Aston University
Birmingham
Adaptive Communications Networks Research Group

Resource Allocation and Rate Adaptation for Video Streaming

Mir Seyedebrahimi and Xiao-Hong Peng
School of Engineering and Applied Science
Aston University, Birmingham, UK

Cosener's NGN-MSN

11 July 2014

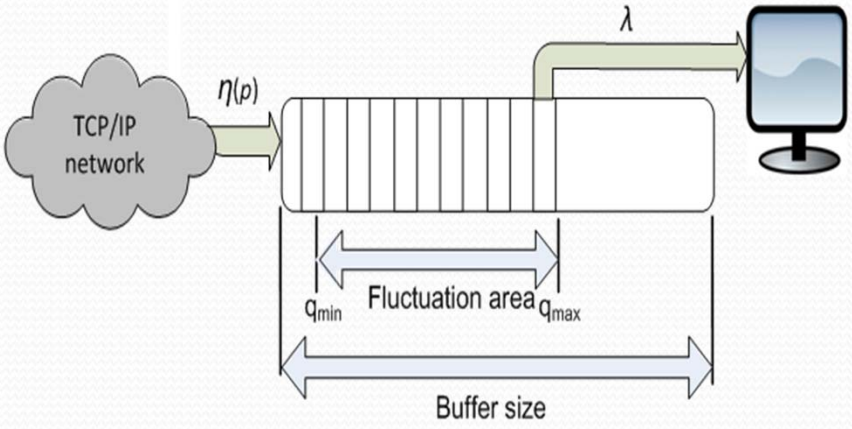
Video Streaming: The Facts

- Three Major Revolutions in Mobile Communications:
  - Capacity of the wireless mobile network → **4G/LTE**
  - User demand → **Smartphones**
  - The video data distribution → **Video Streaming Services**

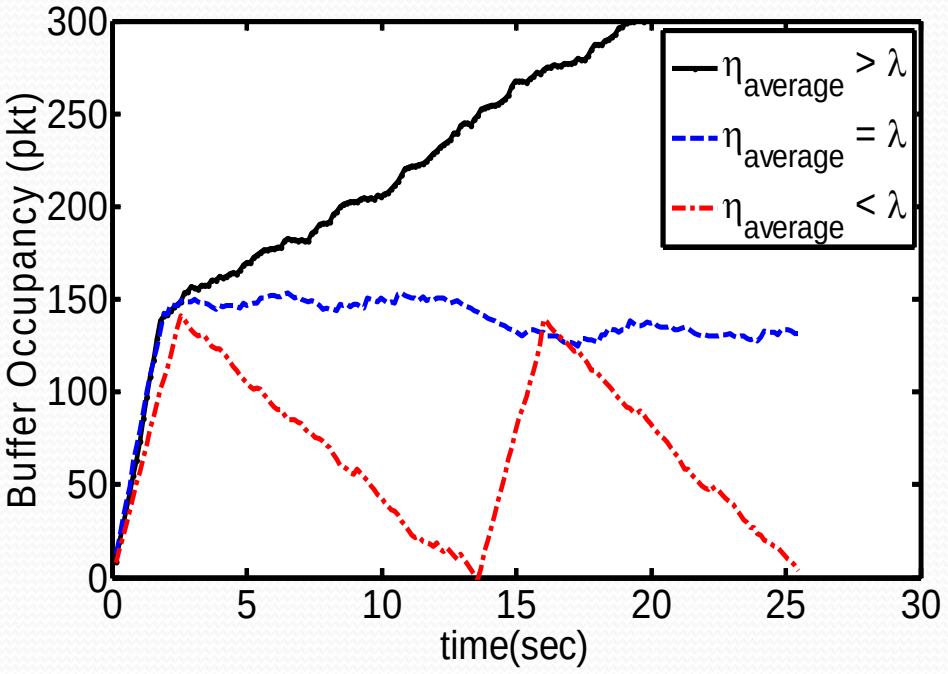
- Higher Network Capacity ? → Smooth Video Streaming
  - Not yet:
    - Edge of the cells
    - Dense areas
    - Indoor coverage
    - **Quality of experience (QoE)**

