Demo: D-LiTE-ful: An evaluation platform for DASH QoE for SDN-enabled ISP offloading in LTE

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ABSTRACT

In this demonstration we extend our recent work - "D-LiTE: A platform for evaluating DASH performance over a simulated LTE network". With *D-LiTE* we stream actual DASH content between real physical clients and an Apache2 server, over a simulated NS3-LTE air interface in real-time. We enhance our platform to encompass both an Software Defined Network (*SDN*)-enabled backhaul and an SDN-enabled WIFI router attached to the backhaul. Similar to data offloading in most ISP networks, with *D-LiTE-ful* we demonstrate how distributing video flows to local WIFI networks improves achievable Quality of Experience (*QoE*) not only for the clients moving to the WIFI hotspot but also for the remaining clients on the LTE network. Based on feedback from both a "Panoramic UI" which provides a mechanism for LTE and Client parametrisation, and a means of viewing the output of their interactions, and an "SDN UI" which offers packet level information and illustrates routing behaviours in the backhaul, we observe real-time variation in both network conditions and improvement in client QoE.

The demonstration showcases how an SDN-enabled multi-faceted ISP network can provide dynamic offloading between LTE and WIFI networks by offering a means of local caching, temporary re-routing of TCP flows and centralised control.

Keywords

Dynamic Adaptive Streaming over HTTP, DASH, NS-3, LTE, D-LiTE-ful, Software Defined Network, SDN, VQM

1. INTRODUCTION

Mobile data, with specific reference to video streaming, has seen a monumental increase in recent years, with total usage of over 75% of all mobile data predicted by 2020. Mobile data offloading, often known as WiFi offloading [1], is offered by ISPs as a means of reducing the quantity of total data usage on cellular networks by moving some of the traffic to localised WIFI-enabled hotspots. Thus temporarily improving the Quality of Experience (*QoE*) of cellular clients by offering the higher data rates of WIFI. In this demonstration we extend our recent work, "D-LiTE: A platform for evaluating DASH performance over a simulated LTE network", to encompass an Software Defined Network (*SDN*)-enabled backhaul and an SDN-enabled WIFI router attached to the backhaul, which we call *D-LiTE-ful*. Due to space limitations we do not present full details of the LTE infrastructure in D-LiTE-ful as these are available in [2]. We do highlight that the LENA module in NS3 provides all of the mechanisms required for real-time streaming of DASH content over LTE. We instead focus on the capabilities and utilisation of the SDN-enabled offloading aspect of D-LiTE-ful to view changes in client achievable quality provided by experimentation with Dynamic Adaptive Streaming over HTTP (*DASH*) [3]. The adaptation aspects of DASH offers a means of changing client viewing quality to adjustments in network conditions.

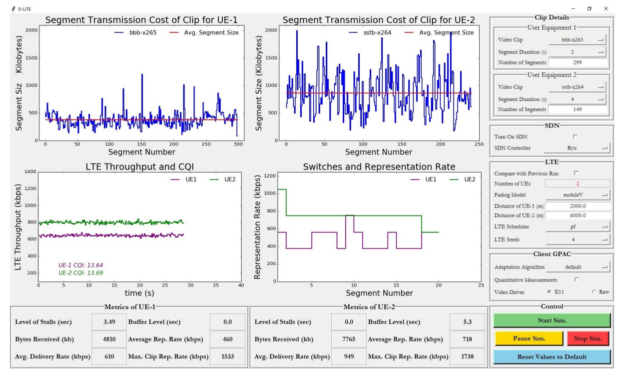

Figure 1: Panoramic User Interface utilised to modify LTE, client and clip settings, as well as view real-time interaction between the network and clients.

In this demonstration we illustrate how distributing video flows to local WIFI networks improves achievable Quality of Experience (*QoE*) not only for the clients moving to the WIFI hotspot but also for the remaining clients on the LTE network. On the cellular network this is achieved by improved throughput as additional scheduler resources can be allocated to the remaining clients. Through the usage of two independent "User Interfaces" (*UI*) we observe real-time variation in both network conditions and improvement in client QoE. A "Panoramic UI", Figure 1, by which LTE and Client parametrisation can be defined and a means of viewing the output of their interactions, as well as an "SDN UI", Figure 3, which offers packet level information and illustrates routing behaviours in the backhaul.

