
Contents

Preface	ix
Introduction	xi
List of Acronyms	xv
Part 1. Sensor Networks	1
Chapter 1. Fluid Models and Energy Issues	3
1.1. The fluid-based approach	4
1.1.1. Sensor density and traffic generation	5
1.1.2. Data routing	5
1.1.3. Local and relay traffic rates	6
1.1.4. Channel contention and data transmission	6
1.1.5. Mean packet delivery delay	7
1.1.6. Sensor active/sleep behavior	7
1.2. Network scenario	7
1.3. The sensor network model	11
1.3.1. A minimum energy routing strategy: computing $u(\mathbf{r}' \mathbf{r})$	11
1.3.2. Channel contention and data transmission: computing $s(\mathbf{r})$ and $P_R(\mathbf{r})$	17
1.3.3. Mean packet delivery delay: computing $q(\mathbf{r})$	22
1.4. Results	24
1.4.1. Model validation	25

1.4.2. Model exploitation	28
1.4.3. Model solution complexity and accuracy	35
Chapter 2. Hybrid Automata for Transient Delay Analysis	37
2.1. Event detection in WSNs	37
2.1.1. The 802.15.4 MAC protocol	39
2.2. Model for single-hop network topologies	40
2.2.1. Single message transfer	40
2.2.2. Multiple message transfers	43
2.3. Solution technique	44
2.3.1. Time discretization	44
2.3.2. Transient solution	46
2.3.3. Performance metrics computation	49
2.4. Model for multi-hop network topologies	50
2.5. Model validation and exploitation results	52
2.6. Discussion	57
Part 2. Vehicular Networks	59
Chapter 3. Safety Message Broadcasting	61
3.1. System description	62
3.2. Dissemination of safety messages	63
3.2.1. The spatial differentiation approach	63
3.2.2. The safety application	64
3.3. Assumptions and notations	65
3.4. Model outline	66
3.5. Computation of the block probability	67
3.6. Computation of the probability of first reception	69
3.6.1. A Gaussian approximation to the transient system behavior	73
3.7. Performance evaluation	77
3.7.1. The impact of power capture	77
3.7.2. The case of occupation probability $\rho = 1$	79
3.7.3. The case of homogeneous occupation probability $\rho < 1$	80
3.7.4. The case of inhomogeneous occupation probability	83
3.7.5. The impact of the forwarding policy	85

Chapter 4. Modeling Information Sharing	89
4.1. System scenario	89
4.2. Modeling information exchange in IVN	90
4.2.1. Model description	91
4.3. Computation of the probability of successful information retrieval	93
4.4. Model validation and exploitation	98
Part 3. Cellular Networks	103
Chapter 5. Multi-RAT Algorithms	105
5.1. RAT network	106
5.1.1. Scenario	107
5.1.2. RAT selection strategy	108
5.2. Network model	109
5.2.1. Functional rates	110
5.3. Model solution	115
5.3.1. Analytical approach	115
5.3.2. Computation of performance metrics	117
5.4. Performance evaluation	118
5.4.1. Setting and results	119
Bibliography	123
Index	127