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Upload Acceleration Transport Network for Upstream Traffics
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Abstract

Photos, videos and other upstream traffics generated by end users are rapidly increasing these days and expected to continue doing so in the future. A lot of factors, such as long round-trip-time (RTT), low robustness of delivery, and transport bottlenecks, etc., lead to low upload rate, which cause poor user experiences. This draft discusses an Upload Acceleration Transport Network(UATN) for upstream traffics that use distributed cache servers and separates the upload transaction into two parts for greater network efficiency.

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1. Introduction

Traditional Internet data services are frequently that end users download content from data centers or Content Service Providers (CSPs) distribute content to their end users, so traffic volume generated by end users account for very small proportion of all Internet traffics. However, as mobile phones and other smart devices are proliferating, above status is changing since more and more end users like directly uploading and sharing their photos, videos or other documents by data centers. Besides, mobile devices emerging are fully cloud-dependent that are not equipped with much storage but rely on large storage in data centers. For these reasons, a large

number of Online Storage Service Providers(OSSPs),Photos Sharing Service Providers (PSSPs), and Videos Sharing Service Providers (VSSPs) emerge at a historic moment so that make upstream traffics rapidly increasing and expected to continue doing so in the future.

To overcome this challenge of massive upstream traffic, just installing more data servers will not be enough[RFC6392]. Moving data server closer to the end users results in greater network efficiency: improved Quality of Service (QoS), increased robustness of delivery,and lower latency. In these existing work, Content Delivery Networks (CDNs) are a representative technique. However, CDNs focus on downstream traffic and are used to deliver large-scale content from data center to end users while do not necessarily apply to upstream traffics[RFC6707]. Since lack of this edge technologies, when end users request to upload content to data center, they may have to face a long "data path", such as Telecommunication Service Provider's Network(TSPN), Metropolitan Area Networks (MANs), Wide Area Networks (WANs), etc., which may worsen the upload environment and force end users to stay tethered to the network for long time. Even over a relatively long distance, throughput may go from maximum to nothing. According to the report in [1], throughput measurements from over 1.5 million mobile devices have shown that compared with an average downstream throughput of over 1860 Kbps, the average upstream throughput is only about 430 Kbps. This is because of the adoption of cache techniques such as CDNs to acelerate downloading large content that moves the "content" closer to end users.

For improving the user experience of upload, it is worthwhile and in fact extremely important to consider an acceleration approach for upload service like their download counterparts. It is generally desirable that a given content item generated by one user can be quickly and robustly uploaded to data centers regardless of that end user's location or attachment network. This is the motivation for establishing UATN so it can provide open content delivery infrastructure for the end-to-end delivery of content from end user to data center. However, no standards or open specifications currently exist to facilitate such acceleration transport network.

The goal of this document is to figure out how to build a UATN for upstream traffics to provide improved quality of user experienceand reduced delivery cost.

1.1. Terminology

This document uses the following terms:

Upload Service Provider (USP):The service provider who operates data servers or cloud service that allows end users to directly upload or

share their content, such as photos, videos, or other documents generated by them. The content may be stored temporarily, or downloaded by other end users,or directly forwarded to another end user. Note that a given entity may operate in more than one role. For example, a company may simultaneously operate as a USP,a CSP, and a CDN Provider, etc.

Upload Acceleration Transport Network (UATN): A transport network between end users and data centers that enables cache servers to provide content upload services on behalf of the USP. A UATN may be wholly or partially realized through a set of cache servers and transport system with control and communication components.

UATN Provider: The service provider who operates a UATN and offers a service of content upload acceleration, typically used by USPs. Note that a given entity may operate in more than one role. For example,a company may simultaneously operate as a USP,a CDN Provider, and a UATN Provider, etc.

1.2. Abbreviations

- UATN: Upload Acceleration Transport Network
- USP: Upload Service Provider
- CSP: Content Service Provider
- EU: End User
- ISP: Internet Service Provider
- NSP: Network Service Provider
- QoE: Quality of Experience
- QoS: Quality of Service
- TSP: Telecommunication Service Provider
- ASP: Acceleration Service Provider

2. Use Cases and Scenarios

2.1. End User to Data Center Use Case

An example is depicted in Figure 1, where USP has deployed its own UATN or established an agreement with UATN Provider for the uploading of this content. When a given end user requests uploading content to

