Impact of the LTE Scheduler on achieving Good QoE for DASH Video Streaming

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Motivation

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- Over 55% of total mobile traffic is now video, approximately 2 Million Terabytes per Month, and is expected to increase to 75% by 2020, approximately 22 Million Terabytes per Month. (Cisco/Statista)
- Adaptive Bitrate Streaming (ABR) over HTTP techniques e.g. Dynamic Adaptive Streaming over HTTP (DASH) are considered the default streaming approach for many video providers, such as Netflix, Hulu and YouTube.
- The objective of this work is to undertake a systematic study on predefined LTE schedulers in NS3 and determine if they can offer improvement in the achievable quality of an adaptive client

Overview

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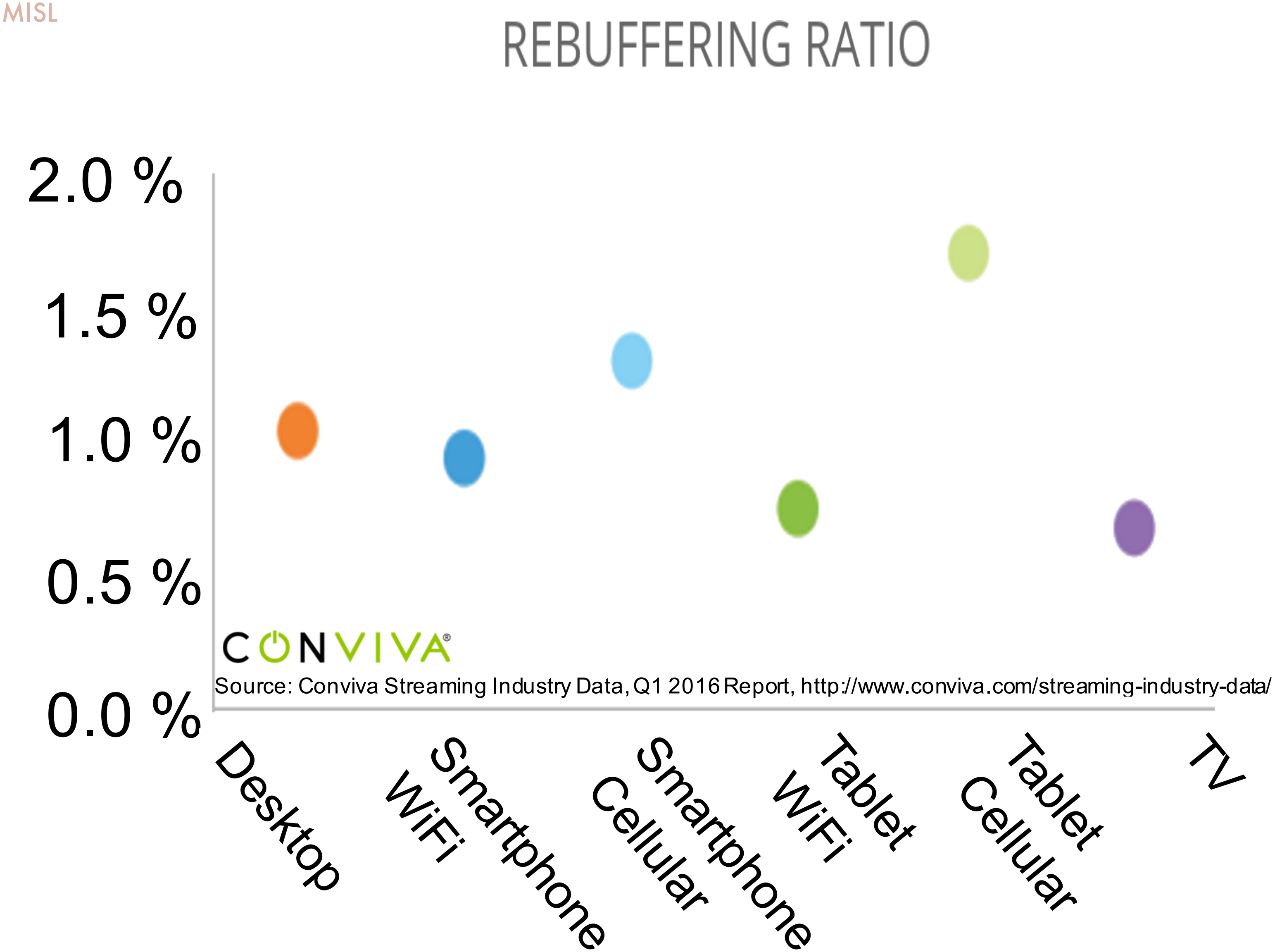
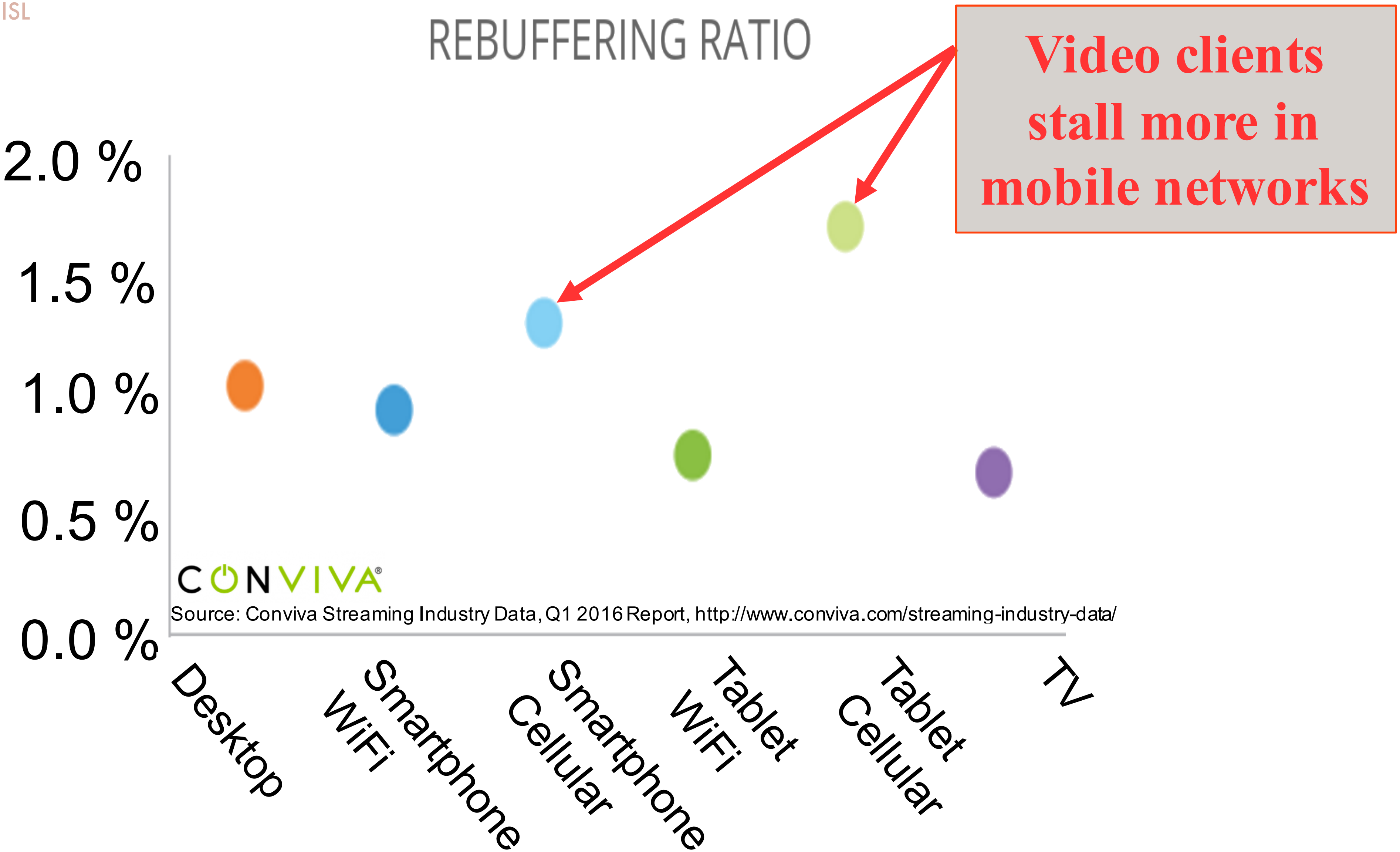
- In this study, we investigated the impact of LTE scheduling policy on the performance of adaptive video streaming using our laboratory testbed using real video content and clients, with an NS3 emulated LTE network.
- We evaluated different adaptive streaming algorithms including the throughput-based FESTIVE [3] , buffer-based approach (BBA) [4] and default GPAC adaptation.
- Our evaluation results consider different performance metrics including video stalls, quality switches, average quality rate, and overall QoE.

