



**HAL**  
open science

## **QoE-aware Multiple-Server Streaming over HTTP**

Joachim Bruneau-Queyreix, Mathias Lacaud, Daniel Negru, Jordi Mongay Batalla,  
Eugen Borcoci

► **To cite this version:**

Joachim Bruneau-Queyreix, Mathias Lacaud, Daniel Negru, Jordi Mongay Batalla, Eugen Borcoci. QoE-aware Multiple-Server Streaming over HTTP. Internation Conference on Multimedia and Expo (ICME), 2017, Hong-Kong, China. 2017. {hal-01589604}

**HAL Id: hal-01589604**

**<https://hal.science/hal-01589604v1>**

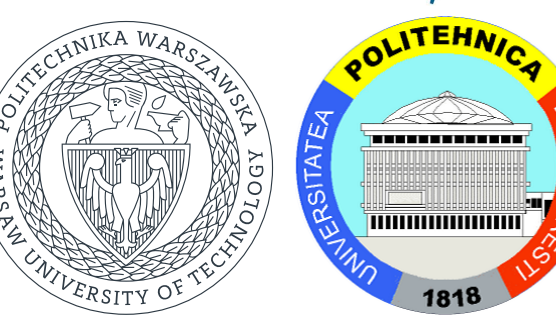
Submitted on 21 Sep 2017

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



