

THIS VERSION WAS PRODUCED BY REVERTING THE SEVENTH  
EDITION KERNEL SOURCE CODE AND A PROGRAM WRITTEN TO  
GENERATE THE INDEX AND CROSS REFERENCE  
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# UNIX OPERATING SYSTEM SOURCE CODE LEVEL SIX

This booklet has been produced for students at the University of New South Wales taking courses 6.602B and 6.657G.

It contains a specially edited selection of the UNIX Operating System source code, such as might be used on a typical PDP11/40 computer installation.

The UNIX Software System was written by K. Thompson and D. Ritchie of Bell Telephone Laboratories, Murray Hill, NJ. It has been made available to the University of New South Wales under a licence from the Western Electric Company.

J. Lions  
Department of Computer Science  
The University of New South Wales.  
June, 1977



6746 access	3472 getgid	2855 nosys	3439 setuid
6956 alloc	6181 getmdev	4999 notavil	8201 sgtty
0734 aretu:	3480 getpid	1771 nseg	3949 signal
1012 backup:	3413 getswit	6577 nulldev	2066 sleep
7040 badblock	3452 getuid	2864 nullsys	3595 smdate
4856 bawrite	4136 grow	5765 open	6086 smount
6585 bcopy	3420 gtime	5804 open1	1293 spl0:
4836 bdwrite	8165 gtty	6702 openi	1297 spl1:
5229 bflush	7067 ialloc	6791 owner	1302 spl4:
5055 binit	1284 idle:	2416 panic	1303 spl5:
6415 bmap	7134 ifree	6517 passc	1308 spl6:
4754 bread	7276 iget	8669 pcclose	1313 spl7:
4773 breada	6922 iinit	8763 pcleader	3614 ssig
4869 brelse	4899 incore	8648 pcopen	5979 sslep
4809 bwrite	0895 incupc:	8748 pcoutput	6028 stat
8274 canon	5018 iodone	8739 pcprint	6045 stat1
3538 chdir	6364 iomove	8682 pcread	3428 stime
3560 chmod	4982 iowait	8719 pcrint	4016 stop
3575 chown	7344 iput	8710 pcstart	8183 stty
8234 cinit	3991 issig	8701 pcwrite	0827 subyte:
0676 clearseg:	7414 itrunc	5259 physio	0826 suibyte:
3725 clock	7374 iupdat	7723 pipe	0860 suiword:
5846 close	3630 kill	7862 plock	6144 sumount
6643 closef	8055 klclose	2433 prdev	1739 sureg
6672 closei	8023 klopen	7882 prele	6811 suser
5038 clrbuf	8062 klread	2340 printf	0861 suword:
1244 copyin:	8078 klrint	2369 printn	5196 swap
1252 copyout:	8090 klsgtty	4204 procxmt	2178 swtch
0696 copyseg:	8066 klwrite	3667 profil	3486 sync
4094 core	8070 klxint	4043 psig	3845 timeout
6542 cpass	1393 ldiv:	3963 psignal	3656 times
5781 creat	5909 link	4164 ptrace	2693 trap
2447 deverror	8879 lpCanon	0967 putc:	2841 trap1
5096 devstart	8863 lpclose	2386 putchar	8535 ttread
0890 display:	8976 lpint	5731 rdwr	8486 ttrstrt
1319 dpadd:	8850 lpopen	5711 read	8505 ttstart
1327 dpcmp:	8986 lpoutput	6221 readi	8550 ttwrite
6069 dup	8967 lpstart	7758 readp	8333 ttyinput
1650 estabur	8870 lpwrite	0740 retu:	8373 ttyoutput
3020 exec	1401 lrem:	3205 rexit	8577 ttystty
3219 exit	1410 lshift:	5123 rhstart	7689 uchar
2268 expand	1550 main	5420 rkaddr	6824 ufalloc
6847 falloc	7455 maknode	5451 rkintr	3510 unlink
8252 flushtty	2528 malloc	5476 rkread	7201 update
3322 fork	5156 mapalloc	5440 rkstart	3270 wait
7000 free	5182 mapfree	5389 rkstrategy	2113 wakeup
6014 fstat	6326 max	5483 rkwrite	7477 wdir
0815 fubyte:	2556 mfree	0889 savfp:	8217 wflushtty
0814 fuibyte:	6339 min	0725 savu:	5720 write
0844 fuiword:	5952 mknod	3354 sbreak	6276 writei
0845 fuword:	9016 mmread	7679 schar	7805 writep
4921 getblk	9042 mmwrite	1940 sched	4433 xalloc
0930 getc:	7518 namei	5861 seek	4490 xccdec
5336 geterror	1826 newproc	3460 setgid	4398 xfree
6619 getf	3493 nice	2156 setpri	4368 xswap
7167 getfs	6566 nodev	2134 setrun	

File param.h	File prf.c	4136 grow	5861 seek	7679 schar
File systm.h	2340 printf	4164 ptrace	5909 link	7689 uchar
File seg.h	2369 printn	4204 procxmt	5952 mknod	File pipe.c
File proc.h	2386 putchar	File text.h	5979 sslep	7723 pipe
File user.h	2416 panic	File text.c	File sys3.c	7758 readp
File low.s	2433 prdev	4368 xswap	6014 fstat	7805 writep
File m40.s	2447 deverror	4398 xfree	6028 stat	7862 plock
0676 _clearseg:	File malloc.c	4433 xalloc	6045 stat1	7882 prele
0696 _copyseg:	2528 malloc	4490 xccdec	6069 dup	File tty.h
0725 _savu:	2556 mfree	File buf.h	6086 smount	File kl.c
0734 _aretu:	File reg.h	File conf.h	6144 sumount	8023 klopen
0740 _retu:	File trap.c	File conf.c	6181 getmdev	8055 klclose
0814 _fuibyte:	2693 trap	File bio.c	File rdwri.c	8062 klread
0815 _fubyte:	2841 trap1	4754 bread	6221 readi	8066 klwrite
0826 _suibyte:	2855 nosys	4773 breada	6276 writei	8070 klxint
0827 _subyte:	2864 nullsys	4809 bwrite	6326 max	8078 klrint
0844 _fuiword:	File sysent.c	4836 bdwrite	6339 min	8090 kls/tty
0845 _fuword:	File sys1.c	4856 bawrite	6364 iomove	File tty.c
0860 _suiword:	3020 exec	4869 brelse	File subr.c	8165 gtty
0861 _suword:	3205 rexit	4899 incore	6415 bmap	8183 stty
0889 _savfp:	3219 exit	4921 getblk	6517 passc	8201 sgTTY
0890 _display:	3270 wait	4982 iowait	6542 cpass	8217 wflushtty
0895 _incupc:	3322 fork	4999 notavil	6566 nodev	8234 cinit
0930 _getc:	3354 sbreak	5018 iodone	6577 nulldev	8252 flushtty
0967 _putc:	File sys4.c	5038 clrbuf	6585 bcopy	8274 canon
1012 _backup:	3413 getswit	5055 binit	File fio.c	8333 ttyinput
1244 _copyin:	3420 gtime	5096 devstart	6619 getf	8373 ttyoutput
1252 _copyout:	3428 stime	5123 rhstart	6643 closef	8486 ttrstr
1284 _idle:	3439 setuid	5156 mapalloc	6672 closei	8505 ttstart
1293 _spl0:	3452 getuid	5182 mapfree	6702 openi	8535 ttread
1297 _spl1:	3460 setgid	5196 swap	6746 access	8550 ttwrite
1302 _spl4:	3472 getgid	5229 bflush	6791 owner	8577 ttystty
1303 _spl5:	3480 getpid	5259 physio	6811 suser	File pc.c
1308 _spl6:	3486 sync	5336 geterror	6824 ufalloc	8648 pccopen
1313 _spl7:	3493 nice	File rk.c	6847 falloc	8669 pcclose
1319 _dpadd:	3510 unlink	5389 rkstrategy	File alloc.c	8682 pcread
1327 _dpcmp:	3538 chdir	5420 rkaddr	6922 iinit	8701 pcwrite
1393 _ldiv:	3560 chmod	5440 rkstart	6956 alloc	8710 pcstart
1401 _lrem:	3575 chown	5451 rkintr	7000 free	8719 pcrint
1410 _lshift:	3595 smdate	5476 rkread	7040 badblock	8739 pcprint
File main.c	3614 ssg	5483 rkwrite	7067 ialloc	8748 pcoutput
1550 main	3630 kill	File file.h	7134 ifree	8763 pcleader
1650 estabur	3656 times	File filsys.h	7167 getfs	File lp.c
1739 sureg	3667 profil	File ino.h	7201 update	8850 lpopen
1771 nseg	File clock.c	File inode.h	File iget.c	8863 lpclose
File slp.c	3725 clock	File sys2.c	7276 iget	8870 lpwrite
1826 newproc	3845 timeout	5711 read	7344 iput	8879 lpCanon
1940 sched	File sig.c	5720 write	7374 iupdat	8967 lpstart
2066 sleep	3949 signal	5731 rdwr	7414 itrunc	8976 lpint
2113 wakeup	3963 psignal	5765 open	7455 maknode	8986 lpoutput
2134 setrun	3991 issig	5781 creat	7477 wdir	File mem.c
2156 setpri	4016 stop	5804 open1	File nami.c	9016 mmread
2178 swtch	4043 psig	5846 close	7518 namei	9042 mmwrite
2268 expand	4094 core			