Quality Assessment for Video Streaming

- Fidelity → **Resolution → Metrics: e.g. PSNR**
- Continuity → **Initial Delay, Buffer Underrun → Metrics: e.g. pause frequency**



Network Dependency of the QoE →



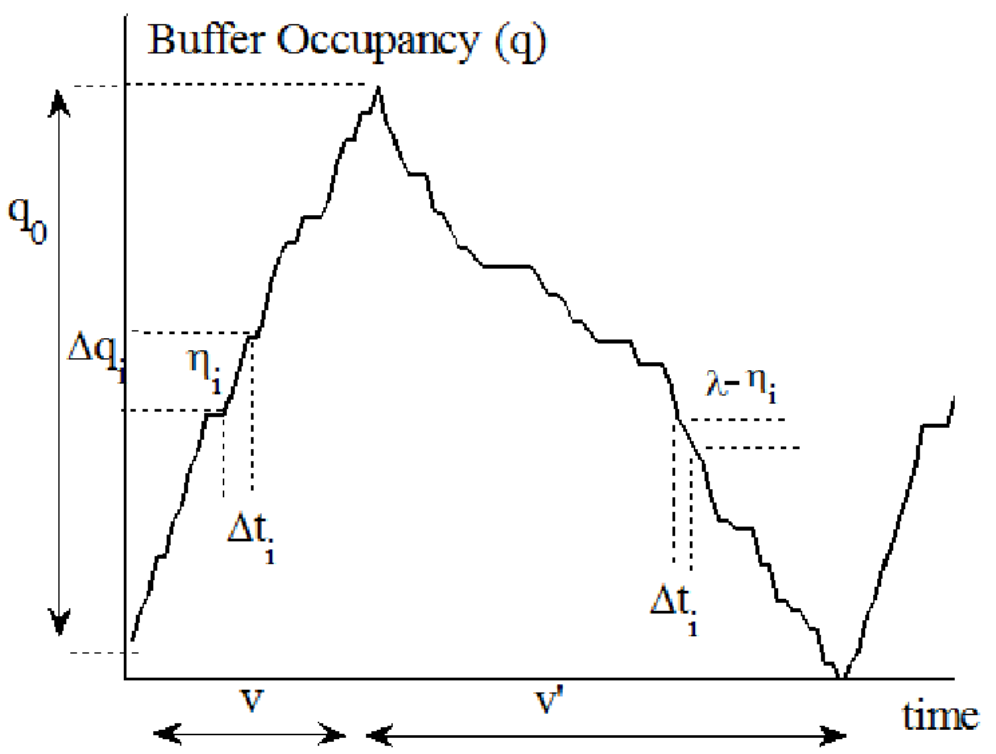
Aston University
Birmingham

A No-Reference Objective Metric: Pause Intensity

(Characterised by the Play-Pause Scenario)

- Pause Intensity:
  - The Combined effects of:
    - Pause duration (v)
    - Pause Frequency (f_v)
  - Depends on the:
    - Network Performance (η)
    - Video Code Rate (λ)
  - Doesn't depend on the:
    - Client Side Buffer Settings (q_o)

