



ROYAL INSTITUTE  
OF TECHNOLOGY

# Quality of Experience: A market perspective analysis

Luis Guillermo Martinez Ballesteros  
Ashraf Widaa  
Zary Segall

25<sup>th</sup> European Regional Conference of the International  
Telecommunications Society (ITS)

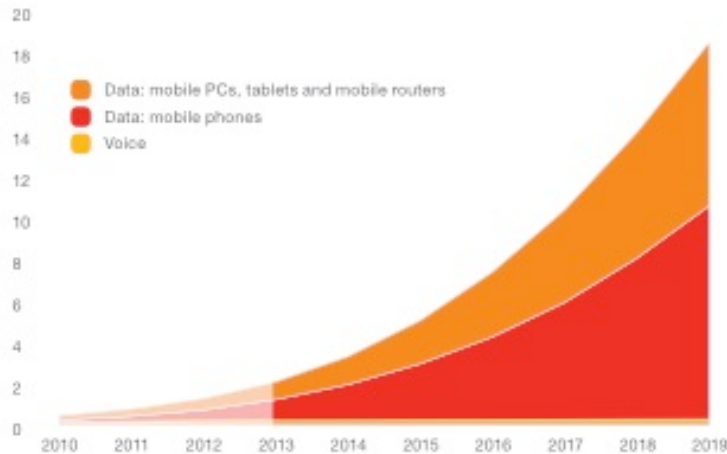
Brussels, June 23th 2014

# Outline

- Motivation
- Current approach
- Proposed approach
- QoE architecture
  - Fully Integrated within the Operator Network (FION)
  - Over the Top (OTT)
- Conclusions and future work

# Motivation

Global mobile traffic (monthly ExaBytes)

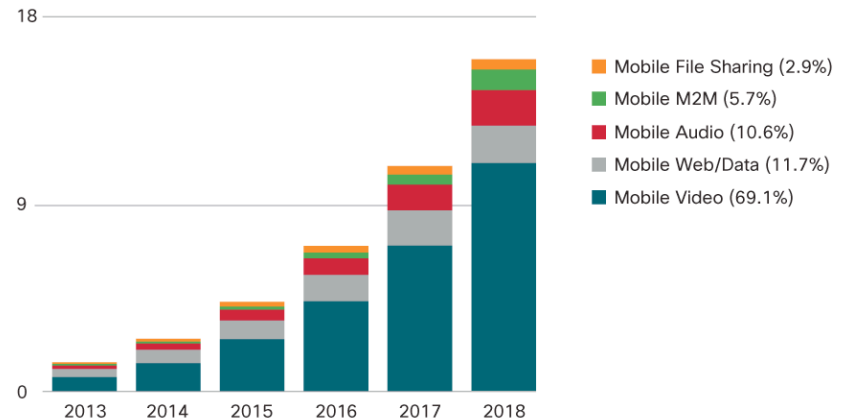


Data tsunami  
(increase in traffic volume)