a1	1828 1894 1904 1915		5235 5236 5407 5412		6973 6981 7000 7008		6981 6982 6984 7002
	2271 2276 2278 2292		5470		7016 7025		7016 7017 7021 7069
	2293	backp	4872 4884 4888 4889	bp	2447 2448 2452 2532		7082 7083 7097 7098
a2	1828 1896 1902 1913		4890		2534 2535 2536 2537		7112 7205 7216 7220
	1915 2271 2282 2283	backup	1009 1012 1015 1047		2538 2540 2541 2542		7221 7379 7386 7387
	2290 2292		2812		2559 2564 2565 2566		7400 7417 7426 7427
aa	2556 2563	bad	3042 3055 3060 3065		2567 2568 2569 2570		7440 7524 7590 7601
abae	5123 5125 5134		3093 3103 3107 3119		2571 2572 2576 2577		7602 7623 7624 7625
abn	7040 7046		3193 3548 3553 5274		2578 2580 2581 2583		7636 7655 7656 7662
abp	5156 5157 5171 5259		5284 5293 5325 6625		2584 2585 3022 3040		7664 8277 8291 8298
	5260 5268 5336 5337		6629 6715 6721 6726		3049 3153 3195 3272		8300 8301 8310 8312
	5341 5389 5390 5396		6766 6777		3282 3290 3298 4809		8315 8316 8319 8320
ac	8333 8340 8373 8382	badblock	6970 7008 7040		4810 4815 4836 4837		8322 8323
access	3041 3552 4109 5815	badtrap	1465 1468		4842 4856 4857 4861	bp1	8278 8319 8322
	5817 6746 7563 7604	bap	6419 6437 6439 6473		4869 4870 4875 4902	br4	0526 0527 0530 0531
	7658		6479 6484 6491 6497		4907 4908 4909 4923		0541
addr	8024 8039 8041 8043		6499 6506		4937 4938 4941 4942	br5	0544
	8044 8051 8052 8079	base	5264 5269 5273 5278		4943 4948 4949 4960	br6	0534 0535
	8082 8083 8084 8086		5291 5305 5306 5307		4961 4962 4963 4966	br7	0512 0513 0514 0515
	8508 8513 8515 8518		5308		4967 4968 4969 4970		0516 0517 0518 0538
	8522	bawrite	4845 4856 6310		4971 4972 4973 4974		0547 0548 0549
adev	4773 4778 4785 4795	bcopy	3238 6124 6585 6931		4975 4982 4983 4987	bread	3282 4754 4799 6051
	4899 4905 4906		6976 7019 7220 7636		4999 5000 5005 5018		6116 6258 6305 6472
adx	2344 2346 2355 2357	bdevsw	4617 4622 4656 4763		5019 5023 5038 5039		6488 6927 6973 7097
	2361		4785 4795 4819 4843		5044 5057 5065 5066		7319 7386 7426 7431
afp	7040 7045		4906 4934 5060 5076		5067 5068 5069 5070		7625
aip	6221 6222 6229 6276		5212 6113 6166 6689		5071 5072 5073 5096	breada	4773 6256
	6277 6284 6746 6747		6722 6926		5097 5105 5123 5124	brlese	3195 3298 4791 4822
	6751	bdp	5060 5076 5077		5132 5160 5171 5172		4848 4869 5028 5073
alloc	6435 6448 6468 6480	bdwrite	4836 6311 6443 6449		5173 5178 5182 5183		6062 6118 6129 6172
	6497 6956		6485 6500 6501		5186 5231 5235 5236		6261 6308 6481 6487
an	6364 6370	bflg	1049 1060 1094 1108		5237 5238 5239 5240		6503 6932 6977 7112
ap	1652 1665 1669 1675		1204 1238		5241 5263 5268 5295		7324 7332 7436 7440
	1678 1679 1685 1691	bflush	5229 7230		5296 5297 5299 5300		7602 7624 7656
	1694 1696 1699 1701	bfreelist	4567 4878 4879 4880		5305 5307 5308 5309	bss	1237 1463
	1708 1712 1715 1717		4884 4891 4932 4953		5310 5311 5313 5315	buf	4520 4523 4524 4525
	1718 1719 1721 1722		4954 4955 4960 5062		5316 5318 5319 5321		4526 4535 4555 4556
	3022 3052 3054 3058		5063 5068 5069 5070		5322 5323 5339 5341		4557 4558 4567 4721
	3154 3155 3156 3159		5071 5235		5342 5343 5392 5396		4756 4775 4810 4812
	3164	bigger	3375 3386		5397 5398 5399 5402		4837 4839 4857 4859
ARDY	5372	binit	1614 5055		5403 5404 5407 5410		4870 4872 4902 4923
aretu	0724 0734 2106 2242	blkno	4754 4758 4773 4780		5412 5413 5420 5421		4983 4985 5000 5002
arg	3845 3871		4781 4799 4899 4908		5427 5442 5444 5447		5019 5021 5057 5065
ASLEEP	7993 8224 8562		4921 4938 4974 5196		5453 5457 5460 5467		5097 5101 5124 5128
atp	8217 8218 8221 8252		5209		5470 5471 6048 6051		5157 5160 5183 5231
	8253 8257 8274 8275	bmap	6248 6298 6415 7626		6052 6062 6224 6256		5260 5263 5337 5339
	8282 8333 8334 8339	bn	6225 6239 6248 6253		6258 6260 6261 6279		5387 5390 5392 5421
	8486 8490 8505 8506		6256 6258 6280 6294		6304 6305 6306 6308		5423 5442 5453 6365
	8512 8535 8536 8540		6298 6304 6305 6415		6310 6311 6364 6365	buffers	4720 5067
	8550 8551 8555 8577		6417 6423 6431 6447		6371 6419 6435 6437	BUSY	7992 8617 8691
	8578 8581		6451 6455 6456 6463		6442 6443 6448 6449	bwrite	3239 4809 4863 4963
av	8577 8578 8582		6464 6478 6496 7043		6450 6468 6470 6472		5241 7021 7221 7400
av_back	4526 4884 4889 5008		7046 7047 9018 9024		6473 6481 6485 6487	byte	1220
	5009 5063		9029 9032 9033 9044		6490 6491 6501 6503	b_addr	3049 3153 3238 3290
av_forw	4525 4888 4891 4953		9055 9059 9065 9066		6924 6927 6931 6932		4529 5044 5067 5107
	4960 5008 5009 5063	bno	6958 6967 6968 6970		6959 6973 6974 6977		5136 5210 5305 5307

	6052 6124 6125 6371	b_resid	4533 5322	chmod	2927 3560	cpass	6388 6542 8558 8705
	6437 6473 6491 6931	B_WANTED	4581 4876 4878 4879	chown	2928 3575		8874 9057
	6935 6974 7017 7098		4887 4942 4954 5030	cinit	1613 8234	cputype	0208 1459 1461 1571
	7174 7212 7220 7328		5166 5187 5203 5216	CINTR	7958 8344 8345		1655 1746 1756 5133
	7387 7427 7432 7433		5219 5296 5318 5321	CKILL	7956 8049		5162
	7636	b_wcount	4528 4762 4784 4794	cl	8637 8832	CQUIT	7957 8344
B_ASYNC	4584 4793 4820 4862		4818 5108 5137 5208	clearseg	0675 0676 1566 3134	CRDELAY	7976
	4887 4962 5027 5239		5310		3395 4155	creat	2920 5781
b_back	4524 4556 4967 4968	B_WRITE	4572 5486 6306 6373	clist	7908 7928 7929 7930	cret	1429 1430
	4970 4971 5062 5068		6386		8634 8643 8644	CRMOD	7970 8047 8342 8412
	5070 5080	b_xmem	4530 5110 5134 5139	clock	0569 0570 3725	csv	1419 1420
b_blkno	2454 4531 4908 4938		5173 5178 5211 5308	CLOCK1	1509 1601	CTLRDY	5374 5462
	4974 5209 5309 5402	c1	8881 8883 8885 8886	CLOCK2	1510 1603	ctype	8379 8424 8426 8440
	5428 6442 6450 6470		8887 8911 8915 8928	cloop	7542 7667		8441 8445 8452 8453
	6484 6498		8929 8930 8959	close	2918 5846		8468 8469 8472
B_BUSY	4576 4887 4941 4966	c2	8881 8890 8894 8898	CLOSED	8609 8653 8675	curpri	0222 2141 2165 2224
	5010 5072 5165 5169		8902 8906 8909	closef	3230 5854 6643	c_arg	0263 3770 3776 3866
	5202 5206 5219 5295	call	0555 0558 0561 0564	closei	6656 6672		3871
	5299 5321		0567 0570 0574 0577	clrbuf	5038 6982	c_cc	7910 8074 8223 8349
B_DELWRI	4586 4817 4823 4847		0752 0776 2669 2771	CMAPSIZ	0141 0203		8543 8544 8560
	4961 5237	call1	0762 0771	colp	8378 8400 8401 8402	c_cf	7911
b_dev	2453 4527 4819 4843	callo	0260 3727 3847		8404 8423 8429 8435	c_cl	7912
	4883 4908 4938 4973	callout	0265 3748 3750 3767		8436 8442 8443 8448	c_func	0264 3748 3751 3769
	5066 5207 5238 5300		3768 3773 3853		8454 8458 8459 8475		3770 3774 3855 3861
	5399 5429 5431	callp	2696 2754 2755 2761	com	5102 5109 5112 5114		3865 3870
B_DONE	4574 4759 4782 4790		2762 2765 2771		5115 5129 5138 5141	c_next	8141 8241
	4817 4847 4989 5026	CANBSIZ	0140 0202 8316		5142 5143	c_time	0262 3751 3753 3767
	5214 5315	canon	8274 8543	cont	7106 7110		3769 3775 3855 3856
b_error	4532	canonb	0202 8291 8300 8316	copsu	1245 1253 1264		3859 3864 3869
B_ERROR	4575 4817 4882 5220		8320	copyin	1243 1244 6374	data	1457
b_error	5311	CAP	8840 8884	copyout	1243 1252 1630 6376	dev	2433 2436 2693 2700
B_ERROR	5342	CARR_ON	7990 8046 8285 8541	copyseg	0695 0696 1915 2292		2702 2718 3725 4754
b_error	5343		8556		3380 3392 4152		4758 4763 4776 4778
B_ERROR	5403 5467 7323	cblock	8140 8141 8146 8149	core	4076 4094		4780 4781 4788 4789
b_flags	4522 4759 4761 4782		8237	coreaddr	5196 5210 5211		4799 4901 4905 4908
	4783 4790 4793 4816	cc	8635 8731 8743 8754	coremap	0203 1568 1896 1982		4921 4927 4931 4934
	4817 4847 4862 4876		8830 8981 8988		2278 2282 2293 3241		4938 4973 5229 5238
	4878 4879 4882 4887	ccc	8835 8910 8918 8935	count	4383 4497		5259 5300 5476 5479
	4941 4942 4954 4961		8937 8941 8942 8946		2668 2762 2765 5196		5483 5486 6676 6679
	4962 4966 4989 5010	ccp	8950 8954 8955 8962	cp	5208 6585 6592		6685 6689 6706 6709
	5024 5026 5027 5030		8236 8239 8240 8244		3025 3049 3061 3072		6716 6722 6956 6961
	5072 5111 5140 5172	cdevsw	8246 8247		3153 3161 3162 3186		6970 6973 6981 6988
	5186 5200 5237 5239		4635 4641 4669 6234		3187 4018 4021 4022		7000 7004 7008 7016
	5295 5296 5299 5315		6287 6685 6716 8213		4024 4026 4028 6048		7040 7048 7067 7072
	5318 5321 5342 5397		8238 8245		6052 6059 6367 6371		7078 7097 7104 7120
	5403 5467 7323	cdp	8238 8245		6372 6374 6376 6377		7134 7138 7167 7173
b_forw	4523 4555 4907 4937	CEOT	7955 8306		6390 6394 6924 6928		7178 7276 7286 7296
	4967 4968 4969 4971	CERASE	7954 8048		6931 6933 6935 6936		7314 7319 8023 8026
	4972 5062 5069 5070	cf	8636 8831		6937 6938 6939 6940		8030 8033 8039 8040
	5071 5079	cfree	8146 8239 8240		7417 7427 7428 7429		8042 8055 8057 8062
B_MAP	4579 5024 5172 5186	cfreelist	0928 0954 0955 0977		7431 7438 7523 7570		8063 8066 8067 8070
B_PHYS	4577 5206 5299 5397		0979 0986 0988 8149		7572 7573 7576 7577		8072 8078 8081 8090
B_READ	2034 2042 4573 4761		8241 8242		7645 7646 8237 8240		8093 8648 8669 8850
	4783 4793 4817 5111	chan	2066 2076 2089 2113		8241 8242		8863 9016 9021 9031
	5140 5479 6260		2118	cp1	7480 7483 7485		9042 9047 9064
B_RELOC	4583 4966	chdir	2924 3538	cp2	7480 7484 7485	devblk	5096 5106 5123 5135

