International Journal of Computer Information Systems and Industrial Management Applications.
ISSN 2150-7988 Volume 10(2018) pp. 272-288

Submitted: 23 Dec, 2017; Accepted: 6 March, 2018; Publish: 19 Oct., 2018

IPTV Quality of Service Improvement Approach Over LTE Network

Mohamed Matoui[1], **Noureddine Moumkine,**[2] **and Abdellah Adib**[3]

[1]Research Team: Networks, Telecommunications, and Multimedia
Department of Computer Sciences, Faculty of Sciences and Technology
Mohammedia, Morocco
matoui.mohamed@gmail.com

[2]Department of Computer Sciences, Faculty of Sciences and Technology
Mohammedia, Morocco
nmoumkine@yahoo.fr

[3]Department of Computer Sciences, Faculty of Sciences and Technology
Mohammedia, Morocco
adibab@gmail.com

Abstract: **The latest experiences hint that IMS (IP Multimedia Subsystem) technologies cannot perform its highest QoS (Quality of Service) approaches as they aren't able to distinguish between the priorities of IPTV (Internet Protocol Television) video components. IMS system also cannot ensure high IPTV data transfer due to the limitation of available cellular bandwidth. Success of IPTV services depends on how the customer perceives QoS related to the provided stream. The satisfaction of this factor is crucial to the success of IMS services. This need constitutes a major challenge for the IMS-based IPTV on the horizon of overcoming the failure of existing QoS models namely IntServ (Integrated Services) and DiffServ (Differentiated Services). In this paper, we try to merge the advantage of high bandwidth assigned to LTE (Long Term Evolution) and a new PHB (Per-Hop Behavior) that classify and differentiate between IPTV sub traffics by using IPv6 Flow Label. This new architecture permits high-quality IPTV video components with the capability to prioritize the sub traffic according to the network administrator policy which itself allows IPTV packets to avoid best-effort treatment. The proposed architecture is implemented using OPNET software using two different scenarios. The obtained results show that IPTV users receive high-quality video data with a change in quantity according to data priority.**
Keywords: IPv6,Flow Label,LTE,QoS,Diffserv,IPTV,IMS.

I. Introduction

The need for information exchange between interlocutors led to the development of various methods of communications with specific characteristics and constraints of each service. In a converged environment, characterized by the emergence of "triple play," the design of new telecommunication architectures, more open, has become a necessity. Such openness will prevent all aspects of fixed / mobile heterogeneity. In the search for an inter-service and inter-network matching solution, IP (Internet Protocol) is presented as a fundamental convergence of NGN (Next Generation Network). It gave a converged IP world in which terminals have become increasingly integrated and ubiquitous. One of the main issues facing telecom operators is to provide multimedia clients with personalized and efficient services depending on the operating environment at the time of service provision. End customers access some multimedia services through completely different devices. These are connected via heterogeneous access networks. The reception quality of the IPTV traffic by the final customer differs according to resources of the acquisition device and network performance. To these quality constraints, add the multimedia traffic sensitivity to QoS parameters namely jitter and packet loss. This is prompting us to design solutions to optimize the QoS by acting on the software components of service delivery i.e., those authenticating and marking users. The negotiation of QoS, as well as the current state of the reception of multimedia product with the entity issuing service, will be an asset to the operator on the horizon to provide traffic with an acceptable QoS. The translation of this philosophy of convergence in an industrial reality materialized in IMS which is a system that serves to cover the convergence of mobile, wireless and fixed networks in a typical network architecture where all data types are housed in an all-IP environment. IMS assumes that the operator must control the media consumption through multimedia sessions using SIP (Session Initiation Protocol) to ensure the required QoS and enable inter convergence services. The latest tests showed that IMS technology still suffers from some confinement factors, which includes the non-differentiation between different IPTV video components. The existing IMS-based

IPTV infrastructure doesn't take account that the IPTV traffic consists of three sub-components or the sensitivity of the linear television latency. With the aim of controlling and guaranteeing the QoS in IMS infrastructure, several methods have emerged, namely: 3GPP approach (3rd Generation Partnership Project) [1], IETF (Internet Engineering Task Force) approach [2] and SLM&M (Service Level Monitoring & Management) approach [3]. All these three proposals use the DiffServ model for QoS management. A detailed study shows that traffic classification adopted by these approaches suffers from several problems. The classification of traffic uses three classes: data, voice, video. In the case of IPTV, we note that traffic can be decomposed into three sub-traffics:

- **BC (BroadCast)** that allows the transfer of real-time video.
- **VoD (Video on Demand)** that includes a library that allows the user to select and view a video.
- **PVR (Personal Video Recorder)** that enable users to record the received stream.

DiffServ model makes the treatment of these three types of flows alike. The difference in sensitivity to QoS parameters requires a reclassification between them. Our contribution aims to remedy this problem.

Digital video streaming has become widely spreading these days. IPTV services become an enormous demand as it provides the transfer of multimedia services over IP network to provide the required QoS needed by the user as security, reliability, and interactivity. It also requires carrying video to wide range of users with different screen sizes and resolution as mobile phones and digital screen cinemas. So, a continuous moving picture and audio are transferred during transmission time. To achieve the required demand with an efficient QoS, the high bandwidth is needed [4] [5] [6] [7]. The 4G cellular network has been assigned enormous bandwidth that ensures reliable delivery of IP traffic from smartphones to enable user transfer high amount of data while moving inside the cell [8]. To allow this next-generation services to interact with the users and guarantee the best IPTV QoS, a new QoS-control paradigm based on adaptive control theory has been developed. These new techniques will provide the user demand according to their QoS requirements. We also apply this proposed approach in LTE to give the best QoS.

Many types of research have worked in improving IPTV services QoS. The poor-quality model has been merged in [6] to promote IPTV network accuracy and efficiency in case of pause or screen with less clarity. Li and Chen in [8] combined time slicing and discontinuous reception (DRX) schemes to build power saving technique for LTE network. The proposed mechanism decreases the UEs consumed power and saves the IPTV services quality. In [9], a new framework has been illustrated to measure the viewers response and analyses TV content. This method leads to use IPTV network data according to users' opinion. A new proposed architecture with new coding has been proposed in [10] to mend robustness when the network capacity increases. To uphold IPTV in LTE network, Broadcast Multicast Service Centre has been designed in [11]. In [12], Chen and Liao succeeded to reduce the switching delay during video transfer using exact packet pairs that increase bandwidth. They also improved playback media stability by using buffers to store selected channel. *IPTV network and QoS parameters have been explained and analyzed in details in [13]. That made a realistic evaluation of IPTV traffic.* Li and Chen support IPTV mobility over a wireless cellular network using spectrum allocation technique [14]. This offers better IPTV services by preserving a good quality of voice service. In [15], IPTV data problems as dropping, blocking and bandwidth usage have been almost solved using new queue model that consider adaptive modulation and coding. IPTV seamless handover in wireless LAN has been achieved in [16] using Physical Constraint and Load-Aware. This technique allows the user to choose the next wireless LAN to access according to its strength, congestion and bit error rate.In [17], the authors provide a comprehensive guide to standardized and state-of-the-art quality assessment models. They also identify and describe parametric QoE formulas for most popular service types (i.e., VoIP, online video, video streaming, etc.), indicating the Key Performance Indicators (KPIs) and major configuration parameters per type. Huang et al propose data-driven QoE prediction for IPTV service. Specifically, they define QoE to evaluate the user experience of IPTV in data-driven approach at first and build a personal QoE model based on an artificial neural network (ANN) [18]. In [19], the development of a testbed for evaluating the quality of experience (QoE) of 3D video streaming service over LTE is described. In the testbed, different network conditions are configured by setting network emulator parameters based on the results obtained by a system-level LTE simulator. In [20], Authors provide a new method to reduce tunneling overhead by allowing multimedia content to be delivered from many different Micro data center as well as Mega data center by using their own unique addresses to create tunneling to transfer multimedia content. A new cost-efficient wireless architecture [wireless live TV (WiLiTV)], consisting of a mix of wireless access technologies [satellite, Wi-Fi, and LTE/5G millimeter wave (mmWave) overlay links], for delivering live TV services is proposed in [21]. In our previous work [22], we presented in details the new PHB (Per-Hop Behavior) that reclassifies and differentiates IPTV sub traffics by using the IPv6 Flow Label field. The proposed PHB will make possible prioritization of sub traffics according to the applied QoS network policy. We have already applied our approach on a fixed network [22] and then on a mobile one [23].

This paper discusses the convergence of heterogeneous multi-service networks and focuses on the study and improvement of the QoS of IPTV traffic in the IMS-Based IPTV. Our contribution aims to introduce the concept of reliability in a multimedia network based on technologies that are designed to provide robust communication for IPTV traffic, and more precisely the real-time video component in various segments that are converged via the IMS-based IPTV platform. In this paper, we introduce briefly our new algorithm that helps in increasing the QoS of IPTV sub traffics and implement it in LTE wireless cellular network to improve the data transfer. Section II presents an Overview of IMS & IMS-Based IPTV. Section III shows briefly QoS issues, types of IP interworking networks and existing suggestions for enhancing QoS using IPv6 Flow Label. Our new QoS optimization mechanism will be explained in section IV, it's based on how to prioritize IPTV sub-traffic using the IPv6 Flow Label field and how to generate new classes of services. In Section V, we discuss our implementation network and the scenarios studied of the LTE-IMS-Based IPTV by using Opnet 17.5. Section VI presents the analysis of the results of the proposed scenarios relating to the various network techniques. Finally, Section VII discusses the conclusion and our prospects in improving that field.

II. Overview of IMS & IMS-Based IPTV

IMS (IP Multimedia Subsystem) represents a new generation of IP-based network infrastructure. It is the solution envisaged to have new multimedia services by the integration between telecoms and data on the same platform. By operating on IP, IMS supports P2P (Peer to Peer) communications between existing telecommunication standards while implementing functional entities that provide interoperability between data and voice services for mobile users (802.11, GSM, CDMA, UMTS) and fixed (PSTN, ISDN). In this architecture, we distinguish between two plans that work separately: signaling and media, unlike the telephone network. The signaling plan manages session control, authorization, and aspects of security and Quality of Service. As for the media plan, it controls encoding and transport. A set of protocols focuses on providing service including presence and instant messaging. The IMS network includes several servers: SIP, Home Subscriber Servers (HSS), application servers and Media Resource Functions (MRF). SIP servers are essential nodes in IMS, entities responsible for call control and sessions, and are denoted CSCF (Call / Session Control Functions). They include: P-CSCF (Proxy-CSCF) , I-CSCF (Interrogating-CSCF) and S-CSCF (Serving-CSCF) [24].

A. Architectural Structure

IMS represented a multimedia service control architecture, independent of access and based on the IP protocol. The integration of voice or data has increased the productivity and overall effectiveness of such a structure. The consolidation of this need gave birth to the IMS platform. The ETSI TISPAN consortium (Telecommunications and Internet Converged Services and Protocols for Advanced Networking) and 3GPP have developed the Quality of Service control architecture and related procedures [25]. The IMS architecture is based on a layered model. The four essential layers are projected in Figure. 1:

- **Acces Layer:** Represents all types of broadband access: UTRAN (UMTS Terrestrial Radio Access Network), CDMA2000, xDSL, cable network, WiFi.
- **Transport Layer:** Represents an IP network. It can integrate QoS mechanisms with MPLS, Diffserv, and RSVP. It consists of routers (edge router and core router) connected by a transmission network. Several scenarios for communication stacks can be considered for the IP network: IP / ATM / SDH, IP / Ethernet, IP / SDH.
- **Control Layer:** Consisting of session control components, it is responsible for the routing of the requests of the signaling between users and the invocation of the services. The nodes constituting this layer are denoted by CSCF (Call State Control Function). This new platform introduced a session control environment on the packet domain.
- **Application layer:** This layer introduces new applications to IMS clients. The integration of the operators is done using their control layer as service aggregators. This layer consists of application servers.

