ISSN : 2231-0711
Sarah Ali Abdullah et al | International Journal of Computer Science Engineering and Technology(IJCSET) | March 2014 | Vol 4, Issue 3, 56-62

Streaming Video Content over NGA (Next Generation Access) Network Technology

Sarah Ali Abdullah, Riyadh Bassil Abduljabbar
Computer Techniques Engineering Department,
Dijlah University, Baghdad, Iraq

Abstract- **Operators throughout the developed world are rolling out IP-based next generation networks (NGNs) with different application. The main objectives of this paper is to examine the performance of NGA network by integrating between both wireless technologies (WiMax IEEE 802.16 / WiFi IEEE 802.11g) and fixed line technologies (ADSL) architecture to support video services by determining whether broadband access network such as WiMax can deliver access network performance comparable to the ADSL and hybrid wireless network under different separated scenarios by using OPNET Modeler v.14.5. The QoS guidelines and the objective performance recommendations are presented in this paper in the context of an end-to-end delay, jitter, and delay variation.**

Keywords— NGA network, Video Service (IPTV, VoD), QoS with DiffServ architecture, simulation model design

I. INTRODUCTION

Broadband access is now a reality in many parts of the world and the launching of video services is undergoing in many countries. One critical question facing here in this paper is whether the architecture and capabilities of wired and wireless access networks will eventually converge. The degree of convergence will determine whether wired and wireless services function as substitutes or complements, with strong implications for market structure and regulatory policy. Wired access networks that were historically distinct, notably switched voice versus broadcast video, are evolving to a common "platform network" architecture. Wired platform networks use the high capacity of fiber-optic-rich physical networks and the general-purpose capability of IP-based protocols to support a Triple Play of voice, video, and data services. To make things even more complicated, it is not always possible to provide customers with a wired internet access network like DSL or Cable Television (CATV). This is often the case in sparsely populated areas, where it would be too expensive to set up wires. For video services, wireless access network technology must be used in future. In the wireless domain, albeit with a lag, there is a similar trend towards increased capacity and towards providing a range of services over a common IP-centric network infrastructure. Recent wireless broadband networks such as 3G, LTE and WiMax provide a general-purpose IP platform with over-the-top services at the application layer, which is similar to the design of wired IP platform networks. In order to allow an efficiently fast and cheap access to the broadband access network infrastructure, WiMax and WiFi together with the DSL can benefit services in an inexpensive way to address the users' demand in terms of bandwidth, QoS, etc. In this work, the focus will also be on the study of the combination of WiMax and WiFi technology networks.

Over the past few years, consumption of online video has been evolved from low-quality, short-form clips to high quality, long-form programs and movies, delivered through platforms such as Apple TV, BBC iPlayer, and Netflix. Consumer behavior is also changing, with the result that people are tending to watch less linear broadcast programming (which is arguably better delivered on other platforms such as terrestrial or satellite systems), and more on-demand content at a time and place and on a device to suit them, whether delivered over the Internet ("over the top") or as a telco managed service [1]. Media providers are exploring new and innovative applications over core IP networks giving rise to emerging video services such as video on demand (VoD) and real-time video streaming. Internet Protocol Television (IPTV) technology distributes video content over IP networks as both managed and unmanaged services. Managed services, such as IPTV and Video Conferencing, are typically provided by carriers who have provisioned the access network and therefore have control over the resulting quality of service (QoS) to their subscribers. Unmanaged services refer to Internet services that have little control over the end-to-end performance between the subscribers and corresponding services [2]. In 2009, the Cisco® Visual Networking Index (VNI) revealed that video had become the dominant type of Internet traffic, exceeding traffic from peer-to-peer file sharing for the first time. In the June 2011 update to this study [1], Cisco forecast that the annual global Internet traffic will quadruple between 2010 and 2015, to reach 966 exabytes - or nearly a zettabyte (10^{21} bytes of data). Internet video will constitute 61 percent of the total traffic carried in 2015, up from 26 percent in 2010, making it the most significant factor in that growth fig.1 [1].

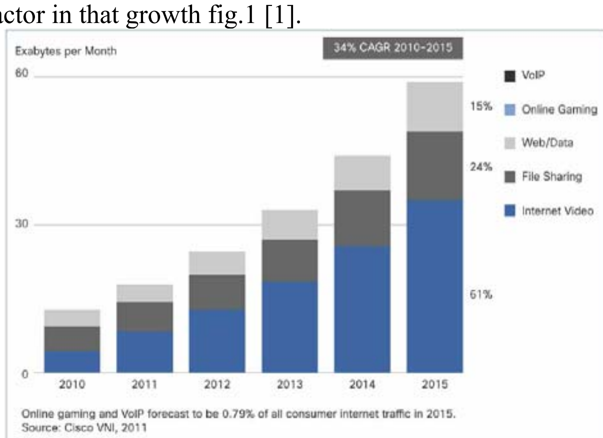

Fig. 1: Internet Video Will Comprise 61 Percent of Internet Traffic in 2015 (Cisco VNI Forecast) [1].

