IPTV IMPROVEMENT APPROACH OVER LTE-WLAN HETEROGENEOUS NETWORKS

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ABSTRACT

IPTV (Internet Protocol Television) includes several video components. The IMS (IP Multimedia Subsystem) cannot differentiate between them what causes their treatment similarly. These sub-components must have different priorities because they have distinct QoS constraints. In this paper, we suggest the implementation of IPTV in a heterogeneous network that improved QoS by providing the capability to prioritize the sub traffic according to the system administrator policy. A new IPv6 flow label field definition was proposed that is ready for standardization. OPNET Modeler software is used to design our approached architecture. The results show that IPTV users receive different amounts of video data based on the stream's priority.

KEYWORD

IPv6, Flow Label, Heterogeneous Networks, LTE, WLAN, QoS, Diffserv, IPTV, IMS & MIPv6

1. INTRODUCTION

1.1. Motivation & Contribution

The design of new, more open telecommunication architectures has become a necessity in a convergent environment, characterized by the emergence of "triple play". Such an opening will prevent all aspects of fixed / mobile heterogeneity. The NGN (Next-Generation Network) architecture will be based on IP because it is a simple and powerful protocol providing end-to-end connectivity to different underlying networks. However, the actual realization of an NGN architecture experiences the various IP technology adoption problem resolution. Indeed, among the main shortcomings of IP has to be overcome is its inability to provide end-to-end quality of service. Mitigating the various security vulnerabilities by protecting the data transmitted on the NGN networks as well as the communicating systems is also necessary. Also, solving problems relating to user mobility by enabling handover (horizontal between several domains and vertical between several technologies) while preserving the continuity of service becomes a must. In an NGN environment, service providers must furnish their clientele with QoS and security guarantees while ensuring their mobility. The end customer IPTV traffic reception quality varies depending on the device acquisition resources and network performance. The negotiation of QoS, as well as the actual reception state of the multimedia product with the entity providing service, will be a trump to the operator to furnish traffic with an acceptable QoS. IMS (IP Multimedia Subsystem) is an IP and SIP (Session Initiation Protocol) standardized architectural framework. It interconnects mobile, wireless, and fixed networks when transmitting multimedia services. IMS assumes that the operator must control the media utilization through multimedia sessions using SIP to ensure the required QoS and enable inter convergence services. The latest experiences exhibit that IMS technology still suffers from some problems, which comprise the nondifferentiation between different IPTV video components. The existing IMS-based IPTV infrastructure does not take account that the IPTV traffic consists of three sub-components and the sensitivity of broadcasting traffic latency. 3GPP approach (3rd Generation Partnership Project) [23], IETF (Internet Engineering Task Force) approach [18], and SLM&M (Service Level Monitoring & Management) approach [19] have emerged to guarantee IMS infrastructure QoS. All these three proposals use the DiffServ (Differentiated Services) model for QoS management. An in-depth study shows that the traffic classification adopted by these approaches causes various problems. Traffic classification uses three classes: data, voice, and video. In connection with IPTV, we state that traffic can be separated into three sub-traffics:

- **BC (BroadCast)** that licenses the transfer of real-time video.
- **VoD (Video on Demand)** that allows the user to watch a selected video from a given library.
- **PVR (Personal Video Recorder)** that allows users to record the received stream.

DiffServ model makes the handling of these three types of flows similar. These flows have a difference in sensitivity to QoS parameters, so they must be treated differently. Our contribution aims to remedy this problem.

A new mechanism that adapts QoS parameters and control systems is proposed in this paper. Knowing that the one implemented in IMS-based IPTV is based on DiffServ, our approach is in the form of a new PHB (Per-Hop Behavior). A new IPV6 Flow label field mechanism has been suggested to classify IPTV sub-traffic. It is used to avoid dealing with the same video traffic with the same effort and distinguish between IPTV packets consequently. We applied our approach to a heterogeneous LTE-WLAN network by using the Riverbed Modeler simulator. The obtained results show that the delay, jitter and packet loss of the BC flow have been minimized which has improved the quality of service of linear TV transmission.

1.2. Related Work

For sending live TV services, a new cost-efficient various wireless architecture is proposed in [3]. In [4], the development testbed is used to evaluate the 3D video streaming QoE over LTE. Various network conditions, in the testbed, are configured by setting parameters of network emulator rested on the outcomes reaped by a system-level LTE simulator. A plethora of types of research has been working on enhancing IPTV services QoS. To support IPTV mobile services, Li and Chen proposed spectrum allocation algorithms [5]. So, preferable IPTV services are presented when maintaining good voice service quality. In [6], IPTV data troubles such as dropping, blocking and bandwidth usage have been, to a larger extent, resolved using a new queue model that regards adaptive modulation and coding. In [7], the authors supply a thorough guide to standardized and cutting-edge quality assessment models and determine QoE to evaluate IPTV user experience in a data-driven approach from scratch and establish a personal QoE model bottomed on an Artificial Neural Network (ANN) [8]. In [9], a new technique is suggested to decrease tunneling overhead. Authors allow multimedia content to be transport from many various Micro data centers as well as Mega data centers. So, the content multimedia data is transferred using their special addresses through tunneling. IPTV seamless handover [13] has been accomplished using Physical Constraint and Load-Aware in wireless LAN. The congestion level of each access point can be estimated using this new method. So, the user can choose to access the next wireless LAN based on its strength and bit error rate. In our previous work [10], we presented in detail the new PHB (Per-Hop Behavior) that reclassifies and differentiates IPTV sub traffics by using the IPv6 Flow Label field. The sub traffics will be prioritized easily using the proposed PHB according to the QoS network policy. Our approach has been tested on both fixed networks [10] and mobile cells (moving users in one cell [11] and stable and moving users in three different cells [1] [2]).