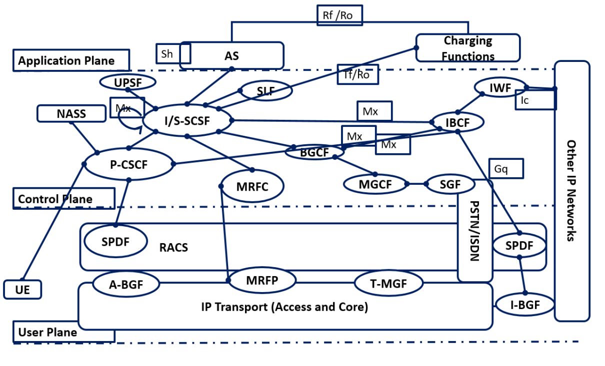

Figure. 1: The global architecture of the IMS

Taking advantage of IMS services to deliver multimedia traffic has led to the design of an IPTV service delivery architecture in IMS. Such a platform is called IMS-Based IPTV whose architecture will be detailed in the following paragraphs.

B. IMS-Based IPTV

This second part presents an architecture that supports IPTV services in an IMS environment. The design extends the current IMS specifications, as well as the functionality required to meet the needs of IPTV services. An IPTV service provider can deploy such an architecture via heterogeneous access networks (mobile, wireless and fixed). In the following, we will focus on ETSI TISPAN IPTV standardization.

1) Functional architecture of IMS-based IPTV

The rise in the number of users of multimedia services requires operators to optimize the design of their service network, in addition to the control mechanisms. [26]

2) IPTV Services

As mentioned before, IPTV Services can be divided into three main groups:
BC (Broadcast): The functions that are responsible for managing this type of flow are:

- OBC-SCF
- OBC-MCF
- OBC-MDF

VoD (Video on Demand): Several components have been set up to manage this service:

- VoD-SCF (Service Control Function).

- VoD-MCF (Media Control Function).
- VoD-MDF (Media Delivery Function).

PVR (Personal Video Recorder): The features responsible for managing this service are:

- PVR-SCF
- PVR-MCF
- PVR -MDF

3) Functional entities

Figure. 2 illustrates the functional architecture of IPTV services. The Service Control Function (SCF) is a SIP applica-

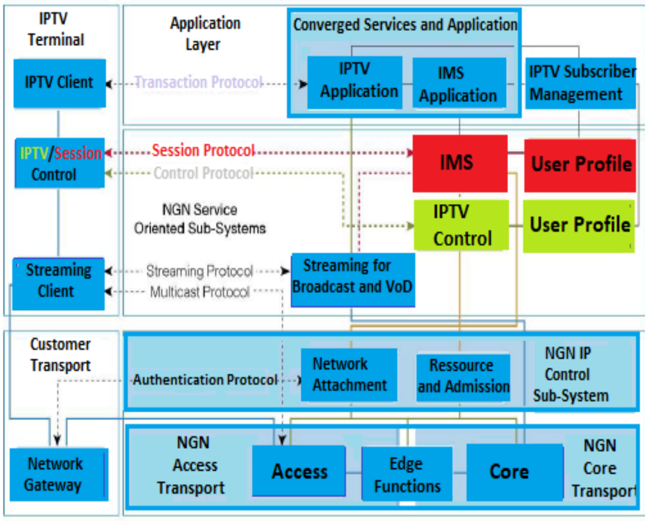

Figure. 2: Functional architecture of IPTV services

tion server whose spots are:

- Service Authorization During initiation or modification of the session, which involves verifying the profile of the IPTV user to allow or deny access to the service.
- Credit control.
- Selecting relevant IPTV media functions.

4) IPTV Media Distribution and Control

The IPTV media functions are responsible for controlling and delivering the media stream to the user terminal. There are two components: MCF (Media Control Function) and MDF (Media Delivery Function).
MCF: It manages the control flow of the MDF component by:

- Management of media processing by MDF.
- Monitoring MDF status.
- Managing interaction with the EU.
- Manipulating interaction with the IPTV service control function (SCF).
- Having a clear view of the state and distribution of the content of the various MDFs controlled by this MCF.
- Selecting an MDF.
- Choosing an MF (Media Function), and return the result of the selection to the SCF then redirect the session to the selected MF (ex: the case where the requested content is not available in this MF or Load balancing between the different MFs).
- Generating billing information.

MDF: It is responsible for handling the delivery of the media stream. Its main tasks are listed below:

- Report the streaming state to the MCF (e.g., report the status of the transfers for an established IPTV session).
- Storing the media and some information about the service.
- Storing frequently requested or user-specific media (example: PVR, Time-shift TV, BC service with Trick mode) in case the user terminal has not performed this task.
- Carry out the encoding of the media in several formats depending on the needs of the terminal (e.g., a TV resolution that depends on the performance or preferences of the terminal).
- Ability to perform content protection such as encryption.
- For BC services, the MDF can act as a multicast source for a BC type media stream.
- Collect user satisfaction reports as the quality of service.

5) UPSF database

This database contains profiles of IMS users; as well as some data, unique to IPTV services.

C. Interaction between functional entities

1) Communication between service/media control

To ensure service, the various components of the IMS-Based IPTV are called upon to interact to optimize the service delivery process. In this context, the communication between the SCFs and the MDF is illustrated in Figure. 3: When a media function is requested by a session (example: BC session), the MF specific to this session will be determined during the session initialization period and the resource allocation procedure. Such a determination may be based on the following criteria:

- The position of the EU.
- Information on the status of all available functions (connection status, availability of resources, etc.).
- The load of the different FMs holding the media.

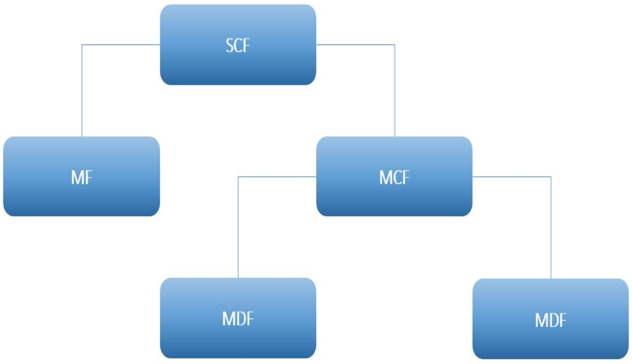

Figure. 3: Communication relationship between SCF and MFs

- The identity of requested content. It should be noted that the media identifier must be designed to simplify its reading.

The selection process is based on the primary functions that can be hosted in a CFS / MCF. The MCF can act as a redirection server to reorient sessions to other MCFs. The SCF must contact the MCF during the session initialization phase and allocation of resources. As for the SCF, it can contact several MCFs via the IMS core as shown in Figure. 4.

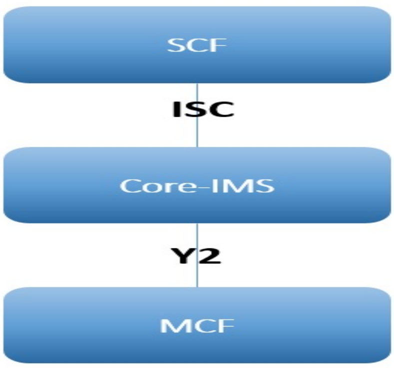

Figure. 4: Points of reference between SCF and MCF

When an MCF is contacted, it must react with the parameters offered for the session corresponding to the content requested by the EU (End User).

2) Communication Interfaces and Protocols

Several scenarios of roaming between IMS-Based IPTV networks can be imagined. By definition, we call the local network the network registering the client, and the network visited the one to which it has moved. The main objective of an IPTV user is to access the services of his subscription by being outside his local network or on the move (IPTV mobile). Accessing IPTV services, wherever one is, uses a series of protocols, the list of which is shown in Figure. 5.
In general, the protocols used for transporting IPTV media are :

- **RTP**: allows packet formatting to carry audio and video content in an IP network. This protocol is used for the broadcasting of channels, controlled by the Real Time Streaming Protocol (RSTP). It is used roughly by streaming services such as telephony, video conferencing.

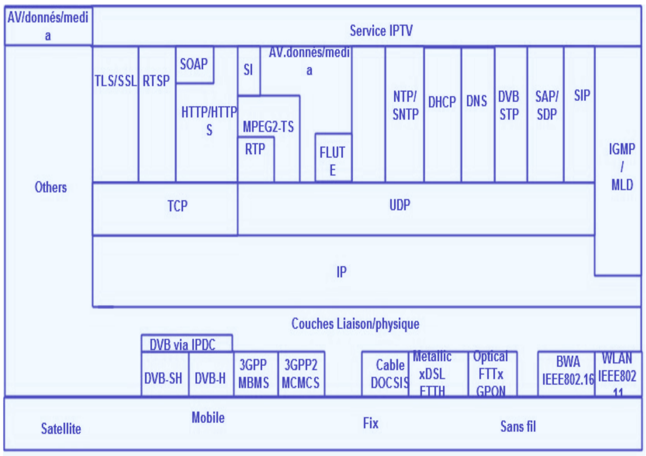

Figure. 5: IMS-based IPTV protocol stack

- **RTCP**: It functions in cooperation with RTP. RTCP supervises transmission statistics, quality of service and helps in the synchronization of multiple traffics.
- **RTSP**: Used to control streaming servers. As a result, RSTP monitors the delivery of RTP data and broadcasts the channels. This protocol is used to establish media sessions between the server and the client. Media servers activate a start or pause command to start and stop data transmission and control the transfer of traffic from the server easily.
- **PIM** (Protocol-Independent Multicast): This is a routing protocol that allows distribution of data over an IP network. Being independent as its name means, it uses the information produced by the different routing protocols such as BGP (Border Gateway Protocol), RIP, OSPF. In the IMS-based IPTV, it is commonly used to route video streams.
- **IGMP** (Internet Group Management Protocol): It manages members of IP multicast groups. Frequently used in broadcast and online games. For IPTV technology, it allows the connection to the channels and the switching inter chains TV.

III. Quality of Service & IPv6 Flow Label

The QoS is defined as the consumer satisfaction measure. This suggests a personal approach which depends on the user perception. However, in telecommunications traffic engineering, this term refers to measurable and qualitative techniques to select, monitor, predict and measure the QoS and ensure predictable behavior [27].

A. QoS Management Models

When an IP network provides services without QoS mechanisms, it is called a "Best Effort" network. In a "Best Effort" class of service, all packages are identical and have the same shipping treatment. A QoS management mechanism in the IP network help to differentiate packets and process them differently. Two primary underlying mechanisms for QoS control are available for IP networks: IntServ and DiffServ [27] [28] [29].

