                          ALTO Cost Calendar
                    draft-ietf-alto-cost-calendar-02

Abstract

   The goal of Application-Layer Traffic Optimization (ALTO) is to
   bridge the gap between network and applications by provisioning
   network related information in order to allow applications to make
   network informed decisions. The present draft extends the ALTO cost
   information so as to broaden the decision possibilities of
   applications to not only decide 'where' to connect to, but also
   'when'. This is useful to applications that need to schedule their
   data transfers and connections and have a degree of freedom to do so.
   ALTO guidance to schedule application traffic can also efficiently
   help for load balancing and resources efficiency. Besides, the ALTO
   Cost Calendar allows to schedule the ALTO requests themselves and
   thus to save a number of ALTO transactions.

   This draft proposes new capabilities and attributes on filtered cost
   maps and endpoint costs enabling an ALTO Server to provide "Cost
   Calendars". These capabilities are applicable to time-sensitive ALTO
   metrics. With ALTO Cost Calendars, an ALTO Server exposes ALTO Cost
   Values in JSON arrays where each value corresponds to a given time
   interval. The time intervals as well as other Calendar attributes
   are specified in the IRD and ALTO Server responses.

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].

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1. Introduction

   IETF is currently standardizing the ALTO protocol which aims at
   providing guidance to overlay applications needing to select one or
   several hosts from a set of candidates able to provide a desired
   resource. This guidance is based on parameters that affect
   performance and efficiency of the data transmission between the hosts
   such as the topological distance. The goal of ALTO is to improve the
   Quality of Experience (QoE) in the application while optimizing
   resource usage in the underlying network infrastructure.

   The ALTO protocol in [RFC7285] specifies a Network Map which defines
   groupings of endpoints in provider-defined network regions (called
   PIDs). The Cost Map Service, Endpoint Cost Service (ECS) and
   Endpoint Ranking Service then provide ISP-defined costs and rankings
   for connections among the specified endpoints and PIDs and thus
   incentives for application clients to connect to ISP preferred
   locations, e.g. to reduce their costs. ALTO intentionally avoids
   provisioning realtime information as explained in the ALTO Problem
   Statement [RFC5693] and ALTO Requirements [RFC5693].Thus the current
   Cost Map and Endpoint Cost Service are providing, for a given Cost
   Type, exactly one path cost value. Applications have to query one of
   these two services to retrieve the currently valid cost values. They
   therefore need to plan their ALTO information requests according to
   their own estimation of the frequency of cost value change.

   With [RFC7285], an ALTO client should interpret the returned costs as
   those at the query moment. However, Network costs can fluctuate,
   e.g. due to diurnal patterns of traffic demand or planned events such
   as network maintenance, holidays or highly publicized events.
   Providing network costs for only the current time thus may not be

sufficient, in particular for applications that can schedule their
traffic in a span of time, for example by deferring backup to night
during traffic trough.

In case the ALTO Cost value changes are predicable over a certain
period of time and the application does not require immediate data
transfer, it can save time to get the whole set of cost values over
this period in one single ALTO response. Using this set to schedule
data transfers allows optimising the network resources usage and QoE.
ALTO Clients and Servers can also minimize their workload by reducing
and accordingly scheduling their data exchanges.

This document extends RFC7285 to allow an ALTO server to provide
network costs for a given duration of time. A sequence of network
costs across a time span for a given pair of network locations is
named an "ALTO Cost Calendar". The Filtered Cost Map Service and
Endpoint Cost Service are extended to provide Cost Calendars. In
addition to this functional ALTO enhancement, we expect to further
gain on storage and on the wire data exchange by gathering multiple
Cost Values for one Cost Type into one single ALTO Server response.

In this draft an "ALTO Cost Calendar" is specified by information
resources capabilities that are applicable to time-sensitive ALTO
metrics. An ALTO Cost Calendar exposes ALTO Cost Values in JSON
arrays where each value corresponds to a given time interval. The
time intervals as well as other Calendar attributes are specified in
the IRD and in the Server response to allow the ALTO Client to
interpret the received ALTO values. Last, the proposed extensions
for ALTO Calendars are applicable to any Cost Mode and they ensure
backwards compatibility with legacy ALTO clients.

In the rest of this document, Section 2 provides the design
characteristics. Sections 3 and 4 define the formal specifications
for the IRD and the information resources. Section 5 provides non-
normative use cases to illustrate the usage of cost calendars. IANA
considerations and security considerations will be completed in
further versions.

