

# Contents

---

|                       |       |
|-----------------------|-------|
| Preface.....          | xiii  |
| Preambles.....        | xv    |
| Acknowledgments ..... | xxiii |
| Editorial Board ..... | xxv   |
| Editors.....          | xxvii |
| Contributors .....    | xxxix |

## **PART I Technical Principles**

---

|  |             |
|--|-------------|
| <b>1</b> ISO/OSI Model .....   | <b>1-1</b>  |
| <i>Gerhard Zucker and Dietmar Dietrich</i>                                   |             |
| <b>2</b> Media .....   | <b>2-1</b>  |
| <i>Herbert Schweinzer, Saleem Farooq Shaukat, and Holger Arthaber</i>        |             |
| <b>3</b> Media Access Methods.....   | <b>3-1</b>  |
| <i>Herbert Haas and Manfred Lindner</i>                                      |             |
| <b>4</b> Routing in Wireless Networks .....                                  | <b>4-1</b>  |
| <i>Teresa Albero-Albero and Víctor-M. Sempere-Payá</i>                       |             |
| <b>5</b> Profiles and Interoperability .....                                 | <b>5-1</b>  |
| <i>Gerhard Zucker and Heinz Frank</i>  |             |
| <b>6</b> Industrial Wireless Sensor Networks .....                           | <b>6-1</b>  |
| <i>Vehbi Cagri Gungor and Gerhard P. Hancke</i>                              |             |
| <b>7</b> Ad Hoc Networks .....   | <b>7-1</b>  |
| <i>Sajjad Ahmad Madani, Shahid Khattak, Tariq Jadoon, and Shahzad Sarwar</i> |             |
| <b>8</b> Radio Frequency Identification .....                                | <b>8-1</b>  |
| <i>Edward Kai-Ning Yung, Pui-Yi Lau, and Chi-Wai Leung</i>                   |             |
| <b>9</b> RFID Technology and Its Industrial Applications.....                | <b>9-1</b>  |
| <i>Vidyasagar Potdar, Atif Sharif, and Elizabeth Chang</i>                   |             |
| <b>10</b> Ultralow-Power Wireless Communication.....                         | <b>10-1</b> |
| <i>Joern Ploennigs, Volodymyr Vasyutynskyy, and Klaus Kabitzsch</i>          |             |

|    |  |      |
|----|--|------|
| 11 | Industrial Strength Wireless Multimedia Sensor Network Technology .....                            | 11-1 |
|    | <i>Vidyasagar Potdar, Atif Sharif, and Elizabeth Chang</i>   |      |
| 12 | A Survey of Wireless Sensor Networks for Industrial Applications .....                             | 12-1 |
|    | <i>Stig Petersen and Simon Carlsen</i>   |      |
| 13 | Vertical Integration.....  | 13-1 |
|    | <i>Thilo Sauter, Stefan Soucek, and Martin Wollschlaeger</i>                                       |      |
| 14 | Multimedia Service Convergence .....   | 14-1 |
|    | <i>Alex Talevski</i>   |      |
| 15 | Virtual Automation Networks.....   | 15-1 |
|    | <i>Peter Neumann and Ralf Messerschmidt</i>  |      |
| 16 | Industrial Agent Technology .....  | 16-1 |
|    | <i>Aleksey Bratukhin, Yoseba Peña Landaburu, Paulo Leitão, and Rainer Unland</i>                   |      |
| 17 | Real-Time Systems.....   | 17-1 |
|    | <i>Lucia Lo Bello, José Alberto Fonseca, and Wilfried Elmenreich</i>                               |      |
| 18 | Clock Synchronization in Distributed Systems.....  | 18-1 |
|    | <i>Georg Gaderer and Patrick Loschmidt</i>   |      |
| 19 | Quality of Service.....  | 19-1 |
|    | <i>Gabriel Diaz Orueta, Elio San Cristobal Ruiz, Nuria Oliva Alonso,<br/>and Manuel Castro Gil</i> |      |
| 20 | Network-Based Control.....   | 20-1 |
|    | <i>Josep M. Fuertes, Mo-Yuen Chow, Ricard Villà, Rachana Gupta, and Jordi Ayza</i>                 |      |
| 21 | Functional Safety .....  | 21-1 |
|    | <i>Thomas Novak and Andreas Gerstinger</i>   |      |
| 22 | Security in Industrial Communication Systems .....   | 22-1 |
|    | <i>Wolfgang Granzer and Albert Treytl</i>  |      |
| 23 | Secure Communication Using Chaos Synchronization .....   | 23-1 |
|    | <i>Yan-Wu Wang and Changyun Wen</i>  |      |

