iJRASET
International Journal For Research in
Applied Science and Engineering Technology


# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 2 **Issue:** X **Month of publication:** October 2014

**DOI:**

International Journal for Research in Applied Science & Engineering Technology(IJRASET)

# Fixed-Mobile Integration: A Next Generation Networking

Abhishek Gaur[1], Antima Jain[2]

[1]GB Pant Govt. Engg. College, New Delhi, Electronics & Comm. Engg. Deptt.
[2] GB Pant Govt. Engg. College, New Delhi,, Computer Science Engg. Deptt.

***Abstract: EPON and WiMAX are two promising broadband access technologies for new-generation wired and wireless access. Their complementary features motivate interest in using EPON as a backhaul to connect multiple dispersed WiMAX base stations. In this article we propose four broadband access architectures to integrate EPON and WiMAX technologies. The integrated architectures can take advantage of the bandwidth benefit of fiber communications, and the mobile and non-line-of-sight features of wireless communications. Based on these integrated architectures, we elaborate on related control and operation issues to address the benefits gained by this integration. Integration of EPON and WiMAX enables fixed mobile convergence, and is expected to significantly reduce overall design and operational costs for new-generation broadband access networks.***

## I. INTRODUCTION

With the emergence of bandwidth-intensive applications such as IPTV and VoD, broadband access is becoming increasingly important. New-generation fiber-based access techniques have been standardized and are gradually permeating from fiber to the curb (FTTC), to the building (FTTB), and to the home (FTTH). Ethernet passive optical network (EPON) is a promising fiber-based access technique [1–3] expected to offer a cheap solution to broadband access due to the ubiquitous deployment of Ethernet-based network equipment. On the other hand, wireless access techniques are also continuously expanding their transmission bandwidth, coverage, and quality of service (QoS) support. With the huge market success of wireless LAN (WLAN, IEEE802.11) systems, the new-generation wireless technique WiMAX (IEEE 802.16) has now been standardized and deployed [4–6].Fiber-based techniques offer super-high bandwidth. However, it is still quite costly to deploy a fiber directly to each home. In contrast, wireless has low deployment costs. Another important advantage of wireless techniques is support of mobility. Nonetheless, wireless techniques generally suffer from a limited wireless spectrum, which is shared by many users, there by severely limiting the bandwidth allocated to each user. Moreover, a wireless system usually requires a broadband fiber feeder to interconnect many disperse access stations to a central office (CO). A combination of EPON and WiMAX may be an attractive solution to broad-band network access, which enables the two techniques to complement each other in many aspects. Specifically, there are several important factors that motivate such integration. First, EPON and WiMAX provide different levels of bandwidth, which shows a good match in capacity hierarchies. EPON supports a total 1Gb/s bandwidth in both downstream and upstream, which is shared by a group of (say 16)remote optical network units (ONUs). On average, each ONU accesses about 60 Mb/s bandwidth, which matches the total capacity offered by a WiMAX base station (BS) that supports~70 Mb/s over a 20 MHz channel. Second, integration enables integrated bandwidth allocation and packet scheduling that helps to better support service QoS and improve network throughput. Third, the integration can support broadband network access and mobility, and help to realize the ambition of fixed mobile convergence (FMC) [7], thereby significantly reducing network design and operational costs.

## II. INTEGRATION OF EPON & WIMAX

We consider two different architectures that can be used to support the integration of EPON and WiMAX. Because of the simplicity of downstream data communications of both EPON and WiMAX technologies, all following discussion on packet forwarding and bandwidth allocation is focused on the more complicated upstream direction.