2. Overview of ALTO Cost Calendars

   An ALTO Cost calendar provided by the ALTO Server provides 2
   information items:

   o   an array of values for a given metric, where each value
       corresponds to a time interval, where the value array can
       sometimes be a cyclic pattern that repeats a certain number of
       times.

o attributes describing the time scope of the calendar such as the
   size and number of the intervals and the date of the starting
   point of the calendar, allowing an ALTO Client to properly
   interpret the values.

An ALTO Cost Calendar can be used like a "time table" to figure out
the best time to schedule data transfers and also to proactively
manage application traffic given predictable events such as flash
crowds, traffic intensive holidays and network maintenance. It may
be viewed as a synthetic abstraction of real measurements that can be
historic or be a prediction for upcoming time periods.

Most likely, the ALTO Cost Calendar would be used for the Endpoint
Cost Service, assuming that a limited set of feasible Endpoints for a
non-real time application is already identified, that they do not
need to be accessed immediately and that their access can be
scheduled within a given time period. The Filtered Cost Map service
is also applicable as long as the size of the Map allows it.

2.1. ALTO Cost Calendar information features

The Calendar attributes are provided in the IRD and in ALTO Server
responses. The IRD announces attributes with dateless values in its
information resources capabilities, where as attributes with time
dependent values are provided in the "meta" of Server responses. The
ALTO Cost Calendar attributes provide the following information:

o attributes to interpret the time scope of the Calendar value
   array:

   * generic time zone,

   * applicable time interval for each calendar value: combining
      numbers and time units to reflect for example: 1 hour, 2
      minutes, 10 seconds, 1 week, 1 month,

   * duration of the Calendar: e.g. the number of intervals provided
      in the calendar.

o "calendar-start-date": specifying when the calendar starts, that
   is to which date the first value of the cost calendar is
   applicable.

o "repeated": an optional attribute indicating for how many
   iterations the provided calendar will have the same values. The
   server may use it to allow the client to schedule its next request
   and thus save its own workload by avoiding to process useless
   requests.

2.2. ALTO Calendar design characteristics

   The protocol extension placeholders for an ALTO Calendar are: the
   IRD, the ALTO requests and responses for Cost calendars.

   Extensions are designed to be light and ensure backwards
   compatibility with base protocol ALTO Clients and with other
   extensions. It uses section 8.3.7 "Parsing of Unknown Fields" of
   RFC7285 that writes: "Extensions may include additional fields within
   JSON objects defined in this document. ALTO implementations MUST
   ignore unknown fields when processing ALTO messages."

   The calendar-specific capabilities are integrated in the information
   resources of the IRD and in the "meta" member of ALTO responses to
   Cost Calendars requests. A calendar and its capabilities are
   associated with a given information resource and within this
   information resource with a given cost type. This design has several
   advantages:

   o it does not introduce a new mode,

   o it does not introduce new media types,

   o it allows an ALTO Server to offer calendar capabilities on a cost
      type, with attributes values adapted to each information resource.

   The Applicable Calendared information resources are:

   o the Filtered Cost Map,

   o the Endpoint Cost Map.

   The ALTO Server can choose in which frequency it provides cost
   Calendars to ALTO Clients. It may either provide calendar updates
   starting at the request date, or carefully schedule its updates so as
   to take profit from a potential repetition/periodicity of calendar
   values.

2.2.1. ALTO Cost Calendar for all cost modes

   Calendars are well-suited for values encoded in the 'numerical' mode.
   However, Calendars can also represent any metric considered as time-
   varying by an ALTO Server. For example, types of Cost values such as
   JSONBool can also be expressed as calendars, as states may be "true"
   or "false" depending on given time periods or likewise, values
   represented by strings, such as "medium", "high", "low", "blue",
   "open" .

Note also that a Calendar is applicable as well to time-varying
metrics provided in the 'ordinal' mode, if these values are time-
varying and their update is carefully managed by the ALTO Server.

2.2.2. Compatibility with legacy ALTO Clients

The ALTO protocol extensions for Cost Calendars have been defined so
as to ensure that Calendar capable ALTO Servers can provide legacy
ALTO Clients with legacy information resources as well. That is a
legacy ALTO Client can request resources and receive responses as
specified in RFC7285.

A Calendar-aware ALTO Server MUST implement the base protocol
specified in RFC7285.

When a metric is available as a calendar, it MUST be available as a
single value as well.

