

FORWARD LINK POWER CONTROL FOR HIGH ALTITUDE PLATFORM
STATION W-CDMA SYSTEM

MOHAMMAD A.M.SADEK

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Universiti Teknologi Malaysia

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ABSTRACT

In parallel with terrestrial and satellite wireless networks, a new alternative based on platforms located in the stratosphere has recently introduced, known as High Altitude Platforms (HAPS). HAPS are either airships or aircraft positioned between 17 and 22.5 km above the earth surface. It has capability to deliver a wide spectrum of applications to both mobile and fixed users over a broad coverage area. Wideband code division multiple access (WCDMA) has emerged as the mainstream air interface solution for 3G networks. Also the ITU has specifically authorized the use of some IMT-2000 (3G) frequency bands from HAPS. This project addresses only forward link power control for high altitude platform station for a WCDMA under the assumption of power control imperfections. Power control improves the uplink and the downlink performance both by equalizing the powers of all users in a cell and by compensating for the channel fading. However in real systems power control imperfections degrade the system capacity. In this project, the performance of two distance based forward link power control schemes (nth-power-of distance and optimum power control schemes) are evaluated for high altitude platform station (HAPS) W-CDMA systems. For a HAPS system with 19 beams, the total capacity of the system would be in the order of 1206 voice users or 144 data users. The coverage of the platform with 19 beams each with a radius of 1.2 km can be approximated by a circle with a radius of 6 km. It has been shown that HAPS UMTS gives capacity and resource management improvements

ABSTRAK

Seiringan dengan rangkaian terestrial dan satelit, satu alternatif rangkaian berdasarkan aplikasi platform terapung di lapisan stratosfera telah diperkenalkan. Ia dikenali sebagai High Altitude Platforms (HAPS). Teknologi HAPS menggunakan kapal terbang atau stesen udara yang diletakkan pada posisi 17km dan 22.5km daripada permukaan bumi. Teknologi ini berkemampuan untuk menghantar maklumat dalam julat spektrum frekuensi yang luas untuk aplikasi perhubungan pengguna-pengguna mobil atau tetap. Posisi HAPS di udara membolehkan kawasan yang agak luas mendapat liputan darinya. Wideband code division multiple access (WCDMA) telah muncul sebagai kod penggunaan yang utama untuk solusi jaringan 3G yang menggunakan perantara udara. ITU telah mengkhususkan penggunaan beberapa julat frekuensi IMT-2000 (3G) untuk penggunaan teknologi HAPS. Projek ini mengkaji penalaan jaringan kuasa arah-hadapan untuk HAPS, menggunakan WCDMA dengan anggapan penalaan kuasa adalah tidak sempurna. Perbaikan penalaan kuasa dilakukan dengan menyamakan penggunaan kuasa oleh setiap pengguna dalam satu sel dan melalui pengimbangan saluran frekuensi yang menurun. Namun, dalam kondisi sebenar, kondisi penalaan kuasa tidak sempurna merendahkan kapasiti sistem secara keseluruhan. Di dalam projek ini, prestasi dua skim penalaan jaringan kuasa arah-hadapan (skim kawalan kuasa-n-dengan jarak dan kuasa optimum) dilaksanakan ke atas sistem HAPS-WCDMA. Untuk sistem HAPS yang menggunakan 19 pancaran, kapasiti total sistem berkenaan adalah 1206 suara pengguna atau 144 data pengguna. Kawasan yang mendapat liputan stesen HAPS yang mempunyai 19 pancaran dengan jejarian setiap pancaran 1.2km boleh dianggarkan dengan yang lingkaran yang berjajari 6km. Telah dibuktikan bahawa HAPS UMTS meningkatkan kapasiti dan prestasi pengurusan sumber.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Terrestrial and satellite systems represent two well established technologies that have been dominant in the telecommunications arena for years. However, in recent years a new alternative has emerged based on quasi-stationary aerial platforms located in the stratosphere, often dubbed high altitude platforms (HAPs). The platforms are positioned at an altitude between 17 and 22 km above the Earth's surface. HAPs seem to represent a dream come true for communication engineers since they preserve most of the advantages of both terrestrial and satellite systems.

One of the appealing features of HAP networks is their easy and incremental deployment, which renders HAPs suitable not only for a host of communication applications but for services beyond telecommunications as well. Typical services that can take advantage of the flexibility of HAP systems are remote sensing and Earth monitoring, positioning and navigation, homeland security, meteorological measurements, and traffic monitoring and control. Moreover, as well as being able to provide permanent services, HAPs are also tailored for limited scope and emergency

applications. However, the focus of this project is on the role of HAPs in beyond third generation (3G) networks. For more details on HAPs the reader is referred to [1], which provides a thorough survey on communications via HAPs.

