### **Index**

Abstract syntax tree, 64–65	Binary program, 226
Access control list (ACL), 594-595	Binding, 29–31
Access path, 566	definition, 29
definition, 566	Binding time, 29–31
Activation record, 169	Blocking factor, 549–550
Ada	definition, 549
concurrent programming, 437–443 package, 437	Blocking of records, 548–550 BNF, 24
real time programming, 439–443 task, 437–439	Bottom up parsing, 75–84 LALR parsing, 83–84
Address translation unit (ATU), 480, 483, 485, 489, 492, 493, 511	operator precedence parsing, 80-83
Allocation data structures, 37, 52-57, see	Buddy system, 465–467
also Stacks, Heaps, Search data structures	Buffering of records, 545–548 Busy wait, 402
Application domain, 1	Capability
Array allocation, 177–179	based addressing, 598–599
Assembler, 86–130	based protection, 596–602
analysis phase, 92–93	definition, 596
data structures, 99, 125, 127	in software, 601–602
intermediate code, 94, 101–104, 110	structure, 597
pass structure, 94–95, 104	Capability list (C-list), 595–596
single pass assembler, 111, 121–130	Command interpreter, 281–285
synthesis phase, 92	Command language, 265
two pass assembler, 95–111	Command menu, 265
Assembly language, 86–91, see also Intel	Communication protocol, 615–619
8088 assembly language	Compiler
advantages, 90–91	back end, 16-19
declaration statements, 89–90	basic block, 203
directives, 90, 96–98	calling convention, 195
imperative statements, 89	code generation, 17–18
literal, 90	code generator, 180–186
Atomic action, 581–583	code optimization, 199–218
Authentication, 592	control flow analysis, 207
rest sales de la particiona del la particiona de la particiona della particiona della particiona della particiona della parti	control structure, 192
Backtracking, 67	control structure compilation, 192-
Batch processing, 277–287	198
memory management, 280	data flow analysis, 208-211
sharing and protection, 280–286	dísplay, 173

dope vector, 178 dynamic memory allocation, 166, 168– 176 dynamic pointer, 170–171 expression compilation, 180–192 front end, 13–16 global optimization, 203, 206–211 intermediate code, 14, see also Intermediate code local optimization, 203–206 memory allocation, 17, 165–180 memory binding, 166 operand descriptor, 181 parameter passing, 196–198 register descriptor, 182 static memory allocation, 166 static pointer, 172 tables, 14 Compiler writing tool, see LEX, YACC Condition variable, 430–432 Conditional critical region (CCR), 422– 425 Contiguous memory allocation, 471–478	Detranslator, 3 Device driver, 540–542 Dining philosophers problem, 410–411 Direct manipulation system, 265 Directory, 563–568 current directory, 565 hierarchy, 564–565 home directory, 565 mounting, 567–568 Disk mirroring, 581 Disk space allocation, 569–571 indexed allocation, 570–571 linked allocation, 570 Distributed control algorithm, 624–633 deadlock handling, 629–633 mutual exclusion, 625–629 Distributed operating system, 604–649 design issues, 608–610 file system, 633–637 reliability, 637–642 resource allocation, 622–624 security, 643–649 Distributed system, see also Event prece
Control structure, 165 Critical region (CR), 419–422 Critical section (CS), 399–408 algorithmic implementation, 402–407 definition, 399 properties of implementation, 399–	dence, Distributed control algorithm definition, 605 model, 606 state, 619-620 Dynamic binding, 30
Data structures, 36–57 Linear data structure, 36 Nonlinear data structure, 36 Deadlock, 371–395 conditions for, 376–377 definition, 371	Editor, 257–259 Encryption, 588–591, 643–646 definition, 589 one-way function, 589 private key encryption, 644 public key encryption, 645 EQU statement, 96, 117
Deadlock handling, 377–395 Banker's algorithm, 389–393 deadlock avoidance, 386–393 deadlock characterization, 377–382 deadlock detection, 383–385 deadlock prevention, 386–388 deadlock resolution, 385–386 mixed approach, 393–394	Event, 324 Event control block (ECB), 355 Event monitoring, 354–357 Event precedence, 620–622 Execution domain, 1 Execution gap, 2 Execution profile, 255
Debug monitor, 260–261 Degree of multiprogramming, 302 Derivation, 21–22	Fault tolerance, 580–583, 639–641 File access, 571–574 File control block (FCB), 562

