

# Index

- Abelian Cayley graphs 88
- abstraction layer 2
- Aloha protocol 48
- antenna switching 45
- AODV 60
- asynchronous communication 6
- augmented Lagrangian 122
- augmented Lagrangian method 342
- automatic repeat request 42
- automotive LAN 256
  
- batch reactor 237
- best response 133, 136
- binary exponential backoff 49
- Bluetooth 40
- Bode's integral formula 282, 283
  
- carrier-sense multiple access 48
- centralized control 179
- Cesàro average 115, 131
- channel capacity 256, 258
- channel transmission blackout 160
- class  $\mathcal{H}$  functions 298
- class  $\mathcal{H}\mathcal{L}$  functions 298
- clock difference 4
- cluster tree 54
- co-design of real-time controllers 294
- co-existence 40
- coherence bandwidth 33
- coherence time 35
- communication constraints 204, 228
- communication imperfections 203
- comparison principle 307
  
- complementary sensitivity-like function 286
- completing the square 301
- component-based application development 7
- component economy 6
- component interface 9
- component reuse 6
- consensus: broadcast 85
- consensus: continuous time 81
- consensus: delay 81
- consensus: directed graphs 83
- consensus: gossip 86
- consensus: noise 82
- consensus: optimization 85
- consensus: packet loss 81
- consensus: performance indices 95
- consensus: problem definitions 79
- consensus: quantization 81
- consensus: randomized 80
- consensus: time-varying 79
- constraint based routing 59
- constraints 152
- context-aware addressing 4
- continuous-time model 228
- continuous-time or emulation approach 208, 247
- contraction mapping 136
- control application layer 2
- controller synthesis 221
- convergecast 56
- convergence rate 112
- cyclic redundancy check 42

- damage confinement 18
- data rate 261
  - in asymptotic average sense, 265
- deadline 10
- de Bruijn graphs 88
- decentralized control 180
  - dynamic problems, 188
  - networks, 193
  - optimization methods, 196
  - static problems, 182
- decentralized model predictive control 151
- decentralized prediction models 154
- decentralized temperature control 166
- decoupling matrices 155
- delay-differential equations 207
- delays 204
- delay spread 33
- design fault 17, 21
- deterministic approach 205
- discrete-time approach 206, 238
- discrete-time NCS model 211
- discrete-time switched linear uncertain system 243
- dispatcher 8
- dispatching module 15
- distributed model predictive control 151
- distributed operation 5
- diversity 43
- doppler spread 35
- dual decomposition 118, 127
- duty cycle 53
- dynamically scheduled medium access 52
- dynamic reconfiguration 3
- dynamic scheduling protocol 230
  
- earliest deadline first scheduling 12
- emulation approach 228
- emulation-based method 302
- entropy 284
- equilibrium point 298
- erasure fading 33
- error 17
- error control 42
- error detection 18
- error recovery 18
- Etherware 7
- Etherware architecture 8
- Etherware components 8
  
- Etherware kernel 8
- event-driven system 10
- event-trigger condition
  - $\mathcal{L}_2$ , 308
  - ISS, 303
  - NUM algorithm, 347
  - remote estimation problem, 333
- event-triggered NUM algorithm 344
  - scaling and convergence, 347
- event-triggering 294
  - 3DOF helicopter example, 350
  - dropouts and delays, 325
  - embedded control systems, 302
  - intersample interval, 313
  - networked control system, 322
  - optimization, 340
  - remote estimation, 330
  - state-dependent, 319
  - under delay, 313
- execution time 11, 15
- expander graphs 88
- expected transmission count 58
  
- fault 17
- fault management policy 21
- fault-tolerant component model 21
- fault tolerance 18
- fault treatment 18
- flat fading 33
- forward error correction 42
- frequency-division multiple access 47
- frequency hopping 44
- frequency-selective fading 33
- Frii's equation 35
  
- gain
  - $\mathcal{L}_2$ , 300
  - induced, 300
- gap (estimation) 332
- generalized averages 90
- Gilbert-Elliott model 39
- gradient method 111
  - projected gradient method, 113
- graph based routing 59
- graph properties 77
- gridding method 244
  
- Hamilton-Jacobi inequality (HJI) 301
- hard real-time 11
- heavy-ball method 112

- heterogeneity 2, 5
- hierarchical model predictive control 172
- hybrid ARQ 43
- hybrid model predictive control 172
- hybrid system 232
  
- IEEE 802.11 40
- IEEE 802.15.1 40
- IEEE 802.15.4 40
- IETF 6LoWPAN 66
- IETF ROLL 66
- impulsive DDEs 207
- impulsive delay-differential equations 223
- incentive compatible 138
- information constraints 180, 182
  - networks, 193–194
  - skyline, 191
- information theory 257, 282
- inter-application communication mechanisms 6
- interaction fault detection service 21
- interaction model 162
- inverted pendulum 257
- inverted pendulum control system 22
- ISA 100 65
- ISM band 40
- ISS-Lyapunov function 299
  