deverror	2447 5460	d_errcnt	4554 5463 5469	EMLINK	0496 5918	filsys	5561 7042
devloc	5096 5098 5104 5123	d_major	2436 4606 4763 4785	end	0611 0632 0654	flag	4813 4816 4820 4823
	5125 5131		4795 4819 4843 4906	ENFILE	0488 6863 7311		6364 6373 6386 7518
devstart	5096 5447		4927 4934 6113 6166	ENODEV	0484 6569		7537 7603 7657 8023
devtab	4551 4840 4903 4924		6192 6234 6287 6680	ENOENT	0468 7538 7612		8648 8652 8669 8671
	5058 5386		6710 6926 8213	ENOEXEC	0474 3102		8833 8850 8853 8857
DIRSIZ	0107 0429 0433 3524	d_minor	2436 4605 4883 5399	ENOMEM	0478 1728		8863 8866 8884 8923
	3526 7484 7486 7572		5429 5431 8026 8030	ENOSPC	0493 6989 7121		8927 8936
	7576 7589 7608 7637		8039 8040 8042 8057	ENOTBLK	0480 6190	flushtty	8227 8252 8346 8350
	7638 7645		8063 8067 8072 8081	ENOTDIR	0485 3547 7560	fmt	2340 2341 2348 2353
display	0888 0890 3740		8093 9021 9031 9047	ENOTTY	0490 8210	fork	2914 3322
DLBASE	8010 8043		9064	ENXIO	0472 6193 6727 8027	FORM	8847 8859 8865 8921
dn	6226 6243 6245 6247	d_open	4618 4636 5076 6113		8654		8928 8930
	6250 6252 6256 6258		6716 6722 6926 8245	eo	7524 7588 7607 7608	found	3329 3333 4176 4180
	6281 6300 6302 6304	d_read	4638 6234		7641 7642		6156 6160
	6305	d_sgTTY	4640 8213	EOF	8612 8689 8728	found1	1994 2021
DONE	7980 8518 8616 8691	d_strategy	4620 4763 4785 4795	ep	7418 7432 7433 7434	found2	1983 2031
	8714 8815 8971		4819 5212		7435	fp	5198 5200 5202 5203
dp	1652 1666 1668 1674	d_tab	4621 4843 4906 4934	EPERM	0467 6816		5204 5206 5214 5215
	1680 1684 1690 1695		5077	EPIPE	0497 7827		5216 5217 5219 5220
	1700 1707 1711 1716	d_write	4639 6287	EROFS	0495 6755		5733 5736 5737 5739
	1718 1720 1722 4840	E2BIG	0473 3064	err	0855 0872 0880 1656		5746 5748 5749 5751
	4843 4844 4903 4906	EACCES	0479 6778		1658 1661 1663 1727		5752 5754 5755 5756
	4907 4924 4932 4934	EAGAIN	0477 3330	error	4219 4226 4234 4241		5807 5827 5829 5830
	4935 4937 4969 4970	EBADF	0475 5740 6630		4248 4260 4281		5836 5848 5850 5851
	4971 4972 5058 5077	EBIT	2658 2753 2776	ERROR	8618 8691 8722 8727		5854 5864 5866 5867
	5078 5079 5080 5100	EBUSY	0481 6135 6163		8750		5869 5889 5890 5894
	5104 5106 5107 5108	ECHILD	0476 3317	esc	8891 8895 8899 8903		5895 5901 5902 6016
	5115 5127 5131 5135	ECHO	7969 8047 8361		8908		6018 6019 6021 6071
	5136 5137 5143 7418	ED	0318 1711	ESPIPE	0494 5870		6073 6074 6078 6079
	7431 7432 7433 7436	edata	0611 0651	ESRCH	0469 3652 4177		6621 6626 6627 6628
	7521 7531 7533 7534	EEXIST	0482 5930 5960	estabur	1629 1650 3118 3138		6643 6644 6648 6849
	7551 7559 7563 7589	EFAULT	0466 5326 6378 6524		3152 3371 4120 4146		6854 6855 6856 6857
	7604 7606 7609 7625		6551 7695		4460		6858 6859 6860 6959
	7626 7658 7660 7662	EFBIG	0492 6424	ETXTBSY	0491 3106 6759		6961 6962 6963 6965
	7663 7664 7665 7670	EINTR	0470 2773	EVENP	7973		6967 6970 6971 6972
dpadd	1318 1319 3292 3293	EINVAL	0487 3620 6157	EXDEV	0483 5937		6975 6976 6978 6979
	3295 3296 5756 5890	EIO	0471 4193 5344 8751	exec	2923 3020		6983 6987 7002 7004
	5895 5986 6382 9051		8854	execnt	0210 3037 3038 3039		7005 7006 7007 7008
dpcmp	1326 1327 5988 5989	EISDIR	0486 5819		3196 3197 3198		7010 7011 7012 7014
	5990 6243 6312	EJECT	8842 8857 8923 8927	exit	3209 3219 4032 4080		7015 7018 7019 7020
DRESET	5369	EJLINE	8820 8927		4278		7022 7023 7025 7026
DRY	5371	eloop	7592 7643 7647	expand	1628 2268 3129 3132		7042 7045 7047 7069
ds	3023 3117 3118 3131	else	1659 1909 2087 2575		3383 3387 4148 4459		7072 7073 7074 7076
	3138 3149		2579 2764 3098 3100		4473		7077 7084 7094 7096
DSRDY	8013 8051		3792 3815 4445 4792	EXPRI	3018 3038		7107 7108 7113 7116
dump	0521 0523 1352 1353		4823 4846 4933 5029	extern	1552 3026 3513 3541		7117 7118 7136 7138
	1355		5113 5141 5411 5432		4097 4925 5768 5784		7139 7141 7143 7144
dup	2953 6069		5748 5750 5754 5879		5912 5955 6031 6091		7758 7759 7763 7805
d_actf	4557 5409 5410 5444		6107 6251 6257 6301		6184 6794 8650		7809 8204 8206 8208
	5457 5470		6304 6308 6310 6375	falloc	5827 6847 7731 7737	FPIPE	5519 5746 5869 6649
d_active	4553 5414 5446 5455		6392 6471 6486 6502	fetch	1051 1173 1180 1184		7746 7748
	5458		6522 6549 7394 7608		1222	FREAD	5517 5713 5747 5753
d_actl	4558 5412 5413		8308 8444 8471 8523	ff	4368 4382		5814 5829 7748
d_close	4619 4637 6166 6685		8662 8677 8729 8886	file	5507 5513 5807 6849	free	7000 7435 7438 7442
	6689	EMFILE	0489 6833		6854 8204	from	6585 6586 6590