1) *IntServ Model*

In IntServ, a particular IP flow is identified by the following parameters: (protocol identifier, destination IP address, destination port, source IP address, port Source). The source application shall provide a flow specification which consists of the characterization of traffic and service requirements. The characterization flow comprises flow (peak, average), the burst size, the network parameters (leaky bucket), service requirements (minimum bandwidth) and performance requirements (delay, jitter, and the loss rate). IntServ uses RSVP (Resource Reservation Protocol) to reserve resources for a stream. RSVP is a protocol used for IP configuration and reservation QoS settings. It supports both IPv4 and IPv6 protocols and is applicable for multicast and unicast modes. In the principle of the RSVP, resources are reserved in each direction separately. The source and destination hosts exchange RSVP messages to establish the state of packet classification and transmission. The source initiates the reservation, but the determination of available resources and the actual booking starts at the receiving end. The resource reservation state at the RSVP nodes is not permanent and must be updated periodically. RSVP is not a routing protocol and its messages the same path as IP packets, which is previously determined by routing tables in IP routers. Since each node on the road must keep the reservation status, RSVP is still impracticable because of the scalability problem for large networks.

2) *DiffServ Model*

Unlike the IntServ model that treats each stream independently, DiffServ model separates traffic into classes. DiffServ routers process the packets based on the class encoded in the IP header (DS Field) in a particular behavior: PHB. Each set of packets defined by a class receives the same treatment, and each class is encoded by a DSCP (DiffServ Code Point). The different ways of treatment in a DiffServ network are called policies. For applying different policies to traffic, it is necessary to have a way to differentiate packets. The IETF has defined the core architecture of DiffServ, which provides a basic way to distinguish a series of traffic at network nodes. DiffServ reuses the ToS (Type of Service) octet of the IPv4 packet header as belonging to different classes that can then be subject to various policies. The assignment of packets to different DiffServ classes is sometimes called staining. IPv6 has kept this same field in its header by calling it Traffic-Class. With the DiffServ model, the network attempts to deliver a particular type of QoS based on packet service class. The network uses the QoS specification to classify, label, form and manage the policy and queues of traffic intelligently.

B. *IPv6 Flow Label*

IPv6 Flow Label is a 20-bits field just after the Traffic Class field of the IPv6 header. This field may be used to label packets of the same packet flow or an aggregation of flows [30]. Several approaches have been proposed to the IETF to use this field to improve QoS on the internet [31]. Some of them have suggested using it to send the bandwidth, delay, and buffer requirements. Others have recommended using this field to send the used port number and the transport protocol [32]. Other approaches have been proposed [33], but none of them have been standardized. However, there is a hybrid approach that takes into account the advanced approaches and applies them to DiffServ model. This method has booked the first 3 bits of the IPv6 flow label field to indicate the methods used and reserved the remaining 17-bit parameter relating to each particular approach. Table 1 summarizes the hybrid approach.

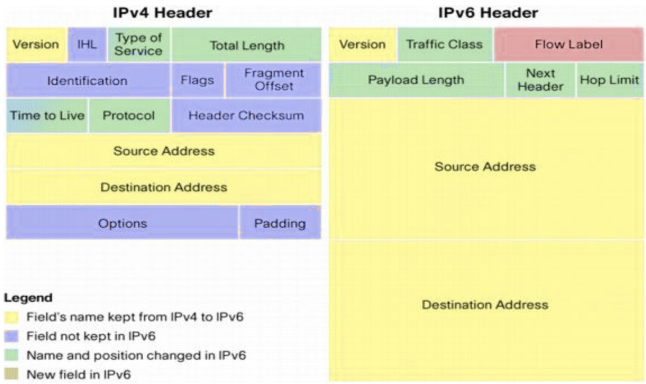

Figure. 6: Packet header differences between IPv4 and IPv6

Table 1: The Bit Pattern for the first 3 Bits of Flow Label

Value	Type of the Used Approach
000	Default
001	A random number is used to define the Flow Label.
010	Int-Serv
011	Diff-Serv
100	A format that includes the port number and the protocol in the Flow Label is used.
101	A new definition explained in [34].
110	Reserved for future use.
111	Reserved for future use

C. *QoS in IMS Network*

The IMS-Based IPTV was not limited to the provision of essential services of IPTV, but it opened the door to 'quadruple play' services and other more advanced ones. The delivery of IPTV services must maintain a certain level of QoS for clean operation. To allow any terminal connected to any network to stay connected (always on), IMS has enjoyed the support of service providers. After being set up by service providers, IMS has allowed users access to communication services using either a fixed or mobile terminal. QoS support requires network capacity to adapt to the needs of employers. According to the lack of the user, it must act on one side on the content, and secondly on the access management functions. IMS had a choice of traditional or recent technologies for service management, especially using the experience inherited from the Internet model in QoS management, but the requirements to provide multimedia services compete to attract many customer and supplier. The critical question whether conventional models presented in this Section are necessary and sufficient? Developing DiffServ and integrate new PHBs to manage intra-traffic distinction will be shown in the next Section.

D. Synthesis and Problematic

There are two patterns of PHB, EF (Expedited Forwarding), and AF (Assured Forwarding). They have been proposed to treat traffic differently. The EF PHB can be used to have low loss, low jitter, low latency, a bandwidth provided and an end to end service through DiffServ domains, while the AF PHB accords several levels routing IP packets dropping packets of lower priority when network congestion rather than the higher priority packets. The AF PHB offers four classes of service to route IP packets. In each AF class, an IP packet is associated with one of three drop precedence levels. An implementation of a video traffic scenario with three different flows allowed us to identify some problems that we summarized in the following: Is there a way to differentiate between sub IPTV traffic? What is the appropriate PHB guarantees the best QoS traffic of linear TV service? What IP packet marking should you use? Is it desirable to modify the marking of IP packets according to the network status? Is there a marking means which allows us to do an intra-IPTV stream marking? In this section, we present the DiffServ architecture used for QoS management in general regardless of the type of service, that is, the same methods are used for IPTV and FTP service. While a particular multimedia service IPTV requires special mechanisms to ensure acceptable QoS, methods that allow reclassification of IPTV traffic are then necessary. For this purpose, in the next section, we propose to present a new particular approach to IPTV that classifies and differentiates packets of different components of this flow by using IPv6 Flow Label which offers more opportunity with its 20-bits instead of 8-bits TOS field.

IV. Improving QoS using Flow Label Proposed Technique

The capability of the network to provide the user requirements when using IPTV service taking in consideration the main parameters like delay, traffic losses, video jitter and quality is the heart of the definition of QoS in our network. As mentioned before, two main QoS models were proposed by IETF (Internet Engineering Task Force): IntServ and DiffServ. The difference between these two models is detailed in [35].

To improve QoS for IPTV services during transmission, IPv6 Flow Label has been used in addition to IMS system. The IMS-Based IPTV was not limited to the provision of essential services of IPTV, but it extends to other services like 'quadruple play' services and other more advanced ones as Flow Label to allow the user to ask for a unique process for its real-time traffic flow [28].

Variable data rate has been assigned for video traffic to ensure the best appearance of scenes and modulation process [36], [37]. But that assignment causes control and same encapsulation problems for video traffic in a DiffServ network due to the difficulty of designing maximum inter-video traffic limit. Also, when serving considerable traffic with a high priority of EF PHB, DiffServ core routers face saturation problem. Because of the growth of real-time data traffic waiting for a delay in the queue due to the use of narrow queues assigned to EF PHB technique. It also causes slow filtering of video packets which leads to dropping it. In dropping process, EF packets at the edge of the DiffServ domain will be treated according to their importance in the GOP (Groupe of Picture) video [38]. The rejection priority for PHBs in AF is often implemented based on WRED (Weighted Random Early Detection). Loyalty order user classification has been integrated into IMS-based IPTV using the eTOM (enhanced Telecom Operation Map) [3]. Using it, network administrator handles the distinction between recipient based packages. For example, if a user is classified as "GOLD," scoring inter users generate another factor to differentiate between the same user with the same classification to affect the credibility of transmission. But in the congestion case, the DiffServ standard will be used by routers to return to the removal process.

As mentioned before, IPTV video data stream can be distinguished into three main traffic: BC, VoD, and PVR. So it will be treated the same in best effort especially in case of traffic congestion [39]. That will lead to traffic latency for sensitive video traffic to latency and loss rate. So, the need for reclassification mechanism between IPTV packets became necessary to decrease that delay and packet losses for especially "BC" users. To achieve that requirement, we propose new priority suppression PHBs for IPTV traffic that differentiates between user data according to their priority [22]. This technique depends on mapping DSCP (Differentiated Services Code Point) values in the IPV6 Flow Label because the TOS field of the IPV4 header is limited to a byte. That will give us the capability to differentiate between different IPTV traffic using more bits while remaining compatible with the DiffServ approach. The IPv6 Flow Label field will thus have the following values:

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								

And as the value of the DSCP field for the EF class is set to 101110, the IPv6 Flow Label field can be written as shown in Table II:

Table 3: 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	1	0	1	1	1	0	x	y	Reserved for future use								

Where x, y are the bits used to differentiate the video Traffic intra-IPTV. The fact that IPTV packets take the same value of the DSCP field, knowing that it uses only six bits, then we will dedicate the following 10 and 11-bits in the IPv6 Flow Label to a reclassification intra-IPTV. The remaining 9-bits will be reserved for future use. We named DSCP-FL the first 11 bits of the IPv6 Flow Label field. These new Flow Label values are mapped to PHBs that are characterized by a high priority, low loss rate, jitter, and latency similar to that of the current EF PHB. Indeed, three IPTV packets belonging successively to the BC traffic, VoD, PVR will be subjected to a treatment illustrated by the algorithm in Figure. 7:

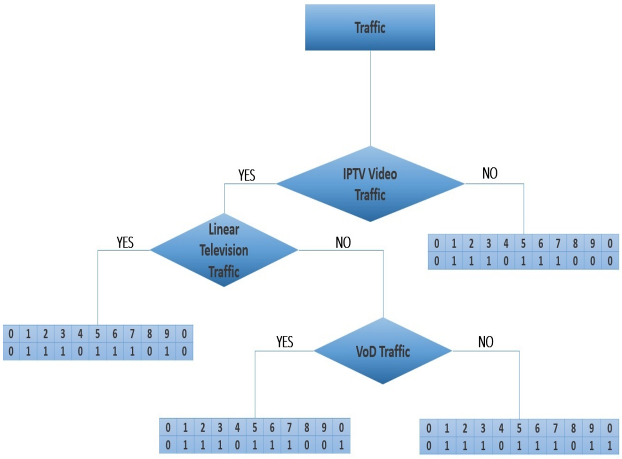

Figure. 7: The Proposed Algorithm to Differentiate Intra IPTV Traffic

In saturation case, low-level priority data will be removed by the DiffServ; in the explained case, it will be the one whose DSCP-FL field has a value close to 011 10111001.

