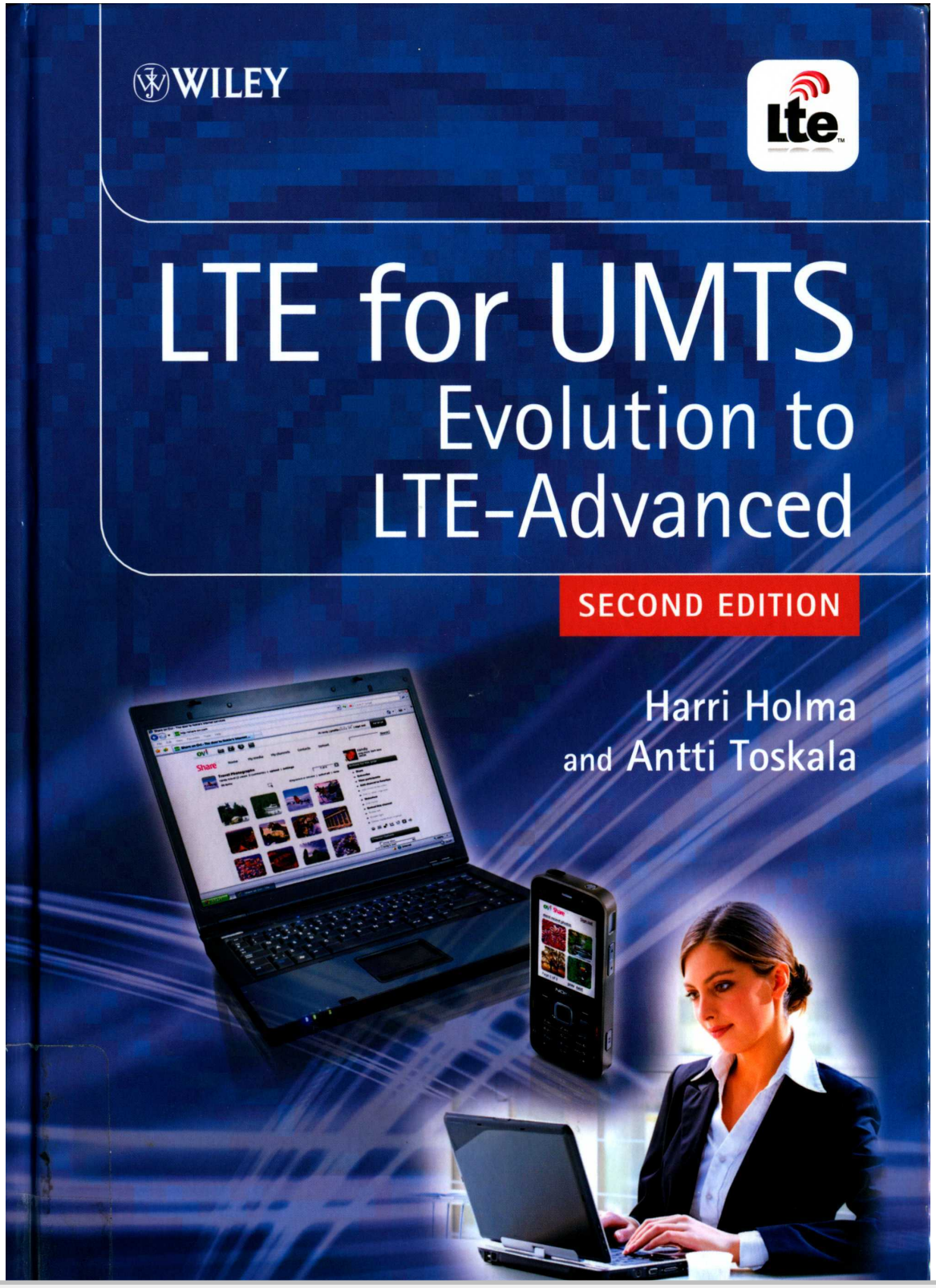

LTE for UMTS

Evolution to LTE-Advanced
Second Edition

Edited by

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5

Physical Layer

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5.1 Introduction

This chapter describes the physical layer of LTE, based on the use of OFDMA and SC-FDMA principles as covered in Chapter 4. The LTE physical layer is characterized by the design principle of not reserving dedicated resources for a single user; resource usage is based solely on dynamically allocated shared resources. This is analogous to resource usage in the internet, which is packet based without user-specific resource allocation. The physical layer of a radio access system has a key role of defining the resulting capacity and ends up being a focal point when comparing different systems in terms of expected performance. However, a competitive system requires an efficient protocol layer to ensure good performance all the way to the application layer and to the end user. The flat architecture adopted, covered in Chapter 3, also enables the dynamic nature of the radio interface as all radio resource control is located close to the radio in the base-station site. The 3GPP term for the base station used in rest of this chapter will be 'eNodeB' (similar to the WCDMA BTS term, which is 'Node B', where 'e' stands for 'evolved'). This chapter first covers the physical channel structures and then introduces the channel coding and physical layer procedures. The chapter concludes with a description of physical layer measurements and device capabilities as well as with a brief look at physical layer parameter configuration aspects. In 3GPP specifications the physical layer was covered in the 36.2 series, with the four key physical layer specifications being [1–4]. Many of the issues in this chapter apply to both FDD and TDD, but in some areas TDD receives special solutions due to the frame being divided between uplink and downlink. The resulting differences needed for a TDD implementation are covered in Chapter 15.

5.2 Transport Channels and their Mapping to the Physical Channels

By the nature of the design already discussed, the LTE contains only common transport channels; a dedicated transport channel (Dedicated Channel, DCH, as in WCDMA) does

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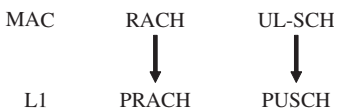
not exist. The transport channels are the 'interface' between the MAC layer and the physical layer. In each transport channel, the related physical layer processing is applied to the corresponding physical channels used to carry the transport channel in question. The physical layer is required to have the ability to provide dynamic resource assignment both in terms of data-rate variance and in terms of resource division between different users. This section presents the transport channels and their mapping to the physical channels.