fstat	2940 6014	hibyte	0180 3456 3476 3582		7285 7345 7521 8205	6673 6678 6702 6703
fubyte	0807 0815 3058 4225		8585 8593	inta	3921 4235 4254	6708 6749 6751 6754
	6550 7693	httab	4728 4844	integ	0175 2070 2095 2391	6758 6764 6769 6771
fuibyte	0809 0814 1564 4218	HUPCL	7966		3416 3852 3872 4885	6774 6793 6796 6798
	9034	HZ	0147 3797 3800		4892 5006 5011 8262	6799 6801 6802 6959
fuiword	0813 0844 1602 1604	IACC	5681 6232 6285 7382		8266	6974 6975 6976 7002
	2734 2754 2756 2766		7391 7462 7751	IO	0641	7017 7018 7019 7069
	4220	IALLOC	5620 5687	iodone	5018 5404 5471	7078 7079 7081 7082
fun	3845 3870	ialloc	7067 7459	iomove	6260 6306 6364	7085 7091 7098 7101
func	7518 7519 7532 7536	IALLOC	7463	iowait	4764 4800 4821 4982	7203 7212 7213 7214
	7574 7579 8510 8515	ialloc	7728	ip	3024 3034 3035 3041	7217 7218 7219 7220
fuword	0811 0845 0847 2758	IALLOC	7752		3090 3105 3130 3142	7223 7224 7225 7226
	2763 3052 4227 8188	icode	1516 1630		3171 3173 3174 3176	7227 7281 7284 7293
	8189 8190	idle	1283 1284 2220 2423		3177 3182 3183 3184	7294 7295 7296 7306
FWRITE	5518 5722 5793 5795	IENABLE	5092 5109 5138 5370		3185 3189 3190 3191	7307 7309 7319 7323
	5816 5829 5832 6656		7981 8051 8052 8615		3194 3512 3519 3520	7324 7328 7332 7414
	7746		8659 8663 8692 8732		3522 3529 3530 3534	7415 7420 7423 7424
f_count	1878 5510 5836 6079		8814 8858		3540 3543 3544 3546	7426 7430 7442 7443
	6655 6657 6855 6857	IEXEC	3041 3552 5631 5698		3549 3552 3555 3556	7457 7459 7460 7462
	7739		6764 6765 7563		3562 3564 3566 3569	7463 7464 7465 7466
f_flag	5509 5739 5746 5829	IFBLK	5624 5691 6100 6189		3570 3571 3577 3579	7467 7468 7477 7478
	5869 6649 6656 7746		6242 6297 6314 6688		3581 3582 3583 3584	7482 7725 7728 7729
	7748		6719 7421		4096 4101 4102 4105	7733 7741 7747 7749
f_inode	5511 5754 5755 5830	IFCHR	5623 5690 6100 6233		4106 4109 4110 4112	7750 7751 7752 7761
	5894 5895 6021 6650		6286 6314 6684 6713		4118 4124 4126 4399	7764 7768 7772 7775
	6656 7747 7749 7764		7421 8209		4405 4406 4410 4411	7776 7777 7778 7786
	7810 8208	IFDIR	3522 3546 5622 5689		4433 4434 4446 4454	7787 7789 7790 7797
f_offset	5512 5751 5752 5756		5818 5921 7559		4464 4470 5767 5770	7799 7807 7810 7815
	5889 5890 5901 5902	IFMT	3041 3522 3546 4110		5771 5774 5783 5786	7817 7825 7826 7835
	6858 6859 7772 7773		5621 5688 5818 5921		5787 5790 5791 5793	7836 7837 7838 7845
	7774 7796 7798		6189 6233 6242 6286		5795 5804 5805 5811	7848 7849 7850 7851
getblk	3040 3237 4758 4781		6297 6682 6711 7559		5911 5914 5915 5917	7852 7862 7863 7867
	4789 4921 6123 6304		8209		5921 5926 5935 5940	7882 7883 7887 8205
	6928 6981 7016 7216	ifree	7134 7355		5941 5942 5945 5954	8208 8209 8213
getc	0926 0930 8258 8259	iget	1616 1618 3519 7078		5958 5959 5966 5967	7280 7328 7331 7378
	8264 8292 8520 8544		7276 7534 7664		5969 5972 6030 6033	7387 7390 7392 7393
	8673 8688 8714 8971	iinit	1615 6922		6034 6036 6037 6045	7395 7397 7398
geterror	4824 4992 5323 5336	ILARG	5625 5692 6427 6444		6046 6050 6051 6052	7279 7329 7330 7331
getf	5736 5850 5866 6018		7425 7445		6053 6055 6089 6097	7378 7388 7389 7390
	6073 6619 8206	ILOCK	1617 1619 5679 5926		6098 6100 6121 6130	3939 4181 4182 4183
getfs	6754 6961 7004 7072		7224 7225 7287 7303		6131 6137 6147 6161	4184 4185 4186 4189
	7138 7167 7383		7316 7351 7868 7872		6162 6167 6168 6169	4190 4191 4192 4194
getgid	2959 3472		7888		6170 6172 6183 6186	4195 4209 4211 4212
getmdev	6093 6151 6181	IMOUNT	5682 6130 6168 7292		6187 6189 6191 6192	4213 4218 4220 4225
getpid	2932 3480	incore	4780 4788 4899		6194 6227 6229 6232	4227 4232 4235 4240
getswit	2950 3413	incupc	0894 0895 3791		6233 6234 6242 6243	4242 4247 4249 4254
getuid	2936 3452	IND	8844 8857 8936		6248 6250 6252 6255	4264 4266 4268 4273
gid	3462 3464 3465 3466	info	8142		6259 6282 6284 6285	4282
	3467	ino	7070 7077 7078 7095		6286 6287 6297 6298	IPCPRI 3914 4182 4190
GO	5095 5109 5138 5368		7100 7105 7107 7134		6300 6302 6312 6314	iput 3194 3232 3533 3534
	5461		7143 7276 7286 7297		6315 6316 6318 6415	3549 3554 3571 3584
grow	2813 4056 4136		7315 7319 7328		6416 6422 6427 6439	4126 4411 5839 5931
gtime	2925 3420	inode	5605 5659 5675 6147		6440 6442 6444 6447	5936 5945 5972 6037
gtty	2944 8165		6161 6222 6227 6277		6451 6452 6456 6466	6137 6169 6194 6691
gword	0818 0830 0848 0851		6282 6416 6793 7104		6467 6470 6646 6650	6802 7091 7325 7344
hbcom	5096 5109		7105 7203 7223 7278		6651 6652 6653 6672	7490 7663 7670 7733

	7741		6452 6467 6758 7224	klopen	4671 8023	lpopen	4675 8850
ip_addr	3937 4185 4218 4220		7225 7287 7288 7292	klou	0561	lpou	0574
	4225 4227 4232 4240		7303 7316 7351 7359	klrbuf	8018 8083	lpoutput	8929 8951 8956 8959
	4242 4247 4249 4254		7382 7391 7396 7448	klrcsr	8017 8051 8084		8986
ip_data	3938 4184 4191 4220		7462 7609 7751 7868	klread	4671 8062	LPPRI	8817 8989
	4227 4235 4242 4249		7869 7872 7888 7889	klregs	8016	lpsr	8824 8853 8858 8971
	4264 4266 4268 4273		7890	klrint	0557 0558 8078	lpstart	8967 8980 8992
ip_lock	3935 4181 4183 4194	i_gid	3177 3582 5610 5669	kls/tty	4671 8090	lpwrite	4675 8870
	4209		6771 7466	kltbuf	8020 8086	lrem	1400 1401 2375 5433
ip_req	3936 4186 4189 4192	i_lastr	5673 6255 6259 7318	kltcsr	8019 8052		6052 7328 7387
	4211 4212 4282	i_mode	3041 3171 3176 3522	klwrite	4671 8066	lshift	1409 1410 5309 6239
IREAD	5629 5696 5815 6651		3546 3566 3569 4110	klxint	0560 0561 8070		6294 9024 9055
	7789 7850 7851		4406 5607 5666 5818	kwlp	0570	main	0611 0669 1550
ISGID	3176 5627 5694		5921 6100 6189 6233	l	2354	maj	6676 6680 6685 6689
ISOPEN	7987 8045 8046		6242 6286 6297 6314	large	6445 6462		6706 6710 6714 6716
issig	2073 2085 2821 3826		6427 6444 6651 6682	lbn	6225 6239 6248 6255		6720 6722
	3991		6711 6764 6774 7081		6259 6280	maknode	4105 5790 5966 7455
ISUID	3171 5626 5693		7082 7329 7354 7388	lbolt	0212 3797 3800 3808	malloc	1896 1982 2282 2528
ISVTX	3568 4406 5628 5695		7421 7425 7445 7463		4925 8650 8660		3234 4375 4457
	5790		7559 7752 7776 7777	LCASE	7968 8047 8309 8353	map	2515 2529 2532 2557
ITEXT	3105 4410 4471 5684		7789 7836 7850 7851		8399		2559
	6758		8209	ldiv	1392 1393 2373 4143	mapalloc	5156 5398
itrunc	4112 5825 7353 7414	i_mtime	5615		5434 6051 7319 7386	mapfree	5025 5182
IUPD	3530 3570 3583 5680	i_nlink	3529 5608 5667 5917		7589 7626	maplock	5155 5165 5166 5167
	5942 6285 6318 6452		5941 7352 7464	link	2921 5909		5169 5187 5188 5189
	6467 7382 7396 7448	i_number	5664 6051 6052 6162	lks	0226 1601 1602 1603	maptab	8117 8309 8311
	7462 7609 7751		7105 7286 7315 7355		1604 1607 3734	max	6326 8443
iupdat	6050 7226 7357 7374		7360 7385 7482 7534	lobyte	0180 3443 3444 3455	MAXCOL	8821 8954
IWANT	5683 7288 7869 7889	i_size0	5611 5670 5894 6243		3464 3465 3475 3581	MAXMEM	0135
	7890		6312 6315 7446		8584 8592	maxmem	0224 1567 1576
IWRITE	4109 5630 5697 5817	i_size1	5612 5671 5895 6243	loop	1951 1957 1969 2025	MAXMEM	1582
	6651 6753 7604 7658		6312 6316 7447 7589		2048 2195 2221 2347	maxmem	1582 1662
	7776 7777 7836		7772 7775 7835 7845		2362 3245 3260 3276	mcc	8834 8924 8925 8950
i_addr	5613 5672 5969 6191	i_uid	3173 3174 3581 5609		3315 4020 4030 4930		8952 8955 8957 8960
	6192 6234 6252 6287		5668 6769 6798 7465		4945 4957 4964 5233	mfree	1568 1583 2044 2278
	6302 6439 6440 6442	j	7070 7099 7101		5242 7075 7092 7119		2293 2556 3241 3283
	6447 6451 6456 6466	jflg	1018 1193 1239		7283 7290 7298 7765		4383 4408 4497
	6470 6679 6680 6709	jmp	0522		7791 7812 7839 7854	min	1582 6241 6247 6296
	6710 7082 7330 7389	jsr	0558 0561 0564 0567		8290 8305		6339 7846
	7423 7430 8213		0570 0574 0577	lp11	8837 8853 8857 8866	mknod	2926 5952
i_atime	5614	k	7070 7103 7104 7105		8884 8910 8918 8923	mlc	8836 8924 8926 8927
i_count	1883 3105 4472 5662	ka6	0322 1459 1460 1560		8924 8925 8926 8927		8931
	6100 6681 7302 7306		1589 1599 2716 9032		8931 8935 8936 8937	mmread	4682 9016
	7317 7350 7362 7750		9065		8941 8942 8946 8950	mmwrite	4682 9042
	7787 7825	kill	2949 3630		8952 8954 8955 8957	mode	5731 5735 5804 5812
i_dev	3519 5663 5935 6051	KISA0	0619		8960 8962 8971 8981		6746 6752 7455 7463
	6053 6162 6250 6300	KISA6	1368 1460		8982 8988 8989 8990	mount	0272 0277 6090 6103
	6422 6754 7104 7286	KISD0	0620	LPADDR	8812 8853 8858 8971		6148 6154 6933 6934
	7314 7355 7383 7386	KL	0165 2393 2397 2398		8972		7169 7172 7204 7210
	7426 7431 7435 7438		2399 2406	lpbuf	8825 8972		7281 7293 7294
	7442 7459 7534 7625	kl11	8015 8030 8057 8063	lpccanon	8859 8865 8875 8879	mp	2528 2529 2534 2556
	7662		8067 8072 8081 8093		8909		2557 2564 2565 6090
i_flag	1617 1619 3105 3530	KLADDR	8008 8039 8041	lpclose	4675 8863		6103 6104 6105 6109
	3570 3583 4410 4471	KLBASE	8009 8041 8043	LPHWAT	8819 8988		6116 6118 6124 6129
	5661 5926 5942 6130	klclose	4671 8055	lpint	0573 0574 8976		6148 6154 6155 6167
	6168 6232 6285 6318	klin	0558	LPLWAT	8818 8981		6170 6171 7204 7210

