Adaptive Video Acceleration™

White Paper

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1. Preface

Giraffic is the enabler of Next Generation Internet TV broadcast technology for OTT Video providers and Consumer Electronics Device Manufacturers, bridging the gap between TV broadcast quality and the boundaries of Internet & mobile video.

Through Giraffic's patented Adaptive Video Acceleration™ (AVA) thin software solution, viewers can now enjoy the highest possible quality video (resolution/bitrate) over their existing Internet connection including UHD 4K streaming, faster streaming and downloads, minimum re-buffering, without relying on network infrastructure upgrades or interconnection agreements. Adopted by major market leaders and with over 50 Million Giraffic-accelerated devices rolling out, Adaptive Video Acceleration™ technology performs bandwidth analytics, HTTP optimization, and play optimization of video delivery and other rich media or large files. Giraffic's Adaptive Video Acceleration™ is a client-only solution on the device that integrates into Device SDK or into Applications, requires no server-side integration and is complementary to the existing video delivery ecosystem.

This white paper describes **Giraffic Adaptive Video Acceleration™** solution.

In section 2 we provide an overview of AVA, and in section 3 we offer a close-up of the algorithm.

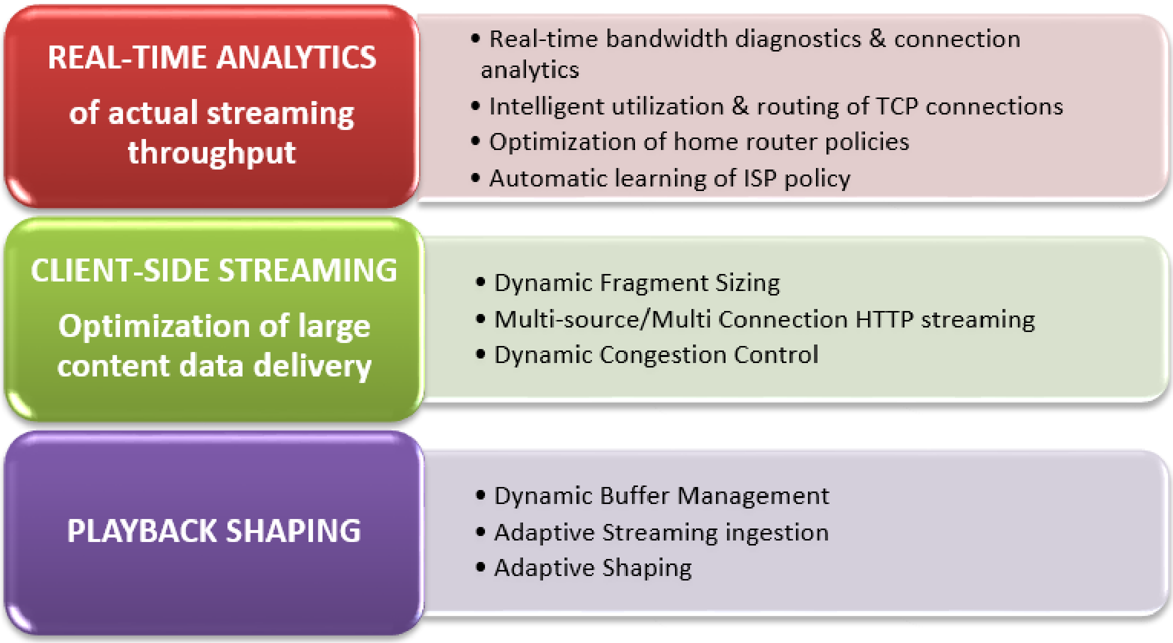
2. Introducing Adaptive Video Acceleration™ (AVA)

"Over-the-Top" (OTT) TV or Broadband TV's phenomenal growth in the recent years has caused a major change in the media production, distribution, and consumption. Internet video traffic represents over 50% of all internet traffic, delivered via billions of connected devices. Beyond the traditional TV experience, online video is equally consumed on tablets and smartphones. Wireline and wireless connectivity being inconsistent in nature, the viewing experience is often burdened with various artefacts from re-buffering in the case of progressive download to sub-optimal video resolution with adaptive streaming. Some solutions have aimed at reconciling the Quality of Experience (QoE) and Quality of Service (QoS) but those require comprehensive network and server side integrations.

With Giraffic's client-only patented AVA, the Consumer Electronics device manufacturers and OTT video providers can now offer the end users the highest possible video resolution over any given Internet connection, enabling UHD 4K, 3DHD (15-30 Mbps) and a sustained consistent throughput for the entire streaming duration.

