Performance Measurements of Laboratory IEEE 802.11 b, g Open Point-to-Multipoint Links

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Abstract. *Performance of wireless communications is a most relevant issue, resulting in more reliable and efficient communications. Security is also important. Laboratory measurements were made on several performance aspects of Wi-Fi (IEEE 802.11 b, g) Open point-to-multipoint links. Our study contributes to the performance evaluation of this technology, using available equipments (DAP-1522 access points from D-Link and WPC600N adapters from Linksys). New detailed results are presented and discussed, namely at OSI levels 4 and 7, from TCP, UDP and FTP experiments: TCP throughput, jitter, percentage datagram loss and FTP transfer rate data. Comparisons are made to corresponding results obtained for point-to-point links. Conclusions are drawn about the comparative performance of the links.*

Keywords: WLAN, Wi-Fi, Open Point-to-multipoint and Point-to-Point Links, Wireless Network Laboratory Performance

1. Introduction

Electromagnetic waves in several frequency ranges, propagating in the air, have been decisively important for the development of wireless communications e.g. Wi-Fi and FSO (free space optics), microwave and laser based technologies, respectively.

The importance and utilization of Wi-Fi have been growing for complementing traditional wired networks. It has been used both in ad hoc mode and infrastructure mode. In this case an access point, AP, permits communications of Wi-Fi devices with a wired based LAN, through a switch/router. By this means a WLAN (wireless local area network), based on the AP, is formed. At the personal home level a WPAN (wireless personal area network) allows personal devices to communicate. Point-to-point (PTP) and point-to-multipoint (PTMP) 2.4 and 5 GHz microwave links are used, with IEEE 802.11a, 802.11b, 802.11g and 802.11n standards [1]. Nominal transfer rates up to 11 (802.11b), 54 (802.11 a, g) and 600 Mbps (802.11n) are specified. CSMA/CA is the medium access control. There are studies on wireless communications, wave propagation [2,3] practical implementations of WLANs [4], performance analysis of the effective transfer rate for 802.11b point-to-point links [5], 802.11b performance in crowded indoor environments [6].

Performance has been seen as a fundamentally important issue, giving more reliable and efficient communications. New telematic applications are specially sensitive to performances when compared to traditional applications. Requirements have been given [7].

Wi-Fi security is very important, as microwave radio signals travel through the air and can be easily captured. Besides WEP, more advanced security methods have been developed to provide authentication such as, by increasing order of security, WPA and WPA2.

Several measurements have been made for 2.4 and 5 GHz Wi-Fi open links [8,9], as well as very high speed FSO [10]. In the present work new Wi-Fi (IEEE 802.11 b,g) results arise, through OSI (Open Systems Interconnection model) levels 4 and 7. Performances are evaluated and compared for laboratory measurements of Open PTMP and PTP links, using available equipments.

The rest of the paper is structured as follows: Chapter 2 is about the experimental details i.e. the measurement setup and procedure. Results and discussion are given in Chapter 3. Conclusions are drawn in Chapter 4.

2. Subject and Method

The measurements used D-Link DAP-1522 bridge/access points [11], Linksys WPC600N wireless adapters [12] and other equipments [8]. The wireless mode was set to access point mode. Interference free communication channels were used for the links. Data were collected under far-field conditions. No power levels above 30 mW (15 dBm) were required as the wireless equipments were close.

The PTP laboratory setup is shown in Fig. 1. The PTMP setup was a generalization of this, involving two wireless links to the AP. TCP and UDP experiments at OSI level 4, were as in [9], permitting network performance results to be recorded. For a TCP connection, TCP throughput was obtained. For a UDP connection with a given bandwidth parameter, UDP throughput, jitter and percentage loss of datagrams were obtained. One PC, with IP 192.168.0.2 was the Iperf server and the other, with IP 192.168.0.6, was the Iperf client. Jitter was continuously computed by the server, as specified by RTP in RFC 1889 [13]. This scheme was also used for FTP measurements, using FTP server and client applications [8]. Batch command files were written to enable the TCP, UDP and FTP tests. The results were obtained through remote control via switch and written as data files to the client PC disk.

3. Results and Discussion

The AP and the PC wireless adapters were configured, for each standard IEEE 802.11 b, g, with typical fixed transfer rates. For every fixed transfer rate, data were obtained for comparison of the laboratory performance of the links, at OSI levels 4 and 7. At OSI level 1, SNR values and noise levels N were recorded, as shown in Fig. 1. For each standard and every nominal fixed transfer rate, an average TCP throughput was determined. This value was used as the bandwidth parameter for every corresponding UDP test, giving average jitter and average percentage datagram loss. The main results, which were reasonably steady versus time, are shown in Figs. 2-3. The statistical analysis, including calculations of confidence intervals, was performed as in [14]. In Fig. 2, polynomial fits were made to the TCP throughput data. The best average TCP throughput performance was found for 802.11g and PTP links (14.5 +- 0.4 and 6.0 +- 0.2 Mbps for PTP and PTMP, respectively). In Fig. 3, the data points for jitter and percentage datagram loss were joined by smoothed lines. The best average jitter performance was found for 802.11 g and PTP links (2.3 +- 0.1 and 3.5 +- 0.4 ms for PTP and PTMP, respectively). Concerning average percentage datagram loss data, the best performances were found, for both standards, for PTP links.

At OSI level 7 we measured FTP transfer rates versus nominal transfer rates for both standards and link types, as in [8]. The results have shown the same trends found for TCP throughput.