Emerge of multimedia  
applications

Exabytes per Month

61% CAGR 2013–2018



Reduce Cost of service  
provision/More efficient  
use of resources

Deliver content adjusted  
to user's expectations

## Current approach

Traffic explosion + more demanding user's expectations

Spectrum

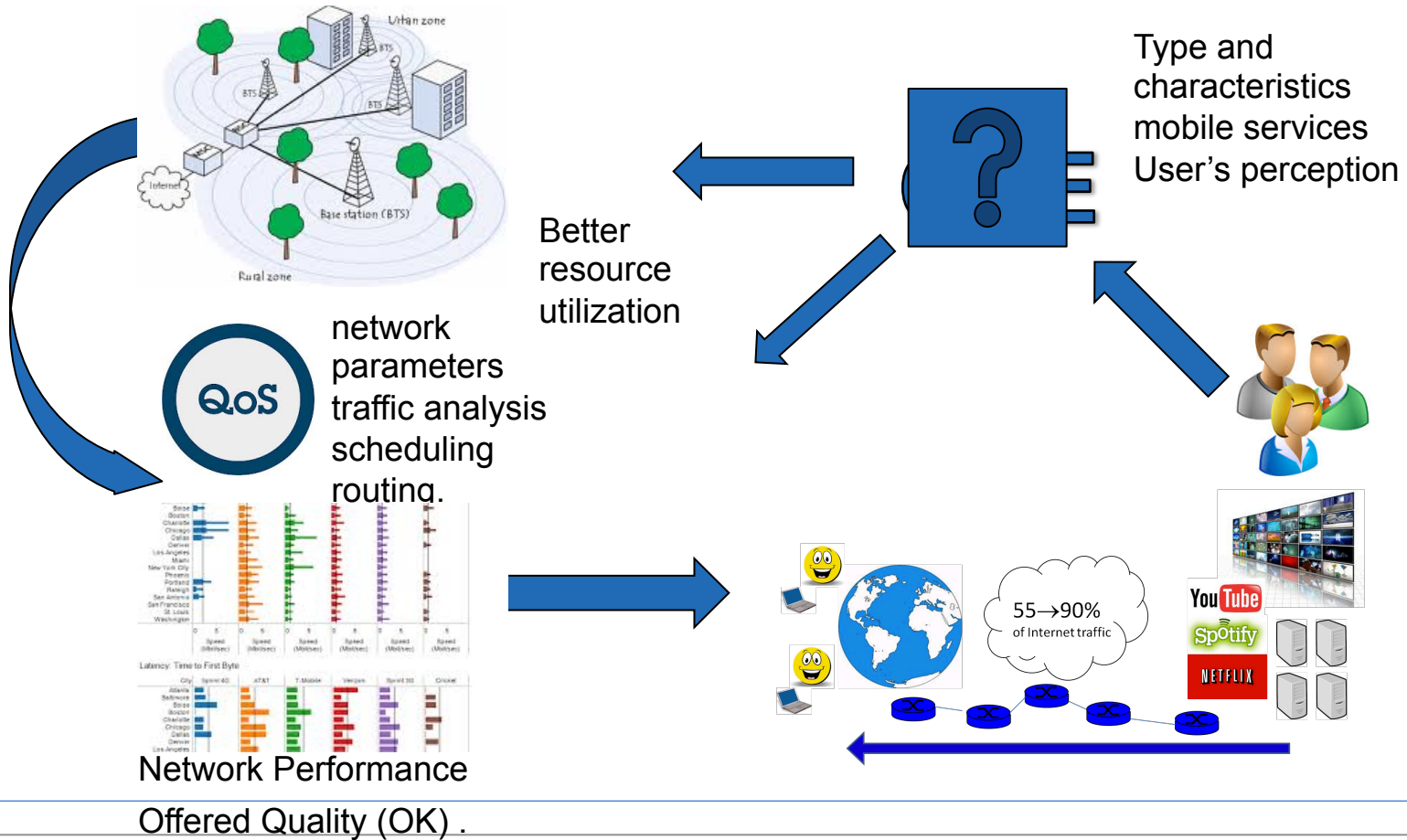
Technology

Network  
Architecture

CAPEX

OPEX

# Current approach



## Current approach

### ➤ **Quality of Experience approaches**

#### ➤ Techno-centric approach:

- Evaluation based on network performance.
- Usually one dimension for user's perception evaluation (i.e., low, fair, good).
- User's perception is primarily a result of traffic load, scheduling and routing techniques.

#### ➤ User-centric approach:

- Evaluation centered on human factors.
- Interdisciplinary approach, incorporating elements such as beauty, enjoyment or fun.
- User's perception is associated to what people think and human needs.