In this paper, we introduced a presentation of the IMS network and IPTV. The proposed algorithm improves the IPTV sub traffics QoS. We also increase the transmitted data by implementing it in the LTE network. Our new QoS optimization mechanism has been explained in section 2. That demonstration is dependent on how to prioritize IPTV sub-traffic utilizing the IPv6 Flow Label field and how to produce new classes of services. In Section 3, we discuss our implementation network and the scenario studied of the heterogeneous LTE-WLAN-IMS-Based IPTV by using Riverbed Modeler. Section 4 reveals the analysis of the output of the suggested scenario of the network's methods. Finally, the conclusion and our outlook on upgrading that field are presented in section 5.

2. ENHANCING QOS UTILIZING A NEW DEFINITION OF IPV6 FLOW LABEL

The network's capacity to supply the user needs upon using IPTV service putting into account the principal parameters such as delay, traffic losses, video jitter, and quality is the core of the definition of QoS in our network. The IETF (Internet Engineering Task Force) offers two significant quality of service models: IntServ (Integrated Services) and DiffServ [17] [22] [14]. The distinction between these models is illustrated further [16]. To upgrade QoS for IPTV services, throughout transmission, IPv6 FL (Flow Label) has been adopted along with the IMS system.

2.1. IPv6 Flow Label & Quality of Service

IPv6 FL is a new IPv6 header field coded on 20 bits. This field can be applied to label packets of another similar packet flow or an accumulation of flows [12]. Several propositions have been suggested to the IETF to adopt this field to improve QoS on the internet [20]. Some researchers have proposed its use to deliver the bandwidth, delay, and buffer requirements. Unlike in [24], the authors suggested sending the transport protocol and the used port number using this field. Other approaches have been introduced [26], but none of them have been standardized. However, a hybrid approach takes into account advanced techniques while remaining compatible with the DiffServ model [20]. This model has registered the first 3 bits of the IPv6 FL field to show the methods adopted and kept the remaining 17-bits parameter connecting to each particular approach. This hybrid approach is collected in Table 1.

Table 1. The representation of the first 3 bits of flow label value type of the used approach

Value Type of The Used Approach

000	Default
001	An arbitrary number is used to define the Flow Label.
010	Integrated Services
011	Differentiated Services
100	Port number and flow label used protocol
101	A new definition explained in [25].
110	Reserved for future use.
111	Reserved for future use

2.2. Optimization of IPTV Broadcasting Traffic

To enhance QoS for IPTV services throughout transmission, IPv6 FL has been utilized with the IMS system. The IMS-Based IPTV expands the provision of essential IPTV services to others such as 'quadruple play' services and more sophisticated ones like Flow Label to enable the user to ask for a single process for its real-time traffic flow [22]. Also, when serving significant traffic with a high priority of EF (Expedited Forwarding) PHB (Per-Hop Behavior), DiffServ core routers face saturation problems. Because of real-time data traffic growth, waiting for a delay in the narrow queues affected to EF PHB technique causes the slow filtering of video packets leading to drop them. At the level of the dropping process, the edge EF packets of the DiffServ domain will be processed according to their significance in the GOP (Groupe of Picture) video [21]. The denial priority for PHBs in AF (Assured Forwarding) is frequently executed based on WRED (Weighted Random Early Detection). Using eTOM (Enhanced Telecom Operation Map), the user's fidelity classification has been integrated with IMS-Based IPTV [19], allowing the network administrator to distinguish between packets based on the recipient. So if the "GOLD" user is sending, another scoring inter factor is generated with the same classification to a for example, if a user class is scoring inter users generate another factor to affirm the transmission credibility. But in case of congestion, routers will use the DiffServ standard returning to the removal process. As mentioned before, three main traffic compose IPTV video data streams: BC, VoD, and PVR. So their treatment will be the same in best effort especially in case of traffic congestion [15] leading to latency for sensitive video traffic to delay and loss rate. So, it is necessary to use IPTV flows reclassification mechanism to decrease BC user's delay and packet losses.

To upgrade QoS for IPTV services throughout transmission, IPv6 FL has been adopted along with the IMS system. To achieve that demand, we propose new priority suppression PHBs for IPTV traffic that differentiates between user data depend on their priority [10]. This technique consists of mapping DSCP (Differentiated Services Code Point) values in the IPv6 flow label as the ToS (Type of Service) field of the IPv4 header is restricted to one byte. So we can distinguish between different IPTV traffic using more bits with the ability to be appropriate with the DiffServ approach. The IPv6 flow label field will thus have the values shown in Table 2.

Table 2. New IPv6 Flow Label Values

0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
0	1	1	DSCP						x	y	Reserved for future use								

Since the DSCP field of the EF class equal to 101110, Table 3 shows the IPv6 flow label field values.

Table 3. New detailed IPv6 Flow Label Values

0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
0	1	1	1	0	1	1	1	0	x	y	Reserved for future use								

X and Y are the bits used to differentiate intra-IPTV video traffic. And since the IPTV packets have the same DSCP field value using only six bits, we will then employ the following bits 10 and 11 of the IPv6 FL for an intra-IPTV reclassification. We reserve the remaining 9 bits for future use. We give the name DSCP-FL to the first 11 bits of the IPv6 FL field. As in the present EF PHB, new Flow Label rates are charted to PHBs with a low loss rate, high priority, jitter, and latency features. Indeed, three IPTV packets relating successively under BC traffic, VoD and PVR will be subjected to a treatment explained through the algorithm in Figure 1:

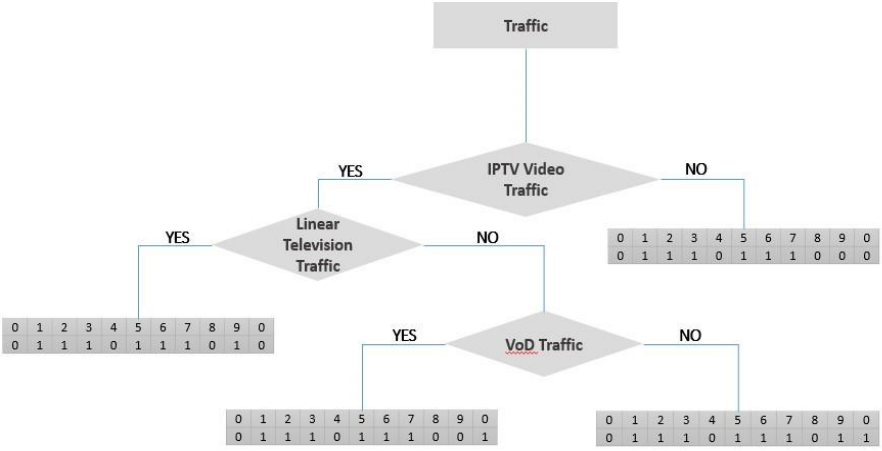

Figure 1. Intra-IPTV Traffic suggested mechanism

DiffServ will eliminate low-level priority data in saturation case. As in Table 4, the DSCP-FL field value is equal to 01110111001 as in the demonstrated case.

Table 4. Flow Label with Highest Priority Level of Suppression

0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
0	1	1	1	0	1	1	1	0	0	1	Reserved for future use								

3. IMPLEMENTATION SCENARIO

In our regarded network, we intend to raise the data received by BC, VoD, and PVR user sequentially and diminish the delay that confronts the BC traffic particularly. Using Riverbed Modeler, we implemented our proposed technique in a heterogeneous LTE-WLAN network. The major idea in the suggested framework architecture is to implement the IMS-Based FL IPTV component in the heterogeneous network.

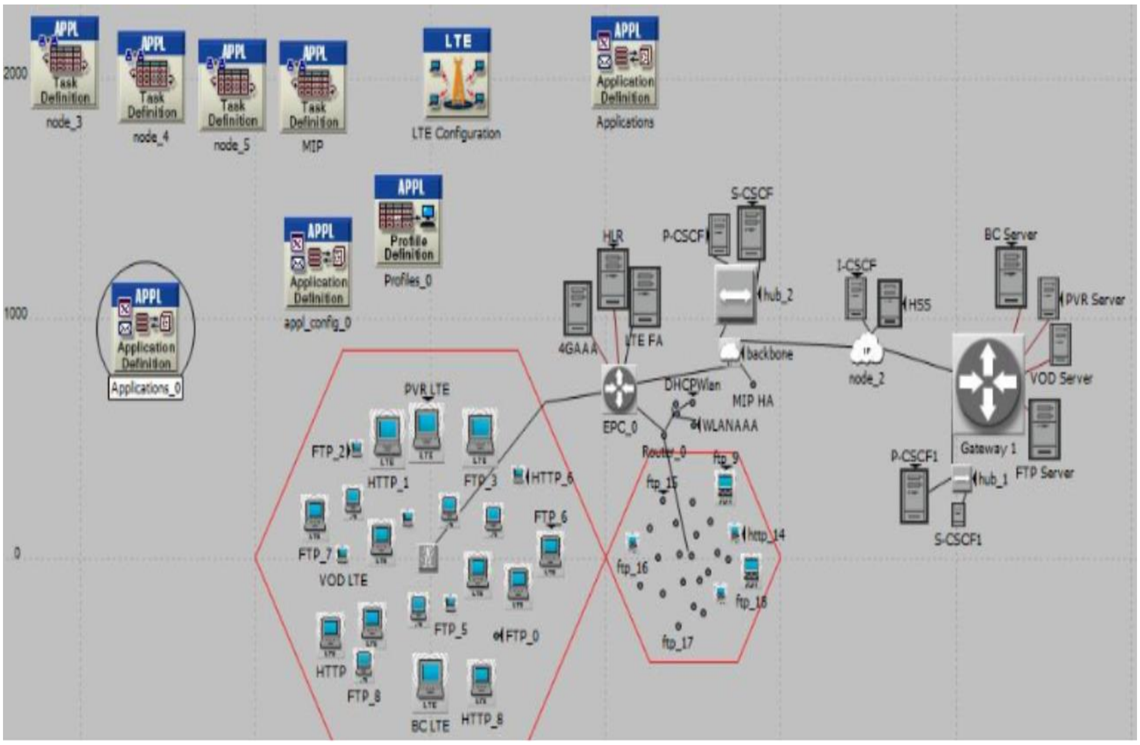

Figure 2. Moving IPTV user in the LTE-WLAN Heterogeneous Network

A new modulated task application module has been developed as the IMS-SIP server does not exist in the Riverbeds modules. MIP-SIP is used for centralized session's control. IMS-MIP-SIP has been used to grantee fast and continuous IPTV service during vertical handover between WLAN and LTE networks. To grantee this task, newly developed modules have been implemented inside Riverbed Modeler as the used server doesn't implement in the existing modules. We defined IMS, MIP-SIP, and IPTV servers in the OPNET library. Also, we implement the tasks used during the authentications. After that, we compare the results of our simulation for each user in two cases; while moving inside the LTE network and when moving in the WLAN network.

In the proposed framework, we have built user registration in the IMS network and IPTV services session establishment in a custom application. In this paper, we contrast between performances of the network in two varied ways. The primary instance without applying the FL QoS based system. The second scenario conforms to apply FL and WFQ (DSCP Based) QoS. Figure 2 introduces three main compositions of the used architecture. The first element comprises the IMS network, the second element includes three servers that substitute the IPTV data center responsible for delivering different types of multimedia contents (PVR, VoD, and BC). The final one is the personal receiver that acquires data from the sender. As the IPTV users are not the only ones in a 4G network, there are 10 FTP, and 10 HTTP users that transmit data in parallel IPTV users. We should also note that we parallel the conclusions of our suggested scenario upon using and disusing our proposed methods to measure the QoS parameters. The traffic delivered is the same from the three various video servers (PVR, BC, and VoD), high-resolution video, and that after the user performs IMS authentication steps. We apply our approach by varying the IPv6 Flow Label for both the servers and the routers inside our network. We also parameters QoS in the used routers to guarantee high performance in our network.

