ISDN Explained

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Worldwide Network and Applications Technology

Third Edition

John M. Griffiths
Queen Mary and Westfield College, University of London
Formerly BT, UK

with

Peter Adams
John Hovell
Kevin Woollard
Derek Rumsey
David Davies
John Atkins
Paul Challener
Malcolm Jones
Graham Hudson
Geoff Morrison
Paul McDonald
Richard Boulter

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Third Edition

Preface to the Third Edition

The first edition of this book was published in mid-1990. At that time there were about 100 000 ISDN basic rate connections in the USA, and about 10 000 in each of Japan, France and Germany; all of these connections were based on the 1984 CCITT recommendations. I can now reveal that the publication of the first edition of this book was scheduled to coincide with the launch of BT's first true ISDN, based on the 1988 recommendations. In the event the book kept to the timetable better than the ISDN launch which was delayed until February 1991. Thus the first edition of this book was initially an interest whetter for those waiting for the ISDN service to emerge in the UK; the significant overseas sales may have been to those already involved in ISDN roll-out, or to those who had even longer to wait than their British colleagues. Even the second edition was for a relatively small British ISDN community. I am indebted to Andrew Kenyon, the BT ISDN Marketing Manager at the time of the launch, who revealed to me (a mere engineer) why it was that its launch was such a problem in a competitive environment. Marketing people like to have a small launch, on a local basis with a single application, so that initial customers can be supported by a small team in the exploitation of the new technology. And we engineers were going round saying that the ISDN was great because it was available all over the country and could do anything. Now the bonds have burst and the large-scale deployment is being supported by a lot of telecoms and applications people, all of whom need to know about the nuts and bolts of the equipment.

Thus this third edition is emerging into a vastly different world. Basic rate ISDN is now in use by hundreds of thousands of people in the UK alone. Worldwide the number is in the millions. Primary rate ISDN for PABX connection is moving from proprietary standards to international standards. People are not just reading about ISDN as a piece of science fiction; many are having to work with it on a daily basis. Thus dealing with its protocols is no longer the province of the specialist but is something that developers, field installers, and even users may have to tackle. To help all these people, a considerable extension of this book has been made which sets out in more detail the format of the messages which control an ISDN connection. Rather than break up the flow of the text the information is included as Appendix C. This appendix is a summarized version of the International Recommendations.

John Griffiths
Queen Mary and Westfield College
University of London
December 1997

Note to lecturers:

To assist in the organisation of courses on this topic, a PC disk is available with more than 60 of the illustrations from this book in Microsoft® PowerPoint® format which can be used for OHP slides. The disk also includes an executable file which calculates the loss probability for traffic consisting of any mix of single and multi-slot traffic which enables you to extend the calculations set out on page 183 to more complex situations. If you are interested in ordering the disk, ISBN 0 471 983594, please contact the Customer Service Department, John Wiley & Sons Ltd., Baffins Lane, Chichester, West Sussex PO19 1UD. Tel. (01243) 779777, E-mail cs-books@wiley.co.uk.

Biographies

John Griffiths (who wrote all the unattributed sections and edited the book) was educated at Ealing Grammar School and the University of Manchester whence he graduated with a 1st in Electrical Engineering. Out of perversity he then spent a year on flying training in the Royal Air Force before joining British Telecom (then the Post Office) in 1967, working on early PCM systems. In 1971 he was promoted and bypassed offers of jobs in the proper subjects of switching and transmission, to take a job in the wilderness (as it was then) of Local Telecommunications. From early work on CATV and Local Network Transmission, this evolved to ISDN and its protocols and has progressed to Broadband ISDN, becoming Division Manager of the Digital Services Division at British Telecom Laboratories, Martlesham, and a Fellow of the Institution of Electrical Engineers. On behalf of that organization he is the UK representative on the Council of the International Symposium on Subscriber Loops and Services (ISSLS). He is now Professorial Fellow at Queen Mary and Westfield College, University of London. He is married with two children and for hobbies he is a flying instructor and train spotter.

Peter Adams (who wrote Chapter 4) joined British Telecom in 1966 as a student apprentice. After obtaining a BSc in electronic engineering from Southampton University in 1970, he joined British Telecom Research Laboratories where he worked on telecommunications applications of digital signal processing. Since 1979 he has headed a group concerned with speech-band data modems and subsequently local network transmission and maintenance. Currently he leads a Local Network Exploitation section.

John Hovell (Section 5.1) joined British Telecom as an apprentice in 1967. He moved to the Research Department in 1974, after graduating with an honours degree in electrical and electronic engineering, where he worked on line card design for early digital exchanges. In 1981 he obtained an MSc in telecommunications systems and went on to lead a group responsible for the ISDN user/network interface. Recently this work has expanded to include testing, in particular the application of Formal Methods to the proving of signalling protocols. He is a chartered engineer and member of the IEE.