2.1 Solution at a Glance

In order to control efficiently the throughput and the routing of TCP connections, AVA analyzes the network conditions and home router policies. This intelligent learning allows to predict accurately the actual throughput, the adaptive resolution and to request pre-downloading of the video data dynamically.



2.2 Technology Highlights

- **AVA is a Client-only solution** – no server integration
    a. AVA is completely standards based (HTTP) + HTTPS
    b. Can be implemented on Application, Device or Chipset level.
- **AVA features a wide support** – any device, any OS, any protocols
    a. Available on Mobile, Tablet, PC, Smart TV, STB, Gaming Console
    b. Any Operating System – IOS, Android, Windows, Linux, Macintosh
    c. Protocols - HTTP/S, HLS, Smooth Streaming, Mpeg-Dash…
- **Security/DRM -** Giraffic maintains content's existing encryption and copyright protection
- **Minimal System Requirements**
    a. Competitive Memory Footprint and Memory Usage
    b. Low CPU usage

3. Technology

A problem frequently encountered by many internet users is re-buffering pauses during video streams, or when using Adaptive Streaming – lower quality (Bitrate) of content being viewed. This phenomenon is particularly frequent when the actual end-users internet connection capacity/throughput is very close to that of the stream quality being consumed, or when the video source is geographically remote from the end user and requires intersecting over multiple networks examples are:

- Shared Wi-Fi connections
- Wireless cellular networks, including 4G/LTE.

- Crowded High speed links (Cable)
- Low quality (high packet loss) links in developing countries
- Local ISP connection is stronger than outboard ISP connection and can't be fully utilized (example: end-user has 5Mbps ADSL line, but is actually downloading at 2Mbps speed).
- Poor routing, but Server and Client connectivity is actually strong.

Video quality being one of the main factors that can impact the viewer's engagement, many attempts at reducing buffering have been made, including streaming protocol congestion control mechanism, compression rate adjustments on-the-fly and Adaptive Streaming protocols where the stream bitrate changes dynamically in accordance with the network condition (Apple HLS, MPEG-DASH, Adobe HDS, Microsoft Smooth Streaming…). Using several streams for downloading a file has been previously proposed. However such methods focused either on downloading the entire file or using the playing bitrate of a streaming a media file to calculate the next fragment to download.

In the case of Adaptive Streaming several versions of the same file (usually with different quality levels) are generated, offering alternatives for the player for every new fragment of data (chunk) to download. The player receives a manifest file describing the list of fragments (and how to retrieve them i.e. URLs/URL pattern) for any particular quality (resolution) level. The typical player then starts downloading the fragments serially while measuring the performance/bandwidth in order to adapt the quality level accordingly. Adaptive Streaming has eliminated re-buffering for most cases, but at the expense of video quality (bitrate) – hence users are getting sub-optimal video quality and with more pixelated and fuzzy viewing – particularly on a big screen.

3.1.1 Congestion Control

AVA provides a congestion control method while dynamically maximizing communication link download throughput, comprising dynamically creating and deleting concurrent download session from one or more URLs and dynamically changing the size of data chunks for each session by continuously monitoring the overall congestion status of said link. Periodical checks aim at updating monitored network statistics to reflect the most current network conditions and select accordingly the most appropriate acceleration strategy. At each period, the number of concurrent download sessions may get updated along with the duration of each session. Subsequently sessions may get created, deleted or change status. Data will be downloaded according to the selected strategy until it is replaced by a more effective strategy that can better utilize the download throughput.

The patented AVA dynamic congestion control algorithm also guarantees that various sub-streams are always strictly complementing each other, without interfering with one another.

Performance benchmarks have been made jointly as well as independently by leading OEM Device Manufacturers and OTT customers, prospects and ecosystem partners worldwide, validating AVA technology on many Consumer Electronics Entertainment platforms. Such benchmarks have revealed an average performance of 3X throughput over different networking conditions, virtually eliminating all re-buffering events. AVA will perform acceleration only when necessary: when the line utilization is good or the network is clear, AVA will not kick in, so no improvement will be observed. In other cases, the end user may experience up to 8X acceleration.

Fig.1 represents a 3X performance gain when streaming content over a real home-line environment. We can observe an increased throughput from 80% to 5X, as the direct result of parallel dynamic connections processing.