	7211 7212 7216	NMOUNT	0133 0277 6103 6154		4495 4935 5737 5771		3776 3778 3847 3860
mpid	0216 1841 1842 1843		7172 7210 7294		5787 5791 5827 5835		3861 3862 3863 3864
	1849 1867	NODEV	0105 3040		5851 5853 5867 5915		3865 3866 3867
MTC	1373	nodev	4659 4660 4661 4662		5929 5959 5967 6019	pad	5575
m_addr	2518 2536 2537 2541		4663 4664 4665 4673		6034 6074 6098 6102	panic	1605 1853 2051 2416
	2564 2565 2567 2571		4675 4677 4678 4679		6104 6108 6111 6155		2719 3236 3521 4377
	2576 2577 2580 2581		4680 4681 4682 4684		6171 6187 6435 6436		4381 4451 4458 4928
m_bufp	0275 6104 6123 6124		4686 4687 4688 4689		6448 6468 6469 6480		4936 6930 7184 7300
	6125 6155 6170 6171		4690 4691		6482 6497 6627 6631	panicstr	2328 2419
	6933 7173 7174 7211	NODEV	5238 6123		6796 6797 6803 6829	partab	7947 8424 8522
	7212	nodev	6566		6853 6864 6990 7079	passc	6394 6517 8544 8695
m_dev	0274 6105 6122 6155	NODEV	6928 7230		7080 7122 7173 7211		9038
	6934 7173 7216 7296	nofault	0757 0766 0854 0855		7284 7306 7309 7312	pc	2693 2734 2754 2756
m_inodp	0276 6121 6167 7295		0871 0872 0876 0881		7326 7460 7461 7590		2757 2766 2767 3725
m_size	2517 2534 2535 2538		0909 0910 0918 1224		7601 7610 7623 7655	pc11	8641 8645 8653 8657
	2542 2564 2565 2566		1225 1228 1232 1259		7665 7666 7671 7729		8658 8673 8675 8688
	2568 2569 2572 2576		1267 1273 1277 1465		7732 7738 7740 8206		8689 8693 8714 8721
	2578 2583 2584		1466	nulldev	4658 4682 4684 6577		8724 8726 8728 8730
n1	7170 7175 7177	NOFILE	0139 0438 1876 3227	nullsys	2864 2912 2942		8731 8734 8743 8744
n2	7170 7176 7177		6624 6828	o1	2447 2454		8754 8755 8756
na	3022 3050 3053 3154	nospace	6966 6969 6986	o2	2447 2454	PCADDR	8607 8659 8663 8674
	3156 3158	nosys	2855 2939 2941 2945	ODDP	7972		8691 8692 8714 8715
namei	3034 3515 3543 4101		2951 2952 2957 2961	ok	4256 4259 4261		8722 8727 8730 8732
	5770 5786 5914 5928		2962 2963 2964 2965	on	6225 6240 6241 6260		8750
	5958 6033 6097 6186		2966 2967 2968 2969		6280 6295 6296 6306	pcclose	4673 8669
	6796 7518		2970 2971 2972 2973		9018 9025 9034 9044	PCIHWAT	8624 8731
nb	5265 5278 5283 5292		2974 2975		9056 9067	pcin	0564 8643 8673 8688
	5306 6419 6447 6448	notavail	4948 4960 5240	open	2917 5765		8693 8730 8731 8734
	6450 6451 6457 6466	notavil	4999	OPEN	8843 8853 8857	PCIPRI	8620 8660 8693
	6472 6479 6488 6497	NPROC	0144 0376 1846 1960	open1	5774 5793 5795 5804	pcleader	8664 8678 8763
	6498 6499 6507		1991 2006 2120 2203	openi	5832 6702	PCOHWAT	8623 8754
nblkdev	4631 4927 5084 6192		2206 3246 3250 3277	os	4368 4373 4374 4380	PCOLWAT	8622 8743
	6720		3327 3639 3810 3953		4383	pcopen	4673 8648
nbp	6420 6480 6484 6488		4023 4172	out	2735 2779 2814 2820	PCOPRI	8621 8755
	6490 6497 6498 6500	nps	2693 3725		3331 3346 3523 3532	pcou	0567
NBUF	0130 4535 4720 5064	NRK	5364		3749 3760 3787 4449	pcout	8644 8714 8743 8744
nc	3022 3051 3062 3063	NRKBLK	5365 5402		4474 5823 5828 5838		8754 8755 8756
	3071 3073 3154 3157	ns	1650 1657 1660 1662		5919 5922 5934 5938	pcoutput	8706 8748 8769
NCALL	0143 0265		1703 1704 1706 1710		5944 5961 5971 6101	pcpbuf	8630 8715
nchrdev	4647 6714 8247		1711		6106 6112 6115 6134	pcpcsr	8629 8663 8714 8750
NCLIST	0146 8146 8240	nseg	1657 1660 1771 3366		7539 7549 7561 7564	pcpint	0566 0567 8739
nd	1650 1657 1660 1662	NSIG	0113 0447 3183 3225		7581 7605 7613 7659	pcrbuf	8628 8730
	1683 1687 1689 1690		3619 3968		7669 8690 8696	pcrcsr	8627 8659 8674 8691
	1692	nswap	0232 1583 4698	out1	6119 6136		8692 8722 8727 8732
NDL11	8012 8015 8026	nt	1650 1657 1660 1662	owner	3564 3579 6791	pcread	4673 8682
newproc	1627 1826 3334		1667 1671 1673 1674	p1	1942 1963 1977 2010	pcrint	0563 0564 8719
newsize	2268 2275 2277 2278	NTEXT	0145 4314 4441		2015 2032 2041 3324	pcstart	8710 8742 8758
	2282	NULL	0104 1752 1833 1847		3326 3335 3727 3768	pcstate	8642 8653 8657 8658
NEXEC	0134 3037 3196		1852 1877 1879 1902		3769 3770 3771 3774		8675 8689 8721 8724
NFILE	0132 5513 6854		1979 1982 2032 2184		3775 3776 3777 3847		8726 8728
nice	2946 3493		2198 2218 2283 3035		3853 3855 3856 3857	pcwrite	4673 8701
NINODE	0131 5675 6161 7103		3229 3235 3284 3328		3859 3860 3863 3869	physio	5259 5479 5486
	7223 7285		3516 3520 3544 3564		3870 3871	PINOD	0155 6963 7007 7074
NKL11	8011 8015 8026 8042		3579 4102 4106 4376	p2	3324 3327 3328 3344		7289
	8043		4401 4402 4407 4440		3727 3750 3751 3752	pipe	2954 7723
NLDELAY	7974		4442 4443 4451 4457		3753 3773 3774 3775	PIPSIZ	7715 7835 7846