II. NGA NETWORK

Telecoms operators are now employing new strategies to deliver thrilling new services using next generation access networks. The full package of this service includes line rental and telephony with a combination of Internet access, IPTV, VoD, entertainment applications and, eventually, cellular phones. In other words this means: multiple services, multiple devices, but one network, with different vendor and one bill. This manoeuvre is much more than just a new commercial product. It is a consequence of the important changes the industry is undergoing, such as technological innovations, social changes and new regulations [3].

Compared with today's networks, next generation networks (NGNs) should bring major benefits to end users in terms of a wider range of higher functionality services, offered at significantly lower prices. Specifically [4]:

- All NGN services, whether voice, data or video-based, are carried over a single IP transport network. Today, a major telecommunications operator typically runs circuit-switched, IP, ATM, frame relay and leased circuit (cross-connect) networks. By moving to NGNs, operators can rationalize sets of provisioning and maintenance procedures and staff by a factor of five. This should lead to a substantial reduction in unit costs and hence prices.
- Network conveyance and intelligence are separated. Network intelligence is located in centralized servers at the edge of the transport network, rather than embedded into local switches. This change of architecture makes it faster and cheaper for service providers to develop and deploy new services.
- Next generation access (NGA), in which the current copper access network is partially or fully replaced by fiber, allows operators to deliver a wide range of new services, both to mass market and corporate customers. The capacity of the copper network will soon be reached. For example, copper-based ADSL2+ might run at 24 mbps under laboratory conditions. In practice, however, one would expect it to offer no more than 8 mbps to 50 per cent of the population in a typical EU country.1 Such speeds are already inadequate for serving corporate sites. Indeed, the growing demand for higher uplink speeds (eg for real-time video, user generated content and online games) and high-definition television (streamed real-time HDTV requires 9–10 mbps) is likely to render them inadequate for consumer-based services within the next few years.

Furthermore, the major components of telecommunications networks that constructed of various types of wired and wireless architectures to support services of Triple Play which shown is in fig. 2 are:

- The backhaul or the central transport between other networks or the internet.
- Core networks that handle high volume aggregated transmissions between the network and the backhaul.
- Distribution networks that extend the line of sight (LoS) coverage area of the core network.
- Local networks that interface directly with the end users.

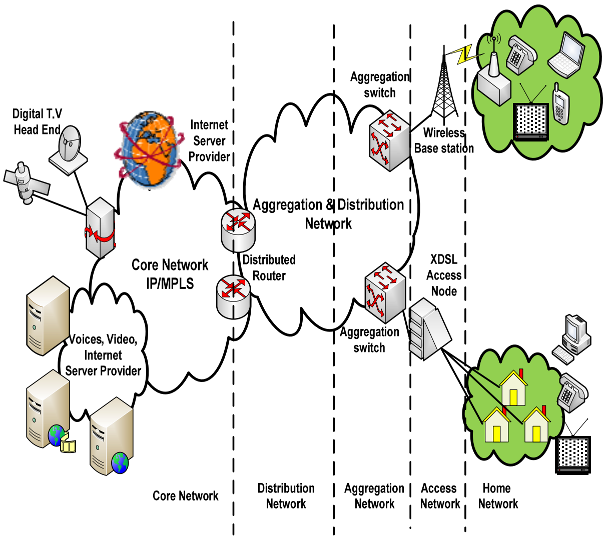

Fig. 2: Overall next generation network environment

III. VIDEO SERVICES OVERVIEW

In the following subtopics a description is given for video service. Video streaming is inherently loss-tolerant yet delay-sensitive [5], which implies that video playback on the subscriber machines, may tolerate some degree of frame loss. However, delays or variations intra-frame reception rapidly degrade the overall video playback experience. While streaming real-time video and VoD possess different transmission and buffering requirements from the network and the client video player, video content may be characterized by several parameters including video format, pixel color depth, coding scheme, and frame inter-arrival rate. Video formats may range from 128 x 120 pixels (horizontal x vertical orientation) to beyond 1920 x 1080 pixels with various color depths. Common Internet video formats (YouTube) use 320 x 240 pixel resolutions while North American digital video disk (DVD) utilizes 720 x 480 and High Definition (HD) standards extend to 1920 x 1080 pixels. The higher the video frame resolution and/or pixel color depth, the larger the raw video content size.