## **PART II Application-Specific Areas**

---

|    |   |      |
|----|---|------|
| 24 | Embedded Networks in Civilian Aircraft Avionics Systems .....                       | 24-1 |
|    | <i>Christian Fraboul, Fabrice Frances, and Jean-Luc Scharbarg</i>                   |      |
| 25 | Process Automation .....  | 25-1 |
|    | <i>Alois Zoitl and Wilfried Lepuschitz</i>  |      |
| 26 | Building and Home Automation .....  | 26-1 |
|    | <i>Wolfgang Kastner, Stefan Soucek, Christian Reinisch, and Alexander Klapproth</i> |      |
| 27 | Industrial Multimedia.....  | 27-1 |
|    | <i>Javier Silvestre-Blanes, Manfred Weihs, and Víctor-M. Sempere-Payá</i>           |      |

|    |   |      |
|----|---|------|
| 28 | Industrial Wireless Communications Security (IWCS)/C42.....                   | 28-1 |
|    | <i>Milos Manic and Kurt Derr</i>  |      |
| 29 | Protocols in Power Generation.....  | 29-1 |
|    | <i>Tuan Dang and Gaëlle Marsal</i>  |      |
| 30 | Communications in Medical Applications.....                                   | 30-1 |
|    | <i>Paulo Bartolomeu, José Alberto Fonseca, Nelson Rocha, and Filipe Basto</i> |      |

## **PART III Technologies**

---

|    |   |      |
|----|---|------|
| 31 | Controller Area Network.....  | 31-1 |
|    | <i>Joaquim Ferreira and José Alberto Fonseca</i>                                  |      |
| 32 | Profibus.....   | 32-1 |
|    | <i>Max Felser and Ron Mitchell</i>  |      |
| 33 | INTERBUS.....   | 33-1 |
|    | <i>Juergen Jasperneite and Orazio Mirabella</i>                                   |      |
| 34 | WorldFip.....   | 34-1 |
|    | <i>Francisco Vasques and Orazio Mirabella</i>                                     |      |
| 35 | Foundation Fieldbus.....  | 35-1 |
|    | <i>Carlos Eduardo Pereira, Augusto Pereira, and Ian Verhappen</i>                 |      |
| 36 | Modbus.....   | 36-1 |
|    | <i>Mário de Sousa and Paulo Portugal</i>  |      |
| 37 | Industrial Ethernet.....  | 37-1 |
|    | <i>Gaëlle Marsal and Denis Trognon</i>  |      |
| 38 | EtherCAT.....   | 38-1 |
|    | <i>Gianluca Cena, Adriano Valenzano, and Claudio Zunino</i>                       |      |
| 39 | Ethernet POWERLINK.....   | 39-1 |
|    | <i>Paulo Pedreiras, Stefan Schoenegger, Lucia Seno, and Stefano Vitturi</i>       |      |
| 40 | PROFINET.....   | 40-1 |
|    | <i>Max Felser, Paolo Ferrari, and Alessandra Flammini</i>                         |      |
| 41 | LonWorks.....   | 41-1 |
|    | <i>Uwe Ryszel, Henrik Dibowski, Heinz Frank, and Klaus Kabitzsch</i>              |      |
| 42 | KNX.....  | 42-1 |
|    | <i>Wolfgang Kastner, Fritz Praus, Georg Neugschwandtner, and Wolfgang Granzer</i> |      |
| 43 | Protocols of the Time-Triggered Architecture: TTP, TTEthernet, TTP/A.....         | 43-1 |
|    | <i>Wilfried Elmenreich and Christian El-Salloum</i>                               |      |
| 44 | FlexRay.....  | 44-1 |
|    | <i>Martin Horauer and Peter Rössler</i>   |      |
| 45 | LIN-Bus.....  | 45-1 |
|    | <i>Andreas Grzemba, Donal Heffernan, and Thomas Lindner</i>                       |      |