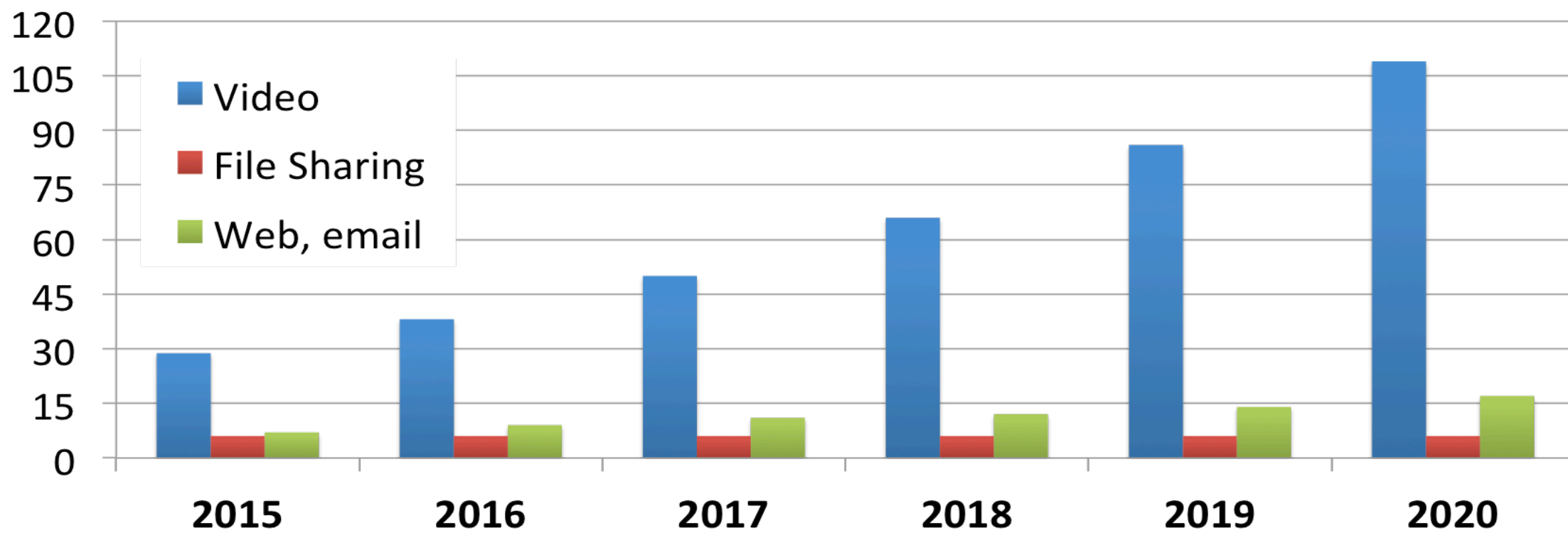
HAL Authorization



## Context: Media Delivery in the Future Media Internet

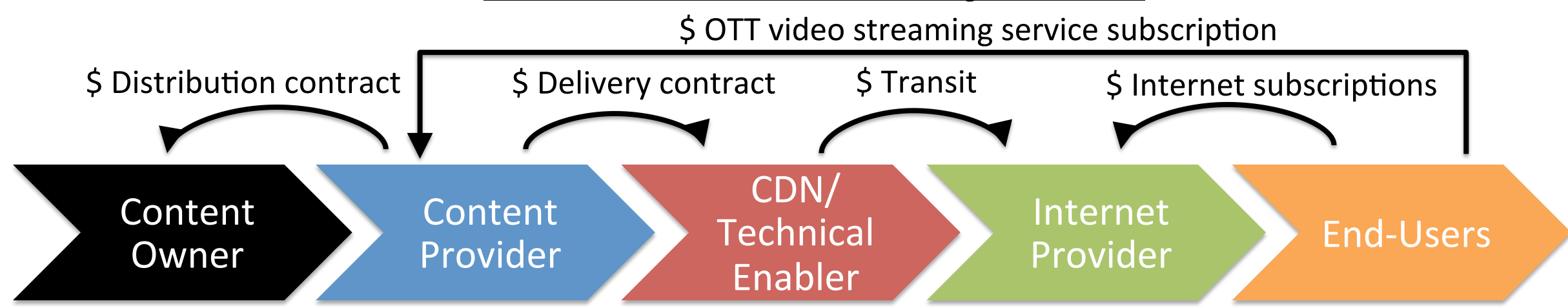
### Traffic Forecasts

ExaB/month Consumer Internet Traffic (2015-2020) - Cisco VNI



- More users
- More content
- Higher demand for quality
- =>
- Almost **82%** of today's internet traffic
- A two-fold increase by 2020

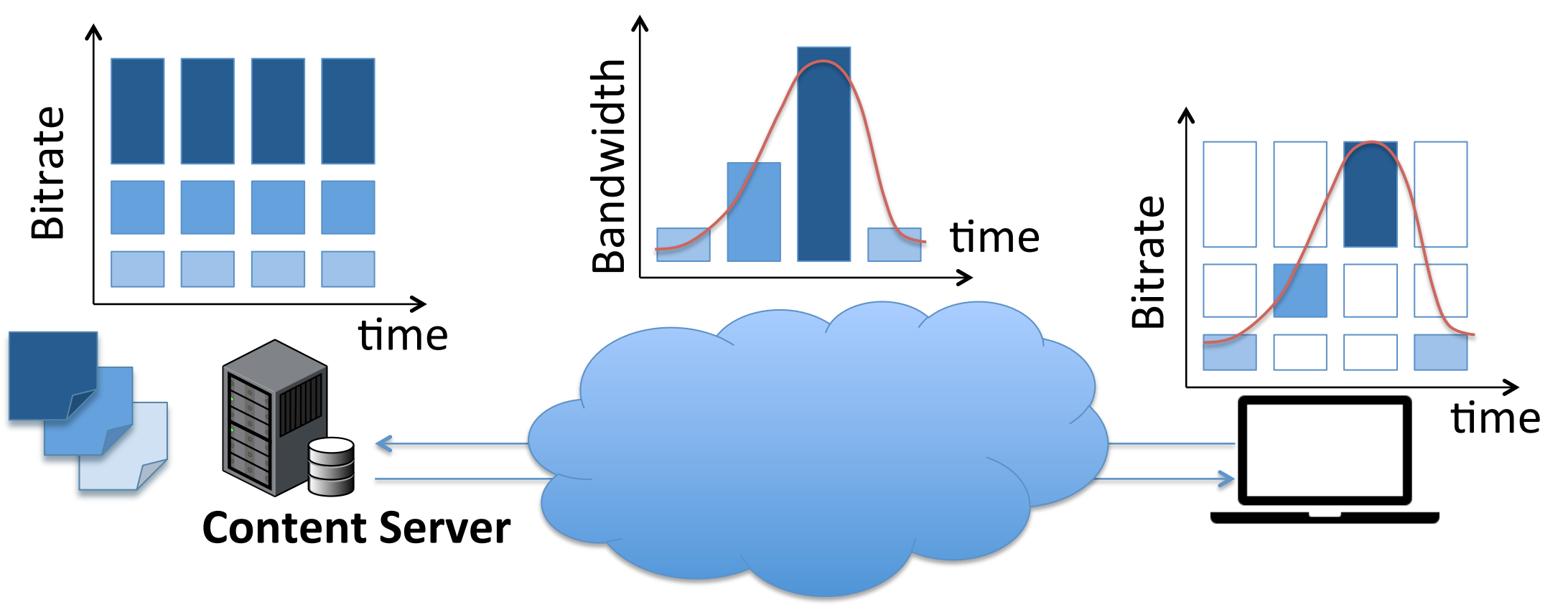
### The media delivery chain



### Content Delivery Networks

- Highly efficient and scalable
- High operating and scaling costs
- Often over-provisioned infrastructure to meet end-users' QoE demand