plock	7768 7815 7862	psig	2074 2086 2105 2822		3284 3301 3328 3811	R7	2612 2679 3188 3347
pp	2158 2160 2161 2162		3827 4043		3973 3974 3975 4026		4058 4061
	2167 3512 3515 3516	psignal	2793 2818 3649 3955		4173	rablkno	4773 4788 4789
	3518 3519 3528 3533		3963 7828	p_textp	0374 1752 1866 1879	rablock	0235 6253 6256 6454
	3728 3794 3795 3796	PSLEP	0159 5994		1979 2032 4378 4401		6456 6504 6506
	3810 3811 3812 3813	PSWP	0154 1955 1968 5167		4402 4448 4469	rabp	4775 4789 4790 4791
	3814 3815 3816 3817		5204 5215	p_time	0365 1869 1962 1964		4793 4794 4795
	3818 4018 4023 4024	ptrace	2938 4164		2009 2011 2047 3812	RAW	7971 8297 8344 8356
	4025	PUSER	0160 2162 3817 3973		3813 4386		8386
PPIPE	0157 7790 7838 7870		3974	p_ttyp	0368 1864 3288 3644	rbp	2450 2452 2453 2454
prdev	2433 2453 6988 7048	putc	0926 0967 8323 8355		3954 8031 8032		4756 4758 4759 4760
	7120 7178		8358 8414 8478 8730	p_uid	0364 1863 3174 3446		4761 4762 4763 4764
prele	3518 3556 5826 6131		8756 8990		3646		4765 4775 4779 4781
	7227 7358 7363 7786	putchar	2351 2359 2375 2386	p_wchan	0373 2076 2089 2122		4782 4783 4784 4785
	7799 7817 7826 7837		2401 2402 2403 2405		2139		4798 4800 4801 4812
	7849 7882	PWAIT	0158 3314	q	3221 3225 3226 3227		4815 4816 4817 4818
pri	2066 2072 2078 2091	pword	0840 0865 0868		3228 3229 3240 3241		4819 4821 4822 4824
PRIBIO	0156 4943 4955 4990	p_addr	0371 1589 1743 1894		3242 3243 3247 3251		4839 4842 4843 4845
	5297 5316		1904 1913 2042 2044		3259 3632 3638 3640		4847 4848 4859 4861
printf	1576 1577 1578 1579		2045 2193 2228 2276		3644		4862 4863 4872 4875
	1580 2340 2421 2436		2290 2294 3134 3241	qc	5393		4876 4877 4882 4883
	2454 2716 2717 2718		3242 3282 3376 3388	ql	5393		4887 4888 4889 4890
	6862 7310		4149 4380 4383 4384	r	0185 1561 1563 1573		4891 4985 4987 4989
printn	2355 2369 2374		4467		1574 1599 1600 1745		4990 4992 5002 5005
proc	0358 0376 1589 1590	p_cpu	0366 2161 3795 3796		1750 1755 1760 2401		5008 5009 5010 5021
	1591 1592 1593 1829		3814 3815 3816		5175 5177 5306 7726		5023 5024 5025 5026
	1830 1846 1942 1943	p_flag	0361 1592 1862 1907		7736 7740 7745 8342		5027 5028 5030 5031
	1960 1991 2006 2115		1961 1992 2007 2023		8413 8934 8951 9026		5101 5105 5107 5108
	2119 2136 2180 2182		2046 2143 2208 2240		9027 9029 9030 9032		5110 5111 5128 5132
	2185 2193 2206 2207		2241 2286 3170 3224		9035 9036 9059 9060		5134 5136 5137 5139
	3222 3246 3248 3250		3289 3302 3303 3309		9062 9063 9065 9068		5140
	3273 3277 3324 3327		3998 4028 4169 4187		9069	rbr	2316
	3632 3639 3644 3728		4379 4385 4466 4468	R0	2605 2679	rc	2388 2390 2395 2399
	3810 3951 3953 3994		4479 5312 5317	r0	2693 2701 2777		2400
	4018 4023 4166 4172	p_nice	0367 1865 2162 3502	R0	3208 3281 3304 3335	RCOM	5094 5112
procxmt	4028 4204	p_pid	0369 1849 1867 3247		3344 3416 3423 3432	rdflg	5196 5206
profil	2956 3667		3251 3278 3281 3285		3443 3455 3456 3464	RDRENB	8014 8051 8084 8614
PS	0164 0668 0677 0679		3304 3335 3344 3482		3475 3476 3482 3497		8659 8692 8732
	0691 0697 0700 0720		3642 4022 4024 4174		3623 3637	rdwr	5713 5722 5731
	0726 0731 0735 0741		4175 4183 4209	r0	3725 3825	read	2915 5711
	0748 0756 0773 0777	p_ppid	0370 1868 3247 3251	R0	4079 4184 4191 5736	readi	3090 3142 4464 5754
	0783 0787 0790		3252 3259 3278 3286		5758 5831 5850 5853		6221 7797
ps	0791		4024 4175		5866 5986 6018 6073	READING	8611 8724 8726
PS	0798 0852 0853 0869	p_pri	0362 2078 2091 2141		6830 7736 7744 7745	readp	5748 7758
	0870 0877 0882 0932		2167 2209 2211 3817		8206	regloc	0237 1011 1025 1038
	0934 0935 0958 0964	p_sig	0363 3287 3305 3625	R1	2606 2679		1148 2677 3186 4258
	0970 0973 0974 0999		3626 3971 3972 3997	r1	2693	RESET	5367 5461
	1005 1285 1286 1288		4000 4049 4050 4273	R1	3297 3305 3424 3433	retry	1840 1844 1850
	1294 1298 1299 1304	p_size	0372 1590 1893 1895	r1	3725	retu	0724 0740 2193 2228
	1305 1309 1310 1314		1978 2042 2044 2274	R1	7744		2294
	2070 2095		2275 3241 4119 4148	R2	2607 2679	returnm	7468
ps	2693 2699 2717 2753		4149 4374 4375	R3	2608 2679	rexit	2913 3205
	2776 3725 3759 3788	p_stat	0360 1591 1847 1861	R4	2609 2679	rf	6621 6623 6624 6626
	3791 3798 3824		1903 1908 1961 1993	R5	2610 2679		7725 7731 7732 7739
PS	3852 3872 4885 4892		2008 2077 2090 2140	R6	2611 2679 3155 4055		7748 7749
	5006 5011 8262 8266		2208 3243 3253 3280		4059	rfp	6646 6648 6649 6650

	6655 6656 6657		2207 2208 2209 2210	savfp	0888 0889 2698		2143 2208 4385
RHRCOM	5121 5141		2211 2219 2223 2228	savu	0724 0725 1889 1905	SLOCK	0393 1992 2007 4379
rhstart	5123		2240 2241 3966 3970		2189 2281 2284 2846		4385 4466 4468 5312
RHWCOC	5120 5142		3971 3972 3973 3974		4476 4477		5317
rip	1831 1859 1860 1863		3975 3976 4046 4048	sbreak	2929 3354	sloop	1953 2004 2014
	1864 1865 1866 1868		4049 4050 4370 4372	schar	1552 4097 4101 7679	slp0	2022
	1876 1877 1892 1893		4374 4375 4378 4379	sched	1637 1940	slp6	1990
	1894 1903 1908 1917		4380 4383 4384 4385	SCHMAG	3707 3814 3815	SMAPSIZ	0142 0204
	5808 5811 5815 5817		4386 4437 4440 4443	seek	2931 5861	smount	2933 6086
	5818 5825 5826 5830		4444 4451 4465 4466	sep	1650 1654 1677 1698	smp	6090 6102 6108 6109
	5832 5839 6675 6678		4467 4468 4469 4470		1714 3023 3094 3100		6111 6121 6122 6123
	6679 6680 6681 6682		4471 4472 4493 4495		3118 3151		6124 6125 6126 6127
	6691 6705 6708 6709		4496 4497 7347 7349	SETD	2660 2734		6128
	6710 6711		7350 7351 7352 7353	setgid	2958 3460	sp	2693 2811 3725 4136
RKADDR	5363		7354 7355 7357 7358	setpri	2156 2823 3818 3828		4137 4141 4143
rkaddr	5420		7359 7360 7362 7363	setreg	1089 1099 1117 1120	spl0	1292 1293 1976 2079
RKADDR	5447		7378 7381 7382 7383		1196		2092 4944 4947 4956
rkaddr	5447		7385 7386 7388 7389	setrun	2123 2134 3254 3310		4959 4991 5170 5218
RKADDR	5459 5460 5461 5462		7391 7396 7417 7420		3976 4188		5245 5320 5416 5996
rkba	5381		7421 7423 7425 7426	setuid	2935 3439		8228 8289 8565 8676
rkcs	5379 5459 5461 5462		7430 7431 7435 7438	sgtty	8171 8191 8201		8697 8759 8993 9037
rkda	5382 5447		7442 7445 7446 7447	si	4139 4143 4144 4146		9070
rkds	5377 5460		7448 7761 7763 7764		4148 4152 4154 4156	spl1	1292 1297 3803
rker	5378 5460		7772 7773 7774 7796	SIDL	0385 1903	spl4	1292 1302 8672 8686
rkintr	0576 0577 5451		7798 7807 7809 7810	sig	3949 3955 3963 3968		8757 8991
rkio	0577		7865 7867 7868 7869		3972	spl5	1292 1303 3766 5408
rkread	4684 5476		7870 7872 7885 7887	SIGBUS	0123 2722 4072		8222 8263 8283 8559
rkstart	5415 5440 5464 5472		7888 7889 7890 7891	SIGEMT	0120 2748 4070	spl6	1292 1308 1958 2075
rkstrategy	4658 5389 5479 5486	rpp	1830 1846 1847 1848	SIGFPT	0121 2793 2797 4071		2088 4886 4940 4952
rktab	4658 5386 5409 5410		1849 1852 1861 1862	SIGHUP	0114		4988 5007 5164 5201
	5412 5413 5414 5444		1863 1864 1865 1866	SIGINS	0117 2734 2736 4053		5213 5234 5294 5314
	5446 5455 5457 5458		1867 1868 1869 1877		4067	spl7	1292 1313 3854 5983
	5463 5469 5470		1878 1879 1880 1881	SIGINT	0115 8345		9028 9061
rkwc	5380		1890 1891 1895 1904	SIGIOT	0119 2744 4069	sps	4873 4885 4892 5003
rkwrite	4684 5483		1906 1907 1913	SIGKIL	0122 3619 3971		5006 5011 8256 8262
RO	0315 1668 1674	RPS	2613 2679 4057 4060	signal	3949 8345		8266
rootdev	0228 1616 1618 4695		4262	SIGPIPE	0126 7828	SRUN	0384 1591 1861 1908
	6926 6927 6934 7728	rrkbuf	5387 5479 5486	SIGQUIT	0116 4066 8345		1961 2008 2140 2208
rootdir	0206 1616 1617 7533	rsr	2315	SIGSEG	0124 2815 4073	ssig	2960 3614
ROOTINO	0106 1616 1618 7297	rtp	8377 8381 8386 8390	SIGSYS	0125 2781 4074	SSIZE	0137 3118 3131 3150
rp	1741 1745 1748 1750		8392 8393 8399 8403	SIGTRC	0118 2740 4053 4068	SSLEEP	0382 2008 2090
	1751 1755 1758 1760		8412 8413 8414 8423	SINCR	0138 4143	sslep	2947 5979
	1761 1762 1763 1943		8440 8452 8463 8468	size	2528 2535 2537 2538	ssr	0759 0760 1013 1016
	1960 1961 1962 1963		8478		2556 2566 2567 2576		1021 1023 1028 1050
	1964 1977 1978 1979	runin	0218 1954 1955 2080		2577 2578 2579 2584		1150 1171 1465 1467
	1980 1981 1991 1992		2081 2082 3820 3821		2586	SSR0	0613 0647 0759 0761
	1993 2006 2007 2008		3822	sleep	1955 1968 2066 3038		0765 1354
	2009 2010 2011 2015	runout	0219 1967 1968 2143		3314 4182 4190 4943	SSR2	0760
	2023 2024 2032 2033		2144 2145 4387 4388		4955 4990 5167 5204	SSTART	7988 8514
	2034 2036 2037 2039		4389		5215 5297 5316 5994	SSTOP	0387 1993 3253 3301
	2041 2042 2044 2045	runrun	0220 0770 0788 2142		6963 7007 7074 7289		4026 4173
	2046 2047 2068 2071		2166 2196 3807		7790 7838 7870 8225	SSWAP	0394 1907 2240 2241
	2076 2077 2078 2089	RW	0317 1684 1690 1707		8287 8563 8660 8693		2286 4479
	2090 2091 2136 2138		1711		8755 8989	SSYS	0392 1592 1992 2007
	2139 2140 2141 2143	rw	5259 5299 6672 6685	SLOAD	0391 1592 1862 1961	start	0521 0522 0611 0612
	2182 2197 2205 2206		6689 6702 6716 6722		1992 2007 2023 2046		0614