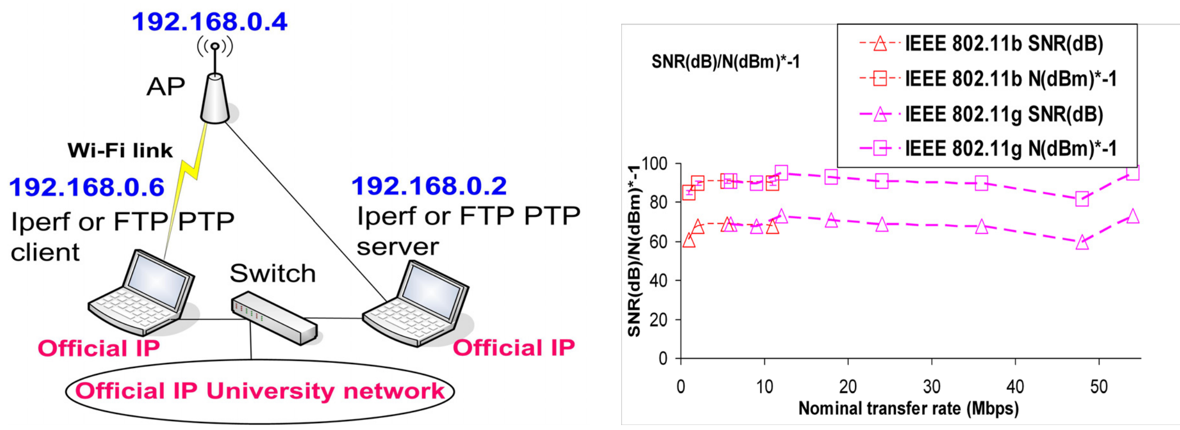

Fig. 1. Wi-Fi laboratory PTP setup scheme and typical SNR (dB) and N (dBm).

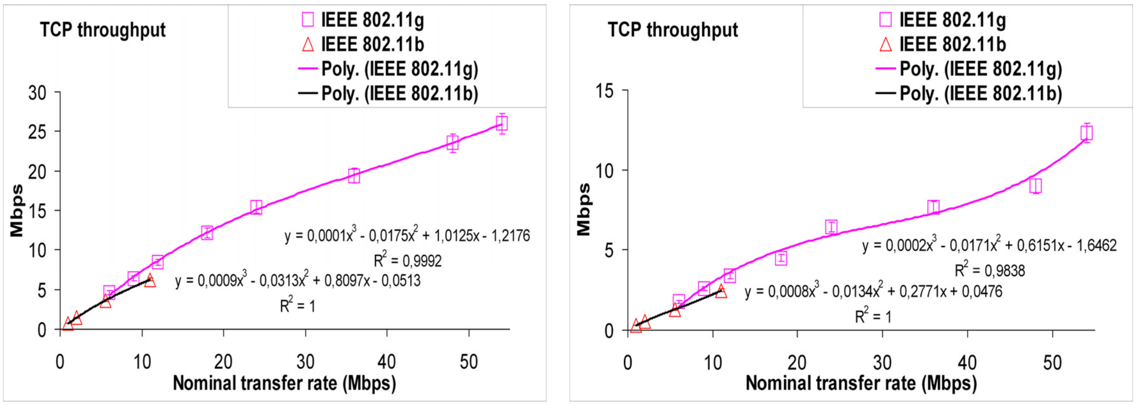

Fig. 2. PTP and PTMP TCP throughput results, versus technology (IEEE 802.11 b,g).

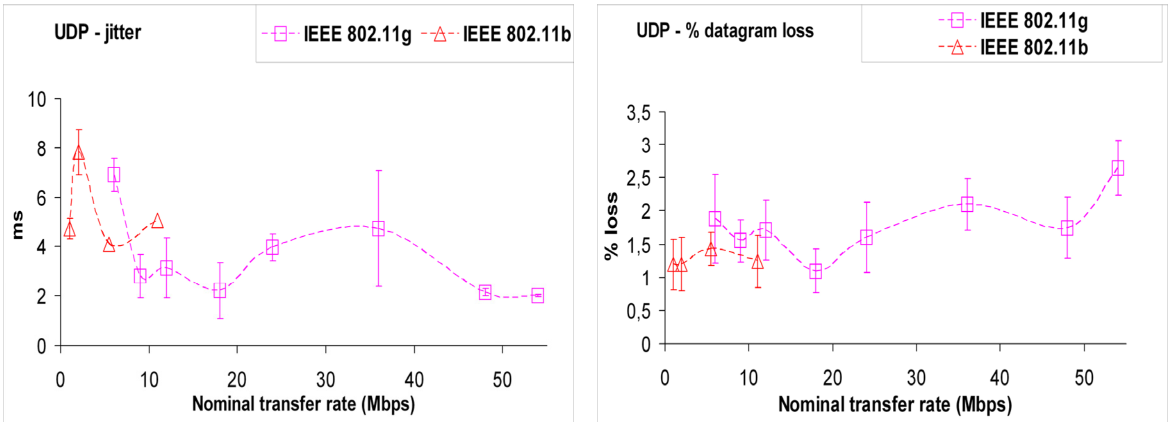

Fig. 3. PTMP UDP jitter and percentage datagram loss results, versus technology (IEEE 802.11 b,g).

4. Conclusions

A laboratory setup arrangement has been planned and implemented, that permitted systematic performance measurements of available wireless equipments (D-Link DAP-1522 access points and Linksys WPC600N adapters) for Wi-Fi (IEEE 802.11 b, g) in Open PTMP links. TCP, UDP and FTP results were obtained and compared, for each standard, to corresponding PTP data. The best average TCP throughput and jitter performances were found for 802.11g and PTP links. Concerning average percentage datagram loss data, the best performances were found, for both standards, for PTP links. In comparison to PTP links, performance degradations were found for PTMP links. This arises because here the access point has to maintain links between PCs. Future performance studies are planned using several equipments, topologies and security settings, not only in laboratory but also in outdoor environments involving, mainly, medium range links.

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