### DASH: Dynamic Adaptive Streaming over HTTP



#### Pros:

- Avoid video freezing by adjusting desired quality to the network conditions
- Increase Quality of Experience (QoE)

#### Limitations:

- Non-resilient to network or server impairments
- Limited by the throughput delivered by one server

### Today's and tomorrow's challenges

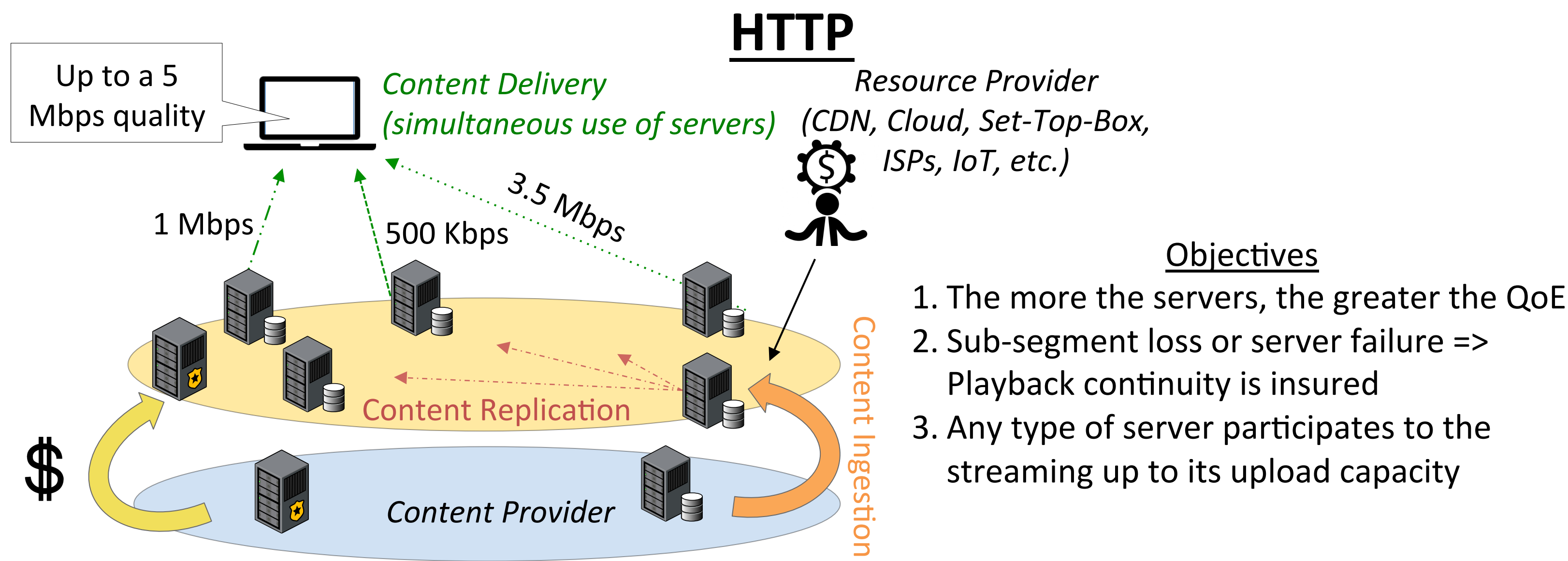
The **problem**: QoE along with scalability costs are major issues in the design of future content delivery solutions.

The **challenges**: Bandwidth aggregation on multiple network paths; Adaptability to communication channel heterogeneity; Uninterrupted video streaming; Quality- and server- adaptation.