### A. Independent Architectures

The most intuitive way to integrate EPON and WiMAX is to use independent architectures as shown in Fig. 1,in which EPON and WiMAX systems are operated independently by considering a WiMAX BS a generic user attached to an ONU (see the upper ONU in Fig. 1). As long as the two devices support a common standard interface (e.g., Ethernet), they can be interconnected. In addition, each ONU can have interfaces to home users for wired access. Thus, the system can offer integrated FMC service. With a common standardized interface (e.g., Ethernet), the direct benefit of the independent architecture is that the ONU and BS can be connected without any special requirements being met. However, because the EPON and WiMAX systems operate independently, the ONU cannot see the details of how the WiMAX BS schedules packets for its associated subscribed stations(SSs), while the BS cannot see the details of how the ONU schedules and

International Journal for Research in Applied Science & Engineering Technology(IJRASET)

sends upstream data to an EPON optical line terminal (OLT). Thus, the architecture may not take full advantage of the integration, particularly in optimal bandwidth allocation of the whole system. Moreover, two independent devices, an ONU and a WiMAX BS, are required at the boundary of the two systems, which is likely to be more costly than using an integrated box as discussed later.

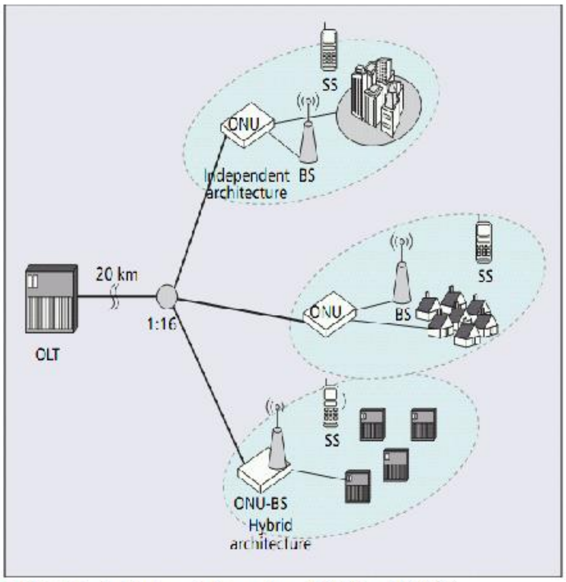


**Figure 1.** *Architectures for integration of EPON and WiMAX.*

B. Hybrid Architecture

A hybrid architecture is an enhanced integration, in which an ONU and a WiMAX BS are integrated in a single system box ( ONU-BS), illustrated in the lower ONU in Fig. 1. Such an arrangement enables full integration of these two devices in both hardware and software. Figure 2 illustrates key functional modules inside the ONU-BS. In hardware, there can be three CPUs; for better integration, these three CPUs can be further integrated into a single CPU. CPU-1 is responsible for data communications within the EPON section and runs the EPON protocols. CPU-3 is responsible for data communications within the WiMAX section and runs the WiMAX protocols. Between them, a central CPU, CPU-2,coordinates the behavior of the other two CPUs.CPU-1 and CPU-3 report their section states,and bandwidth allocation and request details toCPU-2; the latter makes decisions, and then instructs the other two CPUs to request bandwidth from the upstream and allocate bandwidth to each SS in the downstream. The functional modules corresponding to the three CPUs inFig. 2a are shown in Fig. 2b, which mainly illustrates the modules for upstream data communication. Specifically, CPU-1, related to the EPON section, contains the functional components of EPON packet scheduler, priority queues, and EPON packet classifier. CPU-3, related to the WiMAX section, contains the functional components of WiMAX packet reconstructor and WiMAX upstream scheduler. Finally, CPU-2corresponds to the ONU-BS central controller in Fig. 2b.One of the major benefits of this hybrid architecture is that the cost of equipment can be reduced as only a single device box is required. Moreover, because the integrated ONU-BS possesses full information on bandwidth request, allocation, and packet scheduling of both the ONU and the WiMAX BS, optimal mechanisms can be adopted for bandwidth requests in the upstream direction of the EPON network, and bandwidth allocation and packet scheduling in the downstream direction of the WiMAX network. Thus, compared to the previous independent architecture, this hybrid architecture is expected to improve the overall system performance in terms of throughput and service QoS.