This parameter is especially critical if network conditions can impact the frame inter-arrival rates and which, if left uncompensated significantly degrades the video playback quality. The necessity of the client video system to playback frames at a constant rate amidst variable delays in video frame packet arrivals [5] is illustrated in Figure 3.

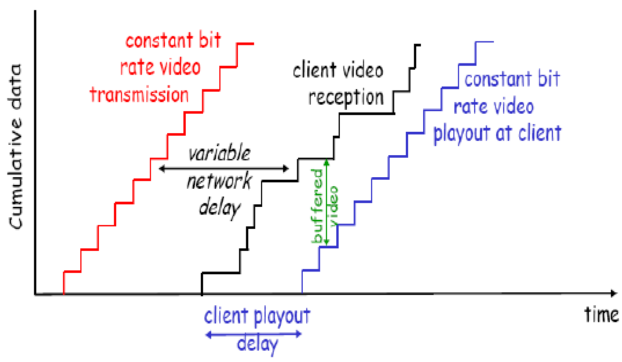

Fig. 3: Buffering required at a video client [5].

Video frame packets inherently experience an end-to-end delay between the sender and the receiver. This delay encompasses the propagation delay and any processing and queuing delays in the intervening routers. Since queuing delays change dynamically and video packets may not necessarily traverse the same path between the VoD server and the client station, the end-to-end delay (referred to as jitter) will vary. IPTV and VoD services need high bandwidth. Depending on the compression and coding technology the following transmission rates should be considered [6]:

- A MPEG-2 coded SD VoD video stream or IPTV stream is 3.5 to 5 Mbit/s per TV channel.
- A MPEG-4 coded SD VoD video stream or IPTV stream is up to 2 Mbit/s per TV channel.
- A HD TV channel uses 8 to 12 Mbit/s when coded with H.264.

Consequently the MPEG-2 video content was abandoned and the simulation focused on the MPEG-4 video content. To simulate VoD service, the video traces (2-hour MPEG-4 Matrix III movie trace) provided by Arizona State University is used, as shown in table 1 [7]. To import video to OPNET, the instructions of [8] is used.

Table 1: Video application characteristics

Parameters	**Matrix III**
Resolution	**352x288**
Codec	MPEG-4 Part 2
Frame Compression Ratio	47.682
Minimum Frame Size (bytes)	8
Maximum Frame Size (bytes)	36450
Mean Frame Size (Bytes)	3189.068
Display Pattern	IBBPBBPBBPBB
Transmission Pattern	IPBBPBBPBBIB
Group of Picture Size	12
Frame Rate (frames/sec)	**25**
Number of Frames	180,000
Peak Rate (Mbps)	7.290
Mean Rate (Mbps)	**0.637**
DSCP	**AF33**

IV. NGA NETWORK CONFIGURATIONS AND SCENARIO DESIGNS

A. Network Topology

The network topology has the network architectures shown in fig. 4. First the "Backbone" subnet, see fig. 5, VoD sources are defined. DSR router is used in unicast mode for delivery unicast traffic (VoD services) to the BRAS at the aggregation subnet. The "BRAS" is a Broadband Remote Access Server router that forwards packets between the core and customer. It is a complex router that implements dynamic per-subscriber IP policies, QoS profiles, rate limiters, packet manipulation, address assignment, session termination, and forwarding.

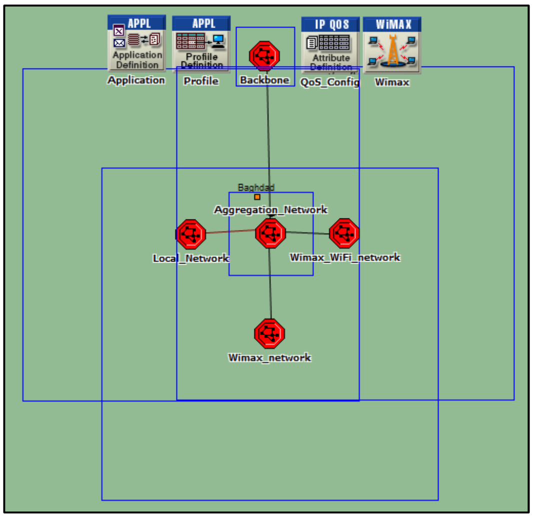

Fig. 4: NGA network topology.