File label, 562	Interprocess communication, 331–332, 447–
File map table (FMT), 570	459
File organization, 542–544	Interprocess message, 447–454
File protection, 569, 592–596	in Mach, 458–459
File sharing, 576–577	in Unix, 456–457
File system, 521, 561-586, see also File	Interrupt hardware, 291–293
access, File sharing, File protec-	Interrupt processing, 293
tion, Atomic action, Disk mir-	IO channel, 523
roring	IO channels, 289–290
actions at file close, 574	IO device, 526–529
actions at file open, 572-573	IO organization, 522–525
integrity, 578–580	IO processor, see IO channel
reliability, 578-584, see also Recov-	IOCS, see Physical IOCS, Logical IOCS
ery, Fault tolerance	
Finite state automaton (FSA), 60	Job class, 352–353
Deterministic FSA (DFA), 60	
Fork-join, 332–333	Kerberos, 647–649
Formal language, 19	Knot, 379
Forward reference, 11	. I i wa
	Language migrator, 3
Garbage collection, 475–476	Language processing, 9
	Language processor, 2–3
Hash table	analysis phase, 9
collision, 44	back end, 12
collision handling, 46–49	definition, 2
hashing function, 44–46	front end, 12
Hash tables, 44–49	intermediate representation(IR), 12
Heap, 55–57, 461–464	definition, 12
Пеар, 33-37, 401-101	pass, 11
Indivisible operation, 413	synthesis phase, 9
Intel 8088	Language translator, 3
architecture, 111–113	LEX, 31–33
assembly language, 117–121	Lexical analysis, see Scanning
	Linker, 221–248, see also Object module
instructions, 113–117	ENTRY statement, 225
linker, 240–243	external reference, 225
autolinking, 239	EXTRN statement, 225
object module, 233–239	
single pass assembler, 111, 121–130	for Intel 8088, 233–245, see Intel 8088
Intermediate code, 187–192, 217	linker
expression tree, 190–192	linking, 225–226, 230–231
	linking for overlays, 245–248
quadruple, 189–190	program relocation, 223-225, 229-
triple, 188–189	230
Interpretation, 7–8	definition, 223
Interpreter, 3-4, 212-218	public definition, 225
advantages, 213	Linking, 225
impure interpreter, 217	Load balancing, 610
schematic, 213–214	Loader, 221, 248

absolute loader, 224	Networking, 611-613
relocating loader, 224	Non-preemptible server, 345
Locality of reference, 486–487	Noncontiguous memory allocation, 479-
Logical address, 481	482
Logical device, 531–532	
	Object module, 221, 227
Logical IOCS, 521, 552–557	Optimizing transformations, 200–203
LR parsing, 76, see also Bottom up pars-	ORIGIN statement, 96, 105, 117
ing	
	OS kernel, 315
Macro	OS mechanism, 314
attributes, 140	OS microkernel, 316–317
conditional expansion, 134, 140–144	OS policy, 314
definition and call, 132–133 expansion, 133–137	Overlay, 245
A-27 37 17 17 17 17 17 17 17 17 17 17 17 17 17 17	Page block table (PBT), 497
expansion time loops, 134, 141–143	Page map table (PMT), 497
expansion time variable, 139–140	
keyword parameter, 135–137	Page reference string, 500
nested macro call, 137–138	Page replacement, 486
positional parameter, 134–135	Page replacement policies, 499–505
semantic expansion, 143-144	FIFO replacement, 502
Macro assembler, 158–160	inclusion property, 504–505
Macro preprocessor, 145–158	LRU replacement, 502–503
data structures, 147–150	optimal replacement, 501
macro definition processing, 150	Paging, see also Thrashing, Locality of
macro expansion, 153-158	reference, Page replacement
Mailbox, 454–456	address translation, 482–484, 489–490
Memory allocation	demand paging, 484
to a process, 469–471	
Memory compaction, 464	memory protection, 492–493
Memory fragmentation, 302–304, 475–476	page, 482
definition, 302	page block, 482
Memory handler, 461	page fault, 485
	page traffic, 485
Memory management, 460–518	sharing of pages, 508-510
Memory protection, 471–473, 492–493	Paging hardware, 488–496
bounds registers, 471–472	Paging software, 496–510
protection keys, 472	Parbegin-Parend, 333-334
Monitor, 426–436	Parse tree, 22–23, 64–65
MULTICS, 515-517	Parsing 15 (4.04
Multiprocessors	Parsing, 15, 64-84, see also Top down
master-slave, 366–367	parsing, Bottom up parsing
symmetrical multiprocessors (SMP),	Password, 592, 593
368	Physical address, 481
Multiprogramming, 287–305	Physical IOCS, 521, 530–542
hardware support, 288–293	rr domain, I
program classification, 297–298	Prediction, 67
program priority 200, 202	Preprocessor, 3
program priority, 298–302	Privileged mode, 290–291
scheduling, 296–302	Problem oriented language, 4
supervisor functions, 295-304	Procedure call 104 105
	Procedure call, 194–198

