Contents

Preface ix
List of abbreviations xi
Timeline xx

1 A brief history of “Ethernet” (from a car manufacturer’s perspective) 1
  1.1 From the beginning 1
  1.2 The meaning of “Ethernet” 4
    1.2.1 Ethernet in the IEEE 5
    1.2.2 Ethernet in industrial automation 8
    1.2.3 Ethernet in aviation 11
    1.2.4 Ethernet in telecommunications 13
    1.2.5 “Automotive Ethernet” 16
Notes 19
References 21

2 A brief history of in-car networking 27
  2.1 Role of in-car networking 27
  2.2 Traditional in-car networking 30
    2.2.1 The early days of in-car networking 30
    2.2.2 Controller Area Network (CAN) 31
    2.2.3 Local Interconnect Network (LIN) 36
    2.2.4 Media Oriented Systems Transport (MOST) 38
    2.2.5 FlexRay 42
    2.2.6 Pixel links 46
    2.2.7 Consumer links 48
    2.2.8 Trends and consequences 49
  2.3 Responsibilities in in-car networking 51
    2.3.1 Role of the relationship between car manufacturer and suppliers 51
    2.3.2 Role of the relationships among car manufacturers 54
Notes 57
References 58
## 3 A brief history of Automotive Ethernet

3.1 The first use case: programming and software updates
   3.1.1 Architectural challenges
   3.1.2 Potential car interface technologies
   3.1.3 The solution: 100BASE-TX Ethernet

3.2 The second use case: a “private” application link

3.3 The Breakthrough: UTSP Ethernet for automotive

3.4 BMW internal acceptance of UTSP Ethernet
   3.4.1 Yet another in-car networking technology
   3.4.2 A suitable pilot application
   3.4.3 The future of Automotive Ethernet at BMW

3.5 The industry framework for a new technology
   3.5.1 From a proprietary solution to an open standard
   3.5.2 Shaping the future at IEEE
   3.5.3 Supportive organizations

3.6 Industry wide acceptance of Ethernet

Notes

References

## 4 The physical transmission

4.1 The Physical Layer (PHY) technology
   4.1.1 100 Mbps BroadR-Reach (OABR)
   4.1.2 Other 100 Mbps solutions
   4.1.3 Technologies for higher data rates

4.2 The automotive communication channel
   4.2.1 Channel framework for OABR
   4.2.2 OABR channel parameters

4.3 ElectroMagnetic Compatibility (EMC)
   4.3.1 Coupling mechanisms of electromagnetic interference
   4.3.2 Standards for EMC
   4.3.3 Measuring EMC
   4.3.4 Typical EMC results for an OABR link
   4.3.5 ElectroStatic Discharge (ESD)

4.4 Other requirements
   4.4.1 The quality strain
   4.4.2 Power over Data Line (PoDL)
   4.4.3 Using Energy Efficient Ethernet (EEE) in cars

Notes

References
5 Protocols for Automotive Ethernet

5.1 Quality of Service (QoS) and Audio Video Bridging (AVB) 134
  5.1.1 How AVB came to Ethernet 134
  5.1.2 The AVB use cases 136
  5.1.3 The AVB protocols and their use in automotive 140
  5.1.4 Quality of Service (QoS) for safety critical control data 151

5.2 Security and VLANs 153

5.3 Using the Internet Protocol (IP)
  5.3.1 Dynamic versus static addressing 157
  5.3.2 IPv4 versus IPv6 158

5.4 Middleware and SOME/IP
  5.4.1 Definition of “middleware” 159
  5.4.2 The history of SOME/IP 159
  5.4.3 SOME/IP features 160
  5.4.4 Service Discovery (SD) 163

Notes 166
References 170

6 Ethernet in automotive system development

6.1 A brief overview of the system development process 175

6.2 The software architecture 178

6.3 The Electric Electronic (EE) networking architecture 179
  6.3.1 EE architecture in perspective 179
  6.3.2 The communication network architecture 182
  6.3.3 The supply network 190

6.4 Test and qualification 192

Notes 195
References 196

7 Outlook 197

Notes 199
References 200

Index 201