A Simple Paradigm for Supporting the New Generation of Internet Based on WLAN over OBS

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Abstract

Wireless local area network (WLAN) and 3G cellular systems can provide high-speed wireless connections that can not be offered by earlier cellular technologies. WLANs are more suitable to hotspots coverage, that is, broadband wireless access with limited mobility. In future, various complementary radio access networks (RANs) will be used in combination with 4G RANs to provide full coverage services. WLAN is expected to be one of these complementary RANs used to achieve broadband wireless service. To enhance the performance of the WLAN, we introduce, for the first time, a paradigm for a system to support the new generation of the internet based on using optical burst switching (OBS) network as the backbone. This system is aimed to combine advantages of the WLANs and OBS to achieve seamless mobile internet services by narrowing the gap between the wireless and the Internet worlds. The internetworking between the WLAN and the OBS with using the two DCF mechanisms and different packet sizes is validated through simulations.

1. Introduction and motivation

Since year 2000 features of the next generation network (NGN) were recognized clearly, based mainly on commercial demands. Accordingly, ITU-T study group 13 defined the concept of the NGN in Recommendation Y.2001 [1]. The definition of NGN is totally based and overlayed on the Internet protocol (IP) networks in all aspects of the provided services and can briefly described as "seamless mobile internet service network that removes the gap between the wireless and the Internet worlds, and combine the positive aspects of the two worlds" [2].

One key point to satisfy wide demands within the NGN (subscribe accessible at any time and at anywhere) is to increase both data rate and speed. Several conscious studies have been focused on different aspects, such as: cellular, satellite, WLAN and wired networks as elements of the end-to-end communications. Most of those studies either investigated each system separately [3, 4], or joined two different wireless systems such as: UMTS/WLAN [5]. Srinivas et al. [6] has investigated WLAN over optical backbone to mange the wide bandwidth demand, they used WDM and considered ALOHA-based MAC protocol for the network backbone instead of carrier sense protocol (CSMA/CD). Recently, optical burst switching (OBS) has been rising as a promising candidate to serve as a backbone of the NG of internet [7, 8], since it has remarkable advantages [9, 10]. Up to date, however, there is no comprehensive study focusing on the WLAN over the OBS as a part of the NG internet systems. We believe that studying such system not only seizes the benefits of OBS potential advantages but also is significant in view of completing the whole picture about the end-to-end communication, since many internetworking links between access points (APs) will use wired networks and have crucial role in the overall system characteristics. Further motivation, in view of compatibility, the two sides of the system are suited to satisfy the requirements in [2]. In the both sides, WLAN and OBS, are based on using the Internet protocol (IP), while in cellular/WLAN systems, there are some difficulties to connect the non IP systems (e.g. GSM, CDMA2000, and UMTS) with WLAN [11]. Using WLAN over OBS could be more efficient in some areas when connecting WLAN to the cellular networks to extend wide coverage area in situations requiring high rate and wide bandwidth. WLANs over OBS guarantees to keep high bandwidth available in WLANs (11Mbps, 54 Mbps, and 200 Mbps in networks using IEEE 802.11b/a/n [12,13], respectively), and the wired part (optical fiber) has tremendous bandwidth (potentially a few tens of terabits per second) and OBS can process data from many WLANs in the same time, while in the hybrid networks, the system suffer from bottleneck bandwidth

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in the cellular network [14], which could harm some delay-sensitive applications. Further, the horizontal handoff: switch between base stations or access points in the homogeneous wireless system, is much faster than switch between heterogeneous networks or some times named as vertical handoff: the switch between heterogeneous networks [15], investigating this topic is beyond scope of this paper and will be done in a separate paper with more details. The contribution of this paper is as follows: in the first part of the paper, introduce the new paradigm of a system based on the most requirements in the new generation of internet. The second part of the paper presents, based on the paradigm in the first part, a validation for the system internetworking between the two parts, both use internet protocol, IP, by using NS2 [16]. Furthermore, influence type of the adopting access mechanism with using different packet lengths in the WLAN are also considered in the simulation. The rest of the paper is structured as follows: In section 2 we present a description to the system in some details through splitting it into its fundamental components: wired and wireless parts. Section 3 validates internetworking the system by using NS2 after explain protocol structure with packets flow. Finally, in Section 4 we present our concluding remarks.