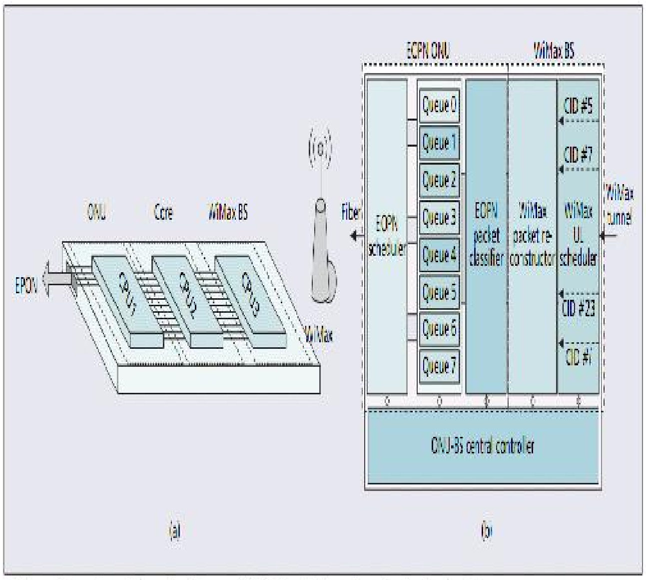


**Figure 2.** *Function modules and architecture of ONU-BS: a) hardware layout; b) functional modules.*

## III. BANDWIDTH ALLOCATION & QOS SUPPORT

For both EPON and WiMAX, it is a challenging issue to efficiently allocate upstream bandwidth to users. Both EPON and WiMAX employs a generic poll/request/grant mechanism; that is, a central station (OLT or WiMAX BS) polls a remote station (ONU or SS) on bandwidth requests, the latter responds with requests for bandwidth, and the central station then grants bandwidth. The poll/request/grant control information is usually exchanged through a dedicated control channel or by piggybacking data packets.Unsolicited bandwidth grants can also be made periodically to support delay-sensitive services or to poll each remote station to enable it to send a request.Based on a generic poll/request/grant mechanism, EPON and WiMAX share much similarity in bandwidth allocation and QoS support. First,EPON requests bandwidth on a per-priority-queue basis, but allocates bandwidth on a per-ONU basis. Upon a granted bandwidth, each ONU makes local decisions to allocate the bandwidth and schedules packet transmission for each priority queue. WiMAX requests band-width on a per-connection basis, but allocates bandwidth on a per-SS basis. Upon being granted bandwidth, each SS makes local decisions to allocate the bandwidth and schedules packet transmission for each service connection. Second, both EPON and WiMAX support two types of bandwidth allocation modes: unsolicited and upon request. They show good similarity in supporting services with different QoS levels, including delay-sensitive services, bandwidth guaranteed services, and best effort services.Third, both EPON and WiMAX classify data traffic in a differentiated services (DiffServ) mode. EPON has up to eight different priority queues in each ONU, while WiMAX classifies the data traffic into five QoS levels ranging from unsolicited grant service (UGS) to best effort(BE).The above similarity facilitates the integration of bandwidth allocation and QoS support in the integrated access architectures (not including the independent architecture). First, the integration of dynamic bandwidth allocation can be done in integrated architectures based on the generic poll/request/grant mechanism. On the EPON side, an ONU fully understands the bandwidth grant information in a WiMAX BS, which help store quest bandwidth from an OLT more efficiently. On the WiMAX side, once an ONU is granted bandwidth, the WiMAX BS fully under-stands how much bandwidth it can allocate for each type of service, and thus can make an optimal bandwidth allocation among all the service flows. Second, to enable more efficient integration, an effective mapping mechanism is required between EPON priority queues and WiMAX service connections. Specifically, the mapping needs to know which WiMAX flow should be stored in which EPON priority queue for equivalent QoS. EPON supports QoS in a DiffServ mode, under which packets are classified and stored in different priority queues. In contrast,although the services of WiMAX are classified to support different levels of QoS, WiMAX is a connection-oriented technology, which essentially follows an integrated service (IntServ) mode.Thus, for integration, an interesting problem ishow to make efficient conversions between DiffServ and IntServ services. In addition, it is also interesting to see how the end-to-end QoS can be supported after these two systems are integrated.

