Table of Contents

Preface XIX
Acknowledgement XXI

PART I THE WIRELESS INTERNET 1

1 An Introduction to Wireless Mobile Internet 3
   1.1 Telecommunication Technologies 3
      1.1.1 Telecommunications: Wired, wireless, and cellular 4
      1.1.2 Internet: Fixed, wireless, and mobile 7
   1.2 Trends Toward Wireless Internet 9
      1.2.1 Access technology: Fixed and mobile 9
      1.2.2 Increase in Internet usage 10
      1.2.3 Telecommunication services for everyone 11
      1.2.4 Mobile cellular technologies coverage 12
      1.2.5 Telecommunication traffic: Voice, data, and multimedia 13
      1.2.6 Mobile Internet traffic 13
   1.3 Wireless Internet Requirements 14
      1.3.1 Extension of Internet with mobility features 14
      1.3.2 Internet connection specifications and QoS 15
      1.3.3 Change in Internet protocols 15
      1.3.4 Authentication, authorization, and accounting 16
      1.3.5 Resource management 17
      1.3.6 Changing the network architecture 17
   1.4 Outline of the Book 18
   References 20
2 Wireless Cellular Data Networks
  2.1 Introduction
      2.1.1 Circuit switching
      2.1.2 Packet switching
      2.1.3 Access network
      2.1.4 Core network
  2.2 Second-Generation Cellular Data Services
      2.2.1 Cellular digital packet data
      2.2.2 High-speed circuit-switched data
  2.3 Recent Advanced Cellular Data Services
      2.3.1 Wireless application protocol
      2.3.2 i-mode
      2.3.3 Freedom of multimedia access
  2.4 Standardization Organizations
      2.4.1 International Telecommunication Union
      2.4.2 European Telecommunications Standards Institute
      2.4.3 Universal Mobile Telecommunications System Forum
      2.4.4 Third-Generation Partnership Project
      2.4.5 Third-Generation Partnership Project 2
      2.4.6 Internet Engineering Task Force
      2.4.7 Mobile Wireless Internet Forum
  2.5 Summary and Conclusions

References

3 Cellular Mobile Networks
  3.1 Global System for Mobile Communications
      3.1.1 GSM architecture
      3.1.2 GSM bandwidth allocation
      3.1.3 GSM control and data channels
      3.1.4 GSM system features
      3.1.5 GSM network architecture
      3.1.6 DCS1800 and PCS1900
  3.2 General Packet Radio Service
      3.2.1 GPRS architecture
      3.2.2 GPRS new routers
      3.2.3 GPRS signaling
      3.2.4 GPRS mobility management
  3.3 Enhanced General Packet Radio Service
      3.3.1 EGPRS phase 1
      3.3.2 EGPRS phase 2
  3.4 Universal Mobile Telecommunication System
      3.4.1 Evolution at all logical layers
      3.4.2 UMTS network architecture
      3.4.3 UMTS core and radio access network
# TABLE OF CONTENTS

3.4.4  UMTS modes of operation 77  
3.4.5  UMTS network protocol 79  
3.4.6  UMTS open service architecture 84  
3.5  Summary and Conclusions 87  

References 87  

4  Mobile Networks of the Future 91  
4.1  IMT-2000 91  
4.1.1  IMT-2000 standards family 92  
4.1.2  cdma2000 94  
4.1.3  IMT-2000 standards harmonization 96  
4.2  Beyond Third-Generation Systems 98  
4.2.1  4G mobile: Interconnecting networks 99  
4.2.2  All-IP networks 101  
4.2.3  A modular approach toward 4G mobile 101  
4.2.4  Mobile Wireless Internet Forum 104  
4.3  Future Mobile Internet Applications 107  
4.3.1  Common Internet applications 110  
4.3.2  Mobile only applications 110  
4.4  Layered Architecture for the Future Mobile Internet 110  
4.4.1  Approaching the mobile Internet 111  
4.4.2  Layered architecture 112  
4.4.3  Network management level 115  
4.5  Summary and Conclusions 118  