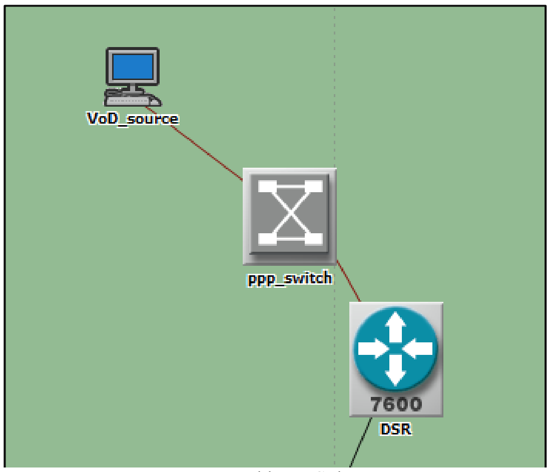

Fig. 5: Backbone Subnet.

In fig.6 the "Aggregation" subnet, consists of Center_Offices router used to provide services received from BRAS router and then forwarding it to AGS1_1 switch connected with DSLAM at the ADSL_network subnet by using 1000Basex_adv (1Gpbs). In the same subnet, Center_Offices connects to the Base Station for both wireless access network (WiMax and hybrid wireless) links used to connect with each other is PPP_SONET_OC42 with data rate (1244.16 Mpbs).

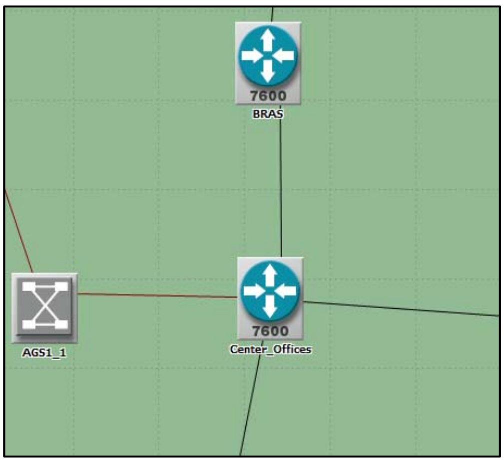

Fig. 6: Aggregation subnet.

In fig. 7 the "Local_Network" subnet, this subnet covered area which contains two DSLAM serving with 20 ADSL "Home_network".

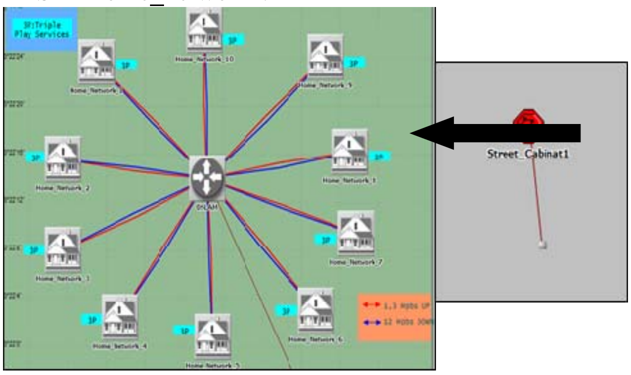

Fig. 7: Local_Network Subnet inside NGA Network Technology.

In fig. 8 the "WiMax_network" subnet, this subnet covered area which contains one Base Station serving with 10 SS's are distributed according to the data rate with the modulation and coding located at 2km from the WiMax BS.

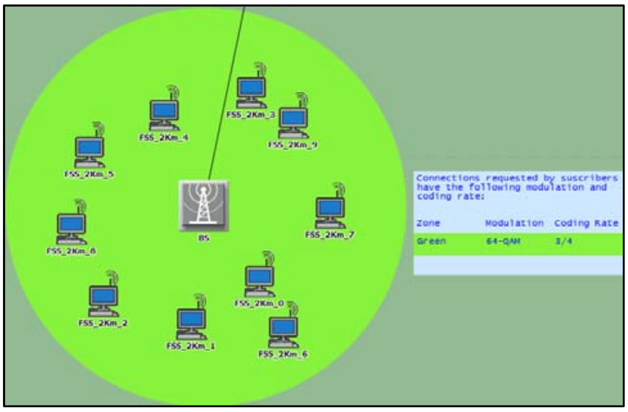

Fig. 8: WiMax_network Subnet inside NGA Network Technology.

In fig. 9, the "WiMax_WiFi_network" subnet covers the area located at 2km from the WiMax BS with 10 WiFi "Home_Networks" also distributed according to data rate with modulation and coding. Each "Home_Network" has AP that connects local home network (WiFi) to large wireless network (WiMax) shown in the sub figure in the same fig. 9.