For compatibility with legacy ALTO Clients specified in RFC7285,
calendared information resources are not applicable for full Cost
Maps for the following reason: a legacy ALTO client would receive a
Calendared Cost Map via an HTTP 'GET' command. As specified in
section 8.3.7 of RFC7285, it will ignore the Calendar Attributes
indicated in the "meta" of the responses. Therefore, lacking
information on calendar attributes, it will not be able to correctly
interpret and process the values of the received array of calendar
cost values.

Therefore, calendared information resources MUST be requested via the
Filtered Cost Map Service or the Endpoint Cost Service, using a POST
method.

3. ALTO Calendar specification: IRD extensions

The Calendar attributes in the IRD information resources capabilities
carry constant dateless values. A calendar is associated with an
information resource rather than a cost type. For example, a Server
can provide a "routingcost" calendar for the Filtered Cost Map
Service at a granularity of one day and a "routingcost" calendar for
the Endpoint Cost service at a finer granularity but for a limited
number of endpoints.

3.1. Calendar attributes in the IRD resources capabilities

When for an applicable resource, an ALTO Server provides a Cost
Calendar for a given Cost Type, it MUST indicate this in the IRD
capabilities of this resource, by an object of type

'CalendarAttributes', associated with this Cost Type and specified
below.

The capabilities of a Calendar aware information resource entry have
a member named "calendar-attributes" which is an array of objects of
type CalendarAttributes. It is necessary to use an array because of
resources such as Filtered Cost Map and Endpoint Cost Map, for which
the member "cost-type-names" is an array of 1 or more values.

A member "calendar-attributes" MUST appear only once for each
applicable cost type name of a resource entry. If "calendar-
attributes" are specified several times for a same "cost-type-name"
in the capabilities of a resource entry, the ALTO client SHOULD
ignore any calendar capabilities on this "cost-type-name" for this
resource entry.

CalendarAttributes calendar-attributes <1..*>;

```
object{
  JSONString    cost-type-names <1..*>;
  JSONString    time-interval-size;
  JSONNumber    number-of-intervals;
} CalendarAttributes;
```

o "cost-type-name":

   * An array of one or more elements indicating the cost-type-names
      in the IRD entry to which the capabilities apply.

o "time-interval-size":

   * is the duration of an ALTO calendar time interval, expressed as
      a time unit appended to the number of these units. The time
      unit, ranges from "second" to "year". The number is encoded
      with an integer. Example values are: "5 minute" , "2 hour",
      meaning that each calendar value applies on a time interval
      that lasts respectively 5 minutes and 2 hours.

o "number-of-intervals":

   * the integer number of values of the cost calendar array, at
      least equal to 1.

- Attribute "cost-type-name" , if used, provides a better readability
to the calendar attributes specified in the IRD and avoids confusion
with calendar attributes of other cost-types.

- Multiplying Attributes 'time-interval-size' and 'number-of-intervals' provides the duration of the provided calendar. For example an ALTO Server may provide a calendar for ALTO values changing every 'time-interval-size' equal to 5 minutes. If 'number-of-intervals' has the value 12, then the duration of the provided calendar is "1 hour".

3.2. Calendars in a delegate IRD

One option to clarify IRD resources is that a "root" ALTO Server implementing base protocol resources delegates "specialized" information resources such as the ones providing Cost Calendars to another ALTO Server running in a subdomain specified with its URI in the "root" ALTO Server. This option is described in Section 9.2.4 "Delegation using IRDs" of RFC7285.

This document provides an example, where a "root" ALTO Server runs in a domain called "alto.example.com". It delegates the announcement of Calendars capabilities to an ALTO Server running in a subdomain called "custom.alto.example.com". The location of the "delegate Calendar IRD" is assumed to be indicated in the "root" IRD by the resource entry: "custom-calendared-resources".

Another advantage is that some Cost Types for some resources may be more advantageous as Cost Calendars and it makes few sense to get them as a single value. For example, Cost Types with predictable and frequently changing values, calendared in short time intervals such as a minute.

3.3. Example IRD with ALTO Cost Calendars

The cost types in this example are either specified in the base ALTO protocol or may be proposed in other drafts see [draft-ietf-alto-performance-metrics]. In this example, the available cost metrics are indicated in the "meta" field by cost type names "num-routingcost", "num-latency", "num-pathbandwidth" and "string-quality-status". Metrics "routingcost" , 'latency' and 'bandwidthscore' are available in the "numerical" Cost Mode. Metric "quality-status" is available in the "string" Cost Mode.