References 118  

# PART II  FUNDAMENTAL TOPICS IN WIRELESS IP 123  

5  Quality of Service in a Mobile Environment 125  
5.1  Defining the Quality of Service 125  
5.1.1  User-level QoS requirements 126  
5.1.2  Technology and network QoS requirements 128  
5.1.3  Correlation between the QoS indicators 131  
5.2  Quality-of-Service Guarantee in IP Networks 133  
5.2.1  Packet classification 133  
5.2.2  Packet isolation 134  
5.2.3  Efficient resource management 135  
5.2.4  Traffic load control 135  
5.2.5  Summary 136  
5.3  Internet Solutions to Quality-of-Service Provisioning 137  
5.3.1  Integrated services 137  
5.3.2  Differentiated services 138  
5.3.3  Comparison between IntServ and DiffServ 140  
5.3.4  IntServ over DiffServ 140
5.4 Cellular Network Solutions to Quality-of-Service Provisioning 141
   5.4.1 GPRS quality-of-service support 141
   5.4.2 UMTS quality-of-service support 142
5.5 Quality-of-Service Establishment in Mobile Networks 143
5.6 Summary and Conclusions 144
References 145

6 Traffic Modeling for Wireless IP 149
   6.1 Introduction 149
      6.1.1 Emerging trend of the next-generation mobile traffic 150
      6.1.2 Importance of traffic modeling 151
      6.1.3 Traffic modeling criteria 151
   6.2 Poisson and Markov Models 152
      6.2.1 Limitation of the Poisson and Markov traffic models 152
      6.2.2 The need for new traffic models 153
   6.3 Characteristics of the Emerging Traffics 154
      6.3.1 Heavy-tailed 154
      6.3.2 Self-similar 156
      6.3.3 Fractal 158
      6.3.4 Long-range-dependence 159
      6.3.5 Suitability of self-similar and long-range dependence 159
   6.4 Self-Similar and LRD Traffic Models 161
      6.4.1 Traditional traffic models 161
      6.4.2 Current and future models 162
      6.4.3 Traffic models for the Internet applications 166
   6.5 Short-Range and Long-Range Dependence Models 172
      6.5.1 Self-similar traffic models 172
      6.5.2 Long-range-dependence traffic models 172
   6.6 Summary and Conclusions 174
References 175

7 Traffic Management for Wireless IP 177
   7.1 Introduction 177
   7.2 Admission Control 181
      7.2.1 Parameter-based admission control 182
      7.2.2 Measurement-based admission control 183
      7.2.3 Quality of service parameters 185
   7.3 Wireless IP Networks 185
      7.3.1 Wireless access networks 186
      7.3.2 Wireless LAN—The IEEE 802.11 standard 186
      7.3.3 Unique characteristics of a wireless LAN 188
      7.3.4 Admission control in wireless IP networks 189
# TABLE OF CONTENTS

### 7.4 Measurement-Based Admission Control
- 7.4.1 Network-load estimation 191
- 7.4.2 Measurement parameters 192
- 7.4.3 Possible sources of error 194
- 7.4.4 Suitability of MBAC in wireless IP networks 195

### 7.5 Implementation of Measurement-Based Admission Control
- 7.5.1 Network reference model 196
- 7.5.2 Wireless IP networks characteristics 197
- 7.5.3 Simulation descriptions 197

### 7.6 Traffic Management Parameters
- 7.6.1 Choice of the parameters 200
- 7.6.2 Verification of the simulation 201

### 7.7 Comparison Between Priority and Reservation Schemes
- 7.7.1 Without reservation or priority 207
- 7.7.2 Reservation 208
- 7.7.3 Priority 216
- 7.7.4 Priority versus reservation 226

### 7.8 Summary and Conclusions

References 244

### 8 Mobility in Cellular Networks
- 8.1 Introduction 247
- 8.2 Mobility Models
  - 8.2.1 Topology models 249
  - 8.2.2 Movement models 250
  - 8.2.3 Residence time models 252
  - 8.2.4 Call-arrival models 257
- 8.3 Location Management Schemes
  - 8.3.1 Update strategies 263
  - 8.3.2 Paging 263
  - 8.3.3 Final remarks 275
- 8.4 Analytical Framework for Location Management
  - 8.4.1 Influential factors 282
  - 8.4.2 Overall cost function 284
  - 8.4.3 Update cost 285
  - 8.4.4 Optimal boundary assignation 287
  - 8.4.5 Paging cost 303
  - 8.4.6 Partition algorithms 312