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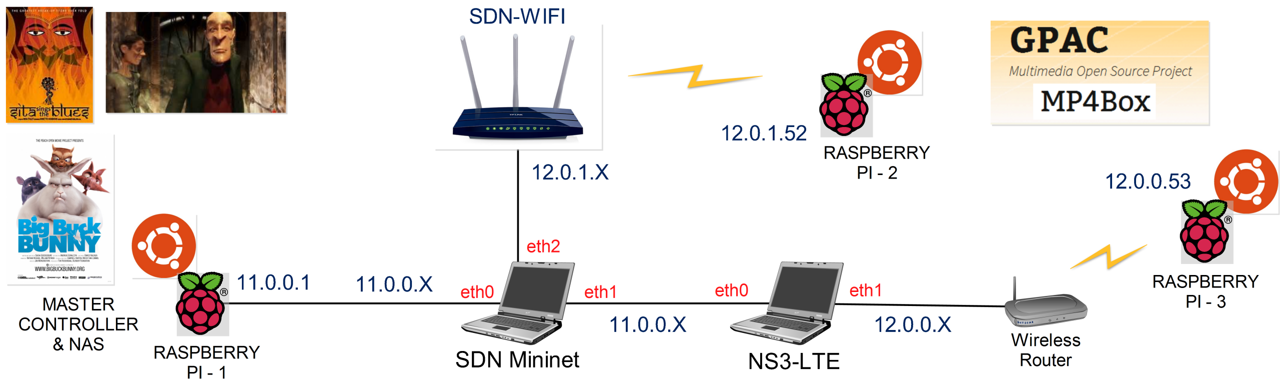
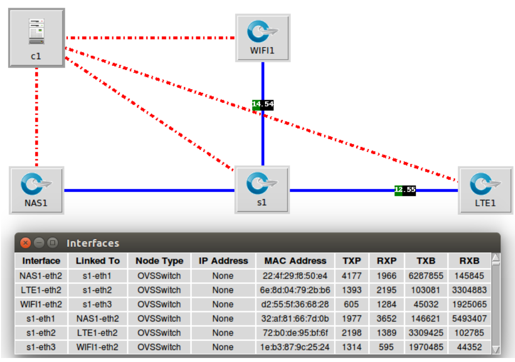


Figure 2: Platform Infrastructure: Physical: server, clients & WIFI, and Simulated: mininet SDN & LTE.



Interface	Linked To	Node Type	IP Address	MAC Address	TXP	RXP	TXB	RXB
NAS1-eth2	s1-eth1	OVSSwitch	None	22:4f:29:f8:50:e4	4177	1966	6287855	145845
LTE1-eth2	s1-eth2	OVSSwitch	None	6e:8d:04:79:2b:b6	1393	2195	103081	3304883
WIFI1-eth2	s1-eth3	OVSSwitch	None	d2:55:5f:36:68:28	605	1284	45032	1925065
s1-eth1	NAS1-eth2	OVSSwitch	None	32:af:81:66:7d:0b	1977	3652	146621	5493407
s1-eth2	LTE1-eth2	OVSSwitch	None	72:b0:de:95:bf:6f	2198	1389	3309425	102785
s1-eth3	WIFI1-eth2	OVSSwitch	None	1e:b3:87:9c:25:24	1314	595	1970485	44352

Figure 3: SDN User Interface illustrates backhaul packet level information and routing behaviours

2. PLATFORM

Overview: In this demonstration, as shown in Figure 2, the SDN backhaul is implemented in mininet [1], which is well-known and widely used, and provides a means of creating a virtual network topology on a single computer. The SDN-enabled WIFI router is a "TP-Link TL-WR1043ND v2" configured with OpenWRT, which is a Linux distribution for embedded devices, and openvswitch, a multilayer virtual switch. Network Management is provided by a single Ryu controller located in mininet, which issues instructions to both mininet and the WIFI router. The network protocol utilised for managing the devices is Openflow version 1.3, which offers a greater range of parameters by which to control the network, and associated flows. Further information and build instructions for the SDN-enabled components utilised in this demo are available at [2]

Nodes attached to the mininet PC are the WIFI router, the NS3-LTE PC, and a local network-attached storage (*NAS*) server. The NAS runs Apache2 which offers the DASH content [4] with options for both H.264 and H.265 streaming. For video decoding and playback we use a well-known multimedia player from GPAC [3], an open-source multimedia framework used for research and academic purpose. On the NAS, we utilise the parametrisation options of the Panoramic UI to define a master controller by which we build both the mininet and LTE networks, call GPAC on the clients, and gather the interactions between the network and the clients.

[1]http://mininet.org
[2]www.cs.ucc.ie/misl/research/current/ivid_demo/wintech2016
[3]https://gpac.wp.mines-telecom.fr/home/about/

Demonstration: This demonstration extends our previous work by illustrating how mobile data offloading improves the QoE of DASH streaming clients in both the WIFI and cellular networks. We implement an SDN backhaul as well as an SDN WIFI router and through the use of a "SDN UI" on the mininet PC we illustrate packet traversal from the NAS to both the WIFI and LTE nodes. Pertinent additional per client metrics available in the "SDN UI" include I.P. address, routing gateway, packets transmitted and packets cached, as seen in Figure 3. Thus providing a means of viewing, in real-time, packets traversing the SDN backhaul and packet/client information. Additional parametrisation options are added to the "Panoramic UI", such as the *compare* button, which provides a visual comparison of QCI and client switching values across multiple runs of the demo. More importantly, we added quantitive evaluation results, i.e. PSNR, and VQM [5], thus providing a comparison of the encoding efficiency of H.264 and H.265, as well as a means of evaluating the stream QoE for each client. The goal of this work is to not only show the impact of data offloading on LTE but to also offer a network level overview through both UI's by which to extract pertinent network level information by which improved QoE can be mandated per client.

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3. REFERENCES

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