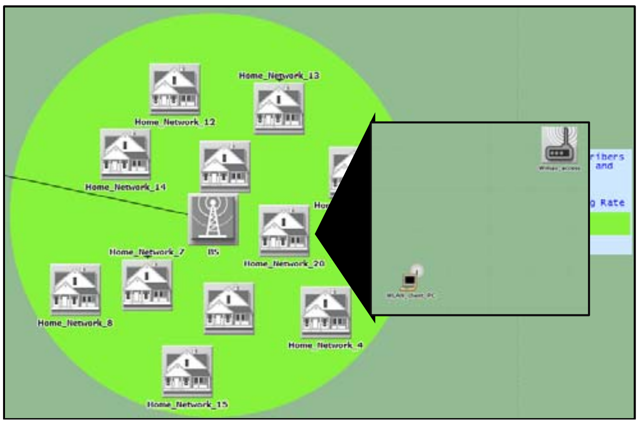

Fig. 9: WiMax_WiFi_network Subnet inside NGA Network Technology

B. QoS Management in NGA Network Simulation Scenarios

Even when data communications are made inside an all IP domain in (wire and wireless) network, different mechanisms and policies for the management of QoS could coexist in the different access networks and nodes involved. In this paper, QoS parameter will be set by using the IP header field for Differentiated Services Code Point (DSCP) with the appropriate traffic class and setting queue priorities with Weight for WFQ with Low Latency Queue (LLQ) profile. The DiffServ architecture will be chosen because it is preferred over “Hard QoS” architecture [9] [10].

C. Simulation Scenario

The following scenarios as pictured in table 6 are used to discuss the factors that affect the performance of the system, which consists of several types of networks with several types of configured parameters, application, and different environments. These scenarios also provide important insights into how to efficiently support NGA traffic with stringent QoS requirements over wireless and wire networks. Also, the scope of this study is whether wireless broadband access meets or exceeds the performance of wired broadband access for video applications in terms of four metrics: packet loss, delay, jitter, and throughput. By experimentally characterizing the application performance over these access networks, the feasibility of WiMax and WiFi for fixed wireless broadband access and ADSL for fixed wire broadband access network have been consecrated.

The main settings and parameters of these scenarios are:

1. Simulation Time: Simulation time was set to (400 sec).
2. Efficiency Mode: Physical layer enable at wireless & WiMax network.
3. Data Rate was set in ADSL with downstream 12Mpbs and upstream 1.3Mpbs.
4. OFDMA PHY profiles:
   The PHY system parameters are designed to reflect a practical WiMax deployment that maximizes video content traffic. Table 2 lists the values assigned to main parameters of the simulation experiment, regarding the WiMax profile.

Table 2: WiMAX Profile for this Study

Parameters	Value
Carrier Frequency	3.5GHz
Bandwidth used	20MHz
Frame duration	5ms
DL and UL bursts modulation	64-QAM
Coding rate	3/4
Subchannelization	PUSC
Subcarriers	2048
Duplexing scheme	TDD
BS transmit power	20W
SS transmit power	0.5W
BS antenna gain	15 dBi
SS antenna gain	14 dBi

5. MAC Service Class with Base Station Definition:
For the purposes of this study, one service class has been created for the video services. The Silver-DL is used, which is configured with rtPS scheduling, 1Mbps for a minimum sustainable data rate and a 5Mbps maximum sustainable data rate for VoD services downlink using AF41 scheduling. Another service class was created using Silver-UP and 1Mbps for a maximum sustainable data rate and a 0.5Mbps minimum sustainable data rate for VoD services uplink data rate as shown in fig10.

6. MAC Service Class with Subscriber Station Definition
SS is also configured to map the higher level video application to the "Silver-UL" service class as similarly performed with the BS. The 2km FSS modulation and coding rates for both uplink and downlink service flows are shown in fig. 11.

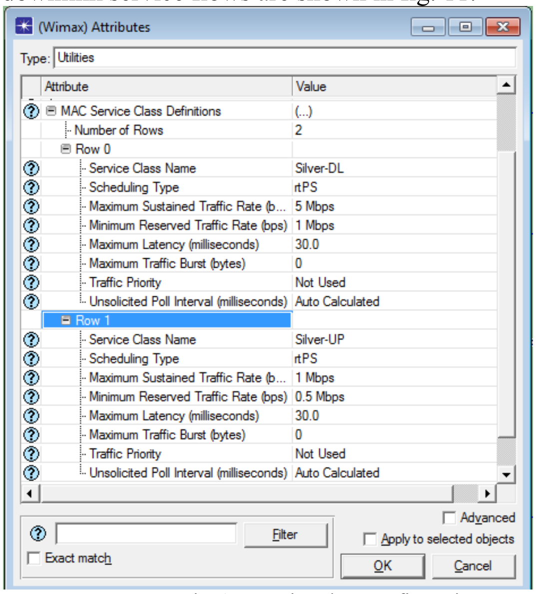

Fig. 10: WiMAX service class configuration.

