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Analysis Quality of Service from Internet Protocol Television (IP TV) Service

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Article Info	ABSTRACT
	IPTV was convergency product between broadcasting, telecommunication and information technology because it gave multimedia service such as TV broadcasting, video, audio, text, and data transmitted by using IP protocol. IPTV service had a better quality than conventional TV, such as voice over internet protocol (VoIP), data (internet), and video on demand (VoD). This research aimed to analyze QoS (delay, jitter, MOS and throughput) from IPTV service such as VoIP, internet (HTTP, FTP), and IPTV in the simulation. The QoS resulted from simulation would be compared with standard ITU-T. The result showed bandwidth requirement for downlink and uplink from the services for VoIP 50 kbps, internet 54 kbps, and the IPTV service 6.5 Mbps. The QoS result showed that used bandwidth less than 15 Mbps, resulted jitter and delay that could not be tolerated or QoS was more than 250 ms and MOS less than 2. The QoS resulted from queue method had been applied on the node DSLAM with bandwidth 8 Mbps, it only could decrease the value of delay and jitter as 50% - 65% at VoIP and internet services. PQ method became one of the queue methods that can be optimalizing of QoS eventhough. It only decreased the jitter 10%.

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1. INTRODUCTION

For the last decade, Television (TV) has become one of the biggest powerful media of information in the world. The progress of TV technology and internet has been evolved into Internet Protocol Television (IPTV). Conventional TV using radio signal for broadcast and radio signal has disadvantages such as weak signal, easy error, and unabality to measure certainly [1]. Therefore, the usage of radio signal begins to be abandoned and to change to IPTV which is a product of the convergence of broadcasting, telecommunications and information technology as a media of information spread. IPTV gives a better quality service than a conventional TV because IPTV uses IP transmission and digital data.

IPTV characteristicss consist of three main services namely video (IPTV, VoD), audio (VoIP) and data (internet) distributed over broadband networks. Quality of conventional TV broadcasts and Internet TV uses the best effort service, while the service end-to-end IPTV uses differentiated service that supports high definition television (HDTV) for broadcast TV.

Availability of Internet bandwidth in Indonesia is still relatively small than it in other developed countries. It makes the users concerned about the quality that will be obtained from a provider. IPTV providers must give guarantee the users about the quality of service and experience (QoS/QoE), security, interactivity, and reliability. Therefore, providers need to take measurements and testing of the quality of services adapted to the tolerance of the ITU-T which is the IPTV organization standarization [2].

2. IPTV SERVICES

IPTV is defined as multimedia services such as television, video, audio, text, graphics, data delivered over IP based on networks managed to provide the required level of quality of service and experience (QoS, QoE), security, interactivity and reliability [2].

Specification of IPTV has a high-speed internet access using the bandwidth (broadband) on digital video. Besides, IPTV services provide video on demand (VoD), Internet services (web access) and voice over internet protocol (VoIP). The use of platform based on IP address makes high performance TV and other services to be more interactive.

The mechanism of IPTV service which is the data (e.g IPTV Broadcast preceded by content provider) transmitted by the provider uses IP-based- packet that have been encoded before and transmitted through xDSL network infrastructure. xDSL infrastructure passes service provider providing service and content, then network provider has distributed them to end user. Then, it will be translated by the user as data, audio, and video using the STB. STB is responsible for restructure the packet from providers in the form of a video stream and decode with a variety of formats MPEG-2, H.264 and Windows Media to become data, audio, and video. IPTV providers are satellite or cable TV provider and telecommunication companies with national and international scale in various parts of the world [3].
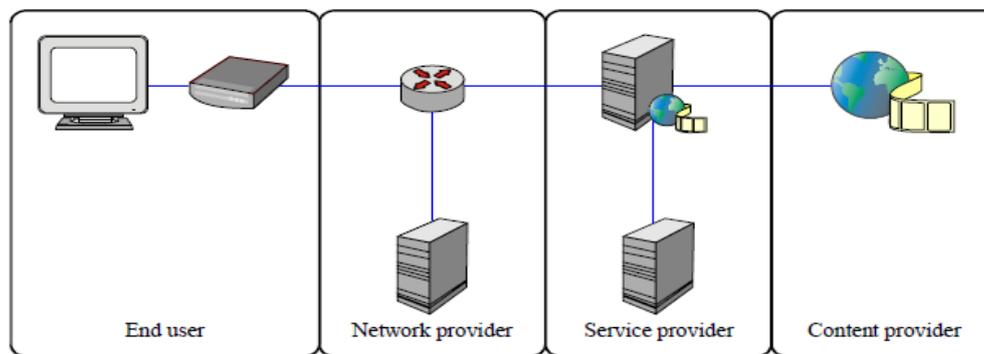