Table 4: Flow Label with the 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	1	1	Reserved for future use								

V. Simulation Scenario

Using OPNET Modeler 17.5, we implemented our proposed technique in LTE cellular network. The main idea of the proposed framework architecture is to perform IMS-Based Flow Label IPTV component in a 4G mobile system.
A new modulated task application module has been developed as IMS-SIP server does not exist in the OPNETs modules. User registration in IMS network and session establishment of IPTV services are built in custom application in the proposed framework. Hereafter, we study the performance of the new integrated architecture in two different scenarios. All scenarios are similar in the main three principal elements: IMS servers, IPTV data servers that responsible for providing the users with the multimedia contents (PVR, VoD, and BC), finally the users that demand IPTV services inside our network. As the IPTV users are not alone in a 4G system, there are 10 FTP, and 10 HTTP users that transfer data at the same time as IPTV users. We must also mention that we compare the results of our proposed scenarios when using and disusing our proposed technique to measure the QoS parameters. The traffic sent is the same from the three different video servers (BC, VoD, and PVR), high-resolution video, and that after the user perform IMS authentication steps. Figure. 8 presents our first scenario. The three IPTV demand users received at the same time with the same amount of data and the same quality. In that scenario, the users move inside the cell with the same velocity 100 m/s. The second scenario shows the IPTV users when moving inside different cells with the same speed while receiving IPTV data. This scenario is shown in Figure. 9.
In our network, we compare between its performances in two different ways. Firstly, we consider the case without applying the Flow Label QoS based system, and in the second case we apply the Flow Label and WFQ (DSCP Based) QoS. PVR, BC and VoD send the same high-resolution video after performing IMS authentication and IPTV video establishment. We apply our technique by changing the IPv6 Flow Label for both the server and the routers inside our network. We also configure QoS parameters in the used routers to ensure high performance in our network.

A. *IMS Registration and Session Initiation*

IMS-level registration is the procedure which is used to authorize the user to access the IMS network and use the IMS services. It is done after IP connectivity for the signaling that has been gained from the access network and the application level registration can be initiated after the registration to the access is performed. A SIP REGISTER request accomplishes IMS-level registration and the user is considered to be always roaming.

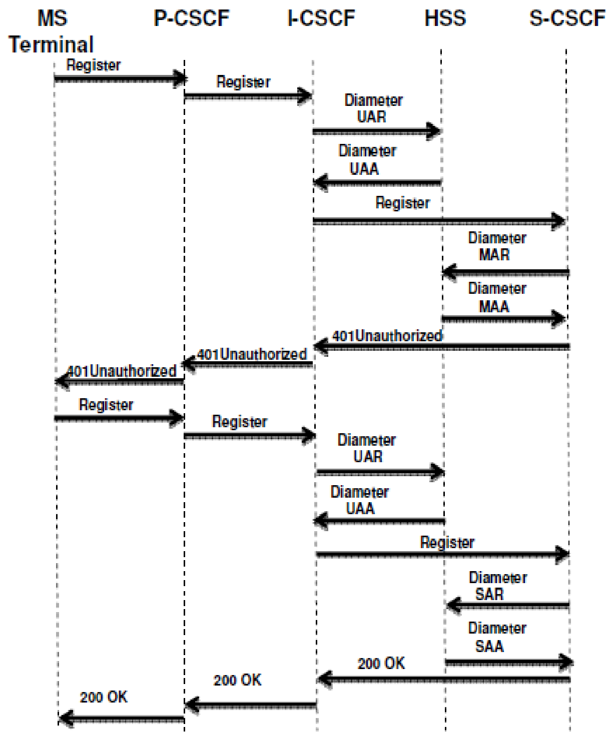

Figure. 10: Registration at the IMS Level

As shown in Figure. 10, the Mobile Station (MS) initiates the registration process by sending SIP register information flow to P-CSCF. Upon message reception, the P-CSCF examines the "home domain name" to discover the entry point to the home network as it might not reside to MS home network. So the SIP REGISTER attaches to the information needed and sends the register information flow to the I-CSCF. To indicate whether the user is already registered and allowed, the Cx-Query/Cx-Select-Pull information flow should be sent to the HSS by the I-CSCF. A Response is sent from the HSS to the I-CSCF and it will contain the S-CSCF name or a list of the qualifications of the available S-CSCFs. Using the name of the most appropriate S-CSCF; ICSCF sends the register SIP REGISTER to S-CSCF. The S-CSCF contacts HSS to authenticate the MS. The HSS stores the S-CSCF name and the S-CSCF stores the information for the indicated user. The I-CSCF sends a user invitation ("401Unauthorized") to the P-CSCF. The P-CSCF repeats the above-presented messages exchange, except the new UAA which this time contains routing information. The S-CSCF returns the 200 OK information flows. The I-CSCF shall release all registration information, and the P-CSCF shall store the home network contact information, and shall send information flow to the MS.

VI. Performance Analysis

In this section, we gathered the collected results for the two proposed scenarios; then we make overall performance analysis. This performance analysis is based on the study of the impact of each scenario on the following performance metrics of each scenario. The collected results are traffic dropped, packet end-to-end delay and jitter. In each scenario, we compare the performance of the three users (BC, VoD, PVR) in case of using and disusing Flow Label QoS.

A. *Scenario 1: All Three Users Moving Inside The Same Cell*

In this scenario, all three users BC, VoD and PVR moves inside the cell with the same speed to make affair comparison between them when applying the proposed technique. Our proposed Flow Label QoS shows a high performance for BC user.

1) *Traffic Dropped*

It can be defined as the data missing while sending from the server to the user. This missing data is due to the congestion of the network and imperfectly data links.

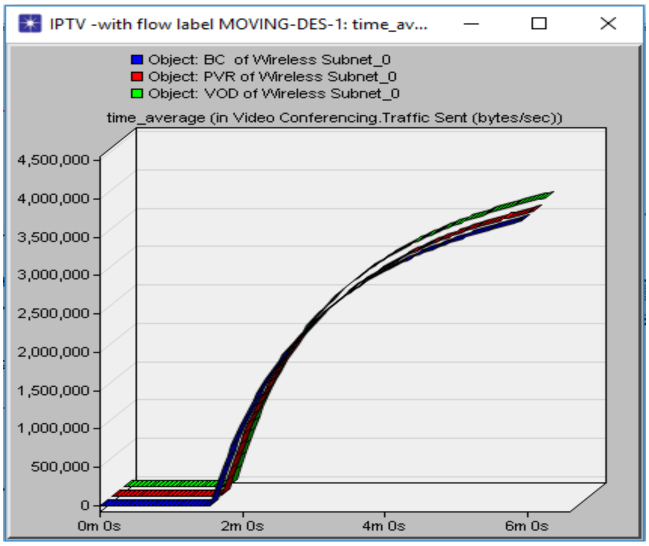

Figure. 11: Traffic sent (bytes/sec)

Figure. 11 shows that all sources sent the same amount of data, although Figure. 12 shows that the amount of data received by BC user is higher than both VoD user and PVR user as BC user has the most top priority then both VoD and PVR users.

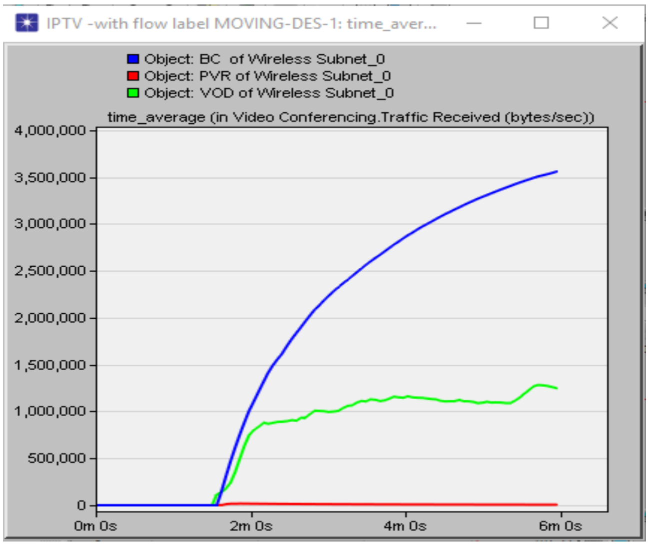

Figure. 12: Traffic Received using Flow Label QoS (bytes/sec)

As shown in Figure. 13 and Figure. 14, BC user and VoD one received a higher amount of data when using Flow Label QoS. In contrast, the amount of data received by the PVR user decreases when using our approach as shown in Figure. 15.

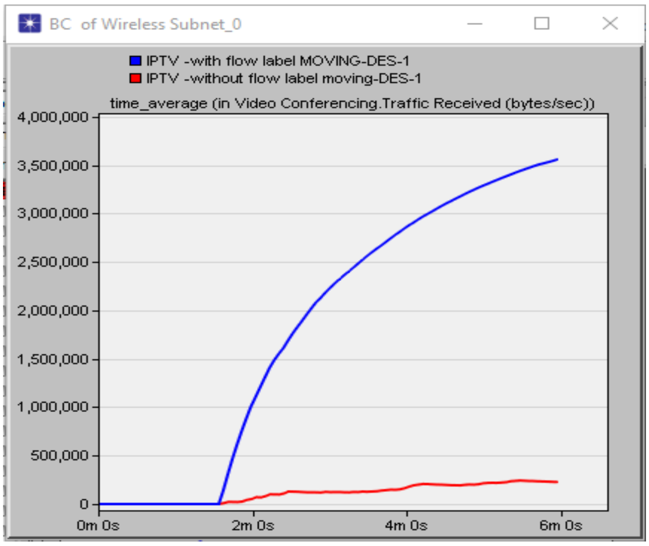

Figure. 13: BC user Traffic Received (bytes/sec)

2) *End-to-End Delay*

The time taken by the packets to travel from the server to the user can be called end-to-end packet delay. As shown in Figure. 16, end-to-end delay made by the BC user is the lowest when using Flow Label QoS. BC user delay as in Figure. 17 is lower than the delay when using Flow Label QoS. In contrast, the delay by PVR users increases when using our technique as shown in Figure .19, while the delay of VoD user remains almost the same as in Figure. 18.