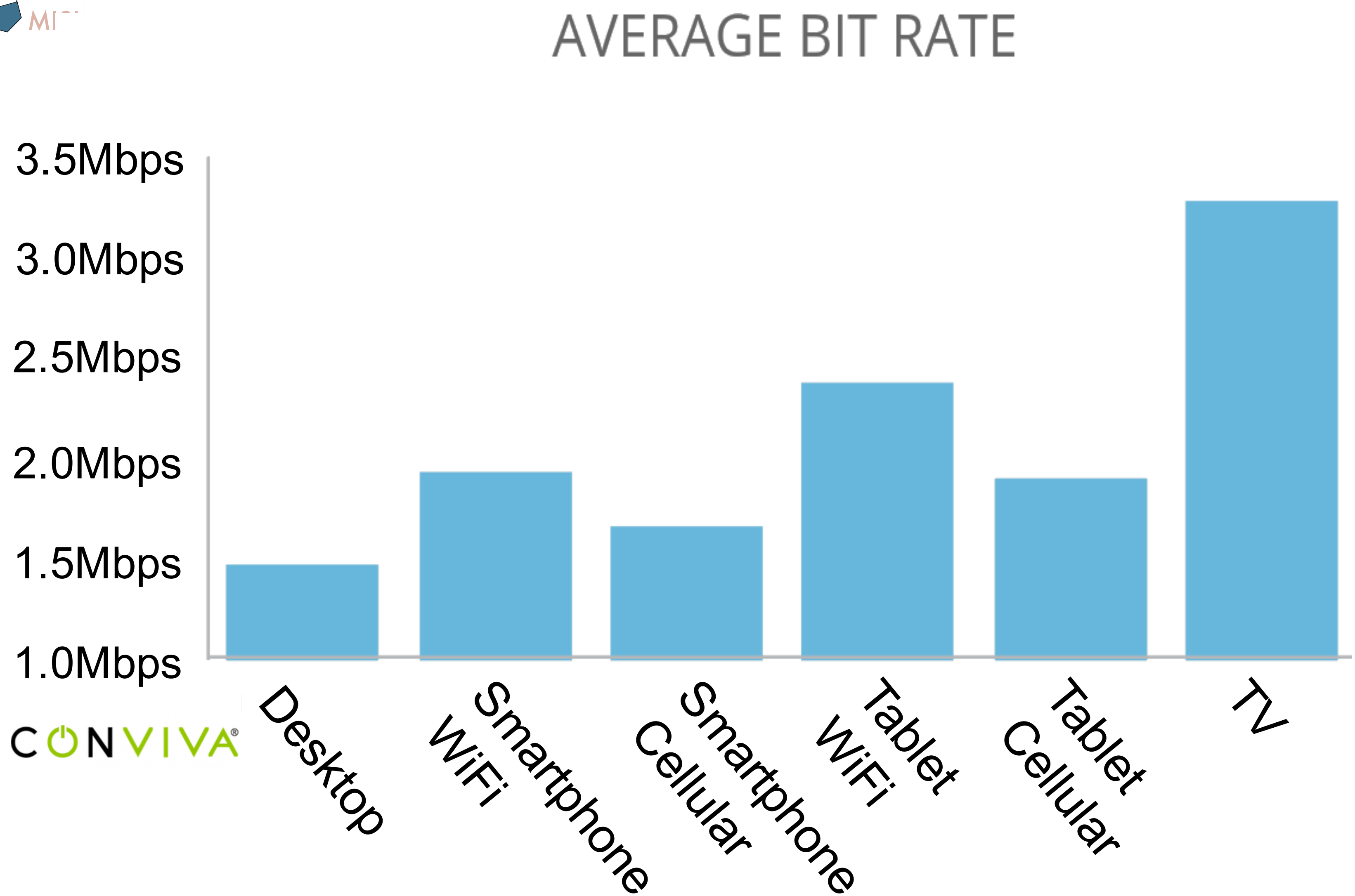
Mobile Video Quality



Mobile Video Quality

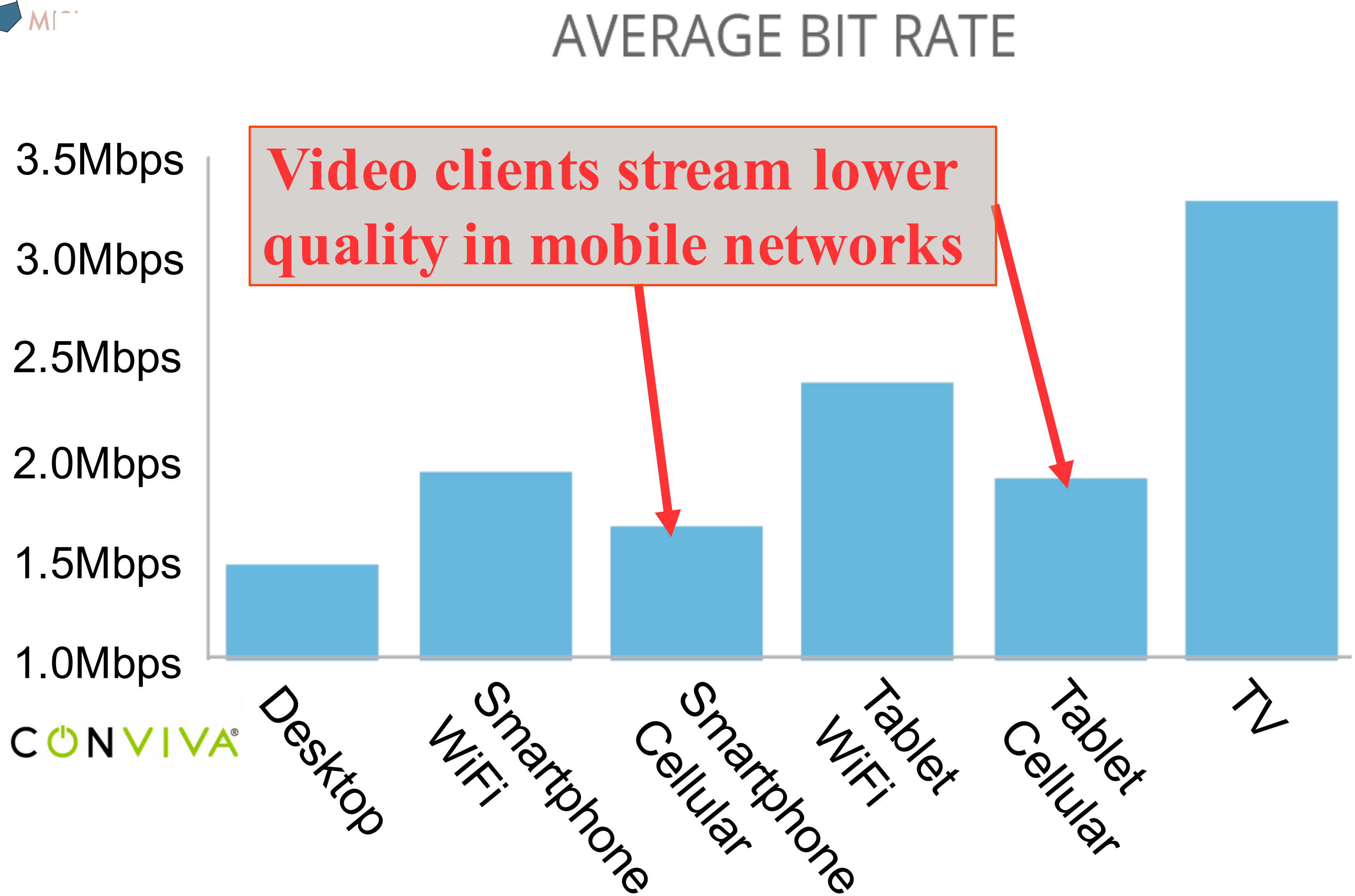


Mobile Video Quality



Source: Conviva Streaming Industry Data, Q1 2016 Report, http://www.conviva.com/streaming-industry-data/

Mobile Video Quality



Source: Conviva Streaming Industry Data, Q1 2016 Report, http://www.conviva.com/streaming-industry-data/

DASH Overview

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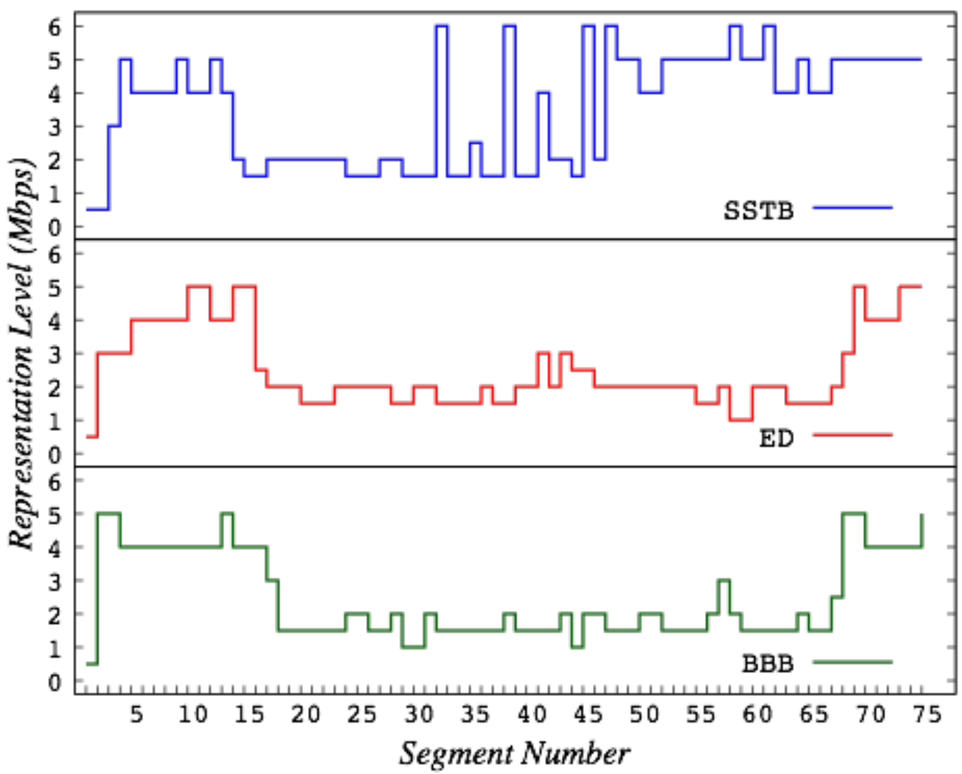
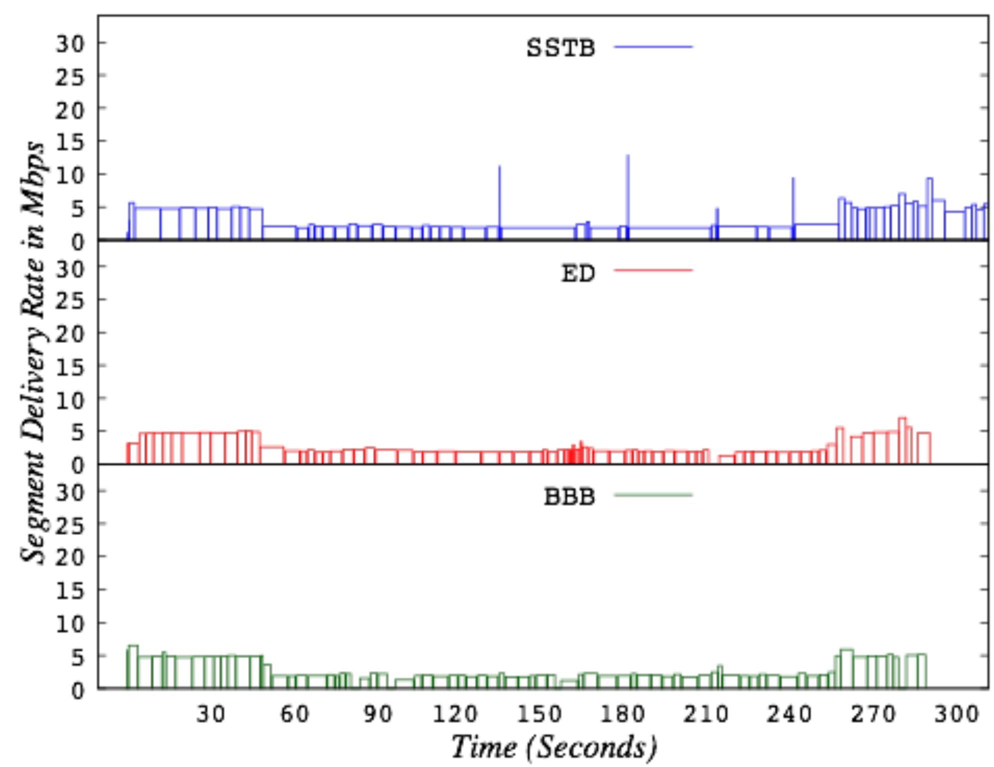
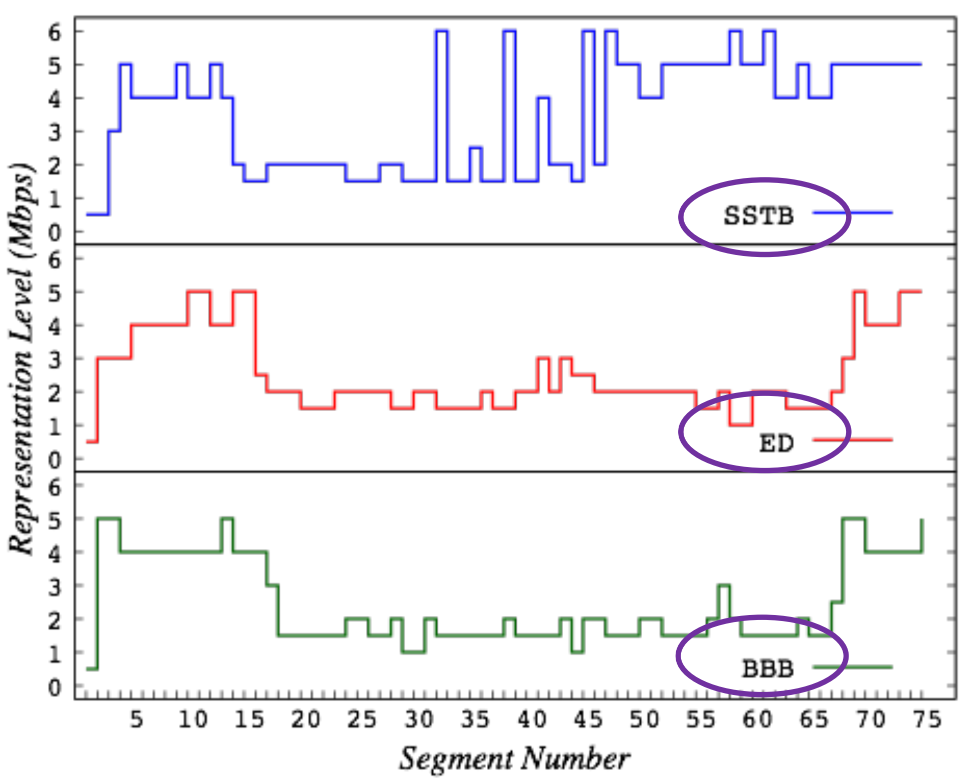
- DASH creates multiple bitrate versions of the same video clip, which allows the client to adapt to changes in the network, at predefined points in time, typically segment boundaries