The example IRD includes 2 particular URIs providing calendars:

o "http://custom.alto.example.com/calendar/costmap/filtered": a filtered cost map in which calendar capabilities are indicated for cost type names: "num-routingcost", "num-pathbandwidth" and "string-service-status",

   o "http://custom.alto.example.com/calendar/endpointcost/lookup": an
      endpoint cost map in which in which calendar capabilities are
      indicated for cost type names: "num-routingcost", "num-latency",
      "num-pathbandwidth", "string-service-status".

   The design of the Calendar capabilities allows that some calendars on
   a cost type name are available in several information resources with
   different Calendar Attributes. This is the case for calendars on
   "num-routingcost", "num-pathbandwidth" and "string-service-status" ,
   available in both the Filtered Cost map and Endpoint Cost map
   service, but with different time interval sizes for "num-
   pathbandwidth" and "string-service-status".

```
GET /calendars-directory HTTP/1.1
Host: custom.alto.example.com
Accept: application/alto-directory+json,application/alto-error+json
---------------

HTTP/1.1 200 OK
Content-Length: [TODO]
Content-Type: application/alto-directory+json

   {
     "meta" : {
        "cost-types": {
           "num-routingcost": {
              "cost-mode" : "numerical",
              "cost-metric" : "routingcost"
           },
           "num-latency": {
              "cost-mode"  : "numerical",
              "cost-metric": "latency"
           },
           "num-pathbandwidth": {
              "cost-mode"  : "numerical",
              "cost-metric": "bandwidthscore",
           },
           "string-qual-status": {
              "cost-mode"  : "string",
              "cost-metric": "quality-status",
           }
         ... other meta ...
        },

    "resources" : {
       "filtered-cost-map-calendar" : {
           "uri" : "http://custom.alto.example.com/calendar/costmap/filtered",
           "media-type" : "application/alto-costmap+json",
```

```
            "accepts" : "application/alto-costmapfilter+json",
            "capabilities" : {
               "cost-constraints" : true,
               "cost-type-names"  : [ "num-routingcost", "num-pathbandwidth",
                                      "string-service-status" ],
               "calendar-attributes" : [
                  {"cost-type-names" : [ "num-routingcost", "num-pathbandwidth" ]
,
                   "time-interval-size" : "1 hour",
                   "number-of-intervals" : 24
                  },
                  {"cost-type-names" : "string-service-status",
                   "time-interval-size" : "30 minute",
                   "number-of-intervals" : 48
                  }
               ] // end calendar-attributes
               "uses": [ "my-default-network-map" ]
               }
            },

        "endpoint-cost-calendar-map" : {
          "uri" : "http://custom.alto.example.com/calendar/endpointcost/lookup",
          "media-types" : [ "application/alto-endpointcost+json" ],
          "accepts" : [ "application/alto-endpointcostparams+json" ],
          "capabilities" : {
            "cost-constraints" : true,
            "cost-type-names" : [ "num-routingcost", "num-latency",
                                  "num-pathbandwidth", "string-service-status" ],
            "calendar-attributes" : [
               {"cost-type-names" : "num-routingcost",
                "time-interval-size" : "1 hour",
                "number-of-intervals" : 24
               },
               {"cost-type-names" : "latency",
                "time-interval-size" : "5 minute",
                "number-of-intervals" : 12
               },
               {"cost-type-names" : "num-pathbandwidth",
                "time-interval-size" : "1 minute",
                "number-of-intervals" : 60
               },
               {"cost-type-names" : "string-service-status",
                "time-interval-size" : "2 minute",
                "number-of-intervals" : 30
               }
             ]
            "uses": [ "my-default-network-map" ]
          } // ECM capab
        } //info resource N
```

```
} // ressources
```

In this example IRD, for the filtered cost map service:

o   the Calendar for 'num-routingcost' and 'num-pathbandwidth' is an
    array of 24 values each provided on a time interval lasting 1
    hour.

o   the Calendar for "string-service-status": "is an array of 48
    values each provided on a time interval lasting 30 minutes.

For the endpoint cost map service:

o   the Calendar for 'num-routingcost': is an array of 24 values each
    provided on a time interval lasting 1 hour.

o   the Calendar for 'latency': is an array of 12 values each provided
    on a time interval lasting 5 minutes.

o   the Calendar for 'num-pathbandwidth': is an array of 60 values
    each provided on a time interval lasting 1 minute.

o   the Calendar for "string-service-status": "is an array of 30
    values each provided on a time interval lasting 2 minutes.