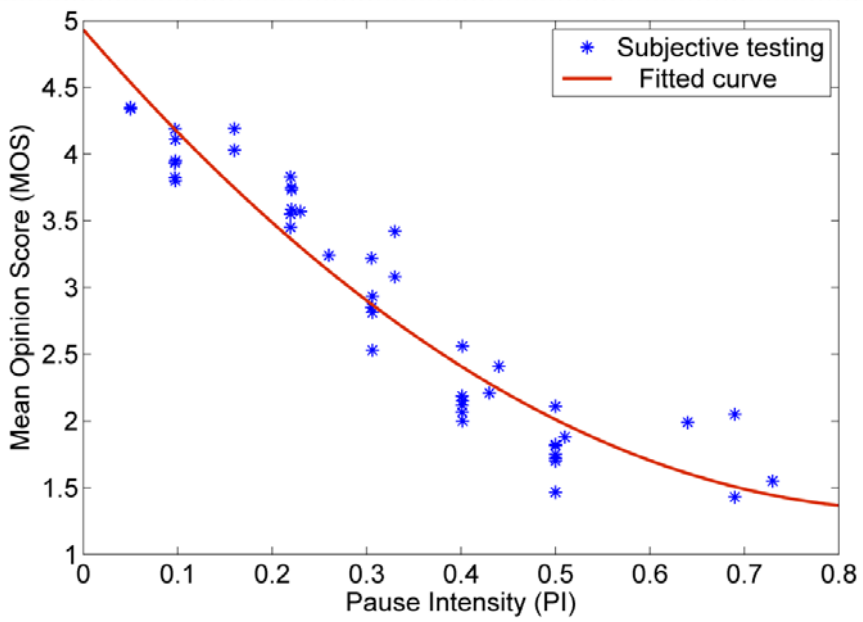
$$PI = \bar{v}.\bar{f_v} = 1 - \frac{\eta}{\lambda}$$



Aston University
Birmingham

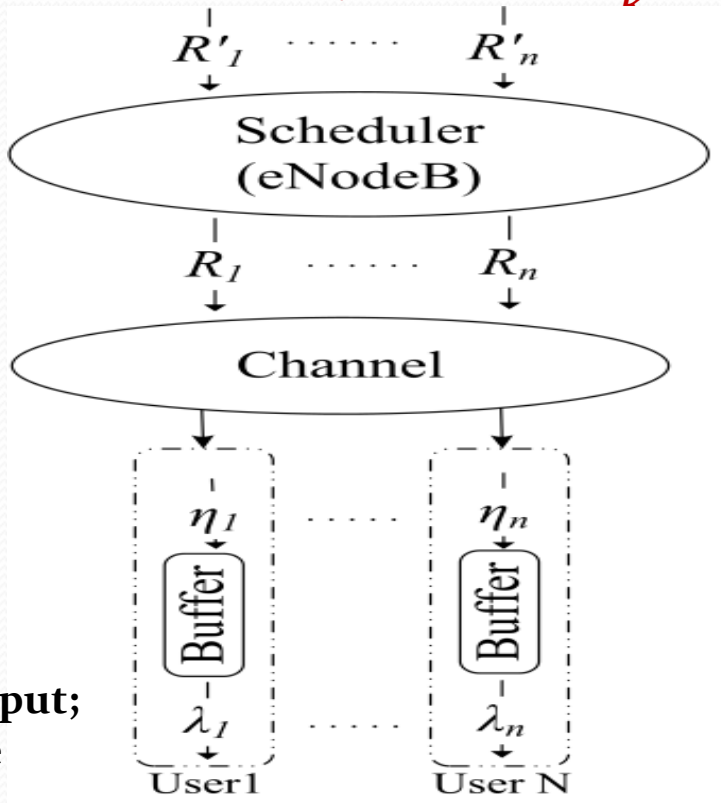
How Useful is PI?