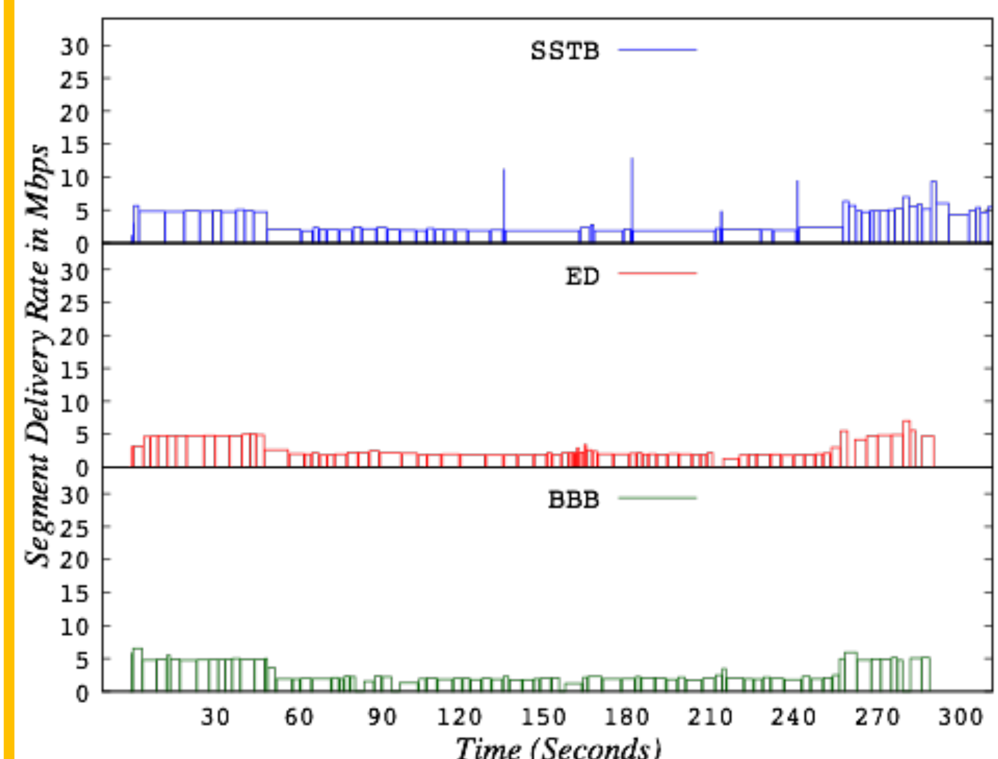




DASH Overview

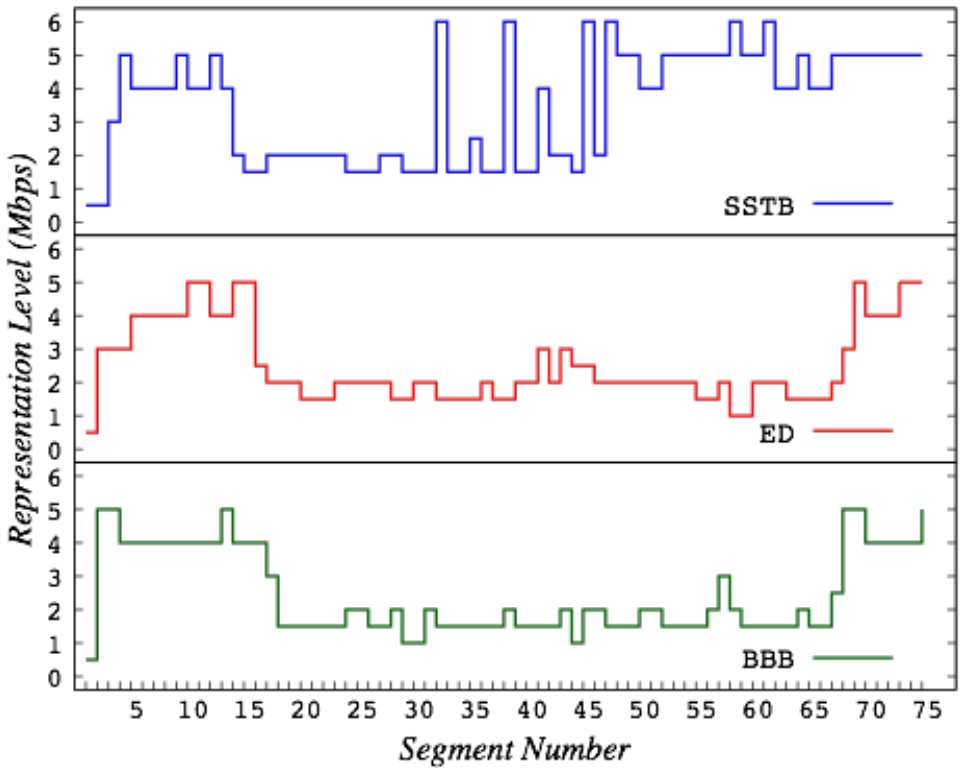
- SSTB, ED and BBB are video clips from our dataset
- Highlighted figure illustrates changes in quality rate per segment over time

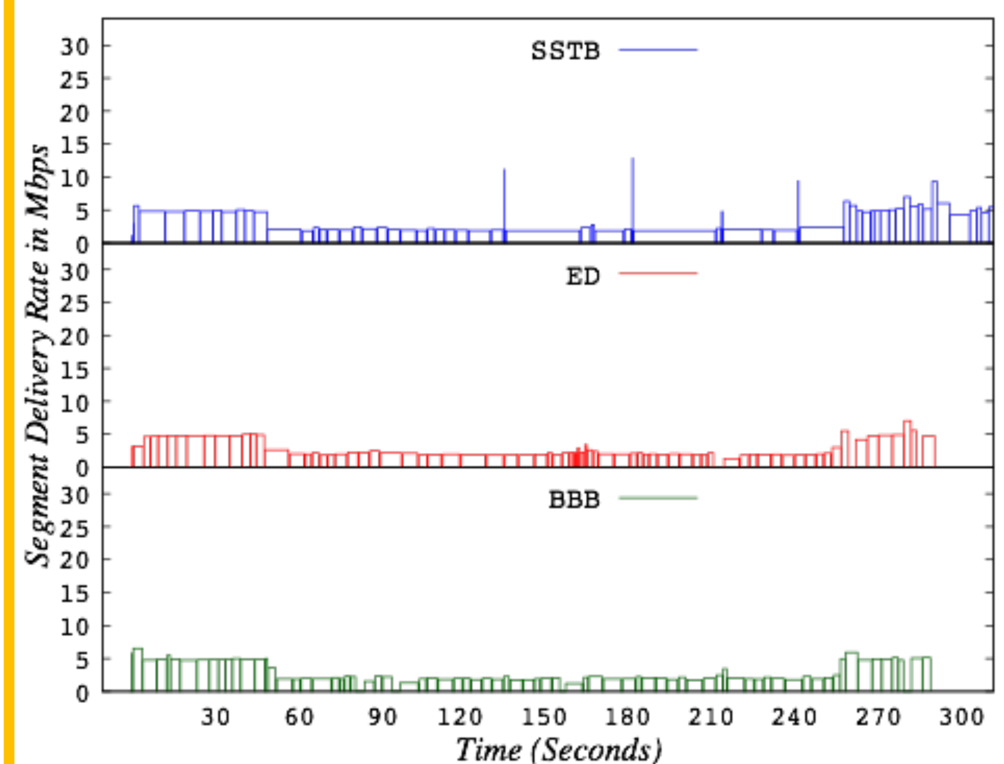




DASH Overview

- Highlighted figure illustrates delivery rate
- Each block denotes a single segment: width denotes delivery time and height delivery rate





DASH Content Utilised

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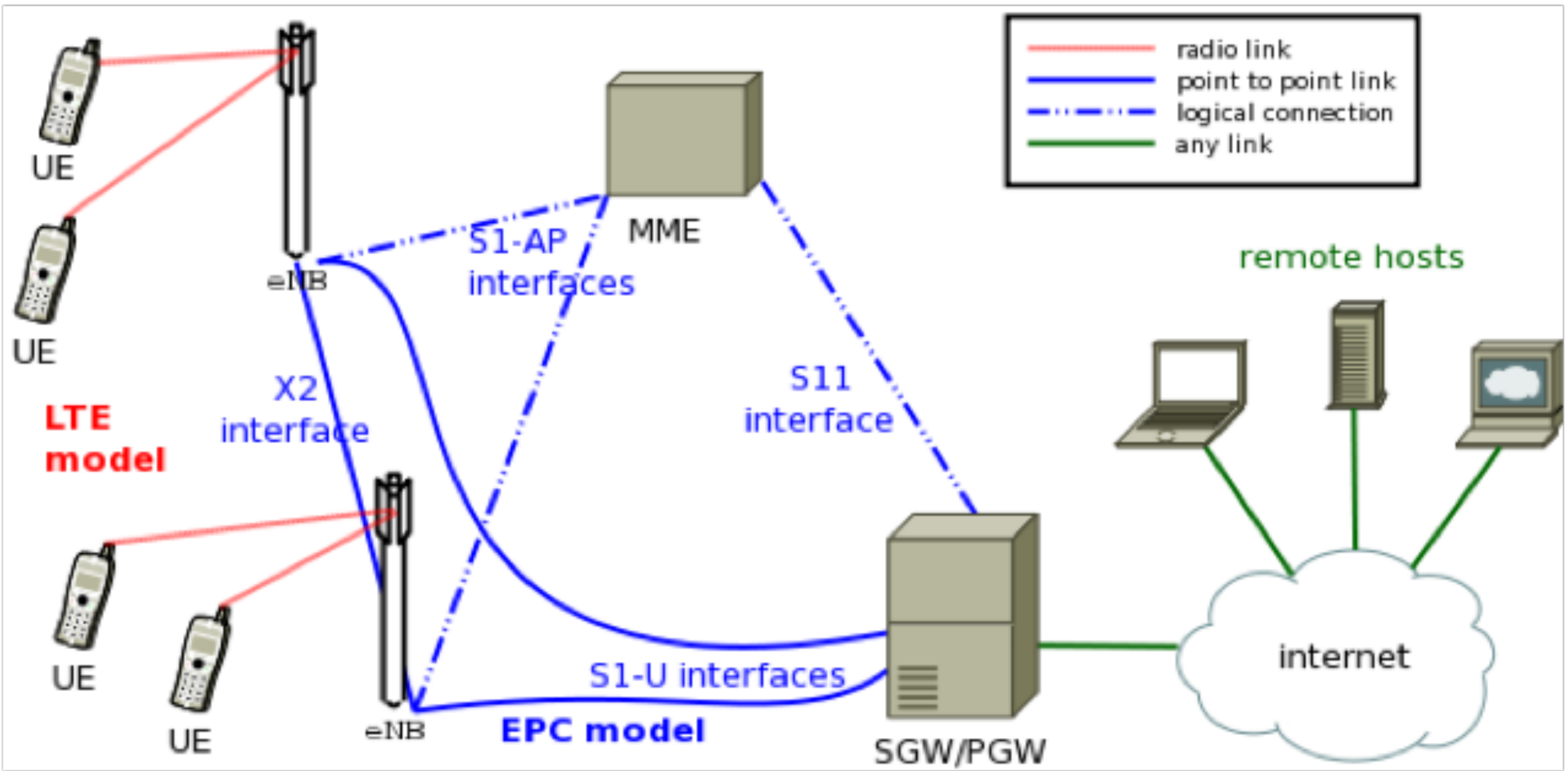
- Recently published at Multi-Media Systems (MMSys 2016)
- All content is encoded in both H.264 (AVC) and H.265 (HEVC). H.264 used in this work.
- Ten quality rates across seven resolutions.
- Twenty three clips from varying genres: action, comedy, documentary, animation, thriller, sci-fi, across three datasets.
- Five different segment durations: 2-, 4-, 6-, 8-, and 10-second for ten- or sixteen-minute videos.
- Three different Datasets: Content-based (used here), Trace-based and Compressed.

