QOS ISSUES OF INTEGRATED FIBER-WIRELESS (FIWI) ACCESS NETWORK

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Abstract
In the past few years there is a huge development in the field of FIWI technology due to continuously increase in demand of high data rate. FIWI technology now a day's proving itself a main tool in the field of telecommunication by its own merit over the existing technologies. The passive optical network which is a existing technology offers high bandwidth and stability but at relatively high cost due to the use of optical devices. On the other hand WMN technology offers us communication among the users with a better flexibility at relatively lower cost but its speed is limited due to channel interference, the efforts are made to combine the merits of both the technologies resulting in a new technology called as FIWI. Various Quality of service methods are proposed to enhance the data rate and efficient utilization of bandwidth for a FIWI access network. In this paper a detailed discussion is made on the Quality of Service (QoS) issues which include data rate, bandwidth and jitter of telecommunication system. This paper is basically a review paper in which the aim is to emphasize on the recent trends of QoS in the FIWI network.

Keywords: *OLT (Optical line terminal), ONU (Optical network Unit), EPON (Ethernet passive optical network), FIWI (Fiber to wireless).*

I. INTRODUCTION

In past years there is a huge growth in the field of broadband access technologies which enables users to access internet in a flexible manner with higher data rate. The broadband access networks basically require higher bandwidth, better flexibility and lower cost. The technologies which are used optical access networks, wireless networks and RoF (radio over fiber network). The PON gives higher bandwidth capacity and stability for accessing the internet but it fails to provide service to user in "Anytime Anywhere manner" and it also requires higher cost due to costly optical devices. On the other hand Wi-Fi allows cheaper deployment of local area networks (LANs). Also spaces where cables cannot be run, such as outdoor areas and historical buildings, can host wireless LANs. On integrating both the technologies i.e Passive optical network at front end and WLAN at back end, A FIWI network is introduced. Current and future demands for Internet access bandwidth have led to extensive deployment of FIWI technologies.

Since FIWI works on high speed (typically of the order of Gbps) any type of delay or jitter results in huge data loss and time of user. Hence Quality of service is one of the key issues in the FIWI network, because it defines several parameters like data rate, bandwidth, delay and jitter. However each network operates independently, it is difficult to connect them [1]. For controlling the QoS in WLAN's hybrid coordination function (HCF)-controlled channel access (HCCA) is used [2], whereas in PON dynamic bandwidth scheme is used[3].In WLAN's , a simple priority based QoS and admission control called PHCCA has been proposed by using queue management mechanism.The mechanism for borrowing and returning bandwidth among queues has been studied. The higher priority queue called class has permission to borrow bandwidth from lower priority queues with the awareness of starvation protection for each priority queue.

The rest of the paper is arranged as follows: Section 2 presents the background of the FIWI access networks. In section 3, related literature works on the QoS of a FIWI networks are discussed. Section 4 focus on the conclusion.

II. BACKGROUND

1) Passive Optical Network

The optical access is gaining more interest as the demand for higher and higher bandwidth is getting stronger. The optical access offers significantly higher bit rates and longer transport distances. The high cost

has been theforemost factor that has been slowing down penetration of the optical access. The passive optical network (PON) is a network, which carries data in the optical domain between the OLT and the ONU or ONT and the transport path of the optical signal is passive. This implies that the optical network devices are non powered, i.e. no electrical devices are used.

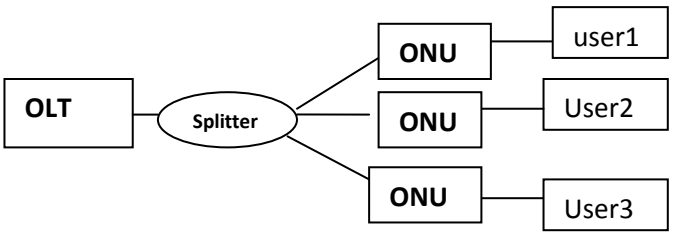

Fig 1: Passive optical network

PON network provides larger bandwidth capacity and better stability but at higher cost due to the use of costly optical devices at the input and output end.

2.2 *Wireless access network*

Wireless access network is widely used due to its low cost, ease of development and workable access. There are several technologies which are present in technical world supporting wireless networks are

2.2.1 WPAN

A wireless personal area network (WPAN) is a personal area network for interconnecting devices centered on an individual person's workspace in which the connections are wireless. Wireless PAN is based on the standard IEEE 802.15.There are various types of WPAN devices which are approved by IEEE standard are shown below:

- IrDA
- Wireless USB
- Bluetooth
- Z-Wave
- ZigBee
- Body Area Network

2.2.2 WLAN

A wireless local area network (WLAN) links two or more devices over a short distance using a wireless distribution method, usually providing a connection through an access point for Internet access. One of the most renowned wireless network is 802.11 called as WIFI.