# Current approach

## ➤ **Techno-centric approach in current mobile networks**

### ➤ Bearer Model - QoS based

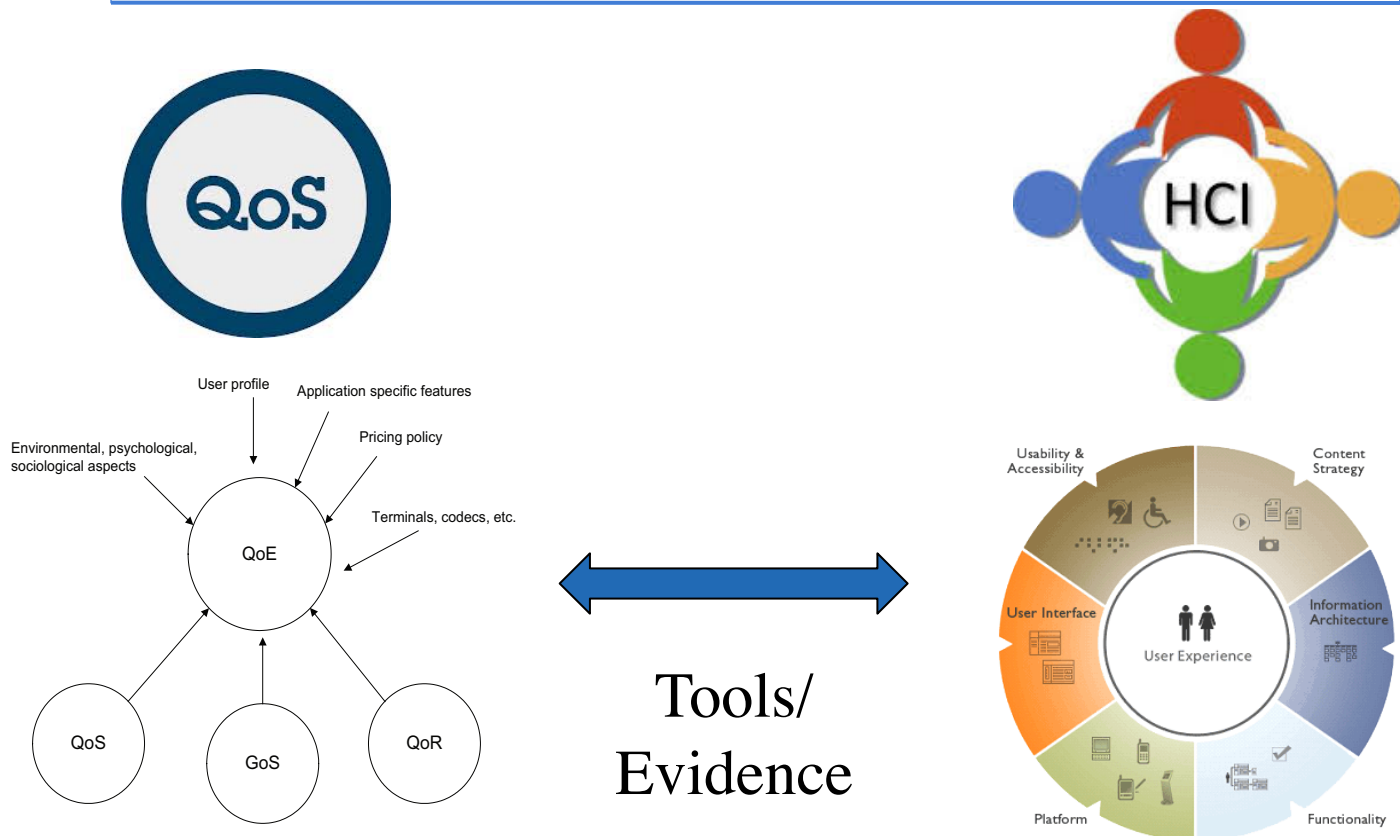
- Traffic separation based on specific QoS requirements.
- Bit rate (maximum/guaranteed) definition.
- Traffic prioritization based on services, no QoE considerations.

### ➤ QoS/QoE gap:

- Good QoS not always generates good QoE.
- Lack of insight in the totality of dimensions of customer's experience. (Human-computer Interaction)
- QoE improvement new approach to design network infrastructure.



## Proposed approach



QoE: “the overall acceptability of an application or service, as perceived subjectively by the end-user.” [2]