www.cs.ucc.ie/misl/research/current/ivid_dataset

Long Term Evolution (LTE) Overview

LTE-EPC Network SimulAtor



networks.cttc.es/mobile-networks/software-tools/lena/

Long Term Evolution (LTE) Overview

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1. Proportional Fairness (PF)
   - schedules a user when a users instantaneous channel quality is high relative to the cumulative average channel condition over time.
   - most deployed eNodeB (eNB) base stations use PF scheduler
   - expected result: all clients should receive adequate throughput, but edge clients may experience issues
2. Frequency Domain Blind Equal Throughput (BET):
   - aims to provide equal throughput to all UEs
   - Maximizes system fairness by allocating to user with lowest cumulative average rate
   - expected result: equalizing throughput may lead to a greater number of switches as clients react to fluctuations in buffer level

Long Term Evolution (LTE) Overview

MISL

3. Frequency Domain Maximum Throughput (MT)
   - aims to maximize the overall throughput of eNB.
   - MT allocates each RB to the user with the best channel condition.
   - expected result: may starve edge clients due to lower channel conditions
4. Priority set scheduler (PSS)
   - is a QoS aware scheduler which combines time domain (TD) and frequency domain (FD) packet scheduling
   - target rate for PSS is set to 700kbps – mid range quality for mobile devices
   - expected result: improved quality rate for edge clients

Long Term Evolution (LTE) Overview

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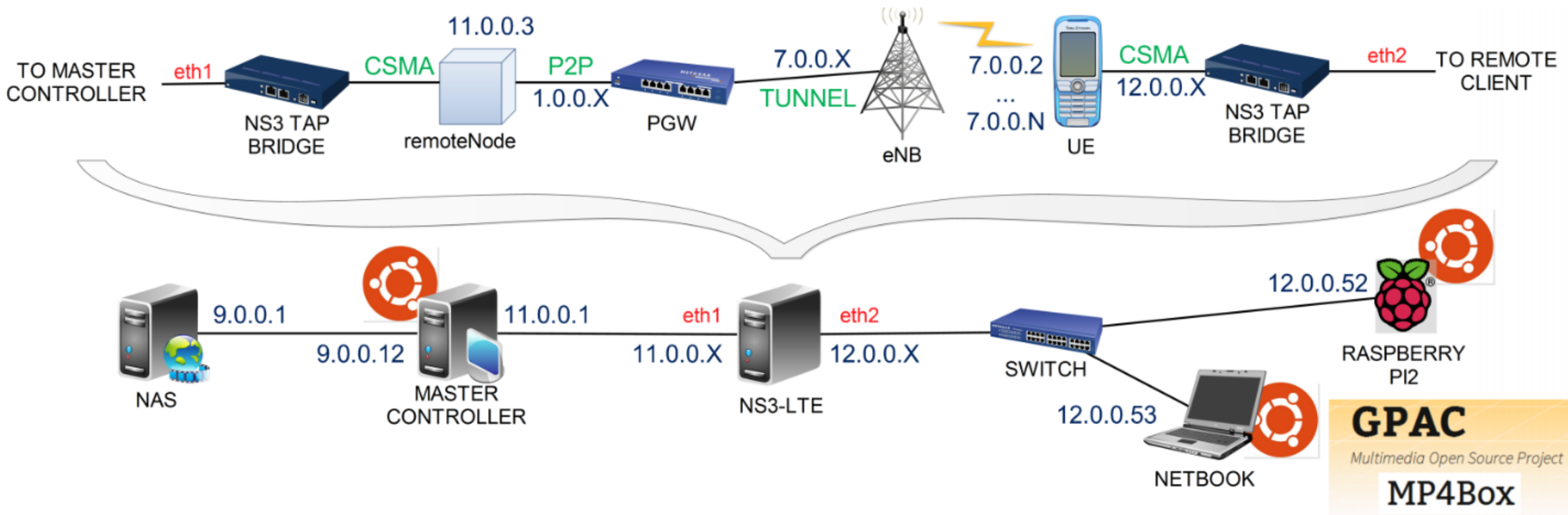
- Three Fading Models:
  - Static: User Equipment (UE) same fading value per resource block (RB)
  - Pedestrian Mobility (3Kmph)
  - Vehicular Mobility (30Kmph)

- All Fading Traces were generated by a MATLAB script provided by LENA

Further information and build instructions for the LENA components utilised in this paper are available at:

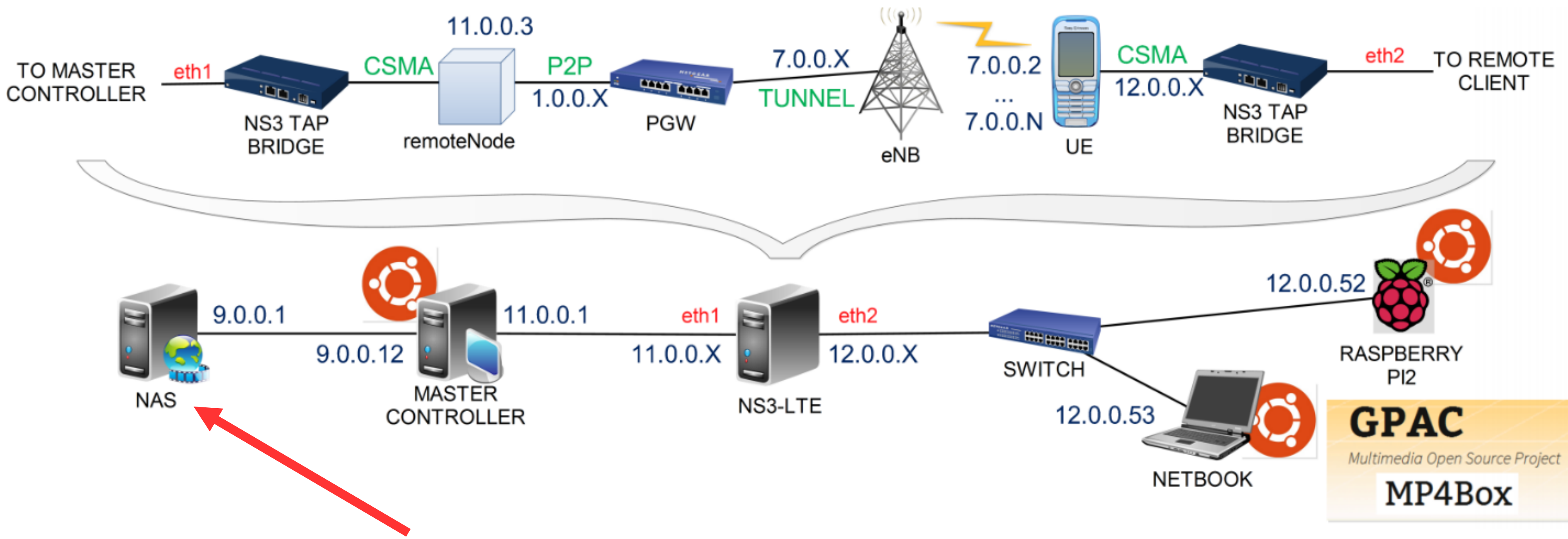
www.cs.ucc.ie/misl/research/current/ivid_demo/lanman2016

Evaluation Setup



Hybrid physical and simulated infrastructure in which actual DASH video clips are streaming from a server to clients over an LTE air-interface in real-time.

Evaluation Setup



The Network Attached Storage node contains the DASH Dataset [12].