USP's data center, the UATN may allow the end user to directly upload the content to its cache server. UATN also selects the optimum cache server to serve this uploading. For instance, UATN considers that the Cache-1 is appropriate, because Cache-1 is an access cache and the end user is directly attached to it[RFC6770]. Through the UATN arrangements put in place between USP and end user(as a result of the upload acceleration service agreement established between USP and UNTA Provider),UATN can redirect the request to Cache-1 and the content is actually delivered to the USP's data center by UATN.

```
              +-------------------+
       +----->| USP's Data Center|
       |      +-------------------+
       |              ^
       |   * * * * * *|* * * * * * * * * * * * ** * * *
       |   *          |                          UATN  *
       |   *      ,--,--,--.            ,--,--,--.      *
       |   *    -'          `-.      ,-'          `-.   *
       |   *  (      Cache      )====(      Cache-1    )  *
       |   *   `-.            ,-'     `-.          ,-'   *
       |   *      `--'--'--'            `--'--'--'      *
       |   *                               ^            *
       |   * * * * * * * * * * * * * * * * *| * * * * * *
       |                                 +------+
       +---------X-----------------------| E U |
                                         +------+
       =========  UATN Data Flow
       ---------  Common Data Flow
```

Figure 1

End users benefit from this arrangement through a better QoE[RFC6390], because the content is uploaded to a nearby surrogate (e.g., lower latency, bottlenecks avoided)[RFC6707]. USPs benefit because they do not need to deploy such an extensive data server, they only need to make one business agreement and one technical arrangement with UATN Provider, but their end users can get a high service quality. TSPs benefit because they do not need to expand the uplink bandwidth, and the upstream throughputs can be improved from end use's perspective. To extend the example, other ASPs, such as CDN Providers may also benefit from this arrangement. They can make their existing CDNs to provide upload services so that the upstream bandwidth can be fully used, and may receive some compensation for the delivery.

2.2. End User to End User Use Case

In this scenario, USP wishes to allow content delivery among its end users with high speed. Consider the following example,illustrated in Figure 2: EU-1 wants to deliver content to EU-2, however, there may have a long "data path" between EU-1 and EU-2, such as TSPN, MANs, WANs, etc. This will cause large delay and inversely proportional TCP throughput. One technique for improving the user seen throughput is to introduce UATN between the sender and the receiver. UATN resolves the problem by separating the current delivery communication into two parts, front-end service from the EU-1(the sender) to UATN and back-end service from the UATN to EU-2 (the receiver) to reduce access network and/or inter-network hop delay.

As an example, suppose a French person wants to deliver content to the end user located in Africa. The USP of this French user can ask a UATN Provider to provide acceleration that content generated by the French people will be first forwarded to the UATN Cache-1 and then is delivered to UATN Cache-2 through UATN's high reliability and performance transport system. At last, the content is actually deliver to African user by UATN's Cache-2.

```
                               +------+
+------------X-----------------| E U-1|
|                              +------+
|  * * * * * * * * * * * * * * * | * * * * * *
|  *                             V     UATN  *
|  *     ,--,--,--.           ,--,--,--.     *
|  *   -'          `-.     ,-'          `-.   *
|  * (     Cache-2      )====(     Cache-1     )  *
|  *  `-.           ,-'     `-.           ,-'   *
|  *     `--'--'--'           `--'--'--'      *
|  * * * * * | * * * * * * * * * * * * * * * * *
|            V
|         +-----+
+-------->|E U-2|
          +-----+
=========  UATN Data Flow
---------  Common Data Flow
```

Figure 2

2.3. Footprint Extension Use Cases

In this use case, the USPs want to extend the infrastructure to support active users rapid growth:

o without compromising the quality of upload.

o keeping additional transit and other network costs at a reasonable level that receives content from geographically or topologically remote end users.

o without incurring the cost of deploying and operating data centers and the associated infrastructure that may not be justified in the corresponding geographic region (e.g., because of relatively low delivery volume, or conversely because of the high investments that would be needed to satisfy the high volume).

In addition,if USPs have a geographically limited footprint (e.g., restricted to one country), or do not serve all end users in a geographic area, they can also establish an agreement with a UATN Provide to provide their services beyond their own footprint.

```
             +-----------+ +-----------+
             | French USP| |Italian USP|
             +-----------+ +-----------+
                ^             ^
            * * *\ * * * * * / * * * * * * * * * * * * *
            *     \         /                  UATN   *
            *     ,--,--,--.            ,--,--,--.     *
            *   -'         `-.      ,-'         `-.  *
            * (    Cache-1     )====(    Cache-2     ) *
            *  `-.           ,-'     `-.          ,-'  *
            *     `--'--'--'            `--'--'--'     *
            *                              ^          *
            * * * * * * * * * * * ** * * * * | * * * * *
                                     +------------+
                                     |North Africa|
                                     |     E Us   |
                                     +------------+
          =========  UATN Data Flow
          ---------  Common Data Flow
                                 Figure 3
```

As an example, suppose a French USP wants to provider upload service to end users located in various countries in North Africa. It can make an agreement with UATN Provider that covers North Africa instead of deploying its own data center in North Africa. Overall, from the end use's perspective, the French USP provides an upload service for the whole North Africa with high data rate. If there are several USPs that have make an agreement with the UATN Provider, cost will keep at a reasonable level, as shown in Figure 3.