I. MOS vs PI



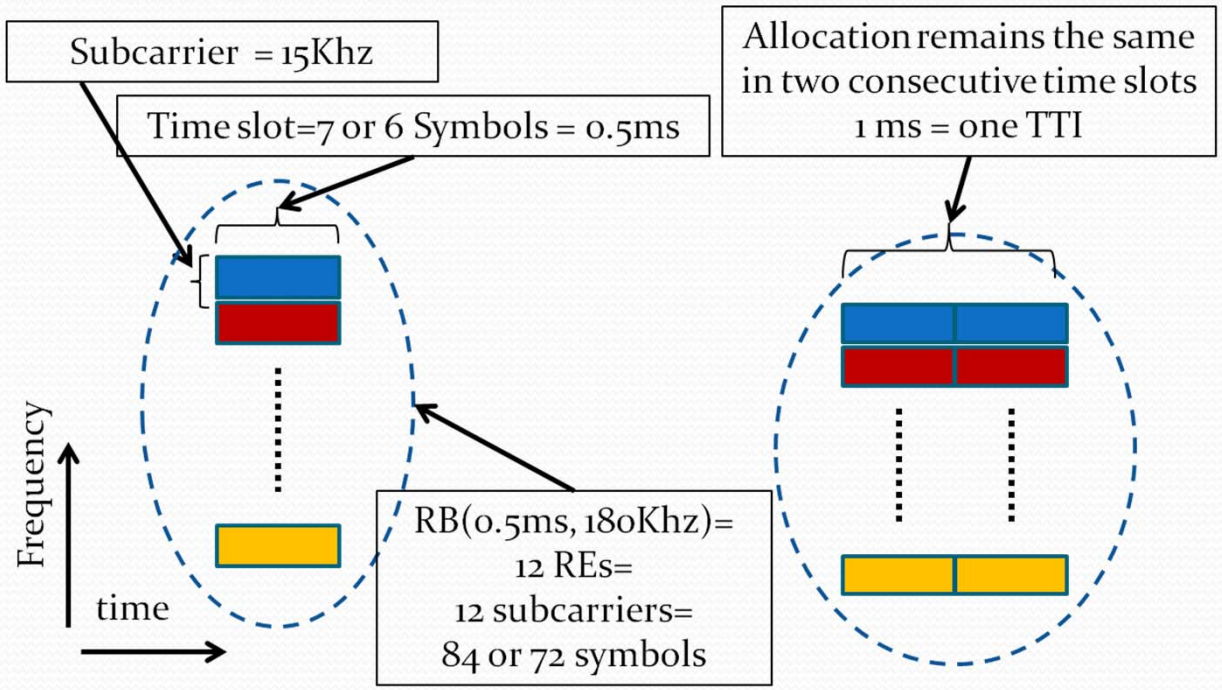
II. QoE evaluation on both client & network sides

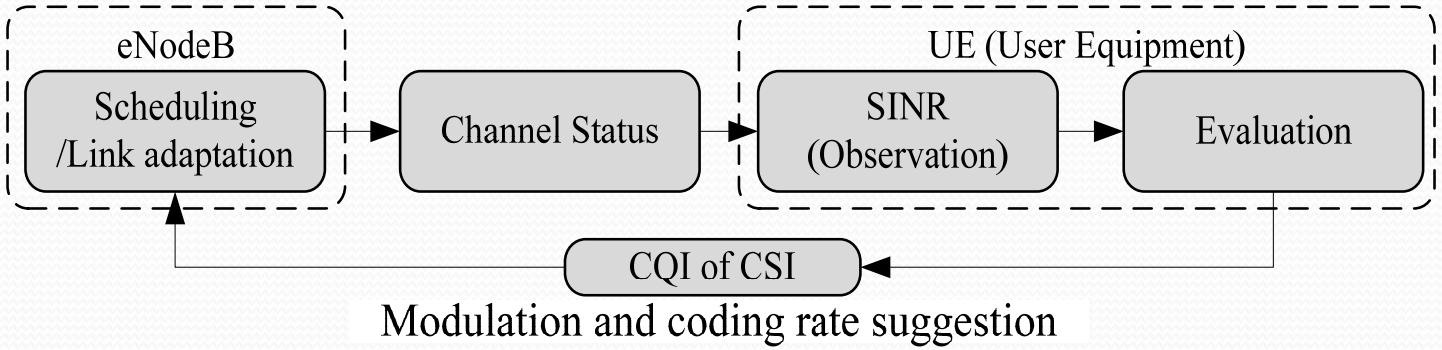
$$PI = 1 - \frac{\eta}{\lambda} = 1 - \frac{\gamma_k R_k}{R'_k}$$



λ: video code rate; γ: transmission effect; η: throughput;
R: total allocation; R': scheduler incoming rate