## Proposed approach

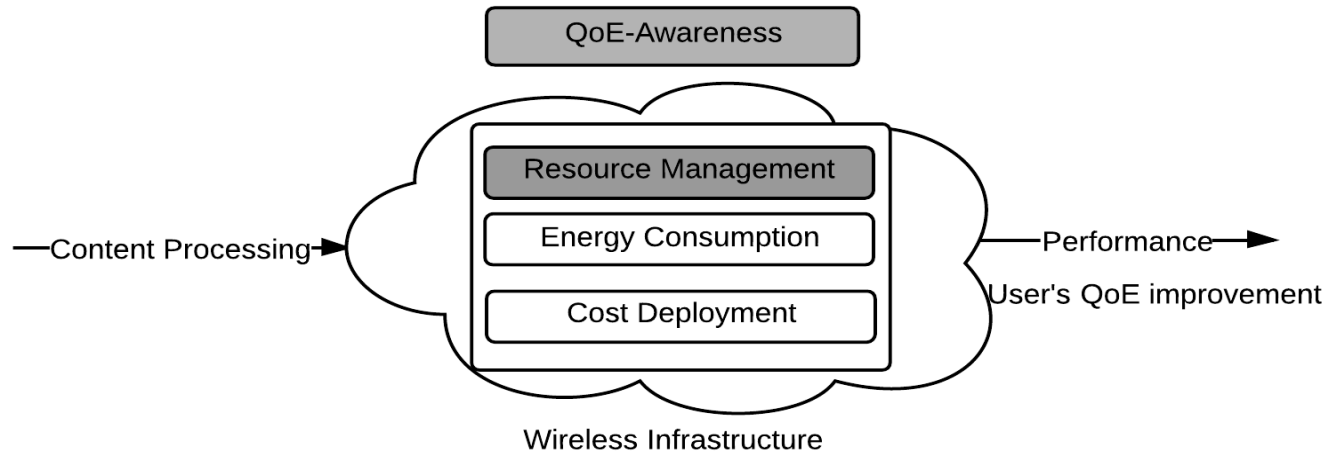
### ➤ Video Scenario – QoE issues



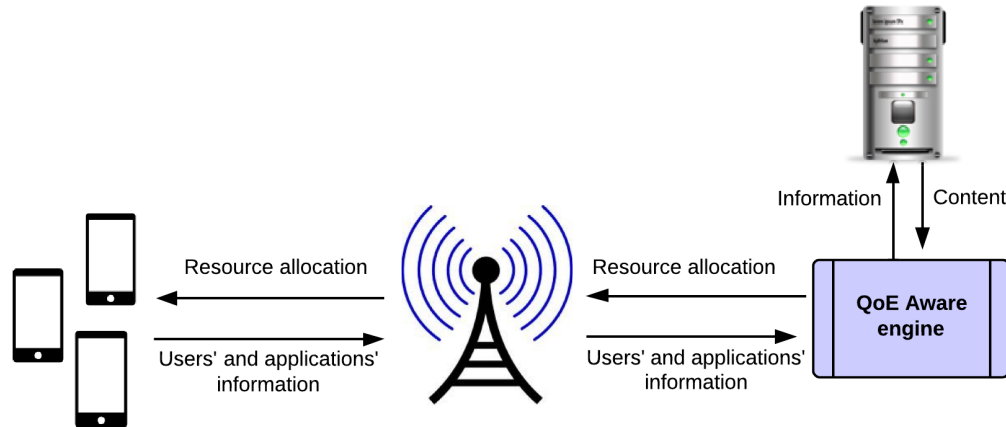
A staggering 60% of views are impacted by stalls, low resolution or buffering. 39.3% of streams are impacted by buffering and 4% never start. Ironically, many consumers are watching on a screen capable of displaying high-quality (HQ) video, yet 63% are viewing below HQ resolution.<sup>5</sup>

- Buffering, stalling and stuttering. The percentage of time spent in buffering (buffering ratio) has the largest impact on engagement across all types of content.
- Poor visual quality. Since lower bitrate streams correspond to poorer quality viewing experiences, the higher the average bitrate the better. Quality has a higher impact on live content compared to VOD.
- To maximize engagement an optimal viewing experience must be delivered