4. ALTO Calendar specification: Service Information Resources

   This section documents the individual information resources defined
   to provide the Calendared information services defined in this
   document.

   The reference time zone for the provided time values is GMT because
   the option chosen to express the time format is the HTTP header
   fields format:

                  Date: Tue, 15 Nov 2014 08:12:31 GMT

4.1. Calendar extensions for Filtered Cost Maps

   A legacy ALTO client requests and gets filtered cost map responses as
   specified in RFC7285.

4.1.1. Calendar extensions in Filtered cost map requests

   The input parameters of a "legacy" request for a filtered cost map,
   defined by object ReqFilteredCostMap in section 11.3.2 of RFC7285,
   are augmented with one additional member.

   A Calendar-aware ALTO client requesting a Calendar on a given Cost
   Type for a Filtered Cost Map resource having Calendar capabilities
   MUST add the following field to its input parameters:

                    JSONBoolean   calendared<1..*>;

   This field is an array of 1 to N boolean values, where N is the
   number of requested metrics. Each boolean value indicates whether or
   not the ALTO Server should provide the values for this Cost Type as a
   calendar. The array MUST contain exactly N boolean values, otherwise
   the server returns an error.

   This field MUST NOT be specified if member "calendar-attributes" is
   not present for this information resource.

   If this field is not present, it MUST be assumed to have only values
   equal to "false".

   A Calendar-aware ALTO client supporting single cost type values, as
   specified in RFC7285, MUST provide an array of 1 element:

                         "calendared" : [true];

   A Calendar-aware ALTO client that is also Multi-Cost aware MUST
   provide an array of N values set to "true" or "false", depending
   whether it wants the applicable Cost Type values as a single or
   calendared value.

4.1.2. Calendar extensions in Filtered Cost map responses

   The calendared costs are JSONArrays instead of JSONNumbers for the
   legacy ALTO implementation. All arrays have a number of values equal
   to 'number-of-intervals'.

   The "meta" field of a Calendared Filtered Cost map response MUST
   include at least:

   o if the ALTO Client supports cost values for one Cost Type at a
      time only: the "meta" fields specified in RFC 7285 for these
      information service responses:

      * "dependent-vtags ",

        * "cost-type" field.

    o if the ALTO Client supports cost values for several Cost Types at
       a time, as specified in [draft-ietf-alto-multi-cost] : the "meta"
       fields specified in [draft-ietf-alto-multi-cost] for these
       information service responses:

        * "dependent-vtags ",

        * "cost-type" field with value set to '{}', for backwards
           compatibility with RFC7285.

        * "multi-cost-types" field.

    o If the client request does not provide member "calendared" or if
       it provides it with a value equal to 'false', for all the
       requested Cost Types, then the ALTO Server response is exactly as
       specified in RFC 7285 [ID-alto-protocol] and
       [draft-ietf-alto-multi-cost].

    o If the value of member "calendared" is equal to 'false' for a
       given requested Cost Type, the ALTO Server must return, for these
       Cost Types, a single cost value as specified in RFC 7285.

In addition, the "meta" field of a Calendared Filtered Cost map
response MUST include the member "calendar-response-attributes" for
the requested information resource, together with the values provided
by the ALTO Server for these attributes. This member is an array of
objects of type "CalendarResponseAttributes", defined as follows:

CalendarResponseAttributes calendar-response-attributes <1..*>;

```
object{
  JSONString    cost-type-names;
  JSONString    calendar-start-time;
  JSONString    time-interval-size;
  JSONNumber    number-of-intervals;
  [JSONNumber   repeated;]              [OPTIONAL]
} CalendarResponseAttributes;
```

Object CalendarResponseAttributes has the following attributes:

    o "cost-type-names": member indicating the cost-type-names to which
       the capabilities apply.

    o "calendar-start-time": indicates the date at which the first value
       of the calendar applies. By default, the value provided for the

"calendar-start-time" attribute SHOULD be no later than the
request date.

o "time-interval-size": as specified in section "Calendar attributes
   in the IRD resources capabilities",

o "number-of-intervals": as specified in section "Calendar
   attributes in the IRD resources capabilities",

o "repeated": is an optional field provided for Calendars. It is an
   integer N greater or equal to '1' that indicates how many
   iterations of the calendar value array starting at the date
   indicated by "calendar-start-time" have the same values. The
   number N includes the provided iteration.