Evaluation Setup

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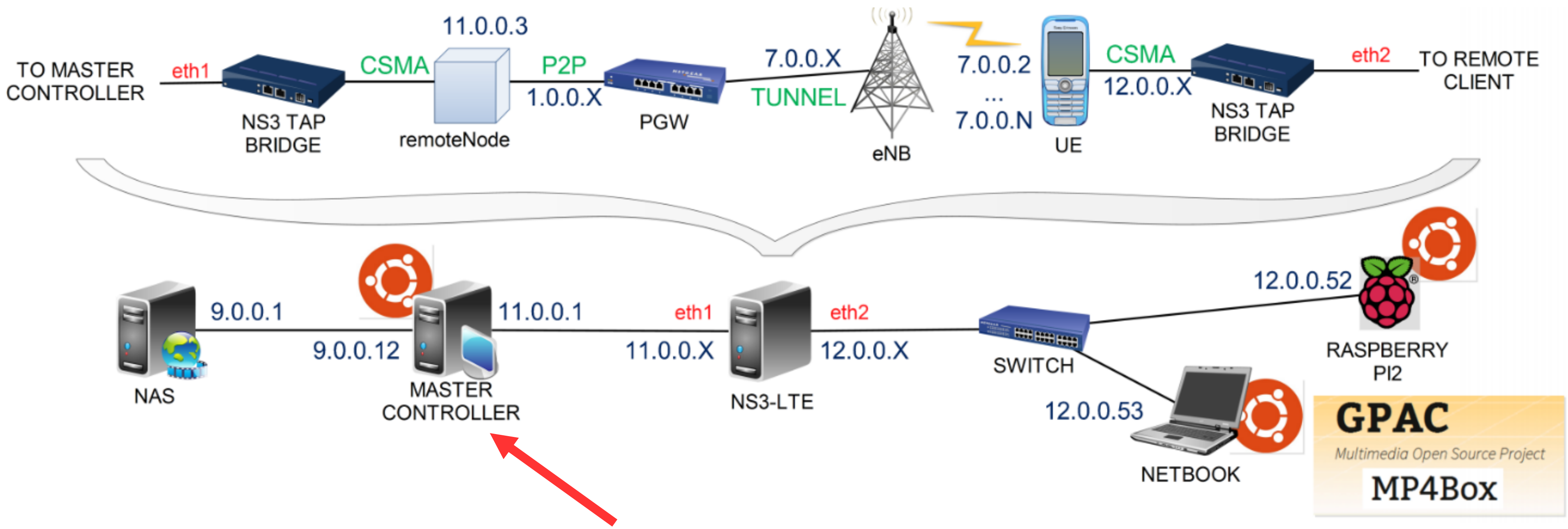
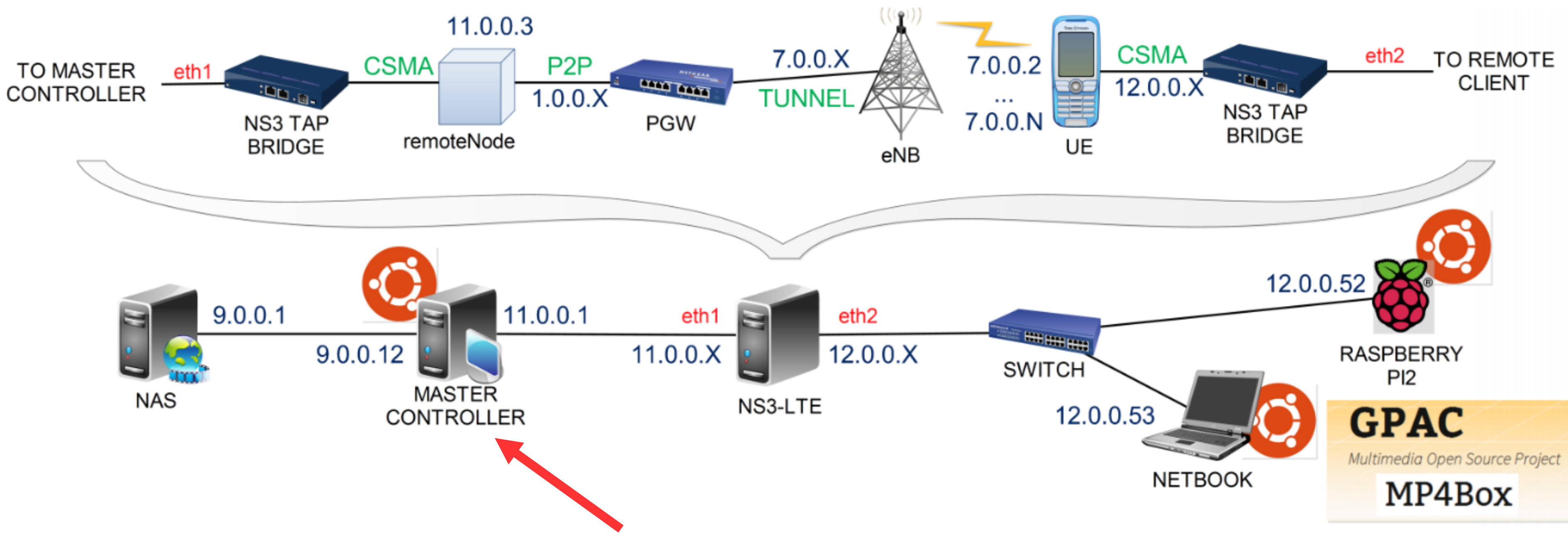


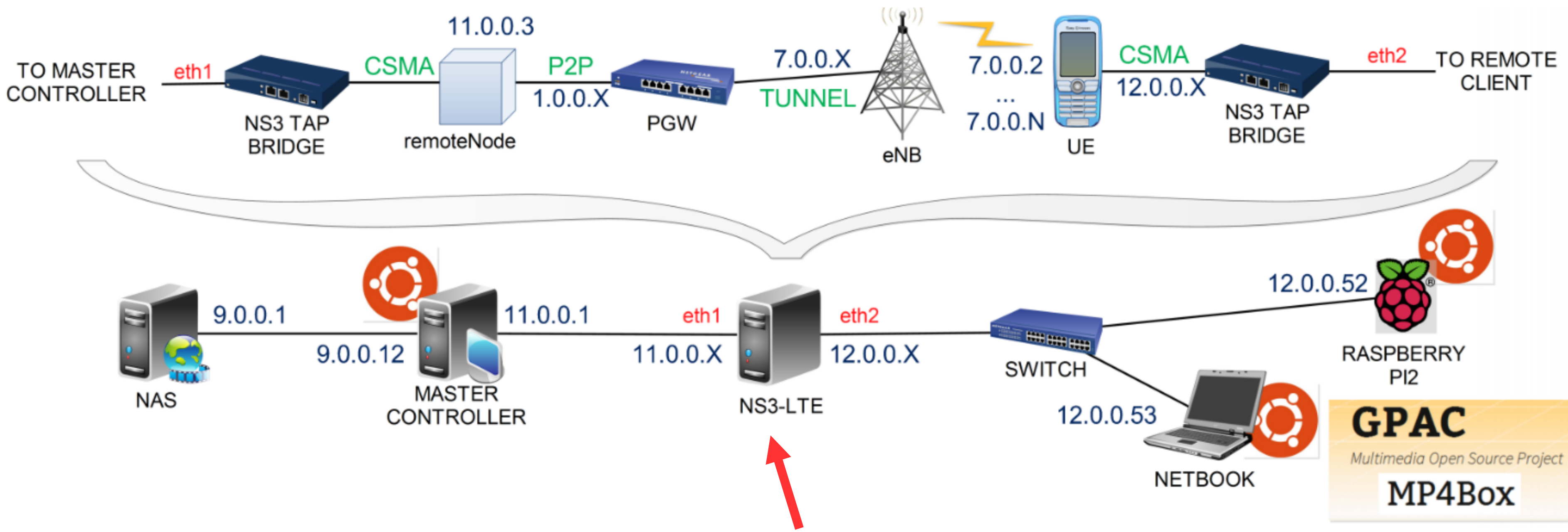
The Master Controller defines the LTE and Client configurations. Such as number and distance of users, fading model, scheduler, simulation time, adaptation model, and clip index.

Evaluation Setup



The Master Controller is also used to gather metrics from LTE and the clients for post processing.
In this work stream data flowing through the Master Controller is not impeded in anyway.

Evaluation Setup



The NS3-LTE machine implements the LTE Evolved Packet Core (EPC) and air-interface for the desired number of clients. The three fading models are implemented here.

Evaluation Setup

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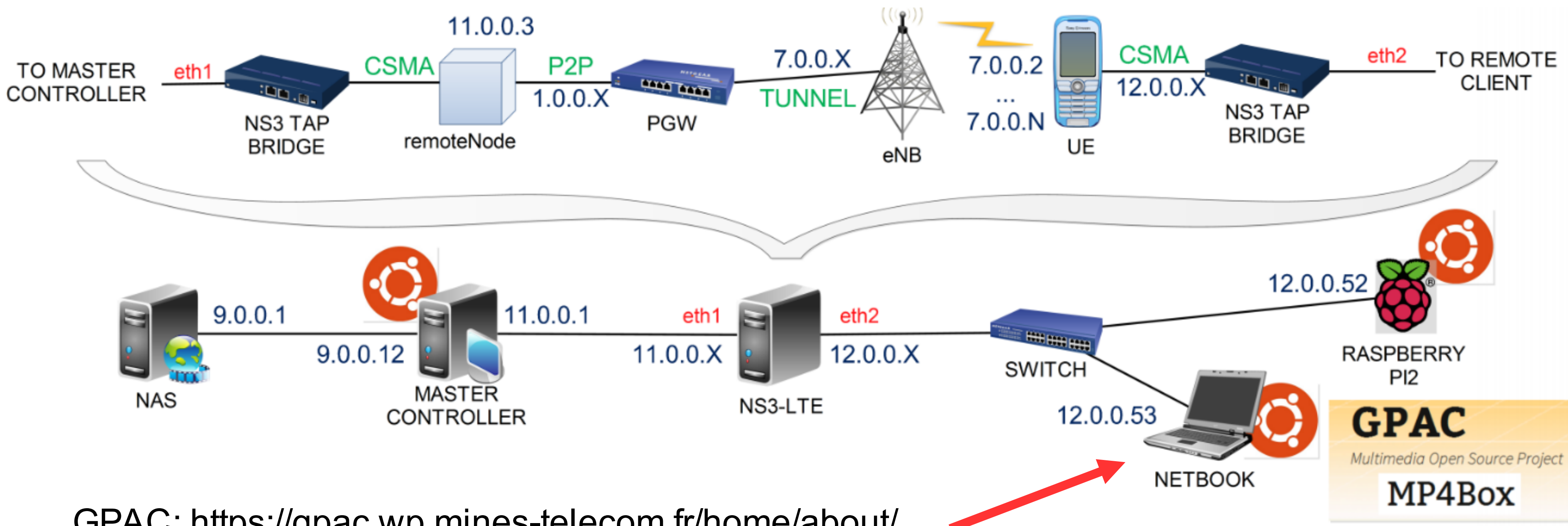

GPAC: https://gpac.wp.mines-telecom.fr/home/about/

Our clients, 6 in this evaluation setup, are a mixture of Raspberry Pi-2's and Netbooks, each containing GPAC, open-source video framework, and implemented adaptation algorithms.

Evaluation Setup

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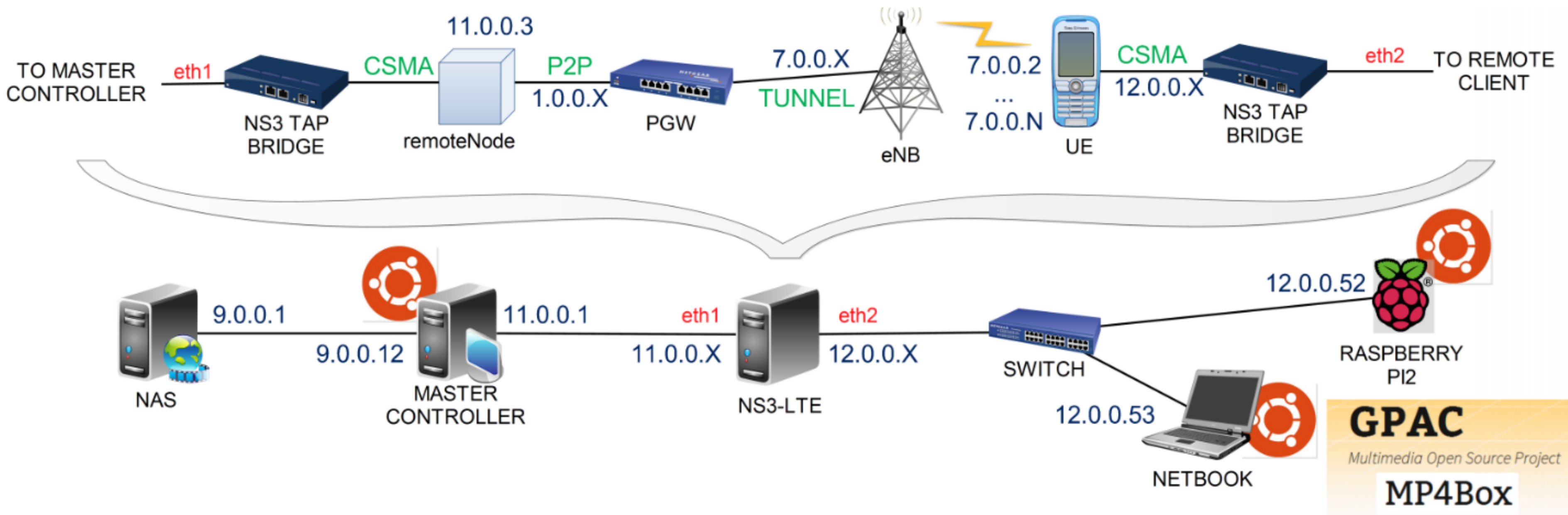

A demonstration of a portable version of our 'D-LiTE' testbed is available to be viewed during the demo session of LANMAN:

14:15 to 15:15 today – Look for the demo 'D-LiTE'