## QoE architecture



## QoE architecture



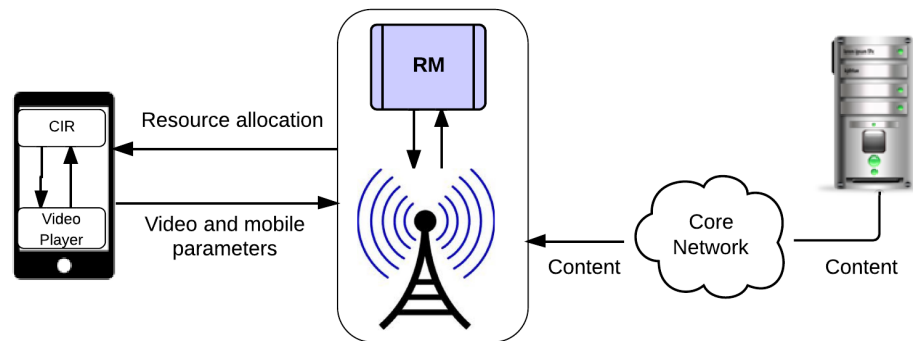
### Application monitor

- Sends the content processing and buffer status to the QoE-aware engine.
- Located in the mobile terminal.

### QoE-aware engine

- Evaluates the information sent by mobile terminals and make resource allocation decisions.
- Placed in the radio interface/content server.
- Interruption detection

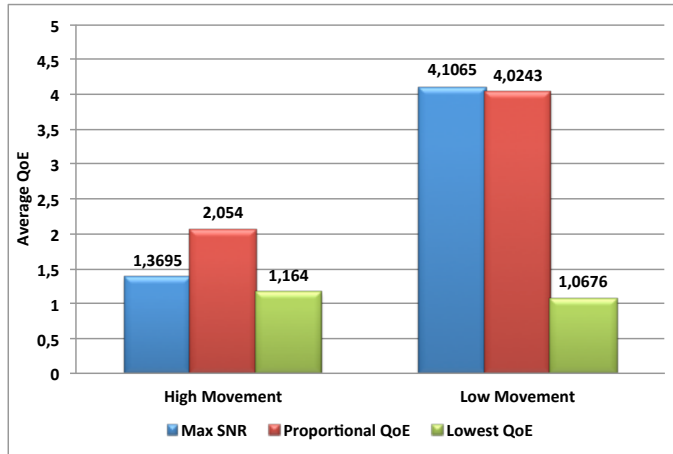
## QoE architecture – FION approach



- BS and radio access network (RAN) aware about what happens in each terminal.
- Fast detection and attention to QoE problems.
- It requires implementation of packet inspection activation at the BS.

# QoE architecture – FION approach

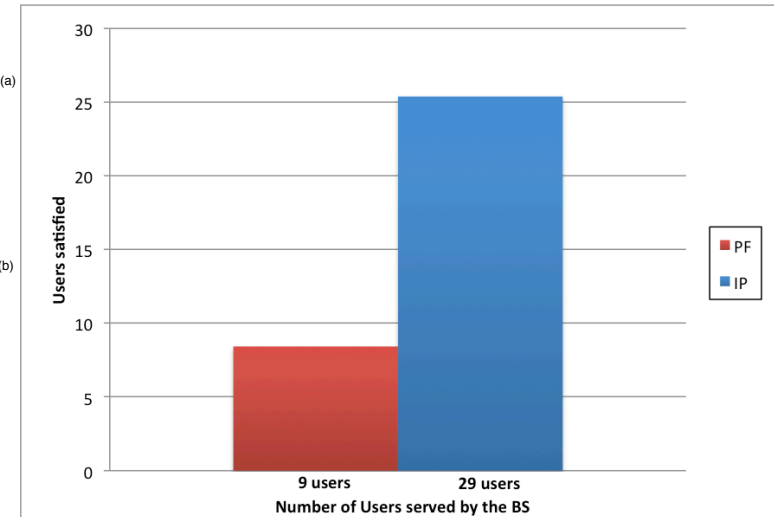
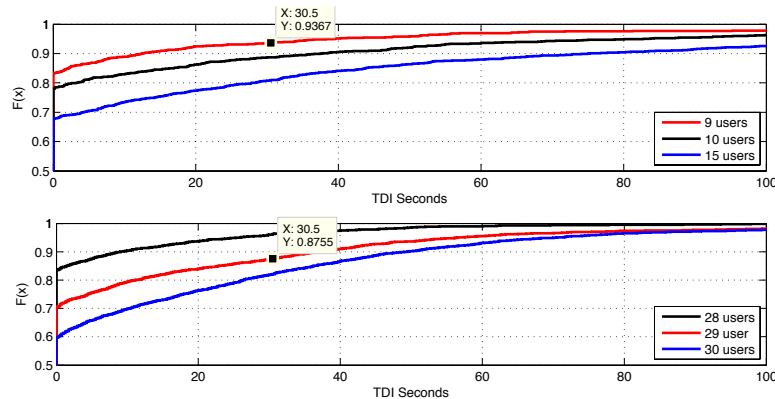
## A. QoE evaluation-based resource allocation.



