

Contents

- 1 The IoT Landscape** 1
 - 1.1 What Is IoT? 1
 - 1.2 Applications 2
 - 1.3 Architectures 4
 - 1.4 Wireless Networks 4
 - 1.5 Devices 4
 - 1.6 Security and Privacy 5
 - 1.7 Event-Driven Systems 5
 - 1.8 This Book 6
 - Reference 6

- 2 IoT System Architectures** 7
 - 2.1 Introduction 7
 - 2.2 Protocols Concepts 7
 - 2.3 IoT-Oriented Protocols 10
 - 2.4 Databases 12
 - 2.5 Time Bases 13
 - 2.6 Security 13
 - References 14

- 3 IoT Devices** 17
 - 3.1 The IoT Device Design Space 17
 - 3.2 Cost of Ownership and Power Consumption 18
 - 3.3 Cost per Transistor and Chip Size 19
 - 3.4 Duty Cycle and Power Consumption 20
 - 3.5 Platform Design 22
 - 3.6 Summary 22
 - References 22

- 4 Event-Driven System Analysis** 25
 - 4.1 Introduction 25
 - 4.2 Previous Work 26
 - 4.3 Motivating Example 27

4.4	IoT Network Model	27
4.4.1	Events	27
4.4.2	Networks	28
4.4.3	Devices and Hubs	28
4.4.4	Single-Hub Networks	29
4.4.5	Multi-hub Networks	29
4.4.6	Network Models and Physical Networks	30
4.5	IoT Event Analysis	30
4.5.1	Event Populations	30
4.5.2	Stochastic Event Populations	32
4.5.3	Environmental Interaction Modeling	34
4.5.4	Event Transport and Migration	34
	References	36
5	Industrial Internet of Things	37
5.1	Introduction	37
5.2	Industrie 4.0	39
5.3	Industrial Internet of Things (IIoT)	41
5.4	IIoT Architecture	42
5.5	Basic Technologies	49
5.6	Applications and Challenges	50
	References	52
6	Security and Safety	55
6.1	Introduction	55
6.2	Systems Security	60
6.3	Network Security	62
6.4	Generic Application Security	64
6.5	Application Process Security and Safety	65
6.6	Reliable-and-Secure-by-Design IoT Applications	66
6.7	Run-Time Monitoring	67
6.8	The ARMET Approach	68
6.9	Privacy and Dependability	72
	References	73
7	Security Testing IoT Systems	77
7.1	Introduction	77
7.2	Fuzz Testing for Security	78
7.2.1	White-Box Fuzzing	80
7.2.2	Black-Box Fuzzing	80
7.3	Fuzzing Industrial Control Network Systems	82
7.4	Fuzzing Modbus	82
7.4.1	The Modbus Protocol	82
7.4.2	Modbus/TCP Fuzzer	85
	References	86
	Index	91