Chapter 12

Next Generation Broadband Services from High Altitude Platforms

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ABSTRACT

In this chapter the authors investigate the possibility and performance of delivering broadband services from High Altitude Platforms (HAPs). In particular, the performance and coexistence techniques of providing worldwide interoperability for microwave access (WiMAX) from HAPs and terrestrial systems in the shard frequency band are investigated. The WiMAX standard is based on orthogonal frequency-division multiplexing (OFDM) and multiple-input and multiple-output (MIMO) technologies and has been regarded as one of the most promising 4G standards to lead 4G market and deliver broadband services globally. The authors show that it is possible to provide WiMAX services from an individual HAP system. The coexistence capability with the terrestrial WiMAX system is also examined. The simulation results show that it is effective to deliver WiMAX via HAPs and share the spectrum with terrestrial systems.

1 INTRODUCTION

The forthcoming fourth generation (4G) communication systems are expected to provide a variety of services based on IP solution to deliver high quality multimedia to users through high data rate wireless channels on an "Anytime, Anywhere" basis. It is thought that the demand for the capacity increases significantly when the next generation of multimedia applications are combined with future 4G wireless communication systems (Ohmori & Yamao et al., 2000). For the design of 4G communication systems, the possibility of employing High Altitude Platforms (HAPs) has been considered as a valid alternative to the traditional terrestrial or satellite based infrastructures (Dovis & Fantini et al., 2001; Mohammed & Arnon et al., 2008).

Wireless communication services are typically provided by terrestrial and satellite systems. The successful and rapid deployment of both wireless networks has illustrated the growing demand for wireless broadband communications. These

DOI: 10.4018/978-1-61520-674-2.ch012

networks are featured with high data rates, re-configurable support, dynamic time and space coverage demand with considerable cost. Terrestrial links are widely used to provide services in areas with complex propagation conditions and in mobile applications. Satellite links are usually used to provide high speed connections where terrestrial links are not available. In parallel with these well established networks, a new alternative using HAPs has emerged recently and attracted international attention (Djuknic & Freidenfelds et al., 1997).

HAPs are airships or planes, operating in the stratosphere, at altitudes of typically 17-22 km (around 75,000 ft) (Collela & Martin et al., 2000; Grace & Thornton et al., 2005; Mohammed & Arnon et al., 2008; Hult & Mohammed et al., 2008). At this altitude (which is well above commercial aircraft height), they can support payloads to deliver a range of services: principally communications and remote sensing. A HAP can provide the best features of both terrestrial masts (which may be subject to planning restrictions and/or related environmental/health constraints) and satellite systems (which are usually highly expensive) (Mohammed & Arnon et al., 2008). This makes HAP a viable competitor/complement to conventional terrestrial infrastructures and satellite systems. Thus HAPs are regarded as a future candidates for next generation systems, either as a stand-alone system or integrated with other satellite or terrestrial systems. The integration and convergence of different technologies and services are key concepts in 4G systems. Current HAPs research and development activities include the COST 297 Action in Europe (Cost297, 2005; Mohammed & Arnon et al., 2008), along with government funded projects in Japan, Korea, and USA. Commercial projects are also underway in Switzerland, USA, China and the UK.

HAPs have been recently proposed as a novel approach for the delivery of wireless broadband services to fixed and mobile users. HAPs can act as base-stations or relay nodes, which may be effectively regarded as a very tall antenna mast or a very Low-Earth-Orbit (LEO) satellite (Karapantazis & Pavlidou, 2005). HAP systems have many useful characteristics including high receiver elevation angle, line of sight (LOS) transmission, large coverage area and mobile deployment. These characteristics make HAPs competitive when compared to conventional terrestrial and satellite systems, and furthermore they can contribute to a better overall system performance, greater capacity and cost-effective deployment (Yang & Mohammed, 2008). The major advantages for the 4G systems integrating HAPs will be the cost-effective coverage deployment, the system flexibility due to the platforms' mobility on demand (e.g., emergency situations) and the possibility of payload upgrading in order to reduce the risk of technology obsolescence experienced with traditional satellites.

Considering the above advantages and depending on the applications, HAPs may be an ideal complement or alternative solution when deploying next generation communication systems with high capacity demands. For example, supporting mobile TV as one of the 3G/4G multimedia applications based on multimedia broadcast and multicast services (MBMS) is subject to challenging issues due to high traffic load deriving from both signaling message exchange and data transmission between multicast sources and end users. When dealing with broadcast and multicast wireless services, key research issues are the effective exploitation of the limited radio spectrums, coordination of users accessing radio resources, delivering services with desired quality of service (QoS) and cost-effective delivery of services in different geographical coverage areas. The delivery of multicast services from HAPs have the following additional advantages compared to terrestrial 4G systems (Araniti & Iera et al., 2005):

- A wide coverage can be provided from the HAPs due to its unique position. A single

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