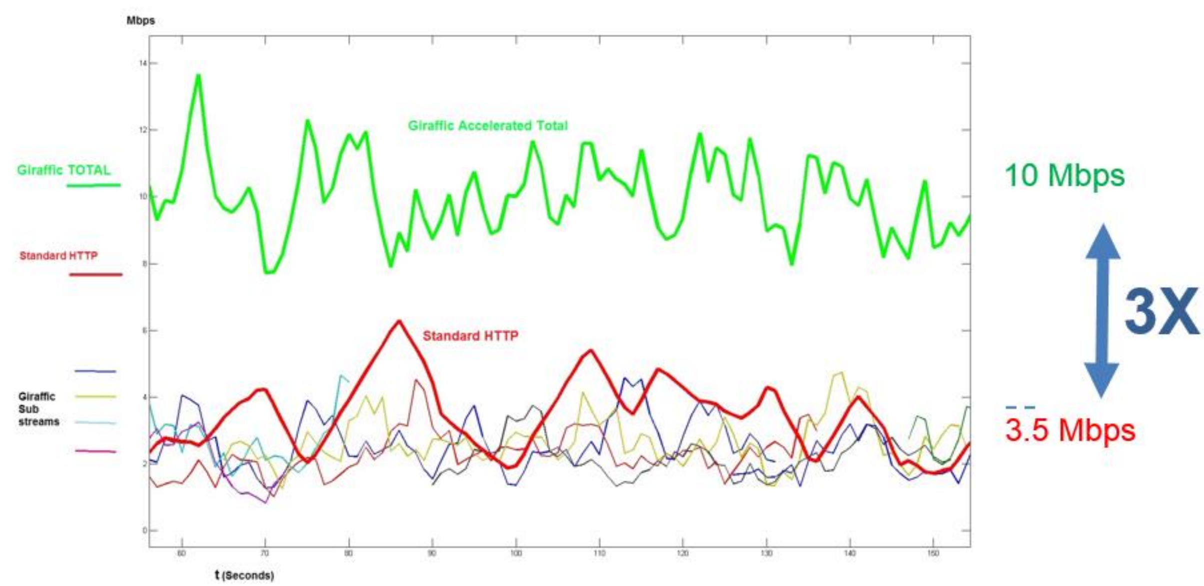


Fig.1 Giraffic Multi-Source Streaming Acceleration Vs Standard HTTP

3.1.2 Playback for Adaptive Streaming

In the case of Adaptive Streaming, additional processing is performed in order to provide the highest possible resolution within the existing networking conditions. This paragraph describes Giraffic's playback shaping predictive process.

Let us consider a typical adaptive video streaming system, comprising of a data source, a video player and a download session controller: the video player initiates the streaming session by requesting the adaptive video manifest which includes metadata of all the possible video and audio qualities. The Giraffic agent parses and learns about the manifest then sends it to the player. At this point the player starts requesting fragments of one of the available resolutions. At start time, the video player aims to fill the video buffer to a predetermined level as fast as possible that enables the playback to start. After it reached that state, the player maintains the buffer size by downloading a new chunk as soon as the previous one has arrived. The player selects the chunk from the video files with the bitrate and resolution corresponding to the maximal network bandwidth capacity detected. Naturally, the network conditions are fluctuating, the end-user experiences frequent video quality variations. In order to avoid such artefacts, AVA accelerates the download speed in two phases: first it aims at maximizing the download throughput by connecting between the data source and the video player a session controller configured to manage a variable number of streams in parallel and an adaptive streaming optimizer configured to predict the next requested resolution by the player.

This goal is achieved by:

1. Shaping the network bursts, thus guaranteeing high quality video with minimal resolution changes.
2. Maximizing download speed for a given internet connection, thus guaranteeing that the player displays the highest resolution possible at minimal resolution changes.

The session controller provides a general mechanism that uses in parallel a variable number of streams in order to maximize the link throughput at any time, and consists of an adaptive streaming optimizer. Fig. 2 provides an overview of the optimized system, fig. 3 depicts the session controller mechanism.