stat	2930 6028	s_inode	5569 7077 7107 7143	8075 8080 8081 8082	t_canq	7929 8258 8321 8543	
stat1	6021 6036 6045	s_isize	5563 7047 7096	8087 8092 8093 8094		8544	
static	2180	s_nfree	5565 6965 6967 6971	8220 8221 8223 8224	t_char	7940	
stime	2937 3428		6975 6987 7010 7011	8225 8227 8255 8257	t_col	7935 8393 8423	
stop	3999 4016		7014 7018 7020 7025	8258 8259 8260 8261	t_delct	7934 8265 8284 8294	
str	2433 2436		7175 7179	8264 8265 8279 8282		8359	
strat	5259 5261 5313	s_ninode	5568 7076 7077 7107	8284 8285 8287 8292	t_dev	7942 8033	
STRC	0395 3170 3224 3309		7108 7113 7118 7141	8294 8297 8299 8304	t_erase	7936 8048 8299 8584	
	3998 4028 4169		7143 7176 7180	8309 8321 8337 8339		8592	
stty	2943 8183	s_ronly	5573 6128 6754 6938	8341 8345 8346 8349	t_flags	7931 8047 8297 8309	
subyte	0807 0827 3161 6523		7214 7383	8350 8355 8357 8358		8336 8341 8342 8344	
suibyte	0809 0826 9067	s_time	5574 6939 6940 7218	8359 8362 8363 8373		8353 8356 8361 8386	
suiword	0813 0860 4240 4242		7219	8374 8381 8488 8490		8390 8399 8412 8440	
sumount	2934 6144	t00	1056 1059	8491 8492 8509 8512		8452 8463 8468 8586	
sureg	1724 1739 2229 2295	t01	1056 1079 1085 1101	8513 8514 8515 8518		8594	
suser	3431 3444 3465 3500	t02	1056 1102	8520 8524 8525 8538	t_kill	7937 8049 8304 8585	
	3522 3579 5921 5957	t03	1056 1103	8540 8541 8543 8544		8593	
	6800 6811	t04	1056 1104	8553 8555 8556 8560	t_outq	7930 8074 8075 8223	
suword	0811 0861 0864 3156	t05	1056 1105	8561 8562 8563 8566		8225 8259 8261 8414	
	3159 3164 3661 4057	t06	1056 1106	8568 8580 8581 8583		8478 8520 8560 8563	
	4058 4247 4249 6055	t07	1056 1093	8584 8585 8586 8589	t_rawq	7928 8260 8264 8287	
	6059 8175 8176 8177	t10	1062	8591 8592 8593 8594		8292 8349 8355 8357	
SW	0166 2391 3416	t11	1057 1110	trap		8358	
SWAIT	0383 1993 2077 3975	t12	1057 1111			7941 8583 8591	
swap	2034 2042 4380 4467	t13	1057 1112	trap1		7938 8045 8046 8059	
	5196	t14	1057 1113	trf	5804 5813 5824	t_state	8224 8285 8491 8514
swapdev	0229 3237 3282 4696	t15	1057 1114	ts	3023 3116 3118 3148		8518 8525 8541 8556
	5207 5212	t16	1057 1107		4437 4455 4456 4457		8562
swaper	2035 2043 2050	t17	1057 1140 1188		4459 4460 4467 5266	u	0459 0646 0659 0662
swapmap	0204 1583 2044 3234	TBDELAY	7975		5275 5277 5283 5291		0744 1440 1441 1593
	3283 4375 4408 4457	TBIT	2615 4060	tst	0604 0605		1618 1619 1665 1666
swbuf	4721 5200 5207 5208	text	1240 4306 4314 4436	TTHIWAT	7961 8560		1678 1694 1699 1715
	5209 5210 5211 5212		4441	TTIPRI	7951 8287		1716 1717 1719 1720
swplo	0231 1583 4697	tim	3845 3851	TTLOWAT	7962 8074		1721 1728 1743 1744
swtch	0770 0791 2084 2093	time	0213 3423 3424 3432	TTOPRI	7952 8225 8563		1752 1754 1859 1876
	2178 2287 3256 4027		3433 3801 3802 3804	ttrbuf	8157		1883 1889 1891 1905
	4480		3806 5984 5985 5988	ttrcsr	8156		1917 2071 2106 2189
SWTED	0396 3302 3303 3309		5989 6050 6939 6940	ttread	8063 8535		2242 2273 2281 2284
	4187		7218 7219 7226 7357	ttrstrt	8486 8524		2701 2734 2752 2763
sync	2948 3486		7392 7393	ttstart	8073 8363 8492 8505		2766 2770 2772 2773
SYS	2661 2759	timeout	3845		8561 8568		2774 2775 2777 2793
sysent	2667 2670 2696 2754	TIMEOUT	7984 8491 8518	tttbuf	8159 8522		2812 2818 2823 2845
	2755 2761 2910	timeouT	8524	tttcsr	8158 8518		2846 2848 2857 3052
SZOMB	0386 3243 3280	TIMEOUT	8525	ttwrite	8067 8550		3056 3064 3085 3086
s_flock	5570 6127 6936 6962	times	2955 3656	tty	7926 8015 8025 8056		3087 3088 3089 3091
	6963 6972 6978 6979	tm	7374 7376 7397 7398		8071 8080 8092 8218		3092 3095 3096 3097
	7006 7007 7015 7022	tmtab	4727 4844		8220 8253 8255 8275		3099 3101 3102 3105
	7023 7214	to	6585 6586 6591		8279 8334 8337 8374		3106 3116 3117 3127
s_fmod	5572 6983 7005 7026	tout	0214 3434 3804 3805		8377 8488 8506 8509		3134 3139 3140 3141
	7084 7144 7213 7217		5989 5990 5991 5992		8536 8538 8551 8553		3148 3149 3150 3151
s_free	5567 6967 6976 7012		5994	TTYHOG	7963 8349		3152 3155 3170 3172
	7019 7025	tp	3949 3954 8025 8030	ttyinput	8087 8333		3173 3174 3177 3183
s_fsize	5564 7047		8032 8033 8044 8045	ttyoutput	8362 8373 8392 8403		3187 3188 3189 3208
s_ilock	5571 6126 6937 7073		8046 8047 8048 8049		8413 8566		3224 3225 3227 3232
	7074 7094 7116 7117		8056 8057 8058 8059	ttystty	8094 8577		3238 3240 3278 3281
	7139 7213		8071 8072 8073 8074	t_addr	7932 8044 8082 8513		3291 3292 3293 3294

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4463	4465	4476	4477	u0	1067	1096				4459	4467	4473		7482	7483	7488	7636	
4478	4479	5269	5273	u1	1067	1189			u_ar0	0452	2701	2812	3155	7640	7646	7664		
5275	5276	5291	5292	u2	1067	1190				3187	3188	3208	3281	u_dirp	0430	2770	4100	5927
5306	5309	5310	5312	u3	1067	1191				3297	3304	3305	3335	6096	7682	7693		
5317	5322	5326	5343	u4	1067	1087				3344	3347	3416	3423	u_dsize	0442	3149	3152	3369
5344	5736	5740	5743	u5	1067	1071	1075	1097		3424	3432	3433	3443	3371	3373	4146	5291	
5744	5745	5751	5752	u6	1067	1069				3455	3456	3464	3475	u_error	0419	1728	2752	2773
5756	5758	5773	5774	u7	1067	1192				3476	3482	3497	3623	2774	2775	2777	2857	
5788	5790	5819	5822	ub	6045	6055	6056	6059		3637	3825	4055	4057	3064	3092	3102	3106	
5831	5833	5835	5850		6060					4058	4059	4060	4061	3317	3330	3547	3620	
5853	5866	5870	5873	UBMAP	0311	1573	1574	5175		4079	4184	4191	4258	3652	4052	4099	4103	
5875	5876	5880	5918		5177					4262	5736	5758	5831	4127	4177	4193	5326	
5927	5930	5933	5935	uchar	3026	3034	3513	3515		5850	5853	5866	5986	5343	5344	5740	5788	
5936	5937	5960	5964		3541	3543	5768	5770		6018	6073	6830	7736	5819	5822	5833	5870	
5966	5969	5986	6018		5784	5786	5912	5914		7744	7745	8206		5918	5930	5933	5937	
6021	6036	6073	6078		5928	5955	5958	6031	u_arg	0440	2763	2766	2770	5960	5964	6094	6114	
6094	6096	6113	6114		6033	6091	6097	6184		3052	3056	3085	3095	6117	6135	6152	6157	
6117	6128	6135	6152		6186	6794	6796	7689		3096	3097	3099	3101	6163	6190	6193	6262	
6157	6163	6190	6193	UDSA	0308	5306				3105	3116	3117	3140	6307	6319	6378	6424	