The **proposition**: A DASH-evolving client-centric **Multiple-Source Streaming (MS-Stream)** protocol that simultaneously uses multiple servers in order to provide high QoE and reliability in heterogeneous environments

## Contributions

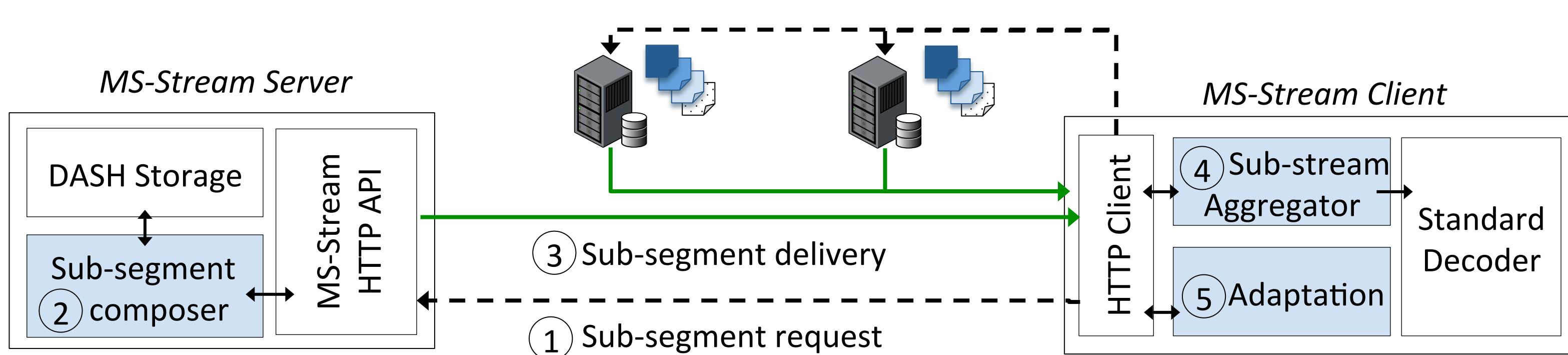
### MS-Stream: Dynamic Adaptive Multiple-Source Streaming over HTTP



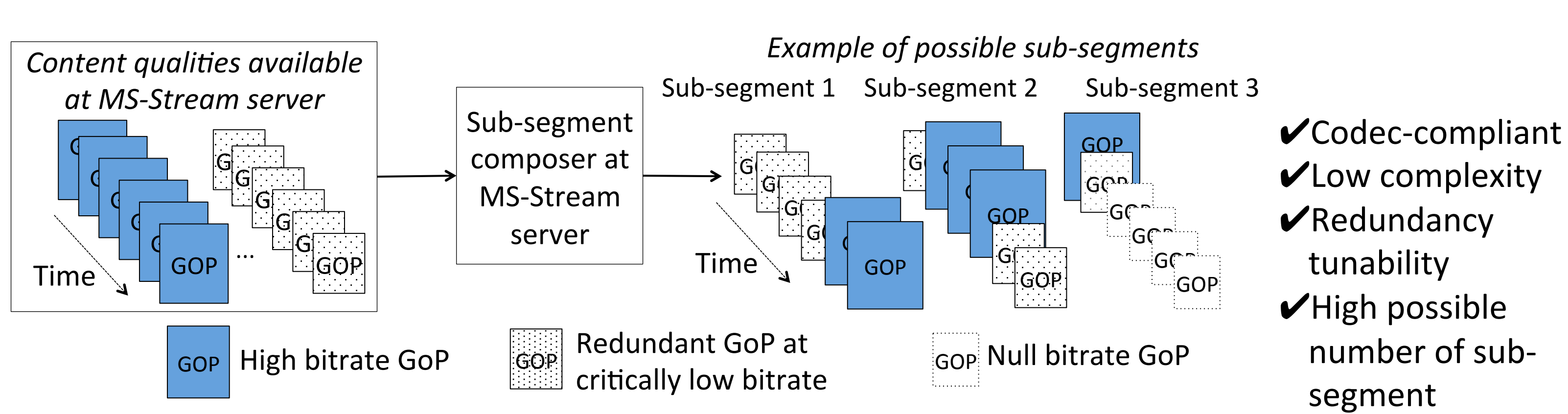
#### Objectives

1. The more the servers, the greater the QoE
2. Sub-segment loss or server failure => Playback continuity is insured
3. Any type of server participates to the streaming up to its upload capacity