Figure 1. The concept of IPTV [4].

The constraints of the development of IPTV services are particularly *delay and jitter* beyond reasonable limits generated for VoIP and IPTV services. The existence of delay and jitter cause the quality of sound and image produced was less well received. XDSL-based IPTV networks must support end-to-end communication based differentiated service will ensure that the data or traffic passing through it enables to reach the destination with high yield [5]. If not, such the situation is certainly disturbing, because the communication provided is classified as a real-time communication that requires delay and jitter produced as small as possible [5].

One of the factors affecting the quality of multimedia communications is network factor such as bandwidth capacity. In network factor, is not only adequate bandwidth needed but also good service is necessary to give priority to packet such as IPTV, Internet and VoIP. Therefore, the management of Quality of Service (QoS) is expected as an alternative solution, so that IPTV services have maximum quality [6].

2.1 QUALITY OF SERVICE (QoS)

QoS is the ability to provide services in a network. According to the International Telecommunication Union (ITU), it is defined as the collective effect of service performance determining the level of service user satisfaction [8]. Otherwise, QoS is the ability to handle network traffic, so that the network can reach the level of services needed by the application. Multimedia services also require setting traffic bandwidth and traffic setting of the correct data packet in order that end-to-end services have high qualities. QoS has features that provide network enhancement such as supporting bandwidth management, fixing the lack of network parameters and network traffic management, controling data traffic, and setting traffic priorities across the network.

IPTV system requires a level of performance in a distributed network of digital service. It uses closed distribution system to transmit and receive the data, audio and video in the best quality protection. The performance in computer networks can be affected by several problems, such as bandwidth, delay, jitter, and latency. They can create big effects for many applications or service qualities. QoS mainly proposes to provide priority including reducing delay, and packet loss and jitter and improving throughput and MOS. Network services refer to the level of speed and reliability of various delivery types of load data in a communication system.

2.2   IPTV QoS PARAMETERS

Queuing is a technique used to improve the QoS from service in networks with dense traffic. Queuing is a function that temporarily stores the packets before they transmitted until they are received on a regular basis, so that network traffic can be managed well. If there is a packet that comes late in a queue, it will experience delay. Delay variation is called jitter because packets coming during delay. The tolerance value often used as standards for the delay, jitter and MOS as follows:

1. Delay according to ITU-T is less than 150 ms, and the maximum delay 250 ms is tolerable.
2. Jitter Thipon standards are excellent (0 ms), good (75 ms), fair (125 ms), and bad (225 ms).
3. Recommendation based ITU-T P.800 used MOS (Mean Opinion Score) scale 1 until 5 for quality of voice. The Scale points are 1 (Bad), 2 (Poor), 3(Fair), 4 (Good) and 5 (Execellent)

The use of several methods such as Deficit Weighted Round Robin (DWRR), First In First Out (FIFO), Priority Queuing (PQ), and Weighted Fair Queueing (WFQ) in IPTV networks can give significant results to improve QoS in the service provided optimally [7].