As described before, the IMS-level registration and session initiation must be proceeded to authenticate the user inside the IMS network before the user initiated the IPTV connection. To proceed with vertical handover without any call drop, we choose the MIP-SIP protocol that provides minimum handover time.

4. PERFORMANCE ANALYSIS

In this section, we gathered the collected results for our proposed scenario; then we make overall performance analysis. End- to end packet losses and traffic dropped are collected. We contrast the three user's performance (BC, VoD, and PVR) in case of using and disusing FL QoS. First, we will explain the user's results when moving inside the LTE network, then when the user made a handover to the WLAN network and move inside the network. In each case, we compare the three user's performance (BC, VoD, and PVR) in case of using and disusing Flow Label QoS. Our proposed FL QoS exhibits a high performance for BC users.

4.1. LTE moving user

BC, VOD and PVR users change their position with the same speed continuously in this scenario. The three users BC, VoD, and PVR move internally for a fair comparison when using the proposed mechanism. Our suggested Flow Label QoS prove the best performance for BC user.

4.1.1. Traffic dropped

It is the data missing while sending from the server to the user. This missing data is owing to network congestion and imperfect data links.

Figure 3 exhibits that all BC, VoD, and PVR servers sent the same quantity of data, while Figure 4 shows that the amount of data received by the privileged user BC exceeds both VoD and PVR users. Indeed, in case of congestion, routers start by removing the PVR packets first and then the VoD packets and will leave the BC packets at the end justifying a higher loss-rate for PVR flows and therefore a lower amount of data received than the BC and VoD users.

Figures 5 and Figure 6 show the effect of our technique on the various flows since BC and VoD users have received more data when using the FL QoS technique favoring the BC then the VoD flows to the detriment of the PVR flow. On the other hand, Figure 7 shows that the PVR user received less data when applying the FL QoS approach, which is quite normal as our technique gave its packets the lowest priority during the data transfer. Thus, when all three users request services at the same time, the PVR will be given the lowest priority in the data transfer.

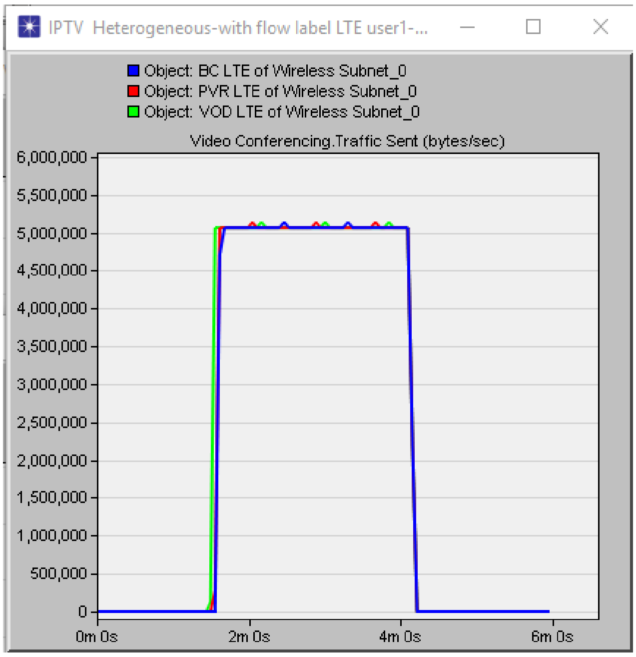

Figure 3 the sending Traffic (bytes/sec)

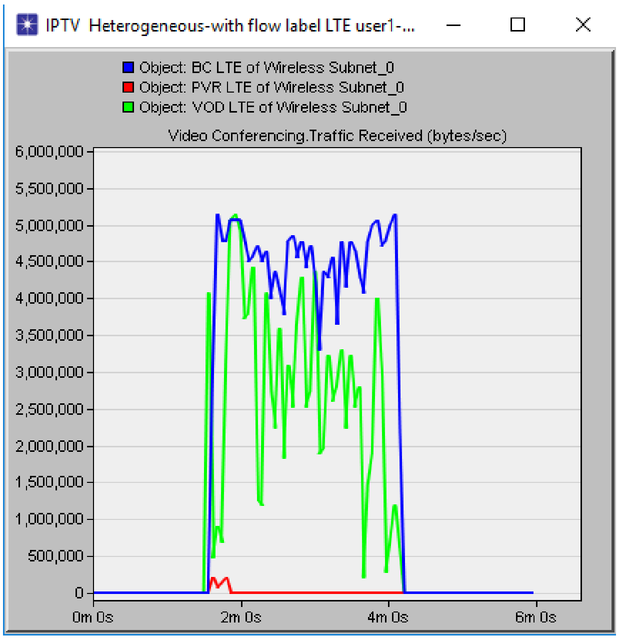

Figure 4 Traffic received in case of using Flow Label QoS (bytes/sec)

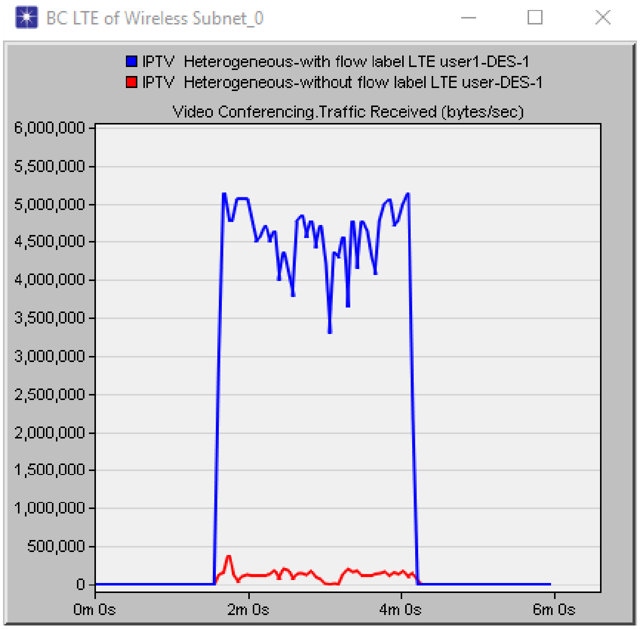

Figure 5 Traffic Received of BC user (bytes/sec)

