

CONTENTS

<i>List of Figures</i>	xiii
<i>List of Tables</i>	xvi
<i>List of Abbreviations and Technical Terms</i>	xix
1. Introduction	1
2. Origins of the Companies and Controlled Competition	27
3. The Evolution of the Japanese Telecommunications Switching Industry	42
4. The Evolution of the Japanese Computer Industry	126
5. The Evolution of the Japanese Optical Fibre Industry	203
6. The Evolution of NEC	255
7. The Future of NTT	351
8. DDI: NTT's Major Competitor	409
9. Conclusion	423
<i>Appendices</i>	
A1. <i>The Firm and Industry in the Evolutionary Process of Economic Change</i>	453
A2. <i>The Evolution of Optical Fibre in Corning Glass</i>	465
A3. <i>The Strengths and Weaknesses of Japanese Information and Communications Companies</i>	485
A4. <i>The Financial Performance of Japanese and Western IC Companies</i>	498
A5. <i>The Performances of NTT, AT&T, and BT Compared</i>	502
A6. <i>International Competitiveness: NEC and Ericsson</i>	504
A7. <i>Market Share in Various Japanese IC Markets</i>	509
<i>Bibliography</i>	511
<i>Index</i>	527

LIST OF FIGURES

1.1 The ten largest information technology suppliers in the world, 1992	11
1.2 The ten largest telecommunications equipment companies in the world, 1992	11
1.3 The ten largest semiconductor manufacturers in the world, 1992	12
3.1 Evolution of telecommunications switching: from crossbar to electronic space-division (SD) switching	47
3.2 Japan's switching technology, 1952–1982	48
3.3 The evolution of digital switching	50
3.4 The worldwide central office market: shipments of digital local lines, by region, 1992	101
3.5 Rest-of-the-world central office market: shipments of digital local lines, by region, 1992	101
3.6 Rest-of-the-world central office market: suppliers of digital local line market share, by region, 1992	103
3.7 Coherence and vertical integration of telecommunications equipment companies	106
3.8 Major switching 'families'	110
3.9 The mechanism of an ATM switch	115
3.10 The division of labour between NTT and vendors in developing the ATM switch	121
4.1 The use of PCs in Japan, the USA, and Europe, 1990–1996	176
4.2 The diffusion of PCs and PC/LAN connections in Japan, the USA, and Germany, 1993	176
4.3 World semiconductor market, by region, 1986 and 1992	177
4.4 Semiconductor market composition, USA and Japan, 1992	178
4.5 US and Japanese semiconductor market shares, 1992	180
4.6 Standards in the Japanese PC market, 1993	189
4.7 The evolution of the computer industry, 1945–1994	194
5.1 The structure of optical fibre	207
5.2 A simple fibre optic link	208
5.3 Outside vapour deposition and inside vapour deposition	220
5.4 Axial vapour deposition	222
5.5 Spectral loss data for silica fibres	225
5.6 Controlled competition in optical fibre	232

5.7 Joint optical fibre patents granted involving NTT and supplying firms, September 1985–September 1986	239
5.8 Flow of information between NTT and supplying companies	240
5.9(a) The optical fibre market share, North America, 1987	242
5.9(b) The optical fibre market share, Western Europe, 1987	242
5.9(c) The optical fibre market share, Japan, 1989	242
5.10 Channel capacity improvement as a function of time, 1890–2030	245
6.1 The evolution of NEC's competences	260
6.2 PC shipments in Japan, 1992	270
6.3 Computer sales, NEC, Fujitsu, and Hitachi, year ending 31 March 1991	271
6.4 The number of software vendors for NEC's personal computer, 1984–1990	276
6.5 The number of application software packages for NEC's PC-9800 series, 1986–1991	276
6.6 The evolution of architecture in major Japanese PC makers	277
6.7 NEC's general concept of C&C development	280
6.8 Information infrastructures combining communications network infrastructures and information service centres, and corresponding end-user systems	281
6.9 The NEC Tree	282
6.10 The evolution of NEC's organization, 1945–1995	289
6.11 The organization of NEC, before and after July 1991	294
6.12 The present organization of NEC's top management	296
6.13 The evolution of research and development in NEC, 1939–1992	300
6.14 NEC's core technology R&D organizational strategy	309
6.15 NEC's R&D planning structure	312
6.16 NEC's R&D network	317
6.17 The transfer of research on AFIS from NEC's research laboratories	328
7.1 Telephone tariffs of NTT and NCCs, 1987(9)–1992(6)	357
7.2 The fall in telephone tariffs, 1980–1990	358
7.3 Market share of long-distance telephone services, NTT and NCCs, 1 April 1991–31 March 1992	362
8.1 Revenue and profit, DDI and competitors, 1987–1993 (\$1 = ¥105)	412
9.1 Level of system integration and technological range of business, Japanese and non-Japanese companies	427
9.2 Customer satisfaction regarding PBXs	441