- An improvement of 140% in QoE grade for videos with high movement level.
- Very limited loss (around 3%) for low movement videos.
- Initial insights about the potential of using QoE-aware solution in the resource allocation schemes.

# QoE architecture – FION approach

## B. Buffer-based resource allocation



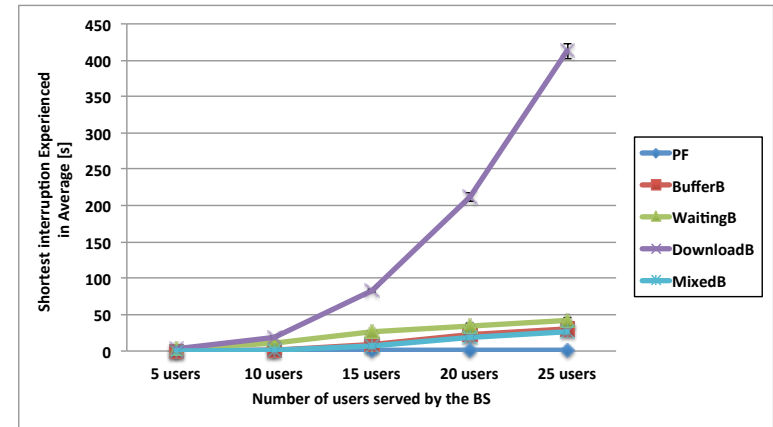
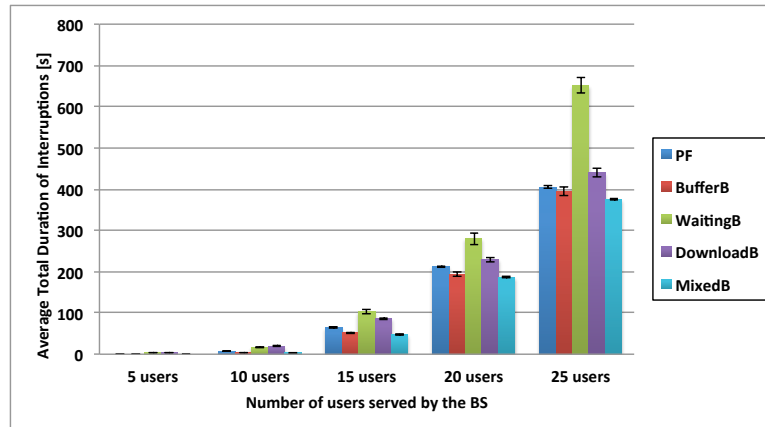
➤ Target total duration of interruptions (TDI) – 90th percentile: 30s (10% total video duration)

➤ Improvement of 2.9 times in terms of the number of users experiencing 30s or less.

➤ Same infrastructure providing better QoE to more users.