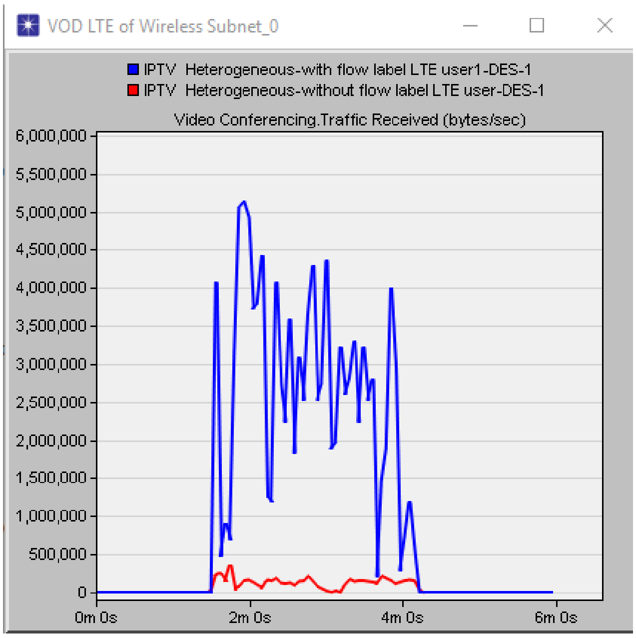

Figure 6 VoD Traffic Received (bytes/s)

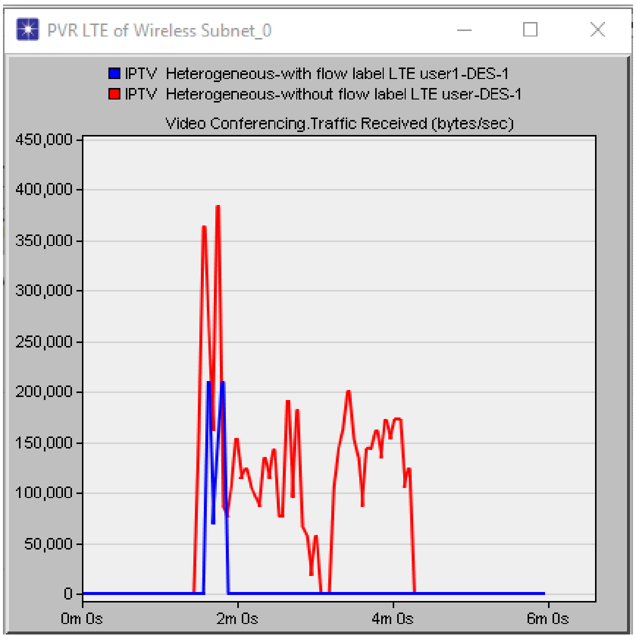

Figure 7 PVR Traffic Received (bytes/s)

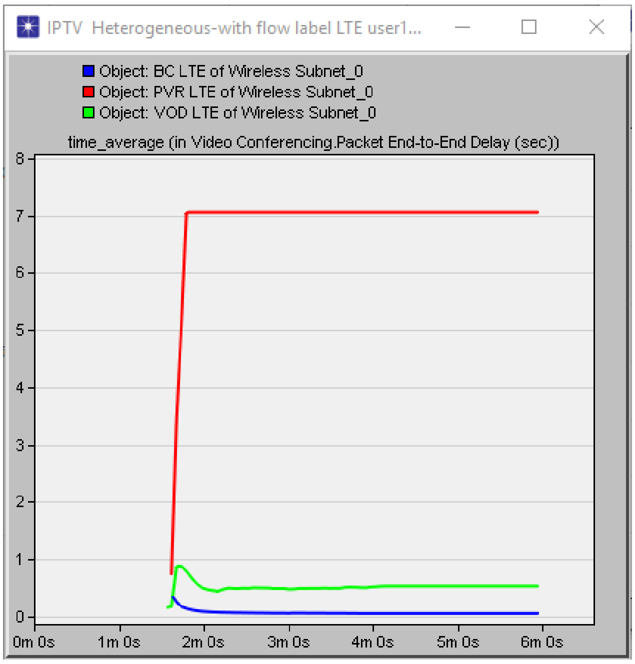

Figure 8 End-to-End delay (sec)

4.1.2. End-to-End Delay

End-to-end delay is the time the packets take to move from the server to the user. Figure 8 exhibits that using FL QoS makes the BC user end-to-end delay the lowest because of the priority applied in our proposed technique in our scenario. When applying our technique, the BC packet delay decreases as in Figure 9. In contrast, Figure 10 and Figure 11 expresses that the delay of VoD and PVR users raises in case of utilizing the FL QoS technique. In case of congestion, our technique starts with the processing BC user and VoD user streams ahead of the PVR flows giving a small increase in the VoD delay and a higher PVR delay.

