Streaming Content Wars: Download and Play Strikes Back

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Abstract. In this paper, the latest developments in the provision of streaming multimedia over the internet are discussed. We emphasize on the newly appearing HTTP adaptive streaming approach that threatens the reign of RTSP, as regards the support of real time media streaming, and we examine the possible uses of each of the two protocols with respect to the different transmission needs, as these are seen from the transport protocol view point.

Keywords: download, progressive download, streaming, HTTP adaptive streaming.

1 Introduction

In response to the technological developments in the technologies available for enhancing the user's viewing experience, media consuming society is driving more and more demanding. The fact that consumers can choose and switch among many different but allied media contents (i.e. when visiting a site on the Internet), reveals the increasing need of streaming services development and the corresponding support by networking protocols and media playback applications.

To this direction, several alternatives have been proposed, as regards the use of protocols, architectures and media distribution models. In the meanwhile, the diffusion of Content Delivery Networks (CDNs) has lead to the increase of the available bandwidth for clients. This fact has an impact on the technologies used for media streaming, as the availability of extra bandwidth has permitted the consideration of protocols traditionally considered as inappropriate for streaming, due to the large overhead that they incur [2]. As a consequence, we have to re-evaluate the standard streaming technologies under the light of this new situation, and also to take into account extra parameters, such as compatibility with web browsers, popularity of technologies for accessing short clips (i.e. videos over YouTube) and current conditions in the media market.

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In this paper, we make an evaluation of the available technologies, having in mind the most challenging scenario: that of live media streaming. In this evaluation, both the main rivals: HTTP and RTSP are considered, and the advantages of the use of each protocol, with respect to the particular distribution environment (unicast, multicast, broadcast) are highlighted. The rest of the paper is organized as follows: In section 2, a report on the technologies used for media distribution is provided. In section 3, an analysis on the selection of the appropriate protocol based on the transmission mode is given. Finally, section 4 closes the paper with conclusions and a use case scenario.

2 History and State of the Art in Media Streaming Technologies

Before continuing with our evaluation, we will go through a general overview of the different technologies used for accessing media content streams over the web. Here, it should be noted that the term of media content is considered to cover information that has a temporal dimension (video and sound) and is therefore subject to streaming. Also both stakeholder sides, namely content consumers and content producers are taken into consideration as regards their needs and requirements from a steaming platform.

From the streaming media consumers' side, it is really important to choose the latest technology for streaming/download, for two main reasons: except from the quality of the result on client's screen which evidently increases as technology advances, each technology affects the number and type of plug-ins that have to be installed on someone's PC so as to view content. The latter introduces issues of compatibility and stability of the software and application components used. On the other side, streaming producers, most of them being media and entertainment companies, focus on the use advertising-based models that depend on user's viewer satisfaction [6]. Therefore, user satisfaction here is important from an economic perspective, as it affects the audience of a particular streaming service. As a conclusion, the selection of tools for supporting the download and play or direct streaming is very important, as it may have a direct effect on the expected revenues and the user's experience and consequent use of the corresponding technologies.

Following this brief analysis, we will continue with the presentation of the technologies available for direct access to multimedia information, starting from the traditional download and play, and going to the dynamically adaptive media streaming.

2.1 Download and Play

This is simplest version of accessing multimedia information: download and play. It can be applied to both static media such as images, but also to non static such as video and sound. In this method, the client has to download and store first the whole media content on his PC and only then he/she will be able to view and use it. However, the media has to be available in the form of a file, excluding the use for covering live events, as the multimedia information that is to be transmitted cannot be "a-priori" available. Download and play is quite an old method that is unable to meet the needs

of contemporary media market. It was the first attempt of getting media content on a personal computer from a server, which, though very simple to be supported even over a web browsing session is no longer considered as an efficient solution for video access.

2.2 Traditional Streaming

In streaming, multimedia data is transferred in a stream of packets that are interpreted and rendered in real time by a software application, as the packets arrive in the user's terminal. For this reason, we need a protocol that is capable of keeping track of the client application state and the progress of the streaming process, from the initial client request for multimedia access, up to the point of connection teardown.

