FRONT-END DESIGN OF LOW POWER RADIO ACCESS POINT FOR RADIO OVER FIBER TECHNOLOGY

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ABSTRACT

Low-cost and easily-installed RAPs grew rapidly in popularity in the early 2000s. These devices offered a way to avoid the tangled messes of category 5 cable associated with typical Ethernet networks of the day. Whereas wiring a business, home, or school often requires stringing many cables through walls and ceilings, wireless networking offers the ability to reduce - or eliminate entirely - the stringing of cables. One IEEE 802.11 RAP can typically communicate with 30 client systems located within a radius of 100 m. However, the actual range of communication can vary significantly, depending on such variables as indoor or outdoor placement, height above ground, nearby obstructions, other electronic devices that might actively interfere with the signal by broadcasting on the same frequency, type of antenna, the current weather, operating radio frequency, and the power output of devices. Network designers can extend the range of RAPs through the use of repeaters and reflectors, which can bounce or amplify radio signals that ordinarily would go un-received. In experimental conditions, wireless networking has operated over distances of several kilometers. The purpose of this study is to design and simulate a Front-end design of low power radio access point for radio over fiber technology. Many simulations were performed using Microwave Office. The mean components were Power Amplifier PA and Band-pass Filter BPF. These two components were designed and simulated on frequency of 2.4 GHz.

ABSTRAK

Kos rendah dan kaedah pemasangan yang mudah berkenaan Titik Akses Radio (RAPs) berkembang dengan pesat dan popular pada awal tahun 2000. Peranti-peranti ini menawarkan suatu cara untuk mengelakkan kekusutan terhadap kabel kategori 5 yang disambungkan kepada jaringan Ethernet yang biasa masa kini. Manakala pendawaian sebuah syarikat, rumah, atau sekolah sering memerlukan pemasangan kabel-kabel melalui dinding-dinding dan siling-siling yang tidak kemas, rangkaian wayarles berupaya mengurangkan atau menghapuskan seluruh pemasangan kabel-kabel yang berserabut itu. Satu IEEE 802.11 RAP lazimnya boleh berkomunikasi kepada 30 sistem pelanggan yang terletak di dalam radius 100m. Bagaimanapun, julat sebenar komunikasi boleh berubah sama sekali, bergantung kepada faktor pembolehubah seperti penempatan tertutup atau terbuka, ketinggian di atas tanah, halangan-halangan berdekatan, peranti-peranti elektronik lain yang berkemungkinan secara aktif menggangu isyarat yang dihantar pada frekuensi yang sama, jenis antena, cuaca, frekuensi operasi radio dan kuasa keluaran peranti tersebut. Pereka jaringan boleh memanjangkan julat RAPs melalui penggunaan pengulang dan pemantul, di mana ia boleh memantulkan atau membesarkan isyarat radio yang biasanya tidak boleh diterima. Dalam keadaan ini, rangkaian wayarles telah beroperasi sejauh beberapa kilometer. Tujuan kajian ini adalah untuk mereka bentuk dan menjalankan simulasi satu rekaan bahagian depan titik akses radio berkuasa rendah pada teknologi gentian. Banyak simulasi telah diusahakan menggunakan Microwave Office. Komponen-komponen utama adalah Penguat Tenaga (PA) dan Turas Jalur Laluan (BPF). Kedua komponen ini telah direkabentuk dan disimulasi pada frekuensi 2.4 GHz.

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BPF	Bandpass Filter
CBS	Central Base Station
DWDM	Dense Wavelength Division Multiplexing
FM	Frequency Modulation
FP	Fabry-Perot
IMDD	Intensity Modulation / Direct Detection
LAN	Local Area Network
LPF	Lowpass Filter
LD	Laser Diode
MMF	Multi-Mode Fiber
MZI	Mach Zehnder Interferometer
MZM	Mach Zehnder Modulator
OIL	Optical Injection Locking
PA	Power Amplifier
RAP	Radio Access Point
RBS	Radio Base Station
RF	Radio Frequency
RoF	Radio-over-Fiber
SMF	Single Mode Fiber
WLAN	Wireless Local Area Network