Case I: Resource Allocation and Link Adaptation in LTE





CQI: Channel Quality Indicator; CSI: Channel State Information

QoE Driven Resource Allocation Algorithm

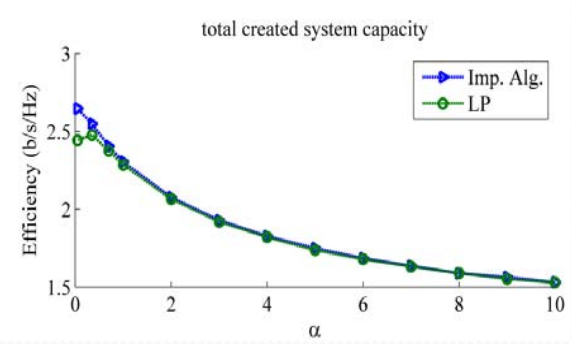
$$\begin{cases} r^* = \arg_r max \sum_{k=0}^{N_{UE}} u_k \\ u_k = PI_k{}^{\alpha}.R_k\,, \qquad u_k \in \mathbb{R}_{\geq 0} \end{cases}$$

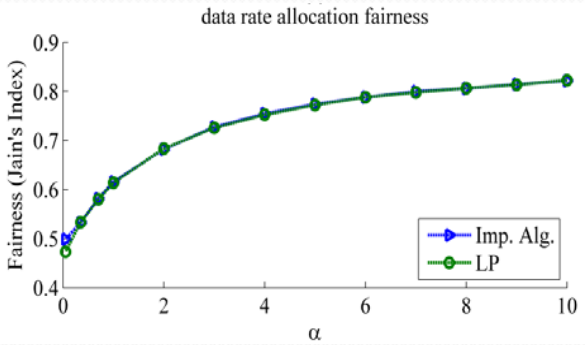
$$\begin{cases} R_k^i = C_k^T.r_k \\ C_k = C_k\big(CQI(SNR)\big) \in \mathbb{R}_{>0}{}^{1\times N_{RB}} \end{cases}$$