Evaluation Setup

- DASH Adaptation Algorithms, widely used in the Literature:
  - FESTIVE [3] :
    - Throughput-based approach – 30 second max buffer size
    - Harmonic mean average for network throughput
    - Cautious startup phase, network probing to improve quality
  - (BBA) [4], specifically BBA2:
    - Buffer-based approach – 240 second max buffer size
    - Two thresholds to determine if a higher/lower rate should be selected
    - Maps future segment transmission cost to improve selection

Evaluation Setup

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- As stated, the Master Controller, gathers clients metrics and per stream/UE creates a colonized trace file containing stream information per delivered segment, example:

Seg_#	Arr_time	Del_Time	Stall_Dur	Rep_Level	Del_Rate	Act_Rate	Byte_Size	Buff_Level
1	1517	1097	0	232	905	248	124131	4.000
2	3629	1711	0	752	2104	900	450106	8.000
3	8115	4090	0	1774	2016	2062	1031136	12.000
4	23418	14936	0	1774	512	1914	957238	0.697
5	27725	1275	0	374	434	138	69286	0.390
6	30130	1690	0	374	745	315	157538	1.985
7	37117	5004	1001	374	417	522	261058	0.000
8	45637	7172	4520	374	239	429	214866	0.000
9	51840	2906	2203	232	301	219	109544	0.000
10	53700	281	0	232	2422	170	85085	2.140

Evaluation Setup

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- Each row provides per segment information

Seg_#	Arr_time	Del_Time	Stall_Dur	Rep_Level	Del_Rate	Act_Rate	Byte_Size	Buff_Level
1	1517	1097	0	232	905	248	124131	4.000
2	3629	1711	0	752	2104	900	450106	8.000
3	8115	4090	0	1774	2016	2062	1031136	12.000
4	23418	14936	0	1774	512	1914	957238	0.697
5	27725	1275	0	374	434	138	69286	0.390
6	30130	1690	0	374	745	315	157538	1.985
7	37117	5004	1001	374	417	522	261058	0.000
8	45637	7172	4520	374	239	429	214866	0.000
9	51840	2906	2203	232	301	219	109544	0.000
10	53700	281	0	232	2422	170	85085	2.140

Evaluation Setup

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- Column values provide information on:
  - Arrival time and delivery time per segment in milliseconds (ms)

Seg_#	Arr_time	Del_Time	Stall_Dur	Rep_Level	Del_Rate	Act_Rate	Byte_Size	Buff_Level
1	1517	1097	0	232	905	248	124131	4.000
2	3629	1711	0	752	2104	900	450106	8.000
3	8115	4090	0	1774	2016	2062	1031136	12.000
4	23418	14936	0	1774	512	1914	957238	0.697
5	27725	1275	0	374	434	138	69286	0.390
6	30130	1690	0	374	745	315	157538	1.985
7	37117	5004	1001	374	417	522	261058	0.000
8	45637	7172	4520	374	239	429	214866	0.000
9	51840	2906	2203	232	301	219	109544	0.000
10	53700	281	0	232	2422	170	85085	2.140

Evaluation Setup

- Column values provide information on:
  - Rebuffering issues and stalls (ms)

Seg_#	Arr_time	Del_Time	Stall_Dur	Rep_Level	Del_Rate	Act_Rate	Byte_Size	Buff_Level
1	1517	1097	0	232	905	248	124131	4.000
2	3629	1711	0	752	2104	900	450106	8.000
3	8115	4090	0	1774	2016	2062	1031136	12.000
4	23418	14936	0	1774	512	1914	957238	0.697
5	27725	1275	0	374	434	138	69286	0.390
6	30130	1690	0	374	745	315	157538	1.985
7	37117	5004	1001	374	417	522	261058	0.000
8	45637	7172	4520	374	239	429	214866	0.000
9	51840	2906	2203	232	301	219	109544	0.000
10	53700	281	0	232	2422	170	85085	2.140

Evaluation Setup

- Column values provide information on:
  - Quality rate switching based on average encoding rate (kbps)

Seg_#	Arr_time	Del_Time	Stall_Dur	Rep_Level	Del_Rate	Act_Rate	Byte_Size	Buff_Level
1	1517	1097	0	232	905	248	124131	4.000
2	3629	1711	0	752	2104	900	450106	8.000
3	8115	4090	0	1774	2016	2062	1031136	12.000
4	23418	14936	0	1774	512	1914	957238	0.697
5	27725	1275	0	374	434	138	69286	0.390
6	30130	1690	0	374	745	315	157538	1.985
7	37117	5004	1001	374	417	522	261058	0.000
8	45637	7172	4520	374	239	429	214866	0.000
9	51840	2906	2203	232	301	219	109544	0.000
10	53700	281	0	232	2422	170	85085	2.140

Evaluation Setup

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- Column values provide information on:
  - Delivery (kbps) and actual rate (kbps) of the segment

Seg_#	Arr_time	Del_Time	Stall_Dur	Rep_Level	Del_Rate	Act_Rate	Byte_Size	Buff_Level
1	1517	1097	0	232	905	248	124131	4.000
2	3629	1711	0	752	2104	900	450106	8.000
3	8115	4090	0	1774	2016	2062	1031136	12.000
4	23418	14936	0	1774	512	1914	957238	0.697
5	27725	1275	0	374	434	138	69286	0.390
6	30130	1690	0	374	745	315	157538	1.985
7	37117	5004	1001	374	417	522	261058	0.000
8	45637	7172	4520	374	239	429	214866	0.000
9	51840	2906	2203	232	301	219	109544	0.000
10	53700	281	0	232	2422	170	85085	2.140

Evaluation Setup

- Column values provide information on:
  - Transmission cost in bytes for the requested segment

Seg_#	Arr_time	Del_Time	Stall_Dur	Rep_Level	Del_Rate	Act_Rate	Byte_Size	Buff_Level
1	1517	1097	0	232	905	248	124131	4.000
2	3629	1711	0	752	2104	900	450106	8.000
3	8115	4090	0	1774	2016	2062	1031136	12.000
4	23418	14936	0	1774	512	1914	957238	0.697
5	27725	1275	0	374	434	138	69286	0.390
6	30130	1690	0	374	745	315	157538	1.985
7	37117	5004	1001	374	417	522	261058	0.000
8	45637	7172	4520	374	239	429	214866	0.000
9	51840	2906	2203	232	301	219	109544	0.000
10	53700	281	0	232	2422	170	85085	2.140

Evaluation Setup

- Column values provide information on:
  - Buffer level of the client once a segment has arrived.

Seg_#	Arr_time	Del_Time	Stall_Dur	Rep_Level	Del_Rate	Act_Rate	Byte_Size	Buff_Level
1	1517	1097	0	232	905	248	124131	4.000
2	3629	1711	0	752	2104	900	450106	8.000
3	8115	4090	0	1774	2016	2062	1031136	12.000
4	23418	14936	0	1774	512	1914	957238	0.697
5	27725	1275	0	374	434	138	69286	0.390
6	30130	1690	0	374	745	315	157538	1.985
7	37117	5004	1001	374	417	522	261058	0.000
8	45637	7172	4520	374	239	429	214866	0.000
9	51840	2906	2203	232	301	219	109544	0.000
10	53700	281	0	232	2422	170	85085	2.140

Evaluation Setup

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- From the columnized trace file we determine:
  - n_{st} :The average number of stalls per session
  - t_{st} The average stall duration per session
  - r_{av} The average received quality rate per session
  - n_{sw} The average number of switches per session
  - l_{sw}: The average switching level – how many quality rates are within a single switch jump
  - χ : The user quality of experience based on DASH-UE model (IEEE Trans. Broadcasting 2015) an objective metric derived based on subjective evaluations.

Evaluation Results – Performance Metrics

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BBA

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.27	5.63	467.19	11.83	1.25
MT	3.97	40.55	530.89	8.04	1.07
PF	0.53	2.76	553.10	9.23	1.17
PSS	0.33	3.12	454.93	9.9	1.19

(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0	0	429.76	11.1	1.34
MT	0.1	0.39	541.21	11.37	1.35
PF	0	0	558.75	11.43	1.35
PSS	0	0	490.56	11.2	1.37

Festive

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	1.37	11.78	480.64	17	1
MT	6.28	43.71	524.80	14.24	1
PF	1.1	11.18	591.24	19.07	1
PSS	1.2	12.60	503.71	22.07	1

(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.033	0.62	458.00	26.83	1
MT	0	0	574.15	22.27	1
PF	0	0	585.80	22.67	1
PSS	0	0	534.23	21.8	1

Evaluation Results – Performance Metrics

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BBA

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.27	5.63	467.19	11.83	1.25
MT	3.97	40.55	530.89	8.04	1.07
PF	0.53	2.76	553.10	9.23	1.17
PSS	0.33	3.12	454.93	9.9	1.19

(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0	0	429.76	11.1	1.34
MT	0.1	0.39	541.21	11.37	1.35
PF	0	0	558.75	11.43	1.35
PSS	0	0	490.56	11.2	1.37

- Maximum Throughput (MT) has the highest number of stalls (n_{st}) and stall durations (t_{st})
- Very high average quality rate (r_{av})
- Lower number of switches (n_{sw}) and switch jumps (l_{sw}) in static in comparison to mobile – we can see switch rates are greater than one, as BBA can jump more than one quality rate per segment

Evaluation Results – Performance Metrics

BBA

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.27	5.63	467.19	11.83	1.25
MT	3.97	40.55	530.89	8.04	1.07
PF	0.53	2.76	553.10	9.23	1.17
PSS	0.33	3.12	454.93	9.9	1.19

(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0	0	429.76	11.1	1.34
MT	0.1	0.39	541.21	11.37	1.35
PF	0	0	558.75	11.43	1.35
PSS	0	0	490.56	11.2	1.37

- Blind Equal Throughput (BET) has the lowest number of stalls (n_{st}) but a mid range stall durations (t_{st}) in static – nothing in mobile
- Relatively low average quality rate (r_{av})
- High number of switches (n_{sw}) and switch jumps (l_{sw}) in both static and mobile

Evaluation Results – Performance Metrics

MISL

BBA

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.27	5.63	467.19	11.83	1.25
MT	3.97	40.55	530.89	8.04	1.07
PF	0.53	2.76	553.10	9.23	1.17
PSS	0.33	3.12	454.93	9.9	1.19

(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0	0	429.76	11.1	1.34
MT	0.1	0.39	541.21	11.37	1.35
PF	0	0	558.75	11.43	1.35
PSS	0	0	490.56	11.2	1.37

- Proportional Fair (PF) & Priority set scheduler (PSS) have a low number of stalls (n_{st}) and relatively low stall durations (t_{st}) in static – nothing in mobile
- Mid range number of switches (n_{sw}) and switch jumps (l_{sw}) in both static and mobile – both higher in mobile
- Higher average quality rate (r_{av}) in PF

Evaluation Results – Performance Metrics

- We see similar results in Festive for MT, but due to the cautious nature of festive, we see no stalls (n_{st}) and stall durations (t_{st}) in Mobile and single rate switch jumps

Festive

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	1.37	11.78	480.64	17	1
MT	6.28	43.71	524.80	14.24	1
PF	1.1	11.18	591.24	19.07	1
PSS	1.2	12.60	503.71	22.07	1

(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.033	0.62	458.00	26.83	1
MT	0	0	574.15	22.27	1
PF	0	0	585.80	22.67	1
PSS	0	0	534.23	21.8	1

Evaluation Results – Performance Metrics

- We see similar results in Festive for MT, but due to the cautious nature of festive, we see no stalls (n_{st}) and stall durations (t_{st}) in Mobile and single switch jumps
- BET fairs worse for Festive for both Static and Mobile in stalls (n_{st}) and stall durations (t_{st}) but similar for the other metrics