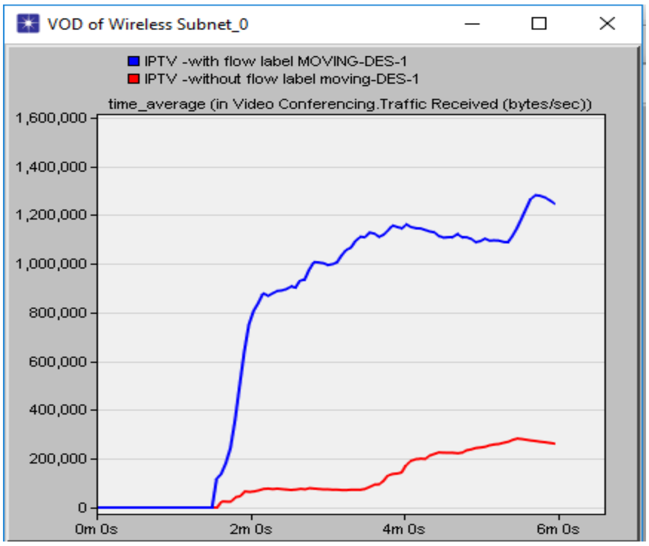

Figure. 14: VoD user Traffic Received (bytes/sec)

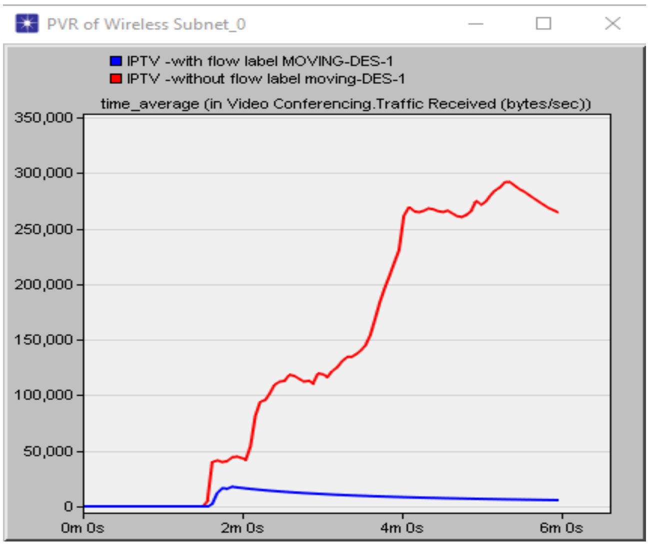

Figure. 15: PVR user Traffic Received (bytes/sec)

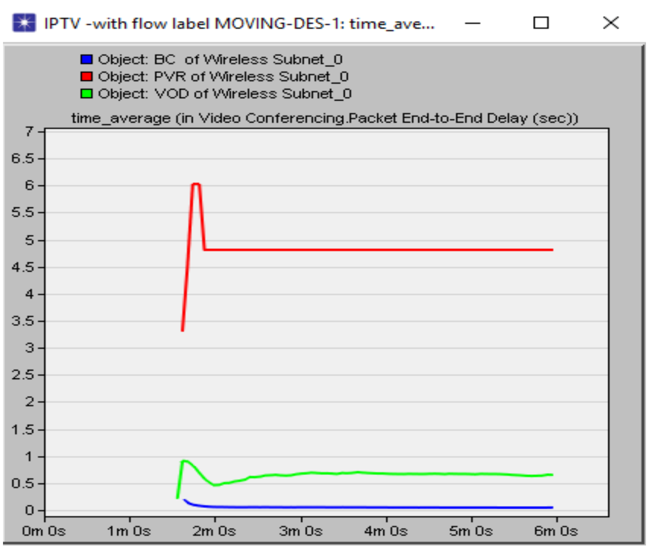

Figure. 16: End-to-End delay (sec)

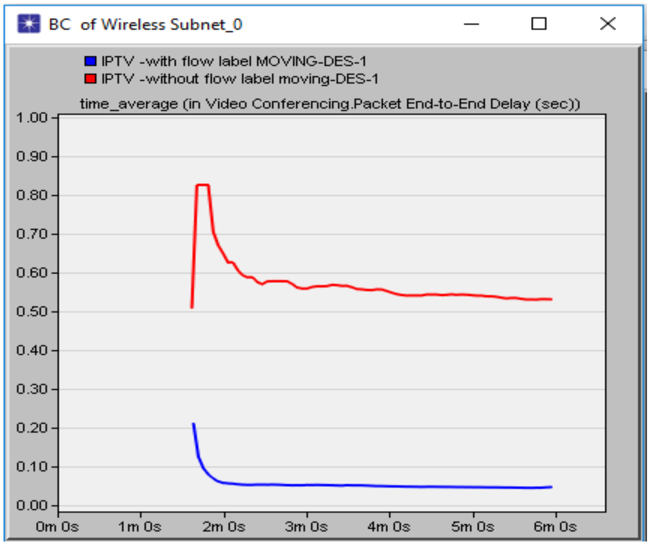

Figure. 17: BC user End-to-End delay (sec)

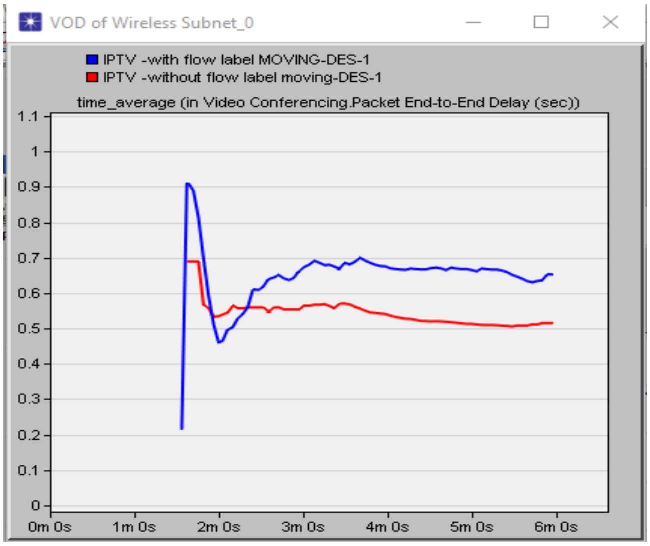

Figure. 18: VoD user End-to-End delay (sec)

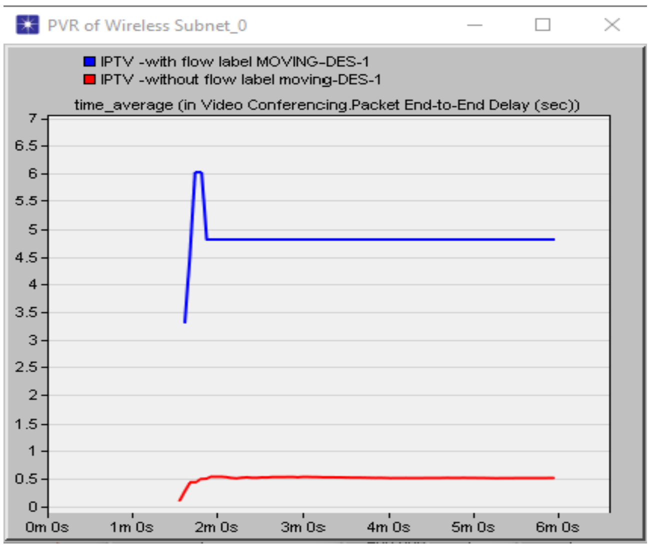

Figure. 19: PVR user End-to-End delay (sec)

3) *Jitter*

Jitter presents the playout buffers size for regular delivery of packets. BC user jitter is the lowest as shown in Figure. 20 when using Flow Label QoS.

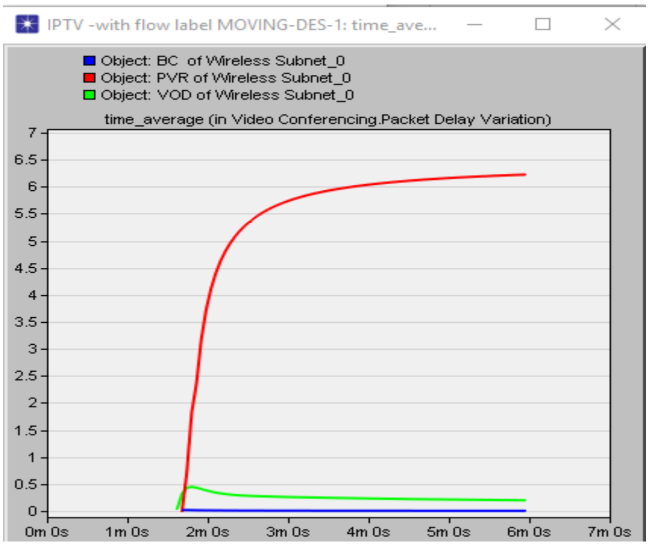

Figure. 20: Jitter (sec)

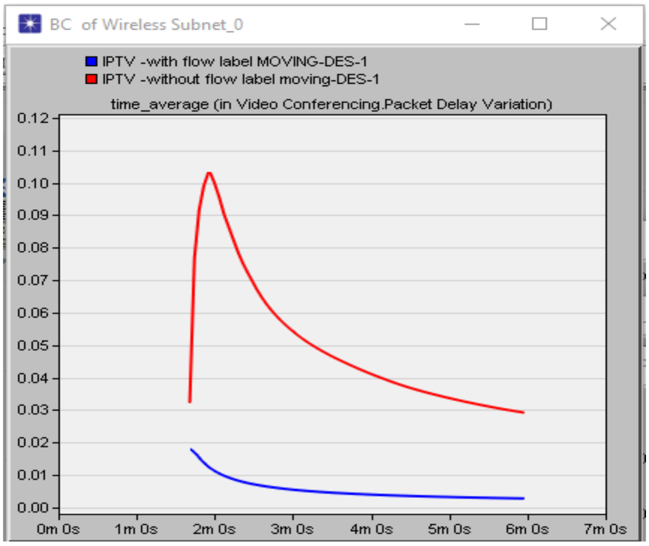

Figure. 21: BC user Jitter (sec)

Figure. 21, Figure. 22, and Figure. 23 represent a comparison of packets delay variation by three users, in the case of using and disusing the Flow Label QoS. BC user jitter as shown in Figure .21 is the lower amount of delay when using our approach. In contrast, the jitter by the VoD and PVR users increases when using Flow Label QoS as in Figure .22 and Figure .23.

B. Scenario 2: Each User Moving In Different Cell

1) *Traffic Dropped*

All sources sent the same amount of data as shown in Figure. 24. In spite of that, BC user received the highest amount of data as shown in Figure. 25, due to its highest priority.

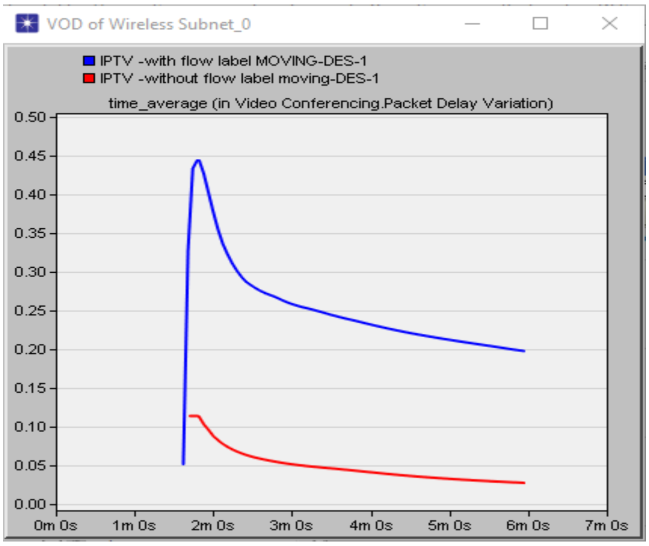

Figure. 22: VoD user Jitter (sec)

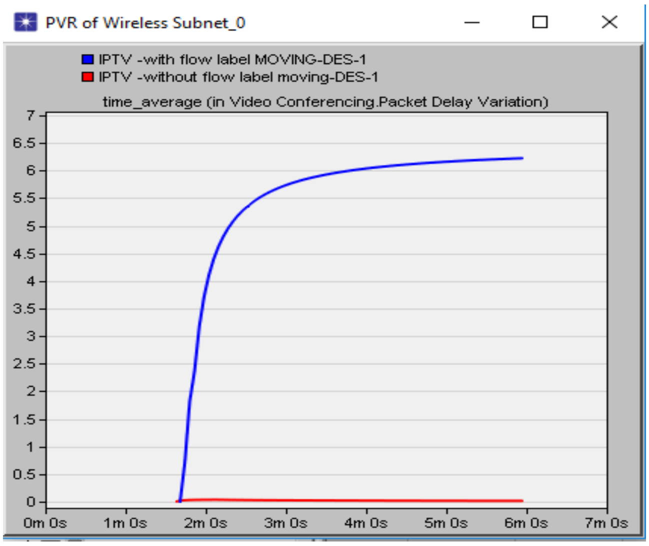

Figure. 23: PVR user Jitter (sec)

