Chapter V
Radio over Fiber for Broadband Communications:
A Promising Technology for Next Generation Networks

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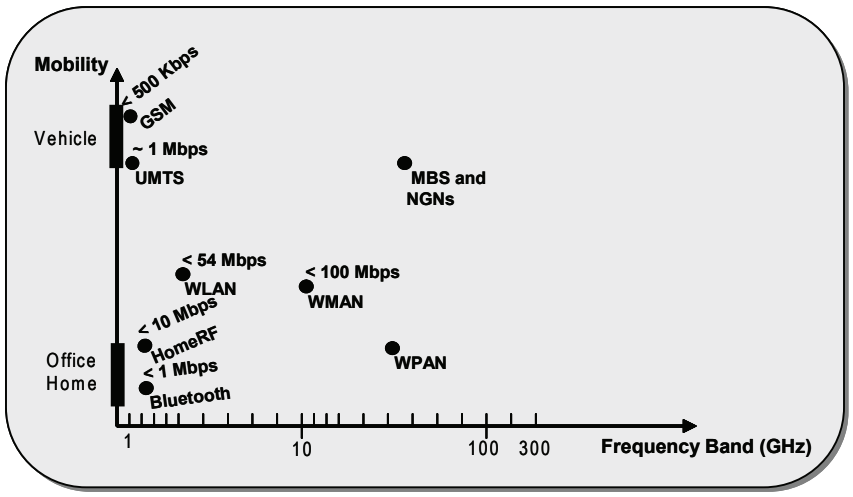
ABSTRACT

The high capacity offered by the optical fiber, combined with the mobility and the flexibility of wireless access, either fixed or not, provides an efficient approach to alleviating the requirements posed by the envisaged provision of any-service, anytime and anywhere, next generation communication networks. The objective of this chapter is to present an overview of Radio-over-Fiber technology, as an emerging infrastructure for next generation, fiber-based, wireless access broadband networking. In particular, the fundamental concept of Radio-over-Fiber technology is reviewed and the partial components comprising it are discussed. Furthermore, the associated architectures are depicted and a short literature survey of trends and applications is considered.

INTRODUCTION

Nowadays, it is well acknowledged that there has been a tremendous growth in communication technologies spanning from mobile telephony and wireless networks, to high definition television and satellite communications. Additionally, a great number of standards has been developed, setting the requirements and the specifications for this rapid expansion (ITU, 2002; IEEE, 1999; ETSI, 2001; IEEE, 2004). Despite this fact, there is an increased necessity for integration or, otherwise, collaboration of heterogeneous technologies, especially for mobile and wire-

Figure 1. The Mobile/Wireless communications landscape in terms of data rates, frequency bands and the most common applications



less communications, into a universal backbone network being capable of providing mobile, broadband, reliable and ever-present services to end users. In other words, this rapid expansion is characterized by the ever increasing requirement for faster and mobile communications with enhanced Quality of Service (QoS). Next generation networks (NGNs) should have the ability to offer mobile multimedia (video, audio and Internet) services to end users, anytime and anywhere (Kim, 2003; Agrawal, 2004; Arroyo-Fernandez, 2003; Arroyo-Fernandez, 2004).

The issues of mobility and multimedia services are strictly connected with the development of wireless broadband networks and network access technologies. An overview of the development of past, current and future wireless communication systems is depicted in Figure 1. Compared to cable networks, broadband wireless networks offer not only user mobility, but also reduced installation and maintenance cost. On the other hand, cable access is still superior in terms of high-speed data delivery. Therefore, the potential of accomplishing similar capacities in wireless networks is of great interest. However, the development of advanced wireless broadband networks, being able to efficiently handle (in terms of NGN services) radio frequency (RF) signals at the mm-wave bands, entails many inherent difficulties that cannot be solved straightforwardly through mainstream microwave technology. In this new communication scenery, Radio-over-Fiber (RoF) technology has an augmented potential to be adopted as an emerging infrastructure for broadband, high-speed mobile/wireless communications.

RoF TECHNOLOGY

The move towards high capacity wireless networks entails the exploitation of higher frequency bands than those utilized at present. In order to achieve similar capacity to cable networks, a shift to mm-wave signals is expected to be essential (2 to 60GHz and beyond). However, several critical issues have to be accounted for the effective deployment of wireless communication systems at these bands. For instance, by shifting towards higher frequencies, the propagation loss, either for uplink or downlink, becomes very high and coverage is severely limited. Additionally, current topologies of wireless systems rely on point-to-point (and point-to-multipoint) transmission of RF signals from a central/control station (CS) to several base stations (BS), where a re-transmission to end users occurs. This process has an increased cost for infrastructure equipment, since the necessary number of required BSs increases, and offers limited system granularity in view of millimetre wave bands utilization for micro-cellular and pico-cellular provision for high capacity mobile communications. Therefore, in order to