RTSP is the traditional and standardized streaming protocol that meets the above needs [10]. In RTSP, packets can be transmitted either over UDP or TCP; the latter is preferred due to its guaranteed delivery, in important aspect in signaling It should be noted that RTSP is used for transferring the control information as regards the handling of the stream, while the actual streaming data are sent using the Real-time Transport Protocol, RTP. Here, it should be noted that since the use of RTP is followed by the use of UDP for delivery of the stream, in cases where there is use behind firewalls, this may lead to blocking of the download stream packets. Furthermore, as UDP does not provide any congestion monitoring mechanism, diagnosis of congestion problems may take place too late, after the problem has already appeared and has affected the user experience, even lead to disconnection of the stream. The following figure provides a graphical representation of the traditional streaming approach.

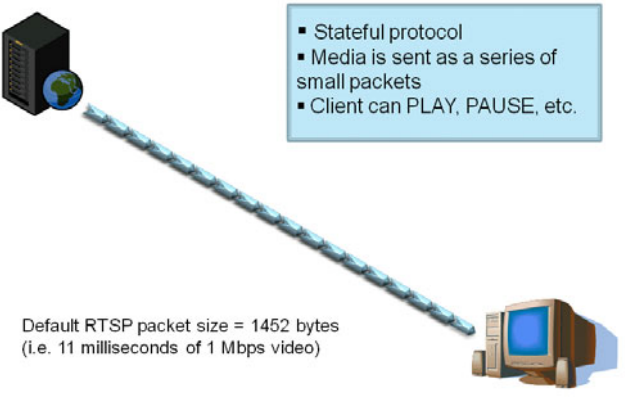

Fig. 1. Traditional streaming [1]

2.3 Progressive Download

Alternatively to the use of RTSP and RTP, the use of the HTTP protocol has been proposed, in a near streaming like approach, called progressive download. Progressive Download is a hybrid approach between the download and play and the streaming, in

which the client does not need to download the whole file before being able to locally reproduce it. Contrary to the download and play approach, content download is not downloaded as a whole but in segments. In this way, the client is able to begin playback of the segment that has already been downloaded locally, before the full download is complete. In the case of any problem, download is paused. One basic difference between streaming and progressive download is in how the media data is received and stored at the end user's terminal. In progressive download, the media data is stored on the terminal's hard drive, in contrast with (real-time) streaming, where media is only delivered, but not stored by the client. A visual presentation of the procedure described above follows in Figure 2.

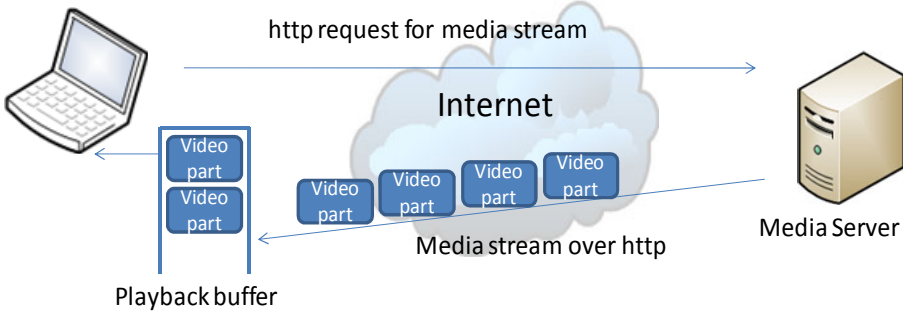

Fig. 2. Progressive Download

2.4 HTTP Adaptive Streaming

Advancing the idea of progressive download of chunks of media data so as to emulate a streaming behavior, the latest approach that seems to incorporate both the advantages of using a standard web protocol and the ability to be used for streaming even live content is the adaptive (HTTP-based) streaming. Adaptive HTTP streaming is based on HTTP progressive download, but contrary to the previous approach, here the files are very small, so that they can be compared to the streaming of packets, much like the case of using RTSP and RTP. To achieve this, the streaming server first divides video/audio file into many small segments (of various sizes) and then encodes them to the desired format. After that, according to network conditions at the time of real streaming (i.e. bandwidth), server sends to each client segments of the client requested content with appropriate size, as depicted in Figure 3. For example, when bandwidth is reduced, in order to avoid the pause of the file download, server sends segments of smaller size, reducing by this way the bit rate of the downloading process. The result is momentarily lower in quality, but uninterrupted viewing experience. Of course, after the recovering of the problem, bit rate increases. So, we get the best quality we can receive each time. The use of HTTP for conveying the streamed information introduces the advantage of having the underlying TCP protocol monitor the network conditions, and through its inherent congestion control mechanism provide the means for early detection of congestion problems.

