
Contents

Preface	VII
1 What Is Guerrilla Capacity Planning?	1
1.1 Introduction	1
1.2 Why Management Resists Capacity Planning	1
1.2.1 Risk Management vs. Risk Perception	2
1.2.2 Instrumentation Just Causes Bugs	3
1.2.3 As Long as It Fails on Time	4
1.2.4 Capacity Management as a Homunculus	5
1.3 Guerrilla vs. Gorilla	6
1.3.1 No Compass Required	7
1.3.2 Modeling Is Not Like a Model Railway	8
1.3.3 More Like a Map Than the Metro	8
1.4 Tactical Planning as a Weapon	9
1.4.1 Scalability by Spreadsheet	10
1.4.2 A Lot From Little	11
1.4.3 Forecasting on the Fly	13
1.4.4 Guerrilla Guidelines	14
1.5 Summary	16
2 ITIL for Guerrillas	17
2.1 Introduction	17
2.2 ITIL Background	17
2.2.1 Business Perspective	19
2.2.2 Capacity Management	21
2.3 The Wheel of Capacity Management	21
2.3.1 Traditional Capacity Planning	21
2.3.2 Running on the Rim	23
2.3.3 Guerrilla Racing Wheel	24
2.4 Summary	25

3	Damaging Digits in Capacity Calculations	27
3.1	Introduction	27
3.2	Significant Digits	28
3.2.1	Accuracy	28
3.2.2	Precision	29
3.3	Sifting for SigDigs	30
3.3.1	Count by Zeros	30
3.3.2	Significance and Scale	32
3.4	Rounding Rules	32
3.4.1	Golden Rule	34
3.4.2	Sum Rule	34
3.4.3	Product Rule	34
3.5	Planning With Dollars and Sense	35
3.5.1	Cost Metric	35
3.5.2	Significant Digits	36
3.6	Expressing Errors	37
3.6.1	Absolute Error	37
3.6.2	Relative Error	37
3.6.3	Standard Deviation	37
3.6.4	Standard Error	38
3.6.5	Error Bars	38
3.6.6	Instrumentation Error	39
3.7	Interval Arithmetic	39
3.8	Summary	40
4	Scalability—A Quantitative Approach	41
4.1	Introduction	41
4.2	Fundamental Concepts of Scaling	41
4.2.1	Geometric Scaling	42
4.2.2	Allometric Scaling	43
4.2.3	Critical Size	44
4.2.4	Sizing Examples	45
4.3	Hardware Scalability	47
4.3.1	Ideal Parallelism	48
4.3.2	Amdahl's Law	49
4.3.3	Multiuser Scaleup	52
4.3.4	Serial-Parallel Duality	55
4.3.5	Scaled Speedup	56
4.4	Universal Scalability Model	56
4.4.1	The Role of Coherency	58
4.5	Other Scalability Models	63
4.5.1	Geometric Model	63
4.5.2	Quadratic Model	63
4.5.3	Exponential Model	63
4.6	Multicores and Clusters	64
		66

4.7	Summary	68
5	Evaluating Scalability Parameters	71
5.1	Introduction	71
5.2	Benchmark Measurements	72
5.2.1	The Workload	72
5.2.2	The Platform	74
5.2.3	The Procedure	75
5.3	Minimal Dataset	75
5.3.1	Interpolating Polynomial	76
5.3.2	Regression Polynomial	76
5.4	Capacity Ratios	77
5.5	Transforming the Scalability Equation	77
5.5.1	Efficiency	78
5.5.2	Deviation From Linearity	78
5.5.3	Transformation of Variables	79
5.5.4	Properties of the Regression Curve	80
5.6	Regression Analysis	82
5.6.1	Quadratic Polynomial	82
5.6.2	Parameter Mapping	83
5.6.3	Interpreting the Scalability Parameters	85
5.6.4	Error Reporting	86
5.7	Less Than a Full Deck	87
5.7.1	Sparse Even Data	88
5.7.2	Sparse Uneven Data	90
5.7.3	Missing $X(1)$ Datum	91
5.8	Summary	94
6	Software Scalability	97
6.1	Introduction	97
6.2	Amdahl's Law for Software	98
6.3	Universal Software Scalability	100
6.4	Concurrent Programming and Coherency	102
6.5	UNIX Multitasking Application	103
6.5.1	The Workload	103
6.5.2	The Platform	104
6.5.3	Regression Analysis	104
6.6	Windows-Based Applications	107
6.6.1	The Workload	107
6.6.2	The Platform	108
6.6.3	Regression Analysis	109
6.7	Multitier Architectures	110
6.7.1	The Workload	111
6.7.2	The Platform	111
6.7.3	Regression Analysis	112