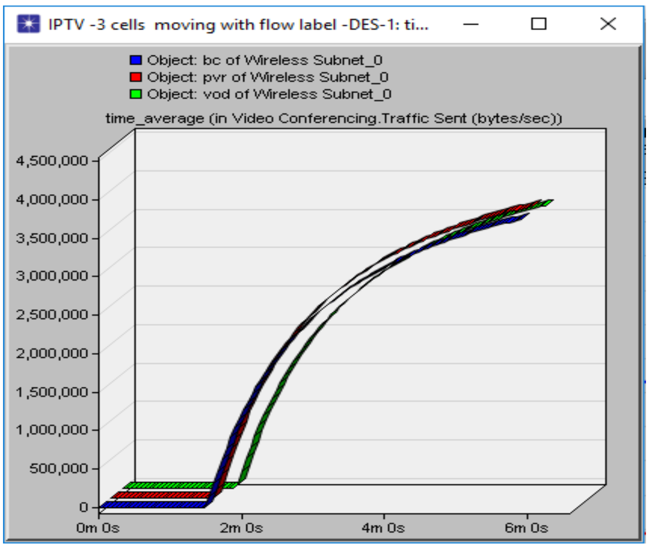

Figure. 24: Traffic Sent (bytes/sec)

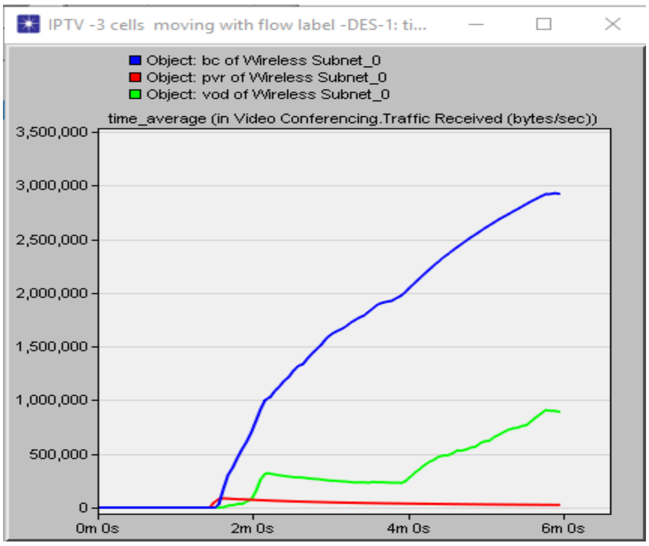

Figure. 25: Traffic Received using Flow Label QoS (bytes/sec)

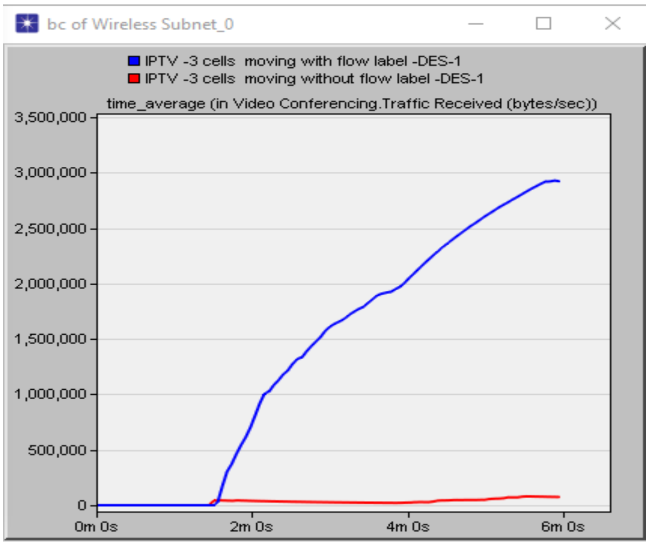

Figure. 26: BC user Traffic Received (bytes/sec)

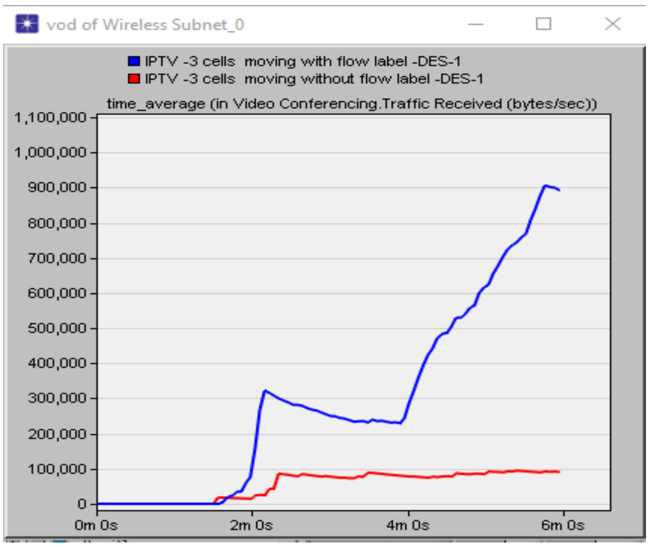

Figure. 27: VoD user Traffic Received (bytes/sec)

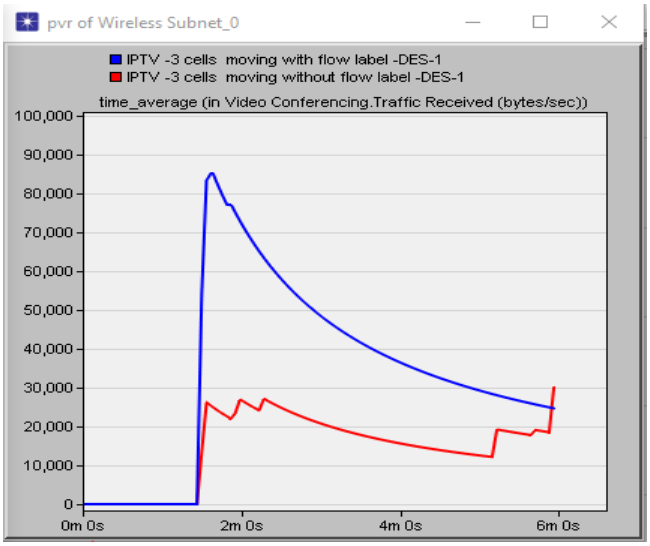

Figure. 28: PVR user Traffic Received (bytes/sec)

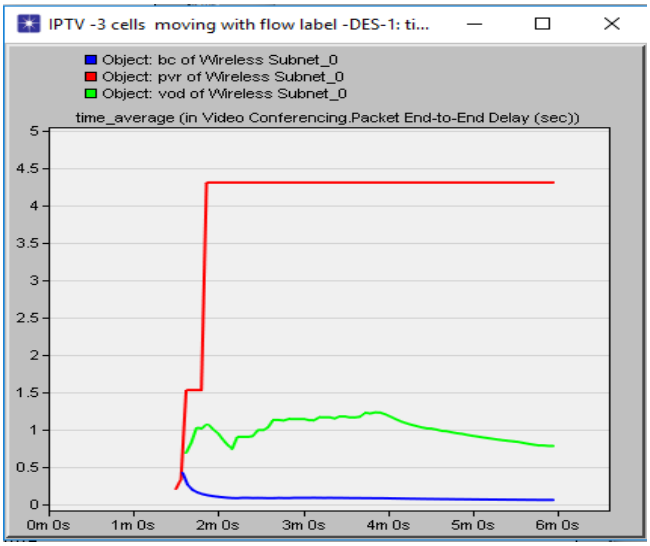

Figure. 29: End-to-End delay (sec)

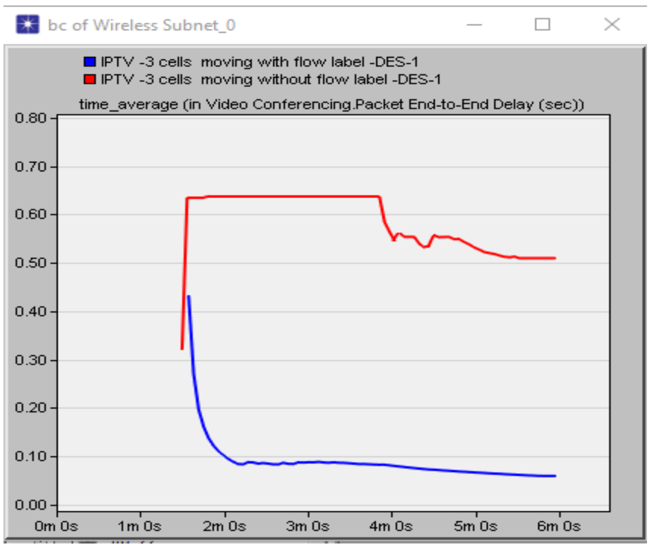

Figure. 30: BC user End-to-End delay (sec)

The traffic received by both BC and VoD users increased with gigabytes when using Flow Label QoS as shown in Figure. 26 and Figure. 27. As the cell contains other users who send data, so when applying our mechanism IPTV users will have the priority among all of them. Unlike that, the traffic received by PVR user is almost the same as shown in Figure. 28. Taking into account that the user moves, so the amount of received data varies in each time.

2) End-to-End Delay

Figure. 29 shows that the PVR user has the highest packet end-to-end delay while BC user has the lowest delay. This is because the priority applied in our proposed technique in the proposed scenario. Figure. 30 shows that BC packet delay decreases in case of applying our proposed technique. In contrast, Figure. 31 and Figure. 32 show that the delay of VoD and PVR users increase in case of using the Flow Label QoS technique. The delay of VoD user increases in the small rate while PVR delay rises with high rate.