Using the member "repeated" helps minimizing on the wire data
exchange: by providing it, an ALTO Server will avoid unecessary
processing of requests for Calendars with unchanged values while it
allows ALTO Clients to save their resources as well.

For example: if the "calendar-start-time" member has value "Mon, 30
Jun 2014 at 00:00:00 GMT" and if the value of member "repeated" is
equal to 4, it means that the calendar values are the same values on
Monday, Tuesday, Wednesday and Thursday. The ALTO Client thus may
use the same calendar for the next 4 duration periods following
"calendar-start-time".

4.1.3. Use case and example: FCM with a bandwidth Calendar

An example of non-real time information that can be provisioned in a
'calendar' is the expected path bandwidth. While the transmission
rate can be measured in real time by end systems, the operator of a
data center is in the position of formulating preferences for given
paths, at given time periods for example to avoid traffic peaks due
to diurnal usage patterns. In this example, we assume that an ALTO
Client requests a bandwidth calendar as specified in the IRD to
schedule its bulk data transfers as described in the use cases.

In the example IRD, calendars for cost type name "num-pathbandwidth"
are available for the information resources: "filtered-cost-calendar-
map" and "endpoint-cost-calendar-map". The ALTO Client requests a
calendar for "num-pathbandwidth" via a POST request for a filtered
cost map.

We suppose in this example that the ALTO Client sends its request on
Tuesday July 1st 2014 at 13:15

```
   POST /calendar/costmap/filtered HTTP/1.1
   Host: alto.example.com
   Content-Length: [TODO]
   Content-Type: application/alto-costmapfilter+json
   Accept: application/alto-costmap+json,application/alto-error+json

   {
     "cost-type" : {"cost-mode" : "numerical", "cost-metric" : "bandwidthscore"},
     "calendared" : [true],

     "pids" : {
        "srcs" : [ "PID1", "PID2" ],
        "dsts" : [ "PID1", "PID2", "PID3" ]
     }
   }


   HTTP/1.1 200 OK
   Content-Length: [TODO]
   Content-Type: application/alto-costmap+json

   {
     "meta" : {
       "dependent-vtags" : [...],
       "cost-type" : {"cost-mode" : "numerical", "cost-metric" : "bandwidthscore"
},
       "calendar-response-attributes" : [
          "calendar-start-time" : Tue, 1 Jul 2014 13:00:00 GMT,
          "time-interval-size" : "2 hour",
          "numb-intervals" : 12
        ]
      },

     "cost-map" : {
        "PID1": { "PID1": [v1,v2, ... v12],
                  "PID2": [v1,v2, ... v12],
                  "PID3": [v1,v2, ... v12] },
        "PID2": { "PID1": [v1,v2, ... v12],
                  "PID2": [v1,v2, ... v12],
                  "PID3": [v1,v2, ... v12] }
     }
   }
```

4.2. Calendar extensions in the Endpoint Cost Map Service

   This document extends the Endpoint Cost Service, as defined in
   {11.5.1} of [RFC7285], by adding new input parameters and
   capabilities, and by returning JSONArrays instead of JSONNumbers as
   the cost values. The media type {11.5.1.1} and HTTP method
   {11.5.1.2} are unchanged.

4.2.1. Calendar specific input in Endpoint cost map requests

   The extensions to the requests for calendared Endpoint Cost Maps are
   the same as for the Filtered Cost Map Service, specified in section
   XXXX of this draft.

   The ReqEndpointCostMap object for a Calendared ECM request will have
   the following format:

   object {
     [CostType cost-type;]
     [CostType multi-cost-types<1..*>;]
     [JSONBoolean   calendared<1..*>;]
     EndpointFilter endpoints;
   } ReqEndpointCostMap;

   object {
     [TypedEndpointAddr srcs<0..*>;]
     [TypedEndpointAddr dsts<0..*>;]
   } EndpointFilter;

4.2.2. Calendar attributes in the Endpoint Cost Map response

   The "meta" field of a Calendared Endpoint Cost map response MUST
   include at least:

   o if the ALTO Client supports cost values for one Cost Type at a
      time only: the "meta" fields specified in {11.5.1.6} of RFC 7285
      for the Endpoint Cost response:

      * "cost-type" field.

   o if the ALTO Client supports cost values for several Cost Types at
      a time, as specified in [draft-ietf-alto-multi-cost] : the "meta"
      fields specified in [draft-ietf-alto-multi-cost] for the the
      Endpoint Cost response:

      * "cost-type" field with value set to '{}', for backwards
         compatibility with RFC7285.