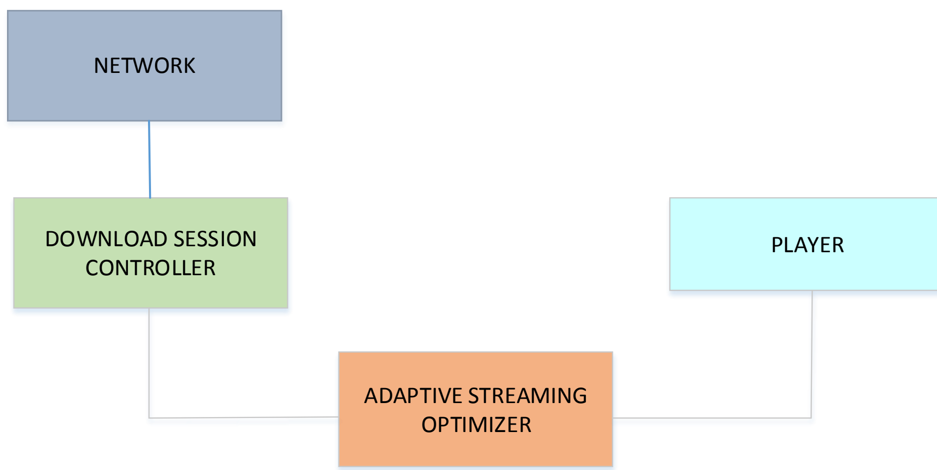


Fig.2 System Overview

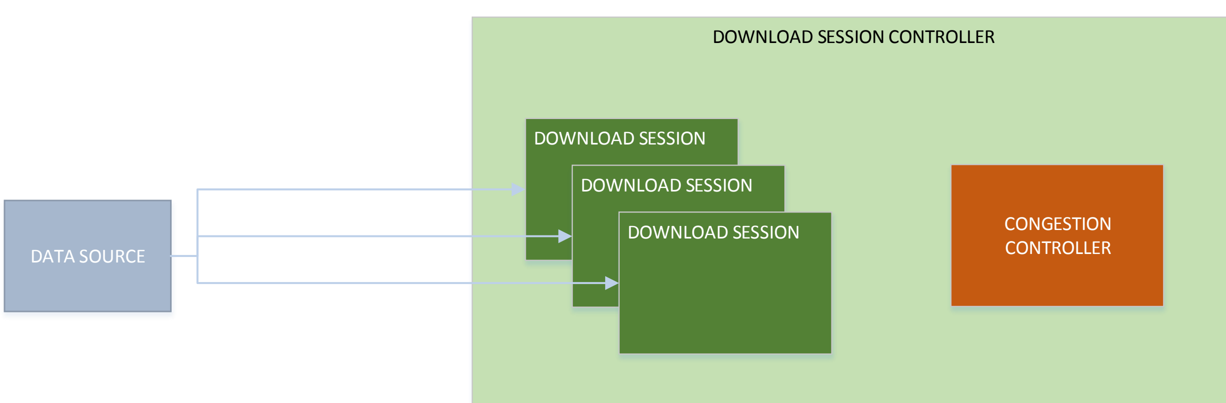


Fig. 3 Download session controller

In adaptive streaming, each stream of a given quality (resolution) is built from fragments. This provides the player the ability to switch between fragments from different stream quality according to the network conditions.
In order to accelerate Adaptive Presentations, the optimizer will get information about the different stream versions available, their relations and the fragments of each individual streams from the manifest file (".m3u8" for HLS, "/manifest" for SmoothStreaming, ".mpd" for MPEG-DASH) as well as the metadata.
Here are the steps performed by the adaptive streaming optimizer:

- The optimizer receives from the player a request for an adaptive video stream to be downloaded from a given URL through a manifest that carries the audio and video quality metadata. The optimizer parses, learns about the manifest then sends it to the player. The player specifies the required resolution.

- The optimizer starts downloading fragments of the requested resolution from the given URL and uploading them to the player.

- Then the optimizer begins performing the optimization process, adjusting the download rate for maximal throughput and upload the accelerated fragments to the player. The process repeats until the end of the stream is reached or a "Fail" status is detected.

Fig. 4 shows a performance enhancement of 2-3x over un-accelerated streaming and the sustained Quality of Service (QoS) resulting from playback shaping: after initial analysis of the network, the adaptive streaming stabilizes and downloads the 6Mbps-encoded video until the end of the playback, while streaming without AVA results in high bitrate variations from one set of fragments to another. This benchmark was performed on a smart TV, streaming a Microsoft Smooth Streaming video clip through Amazon Instant Video, on an ADSL line with a speed of 15 Mbps.