3.   RESEARCH METHOD

The research method simulation uses OPNET Modeler network simulator. The steps are :

1. System requirements IPTV aim to understand simulation globally from parameter settings such as services, applications, profiles, model systems, infrastructure and user behavior. The main requirement in this simulation has three main services or triple play services (VoIP, internet and IPTV).
2. IPTV design is developed into simulator from infrastructure, configuration, and service. IPTV services built use the three main domains namely service provider (content provider include in) as an IPTV service provider, network provider in the regional office that distributes the service to users using xDSL technology, and end-user at home as a receiver service.
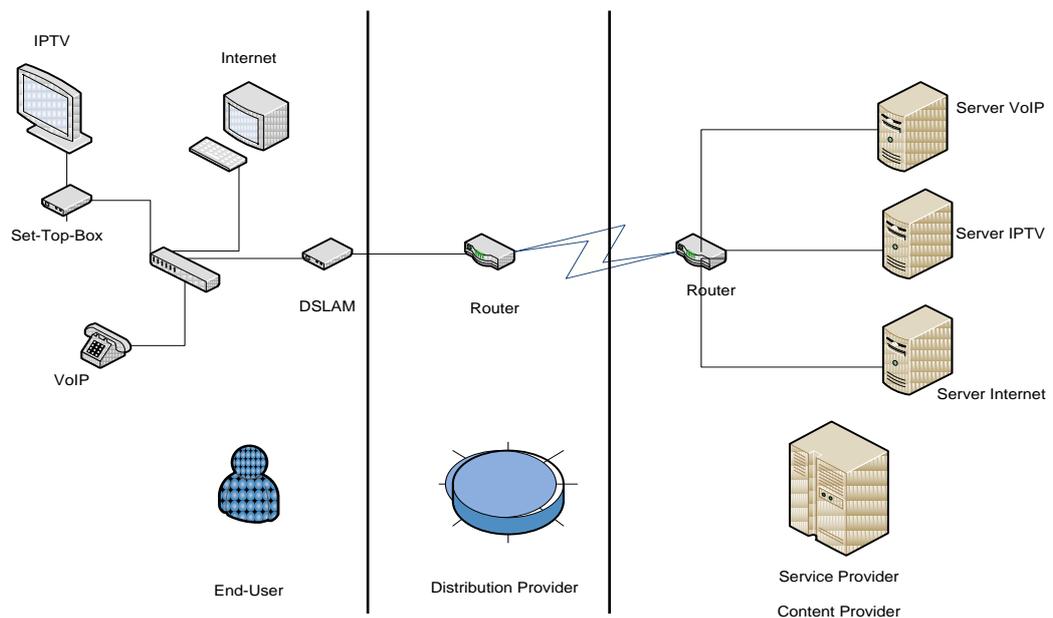

Figure 2. IPTV Network Topology in OPNET Modeler

3. Simulation consists of four scenarios, as follows:
    a) Calculating the minimum bandwidth requirement of each of the VoIP service, internet (HTTP, FTP) and IPTV to the needs of uplink and downlink on the xDSL network (between the end-user and the regional office / dis).
    b) Measuring the QoS value such as MOS, jitter, delay, throughput of the simulation and comparing these results with standard values or tolerance of the ITU-T and Thipon.

c) Testing measurement of the application using queue methods on multiple nodes such as routers, modems and DSLAM (xDSL network) that have high traffic or bottlenack in the queue of data packets to optimize the QoS in the simulation and see improvement the QoS after queue method applicaton.

d) Determining ideal queue method in the optimizing QoS by comparing the results of severall methods such as DWRR, FIFO, PQ, and WFQ.

4. RESULTS AND ANALYSIS

Based on the measurements, testing and comparison of simulations performed on the first through fourth scenario, some results are discovered as follows :

a) Following of information known that the Internet and VoIP bandwidth requirements for downlink and uplink is quite large, especially the IPTV downlink than uplink requirement. therefore, adding various additional services is to increase the uplink capacity. The data passed to the service provider (download and upload) is pretty big especially with an average of 50 kbps. The speed of each is 2 Mbps download and upload to any end-user. This speed is also shared with VoIP service which is not so great. However, a very large bandwidth requirement for IPTV services makes the network load bigger.

Tabel 1. Requirement bandwidth (downlink and uplink) / service (kbps).