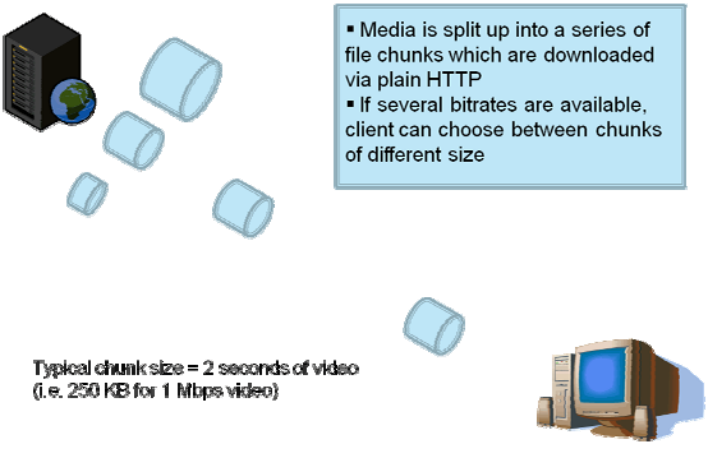

Fig. 3. HTTP Adaptive Streaming [1]

HTTP adaptive streaming enables publishers to offer the users a better video experience by employing adaptive streaming techniques, which is something large companies such as Microsoft (through Smooth Streaming[1]), Adobe Systems[8], Move Networks[5] and Swarmcast[7] have already embraced.

3 Selecting the Best Method Based on User (Transmission) Modes

Following the brief presentation of the different methods for supporting media streaming, in this section we identify the suitability of each method, based in the particular parameters that exist as regards the needs for transmission. The analysis that will follow is focused on the support of real time streaming information, targeting at the live coverage of event. This is considered the worse scenario, which by far covers the needs for streaming information in general, as it has to take into account the direct processing and transmission of the streams, upon production based on live feeds. This automatically allows only two candidates: RTSP and HTTP adaptive streaming.

Furthermore, emphasis is given in the aspect of personalization, as this is an innovation that IPTV or Web-TV services can offer compared to the traditional TV services. By the term personalization, we refer to the specialization of the media streams offered to the end users, so as to match the personal preferences as regards both the content and the specific device parameters (size of screen, processor power e.a.). A detailed analysis as regards the personalization of the media streams can be found in the corresponding report of my-eDirector 2012 project [3] that addresses these issues. It should be noted here that as regards the selection of network access, taking into account the plethora of technologies, all wired, wireless and mobile technologies should be taken under consideration (xDSL, Ethernet, WiMax, WLAN, 3G, and Bluetooth). As many of the above cases present similarities regardless of the status of the physical media involved (i.e. Ethernet and WLAN), evaluation should not be performed based on the particular characteristics of the physical medium, but

rather based on the characteristics of the transmission method. Based on this, the three transmission methods, Unicast, Multicast and Broadcast, are used in the following sections of the paper to present the suitability for use of each protocol.

3.1 Supporting the Unicast Transmission Mode

Here, the use of HTTP adaptive streaming is considered the best candidate, since through the use of the appropriate technology at the server (i.e. Smooth Streaming [1]) it is able to adapt the stream to the available bandwidth. Furthermore, it is able to seamlessly address issues arising both during mobility across domains, but also when switching between network technologies, with immediate redirection of the streaming packet routes. Based on the use of HTTP adaptive streaming, seamless switching between bitrates and encoding levels in order to adapt to the network conditions, and seamless switching across network technologies can be supported. Furthermore, seamless switching across devices is also possible, to the level that this can be supported by the operating systems and the application frameworks available in each device.

3.2 Supporting the Multicast Transmission Mode

As regards the use of multicast, this is mainly of interest to the case where wireless access network technologies are involved, in order to provide a more efficient use of the scarce available bandwidth. Use over wired technologies of course presents no challenges and can be provided in the same way. In the case of multicast use case scenarios, one major challenge is the ability to support seamless switching between transmission modes (unicast to multicast and vice versa) within the same access network technologies, and adaptation to the network conditions based on selection of transmission scheme. To support the above, the use of selection of RTP based adaptive streaming with the use of SIP-RTSP protocols is the best option, as it inherently supports multicasting. The use of HTTP here is not an option due to its unicast oriented nature.