## IV. CONCLUSION AND FUTURE PERSPECTIVES

It is a good match in bandwidth hierarchy to use an EPON as a backhaul to connect multiple disperse WiMAX BSs. In this article we propose two architectures for the integration of EPON and WiMAX. The control and operation of these architectures has been discussed.We found that integration of EPON and WIMAX can help realize fixed mobile convergence and provide a number of attractive features. First, integration enables efficient strategies for bandwidth allocation and packet scheduling that help to achieve better capacity utilization and support of QoS.Second, integration can simplify network operation (e.g., handover operation). Third, integration enables a single passive optical network to simultaneously carry two different types of access networks, and provide both wired and wireless broadband access services. Ultimately, the integration of EPON and WiMAX is expected to save design and operational costs for new-generation broadband access networks. The current integration architectures consider only the fundamental EPON and WiMAX systems. For future even higher access bandwidth, the architectures can be extended to employ more advanced technologies, such as WDM in PON systems, and multiple input multiple output and adaptive antenna systems in WiMAX systems. Finally, although we chose EPON as a representative technique for passive access networks, the proposed integration architectures and related operation principles are also applicable to other PON techniques such as GPON.

## REFERENCES

[1] IEEE 802.3ah, “Ethernet in the First Mile,” June 2004.
[2] G. Kramer, B. Mukherjee, and G. Pesavento, “IPACT: A Dynamic Protocol for an Ethernet PON (EPON),” IEEE Commun. Mag., Feb. 2002, pp. 74–80.
[3] C. M. Assi et al., “Dynamic Bandwidth Allocation for Quality-of-Service over Ethernet PONs,” IEEE JSAC, vol.3, no. 9, Nov. 2003, pp.1467–77.
[4] IEEE 802.16e/D12, “Air Interface for Fixed and Mobile Broadband Wireless Access Systems,” Feb. 2005.
[5] G. Nair et al., “IEEE 802.16 Medium Access Control and Service Provisioning,” Intel Tech. J., vol. 8, no. 3, Aug.2004, pp. 213–28.
[6] WiMAX Forum, “Mobile WiMAX — Part I: a Technical Overview and Performance Evaluation,” Aug. 2006.
[7] M. Vrdoljak, S. I. Vrdojak, and G. Skugor, “Fixed-Mobile Convergence Strategy: Technologies and Market Opportunities,” IEEE Commun. Mag., Feb. 2007, pp. 116–21.
[8] A. Nirmalathas et al., “Wavelength Reuse in the WDM Optical Interface of a Millimetre-Wave Wireless-Wireless Antenna Base Station,” IEEE Trans. Microwave Theory,vol. 49, no. 10, Oct. 2001, pp. 2006–12.
[9] IEEE 802.1D, “Media Access Control (MAC) Bridges,”June 2004.
[10] IEEE 802.1Q, “Virtual Bridged Local Area Networks,”May 2006.

## BIOGRAPHIES

ABHISHEK GAUR (a.abhishekgaur@rediffmail.com) received his B.Tech degree in Electronics & Communication Engineering and M.Tech degree in Digital Communication from Guru Gobind Singh Indraprastha University,Delhi,India in 2010 & 2012 respectively.He is currently working as an Asst. Professor in G.B Pant Govt. Engg. College,Delhi,India in Deptt. of Electronics & Communication Engg.He is also pursuing his Doctorate Degree in the field of Electronics & Communication Engg. with specialization in Optical Communication from Galgotias University, Greater Noida,India.His research interests include Optical-Wireless converged Networks, Optical Access Networks, Consumer Electronics, Heterogeneous Networks(HETNET), Electrical Machines, Digital Design, Control Systems, Microwaves, Antennas and Wireless Backhauling.

ANTIMA JAIN (jain_antu@rediffmail.com) received his B.Tech degree in Information Technology from Rajiv Gandhi Technical University,Bhopal,India and M.Tech degree in Software Engineering from Devi Ahilya University,Indore,India in 2004 & 2008 respectively.She is currently working as an Asst. Professor in G.B Pant Govt. Engg. College,Delhi,India in Deptt. of Computer Science & Engg..She is also pursuing her doctorate degree in Information Technology from Mewar University,Rajasthan,India.Her research interests include Ad-hoc Networks, Wireless Sensor Networks, Cloud Computing, Software Testing, Software Engg and Wireless Backhauling.