Contents

1 Evolutionary Green Computing Solutions for Distributed Cyber Physical Systems 1
Zahra Abbasi, Michael Jonas, Ayan Banerjee, Sandeep Gupta, Georgios Varsamopoulos
1.1 Introduction 2
1.2 Green Computing in DCPS Domains 3
1.2.1 Data Centers 4
1.2.2 WSNs 5
1.2.3 BSNs 5
1.2.4 Problems Statements for Green Computing in DCPS 6
1.3 Overview on EA 8
1.4 EA Applications for Green Computing in DCPS 10
1.4.1 Survey on Evolutionary-Based Solutions for Energy Aware Workload Scheduling in High Performance Computing (HPC) Data Centers 10
1.4.2 Survey on Energy Efficient Routing Problem for WSNs 13
1.4.3 Survey on Applications of EA for Thermal Aware Job Scheduling in HPC Data Centers 16
1.4.4 Survey on Thermal Aware Communication Scheduling in Implanted Biosensor Networks 21
1.4.5 Survey on Energy Harvesting and Cost Management in Data Centers 22
1.5 Conclusion 23
References 25

2 Energy-Aware Provisioning of HPC Services through Virtualised Web Services 29
Alexander Kipp, Tao Jiang, Jia Liu, Mariagrazia Fugini, Ionut Anghel, Tudor Cioara, Daniel Moldovan, Ioan Salomie
2.1 Introduction 30

2.2 Scientific Workflows with Common Workflow Description Languages 32
2.2.1 Requirements for Scientific Workflow Environments 32
2.2.2 Applying Common Workflow Description Languages to the Scientific Computing Domain 33
2.3 Virtualisation Infrastructure 36
2.3.1 General Architecture 36
2.3.2 Applying the Gateway Infrastructure to Different Domains 40
2.4 Energy-Aware Job Scheduling and Deployment 42
2.5 An Example: HPC Workflow 47
2.6 Evaluation 49
2.7 Concluding Remarks 50
References 51

3 Macro Level Models of Power Consumption for Servers in Distributed Systems 55
Tomoya Enokido, Takuro Inoue, Alisher Aikebaire, Makoto Takizawa
3.1 Introduction 56
3.2 Related Studies 58
3.3 System Model 59
3.3.1 Servers and Clients 59
3.3.2 Processes in Servers 60
3.4 Experimentations 62
3.4.1 CP Applications 62
3.4.2 CM Applications 64
3.4.3 ST Applications 66
3.5 Power Consumption Models 69
3.5.1 CP Applications 69
3.5.2 CM Applications 76
3.5.3 ST Applications 78
3.6 Server Selection Algorithms 83
3.6.1 CP Applications 83
3.6.2 CM Applications 84
3.6.3 ST Applications 86
3.7 Evaluation 88
3.7.1 CP Applications 88
3.7.2 CM Applications 90
3.8 Conclusion 91
References 92

4 Energy and Security Awareness in Evolutionary-Driven Grid Scheduling 95
Joanna Kolodziej, Samee U. Khan, Lizhe Wang, Dan Chen, Albert Y. Zomaya
4.1 Introduction 96
4.2 Generic Model of Secure Grid Cluster 97

4.3 Scheduling Problems in Computational Grids 99
4.3.1 Problems Notation and Classification 101
4.4 Independent Batch Scheduling Problem, Scheduling Scenarios and Objective Functions 103
4.4.1 Expected Time to Compute (ETC) Matrix Model Adapted to Energy and Security Aware Scheduling in Grids 104
4.4.2 Security Conditions 106
4.4.3 Energy Model 109
4.5 Security-Aware Genetic-Based Batch Schedulers 112
4.6 Empirical Evaluation of Genetic Grid Schedulers 115
4.6.1 Results 119
4.7 Multi-population Genetic Grid Schedulers 128
4.7.1 Empirical Analysis 130
4.7.2 Results 130
4.8 Related Work 132
4.9 Conclusions 135
References 136

