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Video Delivery in Hybrid Network
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Abstract

The industry trend of delivering video service is moving towards all IP solutions. However, there exit multiple incompatible platforms for video distribution. This document explores the existing video delivery technologies and analyses the challenges of unifying those technologies.

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1. Introduction

Video content delivery is now the major bandwidth usage over the Internet. Globally, IP video traffic will be 82 percent of all IP traffic (both business and consumer) by 2020, up from 70 percent in 2015. 4K Ultra HD technology is by itself a very new trend in the overall electronics landscape, and the impact of it is growing month by month. More content is accessible, in more formats, on more devices, for more people than ever before. Content providers and broadcasters are embracing multi-platform to attract more audiences. For example, IPTV providers not just provide video services on fix network but also consider to start the services for mobile accessed users; Traditional broadcasters not just provide services over cable or satellite, but also consider to start the services over IP network. How to transmit video traffic efficiently over these mutli-platforms poses challenges to these service providers.

This document explores the existing video delivery technologies and analyses these challenges.

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 RFC 2119 [RFC2119].

3. Multi-platform for Video distribution

The same content could be delivered in different networks including broadband, mobile, satellite, cable and terrestrial. And the receiving devices can be all kinds of STBs, mobile phones, tablets and PCs. This is shown in Figure 1.

```
                           Distributions other than IP:
                     +---> Satellite/Terrestrial/Cable
                     |
                     |
     +---------+     |     +---------+             +-----------+
     | Video   | ----+     | IP      | ----------> | IP Mobile | ---+
     | Sources | --------> | Headend | ------+     | Network   |    |
     +---------+           +---------+      |      +-----------+    |
                                            |                       |
                                            |      +-----------+    |
                    To a proliferation      +----> | IP Fixed  | ---+
                       of user devices:            | Network   |    |
                             TV/STBs               +-----------+    |
                             Phones                                 |
                             Tablets    <---------------------------+
                             Desktops
```

Figure 1: Multi-platform Distribution for Video

4. Looking into the Protocols

```
              |        File Mode          | |    Packet      |
              |                           | |     Mode       |
              v                           v |                |
                                            |                |
              +--------------------------+ |                |
              | Codecs                    | v                v
              +--------------------------+
              +--------------------------+ +----------------+
              | ISOBMFF/MPEG-2 TS(M2TS)   | | Codecs/M2TS    |
              +--------------------------+ +----------------+
              +-----------+ +-------------+ +----------------+
              | HTTP      | | NORM/FLUTE  | | RTP            |
              +-----------+ +-------------+ +----------------+

              ^           ^ ^                                ^
              |           | |                                |
              | Pull Mode | |           Push Mode            |
```

Figure 2: Video Delivery Protocol Stacks

Today, there exist many diverged video delivery protocol stacks, as listed in Figure 2. Looking bottom-up, from the angle of transmission methods, the protocol stacks can be categorized into two modes: "Pull Mode" and "Push Mode". In "Pull Mode", client takes the initiative and pulls content from server proactively. Typical "Pull Mode" methods include HTTP progressive download and HTTP Adaptive

Stream (e.g. HLS and DASH). On the other hand, "Push Mode" operations are more server oriented. After session has been established, server controls the delivery by intentionally pushing content to client. Typical "Pull Mode" transmissions include IPTV and other multicast based methods.

Another way to look at the protocol stacks is from the top-down angle, regarding how media are prepared before transmission. Traditional media delivery utilizes "Packet Mode", in which media is packetized with regard to their internal structure, so the resulting packets are optimized for transport and more loss tolerant. An example is transporting H.264 encoded video directly over RTP. Unlike "Packet Mode", segmented media grows more popular as they are adopted by HTTP Adaptive Streaming. Segmented media are referred to as "File Mode" in Figure 2, for the fact that media segments are seen as plain files, and described by additional manifests.

The divergence in the protocol stacks has brought several issues, as the bottom-up angle and the top-down angel do not align with each other ("File Mode" and "Push Mode" are overlapping):

- o "File Mode" is not quite suitable to be used in "Push Mode", as the transports lack timing information.

- o "File Mode" is very difficult to be converted into "Packet Mode", and thus cannot be transported using unreliable protocols such as RTP.

The divergence increases the overall complexity of video delivery. The next section analyzes the impact introduced by the complexity.

5. Impact of Diversity on IP distribution

Currently the IP Headend (as in Figure 1) is unduly complicated by the diversity on IP distribution, as illustrated below:

```
Video                      unicast
Sources      +---------+  (Pull Mode & Push Mode)
-----------> | IP      | ------------------------->
             | Headend |  multicast (Push Mode)
             +----+----+ =========================>
                  |
     +------------+------------+
     |            |            |
Encoding      Packaging     Protection
o MPEG-2      o M2TS        o Access Control
o H.264       o DASH        o Digital Right Management
o H.265       o HLS         o Encryption
```

Figure 3: Complicated IP Headend

It is a tedious job for the IP Headend to encode the same content into different variants using different media profiles, prepare them in several types of packaging, and apply different protection mechanisms before the variants are served. The consequence is increased cost in design, deployment, test and operation.

The situation is further complicated by the diversity of network delivery mechanisms and content forms. Unicast delivery supports "Pull Mode" and "Push Mode", whereas multicast delivery only supports "Push Mode". Each delivery mechanism uses different transport protocols and support different content forms. "Pull Mode" supports "File Mode" content, and "Push Mode" supports content in both "File Mode" and "Push Mode".

"File Mode" content is usually served in "Pull mode". However, it can also be served in "Push Mode" by using reliable multicast technologies (e.g. FLUTE, NORM). Serving "File Mode" content with "Push Mode" delivery would increase delay, as the reliability mechanisms imply using retransmission to recover lost data. It has impact on applications that require low-delay transport, for example, live video or virtual reality.

If an application can tolerate a level of packet loss, then it is possible for the application to transform content from "File Mode" into "Packet mode", and transfer more efficiently in "Push Mode". An example would be to transform HLS media segments of MPEG-2 TS format into RTP packets, and multicast those RTP packets carrying MPEG-2 TS content to endpoints. However, this is only possible if the application is authorized to access the content and do the transformation. It is usually not the case in real-life scenarios. In order to protect contents, such transformation is not allowed in delivery by content providers.

There have been efforts to provide convergence for this diversified situation. New media packaging formats such as MMT, CMAF are proposed by MPEG that can packetize the media in application layer. So the same packaged media content can support both "File Mode" and "Packet Mode". To support the new packaging formats, maybe a content agnostic transport protocol should be developed here in IETF.

6. Security Considerations

TBD.

7. IANA Considerations

None.

8. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <http://www.rfc-editor.org/info/rfc2119>.

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