Festive

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	1.37	11.78	480.64	17	1
MT	6.28	43.71	524.80	14.24	1
PF	1.1	11.18	591.24	19.07	1
PSS	1.2	12.60	503.71	22.07	1

(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.033	0.62	458.00	26.83	1
MT	0	0	574.15	22.27	1
PF	0	0	585.80	22.67	1
PSS	0	0	534.23	21.8	1

Evaluation Results – Performance Metrics

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- We see similar results in Festive for MT, but due to the cautious nature of festive, we see no stalls (***n_{st}***) and stall durations (***t_{st}***) in Mobile and single switch jumps
- BET fairs worse for Festive for both Static and Mobile in stalls (***n_{st}***) and stall durations (***t_{st}***) but similar for the other metrics
- PF and PSS are similar but PF improves the quality rate

Festive

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	1.37	11.78	480.64	17	1
MT	6.28	43.71	524.80	14.24	1
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(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.033	0.62	458.00	26.83	1
MT	0	0	574.15	22.27	1
PF	0	0	585.80	22.67	1
PSS	0	0	534.23	21.8	1

Evaluation Results – Performance Metrics

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BBA

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.27	5.63	467.19	11.83	1.25
MT	3.97	40.55	530.89	8.04	1.07
PF	0.53	2.76	553.10	9.23	1.17
PSS	0.33	3.12	454.93	9.9	1.19

(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0	0	429.76	11.1	1.34
MT	0.1	0.39	541.21	11.37	1.35
PF	0	0	558.75	11.43	1.35
PSS	0	0	490.56	11.2	1.37

Festive

(a) Static Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	1.37	11.78	480.64	17	1
MT	6.28	43.71	524.80	14.24	1
PF	1.1	11.18	591.24	19.07	1
PSS	1.2	12.60	503.71	22.07	1

(b) Mobile Pedestrian Fading

Algorithm	n_{st}	t_{st}	r_{av}	n_{sw}	l_{sw}
BET	0.033	0.62	458.00	26.83	1
MT	0	0	574.15	22.27	1
PF	0	0	585.80	22.67	1
PSS	0	0	534.23	21.8	1

Evaluation Results – Performance Metrics

MISL

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PF	1.1	11.18	591.24	19.07	1
PSS	1.2	12.60	503.71	22.07	1

- Less number of stalls (***n_{st}***) in BBA due to larger buffer, but can be wasted network resources if abandonment occurs
- Lower switches in BBA due to building the buffer at a lower rate
- Higher average quality rate (***r_{av}***) in Festive due to constantly probing the network

Evaluation Results – Average Quality Rate

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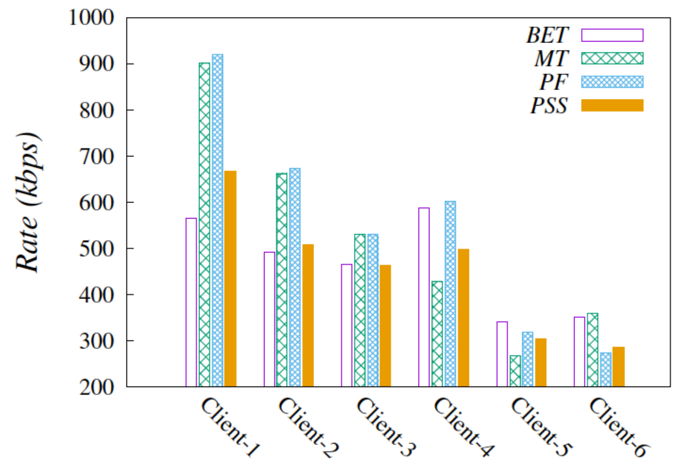
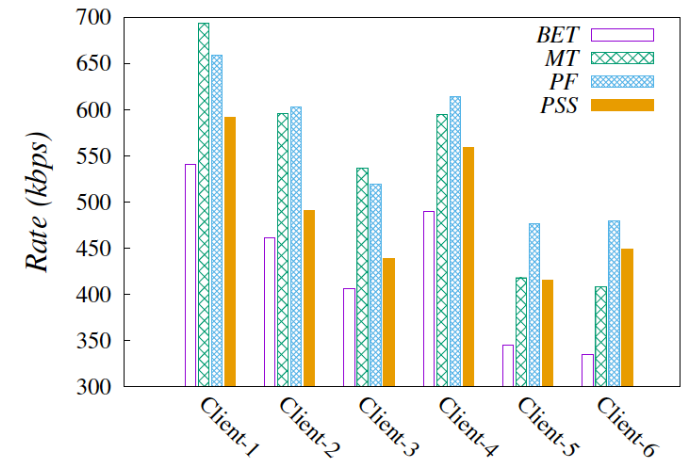
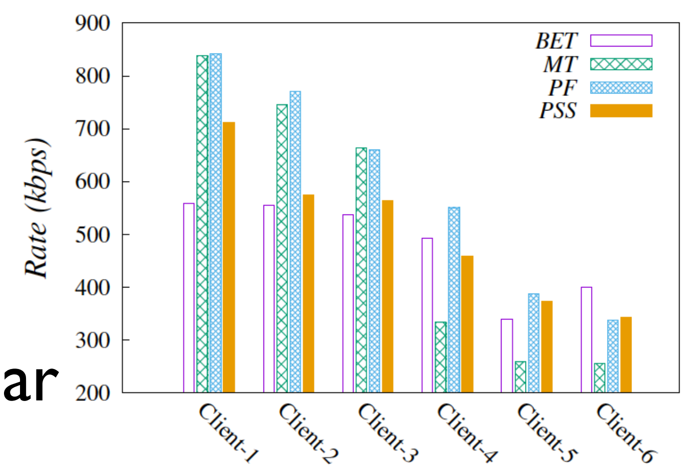
- Averaged per client
- Better quality rate closer to eNB
- MT high quality rate but too many stalls
- BET too low
- PF and PSS similar but PF better



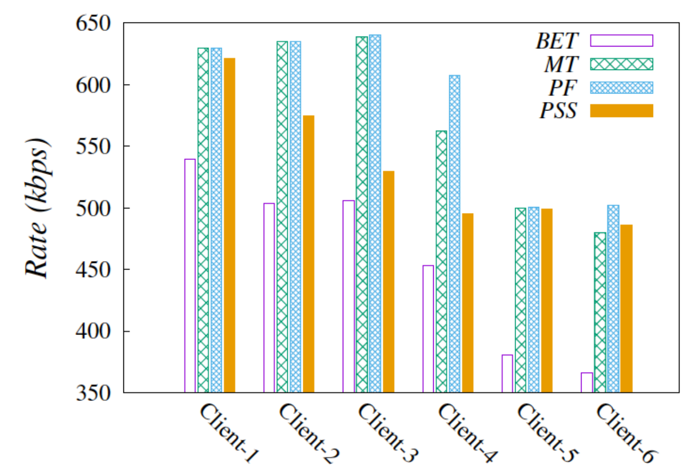
(a) BBA-Static Fading



(b) BBA-Mobile Pedestrian Fading



(d) FESTIVE-Static Fading



(e) FESTIVE-Mobile Pedestrian Fading

Evaluation Results – Average Quality Rate

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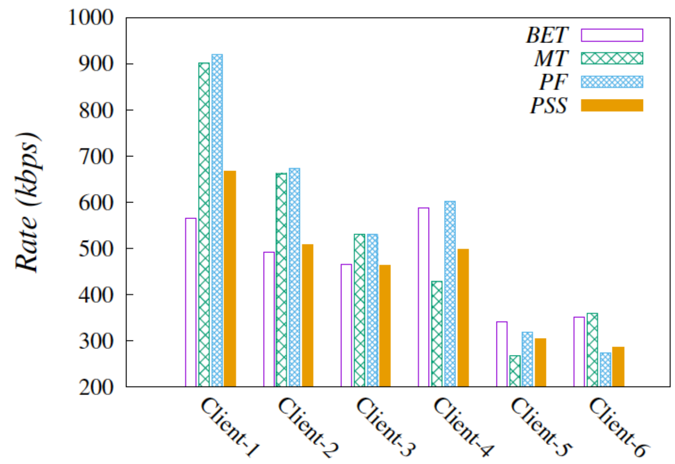
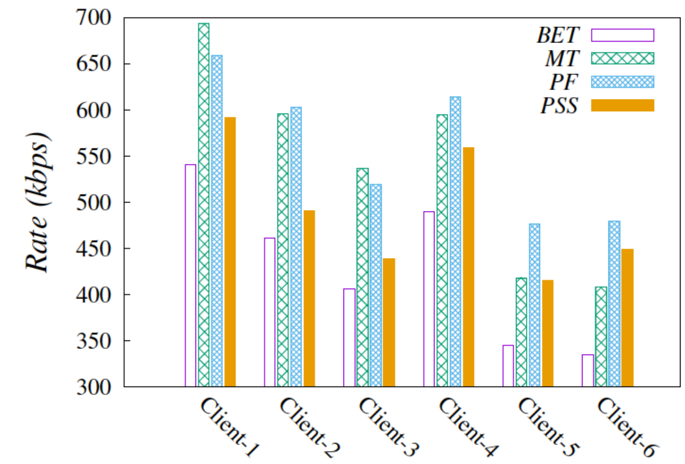
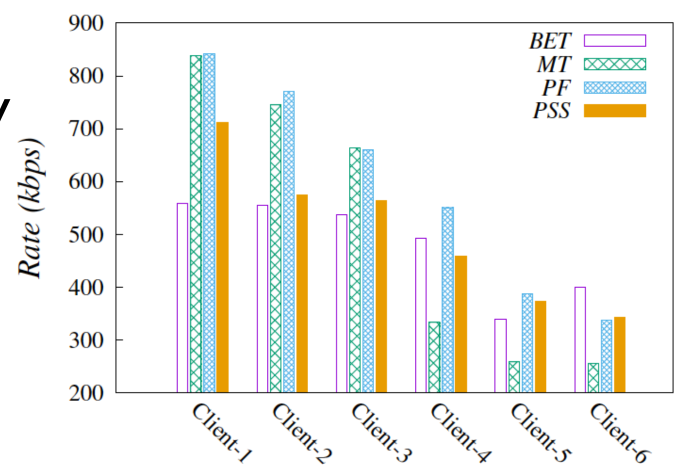
- Static:
  - decreasing rates per distance
  - Lower MT and higher BET for edge case
- Mobile:
  - Increased quality for edge case but lower for close clients
  - Lower BET