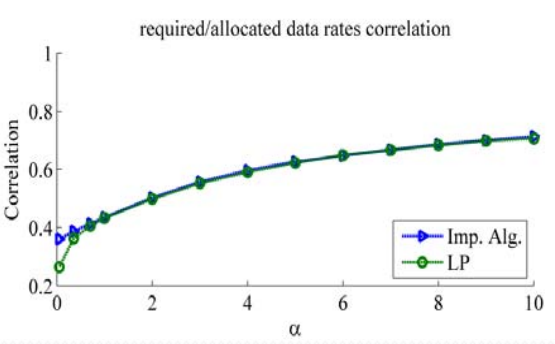
Aston University
Birmingham

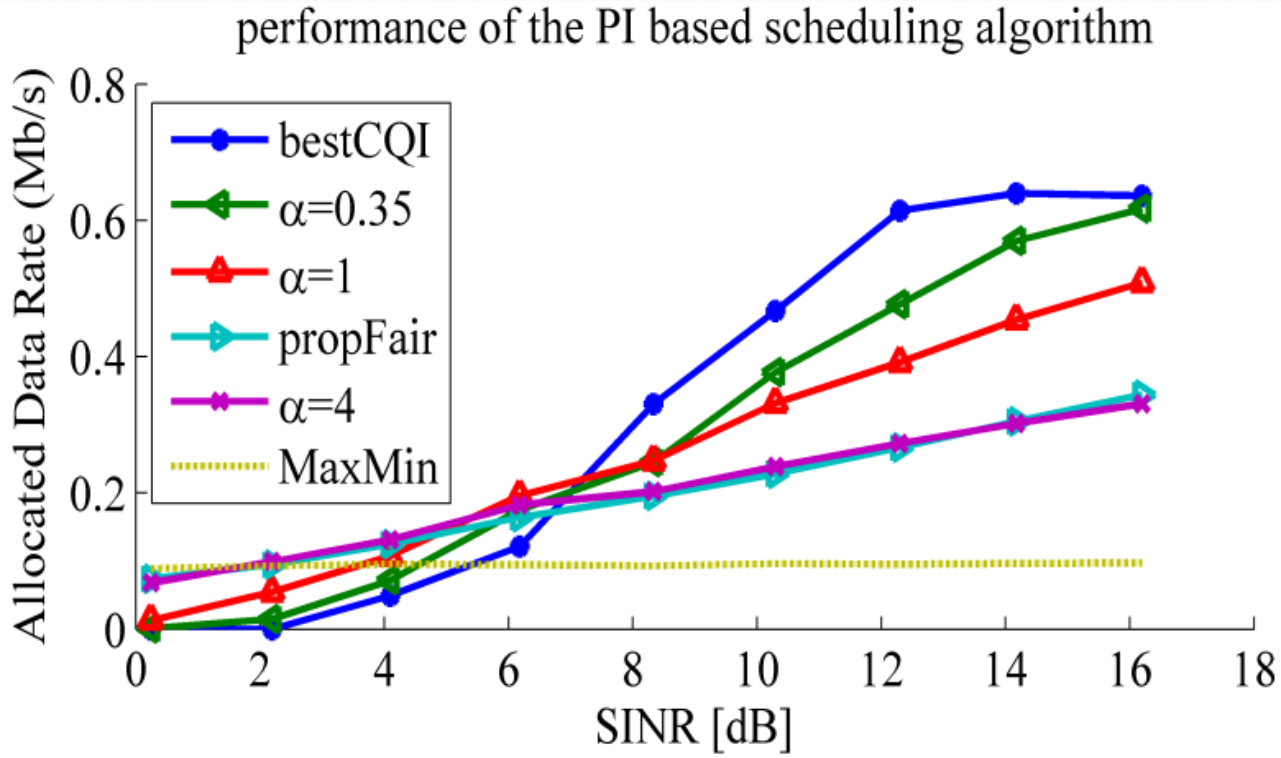
Performance Analysis

(LP --- linear programming; Imp. Alg. --- proposed algorithm)