- job 10
- job placement rule (JPR) 16
  
- Kalman filtering 93
- Krasovskii's method 142
  
- Lagrangian duality 118
- Laplacian weights 83
- large-scale fading 35
- LaSalle's invariance principle 143
- least squares 91
- lifted model 212
- lifted state feedback 222
- lifted state vector 212
- link gain 37
- link metrics 58
- Lipschitz 298
- local temporal autonomy 20
- location difference 4
- LR-WPAN 40
  
- Lyapunov function 139, 141, 143, 298
- Lyapunov-Krasovskii functional 207, 221
  
- MAD (maximal allowable delay) 313
- MANSD (maximum allowed number of successive dropouts) 329
- maximally allowable delay 229
- maximally allowable transmission interval 229
- mean time between failures 17
- mean time to repair 17
- medium access control 45
- medium access delay 47, 49
- mesh topology 54
- message-oriented communication 6
- Metropolis-Hastings 130
- Metropolis-Hastings weights 83
- middleware 2, 5, 7
- minimum data rate problem 261, 265
- model predictive control 150, 152
- motion control example 213
- multi-step methods 112
- mutual information 285
  
- N-version programming 19
- naming service 6, 9
- Nash equilibrium 133, 162
- networked control 1
- networked control system
  - event-triggered, 320
- networked control systems 203
- networked optimization 126
- network-induced imperfections 204
- network topology 54
- network utility maximization (NUM) 341
- non-cooperative game 133
- non-functional requirements 5, 22
- NUM problem 341
  
- on-demand routing 60
- open-loop stepsize rules 112
- operational fault 17
- optimal control problem 152
- outage 37
- outage model 38
- overapproximation techniques 215
  
- packet dropouts 204
- packet loss 160, 272

- packet-loss probability 170
- parameter-dependent Lyapunov functions 220
- Pareto optimality 137
- path loss 36
- period 11, 15
- periodic protocol 243
- permanent fault 17
- polytopic models 207
- polytopic overapproximation 207, 215, 216
- portability 4, 7
- potential game 135, 141
- preamble sampling 53
- predictability 10
- price of anarchy 137
- primal decomposition 124
- primal function 124
- priority inheritance protocol 13
- priority inversion 13
- processor utilization factor 11
- proximal point method 122
  
- quadratic invariance 190
- quadratic programming 153
- quadratic protocol 243
- quality of service (QoS) 14
- quantization 256
- quantization errors 204
- quantized control 258
  - adaptive, 276
- quantizer 260
  - coarsest, 267, 275, 281
  - density of, 269
  - dynamic, 264, 280
  - logarithmic, 269, 280
  - uniform, 259
  
- Random geometric graphs 88
- rate monotonic scheduling 12
- real Jordan form 215
- receding horizon control 153
- receiver sensitivity 37
- recovery block scheme 19
- relative deadline 11, 15
- reliability 5, 17, 20
- remote estimation problem 331
- request-oriented communication 6
- resource sharing protocol 13
  
- reusability 4, 7
- Riccati equation 159
- robust stability analysis 215
- Round Robin protocol 230
- routing 58
- runtime component migration 9, 25
- runtime component upgrade 9, 25
- runtime system management 3, 5
  
- safety-critical system 4
- sampled-data approach 207, 246
- sampled-data NCS 224
- sampled-data system 302
- sampler 302
- sampling/transmission intervals 204
- schedulable 10
- schedule 10
- scheduling policy 10
- second-guessing 187
- self-triggered control 319
- semantic addressing 4, 9
- sensor calibration 92
- separation of concerns 294
- service components 8
- set-point tracking 160
- shortest path routing 58
- signal-to-noise ratio 37
- Slater's conditions 118
- small-scale fading 33
- small-world graphs 88
- soft real-time 11
- software design patterns 9
- software fault injection 18
- spectral factorization 197–198
- sporadic sampling 308
- stability
  - $\mathcal{L}_2$ , 300
  - asymptotic, 298
  - input-to-state (ISS), 299
  - Lyapunov, 298
- stability analysis 205, 218
- stabilization problem 205
- stable 139
  - asymptotically stable, 139
  - globally asymptotically stable, 139
- standard function 136
  - two-sided scalable function, 136
- star topology 54
- static protocol 230

- stochastic approach 205
- strong duality 118
- subgradient 114
  - incremental subgradient, 115
  - networked incremental subgradient, 132
  - projected subgradient, 115
- supermodular game 134
- switching function 243
- synchronous communication 6
  
- task 10
- TCP 61
- thread scheduling rule (TSR) 15
- time-critical system 4
- time-division multiple access 47
- timeliness 5, 10
- tradeoff curves 235
- tradeoffs 204
- transient fault 17
  
- Try-Once-Discard protocol 230
- two-player problem 198–199
  
- UDP 61
- uncertain systems 276
- unreliable channels 272
  
- value function
  - event-triggered estimator, 334
- vehicle spacing example 180
  - solution, 184
  
- weak duality 118
- WirelessHART 63
- wireless propagation 32
- Witsenhausen's counterexample 181
- WLAN 40
  
- Zeno behavior 306
- zero-order hold 302
- Zigbee PRO 62