The success of second-generation (2G) mobile systems, along with the growing exigencies for both mobility and ubiquitous access, prompted the development of new-generation wireless telecommunications systems. 3G networks offer multimedia services to mobile users at transmission rates ranging from some kilobits per second to 2 Mb/s. notwithstanding, new requirements for flexible network access have emerged within the telecommunications community, spurred by the vision of optimal connectivity anywhere, anytime. HAPs are expected to fulfill this vision, providing high bit rates at low cost. The service discovery process can take advantage of some of the outstanding features of HAP systems. Multimedia broadcast and multicast services (MBMS) can be provided by the HAP component of 3G and beyond 3G networks to improve performance in terms of required system capacity and cost [2]. In addition, new applications are expected to thrive with the advent of fourth-generation (4G) networks. Although the term is still vague, it is safe to see 4G as a system that includes all existing and emerging fixed and mobile networks, including broadcast.

1.2 Problem Statement

THIRD-GENERATION wireless communication systems must be able to provide a variety of new services with different requirements in quality under different traffic conditions. These systems are mostly based on the code-division multiple-access (CDMA) technique, which effectively uses the radio spectra by means of universal frequency reuse. Therefore, interference levels limit the capacity of such systems and, consequently, power control is required to achieve good performance [2].

Moreover, if fast power control is employed (as defined, for example in the third generation mobile radio systems standard UMTS), rapid variations of the radio channel due to multipath fading can be compensated, at least in part, for users moving at a low or even moderate speed. The analysis at a system level of multicell CDMA networks under multipath fading and fast power control has been mainly carried out through simulation due to the analytical complexity [3], [4]. Analytical results for the performance of multicell CDMA networks with perfect fast power control under multipath fading have been presented recently but, to simplify the analysis, it is usually assumed that users connect to the nearest base station [5]–[7].

However, in a real system, mobiles will connect to the base station that offers the best average propagation conditions [1]. A more realistic theoretical approach for the analysis of multicell CDMA networks with best base station assignment and ideal fast power control is presented in [2] and [3]. However, when applying power control in practice the performance is restricted by a number of limitations and therefore, perfect power control cannot be achieved [5]. Thus, the main aim in these systems is to maintain power level variations at a low enough level to avoid drastic reductions in system capacity and, therefore, the effect on system performance of imperfections in power control must be considered. The issue of the effect of power control errors on CDMA systems has received a great deal of attention over the last few years [3]. Many of the previous papers analyzing the effects of power control imperfections on cellular CDMA networks do not explicitly address the effect of multipath fading, and its effect is included in the ratio of required energy per bit to interference density or in power control errors. Such simplification prevents an accurate characterization of the interference statistics, which are closely related to capacity in CDMA systems. Furthermore, intracell interference statistics are usually oversimplified in the analysis of multicell CDMA systems and render the results obtained inaccurate. In [3], the effect of power control imperfections is evaluated for a packet CDMA system. Though the interference statistics are accurately calculated by numerical analysis, only one isolated cell is considered. The impact of power control imperfections on a multicell CDMA system is examined in [2], but average intercell interference is accounted for by considering that it is a fraction of average intracell interference,

while we have shown in [1] and [3] that this simplification leads to very optimistic results.

1.3 Objective

To estimate and study the performance of forward link power control Schemes (n-th-power of distance and optimum power control schemes) are evaluated for HAPS WCDMA.

To estimate the downlink capacity for WCDMA HAPS under the power control imperfection.

1.4 Scope of work

At preliminary stage, the network architecture, end user radio link performance of HAPS was understood. In case of network architecture, the proposed deployment of HAPS structure in Malaysia by Qucom HAPS Sdn. Bhd. Is followed. For end user radio link research was performed for an UMTS terminal in the allocated 3G frequency

Capacity estimation for a WCDMA HAP station under the assumption of power control imperfections

Improvement of the downlink performance by equalizing the powers of all users in a cell and by compensating for the channel fading

Evaluation downlink capacity considering imperfect power control, letting the number of users in each cell followed uniform distributed will be conducted

1.5 Organization of the Thesis

This thesis is organized into six chapters to completely cover the whole research work that has been conducted for WCDMA HAPS platform positional instability project.

After introduction overview of HAPS structure, types, operations, functionality were presented in the second chapter. Third chapter discuss and presents the literature review. Fourth chapter describes the methodology that has been followed. Fifth Chapter presents the obtained results and detailed discussion of obtained findings. Lastly, sixth chapter presents conclusion and future works.

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