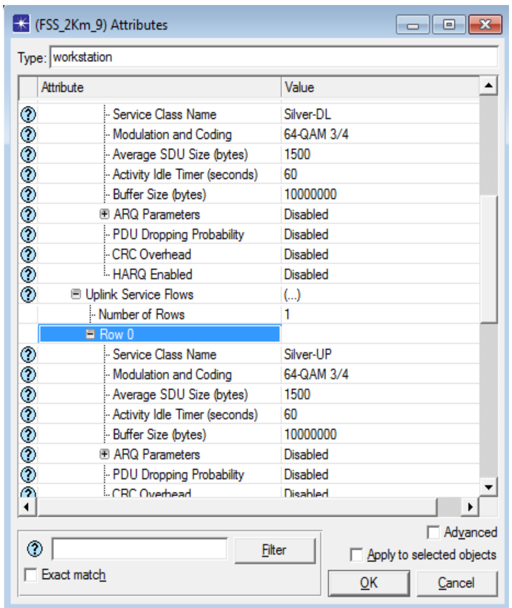

Fig. 11: SS service flow modulation and coding rates.

7. WiFi SS's and AP's configuration:
IEEE 802.11g will be used in our simulation scenario. Even through some of the WiFi SS and WiMax_wlan_router (AP) related parameters are changed between the different scenarios; many of them have remained the same. All the parameters that are common to all of the scenarios are listed in fig. 12.

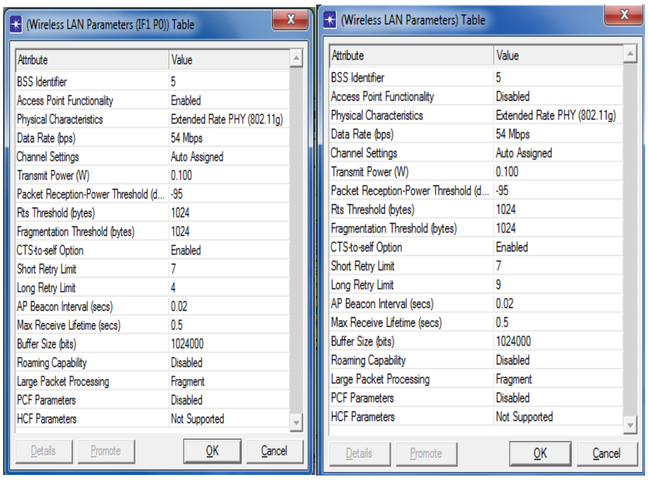

Fig. 12: Configuration Parameter Setup for AP and WLAN client.

D. Simulation Results and Analyses

In every scenario, the computed and measured three types of networks (ADSL, WiMax and hybrid wireless) results will be explained in this section. These networks could be divided into many incompatible regional and country-specific networks with a different protocol. The results shown in the figure 13 and 14 indicate that the ADSL client performed better than the WiMax client station and WiFi client. The simulated end-to-end delay and jitter are shown in figures (13, 14) included three video client curves are averaged across the 400sec. These results indicate that the ADSL client approaches the ideal delay of 10ms and ideal jitter of 0.014ms. WiMax and WiFi client station curves closely tracked each other with expected value (delay 200-400ms) and (jitter 20-40ms).

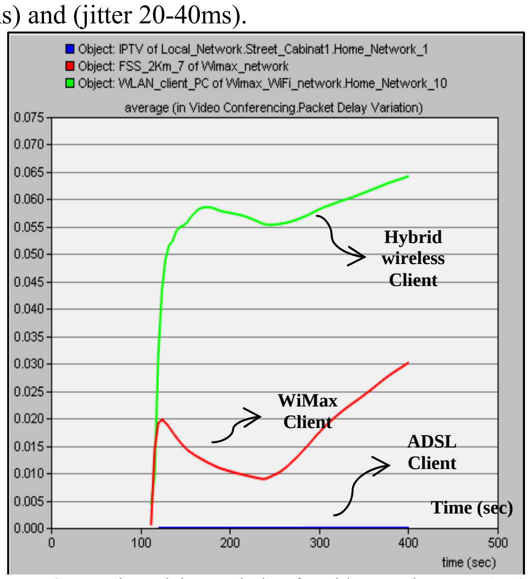

Fig. 13: Comparison delay-variation for video service over ADSL, WiMax and WiFi client station.