2.4. Offload Use Case

A USP's access server or servers is/are likely to be dimensioned to support an expected maximum traffic load. However, unexpected spikes in content popularity (flash crowd) may drive load beyond the expected peak. The USP may use UATN so that some requests may be redirected to UATN to increase its effective capacity during the peak of traffic.

For example, a USP can offload traffic to UATN for the duration of a specific maintenance operation or a special event, as in the scenario depicted in Figure 4. For instance, during a major event, such as a celebrity's wedding or a major sport competition, many people in a confined space may deliver and upload photos, video related to this event, the USP and TSP are likely to experience a flash crowd during the event and will need to offload traffic. While UATN can support a more typical traffic load and be able to handle the offloaded traffic.

```
     +------------------+
+--->| USP's Data Server|<----------------------+
|    +------------------+                       |
|             ^                                 |
|  * * * *  * | * * * * * * * * * * * * * * * * |
|  *          |                        UATN   * |
|  *     ,--,--,--.            ,--,--,--.     * |
|  *   -'         `-.      ,-'          `-.  * |
|  * (    Cache-1     )====(    Cache-2     ) * |
|  *  `-.           ,-'     `-.          ,-'  * |
|  *     `--'--'--'            `--'--'--'     * |
|  *          ^                     ^         * |
|  * * * * * *| * * * * * ** * * * *| * * * * * |
|          +-----+               +-----+        |
+---X------|E U-1|               |E U-2|-----X--+
           +-----+               +-----+
=========  UATN Data Flow
---------  Common Data Flow
```

Figure 4

3. Upload Acceleration Transport Network Approach

The UATN is a distributed system consisting of lots of widely deployed servers to enable the delivery of highly scalable distributed applications. UATN is comprised of multiple delivery networks, each tailored to a different type of content. For example, picture content, streaming media, or static web content. At a high

level, UATN shares a similar architecture, which is shown in Figure 5, but the underlying technology and implementation of each system component may differ in order to best suit the specific type of content.

The main components of UATN are as follows:

When the user types a USP's domain name into his/her browser, the domain name is translated by the mapping system into the IP address of an edge server to serve the content (arrow I). The mapping system should collect and analysis historical and current data regarding the virtual network and server conditions. This data is used to choose an edge server that is located close to the end user.

Each edge server is part of the edge server platform, a distributed deployment of servers located in many sites. These servers are responsible for processing requests from nearby EUs and receiving content generated by them (arrow 2).

In order to respond to a request from a user, the UATN must deliver the content stored by edg server/servers to the designated data center. The transport system is used to deliver content between edge server platform and designated data center in a reliable and efficient manner. More generally, the transport system is responsible for moving data and content over the long-haul Internet with high reliability and performance.

The communications and control system is used for disseminating status information, control messages, and configuration updates in a fault-tolerant and timely fashion.

Finally, the user control portal serves two functions. First, it provides a configuration management platform that allows a USP to retain fine-grained control how the content is uploaded to their data center by the end user. These configurations can be told timely to the edge platform via the communications and control system. Note that this configuration management applies to the third party UATN providers, if a USP deploys its own UATN, the configuration management platform can be omitted. In addition, the user control portal provides a redirection approach of user request that redirects the upload request to the UATN.

While all of UATN incorporates the component outlined above, the specific design of each system is influenced by application requirements. For instance, the transport system of a UATN will have a different set of requirements and a different architecture.

```
               **************************************
               *                    Virtual Network *
      +----    * +--------+                         *
      |E U|----->|  Edge  |                         *
      +---+    * | Server |\                        *
               * +--------+ \                       *
               *             \     , --,--,--.      * +-----------+
      +---+    * +--------+   ----'-------------`-.-->|           |
      |E U|----->|  Edge  |---( Transport System  )-->|Data Center|
      +---+    * | Server |   -`-.-------------,'---->|           |
               * +--------+  /      `--'--'--'      * +-----^-----+
               *            / III                   *       |
      +---+ II * +--------+/                        *       |
      |E U|----->|  Edge  |                         *       |
      +---+    * | Server |                         *  +----v----+
               * +- ^-----+                         *  |   USP   |
        |      *** / ********************************  +----^----+
        |         /                                         |
        |      +--|-------------------------------------+   |
        |      |    Communication and Control System    |   |
        | I    +--|-- ^--------------------------------^-+   |
        |         |   |                                |     |
        \     +---v---v-----------+       +-----------v-----v---+
         - -> |   Mapping System  |       | User Control Portal |
              +-------------------+       +---------------------+
```

Figure 5

4. New Protocol Considerations

This document does not call for changes or additions: any new session, transport or network protocols; new protocols for delivering content from a UATN to an End User/User agent; new protocols for ingestion of content between a UATN and a USP.

5. Security Considerations

This document focuses on approach and the motivational use cases for UATN, and does not analyze the associated threats. Those threats will be discussed in future.

6. Acknowledgments

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