## QoE architecture – FION approach

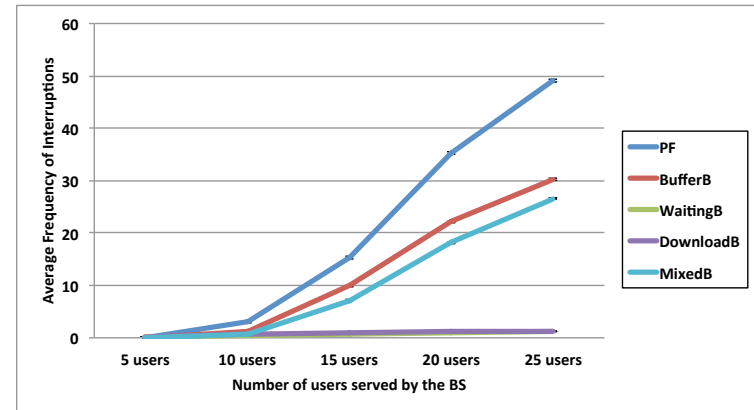
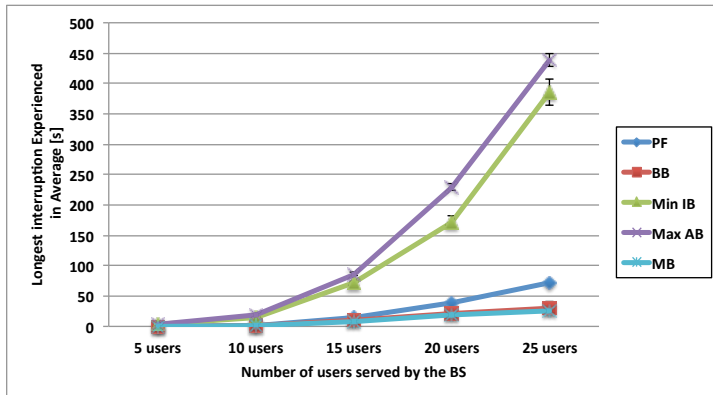
### B. Buffer-based resource allocation (Considering waiting, downloading and offline time)



- Reduction in the average TDI goes from 74%(with 5 users) to 8% (with 25 users) with MixedB scheme compared to PF scheme.
- Schemes only focused on the evaluation of online times (WaitingB/ DownloadB) reduce the performance of the system increasing TDI.
- Schemes looking at the buffer capacity can guarantee a reduction in the length of the interruptions.

# QoE architecture – FION approach

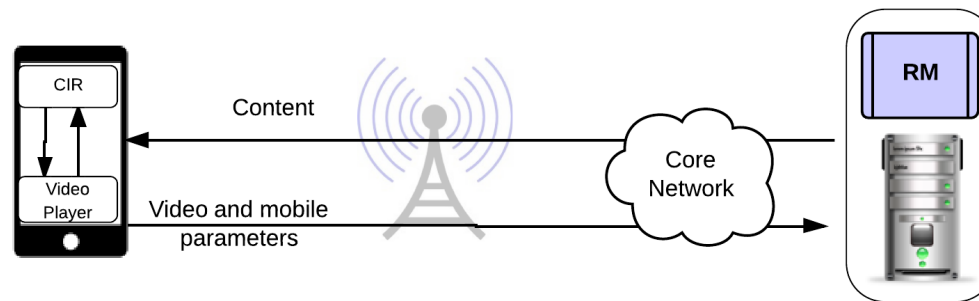
## B. Buffer-based resource allocation (Considering waiting, downloading and offline time)



- Although PF shows the best performance when maximum length of interruptions is considered, observing the frequency of the interruptions, PF shows the higher frequency values compared to the proposed schedulers.
- PF shows around 25% more interruptions during the playback than the best of the other considered RRM schemes. This recurrence in the number of interruptions will affect the user's perceived quality more



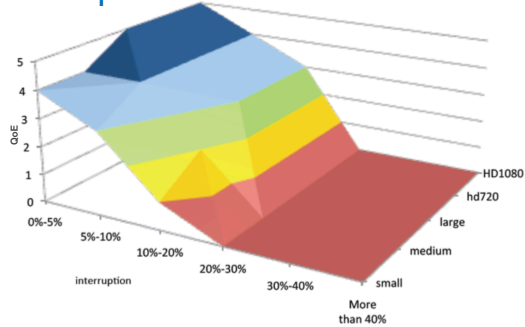
## QoE architecture – OTT approach



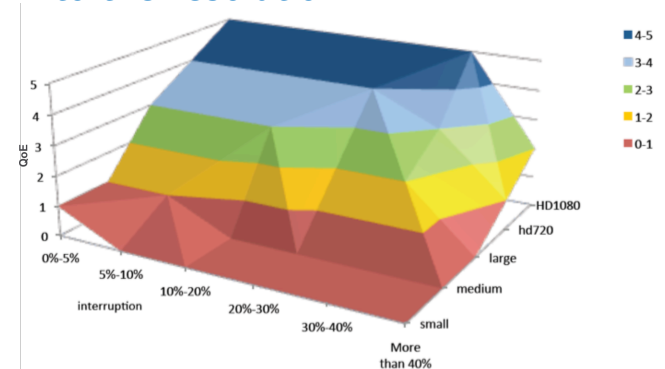
- ISP responsible only for transporting IP packets .
- Resources controlled by content provider.
- Impacted by core network load.