Kevin Woollard (Section 5.2 and Appendix A) graduated with a BSc degree in physics from Bath University in 1983. He returned to British Telecom to work on network related aspects of ISDN and in particular has implemented a Layer 2 handler for an experimental ISDN exchange. He was involved in ISDN conformance test specifications as a member of the European group responsible for the WAN-CTS conformance tests for ISDN equipment, working on aspects of automatic test case generation from protocol specifications.

Derek Rumsey (Section 5.3) joined British Telecom in 1965. Following a period working on the development of microwave radio links, he joined a division responsible for the system design of data networks where he specialized in packet network protocol. In 1981 he became involved in the development of protocols for ISDN access and currently heads a group responsible for the specification of signalling systems for access to British Telecom's ISDN.

David Davies (Section 5.4) joined British Telecom in 1974 after graduating from Oxford University. He became involved in the development of protocols for the ISDN in 1982 and now heads a group responsible for international Standards relating to the ISDN customer access. Until 1990, he chaired the ETSI committee which is responsible for developing the ISDN user–network protocol Standards and is a delegate to the CCITT Study Group which studies this subject.

John Atkins (Chapter 7) is Head of the Data Communication Networks Section at British Telecom Laboratories. His background includes R&D in digital switching systems for voice and data services, exploiting both circuit and packet modes of operation. His present interests lie mainly in the networking of non-voice services, and span LANs, MANs, and public wide area networks, with special reference to the ISDN.

Paul Challener (Section 8.1) gained a 1st class honours degree in electronic engineering from Nottingham University in 1974 and became a Chartered Engineer in 1981. He is well known internationally in the speech coding community and has contributed extensively in IEE and IEEE activities both at home and abroad. He is currently Head of the Voice Terminals Section at British Telecom Laboratories, concentrating on developments involving interactive speech and high quality audio processing. He has worked on high quality speech and music coding since 1982.

Malcolm Jones (Section 8.3) joined the Research Department of the Post Office in 1963 and worked on communications systems for government departments until 1970 when more specialist activities on maximizing the capacity of coaxial cables for submarine and land-line applications were undertaken. This was followed by data modem design using adaptive equalizers for higher speed operation over the PSTN. This led to general terminal development and international standardization work for the PSTN, particularly in the areas of facsimile and teletex. Current activities are still in the area of terminal development including for the ISDN in the form of PC based 64-kbit/s terminal products and for satellite based networks with their unique broadcasting ability.

Graham Hudson (Section 8.4) began his career in British Telecom as a technician apprentice in 1966, and then, with a BT scholarship, he obtained an honours degree in electrical and electronic engineering at City University, London. In the early 1980s, as Head of the Advanced Videotex Terminals Group, he was responsible for the development of ISDN photovideotex terminals. During this time he was chairman of the ESPRIT PICA project and the ISO JPEG, both concerned with the development and selection of photographic coding techniques. He is now Head of the Home and Office System Section at British Telecom Laboratories. He is a chartered engineer and a member of the IEE.

Geoff Morrison (Section 8.5) joined the Visual Telecommunications Division of the British Post Office Research Laboratories after graduating from St John's College, Cambridge in 1971. He has worked on video terminal and transmission aspects, both analogue and digital, mainly for videotelephone and videoteleconferencing services. He is head of a group responsible for low bit-rate video coding Standards and was a UK representative in the CCITT Specialists Group which formulated Recommendation H.261. His current interests include coding for storage devices and for asynchronous transfer mode networks.

Paul McDonald (Section 9.4) joined British Telecom in 1987 after graduating with a BEng (Hons) in Electronic and Microprocessor Engineering from Strathclyde University. Since then his work has encompassed research into a broad range of ISDN topics including the ISDN basic rate interface, broadband ISDN, ATM techniques, and SDH transmission Standards. Over the past few years he has been investigating the problems of interworking mobile systems with the ISDN, in particular the effects on access and CCITT No 7 signalling protocols.

Richard Boulter (Section 9.5) joined British Telecom in 1963 as a student apprentice. After graduating from Birmingham University in 1967 he joined a data transmission research group at the Research Station. In 1974, he was responsible for specifying the synchronization equipment for the UK digital network. After further work on line-card developments for digital exchanges and a six-month consultancy period with SHAPE Technical Centre, he headed a section concerned with systems evolution. Since then, he has been involved in specification work on BT's ISDN, studies into the evolution of the local network and acted as manager of two RACE collaborative projects on broadband ISDN.

Contents

Chapter 1

Network Evolution

1.1 THE TELEGRAPH

The earliest telecommunications systems were optical. Although the use of beacon fires to warn of anticipated dangers is widely known, it is difficult to regard as telecommunication a system which only allowed the transmission of one bit of information over a period of several weeks. There were several attempts at more flexible systems using large shutters or movable arms which could be mounted on tops of hills (Figure 1.1). These were observed from adjacent hills and relayed on. The system which came into virtual universal use was the French semaphore system invented in 1792. By 1830 much of Europe was covered by such networks.