Several WIFI standards are shown below:

Standard	Speed	Freq band
802.11a	54 Mbps	5GHz
802.11b	11 Mbps	2.4GHz
802.11g	54 Mbps	2.4 GHz

Various more standards are there for Internationalization (802.11d), Improving service quality (802.11e), Roaming (802.11f) etc.

2.2.3 WiMax

WiMax (Worldwide interoperability for microwave access) is a IEEE approved WMAN network given by 802.16 standard. WiMax provides higher speeds, over greater distances and for a great number of users.WiMax could potentially able to provide services in a better way then cables and phones.WiMax is able to provide two forms of services LOS and NLOS.
Various WiMax standards are shown below:

Standard	Description
802.16	Fixed broadband wireless Access(10-66 GHz)
802.16e	Mobile broadband wireless access
802.16f	Management information Base.
And many more upto	
802.16m	Advanced air interface with data rates of 100 Mbps mobile and 1 Gbps fixed.

2.3 Cell phone technology

A cellular network is a widely used in mobile communications each served by at least one fixed-location transceiver, known as a cell site or base station. In a cellular network, each cell uses a different set of frequencies from neighboring cells, to avoid interference and provide guaranteed bandwidth within each cell.

Cellular networks offer a number of desirable features:

- More capacity than a single large transmitter, since the same frequency can be used for multiple links as long as they are in different cells.
- Mobile devices use less power than with a single transmitter or satellite since the cell towers are closer.
- Larger coverage area than a single terrestrial transmitter, since additional cell towers can be

added indefinitely and are not limited by the horizon.

2.4 Fiber-Wireless Access Network:

FiWi technology [1] was proposed after combining the merits of optical and wireless access network i.e. Large Bandwidth-distance product, immunity to noise and intereference, very low cost per unit bandwidth.

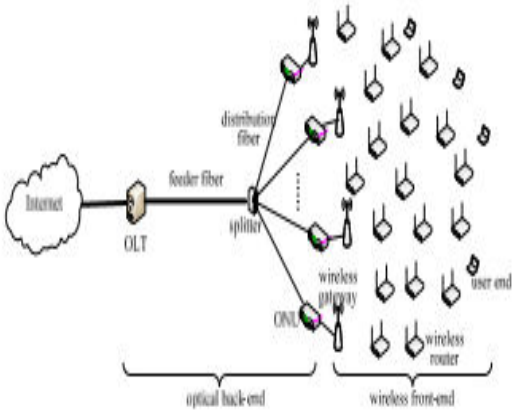

Fig.3 FiWi architecture [4]

The architecture proposed for a FiWi network as shown in fig.3 above. The architecture was classified as front end and back end. The whole network was divided into various segments, each consisting of pairs of ONU's and wireless routers connected to the users locating in different geographical areas [5]. The ONU is a key device in the network because it act as a interpreter between front end and back end. Its function is to convert optical signals into wireless signals and vice-versa. A wireless gateway is connected with each ONU through a wire, which helps to scatter wireless signals in the channel. The users which are located in different areas can access internet through different pairs of wireless routers and ONU's. Now If someone wants to access the internet, initially he has to send his data to its corresponding wireless router, and then further router transmits it to its primary ONU following a multi hop wireless path via wireless gateway. After reaching to one of the ONU's the data was then forwarded to OLT through the fiber cable and then this data is injected into the internet back bone. Then internet gives service to the user in the reverse fashion as stay ahead [5].

3 QUALITY OF SERVICE(QoS)

QoS gives us the performance of offered services whether they are good or not. Most important parameters which measures QoS are throughput which is a total workdone in a specified time interval. Other are delay, jitter, Reliability etc. Quality of service for WLAN is given by EDCA and HCCA. EDCA is enhanced distributed channel access which is having a traffic priority. It works on the principle of FIFO, having a FIFO stack for each traffic priority. High priority will wait less time than the low priority traffic and each have different backoff value. The other is HCCA which s Hybrid controlled channel access having advanced traffic priority and works in contention free period. Passive optical network performs dynamic bandwidth assignment(DBA) for best utilization of available bandwidth so as to improve the quality of service.

4 LITERATURE REVIEW

Reliable network performance has long been an important factor for many network applications. However, with an increasing amount of audio and video being sent over public, packet-switched networks, the ability to provide quality of service (QoS) guarantees may be more important in today's networks than it ever was. The primary goal of QoS is to provide priority including dedicated bandwidth, controlled jitter and latency (required by some real time interactive traffic) and improved loss characteristics. It is also important that providing priority for one or more flows does not make other flows fail. As such, a good deal of effort has been applied to the task of finding ways to provide reliable network performance while at the same time utilizing the total network resources in an efficient manner[6].

As FIWI is a integrated network of PON and WLAN network, it is difficult to match the quality of service of FIWI network. Therefore various methods are proposed for getting better quality of service which are discussed below.

