Video Streaming over Multimedia Network using TCP

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Abstract- ***This paper aims to study about Video Streaming Services. Video streaming services have become increasingly popular, especially in the wake of the COVID-19 pandemic. These services have reached every corner of the world and have transformed the way we consume media.The business model of a video live streaming platform involves both a streamer and a platform provider, who simultaneously have an incentive alignment and a payoff conflict. The streaming platform relies on the efforts of streamers to strengthen its market share. Streamers can employ influencer marketing to construct their own additional revenue from commercials, which can affect the sales from the advertisements operated by the platform.In addition to advertising, major revenue sources of video live streaming services include subscriptions. To promote marketers' merchandise, video live streaming platform providers can utilize pre-roll ads or mid-roll ads, which appear before a live video starts or in the middle of a live video.***

Indexed Terms- ***Streaming, On-Demand, Live Streaming. Buffering, Bandwidth, Data Packets, Content Management System (CMS), Library, Recommendations, Feedback, Parental Control.***

I. INTRODUCTION

Video streaming services are online platforms that provide multimedia content such as TV shows, movies, music, or audiobooks1. Here's a brief introduction:

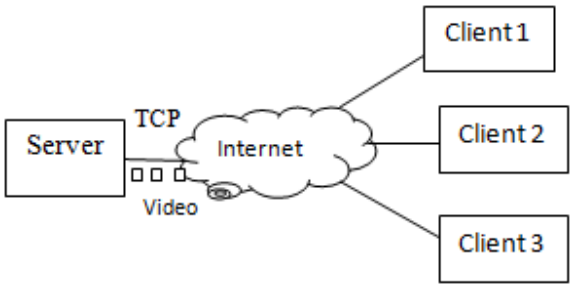
What is Streaming?

Streaming is the continuous transmission of audio or video files from a server to a client. In simpler terms, streaming is what happens when consumers watch TV or listen to podcasts on Internet-connected devices. With streaming, the media file being played on the client device is stored remotely, and is transmitted a few seconds at a time over the Internet.

How Does Streaming Work?

Just like other data that's sent over the Internet, audio and video data is broken down into data packets. Each packet contains a small piece of the file, and an audio or video player in the browser on the client device takes the flow of data packets and interprets them as video or audio.

Streaming vs Downloading:
Streaming is real-time, and it's more efficient than downloading media files. If a video file is downloaded, a copy of the entire file is saved onto a device's hard drive, and the video cannot play until the entire file finishes downloading. If it's streamed instead, the browser plays the video without actually copying and saving it



II. FEATURES OF STREAMING SERVICES

Streaming services offer a variety of features to enhance the user experience. Here are some key features that users often look for in streaming platforms:

User-friendly interface: A simple and intuitive interface is crucial. Statistics show that 70% of

customers abandon purchases because of bad user experience1. Users want easy access to their content without having to navigate through a confusing array of buttons, tabs, and folders.

Security and privacy: With easy and unlimited access to visual and audio content, it's important to ensure the safety of users. This involves choosing the right servers, taking care of encryption standards, certificates, and security protocols.

Video Content Management: A Content Management System (CMS) is a must-have for every streaming platform. It helps manage and organize the content that is being streamed.

Scalability: As the number of users increases, the platform should be able to scale and handle the increased load.

Pricing plans: Different pricing plans cater to different segments of users, offering flexibility and options.

Onboarding: A smooth onboarding process ensures users can easily understand and navigate the platform.

Registration: An easy and secure registration process is essential.

Search: A robust search function allows users to easily find the content they're looking for.

Library: A vast library of content ensures users always have something new to watch.

Recommendations: Personalized recommendations based on user preferences and viewing history enhance the user experience.

Feedback: Platforms should have a system for users to provide feedback, helping to improve the service.

Offline availability: The ability to download content for offline viewing is a valuable feature for users with limited or unreliable internet access.

Multi-language support: Support for multiple languages ensures the platform is accessible to users from different linguistic backgrounds

2.1 Disadvantages of Using Streaming Services

a. Requires a Fast and Stable Internet Connection: Streaming videos require sufficient bandwidth to play, especially at higher quality. If your internet connection is slow or unstable, you may experience buffering, lag, or lower video quality.
b. High Data Usage: Streaming consumes a significant amount of data, which could be a concern if you have a limited data plan.
c. Risk of Impulsive Actions: Live streaming increases the risk of impulsive actions.
d. Negative Comments: Some viewers may post negative comments beneath a live video.
e. Technical Issues: Even the most prominent companies have experienced technical issues.
f. Addictive: Streaming services can be addictive, especially with the availability of binge-watching.
g. Physical Strain: Prolonged screen time can lead to physical strain and health issues.
h. Limited Content: While streaming services offer a vast library of content, they may not have every movie or show you want to watch. The availability of content can also vary by region.
i. Cost: While streaming services are generally cheaper than cable, subscribing to multiple services can add up.