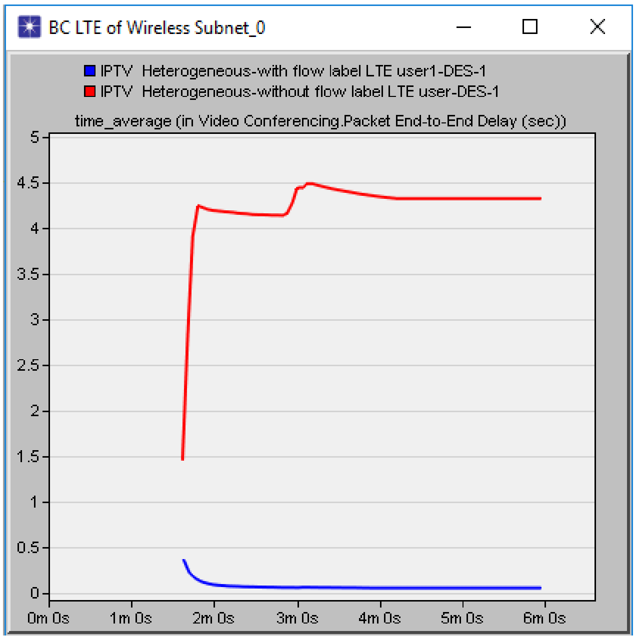

Figure 9 End-to-End delay of BC user (sec)

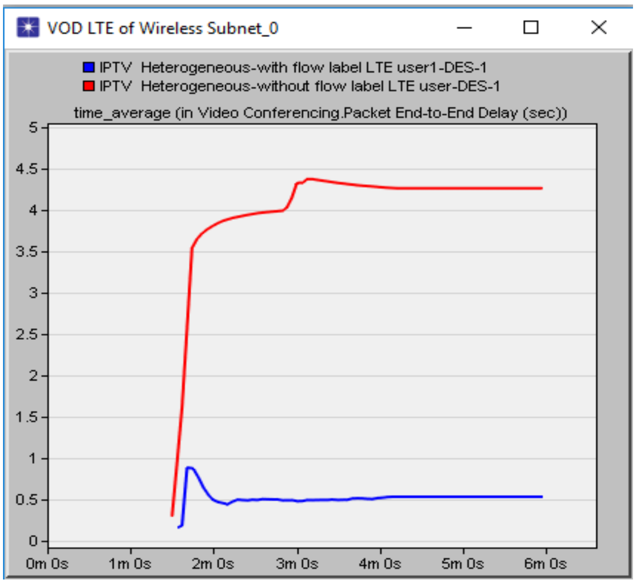

Figure 10 End-to-End delay of VoD user (sec)

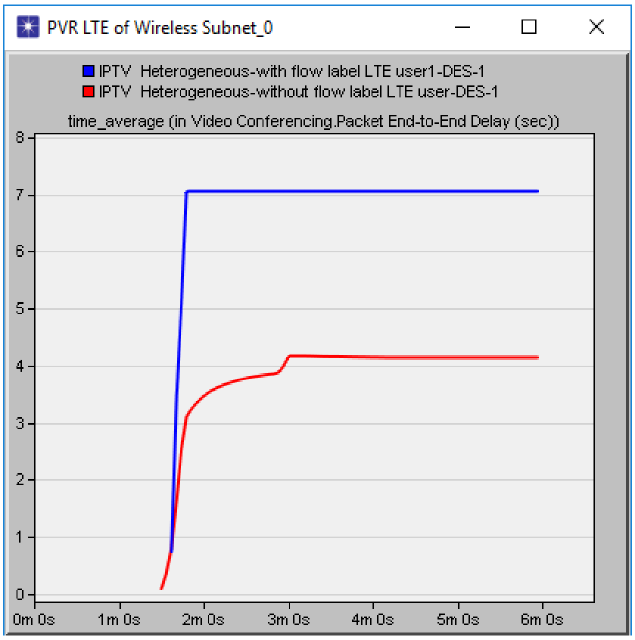

Figure 11 End-to-End delay of PVR user (sec)

4.2. WLAN moving user

4.2.1. Data Losses

Our comparison was based on all users send the same amount of data as shown in Figure. 12. As we expected, the highest data was received by BC user as shown in Figure. 13, due to its highest priority. Our technique assigns the highest processing priority to the BC stream as well as the lowest deletion priority to this stream, so as explained above, in case of congestion, the routers first delete the packets of the PVR and VoD streams and leave the packets of the BC stream last, which justifies that the amount of data received by the BC user is higher than that of the VoD and PVR users

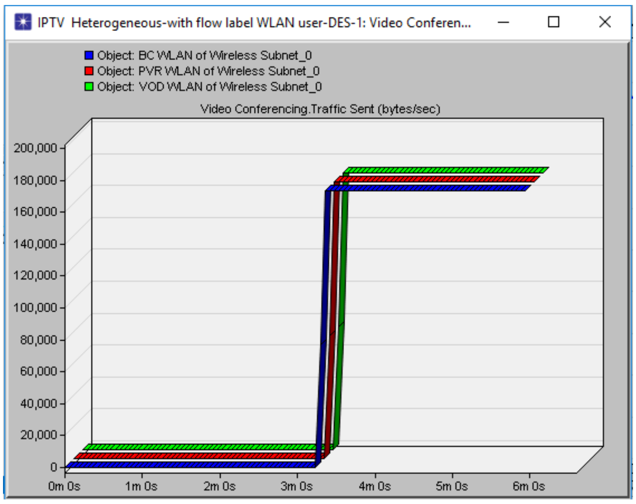

Figure 12 Traffic Sent (bytes/sec)

Figure. 14 shows that the BC user has received more data by applying the flow label QoS technique and Figure. 15 shows the VoD user has received lower amounts of data traffic, which is justified as our FL QoS method favors BC traffic at the expense of both VoD and PVR flows. Thus, the BC streams are least susceptible to being dropped by routers in case of congestion, so the amount of traffic received by the BC user is greater than the amount of traffic received by VoD and PVR respectively. On the other hand, the decrease with large quantity for the PVR user is seen in Figure. 16. Taking into consideration also that as the user is moving, the distance between him and base station varies, thus the quantity of data varies.