2. The system description

Figure 1 shows the scheme of the system, where OBS's core network interfaces the client networks through OBS edge router (ER). Each edge router connects many access points, which represents the interface between the wireless and wired worlds. Each access point form a basic service set (BSS): based on one access point coverage an area and communicate with n mobile stations and do forwarding of packets destined to the nodes associated with it. Following is a brief description for each part in the system:

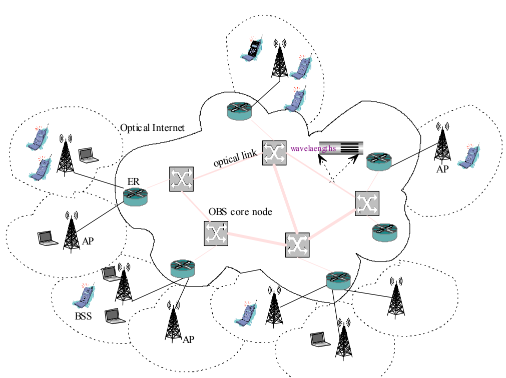


Fig.1 A schematic sketch for the WLAN over OBS system.

A- The wired part

The optical burst switched network consists of optical switching nodes that interconnect via fiber links, each optical fiber capable of supporting multiple wavelength channels using wavelength division multiplexing (WDM). The edge router pre-sorts the incoming packets, buffers them, assembles into bursts (sending), or disassembles bursts into packets (receiving) [7]. The core nodes are primarily responsible for switching the bursts data (BDP) from input ports to output ports based on the burst header packets (BHP) and for handling burst contentions [17].

The strategy used to assemble the bursts is the key to OBS network design, since the statistical characteristics of the assembled traffic affect the data loss probability [18] and the burst aggregation process contributes to the end-to-end delay. Mechanisms of aggregating incoming packets into a burst carry out via using one of the available methods: (i) Fixed Aggregation Time (FAT), (ii) Fixed Burst Size (FBS), (iii) Maximum Aggregation Time/Maximum – Minimum Burst Size (MTMMB), (iv) Limited Burst Size (LBS), and (v) Unlimited Burst Size (UBS). FAT, FBS, and MTMMB were proposed for conventional OBS network, while LBS and UBS were designed specifically for WR (wavelength routing)-OBS networks. FAT and MTMMB are selected based on the end-to-end delay requirements of the packets. On the other hand, if there is no delay constraint, the FBS scheme may be more appropriate, since having fixed-sized bursts in the network reduces the loss due to burst contentions in the network (variance in burst length is zero) [19]. Using both timeout and size threshold together provides the best of both schemes, and hence is more flexible than using only one mechanism. This MTMMB scheme can enhance minimization of both loss and delay.

B- The wireless part

The second crucial and completion part of the system is the wireless part, where the mobile terminals connect with the router-edges of the backbone via the access points/base station wirelessly. The mobile stations move within a region covered by an access point or as well-known as basic service set (BSS). Architecture and protocols mechanisms of WLAN have been extensively studied in many literatures [20]. IEEE 802.11 has been standardized as the main protocol for WLANs. IEEE 802.11 standard has defined two access modes to access the transmission medium, namely distributive co-ordination function (DCF) and point co-ordination function (PCF), between the communications nodes connected wirelessly. For several reasons [21] DCF has been rising as an attractive accessible mechanism and becomes a compulsory method. The DCF is based on using the well-known carrier sense multiple access/collision avoidance (CSMA/CA). DCF defines two mechanisms to access transmission medium: the basic access scheme and request to send/clear to send (RTS/CTS) scheme. The former is the default scheme where a station can transmit data packets when the medium is sensed idle for a period more than distributed interframe space (DIFS). Otherwise, the stations defer their transmitting until the medium is sensed idle again (see [2, 22] for more details). The RTS/CTS, and sometimes called four-ways handshaking, is used to cope with hidden stations problem and also used to reserve the channel in advance of transmitting large data packets to reduce the duration of collisions.

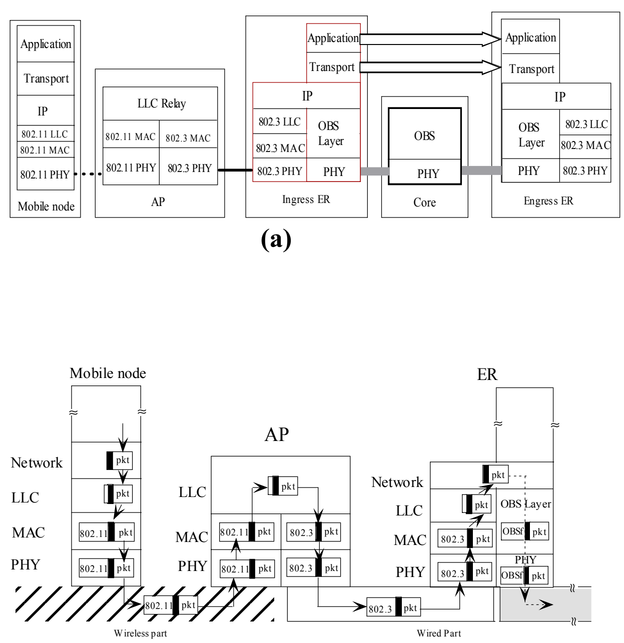
3. System interconnections and simulation results