The author [7] evaluated an EPON DBA algorithm which can be separated into inter and intra-ONU scheduling. In this paper by proposing a new active intra-ONU scheduling the author reduces the waste of allocated bandwidth due to the unused slot remainder (USR) problem. For achieving fairness with low complexity author [7] proposed a new intra scheduling algorithm called as DWRR (Deficient weighted round robin) which supports weighted fair bandwidth distribution for class of service (CoS) queues of variable length packets. For providing Guaranteed bandwidth to all types of traffic author [8] explained an algorithm M-DWRR (Modified Deficient Weighted round robin). In this algorithm

guarantees for every class of traffic the "agreed upon" bandwidth and quality of service by enforcing the weight policy. However if the traffic of one priority queue is light, then allocated resources can be utilized by other traffic classes.

For making QoS of the WLAN better the author [2] specified HCCA (HCF Controlled channel access) in which STA (who demands priority of data) request transmission opportunity to AP by sending QoS parameters. The AP calculates transmission opportunity (TXOP) which is the period in which STA can transmit the data based on the QoS requirements. The STA starts to transmit the data when it receives a frame giving permission from the AP to start transmission. However in HCCA, the number of STAs which an AP may support is restricted to provide a better QoS.

QoS. Internet facility including broadband and mobile provided by wireless LANs have been modified to be used with VoIP and P2P services for internet web browsing. But WLANs have some performance limitations such as same TCP and UDP flows, as it will not be able to support other traffic conditions like homogeneous and heterogeneous. To remove all these limitations a new QoS guarantees technology called EDCA have been proposed and discussed in [10]. According to him EDCA is a rate control scheme which provide guaranteed QoS at flow level inWLANs. The QoS in passive optical network is controlled by Dynamic bandwidth allocation which is explained in [3]. DBA is executed by the OLT for allocating bandwidth to the ONU according to the amount of traffic present. There are basically two types of DBA methods, SR-DBA (Status reporting DBA) and TM-DBA (Traffic management DBA).In SR-DBA ,OLT assigns the bandwidth on the basis of ONU's report frame(ONU records the amount of traffic in a frame). However ONU has to wait till the bandwidth is allocated by OLT, So in SR-DBA transmission latency is there and traffic arrival is low. Whereas in TM-DBA OLT assigns a small amount of additional bandwidth to the ONU. In case ONU has no traffic to transmit, it sends idle frames during the excess allocation of bandwidth. Accordingly the number of idle frames notifies OLT about the need of bandwidth or not. But in this excess bandwidth allocation increases transmission latency of the data from other ONUs. In summary, bandwidth utilization and responsiveness of these two schemes are different they both suffer from transmission latency.

FIWI network aim to integrate passive optical networks. The advantage of such types of network is their wide coverage and high speed communication capability. The proposed method [1] leads to a transmission delay of 1.5 milliseconds (ms), which is even lower than the transmission delays experienced by the other methods for the minimum number of ONU's (3).

5 CONCLUSION

In this paper, a detailed discussion is made on different broadband access technologies along with FIWI technology. Since FIWI technology provides huge amount of speed at relatively large amount of data, quality of service is a main issue to make a network more feasible. As QoS is a main issue in FIWI network, a detailed discussion was made in this paper on various algorithms available. It was analyzed from the literature survey that the QoS for passive optical network and WLAN are different. The efforts are made to combine both the technologies and get better quality of service which includes data rate, bandwidth, latency and jitter of telecommunication systems.

Table 1: Comparison of various wireless techniques for QoS issues in FIWI network

Wireless Techniques	Characteristics	Advantage	Limitations	References
EDCA (Evolution of Distributed coordination function)	Traffic Priority	Works in contention period	Inefficient to reduce contention on the medium	[9],[12]
PHCCA(Priority based HCF channel controlled access) in WLAN	Advanced traffic priority	Works in both the periods contention and contention free period	High Complexity	[11]
EPON DBA algorithm which can be separated into inter and intra-ONU scheduling.	Reduces the waste of allocated bandwidth	the unused slot remainder (USR) problem has been solved	Used only in intra-ONU scheduling	[7]
DWRR (Deficient weighted round robin) intra-ONU scheduling algorithm	Variable length packets	Based on weighted fair bandwidth distribution	Not Applicable for any other type of traffics and Bandwidth utilization is limited	[8]
M-DWRR (Modified Deficient Weighted round robin)	Applicable for all types of traffics	Guaranteed bandwidth to all types of traffics	M-DWRR is having complex circuitry	[10]
SR-DBA method in EPON	OLT assigns the bandwidth on the basis of ONU's report frame	Distribution of bandwidth is efficiently used	latency is more and traffic arrival is low.	[3]
TM-DBA	OLT assigns a small amount of additional bandwidth to the ONU.	All the ONU's able to transmit data without delay	Excess bandwidth allocation and hence latency is more from other ONU's	[3]
FIWI QoS	EPON DBA+WLAN HCCA	Wide coverage and high speed communication capability.	delay which increases as the number of ONUs increases	[1]

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