calling convention, 195–196	ambiguity, 27
side effect, 194	classification, 25–26
Procedure oriented language, 4	definition, 20
Process, 321–340	handle, 78
creation, 322	nonterminal symbol, 20
definition, 320	operator grammar, 26
dispatching, 354, 358	operator precedence, 79
interacting processes, 327–332	operator precedence grammar, 79–80
control synchronization, 329-330	production, 20
data access synchronization, 330	recursive specification, 23–25
definition, 328	simple phrase, 78
implementation, 332–340	simple precedence, 77
preemption, 354, 358	simple precedence grammar, 77
scheduling, 326, 358–360, 362–364	string, 19
state, 322–323	terminal symbol, 19
termination, 327	Protocol, 449
Process control block (PCB), 324–326	d)
Process precedence, 396	Race condition, 330, 399
implementation, 398	Readers–Writers problem, 409–410, 417–
Process precedence graph, 397	419
Process precedence sequence, 397–398	Readers-Writers problem, 425, 444
Process synchronization, 396–443, see also	Real time application, 311–313
Critical section, Semaphores, Crit-	definition, 311
ical region, Conditional critical	Real time system, 311–313
region	Recovery, 583–584, 638–639
classical problems, 408–411	Recursion, 175–176
control synchronization, 396–398	Reduction, 22
Producer–Consumer problem, 408–409, 416–	Regular expression, 61–62
417, 421–422	Relocation factor, 224
Producer-Consumer problem, 424, 442	Remote procedure call (RPC), 617–619
Program flow graph (PFG), 207	Resiliency, 641–642
Program generation, 5–7, 257	Resource knot, 381
Program instrumentation, 256	Resource request and allocation graph (RRAG),
Program interpretation, 9	373–374
Program mix, 297	Response time, 305
Program priority, 298–302	Round robin scheduling, 306
Program relocation, 473–474	0
Program translation, 7, 9	Scanning, 14–15, 59–63
Programming environment, 262–264	use of automata, 60–63
Programming language	Scheduling, 279, 296–297, 306–309, 343–
	368 1 368 1
data type, 162–163	
definition, 162	job scheduling, 351–353
execution gap, 2	non-preemptive, 345–348
	preemptive, 348–350
semantic gap, 162–165	process scheduling, 353–365
Programming language grammar, 19–27	multi-level scheduling, 362–364
alphabet, 19	multiprogramming, 358–360

Time slice, 307 Time-stamp, 621–622

: 1 : 260 262	Token, 626
time sharing, 360–362	Top down parsing, 65–75
Search data structures, 37–52	LL parsing, 73–74
Security, 643–649	recursive descent parsing, 71-73
Segmentation, 511–517	without backtracking, 69-70
Self relocating program, 232	Turn around time, 279
Semantic analysis, 15–16	Two phase commit, 640–641
Semantic gap, 1	Two phase commis, and and
Semaphore, 413–419	Unix
definition, 413	access control list, 595
implementation, 415–416	buffer cache, 558
Sentence, 21	device driver, 541–542
Sentential form, 21	
Shift-reduce parsing, 76, see also Bottom	directory mounting, 585–586
up parsing	file allocation, 584–585
Simula, 426–428	file descriptor, 558
Software tool, 249–269	file processing, 558–559
definition, 249	file sharing, 586
program generation, 257	file system, 584–586
program preprocessing, 256	i-node, 558
Source language, 3	interprocess message, 456-457
Specification gap, 2	memory management, 511
Spooling, 393	process, 334–335
•	process management, 365–366
Stable storage, 581	User interface (UI), 264–269
Stack, 52–54	Osci interface (O1), 204–209
Static binding, 30	Virtual memory (VM), 480-482, see also
Swapping, 309	Paging
Symbol table, 38	
Syntax analysis, see Parsing	address translation, 480–481
System call, 295	Virtual memory system, 481
The state of the s	VTOC, 562
Table organizations, 41–49, see also Hash	Weit for and (WEC) of
table	Wait for graph(WFG), 374
binary search, 43–44	Working set, 506–507
linked lists, 49	definition, 506
sequential search, 42–43	VACC at a
tree structured tables, 49–50	YACC, 31–34
Target language, 3	
Text editor, see Editor	
Thrashing, 487–488	
Threads, 336–342	
Kernel level threads, 338–339	
User level threads, 339–340	
Throughput, 296	A SECTION AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRES
Time sharing, 305–309	- W
memory management, 309	
scheduling, 306–309	9 Mi 200 jun 2,000

### Second Revised Edition



# Systems Programming and

## **Operating Systems**

Extensively rewritten to enhance readability and cohesion. Numerous improvements in the presentation of concepts have been effected throughout; errors and ambiguities have been corrected.

#### Highlights of this edition:

- Added a section on resource allocation and user interface functions.
- The section on threads has been rewritten.
- Discussion of working set allocator is revised completely—elaborations are added to the example on working set allocator.
- New discussion added on IO initiation.
- Sections on hashing function, garbage collection, code optimisation, relocation and linking concepts, deadlock handling algorithms, system states and many others have been elaborated upon and rewritten to enhance understanding.
- Chapters on Software Tools, Assembler, Interprocess Communication,
   File Systems and Protection and Security are substantially rewritten.

Visit us at: www.tatamcgr

ISBN-13: 978-0-07-44 ISBN-10: 0-07-46357

The McGraw-Hill Companies



**Higher Education**