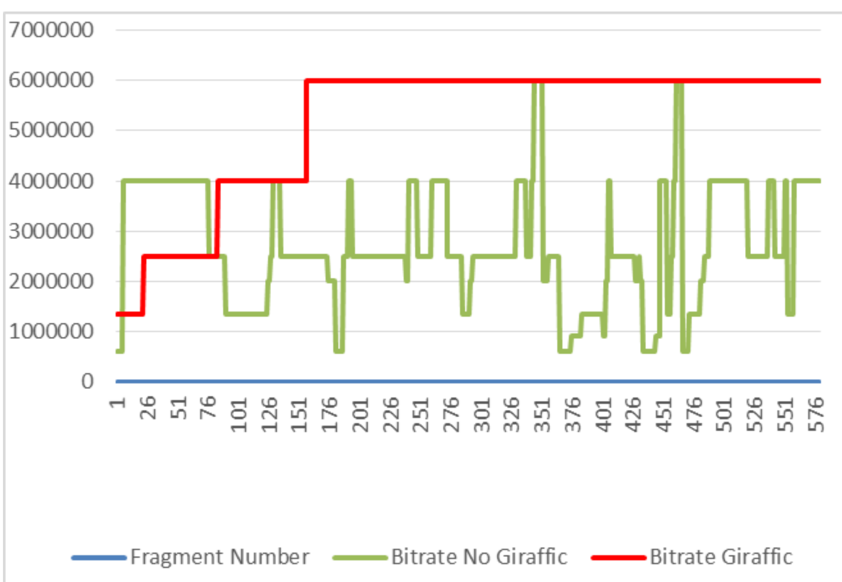


Fig. 4 Optimization of a Smooth Streaming video clip

3.1.3 DRM and Security

For secured or encrypted data, the same algorithm applies with additional steps involving retrieving the decryption keys from the key server and authenticating the device in use. In the case when the manifest response includes a cookie for requesting the fragments, the Giraffic agent handles the cookies on behalf of the player.

3.2 Integration

The Giraffic client can be integrated on the device operating system / firmware level or player – in order to enable acceleration of all content being streamed or downloaded on such device, agnostic to the content providers, or it can also be integrated within particular apps as part of the content providers' application (as a shared/static library within the Application).

Giraffic's AVA is a cross-platform solution with support for iOS, Android, Linux, Windows, etc... It can be implemented on the middleware level, device OS level or part of the firmware on a chip-level solution. The only requirement is that http 1.1 range request feature is supported on the device of interest.

Fig.5 provides an example of Giraffic integration on a Linux platform. Other platform integration will involve the same steps, namely:

- Run Giraffic Agent as a background service
- Redirect all URL traffic to the Giraffic proxy

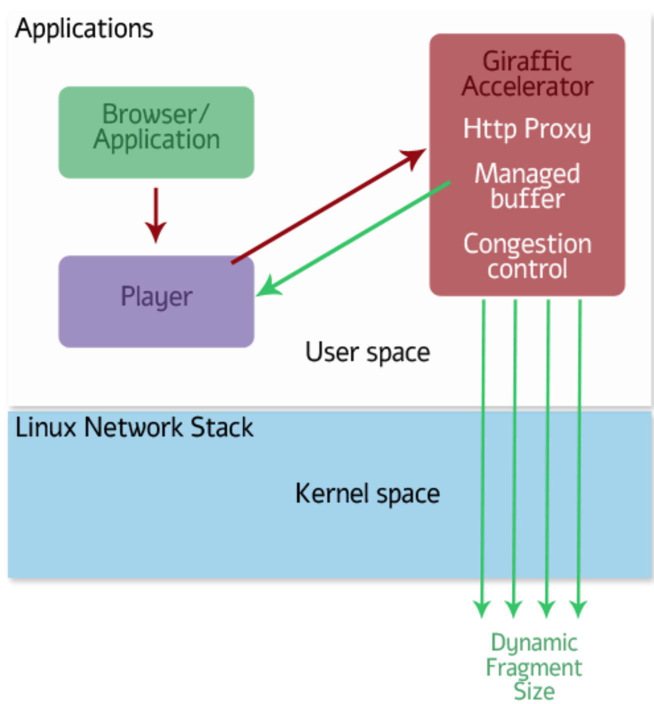


Fig. 5 Example of client-integration on Linux platform

4. Summary

Giraffic's patented Adaptive Video Acceleration technology applied to adaptive streaming is a simple, easy-to-integrate and elegant solution as it requires minimal memory and CPU usage. Being entirely client-based, AVA is maximizing the throughput and is complementary to other existing ecosystem solutions such as efficient video encoding, Adaptive Streaming (HLS, SmoothStreaming, MPEG-DASH), and the network and CDN ecosystem.

OTT content providers and Consumer Electronics Entertainment device manufacturers can now offer the demanding online consumer broadcast-TV quality by integrating either at the applications level or at the device middleware level. **With an average performance of 3X, the end-user benefits a smooth viewing up to UHD (4K) and 3DHD experience throughout the entire playback duration in most networking conditions.**

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For further information on Giraffic's Adaptive Video Acceleration technology, please contact sales@giraffic.com or visit www.giraffic.com.

The content of this white paper is protected under patents:

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