In 1837 the first practical electrical telegraph appeared. In Europe Cooke and Wheatstone produced their five-wire telegraph (Figure 1.2). In the same year Samuel Morse invented his well-known system, although it was another seven years before it was put into service. For the next 40 years telegraphy evolved technically and in its services. The five wires of the Wheatstone system were complex and expensive but the ability of unskilled operators to use it made it in some situations more attractive than the morse system. The ideal was a system which only used two wires (or one and an earth return) and was simple to operate. The eventual result of this was the teletypewriter developed in 1915 by Kleinschmidt and Morkrum in the USA.

In functional terms by 1875 the telegraph network was simple with European countries each offering a state monopoly telegram service. In the USA, while not an actual monopoly, the telegraph network was dominated by Western Union. Hence a resident of that time could have considered that he or she had an Integrated Services Digital Network (ISDN), there only being one network for all the services available at that time and this being digital in nature.

1.2 THE TELEPHONE ARRIVES

The coming of the telephone in 1875 removed both the integration and digitalization of the network. Bell's early attempts at telephony involved

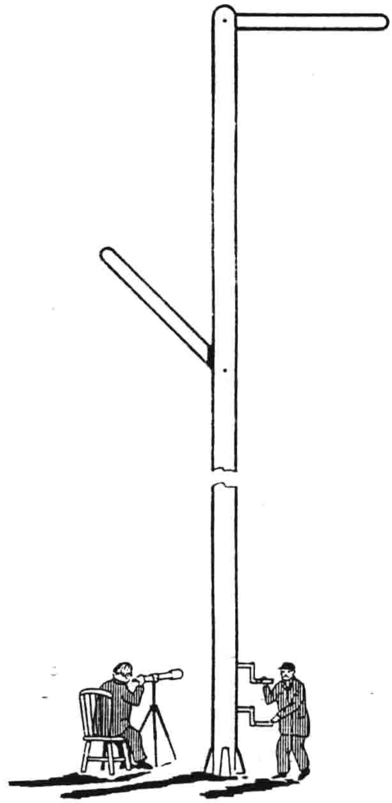

Figure 1.1
The semaphore.

operating a make–break contact by a microphone diaphragm in a binary way, but his early success relied on the change of magnetic circuit impedance and hence magnetic field in a coil due to movements of a diaphragm. However, this lacked sensitivity. Elisha Gray made real progress when he made the contact softer using a diaphragm connected to a wire immersed in a fluid giving a resistance change proportional to the audio pressure change (Figure 1.3). Edison's carbon microphone invented in 1878 was a more convenient way of achieving the same effect.

The scene was therefore set for two clearly separate telecommunications networks. On the one hand, the telephony network carrying signals whose magnitude was fairly linearly related to the sound pressure incident upon the sending microphone and were hence called 'analogue'. Its big advantage was that it could be used by unskilled operatives; communication simply involved speaking and listening and what can be more natural than

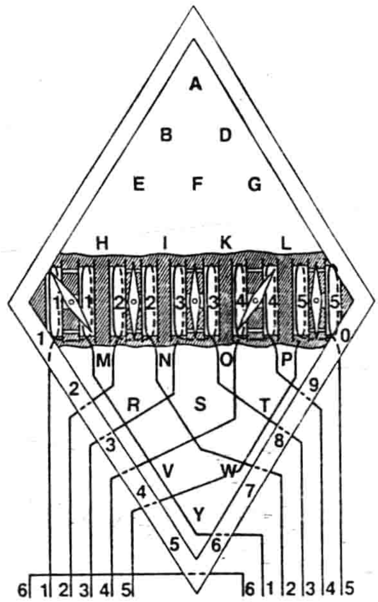

Figure 1.2
Wheatstone's telegraph.

that? On the other hand, the digital telegraph network had the advantage that a hard copy of the communication is produced. In technical terms the telegraph network had further advantages; at a very early stage a means of relaying (Figure 1.4), or repeating, signals was developed such that operation over long distances was possible. This has always presented a problem for telephony and was initially solved by using wires of extraordinary

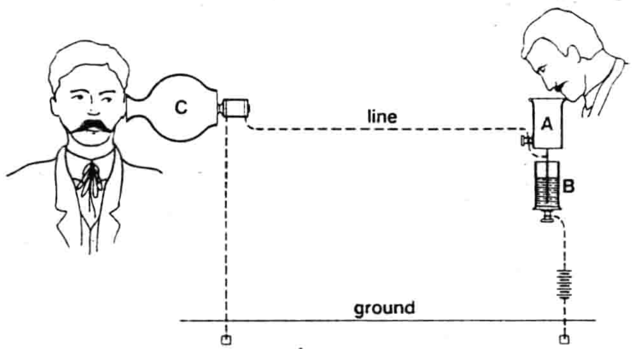

Figure 1.3
Elisha Gray. Instruments for transmitting and receiving vocal sounds telegraphically. Caveat filed 14 February 1876.