2.2 Advantages of Using Streaming Services:

a. Immediate Access: Streaming content starts to play almost instantly, regardless of the size of the audio or video file. There's no need to wait for it to download in its entirety.
b. No Storage Required: Streaming doesn't require storage space. You don't need a large hard drive to hold content you want to watch or listen to.
c. High-Quality Streams: Professional streaming services often provide high-quality streams, enhancing the viewing or listening experience.
d. Greater Audience Potential: Streaming services can reach a wider, worldwide audience.
e. Variety of Content: Streaming platforms offer a wide variety of content, including movies, TV shows, music, and more.
f. Ease and Convenience: Streaming services are easy to use and offer the convenience of accessing content anytime, anywhere.
g. Analytics Tracking: Some streaming services provide analytics, helping businesses understand viewer behavior and preferences.

h. Cost-Effective: Streaming services are generally cheaper than traditional cable or satellite TV subscriptions.
i. Customizable Experience: Many streaming services offer personalized recommendations based on your viewing history and preferences.
j. Mobile Streaming: Most streaming services are mobile-friendly, allowing you to stream content on various devices.

Table 1. Summary of Features of TCP and UDP in Wireless Video Streaming

Features	TCP	UDP
Reliability	Reliable. Uses Sequence number and Ack. Avoids Packet loss	Unreliable. No sequence number and Ack so Packet loss occurs
Error Recovery and Error Concealment	TCP is a Congestion control protocol. No need of error recovery and error concealment mechanisms	UDP is a non-congestion control protocol. FEC, Retransmission mechanisms are needed
Firewall penetration	TCP penetrates with the firewall by means of HTTP	UDP does not penetrate firewall
Selective Frame transmission	TCP provides selective frame transmission	UDP do not provide selective frame transmission

III. ADVANCED TCP FOR WIRELESS ENVIRONMENT

Danny De Vleeschauwer and David Robinson [2] have proposed the HTTP adaptive video streaming mechanisms and the authors have suggested the researchers to follow the following features to make TCP more robust. H. Inamura et al [3] states the additional features of TCP.

1. Client-Side Buffer: The size of the buffer at the client end has to be chosen such that no delay occurs while streaming video
2. Early Congestion Notification (ECN): ECN signals are used to notify whether packet loss occur due to error or congestion
3. Selective Acknowledgement (SACK): Instead of sending the entire packets for retransmission, the lost packets alone are retransmitted.

Multimedia streaming via TCP-analytical performance study have been discussed in Bing Wang et al [4]. The best results are obtained in this paper, if its throughput is two times the bit rate. Kim and Ammar [5] worked on stored media streaming using TCP based on receiver buffer size. TCP streaming model and quality of experience has been assessed by Jinyao Yan et al [6].

IV. CONGESTION CONTROL ALGORITHMS IN THE INTERNET

To achieve TCP Fairness and friendliness, the congestion control methods should have the following capabilities
i. It should maintain Network Stability
ii. Effective Bandwidth utilization is needed
iii. Smooth playback is to be followed

V. CLASSIFICATION OF TCP FRIENDLY CONGESTION CONTROL ALGORITHMS

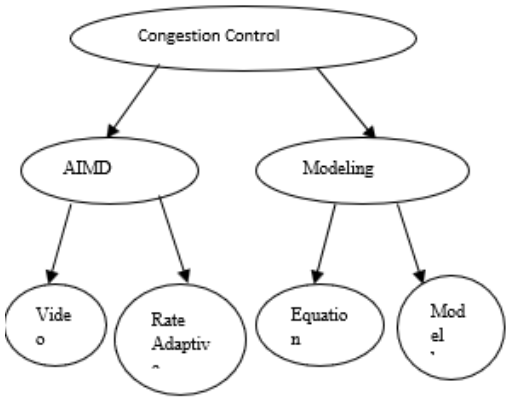


Figure 2. Classification of TCP Congestion Control Algorithms

5.1 AIMD Congestion Control Scheme

According to Qian Wang et al [7], AIMD Congestion Control Algorithm is given by AIMD(A,B)

(or)

E: Wt+s ← Wt+ A, A>0 (1)

F: Wt+δt ← (1-B) Wt, 0<B<1,

Where,

E-Window size increase

F-Window size decrease

Wt –Window Size at time t

S-Round Trip

A=1 packet

B=1/2

Disadvantage of TCP AIMD

- Oscillations in the sending rate
- Sending rate is halved for a single packet drop

5.2 Window Based Approach

D. Bansal, H. Balakrishnan [8] presents a TCP Friendly congestion control schemes by modifying the Equation1.The parameters m and n are used in equation 2.

E: Wt+s ← Wt + AnWtm; A>0 (2)

F : W t+δs ←W t- B Wt n ; 0< B<1

where,

m and n are the parameter space.