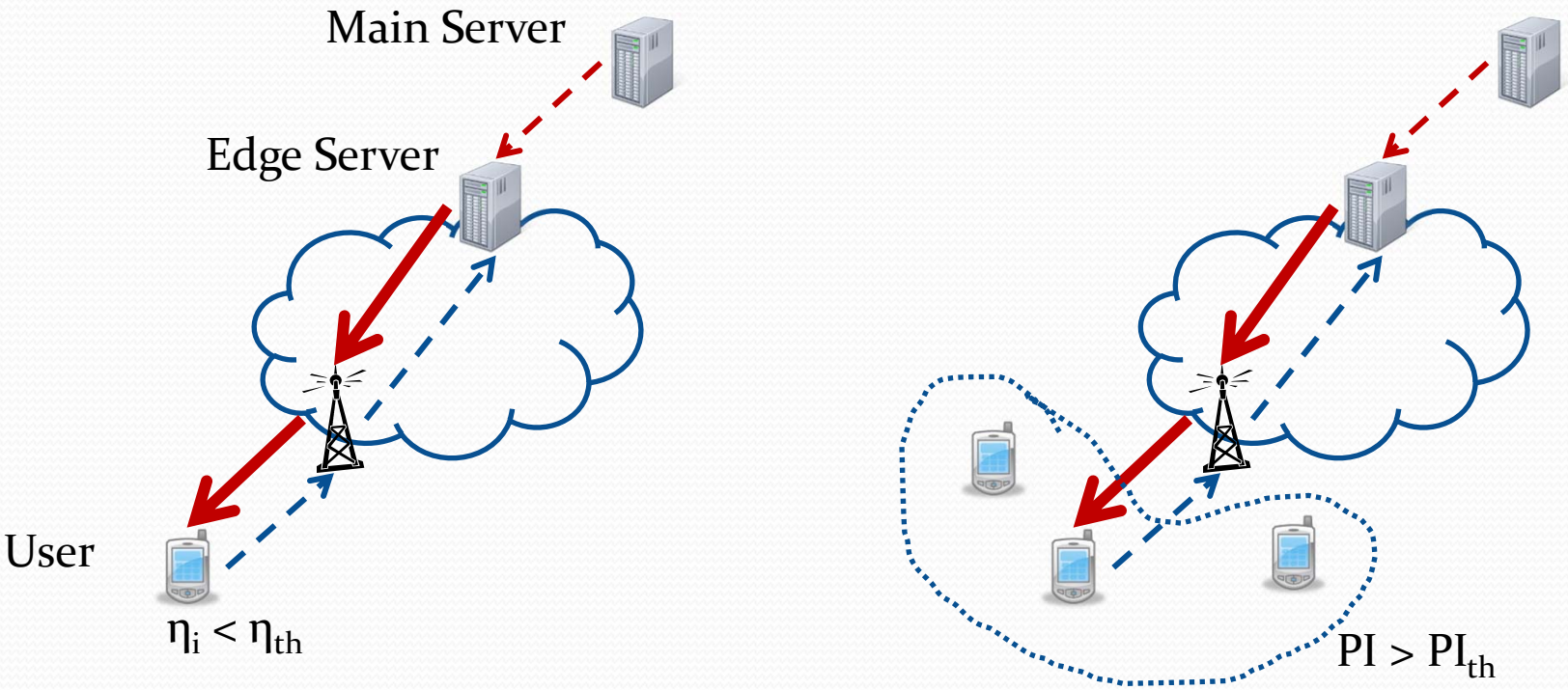




Aston University
Birmingham

Case 2: QoE Driven Rate Adaptation in Video Streaming

e.g. http-based adaptive rate streaming

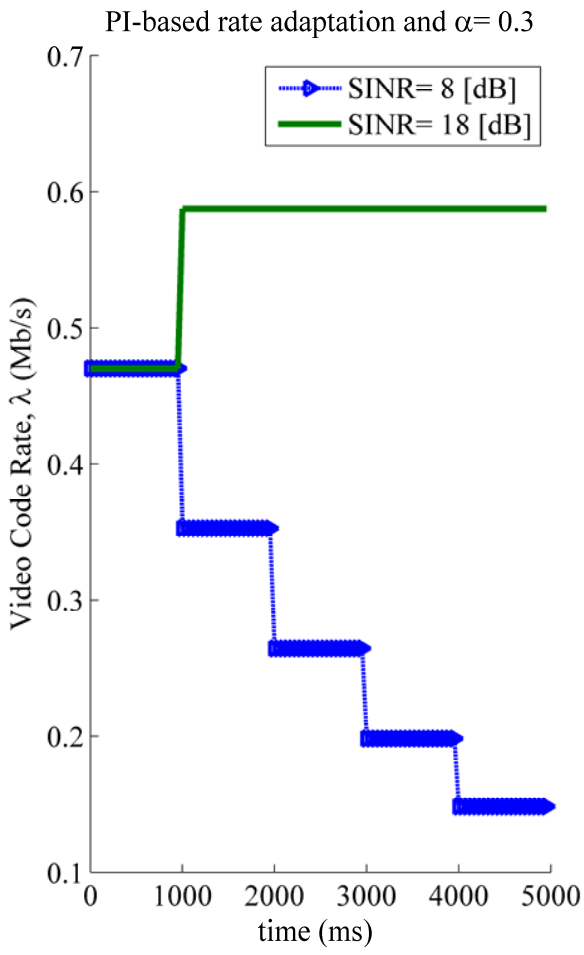


$$PI_i > PI_{th} \rightarrow \eta_i < (1- PI_{th})*\lambda_i$$

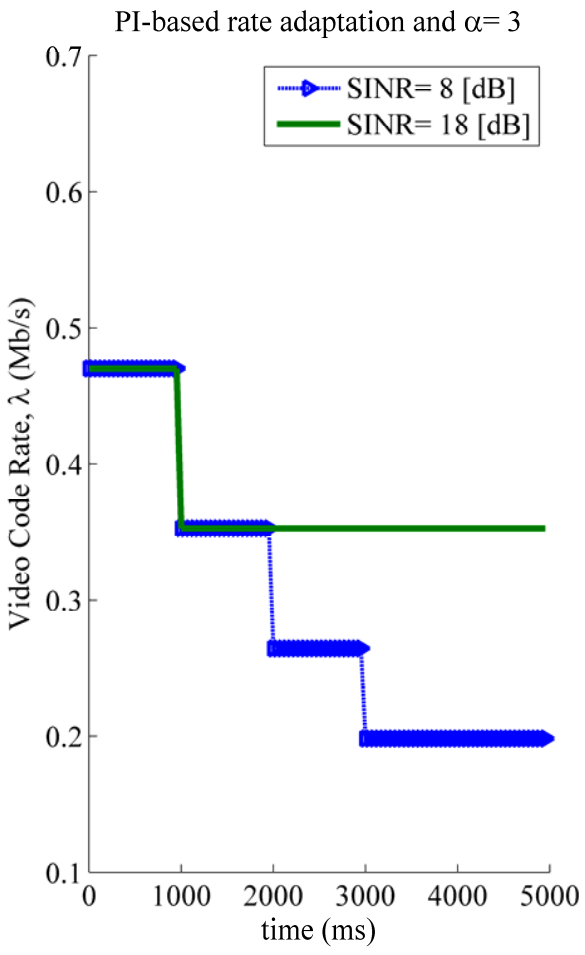
PI can take the network statistics and the required data rate into account

Aston University
Birmingham

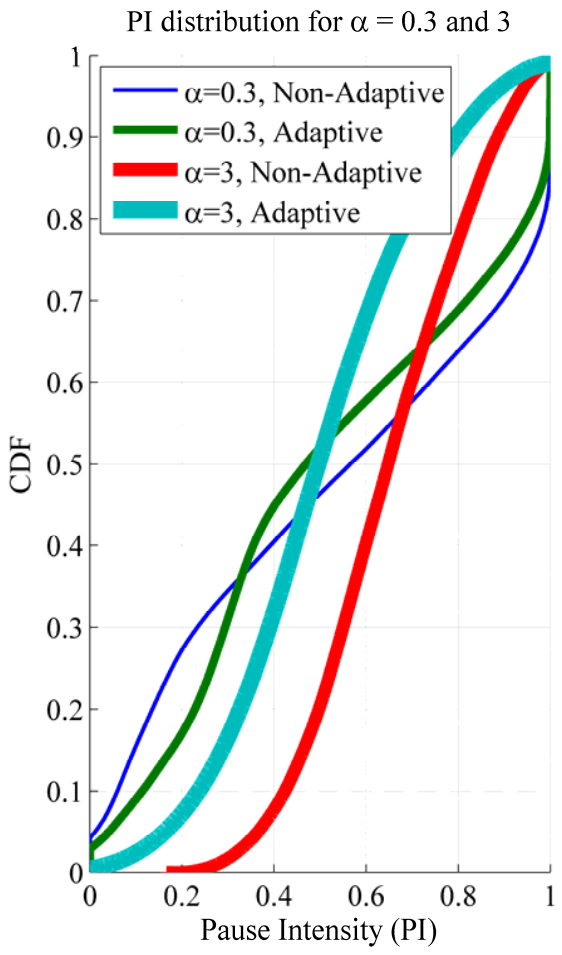
Performance Analysis



(a)



(b)



(c)

Summary

- Pause Intensity shows a strong correlation with video quality perceived by the viewer.
- Pause Intensity can aid adaptive redistribution of video traffic to meet QoE requirements under network resource constraints.
- Recent related publications:

  - "Model and performance of a no-Reference quality assessment metric for video streaming" *IEEE Trans. on Circuits and Systems for Video Technology,* December 2013.

  - "A quality driven framework for adaptive video streaming in mobile wireless networks," IEEE Wireless Communications and Networking Conference (WCNC), April 2014.

Thank you