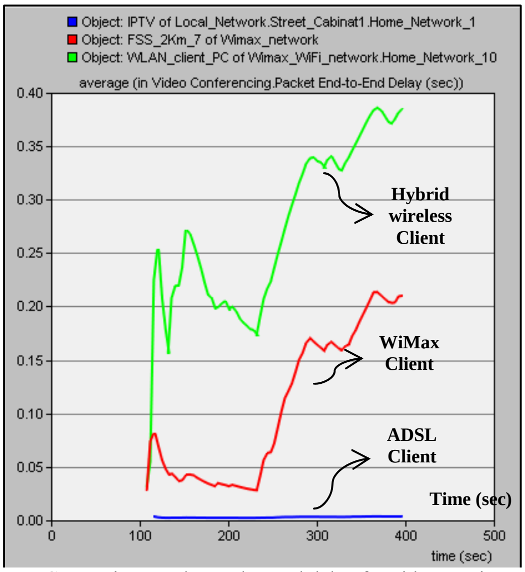

Fig. 14: Comparison packet end to end delay for video service over ADSL, WiMax and WiFi client station.

All three client curves shown in fig. 15 tracked each other as expected. Note that the ADSL station surpassed the WiMax station and WiFi station throughput when measured in bytes/sec. The observed throughput, ranging from 0.40 Mbps to 0.72 Mbps, falls within specified metric and corresponds to the mean traffic rate for the MPEG-4 content listed in Table 1.

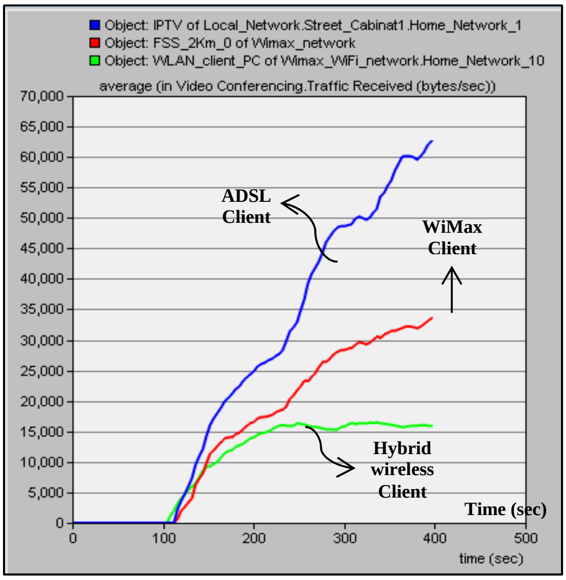

Fig. 15: The average throughput for video service over ADSL, WiMax and WiFi client station.

The resulting video packet loss was observed on all three video clients. The OPNET Modeler does not provide a video application layer loss statistic and, hence, the loss shown in fig. 16 is represented as the curve deviation from the 25 packets/sec position on the vertical axis. All three curves are averaged across the 2-hour movie duration. The ADSL client curve (top) approaches a received packet rate that matches the VoD sending rate of 25 packets/sec. The WiMAX station and WiFi station exhibit a deviation from the encoding rate with more pronounced degradation as the subscriber to base station distance increases.

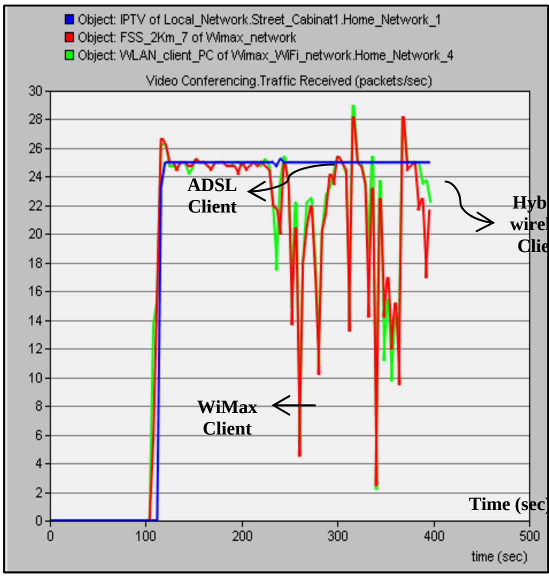

Fig. 16: Received packets/sec video service over ADSL, WiMax and WiFi client station.