- The Broadcast Channel (BCH) is a downlink broadcast channel that is used to broadcast the necessary system parameters to enable devices accessing the system. Such parameters include, for example, the cell's bandwidth, the number of transmit antenna ports, the System Frame Number and PHICH-related configuration.
- The Downlink Shared Channel (DL-SCH) carries the user data for point-to-point connections in the downlink direction. All the information (either user data or higher layer control information) intended for only one user or UE is transmitted on the DL-SCH, assuming the UE is already in the RRC_CONNECTED state. However, as in LTE, the role of BCH is mainly to inform the device of the scheduling of the system information. Control information intended for multiple devices is also carried on DL-SCH. In case data on DL-SCH are only intended for a single UE, then dynamic link adaptation and physical layer retransmissions can be used.
- The Paging Channel (PCH) is used to carry paging information for the device in the downlink direction in order to move the device from the RRC_IDLE state to the RRC_CONNECTED state.
- The Multicast Channel (MCH) is used to transfer multicast service content to the UEs in the downlink direction. 3GPP decided to provide full support in Release 9 (for shared carrier case).
- The Uplink Shared Channel (UL-SCH) carries the user data as well as device-originated control information in the uplink direction in the RRC_CONNECTED state. As with the DL-SCH, dynamic link adaptation and retransmissions are available.
- The Random Access Channel (RACH) is used in the uplink to respond to the paging message or to initiate the move from the RRC_CONNECTED state due to UE data transmission needs. There is no higher layer data or user data transmitted on RACH (as can be done with WCDMA) but it is used to enable UL-SCH transmission where, for example, actual connection set up with authentication and so forth will take place.

In the uplink direction the UL-SCH is carried by the Physical Uplink Shared Channel (PUSCH). The RACH is carried by the Physical Random Access Channel (PRACH). Additional physical channels exist but these are used only for physical layer control information transfer as covered in section 5.6 on control information. Transport channel mapping is illustrated in Figure 5.1.

In the downlink direction, the PCH is mapped to the Physical Downlink Shared Channel (PDSCH). The BCH is mapped to Physical Broadcast Channel (PBCH) but, as is shown



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