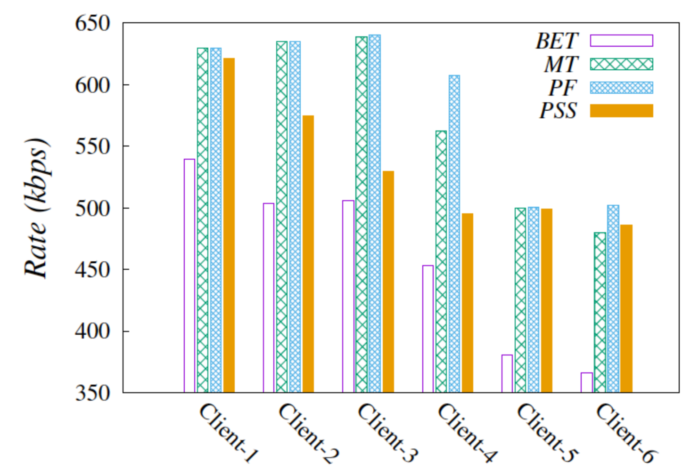
(a) BBA-Static Fading



(b) BBA-Mobile Pedestrian Fading



(d) FESTIVE-Static Fading



(e) FESTIVE-Mobile Pedestrian Fading

Evaluation Results – Client QoE

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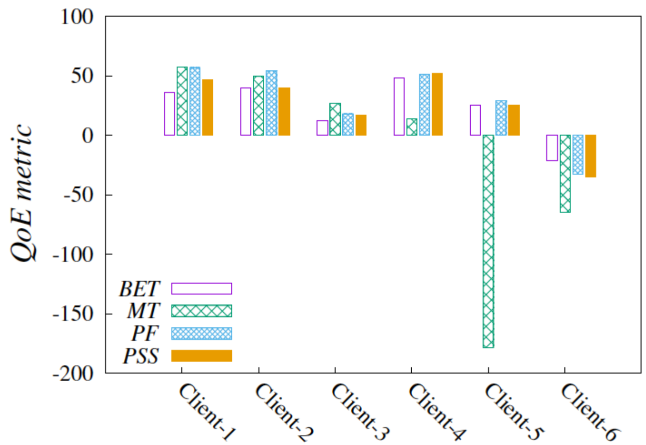
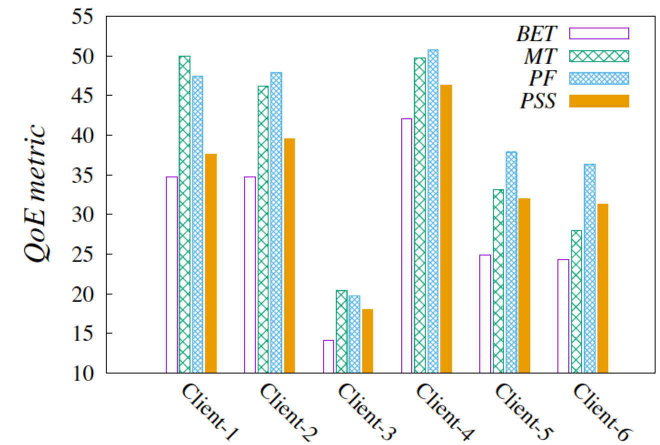
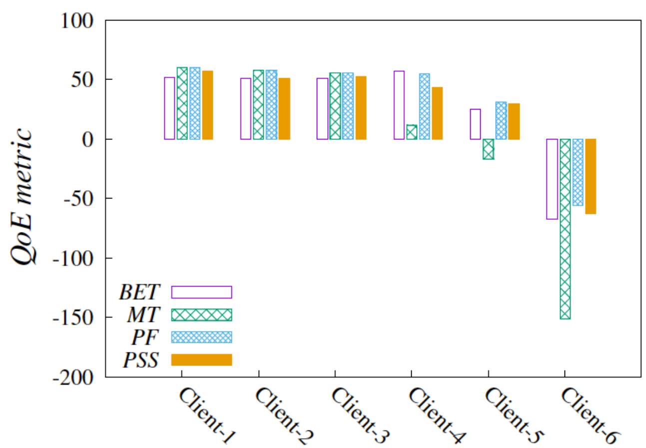
- Clearly stalls at edge clients impacts QoE (MT)
- Equalizing throughput also reduces QoE (BET)
- Edge clients in Static very bad QoE due to abandonment
- Mobile better overall QoE



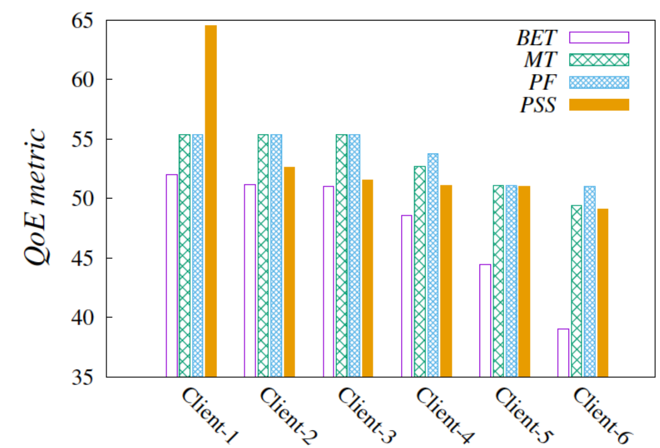
(a) BBA-Static Fading



(b) BBA-Mobile Pedestrian Fading



(d) FESTIVE-Static Fading



(e) FESTIVE-Mobile Pedestrian Fading

Conclusion

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- Key Insight: our performance evaluation shows that when a UE is mobile there are significantly fewer, reduced duration, stalls, and better average received quality rate, leading to higher user QoE.
  - Our results indicate that user mobility within a cell mitigates the effects of long-term fading on video delivery, unlike for static users at the cell-edge where fading effects are significant.
- We show that cell-edge users suffer from significant streaming performance degradation with all schedulers.
- In such settings, we found that the proportional fair scheduler leads to the best QoE on average, but achievable quality will also depend as much on the adaptation algorithm utilised.

Summary

- We utilized a Hybrid physical and simulated infrastructure to evaluate LTE schedulers in NS3
- We used our DASH Dataset to stream actual content to real clients over our 'D-LiTE' evaluation platform
- We investigated the impact of LTE scheduling policy on the performance of the adaptive streaming clients
- We presented evaluation results for two adaptive streaming algorithms: the throughput-based FESTIVE [3] , and buffer-based approach (BBA) [4].

Impact of the LTE Scheduler on achieving Good QoE for DASH Video Streaming

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Questions???

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ADDITIONAL SLIDES

Evaluation Results – PF, Static, 4-sec seg.

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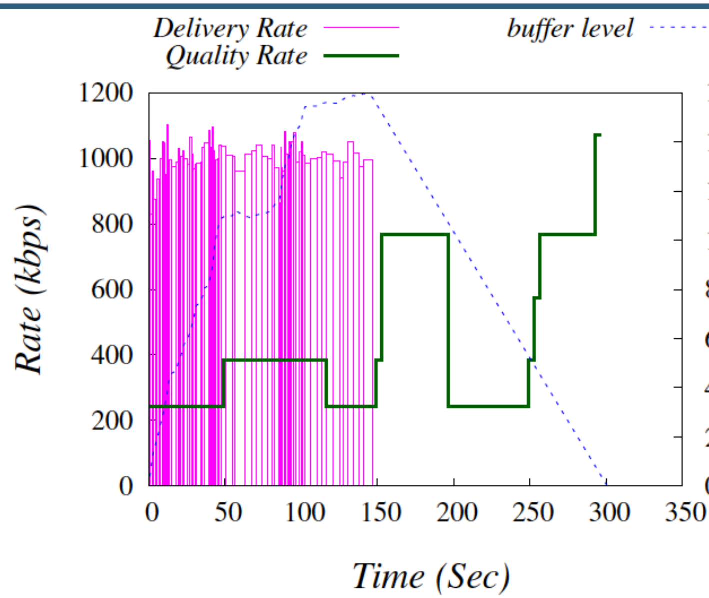
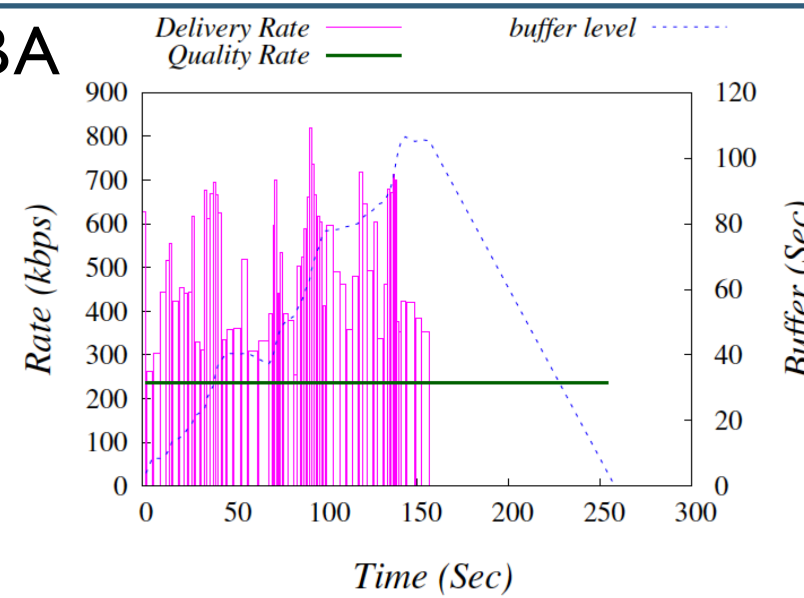
BBA

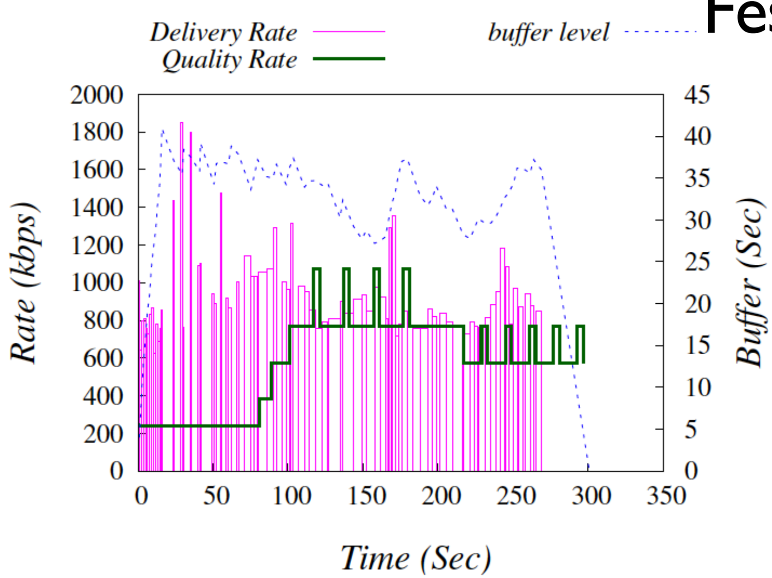


(e) BBA-Client 3

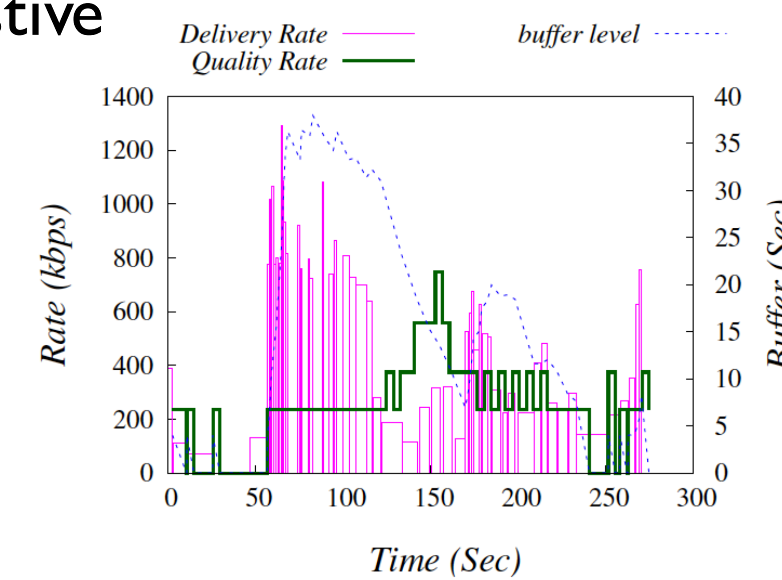


(f) BBA-Client 5

Festive



(b) FESTIVE-Client 3



(c) FESTIVE-Client 5