Application	VoIP_DL	VoIP_UL	PC_DL	PC_UL	IPTV_DL	IPTV_UL
Bandwidth requirement (kbps)	50	50	54	54	6538	0,14

Increasing uplink capacity activates IPTV services such as email services, interactive games, e-commerce, e-transaction, e-vote, etc. The conclusion is behavior of the user (user-behavior) on the IPTV network is very dominated by interactive services. In addition, infrastructure of IPTV technology is a part of DSL broadband technology and has high data transfer. Utilization DSL infrastructure is to make the development of IPTV services to be easier and cheaper by using xDSL.

b) Testing conducted uses four categories from bandwidth packet provided by the service provider. Measurement bandwidth used is not an available internet bandwidth but bandwidth DSL from service provider. The bandwidth distribution from the network service provider has high rate. QoS measurements are done on the internet and VoIP services (in order of service that is run). Delay on low bandwidth (3 Mbps) and medium (5 Mbps, 10 Mbps) are greater than 250 ms. It means that values of tolerance can not meet. On the other hand, in high bandwidth (> 10 ms), delay and jitter are still acceptable, so it is still considered to be optimal with the ideal network conditions. It shows that the higher bandwidth, the smaller the value of delay and jitter.
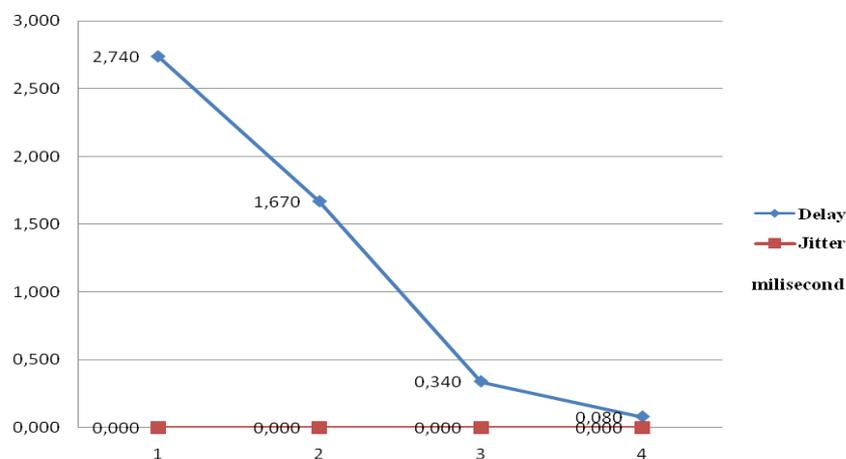

Figure 3. The Result of QoS from measurement from internet and VoIP services

Furthermore, the bandwidth of 10 Mbps and 15 Mbps generate MOS values with category 2 and 3, meaning that services can communicate each other even with low quality. Based on these results, the larger of the bandwidth (10 Mbps) offered, the greater MOS up to 150% - 250% which can be given
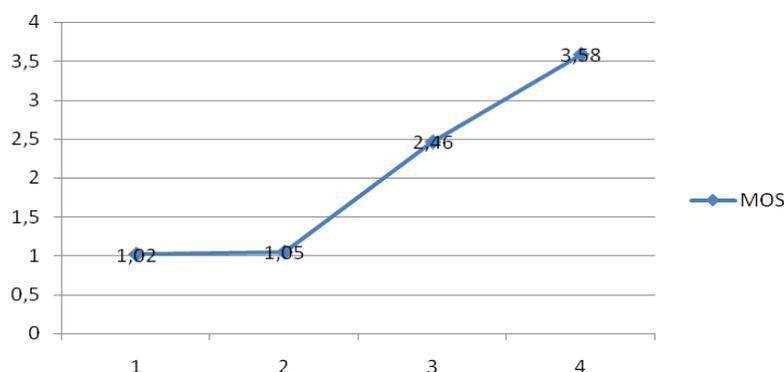

Figure 4. MOS from internet and VoIP services

It means that services can communicate with each other even with low quality. Based on these results, it is seen that the greater bandwidth ($\geq$ 10 Mbps) offered, the greater the increase of MOS up to 150% - 250%.