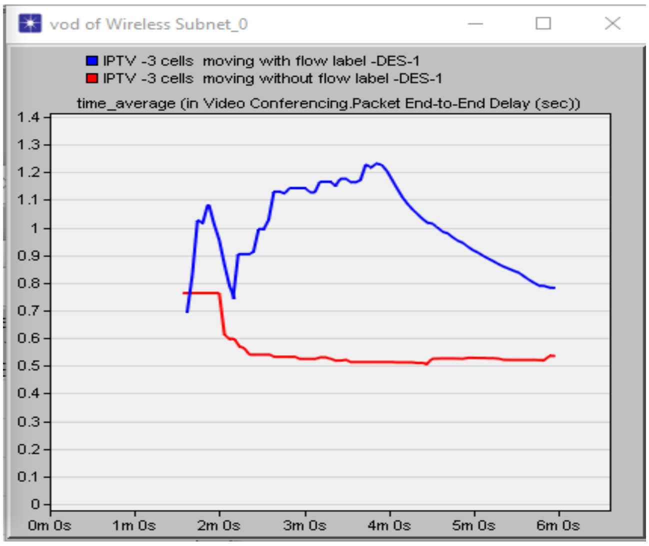

Figure. 31: VoD user End-to-End delay (sec)

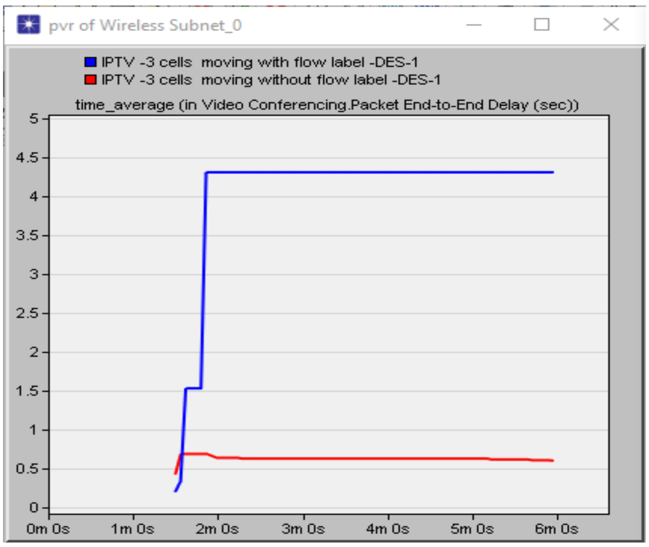

Figure. 32: PVR user End-to-End delay (sec)

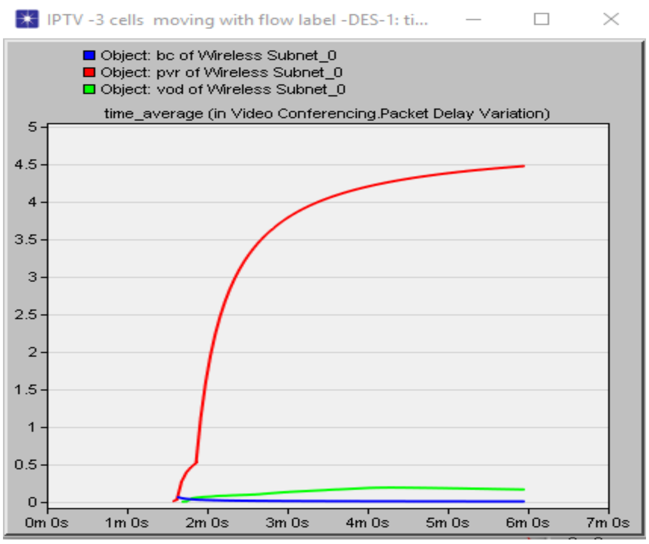

Figure. 33: Packet delay variation (sec)

3) Jitter

Figure. 33 shows that PVR user has the highest jitter, unlike VoD and BC users that has the lowest jitter almost zero in case of BC user. BC user delay as in Figure. 34 is the lower amount of delay when using Flow Label QoS. In contrast, the delay by the VoD and PVR users increases when using Flow Label QoS as shown in Figure.35 and Figure. 36.

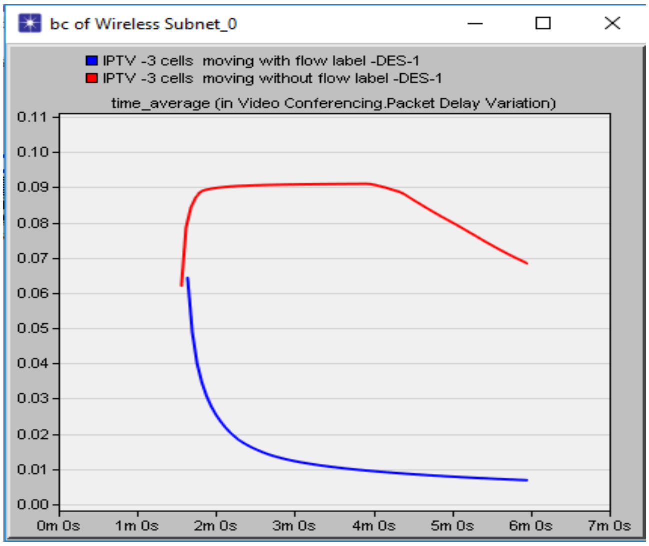

Figure. 34: BC user Jitter (sec)

VII. Conclusion & Perspectives

In the recent years, many researchers try to improve the QoS of IPTV services that consider real-time traffic mainly traffic losses and latency. None of them consider the problem of classification of IPTV sub traffic and the differentiation between the BC, VoD, and PVR packets. To fix this problem, we propose a new addressing algorithm that classifies between the packets by using IPv6 Flow Label field. This algorithm provides a reliable solution to increase QoS of IPTV sub traffic by increasing the priority of BC traffic over VoD

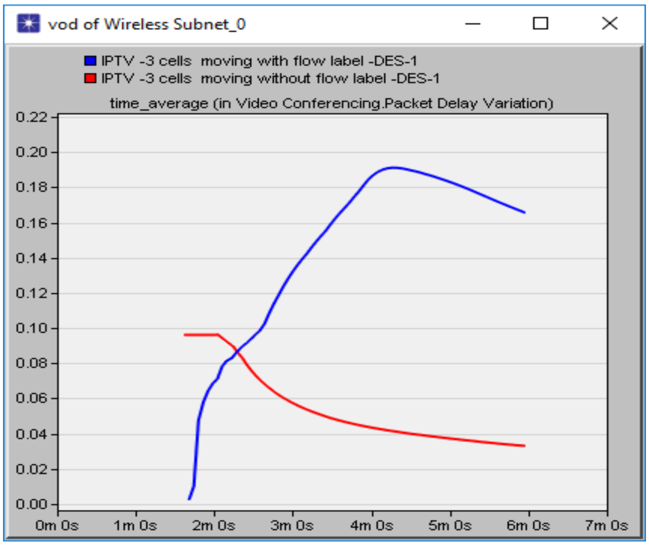

Figure. 35: VoD user Jitter (sec)

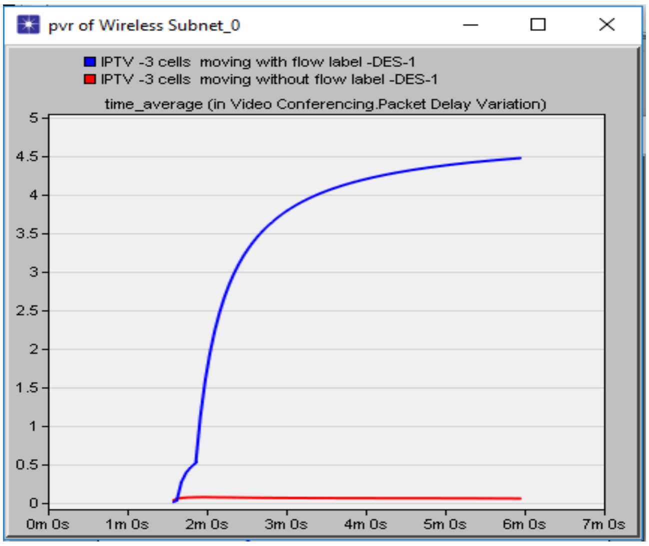

Figure. 36: PVR user Jitter (sec)

and PVR traffics. We also improve the quality of IPTV services by applying that technique to a 4G cellular system. As LTE system provides the high bandwidth that helps in increasing the quality of sending data by rising the amount of sent data. We study the performance of this algorithm using two different scenarios as mentioned in section V. The performance results show that the amount of data received by BC user which has the highest priority is the best in case of the moving user. We are working on applying this technique to the next interworking heterogeneous network (LTE-WLAN-WiMAX). In the future, we will work on improving the security issues in IMS-Based IPTV network and solve its related issues.

References

[1] M. S. Siddiqui, R. A. Shaikh, and C. S. Hong, "Qos control in service delivery in ims," in *Advanced Communication Technology, 2009. ICACT 2009. 11th International Conference on*, vol. 1. IEEE, 2009, pp. 157–160.

[2] D. C. Zamora and H. Przybysz, "Policy and charging control architecture," 2011, uS Patent App. 12/934,217.

[3] B. Raouyane, M. Bellafkih, M. Errais, and D. Ranc, "Ws-composite for management & monitoring ims network." *International Journal of Next-Generation Computing*, vol. 2, no. 3, 2011.

[4] J. H. August E. Grant, *Meadows-Communication Technology Update and Fundamentals*. Twelfth Edition-Focal Press, 2010.

[5] A. Kumar, *Implementing Mobile TV: ATSC Mobile DTV, MediaFLO, DVB-H/SH, DMB, WiMAX, 3G Systems, and Rich Media Applications*. Focal Press, 2012.

[6] R. Li, Z. Wu, R. Huang, X. Wei, and Y. Qian, "Evaluation for iptv service based on poor-quality model," in *Wireless Personal Multimedia Communications (WPMC), 2016 19th International Symposium on*. IEEE, 2016, pp. 293–298.

[7] A. Punchihewa, A. M. De Silva, and Y. Diao, "Internet protocol television (iptv)," *Multimedia Research Group*, 2010.

[8] M. Li and H.-L. Chen, "Design of power saving mechanism for lte-a networks supporting mobile iptv services," in *Communication Problem-Solving (ICCP), 2015 IEEE International Conference on*. IEEE, 2015, pp. 58–61.

[9] M. Kren, U. Sedlar, J. Bešter, and A. Kos, "Determination of user opinion based on iptv data," in *Transparent Optical Networks (ICTON), 2016 18th International Conference on*. IEEE, 2016, pp. 1–5.

[10] M. Kwon, J. Kwon, B. Park, and H. Park, "An architecture of iptv networks based on network coding," in *Ubiquitous and Future Networks (ICUFN), 2017 Ninth International Conference on*. IEEE, 2017, pp. 462–464.

[11] O. Bataa, O. Chuluun, T. Orosoo, E. Lamjav, Y.-i. Kim, and K. Gonchigsumlaa, "A functional design of bm-sc to support mobile iptv in lte network," in *Strategic Technology (IFOST), 2012 7th International Forum on*. IEEE, 2012, pp. 1–5.

[12] Y.-C. Chen and C.-Y. Liao, "Improving quality of experience in p2p iptv," in *Network Operations and Management Symposium (APNOMS), 2016 18th Asia-Pacific*. IEEE, 2016, pp. 1–4.

[13] F. A. Elgeldawy, G. M. Salama *et al.*, "Performance of qos parameters for iptv through ngn," in *Research and Development (SCOReD), 2016 IEEE Student Conference on*. IEEE, 2016, pp. 1–6.

[14] M. Li and L.-W. Chen, "Spectrum allocation algorithms for wireless cellular networks supporting mobile iptv," *Computer Communications*, vol. 99, pp. 119–127, 2017.

[15] M. Li, "Queueing analysis of unicast iptv with adaptive modulation and coding in wireless cellular networks," *IEEE Transactions on Vehicular Technology*, 2017.

[16] H. S. Fard and A. G. Rahbar, "Physical constraint and load aware seamless handover for iptv in wireless lans," *Computers & Electrical Engineering*, vol. 56, pp. 222–242, 2016.

[17] D. Tsolkas, E. Liotou, N. Passas, and L. Merakos, "A survey on parametric qoe estimation for popular services," *Journal of Network and Computer Applications*, vol. 77, pp. 1–17, 2017.

[18] R. Huang, X. Wei, Y. Gao, C. Lv, J. Mao, and Q. Bao, "Data-driven qoe prediction for iptv service," *Computer Communications*, 2017.

[19] M. Solera, M. Toril, I. Palomo, G. Gomez, and J. Poncela, "A testbed for evaluating video streaming services in lte," *Wireless Personal Communications*, vol. 98, no. 3, pp. 2753–2773, 2018.