CHAPTER 1

INTRODUCTION

1.1 Introduction

For the future provision of broadband, interactive and multimedia services over wireless media, current trends in cellular networks to reduce cell size to accommodate more users and to operate in the microwave/millimeter wave (mm-wave) frequency band to avoid spectral congestion in lower frequency bands. It demands a large number of radio access points to cover service area and cost-effective RAP is a key to success in the market. This requirement has led to the development of system architecture where such as signal routing/processing, handover and frequency functions allocation are carried out at a radio base station (RBS), rather than at the radio access point (RAP). Furthermore, such a centralized configuration allows sensitive equipment to be located in safer environment and enables the cost of expensive components to be shared among several RAPs. An attractive alternative for linking a RBS with RAPs in such a radio network is via an optical fiber network, since fiber has low loss, is immune to EMI and has broad bandwidth. The transmission of radio signals over fiber, with simple optical-to-electrical conversion, followed by radiation at remote antennas, which are connected to a central RBS, has been proposed as a method of minimizing costs. The reduction in cost can be brought about in two ways. Firstly, the remote antenna RAP or radio distribution point needs to perform only simple functions and it is small in size and low in cost. Secondly, the resources provided by the RBS can be shared among many antenna RAPs. This technique of modulating the radio frequency (RF) subcarrier onto an optical carrier for distribution over a fiber network is known as "*Radio over Fiber*" (RoF) technology.

To be specific, the RoF network typically comprises a central RBS, where all switching, routing, medium access control (MAC) and frequency management functions are performed, and an optical fiber network, which interconnects a large number of functionally simple and compact antenna RAPs for wireless signal distribution. Since RoF technology was first demonstrated for cordless or mobile telephone service in 1990, a lot of research efforts have been made to investigate its limitation and develop new, high performance RoF technologies. Their target applications range from mobile cellular networks, wireless local area network (WLAN) at mm-wave bands, and broadband wireless access networks to road vehicle communication (RVC) networks for intelligent transportation system .Due to the simple RBS structure, system cost for deploying infrastructure can be dramatically reduced compared to other wireline alternatives. In addition to the advantage of potential low cost, RoF technology has the further a benefit of transferring the RF signal to and from a RBS that can allow flexible network resource management and rapid response to variations in traffic demand due to its centralized network architecture.

In summary, some of its important characteristics are described below:

i. The system control functions, such as frequency allocation, modulation and demodulation scheme, are located within the RBS, simplifying the design of the RAP. The primary functions of the RBSs are optical/RF conversion, RF amplification, and RF/optical conversion.

ii. Due to simple RAP structure, its reliability is higher and system maintenance becomes simple.

iii. In principle, optical fiber in RoF is transparent to radio interface format (modulation, radio frequency, bit rate and so on) and protocol. Thus, multiple services on a single fiber can be supported at the same time.

iv. Large distances between the RBS and the RAP are possible.

On the other hand, to meet the explosive demands of high-capacity and broadband wireless access, millimeter-wave (mm-wave) radio links (26-100 GHz) are being considered to overcome bandwidth congestion in microwave bands such as 2.4 or 5 GHz for application in broadband micro/picocellular systems, fixed wireless access, WLANs, and ITSs.

The larger RF propagation losses at these bands reduce the cell size covered by a single RBS and allow an increased frequency reuse factor to improve the spectrum utilization efficiency. Recently, considerable attention has been paid in order to merge RoF technologies with mm-wave band signal distribution. The system has a great potential to support cost-effective and high capacity wireless access. The distribution of radio signals to and from RBSs can be either mm-wave modulated optical signals (RF-over-fiber), or lower frequency subcarriers (IF-over-fiber). Signal distribution as RF-over-fiber has the advantage of a simplified RAP design but is susceptible to fiber chromatic dispersion that severely limits the transmission distance. In contrast, the effect of fiber chromatic dispersion on the distribution of intermediate-frequency (IF) signals is much less pronounced, although antenna RBSs implemented for RoF system incorporating IF-over-fiber transport require additional electronic hardware such as a mm-wave frequency local oscillator (LO) for frequency up- and downconversion. These research activities fueled by rapid developments in both photonic and mm-wave technologies suggest simple BSs based on RoF technologies will be available in the near future. However, while great efforts have been made in the physical layer, little attention has been paid to upper layer architecture. Specifically, centralized architecture of RoF networks implies the possibility that resource management issues in conventional wireless networks could be efficiently addressed. As a result, it is required to reconsider conventional resource management schemes in the context of RoF networks.

1.2 Objective

The objective of this project is to design and simulate a front-end design of low power radio access point for radio over fiber technology. It is important to study and identify all the objectives to carry out the study.

1.3 Scope of the work

In this report, the main concerned is RoF architecture and to do this will follow these steps:

i. Design and simulate the Power Amplifier
ii. Design and simulate the Band-Pass Filter
iii. Simulation using Microwave Office

1.4 Thesis outline

The remaining part of this report is divided into four chapters as detailed as follow:

Chapter 2 gives an overview of Radio over Fiber (RoF) technology. It also gives an introduction about the importance of RoF.

Chapter 3 will talk about Radio Access Point (RAP) and its main components and will focus on two parts which are the Band-pass Filter (BPF) and the Power Amplifier (PA)

Chapter 4 describes the methodology and project implementation of this report. Simulation results are presented and discussed in this chapter.

Chapter 5 contains the conclusion and will go through some ideas that will improve the project in future work.