# QoE architecture – OTT approach

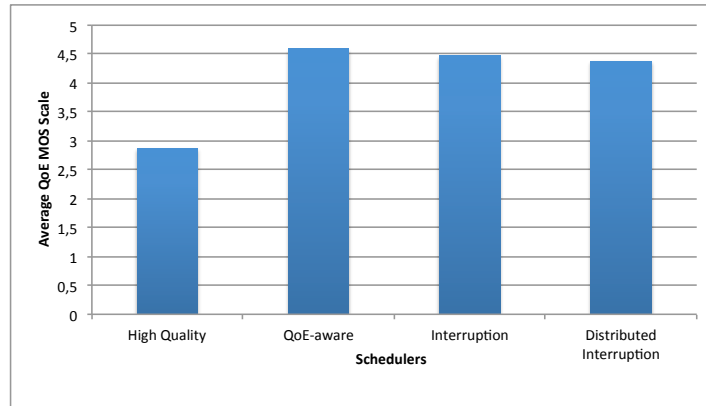
profile A: Interested on few interruptions



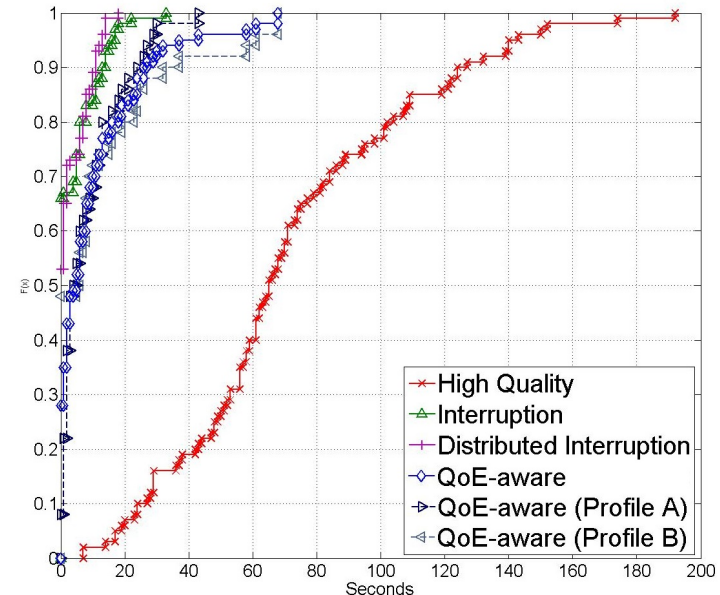
profile B: More importance to the resolution



## QoE architecture – OTT approach



- While the reference case can guarantee less than 10s of interruptions only in 5% of the video playbacks, Distributed Interruption allows increasing in 85% the probability of experiencing the same amount of interruptions.
- High average QoE is obtained with the use of the QoEaware scheme, where an increase of 60% regarding the reference case is possible.



## Conclusions

- User's QoE can be improved by incorporating a more user centric approach in the resource allocation:
  - Viewer measurement: Continuous, real time, in browser viewer monitoring across platforms
  - Dynamic stream adjustment: Per viewer quality decision making in real time, based on multi-bitrate and multi-CDN optimization
  - Network quality mapping: Preemptive intelligence, based on local and global data identifies congestion and drives preventative stream adjustments
  
- Inclusion of QoE related information could support the network resource management and impact user's service appreciation.

## Future Work

- To identify how commercial strategies design and deployment infrastructure plans might consider QoE and user's perception.
- To identify important challenges they will face regarding QoE improvements and user centric design.
  - ✓ Content consumption
  - ✓ Type of devices
  - ✓ New services
- To provide elements that can support the use of QoE as competitive/differentiation factor in the provision of telecommunication services.

**Thanks for your attention!!**



**Questions?**

**[lgmb@kth.se](mailto:lgmb@kth.se)**