|    |  |      |
|----|--|------|
| 46 | Profisafe.....   | 46-1 |
|    | <i>Ron Mitchell, Max Felser, and Paulo Portugal</i>                            |      |
| 47 | SafetyLon.....   | 47-1 |
|    | <i>Thomas Novak, Thomas Tamandl, and Peter Preininger</i>                      |      |
| 48 | Wireless Local Area Networks.....  | 48-1 |
|    | <i>Henning Trsek, Juergen Jasperneite, Lucia Lo Bello, and Milos Manic</i>     |      |
| 49 | Bluetooth.....   | 49-1 |
|    | <i>Stefan Mahlknecht, Milos Manic, and Sajjad Ahmad Madani</i>                 |      |
| 50 | ZigBee.....  | 50-1 |
|    | <i>Stefan Mahlknecht, Tuan Dang, Milos Manic, and Sajjad Ahmad Madani</i>      |      |
| 51 | 6LoWPAN: IP for Wireless Sensor Networks and Smart<br>Cooperating Objects..... | 51-1 |
|    | <i>Guido Moritz and Frank Golatowski</i>                                       |      |
| 52 | WiMAX in Industry.....   | 52-1 |
|    | <i>Milos Manic, Sergiu-Dan Stan, and Strahinja Stankovic</i>                   |      |
| 53 | WirelessHART, ISA100.11a, and OCARI.....                                       | 53-1 |
|    | <i>Tuan Dang and Emiliano Sisinni</i>  |      |
| 54 | Wireless Communication Standards.....  | 54-1 |
|    | <i>Tuan Dang</i>   |      |
| 55 | Communication Aspects of IEC 61499 Architecture.....                           | 55-1 |
|    | <i>Valeriy Vyatkin, Mário de Sousa, and Alois Zoitl</i>                        |      |
| 56 | Industrial Internet.....   | 56-1 |
|    | <i>Martin Wollschlaeger and Thilo Sauter</i>                                   |      |
| 57 | OPC UA.....  | 57-1 |
|    | <i>Tuan Dang and Renaud Aubin</i>  |      |
| 58 | DNP3 and IEC 60870-5.....  | 58-1 |
|    | <i>Andrew C. West</i>  |      |
| 59 | IEC 61850 for Distributed Energy Resources.....                                | 59-1 |
|    | <i>Sidonia Mesentean, Heinz Frank, and Karlheinz Schwarz</i>                   |      |

## **PART IV Internet Programming**

---

|    |   |      |
|----|---|------|
| 60 | User Datagram Protocol—UDP.....                       | 60-1 |
|    | <i>Aleksander Malinowski and Bogdan M. Wilamowski</i> |      |
| 61 | Transmission Control Protocol—TCP.....                | 61-1 |
|    | <i>Aleksander Malinowski and Bogdan M. Wilamowski</i> |      |
| 62 | Development of Interactive Web Pages.....             | 62-1 |
|    | <i>Pradeep Dandamudi</i>                              |      |
| 63 | Interactive Web Site Design Using Python Script.....  | 63-1 |
|    | <i>Hao Yu and Michael Carroll</i>                     |      |

- 64 Running Software over Internet .....64-1  
*Nam Pham, Bogdan M. Wilamowski, and Aleksander Malinowski*
- 65 Semantic Web Services for Manufacturing Industry.....65-1  
*Chen Wu and Tharam S. Dillon*
- 66 Automatic Data Mining on Internet by Using PERL Scripting Language ..... 66-1  
*Nam Pham and Bogdan M. Wilamowski*

## **PART V Outlook**

---

- 67 Trends and Challenges for Industrial Communication Systems ..... 67-1  
*Peter Palensky*
- 68 Processing Data in Complex Communication Systems .....68-1  
*Gerhard Zucker, Dietmar Bruckner, and Dietmar Dietrich*
- Index..... Index-1**