* "multi-cost-types" field.

If the client request does not provide member "calendared" or if it provides it with a value equal to 'false', for all the requested Cost Types, then the ALTO Server response is exactly as specified in RFC 7285 [ID-alto-protocol] and [draft-ietf-alto-multi-cost].

If the ALTO client provides member "calendared" in the input parameters with a value equal to 'true' for given requested Cost Types, the "meta" member of a Calendared Endpoint Cost Map response MUST include, for these Cost Types, the same additional member "calendar-response-attributes", as specified for the Filtered Cost Map Service. The Server response is thus changed as follows, w.r.t RFC 7285 and [draft-ietf-alto-multi-cost]:

o the "meta" member has one additional field "CalendarResponseAttributes", as specified for the Filtered Cost Map Service,

o the calendared costs are JSONArrays instead of JSONNumbers for the legacy ALTO implementation. All arrays have a number of values equal to 'number-of-intervals'.

If the value of member "calendared" is equal to 'false' for a given requested Cost Type, the ALTO Server must return, for these Cost Types, a single cost value as specified in RFC 7285.

4.2.3. Use case and example: ECS with a routingcost Calendar

Let us assume an Application Client is located in an end system with limited resources and having an access to the network that is either intermittent or provides an acceptable quality in limited but predictable time periods. Therefore, it needs to both schedule its resources greedy networking activities and its ALTO transactions.

The Application Client has the choice to trade content or resources with a set of Endpoints and needs to decide with which one it will connect and at what time. For instance, the Endpoints are spread in different time-zones, or have intermittent access. In this example, the 'routingcost' is assumed to be time-varying, with values provided as ALTO Calendars.

The ALTO Client associated with the Application Client queries an ALTO Calendar on 'routingcost' and will get the Calendar covering the 24 hours time period "containing" the date and time of the ALTO client request.

For Cost Type 'num-routingcost', the solicited ALTO Server has
defined 3 different daily patterns each represented by a Calendar, to
cover the week of Monday June 30th at 00:00 to Sunday July 6th 23:59:

- C1 for Monday, Tuesday, Wednesday, Thursday, (week days)

- C2 for Saturday, Sunday, (week end)

- C3 for Friday (maintenance outage on July 4, 2014 from 02:00:00 GMT
to 04:00:00 GMT, or big holiday such as New Year evening).

In the following example, the ALTO Client sends its request on
Tuesday July 1st 2014 at 13:15.

```
POST /calendar/endpointcost/lookup HTTP/1.1
Host: alto.example.com
Content-Length: [TODO]
Content-Type: application/alto-endpointcostparams+json
Accept: application/alto-endpointcost+json,application/alto-error+json

{
  "cost-type" : {"cost-mode" : "numerical", "cost-metric" : "routingcost"},
  "calendared" : [true],
  "endpoints" : {
    "srcs": [ "ipv4:192.0.2.2" ],
    "dsts": [
      "ipv4:192.0.2.89",
      "ipv4:198.51.100.34",
      "ipv4:203.0.113.45",
      "ipv6:2000::1:2345:6789:abcd"
    ]
  }
}


HTTP/1.1 200 OK
Content-Length: [TODO]
Content-Type: application/alto-endpointcost+json

{
  "meta" : {
    "cost-type" : {"cost-mode" : "numerical", "cost-metric" : "routingcost"},
    "calendar-response-attributes" : [
       { "calendar-start-time" : Mon, 30 Jun 2014 00:00:00 GMT,
         "time-interval-size" : "1 hour",
         "numb-intervals" : 24,
         "repeated": 4 }
     ],
    } // end meta

    "endpoint-cost-map" : {
      "ipv4:192.0.2.2": {
        "ipv4:192.0.2.89"    : [v1, v2, ... v24],
        "ipv4:198.51.100.34" : [v1, v2, ... v24],
        "ipv4:203.0.113.45"  : [v1, v2, ... v24],
        "ipv6:2000::1:2345:6789:abcd" : [v1, v2, ... v24]
      }
    }
}
```

   When the Client gets the Calendar for "routingcost", it sees that the
   "calendar-start-time" is Monday at 00h00 GMT and member "repeated" is
   equal to '4'. It understands that the provided values are valid
   until Thursday included and will only need to get a Calendar update
   on Friday.