The Equation 2 becomes TCP Friendly if it satisfies the following

m+n=1 and n<=1

Disadvantage

- It is difficult to configure the parameters (m,n) space according to the required application.

5.3. Rate Based Approach

Reza Rejaie et al [9] has discussed the Rate Adaptation protocol for real time streams. The rate-based scheme is not acknowledgement based when compared with window-based scheme. Packet sending is not based on acknowledgements but it is based on the sending rate timer. Rate Adaptation Protocol (RAP) and LDA are the examples of this scheme. RAP is used in unicast playback of real time systems. RAP uses Inter Packet Gap (IPG). IPG doubles multiplicatively if congestion occurs or it decrease additively if congestion does not occur.

Advantages

- Adaptation of the sending rate reduces oscillations
- Reduces traffic in real time application

Disadvantages

- Sending rate is reduced due to single packet loss, so performance is reduced in the case of real time applications

5.4. Modeling Based Approach

J. Padhye et al [10] proposed the Modeling schemes to solve the above drawbacks. The Response Function of this scheme is given in Equation 3.

$TR=Q/(S\sqrt{2/3p}+tn(3\sqrt{3p/8}).p(1+32p2))$ (3)

Where,

TR - Maximum sending rate

Q - Size of the packet

S - Round Trip

tn - Time out value

5.5 Equation Based schemes

These schemes are developed for Unicast traffic The transmission rate depends upon rate of loss and round-trip time. These parameters are adjusted to achieve a reasonable transmission rate. According to this technique, the client has to send the feedback. TFRC is an example for this scheme

Advantage

- Sending rate is reduced to half for successive loss events

5.5.1 Design goals of TFRC

S. Floyd et al [11] proposed the TFRC for Unicast traffic. The authors have discussed several design goals. Transmission rate is reduced to half on successive loss events and if the feedback is not received from the client end, again the transmission rate is reduced to half. So, the transmission rate purely depends upon the successive loss rate and the feedback. The parameters are calculated based on the Response Function as stated in Equation 3.

Advantages

- TFRC reduces its sending rate more smoothly thereby reducing the oscillations in the sending rate.

5.6 Model Based

This scheme is based on the the formulation

Throughput = f(Wmax ,R,p,B),

Where,

Wmax-Receiver Declared window size

R-Transmission Rate

p-Loss Rate Probability

B-Round trip time

TFRCP is an example for this scheme

Advantage

- Reduces oscillations in the sending rate
- Suitable for real time multimedia applications

VI. DYNAMIC TCP FRIENDLY AIMD ALGORITHM (DTAIMD)

Lin Cai et al [12] proposed the DTAIMD algorithm which is based on AIMD(α,β)

Step 1: If(cwnd≥1/1- β) //congestion window is large

Step 2: α=3(1- β)/1+ β

Step 3: else if(cwnd= =1) //congestion window is minimal

Step 4: α=1

Step 5: else //if 1<cwnd≤1/1- β

Step 6 α=3/2cwnd-1

The results in this paper showed that the above algorithm is suitable for multi rate multimedia applications. The scenario has been tested with different (α,β) pairs and the proposed DTAIMD algorithm yield better throughput when compared with TCP.

VII. DESIGN OF MEDIA TCP FRIENDLY CONGESTION CONTROL (MTCC) APPROACH

Hsien-Po Shiang and Mihaela van der Schaar [13] proposed a new Congestion Control approach for Wired IP Networks. The authors have proposed an algorithm for independent and interdependent packets. Window size is modified without altering the design of the receiver side. The design of this approach are given below.

1. The RTP packets are classified into M classes
2. MTCC uses the retransmission mechanism of TCP but the expired packet in the buffer is not retransmitted
3. MTCC adjust the congestion window based on the Transmission Scheduler and Network Estimator
4. Transmission Scheduler selects the number of packets to be sent in k time slots
5. The Network Estimator updates the packet Loss rate

CONCLUSION AND FUTURE WORK

The future of video streaming services is expected to be shaped by several key trends:

a. Cloud Video Streaming: Cloud servers are increasingly being used to store unlimited data, with cloud video streaming being one of the key technological revolutions. This technology allows users to access their music, photos, and documents from any computer or mobile device, anywhere in the world1. Examples of cloud streaming platforms include Netflix, Hulu, Amazon Prime, and YouTube.

b. Changes in Consumer Behavior: On-demand video has radically changed consumer behavior. Consumers increasingly expect relevant and attractive TV and video content that can be accessed anytime, anywhere, and in the format that best suits their immediate needs.

c. Digitalization and Personalized Advertising: Digitalization, personalized advertising, and less regulation are some of the factors that will determine the main future developments in the TV and video industry.

In conclusion, the future of video streaming services is likely to be characterized by increased use of cloud technology, changes in consumer behavior, and the impact of digitalization. These trends suggest a future where video content is increasingly accessible, personalized, and delivered efficiently.

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