specific Announcement (non-endpoint attributes)
- Extended Input Parameters:

```
object {
  ...
  [EndpointFilter    endpoints;]
  [ExtEndpointFilter endpoint-flows<1..*>;]
} ReqEndpointCostMap;

object {
  [JSONObject flow-spec-announce;]
} ExtEndpointFilter : EndpiontFilter;
```

- "flow-spec-announce" is used to specify all non-endpoint attributes for flows.

How Does it Address Multicast Query

- First-step solution: Introduce "transmission-type" in "flow-spec-announce".

```
{ "srcs": ["tcp6:203.0.113.45:54321"],
  "dsts": ["tcp6:group1.example.com:21"],
  "flow-spec-announce": {
    "transmission-type": "multicast" } }
```

- The ALTO server will interpret the destination addresses as multicast groups, and then expose all flows to the multicast targets:

```
"endpoint-cost-map": {
  "tcp6:203.0.113.45:54321": {
    "tcp6:group1.example.com:21": [ "ane:S2", "ane:D3" ] },
  "tcp6:group1.example.com:21": {
    "tcp6:[fe80::40e:9594:da3d:34b]:21": [ "ane:G1" ],
    "tcp6:[fe80::826:daff:feb8:1bb]:21": [ "ane:G2" ] } }
```

Open Discussions

- Response for different flows between same endpoints.
  - Extend the response format without changing the request format
- Difficulty to implement it in real systems.

Next Steps

- Check more use cases for flow-based query.
- Implement it and show some experimental results by next meeting.
- WG item?

Backup Slides

Review Flow-based Query Design

General Requirements on ALTO for the Unified Interface:

- **More flexible input**: Target of **FCS**
- **More flexible output**: Target of Path Vector, Unified Property, Multi-Cost (RFC8189), Cost Calendar

Requirements on the Input Flexibility:

- **#1** More flexible shape of query space
- **#2** More expressive encoding of query entry

Basic Proposal of FCS:

- Arbitrary end-to-end query
- Expressive endpoint address
- Extensible flow description and arbitrary flow query

Remaining Issues

- Q1: How to achieve a unified query model?
  - We have two design options for the query model:
    - Partial mesh src-dst pairs
    - Extensible header space set

- Q2: How to resolve the flow attribute conflicts?
  - A flow definition may be invalid: A TCP socket source address cannot establish a valid connection with a UDP socket destination address.
  - Allow the server to notify this invalidity to the client as early as possible.

Q1: Unified Query Model

Design Option	Partial Mesh Src-Dst Pairs (Current Option)	Extensible Header Space Set (Another Option)
Example	`[{"srcs": [addr1], "dsts": [addr3, addr4]}, {"srcs": [addr2], "dsts": [addr3, addr5]}]`	`{"f1": {"ipv4:destination": v1, "ethernet:vlan-id": v2}, "f2": {"ipv4:destination": v3, "ipv4:source": v4}, "f3": {"ipv4:destination": v5, "ipv4:source": v6, "ethernet:vlan-id": v7}}`
Compatibility	Response can be compatible	Incompatible
Request Size	Can be reduced	Cannot be reduced
Extensibility	Can introduce new endpoint address types	Can introduce new flow attributes
Flexibility	Cannot request non-endpoint flow attributes	Can support arbitrary flow attributes
Complexity	Validation is simple (Only need to check source and destination)	Validation is complex (Need to check every shown attributes)

Comparison between two design options

New Registered Address Types

Address Type	Encoding	Semantics	Potential Use Cases
eth	MAC Address (EUI-48 or EUI-64)	The ethernet address	Layer2 flows between inter DCNs
domain	Domain Name (RFC2181)	Can be resolved by an A record	CDN
domain6		Can be resolved by an AAAA record	
tcp	IPv4 Socket Address	The client/server address of a tcp socket with an IPv4 address	Flow-level scheduling
udp		The client/server address of a udp socket with an IPv4 address	
tcp6	IPv6 Socket Address	The client/server address of a tcp socket with an IPv6 address	
udp6		The client/server address of a udp socket with an IPv6 address	

Q2: Flow Attribute Conflicts

- Original Design:
  - Declare conflicts of new address type with each existing address types.
  - For example: tcp and udp
  - Some network with special technologies (e.g. NAT) may avoid some conflicts. So a server can declare the capability disagree with the conflicts defined in the registry.
- Key observation: Most of address types conflict with others.
- Current Design:
  - Declare compatibility instead of conflicts.
  - If the address type combination of a src-dst pair is not defined in the compatibility registry, it SHOULD be regarded as invalid.
  - A server can extend compatible address type combinations into its own capability.