6.7.4	Why It Works	114
6.8	Classification by Workload	115
6.9	Summary	116
7	Fundamentals of Virtualization	117
7.1	Introduction	117
7.2	The Spectrum of Virtual Machines	118
7.2.1	VM Spectroscopy	118
7.2.2	Polling Rates and Frequency Scales	119
7.3	Microlevel Virtual Machines: Hyperthreading	119
7.3.1	Micro-VM Polling	122
7.3.2	Thread Execution Analysis	123
7.3.3	Missing MIPS Explained	124
7.3.4	Windows 2000 Production Server	126
7.3.5	Guerrilla Capacity Planning	127
7.4	Mesolevel Virtual Machines: Hypervisors	127
7.4.1	Fair-Share Scheduling	129
7.4.2	Meso-VM Polling	132
7.4.3	VMWare Share Allocation Analysis	134
7.4.4	J2EE WebLogic Production Application	135
7.4.5	VMWare Scalability Analysis	137
7.4.6	Guerrilla Capacity Planning	138
7.5	Macrolevel Virtual Machines: Hypernets	138
7.5.1	Macro-VM Polling	139
7.5.2	Bandwidth Scalability Analysis	140
7.5.3	Remote Polling Rates	141
7.5.4	Guerrilla Capacity Planning	142
7.6	Summary	142
8	Web Site Planning	143
8.1	Introduction	143
8.2	Analysis of Daily Traffic	144
8.2.1	The Camel and the Dromedary	144
8.2.2	Unimodal but Bicoastal	146
8.3	Effective Demand	148
8.3.1	Modeling Assumptions	149
8.3.2	Statistical Approach	149
8.4	Selecting Statistical Tools	150
8.4.1	Spreadsheet Programming	150
8.4.2	Online Support	150
8.5	Planning for Data Collection	151
8.5.1	Commercial Collectors: Use It or Lose It	151
8.5.2	Brewing in the Background	151
8.6	Short-Term Capacity Planning	152
8.6.1	Multivariate Regression of Daily Data	152

8.6.2	Automation Using Spreadsheet Macros	153
8.7	Long-Term Capacity Planning	155
8.7.1	Nonlinear Regression of Weekly Data	155
8.7.2	Procurement Curves	156
8.7.3	Estimating Server Scalability	157
8.7.4	Calculating Capacity Gains	158
8.7.5	Estimating the Doubling Period	161
8.8	Summary	162
9	Gargantuan Computing—GRIDs and P2P	165
9.1	Introduction	165
9.2	GRIDs vs. P2P	166
9.3	Analysis of Gnutella	167
9.4	Tree Topologies	168
9.4.1	Binary Tree	169
9.4.2	Rooted Tree	169
9.4.3	Cayley Tree	169
9.5	Hypernet Topologies	169
9.5.1	Hypercube	170
9.5.2	Hypertorus	170
9.6	Capacity Metrics	170
9.6.1	Network Diameter	170
9.6.2	Total Nodes	171
9.6.3	Path Length	171
9.6.4	Internal Path Length	171
9.6.5	Average Hop Distance	171
9.6.6	Network Links	172
9.6.7	Network Demand	172
9.6.8	Peer Demand	172
9.6.9	Bandwidth	173
9.7	Relative Bandwidth	173
9.7.1	Cayley Trees	173
9.7.2	Trees and Cubes	174
9.7.3	Cubes and Tori	175
9.7.4	Ranked Performance	176
9.8	Summary	176
10	Internet Planning	179
10.1	Introduction	179
10.2	Bellcore Traces	180
10.3	Fractals and Self-Similarity	182
10.4	Fractals in Time	186
10.4.1	Short-Range Dependence	186
10.4.2	Long-Range Dependence	188
10.5	Impact on Buffer Sizing	190

10.5.1	Conventional Buffer Sizing	190
10.5.2	LRD Buffer Sizing	192
10.6	New Developments	193
10.6.1	Ethernet Packetization	194
10.6.2	LRD and Flicker Noise	196
10.7	Summary	197
11	Going Guerrilla—A Case Study	199
11.1	Introduction	199
11.2	Guerrilla Monitoring Phase	199
11.3	The Basic Solution	201
11.3.1	Implementation Details	202
11.3.2	Orca Output Examples	203
11.3.3	Round-Robin Database	203
11.4	Extending the Basic Solution	206
11.4.1	Mainframe Data Processing	206
11.4.2	Guerrilla Planning Phase	207
11.4.3	Monitoring With ORCAAlerts	208
11.5	Future Developments	209
11.6	Summary	210
 Appendix		
A	Amdahl and the Repairman	213
A.1	Repairman Queueing Model	213
A.2	Amdahl's Law for Parallel Subtasks	214
A.2.1	Single Task	215
A.2.2	Two Subtasks	215
A.2.3	Multiple Subtasks	215
A.3	Amdahl's Law for Concurrent Multitasks	217
A.4	Note On Nelson's Approach	217
B	Mathematica Evaluation of NUMA Parameters	219
B.1	Mathematica Packages	219
B.2	Import the Data	219
B.3	Tabulate the Data	220
B.4	Plot Normalized Data	220
B.5	Nonlinear Regression	221
B.6	ANOVA Report	221
B.7	Maximal CPU Configuration	222
B.8	Plot of Regression Model	222

C	Abbreviations and Units	223
	C.1 SI Prefixes	223
	C.2 Time Suffixes	223
	C.3 Capacity Suffixes	224
D	Programs for Chapter 3	225
	D.1 Determine SigDigs in VBA	225
	D.2 Determine SigDigs in Mathematica	226
	D.3 Determine SigDigs in Perl	227
E	Programs for Chapter 8	229
	E.1 Example Data Extractor in Perl	229
	E.2 VBA Macro for Calculating U_{eff}	231
F	The Guerrilla Manual	235
	F.1 Weapons of Mass Instruction	235
	F.2 Capacity Modeling Rules of Thumb	238
	F.3 Scalability on a Stick	240
	F.3.1 Universal Law of Computational Scaling	240
	F.3.2 Areas of Applicability	241
	F.3.3 How to Use It	241
	Bibliography	243
	Index	249