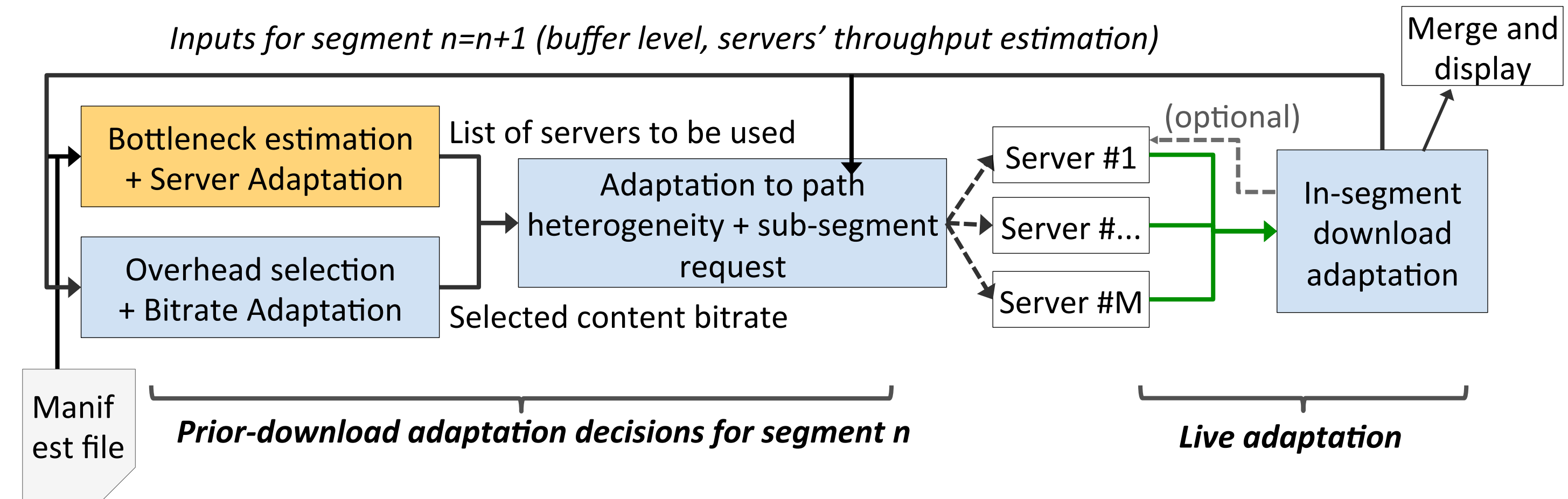
### A DASH-based streaming protocol architecture