### 8.5 Summary and Conclusions
References 319

### 9 Transport Protocols for Wireless IP
- 9.1 Introduction 325
### TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.2</td>
<td>Overview of the Transmission Control Protocol</td>
</tr>
<tr>
<td>9.2.1</td>
<td>TCP/IP architecture</td>
</tr>
<tr>
<td>9.2.2</td>
<td>General features in TCP</td>
</tr>
<tr>
<td>9.2.3</td>
<td>TCP segment structure</td>
</tr>
<tr>
<td>9.2.4</td>
<td>TCP flow control</td>
</tr>
<tr>
<td>9.2.5</td>
<td>TCP time-out mechanism</td>
</tr>
<tr>
<td>9.2.6</td>
<td>TCP congestion control</td>
</tr>
<tr>
<td>9.2.7</td>
<td>Some conclusions on TCP</td>
</tr>
<tr>
<td>9.3</td>
<td>Transmission Control Protocols for Wireless Channel</td>
</tr>
<tr>
<td>9.3.1</td>
<td>Exploring the problem</td>
</tr>
<tr>
<td>9.3.2</td>
<td>TCP performance expectation in wireless channel</td>
</tr>
<tr>
<td>9.3.3</td>
<td>TCP enhancements</td>
</tr>
<tr>
<td>9.4</td>
<td>Explicit Loss Notification with Acknowledgement</td>
</tr>
<tr>
<td>9.4.1</td>
<td>A new acknowledgement packet</td>
</tr>
<tr>
<td>9.4.2</td>
<td>A new agent at base station</td>
</tr>
<tr>
<td>9.4.3</td>
<td>Procedure at TCP sender</td>
</tr>
<tr>
<td>9.5</td>
<td>Performance Analysis</td>
</tr>
<tr>
<td>9.5.1</td>
<td>Simulation environment</td>
</tr>
<tr>
<td>9.5.2</td>
<td>Throughput performance</td>
</tr>
<tr>
<td>9.5.3</td>
<td>Delay performance</td>
</tr>
<tr>
<td>9.5.4</td>
<td>Congestion window performance</td>
</tr>
<tr>
<td>9.6</td>
<td>Transmission Control Protocols for Cellular Networks</td>
</tr>
<tr>
<td>9.7</td>
<td>Summary and Conclusions</td>
</tr>
<tr>
<td></td>
<td>References</td>
</tr>
</tbody>
</table>

### 10 Internet Protocol for Wireless IP

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>Introduction</td>
</tr>
<tr>
<td>10.2</td>
<td>Overview of the Internet Protocol</td>
</tr>
<tr>
<td>10.2.1</td>
<td>Hierarchical routing in the Internet</td>
</tr>
<tr>
<td>10.2.2</td>
<td>Internet control message protocol</td>
</tr>
<tr>
<td>10.2.3</td>
<td>General features of Internet protocol</td>
</tr>
<tr>
<td>10.3</td>
<td>Internet Protocol Version 6</td>
</tr>
<tr>
<td>10.3.1</td>
<td>IPv6 motivations</td>
</tr>
<tr>
<td>10.3.2</td>
<td>IPv6 header format</td>
</tr>
<tr>
<td>10.3.3</td>
<td>Internet protocol transition</td>
</tr>
<tr>
<td>10.3.4</td>
<td>Current status of IPv6</td>
</tr>
<tr>
<td>10.3.5</td>
<td>Wireless: Direction for IPv6</td>
</tr>
<tr>
<td>10.4</td>
<td>Mobile IP</td>
</tr>
<tr>
<td>10.4.1</td>
<td>Protocol overview</td>
</tr>
<tr>
<td>10.4.2</td>
<td>Performance issues in Mobile IPv4</td>
</tr>
<tr>
<td>10.4.3</td>
<td>Mobile IPv6</td>
</tr>
<tr>
<td>10.4.4</td>
<td>Handover in Mobile IPv6</td>
</tr>
<tr>
<td>10.4.5</td>
<td>Hierarchical mobility agent</td>
</tr>
<tr>
<td>10.5</td>
<td>Cellular IP and HAWAII</td>
</tr>
</tbody>
</table>
**TABLE OF CONTENTS**