First, we present the structure protocol for the WLAN over OBS as shown in Fig. 2-a. In this structure, the first two layers of the APs (PHY and DATA) play the required connection between the two protocols: 802.3 in the wired side (governing the connection between the ER and the access point) and 802.11 in the WLAN side. Fig. 2-b illustrates packets flow between the two sides through the AP. The simulation parameters considered in this study are: in the wired part: one OBS core node and two edge routers, ingress and egress, delay in fiber link = 1ms, number of channels per link = 9, 8 data channels and one control channel , bandwidth and delay between the host and the edge node are 1 Gbps and 1 ms, respectively. BHP = 64B, RAM size = 10MB, and processing time at each node $=1\mu s$. The mechanisms of aggregating incoming packets is MTMMB, burst time out = 10 ms and maximum burst size = 45KB. While for the wireless section settings are: DSDV routing protocol, IEEE 802.11b, 11 Mbps, RTS/CTS handshaking and basic access mechanisms are considered. All other parameters are adjusted as in the default values in wireless package of NS2 [16].

Fig. 3 shows the throughput as a function of time, simulated by using NS2, where the mobile node starts transmitting packets after 1s from beginning of the simulation time. To check validity of the system for the both available mechanisms in WLANs and the influence of adopted packet lengths, we simulate the system for both mechanisms: basic access, Fig. 3-a, and four-ways handshaking, Fig. 3-b. Both cases are simulated for three different packet lengths: 500B, 1000B, and 1500B. The results show that the throughputs are stable at the both adopting mechanisms and high throughput values can be achieved with adopting the basic access mechanism with long packet lengths. We can justify that since adopting basic access leads to fill in queue at the ER and hence the process of making a burst is faster than using four-ways handshaking mechanism. In RTS/CTS mechanism, exchanging RTS and CTS packets spends sometimes in advance of transmitting the data packets, i. e. the number of packets arrive to the ER for burstification is lower than in basic access mechanism for the same period since the adapting scheme is MTMMB.

4.Conclusions

This study presents a paradigm for a system based on using WLAN over OBS to support the new generation of internet. The analyses to the protocols and packet flow show that internetworking is enabled and works toward narrowing the gap between the wireless and wired worlds. The simulation results show that the throughput in a link between a mobile node and a fixed terminal connected through the OBS is stable for the whole system, and adopting basic access mechanism with long packets in the WLAN is guaranty to achieve high throughputs. This study provides a background towards optimizing performance of systems to support the next generation of internet.



(b)

Figure 2 (a) the structure protocol of WLAN over OBS, and (b) packet flow through the AP, (OBSf = OBS frame).

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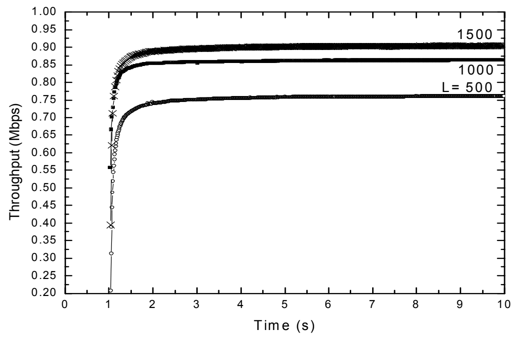
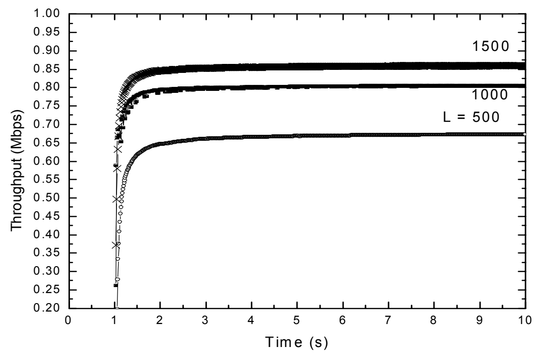


(a)



(b)

Figure 3 Throughput as a function of time for: (a) Basic access mechanism, and (b) Four-ways handshaking mechanism, simulated for packet lengths: 500B, 1000B, and 1500B.

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