The captured PHY layer statistics provide insight into the performance of the WiMAX access network. The dropped packet rates by the PHY layer for the two WiMAX stations are shown in fig. 17. The BS in WiFi (heterogeneous wireless) station exhibits a much higher loss rate than the BS in WiMax stations over the 2-hour interval.

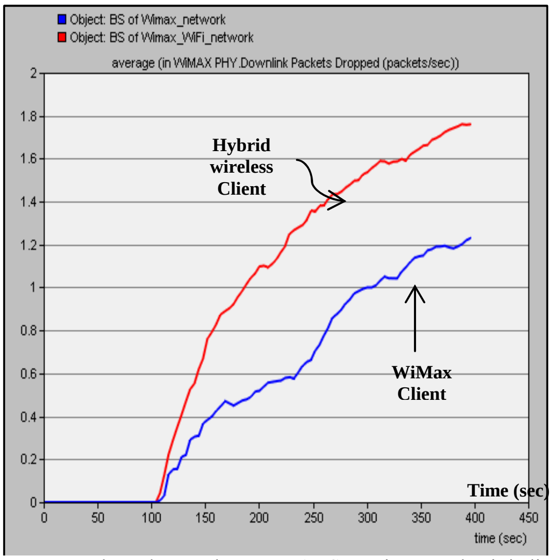

Fig. 17: PHY layer lost packets over ADSL, WiMax and WiFi client station.

V. Conclusions

A few years ago, the discussion was not about whether NGA was necessary, it was about when and how quickly to provide it. Today the discussion is no longer about when NGA will happen, it is about how. Given the long-term nature of the investment, the principal consideration should be deployment of infrastructure capable of meeting requirements well into the future. As it is observed from the results, ADSL has exhibited behavior that approach the ideal values for the performance metrics of video content services, while WiMax, and a hybrid wireless network has demonstrated promising behavior within the bounds of the defined metrics. The simulation results also demonstrate the effectiveness of heterogeneous network, as a bandwidth management scheme, for deploying video content services in-home networks.

REFERENCES

[1] "Broadband Access in the 21st Century: Applications, Services, and Technologies", Cisco and/or its affiliates, http://www.cisco.com/en/US /solutions/collateral/ns341/ns525/white_paper_c11-690395.html

[2] Will Hrudey and Ljiljana Trajković, "Streaming Video Content Over IEEE 802.16/WiMAX Broadband Access", Simon Fraser University, Vancouver, British Columbia, 2009.

[3] Francisco J. Hens and Jose´ M. Caballero," *TRIPLE PLAY Building the Converged Network for IP, VoIP and IPTV*", Trend Communications Ltd., UK, John Wiley & Sons, 2008.

[4] David Lewin, " Legal and regulatory reviews Regulating next generation networks", Journal of Telecommunications Management, Vol. 1, 1 96–105, 21st May, 2007.

[5] J. Kurose and K. Ross, *Computer Networking: A Top-Down Approach*, 4/e. Boston, MA: Pearson/Addison-Wesley, 2008, p. 590, p. 612, and p. 624.

[6] A. Quadir, M. T. Arefin, and H. E. Sandström," Reliable IPTV Service Delivery Using PIM-SSM Routing ", Department of CSE, University of Development Alternative, Dhaka, Bangladesh 3Mid Sweden University, S 851 70 Sundsvall, Sweden, Received 9 June 2009, accepted in final revised form 21 August 2009.

[7] Arizona State University, "Video traces for network performance evaluation," [Online] Available: trace.eas.asu.edu/tracemain.html, [Accessed: Apr. 22, 2012].

[8] M. Hefeeda, "Importing video traffic into opnet," [Online] Available: http://nsl.cs.sfu.ca/wiki/index.php/, [Accessed: Apr. 22, 2012].

[9] G. P. Sotiropoulos, D. K. Styliaras, E. A. Kosmatos, C. A. Papagianni, N. D. Tselikas and I. S. Venieris ," *Performance evaluation study for QoS-aware triple play services over entry-level xDSL connections* ", Intelligent Communications and Broadband Networks Laboratory School of Electrical and Computer Engineering, National Technical University of Athens, Journal of Network and Computer Applications 32215– 225, 2009 .

[10] Nikolaos Zotos, Evangelos Pallis, and Anastasios Kourtis, "*Performance Evaluation of Triple Play Services Delivery with E2E QoS Provisioning*", International Journal of Digital Multimedia Broadcasting, Volume 2010, Article ID 836501, 14 pages doi:10.1155/2010/836501, Accepted 21 June 2010.