List of Figures

xv

A1.1 Four key concepts for a theory of the firm	464
A3.1 Investment in research and investment and facilities for LSIs	490
A3.2 Customers' valuations of PBX characteristics in the US market, 1992	496
A7.1 Who's who in Japan's markets	509

LIST OF TABLES

1.1 Japan's exports by value, 1980 and 1991	9
1.2 The comparative strength of Japanese companies in selected US markets, 1990	13
1.3 Foreign sales ratios for selected companies, early 1990s	20
2.1 Payment to foreign companies for automatic switches by the Ministry of Communications, 1925–1929	36
2.2 Value of Ministry of Communications' purchases of telecommunications equipment, 1926–1931	39
2.3 NEC's sales to the Ministry of Communications, 1925–1931	40
3.1 Major competitors and drop-outs in telecommunications switching, 1990s	43
3.2 Cumulative line shipments of central office switching equipment, up to 1992	99
3.3 Shipments of central office switching equipment to the USA, 1991 and 1992	100
3.4 The central office switching equipment market in Japan, 1990	102
4.1 Technology agreements between Japanese and US computer companies	138
4.2 The financing of the Japanese computer industry, 1968–1975	151
4.3 Global alliances in microprocessors	182
4.4 The top 25 Japanese software companies, 1991	184
4.5 The software and computer services industry, 1985	186
4.6 Software and computer services in Japan, 1985	191
5.1 Joint optical fibre patents granted involving NTT and its supplying firms, September 1985–September 1986	239
6.1 NEC's products, 1987 and 1993	259
6.2 Research and development in Japanese and Western IT companies, 1993	298
6.3 The present organization of NEC's research and development	311
6.4 Transfer of Bell Laboratories researchers (area 11) to business units in AT&T, 1988–1992	314
6.5 Results of system accuracy tests for NEC's AFIS	324
6.6 Chronology of the development of NEC's AFIS	328
6.7 NTT's five-year telecommunications expansion programmes, 1953–1985	332
6.8 Breakdown of NEC's sales, 1939–1993	333

6.9 Export ratios of selected Japanese companies, 1992	335
6.10 NEC's 'committed' shareholders, 1993	343
6.11 NEC's strategic alliances, 1899–1994	347
6.12 The globalization of NEC	349
7.1 NTT's research and development, 1986–1992	359
7.2 Type I domestic telecommunications revenue, 1991 and 1992	364
7.3 Revenue and profits, NTT and the NCCs, 1985–1992	365
7.4 Breakdown of NTT's revenue, expenditure, and income, 1991	367
7.5 NTT's capital expenditure, 1987–1991	369
7.6 NTT dividends compared with those of other public corporations, 1990 and 1991	370
7.7 The 'Terrific Ten' Japanese companies, ranked by performance, 1992	371
7.8 Some NTT performance ratios, 1987–1991	372
7.9 Telecommunications Council membership, 1990	385
9.1 Value of information and communications sales in major Japanese companies, 1993	430
9.2 The top ten corporations receiving US patents, 1987–1990	432
9.3 Research and development in selected Western information technology companies, 1993	434
9.4 Research and development in selected Japanese information technology companies, 1993	435
9.5 R&D performance in Japanese and Western information technology firms, 1992	436
9.6 Global competitiveness of Japanese companies in selected information and communications markets	439
A3.1 Categories of information communications systems	489
A3.2 Japan's imports and exports of telecommunications equipment, 1991	493
A3.3 The Japanese PBX market, 1990–1992	494
A3.4 The US PBX market, 1991 and 1992	495
A4.1 Profitability of selected Western information technology companies, 1993	498
A4.2 Profitability of selected Japanese information technology companies, 1993	498
A4.3 Average profitability of selected Western and Japanese information technology companies, 1993	498
A4.4 Financial performance of selected Western information technology companies, 1994	500

A4.5 Financial performance of selected Japanese information technology companies, 1994	501
A5.1 Profitability of BT, AT&T, and NTT, 1993	502
A5.2 Financial performance of selected telecommunications carriers, 1994	502
A5.3 R&D performance of BT, AT&T, and NTT, 1992	503
A6.1 Digital switches sold by NEC and Ericsson, 1990	505