### Standard-compliant sub-segment composition



### A two-phase consumption and adaptation algorithm

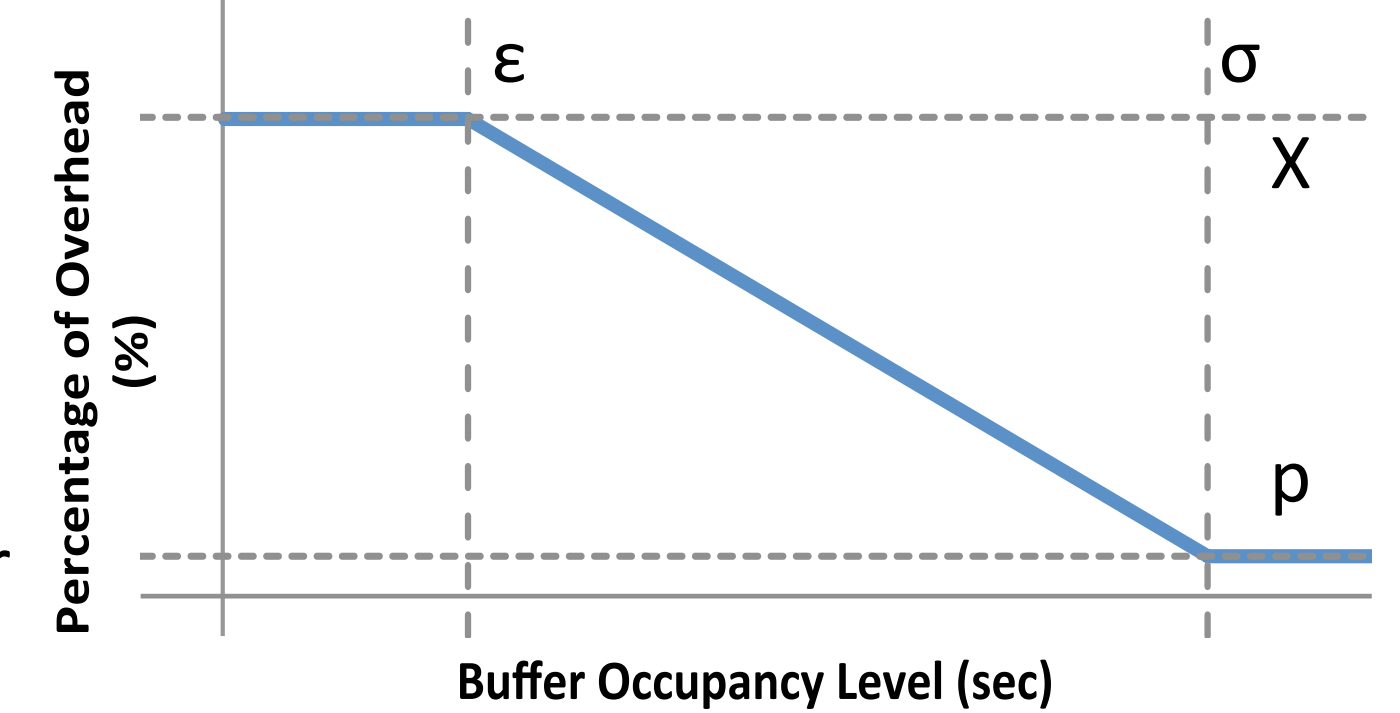


#### Bottleneck estimation and server adaptation:

- Estimating the presence and the type of bottleneck (at server or at client side) based on TCP connections' throughput stability in time (78% reliable);
- Additive-Increase Multiplicative-Decrease approach to adjust the number of simultaneously used servers (based on bottlenecks, target bitrate).

#### Overhead selection:

- Limiting and minimizing bandwidth consumption overhead due to GoP redundancy.
- Minimization method based on client buffer occupancy



#### Adaptation to path heterogeneity:

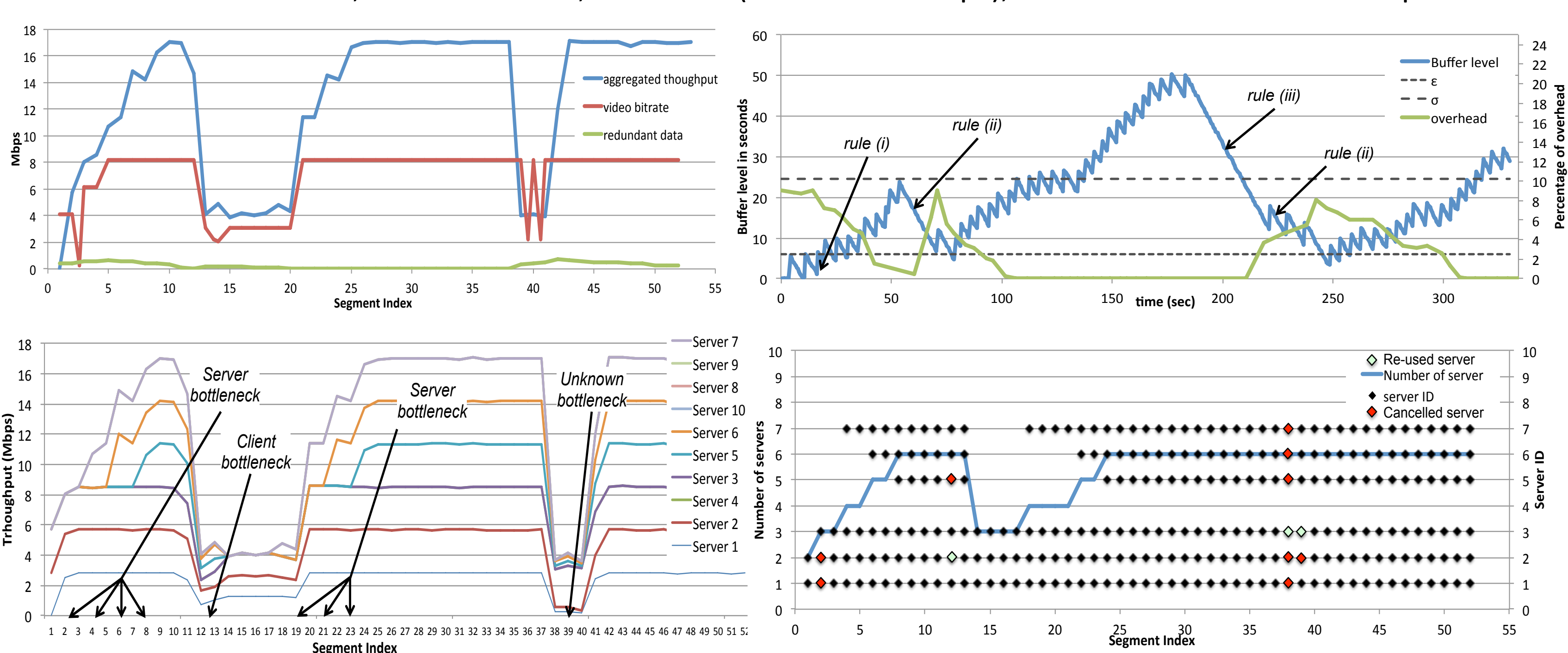
- Assigning sub-segment delivery to servers according to their observed goodput.

