

# Index

$N_P$ , 4, 235  
 $N_P^*$ , 5  
 $P_{ID}$ , 4, 235  
 $\mathbb{N}_P$ , 6  
 $\text{Pid};$ , 6  
`RecvMsg`, 7  
`SendMsg`, 7  
`agg`, 7  
`global_block_range`, 191  
`global_block_ranges`, 191  
`global_ind`, 7  
`local`, 7  
`map`, 7, 85  
`pRUN`, 9  
`put_local`, 7  
`synch`, 71  
`transpose_grid`, 206  
 $1^*N_P$ , 5  
  
Amdahl fraction, 118  
Amdahl's Law, 117  
Application characteristics, 112  
  
Bandwidth, 112, 116  
Bandwidth versus message size, 95  
Barrier synchronization, 175  
Beamforming, 39  
  
Client/server, 61  
Coarse grained block, 113  
Code and Cost Modeling (CoCoMo),  
    135  
Coding rate, 136

Communication  
    all-to-all, 60, 97, 128  
    bandwidth, 126  
    complexity, 108  
    latency, 126  
    nearest-neighbor, 60  
    network, 125  
    overhead, 98  
    pattern, 60  
    pipeline, 60  
    scatter/gather, 60  
    time, 116, 126  
Computation-to-communication, 63,  
    65, 108, 155  
Computational complexity, 108, 152  
Computational science, 144  
Compute time, 115  
Concurrency, 87, 234  
Convolution, 22, 57  
Corner turn, 128  
Critical path, 221  
  
Data structures, 108  
Debugging steps, 18, 71, 100  
Degrees of parallelism, 108, 113, 154  
Discrete Fourier Transform (DFT),  
    201  
Distributed arrays  
    block, 5, 81, 239  
    block-cyclic, 82, 239  
    constructor, 7  
    cyclic, 81, 83, 239  
    design goals, 80  
    flat, 239

- fragmented, 78
- hierarchical, 239
- hybrid, 184, 189, 191, 217, 220, 225
- implementation level, 90
- index, 185
- indexing, 5, 238
- local part, 5, 47, 77, 237
- model, 62, 70, 130
- output, 47
- overlap, 62, 66, 81
- pure, 78
- redistribution, 5, 7, 93
- 
- Efficiency**
  - communication, 156
  - compute, 133, 156
  - software, 134
- 
- Fast Fourier Transform (FFT)**
  - 1D, 201
  - 2D, 203, 235
  - algorithm, 149
  - bandwidth, 205
  - Gigaflops, 204
- 
- File IO, 30**
- 
- Filtering in two dimensions, 234**
- 
- Fixed problem size, 121**
- 
- Function overloading, 91**
- 
- Hardware model, 123**
- 
- High Performance Computing (HPC)**
  - Challenge**
    - characteristics, 154
    - Kuck diagram, 148
    - memory hierarchy, 146
    - spatial/temporal, 147
  - High Performance Embedded Computing (HPEC)**
    - Challenge, 235
  - 
  - High Performance Linpack (HPL)**
    - algorithm, 151, 217
    - Gigaflops, 218
  - 
  - Inverse bandwidth, 126**
- 
- Kuck diagram, 128, 148, 235, 238, 240**
- 
- Latency, 131**
- 
- Latency versus message size, 98**
- 
- Load balancing, 83**
- 
- Load imbalance, 84**
- 
- Locality, 87, 234**
- 
- LU**
  - algorithm, 217
  - parallel, 219
  - performance, 221
- 
- Manager/worker, 61, 62, 67, 130**
- 
- Mandelbrot set, 13**
- 
- Map, 5, 8, 50, 62, 80, 236, 240**
- 
- Map-based programming, 8, 80**
- 
- MATLAB**
  - usage, xix
- 
- MatlabMPI, 95**
- 
- Memory bandwidth, 177**
- 
- Memory hierarchy, 123, 124, 129, 146, 156**
- 
- Message passing, 7, 62, 65, 69, 95, 130**
- 
- Message Passing Interface (MPI)**
  - rank, 62
- 
- Message Passing Interface (MPI)**
  - size, 62
- 
- Multicore, 123**
- 
- Multinode, 123**
- 
- Network topology, 125**
- 
- Owner computes, 62, 78, 131**
- 
- P notation, 5, 235**
- 
- Parallel**
  - coarse-grained, 21
  - conduit, 243
  - data, 113
  - easy applications, 145
  - embarrassingly, 12, 103, 172
  - execution, 9, 92
  - fine-grained, 12
  - hard applications, 145
  - multistage, 41

- pipeline, 49, 83, 113, 242
- pleasingly, 12
- task, 61, 113, 243
- Performance, 98
  - estimating, 157
  - memory, 55
  - message size, 98, 126, 187
  - metrics, 107
  - multicore, 177, 197, 209
  - multinode, 177, 198, 211
  - profiling, 56
  - serial, 58
  - time, 55
  - versus effort, xix, 80, 89, 102, 136, 163
- pMatlab
  - development, xxiv
- Polymorphism, 90
- Processor Index Tagged FAmiLy of Line Segments (PITFALLS), 93
- Processor sizing, 113
- Productivity, 137, 166
- Programming patterns, 59
- RandomAccess
  - algorithm, 151, 183
  - Giga Updates Per Second (GUPS), 183
- Scaled problem size, 121
- Scaling, 102
  - Scaling out, 178
  - Scaling up, 178
- Simulation science, 144
- Single-Instruction Multiple-Data (SIMD), 144
- Single-Program Multiple-Data (SPMD), 4, 234
- Size, weight, and power, 132
- Software cost, 135
- Software Lines of Code (SLOC), 100, 135
- Spatial locality, 122
- Spatial score, 122
- Speedup, 20, 119
  - linear, 100, 119
  - saturation, 120
  - sublinear, 119
  - superlinear, 120
- StarP, xxiii
- Stream
  - algorithm, 149, 171
  - all-to-all, 150
  - bandwidth, 171
  - embarrassingly parallel, 149
- Strong scaling, 121
- Supercomputer, 143
- Temporal locality, 122
- Temporal score, 122
- Throughput, 132
- Vectorize, 144
- Von Neumann model, 121
- Weak scaling, 121