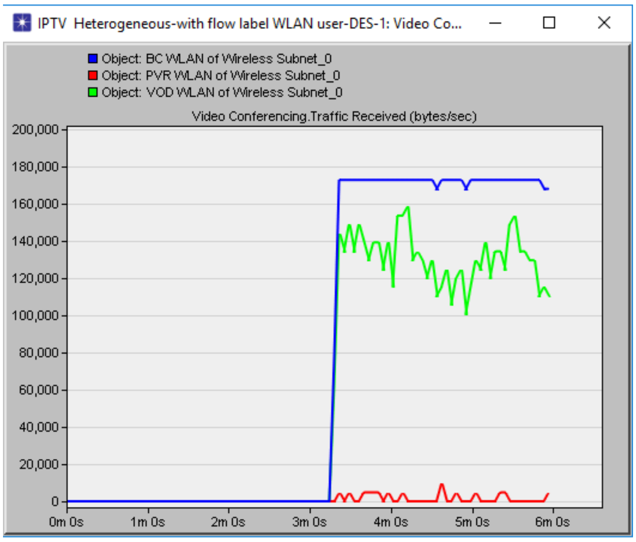

Figure 13 Traffic Received using Flow Label QoS (Bytes/sec)

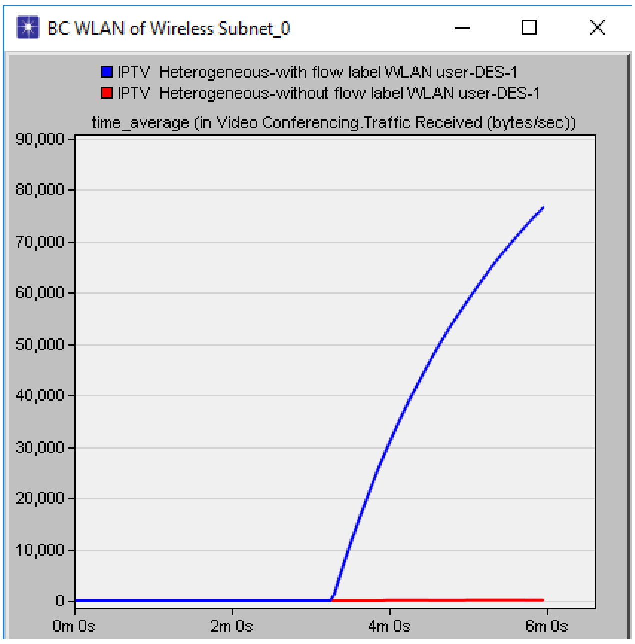

Figure 14 BC user Traffic Received (bytes/sec)

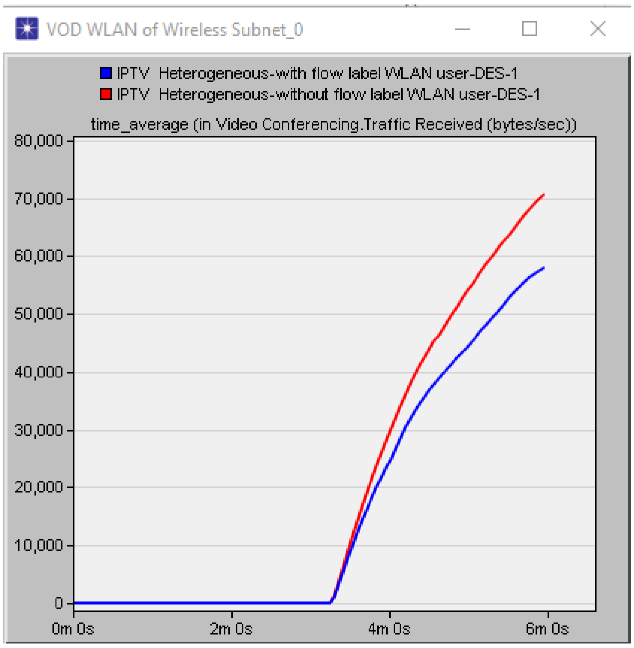

Figure 15 VoD user Traffic Received (bytes/sec)

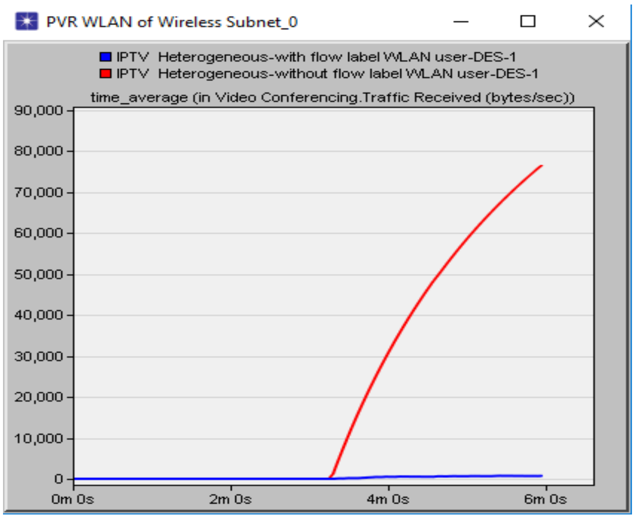

Figure 16 PVR user Traffic Received (bytes/sec)

4.2.2. End-to-End Delay

Figure 17 exhibits that using FL QoS makes the BC user end-to-end delay the lowest because of the priority applied in our proposed technique in our scenario. When applying our technique, the BC packet delay decreases as in Figure 18. In contrast, Figure 19 and Figure 20 expresses that the delay of VoD and PVR users raises in case of utilizing the FL QoS technique. In case of congestion, our technique starts with the processing BC user and VoD user streams ahead of the PVR flows giving a small increase in the VoD delay and a higher PVR delay.