5 Power Consumption Constrained Task Scheduling Using Enhanced Genetic Algorithms 139
Gang Shen, Yanqing Zhang
5.1 Introduction 139
5.2 Power Consumption Constrained Task Scheduling Problem 141
5.3 Enhanced Genetic Algorithm for the Green Task Scheduling Problem 144
5.3.1 Genetic Algorithm 144
5.3.2 Shadow Price Enhanced Genetic Algorithm 145
5.3.3 Green Task Scheduling Using *SPGA* 147
5.4 Performance Analysis 151
5.5 Conclusions 156
References 157

6 Thermal Management in Many Core Systems 161
Dhireesha Kudithipudi, Qinru Qu, Ayse K. Coskun
6.1 Introduction 161
6.2 Thermal Monitoring 162
6.2.1 Uniform Sensor Placement 163
6.2.2 Non-uniform Sensor Placement 163
6.2.3 Quality-Threshold Clustering 164
6.2.4 K-Means Clustering 165
6.2.5 Determining Thermal Hot Spots to Aid Sensor Allocation 166
6.2.6 Non-uniform Subsampling of Thermal Maps 168
6.3 Temperature Modeling and Prediction Techniques 170
6.3.1 Thermal Modeling 171

6.3.2 Temperature Prediction ... 173
6.4 Runtime Thermal Management ... 177
6.4.1 Model-Based Adaptive Thermal Management ... 177
6.5 Conclusions ... 182
References ... 183

7 Sustainable and Reliable On-Chip Wireless Communication Infrastructure for Massive Multi-core Systems ... 187
Amlan Ganguly, Partha Pande, Benjamin Belzer, Alireza Nojeh
7.1 Introduction ... 188
7.2 Related Work ... 188
7.3 Wireless NoC Architecture ... 190
7.3.1 Topology ... 191
7.3.2 Wireless Link Insertion and Optimization ... 192
7.3.3 On-Chip Antennas ... 195
7.3.4 Routing and Communication Protocols ... 196
7.4 Performance Evaluations ... 199
7.4.1 Establishment of Wireless Links ... 200
7.4.2 Performance Metrics ... 202
7.4.3 Performance Evaluation ... 203
7.5 Reliability in WiNoCs ... 211
7.5.1 Wireless Channel Model ... 212
7.5.2 Proposed Product Code for the Wireless Links ... 215
7.5.3 Residual BER of the Wireless Channel with H-PC ... 216
7.5.4 Error Control Coding for the Wireline Links ... 217
7.6 Experimental Results ... 220
7.7 Conclusion ... 223
References ... 223

8 Exploiting Multi–Objective Evolutionary Algorithms for Designing Energy–Efficient Solutions to Data Compression and Node Localization in Wireless Sensor Networks ... 227
Francesco Marcelloni, Massimo Vecchio
8.1 Introduction ... 228
8.2 Related Works ... 231
8.2.1 Data Compression in WSN ... 231
8.2.2 Node Localization in WSN ... 232
8.3 Data Compression in WSN: An MOEA–Based Solution ... 233
8.3.1 Problem Statement ... 233
8.3.2 Overview of Our Approach ... 234
8.3.3 Chromosome Coding and Mating Operators ... 235
8.4 Node Localization in WSN: An MOEA–Based Solution ... 236
8.4.1 Problem Statement ... 236
8.4.2 Overview of Our Approach ... 237
8.4.3 Chromosome Coding and Mating Operators ... 238
8.5 Multi–Objective Evolutionary Algorithms ... 238

8.5.1 NSGA–II 239
8.5.2 PAES 239
8.6 Experimental Results for the Data Compression Approach 240
8.6.1 Experimental Setup 240
8.6.2 Selecting an MOEA for the Specific Problem 241
8.6.3 Experimental Results 242
8.6.4 Comparison with LTC 244
8.7 Experimental Results for the Node Localization Approach 247
8.7.1 Experimental Setup 247
8.7.2 Experimental Results and Comparisons 249
8.8 Conclusions 252
References 253