10.5.1 Cellular IP 378
10.5.2 HAWAII 380
10.5.3 Cellular IP versus HAWAII 381
10.6 Summary and Conclusions 381
References 382

**PART III  ADVANCED TOPICS IN WIRELESS IP** 385

11 Internet Perspectives on Wireless IP 387
   11.1 Packet Data Services 387
      11.1.1 Access layer 389
      11.1.2 Data link layer 389
      11.1.3 Network layer 390
      11.1.4 Security 390
   11.2 Packet Data Services—A Functional Model 390
      11.2.1 Home agent 391
      11.2.2 Packet data serving node 391
      11.2.3 Authentication, authorization, and accounting 392
      11.2.4 Packet control function 393
      11.2.5 Radio resource control 393
      11.2.6 Mobile station 394
   11.3 Architecture Models 394
   11.4 Summary and Conclusions 397
References 398

12 Mobile Ad Hoc Networks and Future Challenges 401
   12.1 Introduction to Mobile Ad Hoc Networks 401
      12.1.1 Wireless LAN 402
      12.1.2 Ad hoc networking using the wireless LAN 402
      12.1.3 IEEE 802.11 specifications 404
   12.2 Integrated Ad Hoc Power Management 405
      12.2.1 Device power consumptions 406
      12.2.2 Power managements 406
   12.3 MAC Protocol for Ad Hoc Networks 407
   12.4 Quality of Service Support for Ad Hoc 408
   12.5 Ad Hoc Service Discovery Architectures 409
   12.6 Forwarding Models and Incentives 410
   12.7 Ad Hoc Addressing and Naming 412
   12.8 Connection Precedence and Preemption 413
   12.9 Summary and Conclusions 414
References 415

13 Satellites in Wireless IP 417
   13.1 Introduction 417
13.2 Overview of Satellite Communications 418
  13.2.1 Mobile satellite services—First generation 418
  13.2.2 Mobile satellite services—Second generation 418
  13.2.3 Broadband satellite systems 420
13.3 Satellite for the Global Internet 422
  13.3.1 Connection architecture of satellites 422
  13.3.2 Application of satellites 422
13.4 Satellite in Third-Generation Wireless Networks 424
13.5 Technical Issues for Satellite-Based Internet Implementation 427
  13.5.1 Mobility management 427
  13.5.2 Location management 429
  13.5.3 Routing management 429
  13.5.4 Handoff management 429
  13.5.5 Quality of service management 430
13.6 Mobility Management in Satellite and Terrestrial Networks 430
  13.6.1 Satellite networks 431
  13.6.2 Cellular networks 431
  13.6.3 Handoff management versus location management 432
13.7 Satellite Transport of the Internet Traffic 432
  13.7.1 TCP imperfections 433
  13.7.2 TCP enhancements 433
13.8 Summary and Conclusions 434
References 436

Acronyms 439

Index 449

About the Author 461
A wireless network is a computer network that uses wireless data connections between network nodes. Wireless networking is a method by which homes, telecommunications networks and business installations avoid the costly process of introducing cables into a building, or as a connection between various equipment locations. Wireless telecommunications networks are generally implemented and administered using radio communication. This implementation takes place at the physical level (layer) of the OSI Stay connected anywhere with high speed Mobile Internet service on the TELUS 4G network. Find the best wireless internet plan and stick, hub, or hotspot for you. Mobile Internet. Need to connect 1 device, or up to 32? No problem. Our Mobile Internet devices go with our Mobile Internet plans so youâ€™re always connected, wherever you go. Smart Hub. LTE Advanced Enabled: LTE Cat 6 allows users to experience download speeds up to 300Mbps and upload speeds up to 50Mbps.