Chapter 5
Signaling Protocols of Integrated Services Digital Networks

Gusztáv Adamis
Budapest University of Technology and Economics, Hungary

ABSTRACT
This chapter is devoted to the classical ISDN signaling protocols. The main reason for which we deal with these protocols in detail is that they are – with modifications and extensions – also used in GSM and UMTS systems. In this chapter, we discuss the access (subscriber) and the core network signaling protocol stacks of ISDN: (a) The DSS1 (Digital Subscriber Signaling System No. 1): We do not deal with the physical layer, but we discuss the upper two layers: LAPD (Link Access Procedure on D channel) and DSS1 3rd layer. (b) The SS7 (Signaling System No. 7): Used in core network for signaling. We introduce the structure and the functional elements of SS7, and we go through the four levels of the protocol stack.

INTRODUCTION

In this chapter, we discuss the signaling systems which are used primarily in the ISDN: DSS1 is the signaling system used at the ISDN subscriber access points (at the user-network interfaces) while the SS7 in the ISDN core network.

At the beginning we present the DSS1. We discuss in detail the LAPD, which is used to organize the exchange of signaling information between subscriber terminals and a local exchange as well as the DSS1 3rd layer which is used for call control between the network and the terminals.

After the discussion of the ISDN access protocols we turn our attention to the core network. We introduce to the reader the SS7 which is developed by the ITU-T as the signaling system.

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of the international network, but the SS7 is used in general in the national networks as well. We show the functions of the Message Transfer Part and the ISDN User Part in detail. By the end of this chapter, the reader will be familiar with the ways in which the signals are routed in the networks and in which the network is managed, as well as with the typical signaling sequence used to establish a call in the core network.

But we have to clear some basic notions before we come to the details.

ISDN terminology uses the term “channel” to refer to the medium that carries information typically in a bidirectional way: A B (Bearer) channel carries the bidirectional voice signals of a call or bidirectional user data e.g. of an Internet connection. D (Data) channels are used mainly for bidirectional signaling purposes to control the connections of the B channels, but they can carry bidirectional low-speed user data as well. However actually a channel is a uni-directional structure. Circuits are defined as composed of two channels in opposing directions. So it is a misnomer to talk about “B channels” and “D channels”, they should really be called as “B circuits” and “D circuits”. But there is the “tradition” of talking of bidirectional channels, which is formally incorrect. Since this incorrect linguistic form does function within the telecommunications community, we will also use it later on.

In the telecommunications systems the signaling information can either be carried over the same circuits (in the same channels) as the voice or in (at least logically, but sometimes physically separated) dedicated signaling channels. In the latter case typically one signaling channel satisfies the signaling need of several voice/data channels, so this is why these systems are called common channel signaling systems (CCSS), while the others are the channel associated signaling systems (CAS). In ISDN only CCSS systems are used. In the core network the SS7 is obviously a common channel system (it is often referred to as Common Channel Signaling System 7), but – though it is not as obvious – the DSS1 at the user-network interface is also a CCSS system, since a D channel is common for several B channels. CAS systems are used e.g. in the analogue subscriber loops.

**Digital Subscriber Signaling System No.1**

The physical, logical, and procedural elements of communication on the user-network interface of the ISDN are jointly described as an access type. Two such types have been standardized: BRA (Basic Rate Access type) and PRA (Primary Rate Access type). Both operate on a number of bidirectional B channels transmitting data at the rate of 64 kbps in each direction, and a single, common bidirectional D channel. BRA operates on two B channels and a D-channel with the capacity of 16 kbps, while PRA operates on 30 (or in some countries 23) B-channels, with a D channel of 64 kbps. The representation of these channels at the level of the transmitted signal is the subject of the physical layer (L1) of DSS1, and, of course, is different for BRA and PRA accesses. This issue is, however, beyond the scope of this book (the reader is referred to (ITU-T, 1995) for BRA and (ITU-T, 1993/3) for PRA). The higher layers: L2 and L3 are applicable to both, BRA and PRA (with only minimal parameterization), and will be discussed jointly, with BRA as their application example.

**Link Access Procedure on D Channel**

The 2nd – commonly referred as data link – layer of the ISDN user-network connection is called a Link Access Procedure on D channel (LAPD) (ITU-T, 1997) and provides error free transmission of signaling messages between the exchange and the terminal(s) through the D channel of a Digital Subscriber Line (DSL). In this subsection we summarize the different signaling frame types of LAPD in details to show in a case of a