#### In-segment download adaptation

- Monitor sub-segment downloads progress;
- Three in-segment download adaptation rules to cancel late sub-segment delivery or re-assign the delivery of missing GoPs to other servers.

## Functional validation

A 10-server test-bed; a 10-min video; 8 bitrates (from 1 to 8 Mbps), redundant bitrate at 150Kbps



## Significant Results

### Evaluation over the Internet (DASH versus MS-Stream)

| Eval ID | Available Thr. (Mbps) | # of clients | # of servers | $O_{max}$ | $\epsilon$ (sec) | $\sigma$ (sec) | Mean Bitrate (Mbps) | Avg. Quality Changes | Avg. Rebuffering | Avg. Start-up delay | Avg. BW overhead | Avg. Used servers |
|---------|-----------------------|--------------|--------------|-----------|------------------|----------------|---------------------|----------------------|------------------|---------------------|------------------|-------------------|
| DASH_0  | 10                    | 1            | 1            | -         | -                | -              | 7.90                | 5.10                 | 0                | 2.21 sec            | 0%               | 1                 |
| DASH_1  | 20                    | 2            | 1            | -         | -                | -              | 6.87                | 10.32                | 7.22             | 4.11s sec           | 0%               | 1                 |
| MS_0    | 10                    | 1            | 10           | 10%       | 6                | 25             | 7.97                | 3.21                 | 0.01             | 1.58 sec            | 3.91%            | 9.52              |
| MS_1    | 20                    | 2            | 10           | 10%       | 6                | 25             | 7.43                | 5.32                 | 0.31             | 1.57 sec            | 4.37%            | 7.59              |
| MS_2    | 20                    | 2            | 10           | 10%       | 12               | 25             | 7.78                | 4.11                 | 0.29             | 1.56 sec            | 6.43%            | 7.68              |
| MS_3    | 20                    | 2            | 10           | 15%       | 12               | 25             | 7.80                | 4.69                 | 0.19             | 1.65 sec            | 9.12%            | 7.61              |

### References

- J. Bruneau-Queyreix, M. Lacaud, D. Negru, J. Batalla, and E. Borcoci, « QoE Enhancement Through Cost-Effective Adaptation Decision Process for Multiple-Server Streaming over HTTP » in *IEEE International Conference on Multimedia and Expo (ICME)*, 2017.
- J. Bruneau-Queyreix, M. Lacaud, D. Negru, J. Batalla, and E. Borcoci, « Adding a New Dimension to HTTP Adaptive Streaming through Multiple-Source Capabilities », in *IEEE MultiMedia Magazine (in press)*, 2017.
- J. Bruneau-Queyreix, M. Lacaud, D. Negru, J. Batalla, and E. Borcoci, « MS-Stream: A Multiple-Source Adaptive Streaming Solution Enhancing Consumers Perceived Quality », in *IEEE Consumer Communications and Networking Conference (CCNC)*, 2017.
- J. Bruneau-Queyreix, M. Lacaud, D. Negru « A Multiple-Source Adaptive Streaming Solution Enhancing Consumers Perceived Quality », in *IEEE Consumer Communications and Networking Conference (CCNC) demo track*, 2017.
- J. Bruneau-Queyreix, M. Lacaud, D. Negru, J. Batalla, and E. Borcoci, « Multiple-Description DASH: Pragmatic video streaming maximizing end-users' quality of experience » in *IEEE International Conference on Communications (ICC)*, 2016.