Table 2. The QoS measurement of internet services and VoIP

Bandwidth	Application	Delay (sec)	Jitter (sec)	Throughput (kbps)	MOS
Low 3 Mbps	internet, VoIP	2.74	0.00	10.88	1.02
Medium 5 Mbps	internet, VoIP	1.67	0.00	11.46	1.05
Medium 10 Mbps	internet, VoIP	0.34	0.00	12.53	2.46
High 15 Mbps	Internet, VoIP	0.08	0.00	12.80	3.58

QoS measurements service is resumed on the Internet, VoIP, and IPTV with four categories of the same bandwidth. At 10 Mbps bandwidth and 15 Mbps, delay and jitter values increase by 100% to 300%, higher than it in the previous test. Low and medium bandwidth (3, 5, 10 Mbps) produces delay 250 ms, while the high bandwidth produces delay about 50 ms. Jitter on the low and medium bandwidth greater than 225 ms are different from medium and high bandwidth $\geq$ 100 ms, so that it can still be tolerated. In addition, this scenario also conducts performance measurement to Internet services on HTTP and FTP protocols. The average of response time object and response time page with three services in the HTTP protocol using bandwidth $\leq$ 5 Mbps needs longer time. Meanwhile, the response time page generated on the bandwidth $\geq$ 10 is 50% faster. It can be concluded that the greater the bandwidth with not too busy traffic oe with few services that run, the faster response time to object and page on the website page.

Performance measurement for the FTP protocol by the Internet service, VoIP, and IPTV produces response time to download an average of 10 minutes, upload an average of 6 minutes and the average throughput of 9 kbps. Response time for download and upload to use FTP protocol requires a longer time if using a bandwidth $\leq$ 5 Mbps. Bandwidth $\geq$ 10 Mbps produces the response time download and upload less than 4 s. This suggests that the greater the bandwidth, the faster response time to download and upload.
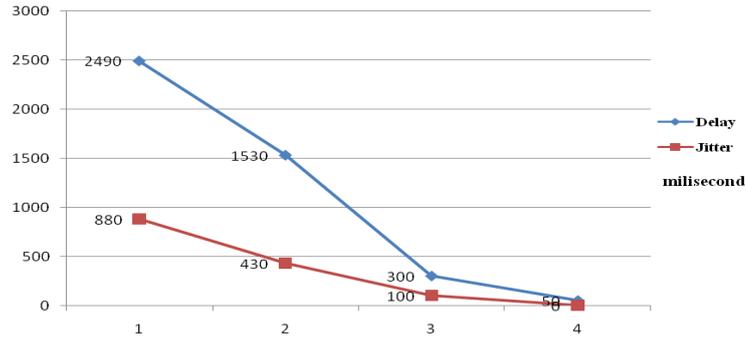
Figure 5. Result of QoS measurement from internet, VoIP and IPTV services

Table 3. The QoS measurements of internet services, VoIP, and IPTV

Bandwidth	Application	Delay (sec)	Jitter (sec)	Throughput (kbps)
Low 3 Mbps	internet, VoIP, IPTV	2.49	0.88	562
Medium 5 Mbps	internet, VoIP, IPTV	1.53	0.43	1107
Medium 10 Mbps	internet, VoIP, IPTV	0.30	0.10	4655
High 15 Mbps	internet, VoIP, IPTV	0.05	0.00	6188

The results of QoS on the node without queuing method will be compared with the results of QoS by using method queue on the VoIP service. The average of delay on the DSLAM produced is about 300 ms, so DSLAM node can reduce delay about 50%. After using the queue method, the DSLAM can reduce jitter about 10% compared to the other nodes.

Table 4. Comparison of the value of applying QoS queuing method on VoIP service

Node	Delay (Sec)	Jitter (sec)	Throughput (kbps)	MOS
Base	0.625013736	6.56604E-05	12.18839153	1.8250666
DSLAM	0.397018641	4.25828E-06	12.79472467	2.6225192
Router	0.625013736	6.56604E-05	12.18839153	1.8250666
Modem	0.626367917	6.60501E-05	12.18388552	1.8217356

MOS obtained without the queue methode is included in category 1,and the modem and the router is still in the category 1 too. It means that the communication can not be possible to do. When the DSLAM uses queue method, MOS category increases to be two or three categories or increase about 100%.

c) On the internet service, response time for the object and the page on the HTTP protocol shows significantly optimal results on the node DSLAM because it can reduce the delay and jitter about 50% compared to it that does not use the queue method on the modem and router nodes.