4.2.4. Use case and example: ECS with a multi-cost calendar for
        routingcost and latency

   In this example, it is assumed that the ALTO Server implements multi-
   cost capabilities, as specified in [draft-ietf-alto-multi-cost] .
   That is, an ALTO client can request and receive values for several
   cost types in one single transaction. An illustrating use case is a
   path selection done on the basis of 2 metrics: routing cost and
   latency.

   As in the previous example, the IRD indicates that the ALTO Server
   provides "routingcost" Calendars in terms of 24 time intervals of 1
   hour each.

   For metric "latency", the IRD indicates that the ALTO Server provides
   Calendars in terms of 12 time intervals values lasting each 5
   minutes.

   In the following example transaction, the ALTO Client sends its
   request on Tuesday July 1st 2014 at 13:15.

POST calendar/endpointcost/lookup HTTP/1.1
  Host: alto.example.com
  Content-Length: [TODO]
  Content-Type: application/alto-endpointcostparams+json
  Accept: application/alto-endpointcost+json,application/alto-error+json

  {
    "cost-type" : {},
    "multi-cost-types" : [
        {"cost-mode" : "numerical", "cost-metric" : "routingcost"},
        {"cost-mode" : "numerical", "cost-metric" : "latency"}
    ],
    "calendared" : [true, true],
    "endpoints" : {
      "srcs": ["ipv4:192.0.2.2"],
      "dsts": [
        "ipv4:192.0.2.89",
        "ipv4:198.51.100.34",
        "ipv4:203.0.113.45",
        "ipv6:2000::1:2345:6789:abcd"
      ]

```
      }
   }


   HTTP/1.1 200 OK
   Content-Length: [TODO]
   Content-Type: application/alto-endpointcost+json

   {
     "meta" : {
       "multi-cost-types" : [
          {"cost-mode" : "numerical", "cost-metric" : "routingcost"},
          {"cost-mode" : "numerical", "cost-metric" : "latency"}
        ],
       "calendar-response-attributes" : [
          { "cost-type-name : num-routingcost"
            "calendar-start-time" : Mon, 30 Jun 2014 00:00:00 GMT,
            "time-interval-size" : "1 hour",
            "numb-intervals" : 24,
            "repeated": 4 },
          { "cost-type-name : num-latency"
            "calendar-start-time" : Tue, 1 Jul 2014 13:00:00 GMT,
            "time-interval-size" : "5 minute",
            "numb-intervals" : 12}
        ],
       } // end meta

       "endpoint-cost-map" : {
         "ipv4:192.0.2.2": {
           "ipv4:192.0.2.89"     : [[r1, r2, ... r24], [l1, l2, ... l12]],
           "ipv4:198.51.100.34" : [[r1, r2, ... r24], [l1, l2, ... l12]],
           "ipv4:203.0.113.45"  : [[r1, r2, ... r24], [l1, l2, ... l12]],
           "ipv6:2000::1:2345:6789:abcd" : [[r1, r2, ... r24], [l1, l2, ... l12]]
         }
       }
   }
```

   When receiving the response, the client sees that the calendar values
   for 'routing cost' are repeated for 4 iterations. Therefore, in its
   next requests until the routing cost calendar is expected to change,
   the client will only need to request a calendar for "latency".

   Without the ALTO Calendar extensions, the ALTO client would have no
   clue on the dynamicity of the metric value change and would spend
   needless time requesting values at an inappropriate pace. In
   addition, without the Multi-Cost ALTO capabilities, the ALTO client

would duplicate this waste of time as it would need to send one
request per cost metric.

5. IANA Considerations

Information for the ALTO Endpoint property registry maintained by the
IANA and related to the new Endpoints supported by the acting ALTO
server. These definitions will be formulated according to the syntax
defined in Section on "ALTO Endpoint Property Registry" of [RFC7285]
,

Information for the ALTO Cost Type Registry maintained by the IANA
and related to the new Cost Types supported by the acting ALTO
server. These definitions will be formulated according to the syntax
defined in Section on "ALTO Cost Type Registry" of [RFC7285],

5.1. Information for IANA on proposed Cost Types

When a new ALTO Cost Type is defined, accepted by the ALTO working
group and requests for IANA registration MUST include the following
information, detailed in Section 11.2: Identifier, Intended
Semantics, Security Considerations.

5.2. Information for IANA on proposed Endpoint Properties

Likewise, an ALTO Endpoint Property Registry could serve the same
purposes as the ALTO Cost Type registry. Application to IANA
registration for Endpoint Properties would follow a similar process.

6. Acknowledgements

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and Yichen Qian for fruitful discussions and review feedback.

7. References

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