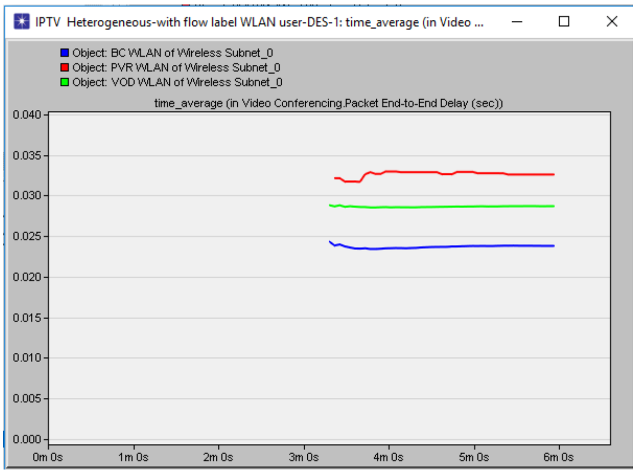

Figure 17 End-to-End delay (sec)

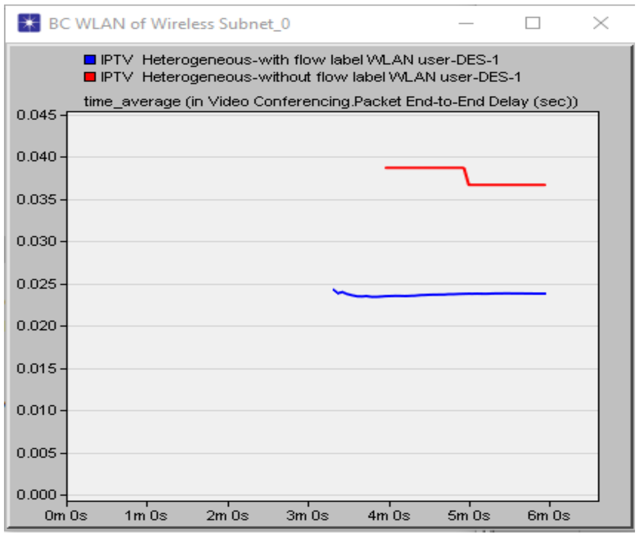

Figure 18 BC user End-to-End delay (sec)

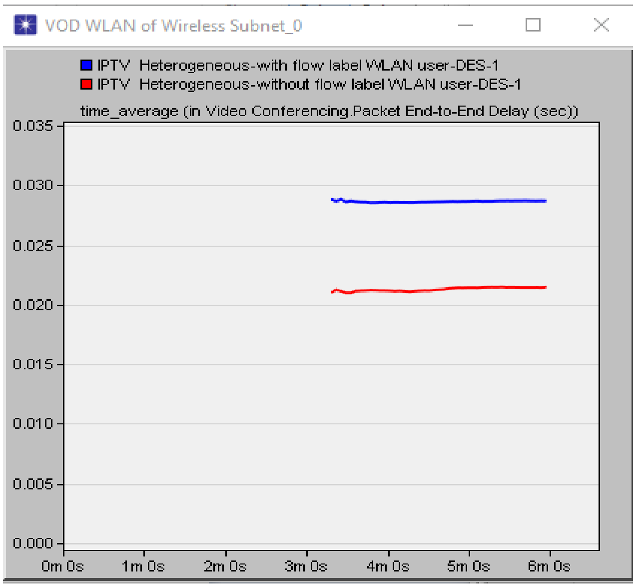

Figure 19 VoD user End-to-End delay (sec)

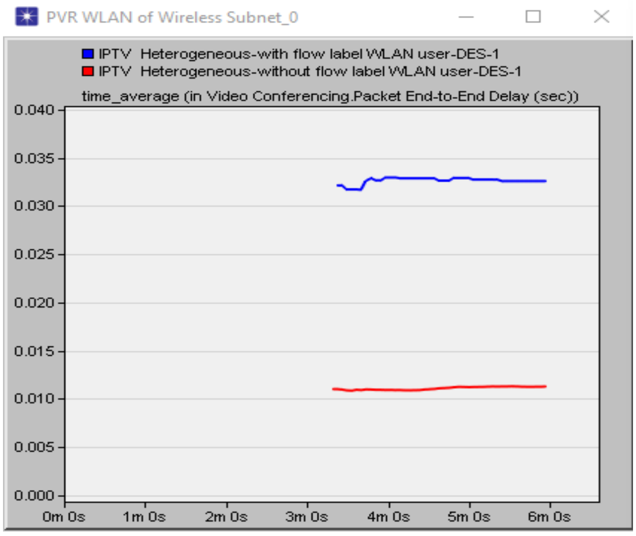

Figure 20 PVR user End-to-End delay (sec)

4.3. Discussion

In this scenario, we notice that in case of network congestion, the routers proceed to the different sub-traffics delay's optimization but with the existence of our reclassification and differentiation mechanism of the packets, the delay and jitter for PVR user are maximized. As for BC sub traffic, it has been minimized as a result of our new classification mechanism for BC clients and also because of this sub-traffics latency's sensitivity. Our results show that our approach has allowed us to improve the broadcast video quality to the detriment of VoD and PVR. Such a situation is just a demonstration of our reclassification approach's effectiveness. In reality, the administrator can designate the highest priority traffic according to the policy followed by the service provider. The decomposition of IPTV traffic allowed us to set up PHBs specific to IPTV media. The simulations results show the added value of our classification algorithm in improving the video QoS.

5. CONCLUSION & PERSPECTIVES

In recent years, numerous researchers have attempted to enhance the QoS of IPTV services by seeking to minimize primarily the loss rate and delay of real-time traffic. None of them regards the trouble of classification of IPTV sub traffic and the distinction between the BC, VoD, and PVR packets. To resolve this problem, we suggested a new addressing algorithm that assorts the packets using the IPv6 FL field. This algorithm provides a reliable solution for improving the QoS of IPTV sub traffic by prioritizing BC packets over that of VoD and PVR streams. We also enhance the quality of IPTV services by implementing that method to an LTE-WLAN Heterogeneous system. We project the performance of this algorithm using an empirical lab as mentioned in section 4. The performance outcome shows that the quantity of data received by BC user which has the highest priority is the topmost in the case of the moving user. Our outcomes demonstrate also that the packet losses and end-to-end delay went down for BC users, but went up for PVR which explains that our methods work well. We are working on implementing this technique to the next interworking heterogeneous network (LTE-WLAN-WiMAX). In the future, we will try to solve some security problems in the IMS-Based IPTV network and reduce the channel zapping time.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

AUTHOR'S CONTRIBUTIONS

Mohamed Matoui, Noureddine Moumkine and Abdellah Adib: Contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

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