

Chapter 13

Radio-over-Fibre Networks for 4G

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ABSTRACT

Radio-over-Fibre (RoF) is an optical communication technique based on the transmission of standard wireless radio signals through optical fibre in their native format. This technique is an enabling step in the deployment of dense fourth generation (4G) cellular and pico-cellular wireless networks. The optical fibre provides a huge bandwidth that can support a variety of wireless systems, regardless of their frequency bands, being protocol-transparent which is reflected in a great network flexibility. Radio-over-fibre techniques enable a high user capacity by frequency reuse, simplify the network operation as the signals are distributed in their native format, and permit to transfer signal part of the processing power from the base station units to the central control station, thus reducing the overall deployment cost and complexity. The principles of radio-over-fibre are presented in this chapter, including the key transmission impairments and the expected performance. The main application scenarios are discussed. These include the backhaul of 4G or base-stations, addressing 4G and 3G compatibility issues, and distributed-antenna system (DAS). Finally, emerging applications like radio-over-fibre in beyond-3G scenarios and transmission of 60 GHz wireless are also described in this chapter.

INTRODUCTION

The huge number of subscribers to the latest media services with multimedia contents increased considerably the demand of broadband communication

systems. These users must be able to access multimedia contents at any time and in any place. This brings out the paradigm to achieve high-capacity services always available for the users and pushed for the development of new communication systems using both wireline and wireless technologies (Stuckmann & Zimmermann, 2007). The main

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benefits of wireless services rely on its intrinsic mobility and fast deployment. For these reasons, wireless architectures have experienced a great development in the last years. But the radio spectrum scarcity has pushed the industry and operators to look for efficient ways of transporting and distributing the radio signals to remote locations, avoiding the use of high-frequency equipment which increases considerably the cost of the operator's architecture.

Radio-over-fibre (RoF) systems, eventually called microwave-photonics systems (Seeds & Williams, 2006; Capmany & Novak, 2007), offer a cost-effective solution when a dense distribution of the wireless signal is required, like in the cellular coverage of urban areas or when antenna clusters are employed. Using RoF technology, network architectures can be implemented in different scenarios. A description of different applications is shown in Figure 1. The first application scenario consists of distributing wireless services for the operator from the central office (CO) to several base stations (BS), as shown in Figure 1(a) called RoF transport. The second application scenario described in Figure 1(b) is used to interconnect several base stations and provide 4G services to the

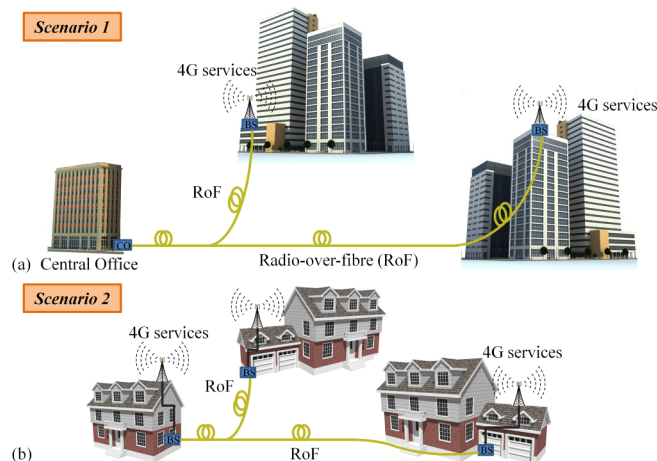
end customer, i.e. last-mile access and femtocell networks. Radio-over-fibre provides the benefits of scalability and transparency to the radio service in these applications.

BACKGROUND

Fourth generation (4G) mobile broadband networks employing technologies like WiMAX, LTE (Long Term Evolution), and IMS (IP Multimedia Subsystem) transport high data rate signals to support high quality communication services. Pervasive presence of fourth-generation (4G) wireless requires an efficient, flexible and not bandwidth-limited backhaul. RoF optical technology addresses this need, being one of key enabling technologies for deployment of 4G networks.

In the last years, the migration to IP services has been increased considerable, i.e. WiMax and LTE are all IP, CDMA is migrating, and UMTS 3G is moving to IP via ATM and Ethernet. Ethernet is still the most successful and widely deployed local area network transport technology in the world due to its flexibility and cost-effective networks. On the other hand, wireless networks

Figure 1. Application scenarios of Radio-over-Fibre (RoF) systems for 4G distribution: (a) RoF for transport and (b) RoF for BS interconnection



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