It should be noted that an added value feature in the case of multicasting is the ability to provide personalization of the media streaming experience. This can either be supported through the dynamic selection of multicast channel according to the personal preferences of users, or through the switching from multicast to unicast in cases of reduced interest to particular streams.

3.3 Supporting the Broadcast Transmission Mode

As regards the use of broadcast, this is best suited to TV like use case scenarios, and for this DVB-H and DVB-T technologies are the most appropriate. Here, one major challenge is the personalization of the streaming experience. Two different approaches can be considered here: the first regards personalized coverage over DVB-H, bypassing the issue that use of broadcasting does not allow the provision of a separate per user stream at the download, while the second addresses the issue of the

effective use of DVB-H in order to offer the user a more rich experience that will allow him/her to personalize the viewing experience.

To achieve the above, extensions to the traditional DVB-H support are needed, according to which the terminal is considered to be operating as a plain TV-like receiver will be able to receive extra recommendation information and real-time metadata about the received streams, while feedback from the user's selections will be sent back to the system. This can be available through the use of extra communication channels based on multicast and unicast transmission through the use of 3G or WiFi technologies, in parallel to the DVB-H streams. Use of SIP protocol can be deployed here in order to support the return channel and to convey the user's selections, enhancing the end user experience over the DVB-H transmitted stream and introducing full interactivity capabilities to the media distribution model.

In the context of this scenario, switching (not necessarily seamlessly) between unicast and broadcast can be performed according to the personal preferences of the users, so as to better accommodate the needs for personalization of the transmission.

4 Use Case Scenario and Conclusions

From the above analysis, we can see that the selection of the best way to support the media streaming services depends on the transmission mode that will be applied. Though HTTP offers more capabilities for personalization of the offered streams, it is oriented towards unicast transmission, which is not as effective as alternative methods such as multicast and broadcast. Furthermore, since HTTP adaptive streaming is making use of standard protocols (the exact same protocols used for access to web services) their deployment over a wide range of platforms and network environments is seamless, creating minimum implications as regards the use behind firewalls and NATs. Finally, the ability to deploy TCP transmission for the media streams and the control information, offers an advantage as regards early detection of network congestion and also fast adaptation of the transported stream rate.

On the other hand, use of RTSP is closely related to the efficient use of the network resources, as it can be easily deployed over all types of transmission. Therefore, bulk distribution of streams using multicast and broadcast can be supported, while for accommodating the return channel needs with user selections and feedback can be still be supported over unicast. Furthermore, RTSP protocol is designed to accommodate streaming of media and therefore inherently supports media handling capabilities.

The selection of the most appropriate method therefore lies in the hands of the engineers that design the end to end distribution architecture. Though there is no golden rule as regards the selection of the protocol, several parameters can be evaluated so as the reach a decision: Need for multicast/broadcast, need for operation behind firewalls and NATs, switching among devices and networks. An example for selection is presented in the following table, taken from the access network technologies selected in my-eDirector 2012 project and the corresponding support in terms of protocols.

Table 1. Selection of protocols and access network technologies in My-e-Director 2012[9]

	Access Network Technology	Data Transfer	Streaming Protocol	Transfer Protocol	Return channel feedback
UNICAST	**Ethernet**	IP	HTTP	TCP	HTTP
	ADSL	IP	HTTP	TCP	HTTP
	WiFi	IP	HTTP	TCP	HTTP
	3G	IP	HTTP	TCP	HTTP
	WiMAX	IP	HTTP	TCP	HTTP
MULTICAST	**WiFi**	IP	RTP	UDP	SIP - RTSP
	WiMAX	IP	RTP	UDP	SIP - RTSP
	Ethernet	IP	RTP	UDP	SIP - RTSP
BROADCAST	**DVB - H**	TS	MPE 2-TS	MPE-FEC	HTTP

In the above table, we see that following the analysis presented earlier in the paper, the corresponding use of HTTP and RTSP has been selected so as to match the different needs for transmission of the streams. As one of the key aspects of the project is personalization of the streams, provision has been taken in order to be able to offer personalized services even in the case where multicast and broadcast is used. The results clearly indicated that no single universal can be adopted.

As a conclusion, the return of the progressive download has been remarkable, as it has been accompanied by the corresponding capability for adaptive transformation of the stream, even in conditions of real time coverage of events. However, the use of RTSP is still the only solution when it comes to the use of multicast and broadcast, while the forthcoming developments with the introduction of IPv6 and the next generation of RTSP may create new scenery in the field of media streaming over the internet.

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