[20] A. Alsaffar, M. Aazam, C. S. Hong, and E.-N. Huh, "An architecture of iptv service based on pvr-micro data center and pmipv6 in cloud computing," *Multimedia Tools and Applications*, vol. 76, no. 20, pp. 21 579–21 612, 2017.

[21] R. Kumar, R. Margolies, R. Jana, Y. Liu, and S. S. Panwar, "Wilitv: Reducing live satellite tv costs using wireless relays," *IEEE Journal on Selected Areas in Communications*, vol. 36, no. 2, pp. 233–245, 2018.

[22] M. Matoui, N. Moumkine, , and A. Adib, "An ipv6 flow label based approach for iptv quality of service," in *Wireless Networks and Mobile Communications (WINCOM), 2017 International Conference on*. IEEE, 2017, pp. 186–192.

[23] M. Matoui, N. Moumkine, and A. Adib, "An ipv6 flow label based approach for mobile iptv quality of service," in *International Conference on Innovations in Bio-Inspired Computing and Applications*. Springer, 2017, pp. 69–80.

[24] 3GPP. (June,2012) 3rd generation partnership project;technical specification group services and system aspects;ip multimedia subsystem (ims);stage 2,(release 11).

[25] ETSI. (March,2011) End-to-end quality of service (qos) concept and architecture (3gpp ts 23.207 version 10.0.0 release 10).

[26] TISPAN. (November,2008) Telecommunications and internet converged services and protocols for advanced networking (tispan);ip multimedia subsystem (ims);functional architecture.

[27] 3GPP. (December,2011) 3g ts 23.107 v5.0.0: Quality of service, concept, and architecture.

[28] P. Bhattarakosol, *Intelligent Quality of Service Technologies and Network Management: Models for Enhancing Communication: Models for Enhancing Communication*. IGI Global, 2010.

[29] K. Sambath, M. Abdurahman, and V. Suryani, "High quality of service video conferencing over ims," *International Journal of Information and Education Technology*, vol. 6, no. 6, p. 470, 2016.

[30] D. S. and H. R., "Internet Protocol, Version 6 (IPv6) Specification," *Proceedings of The 3rd international conference on Mobile multimedia communication, article No .15.ICST*, December 1998.

[31] Q. Hu and B. Carpenter, "Survey of proposed use cases for the IPv6 flow labe," *draft-hu-flow-label-cases-03*, February 2011.

[32] B. Prakash, "Using the 20 bit flow label field in the ipv6 header to indicate desirable quality of service on the internet," Ph.D. dissertation, University of Colorado, 2004.

[33] A. Conta and J. Rajahalme, "A model for diffserv use of the ipv6 flow label specification," *IETF Internet Draft*, 2001.

[34] R. Jee, S. Malhotra, and M. Mahaveer, "A modified specification for use of the ipv6 flow label for providing an efficient quality of service using a hybrid approach," IPv6 Working Group Internet Draft,(2002-04). draft-banerjee-flowlabel-ipv6-qos-03.txt, Tech. Rep.

[35] S. Jiang, *Future wireless and optical networks: networking modes and cross-layer design*. Springer Science & Business Media, 2012.

[36] J. Lloret, A. Canovas, J. Tomas, and M. Atenas, "A network management algorithm and protocol for improving qoe in mobile iptv," *Computer Communications*, vol. 35, no. 15, pp. 1855–1870, 2012.

[37] J. Farmer, B. Lane, K. Bourg, and W. Wang, *FTTx Networks: Technology Implementation and Operation*. Morgan Kaufmann, 2016.

[38] D. Leghroudi, M. Belfkih, N. Moumkine, and M. Ramdani, "Differentiation intra traffic in the iptv over ims context," in *e-Technologies and Networks for Development*. Springer, 2011, pp. 329–336.

[39] E. S. Sabry, R. A. Ramadan, M. A. El-Azeem, and H. ElGouz, "Evaluating iptv network performance using opnet," in *Communication, Management and Information Technology: Proceedings of the International Conference on Communication, Management and Information Technology (Iccmit 2016)*. CRC Press, 2016, pp. 377–384.

Author Biographies

Mohamed Matoui got his engineering degree in Networks and Telecommunications from the National School of Applied Sciences of Fez,Morocco in 2010.He currently works as an engineer trainer in new informations and communication technologies institue in Mohammedia ,Morocco.He is preparing his PhD degree in the field of convergence of multiservice of heterogeneous networks.He works about IPTV QoS in IMS.

Noureddine Moumkine received the PhD degree from the Faculty Of Sciences Semlalia, Marrakech, Morocco in 2006. He is a professor at the Faculty Of Sciences and Technology Mohammedia since 2007.His research interests are in QoS in NGN and images processing.

Abdellah Adib received the Doctorat de 3rd Cycle and the Doctorat d'Etat-es-Sciences degrees in Statistical Signal Processing from the Mohammed V-Agdal University, Rabat, Morocco, in 1996 and 2004, respectively. From 1986 until 2008, he was with the Institut Scientifique, Mohammed V University, Rabat, Morocco, as an associate professor. S-ince September 2008 he has been with the Department of Informatics, Hassan II University, Mohammdia, Morocco, as professor. His teaching includes informatics, statistical and digital signal processing. His research interests are in digital communications and statistical signal processing, with emphasis on (blind) array processing.

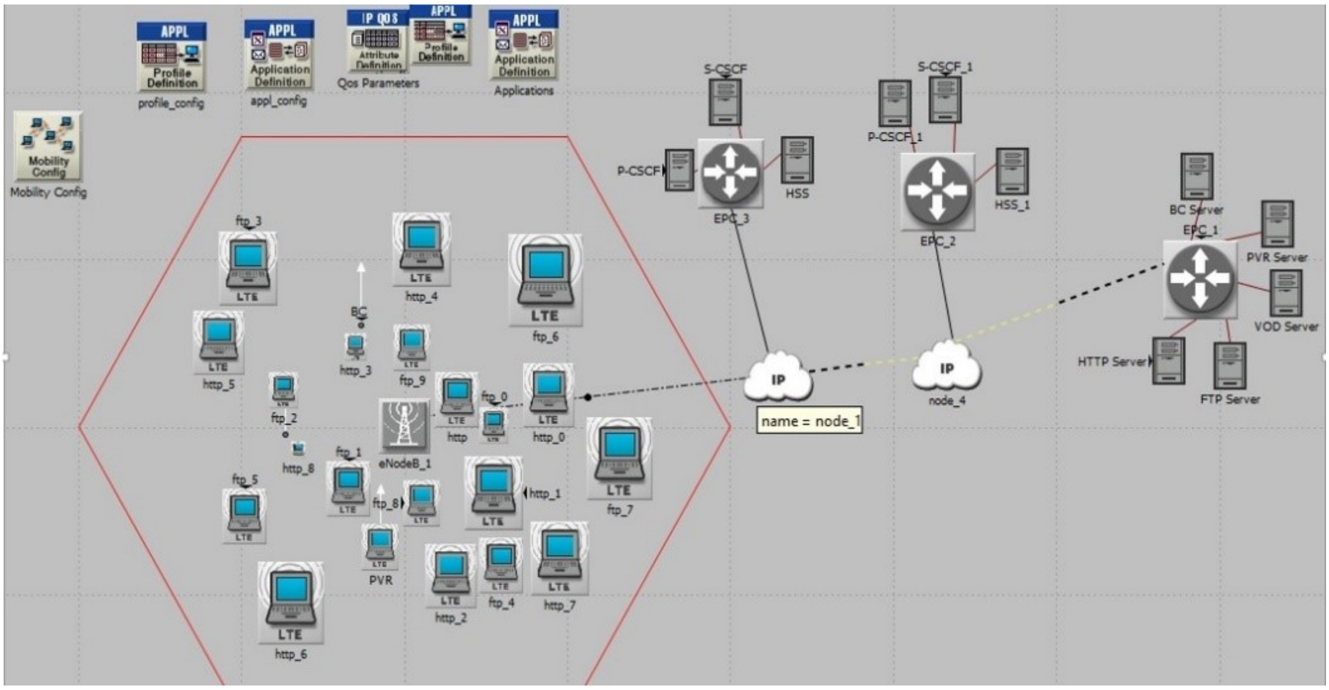

Figure. 8: Moving IPTV users in one cell

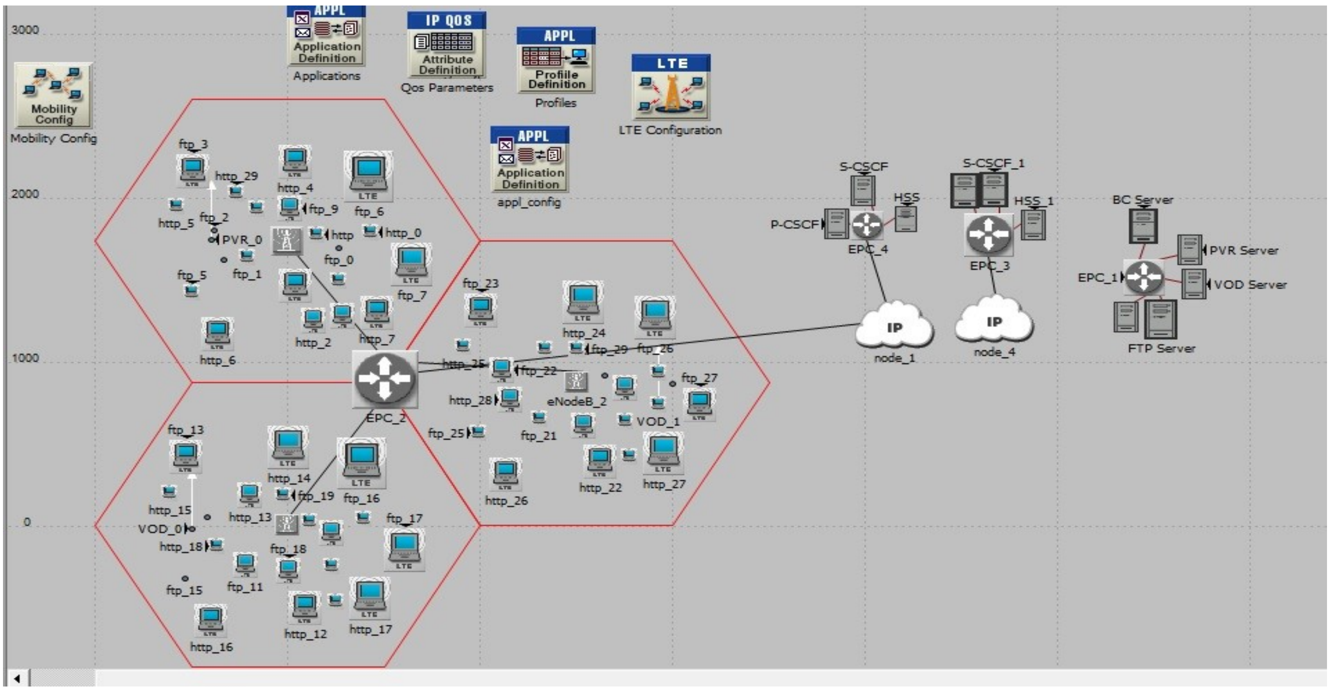

Figure. 9: Moving IPTV user in three different cells