Table 5. Comparison of Response Time (Object and Page) from the application of methods queued at the Internet service (HTTP)

Node	Object Response Time (Sec)	Page Response Time(Sec)	Throughput (kbps)
Base	4.507278855	5.65579227	12.10
DSLAM	2.180966387	3.164359429	11.76
Router	4.507278855	5.65579227	12.10
Modem	4.477394197	5.107507051	11.16

The average of throughput generated is 11 kbps. On the other hand, it is inversely proportional to response time (download, upload), and to FTP protocol that has a substantial delay in node modem and DSLAM node compared to other nodes without queuing method and router. Delay cannot be optimized in this service. However, jitter can be reduced by 60% in router that has been applied by queuing method.

Table 6. Comparison of Response Time (Download and Upload) from the application of the method in the service queue internet (FTP)

Node	Download Response Time (sec)	Upload Response Time (sec)	Throughput (kbps)
Base	32.40523053	82.13047812	50.50
DSLAM	87.2098239	109.2320677	64.27
Router	32.40523053	82.13047812	50.50
Modem	144.1337742	57.96670201	36.74

Application of methods queued on IPTV service can not optimize QoS because the bandwidth requirements are quite large with a very dense traffic.

Table 7. Comparison of the QoS of the application of methods queued in IPTV services

Node	Delay (sec)	Jitter (sec)	Throughput (kbps)
Base	0.46123984	0.165875501	562
DSLAM	0.831234588	0.652392888	562
Router	0.46123984	0.165875501	562
Modem	0.452657499	0.164875921	562

Based on the measurement made, the application of queuing method on IPTV service cannot optimize QoS because the bandwidth requirement is quite large with a very dense traffic.

d)   The test with internet services, VoIP, and IPTV produces the average of throughput of 4655 kbps. The average delay is 5000 ms, and the average jitter generated is 500 ms. The result of the measurement and comparison in this scenario shows that PQ method could be one of the alternative methods for optimizing QoS (delay, jitter).

Table 8. Comparison of results with the method of QoS on the DSLAM queue on the internet and VoIP services

Queue Method	Application	Delay (sec)	Jitter (sec)	Throughput (kbps)	MOS
DWRR	internet, VoIP	1.3183321	0.00022103	11.904	1.45129001
FIFO	internet, VoIP	1.87457496	0.00107654	11.904	1.20921393
PQ	internet, VoIP	1.28456992	0.00021591	12.288	1.50736497
WFQ	internet, VoIP	1.31974979	0.00022077	11.904	1.44980586

On the internet services and VoIP, QoS value of delay, jitter, and MOS can be slightly optimized by 10% compared to other methods, while the value of QoS with internet service, VoIP, and IPTV using PQ method can only optimize jitter less than 54 ms compared to the other methods of 180 ms.

Table 9. Comparison of results with the method of QoS on the DSLAM queue
on the internet, VoIP and IPTV services

Queue Method	Application	Delay (sec)	Jitter (sec)	Throughput (kbps)
DWRR	internet, VoIP, IPTV	5.52610705	2.5339077	4655
FIFO	internet, VoIP, IPTV	5.56107052	0.18516953	4655
PQ	internet, VoIP, IPTV	5.61070522	0.05451439	4655
WFQ	internet, VoIP, IPTV	4.12001309	1.36750515	4655

Applying queue methods on IPTV service can not optimize QoS because the bandwidth requirements are quite large with a very busy traffic. Based on the QoS testing with internet and VoIP services using PQ method, QoS (delay, jitter, MOS) can be slightly optimized about 10%   compared to other methods, while QoS in the Internet service, VoIP, and IPTV using the PQ method can only optimize the jitter that is less than 54 ms than other methods that are less then 180 ms.

5. CONCLUSION

IPTV is a technology that provides multimedia services integratedly such as VoIP services, Internet and VoD. Increasingly users of these services make the network infrastructure increasingly burdened with declining service quality. Therefore, the Quality of Service becomes an alternative way in order that multimedia services of the provider and the end user can improve the quality of service by applying some queuing methods at the nodes which often experience bottlenecks.

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