	6524 6551 6569 6630		4048 4119 4148 4149		1721 1754		x5	2340
	6727 6755 6759 6778		4169 4175 4209 4273	u_utime	0448 3296 3341 3660		x6	2340
	6816 6833 6863 6929		4401 4402 4448 4465		3789		x7	2340
	6989 7121 7311 7538		4478 4479 5312 5317	v	8090 8091 8094 8167		x8	2340
	7548 7560 7571 7580		7828 8031 8032		8170 8201 8202 8213		x9	2340
	7612 7695 7827 8027	u_prof	0453 3127 3670 3671		8580 8582 8583 8584		xa	2340
	8172 8210 8654 8751		3672 3673 3790 3791		8585 8586 8590 8591	xalloc	3130 4433	
	8854 9038 9057	u_qsav	0445 2106 2846		8592 8593 8594	xb	2340	
u_fsav	0416 3189 4255	u_rgid	0423 3465 3467 3475	vp	8168 8170 8171 8175	xbr	2318 2399	
u_gid	0421 3177 3466 3476	u_rsav	0415 1889 2189 2281		8176 8177	xc	2340	
	6771 7466		4476	VTDELAY	7977 8463	xccdec	4378 4403 4490	
u_ino	0432 3519 3527 7482	u_ruid	0422 3444 3447 3455	wait	2919 3270	xfree	3128 3233 4398	
	7640 7664		4111	WAITING	8610 8657 8658 8721	xp	4399 4401 4403 4404	
u_intflg	0454 2772 2845 2848	u_segflg	0418 3089 3091 4117	wakeup	2082 2113 2145 3197		4405 4407 4408 4409	
u_name	0433 7483 7646		4123 5745 6372 6521		3248 3249 3434 3805		4436 4441 4442 4444	
u_offset	0427 3087 3088 3140		6548 7487 7587		3808 3822 4025 4195		4446 4447 4448 4451	
	3524 4113 4114 4462	u_sep	0444 3151 3152 3365		4213 4389 4877 4880		4452 4453 4454 4456	
	5309 5751 5752 6239		3371 4146 5276 5306		5031 5188 5217 5319		4457 4467 4469 4475	
	6240 6244 6294 6295	u_signal	0447 2734 3183 3225		6652 6653 6979 7023		4483 4490 4491 4495	
	6309 6313 6315 6316		3623 3624 4003 4051		7117 7778 7852 7891		5911 5928 5929 5931	
	6382 6528 6529 6555		4054		8075 8260 8261 8357	xsr	2317 2393 2397 2398	
	6556 7585 7586 7608	u_ssav	0446 1905 2242 2284		8734 8744 8982		2406	
	7622 7626 7636 7638		4477	WCOM	5093 5114	xswap	1906 2024 2285 4368	
	7642 7795 7796 7798	u_ssize	0443 3150 3152 3370	wdir	5940 7467 7477		4478	
	7844 7845 7846 9024		3371 3376 3378 3389	wf	7725 7737 7738 7746	XTABS	7967 8047 8390	
	9025 9051 9055 9056		4141 4143 4146 4150		7747	x_caddr	1753 2036 4309 4497	
u_ofile	0438 1876 3227 5835		4156 5292	wflushtty	8058 8217 8589	x_ccount	1881 1980 2033 2039	
	5853 6078 6626 6829	u_stime	0449 3293 3338 3793	WLO	5373		4313 4453 4475 4483	
	6856 7740	u_tsize	0441 3148 3152 3366	WO	0316 1762		4495 4496	
u_pdir	0435 5935 5936 7459		3371 4146 5275	WOPEN	7985	x_count	1880 4312 4404 4447	
	7489 7490 7606	u_uid	0420 3172 3173 3445	write	2916 5720		4452	
u_procp	0424 1593 1743 1752		3456 3567 3646 4111	writei	3528 4118 4124 5755	x_daddr	2034 4308 4409 4457	
	1859 1891 1917 2071		6763 6769 6798 6814		6276 7489 7848		4467	
	2273 2793 2818 2823		7465	wriep	5749 7805	x_iptr	4311 4405 4407 4442	
	3134 3170 3174 3224	u_uisa	0436 1665 1678 1694	x1	2340 2346		4446 4454	
	3240 3278 3314 3326		1699 1715 1716 1717	x2	2340	x_size	1981 2034 2037 4310	
	3376 3388 3446 3482		1744	x3	2340		4408 4456 4497	
	3502 3625 3626 3638	u_uisd	0437 1666 1719 1720	x4	2340	z	8407 8885	
	3794 3828 3996 4021							



# 1

**Initialization**  
**Process Initialization**



```

0100 /* fundamental constants: do not change */
0101
0102
0103 #define USIZE 16 /* size of user block (*64) */
0104 #define NULL 0
0105 #define NODEV (-1)
0106 #define ROOTINO 1 /* i number of all roots */
0107 #define DIRSIZ 14 /* max characters per directory */
0108
0109
0110 /* signals: do not change */
0111
0112
0113 #define NSIG 20
0114 #define SIGHUP 1 /* hangup */
0115 #define SIGINT 2 /* interrupt (rubout) */
0116 #define SIGQUIT 3 /* quit (FS) */
0117 #define SIGILL 4 /* illegal instruction */
0118 #define SIGTRC 5 /* trace or breakpoint */
0119 #define SIGIOT 6 /* iot */
0120 #define SIGEMT 7 /* emt */
0121 #define SIGFPE 8 /* floating point exception */
0122 #define SIGKIL 9 /* kill */
0123 #define SIGBUS 10 /* bus error */
0124 #define SIGSEGV 11 /* segmentation violation */
0125 #define SIGSYS 12 /* sys */
0126 #define SIGPIPE 13 /* end of pipe */
0127
0128 /* tunable variables */
0129
0130 #define NBUF 15 /* size of buffer cache */
0131 #define NINODE 100 /* number of in core inodes */
0132 #define NFILE 100 /* number of in core file structures */
0133 #define NMOUNT 5 /* number of mountable file systems */
0134 #define NEXEC 3 /* number of simultaneous exec's */
0135 #define MAXMEM (64*32) /* max core per process;
0136 first number is kw */
0137 #define SSIZE 20 /* initial stack size (*64 bytes) */
0138 #define SINCR 20 /* increment of stack (*64 bytes) */
0139 #define NOFILE 15 /* max open files per process */
0140 #define CANBSIZ 256 /* max size of typewriter line */
0141 #define CMAPSIZ 100 /* size of core allocation area */
0142 #define SMAPSIZ 100 /* size of swap allocation area */
0143 #define NCALL 20 /* max simultaneous time callouts */
0144 #define NPROC 50 /* max number of processes */
0145 #define NTEXT 40 /* max number of pure texts */
0146 #define NCLIST 100 /* max total clist size */
0147 #define HZ 60 /* Ticks/second of the clock */
0148
0149

```

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```

0150
0151 /* priorities: do not alter much */
0152
0153
0154 #define PSWP -100
0155 #define PINOD -90
0156 #define PRIBIO -50
0157 #define PPIPE 1
0158 #define PWAIT 40
0159 #define PSLEP 90
0160 #define PUSER 100
0161
0162 /* Certain processor registers */
0163
0164 #define PS 0177776
0165 #define KL 0177560
0166 #define SW 0177570
0167
0168 /* ----- */
0169
0170 /* structures to access integers : */
0171
0172 /* single integer */
0173
0174 struct { int integ; };
0175
0176
0177 /* in bytes */
0178
0179 struct { char lobyte; char hibyte; };
0180
0181
0182 /* as a sequence */
0183
0184 struct { int r[]; };
0185
0186
0187
0188 /* ----- */
0189
0190
0191
0192
0193
0194
0195
0196
0197
0198
0199

```

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```

0200 /* various global variables */
0201
0202 char canonb[CANBSIZ]; /* buffer for erase and kill */
0203 int coremap[CMAPSIZ]; /* space for core allocation */
0204 int swapmap[SMAPSIZ]; /* space for swap allocation */
0205
0206 int *rootdir; /* pointer to inode of root directory */
0207
0208 int cputype; /* type of cpu =40, 45, or 70 */
0209
0210 int execnt; /* number of processes in exec */
0211
0212 int lbolt; /* time of day in 60th not in time */
0213 int time[2]; /* time in sec from 1970 */
0214 int tout[2]; /* time of day of next sleep */
0215
0216 int mpid; /* generic for unique process id's */
0217
0218 char runin; /* scheduling flag */
0219 char runout; /* scheduling flag */
0220 char runrun; /* scheduling flag */
0221
0222 char curpri; /* more scheduling */
0223
0224 int maxmem; /* actual max memory per process */
0225
0226 int *lks; /* pointer to clock device */
0227
0228 int rootdev; /* dev of root see conf.c */
0229 int swapdev; /* dev of swap see conf.c */
0230
0231 int swplo; /* block number of swap space */
0232 int nswap; /* size of swap space */
0233
0234 int updlock; /* lock for sync */
0235 int rablock; /* block to be read ahead */
0236
0237 char regloc[]; /* locs. of saved user registers
0238 (see trap.c) */
0239
0240
0241 /* ----- */
0242
0243
0244
0245
0246
0247
0248
0249

```

```

0250
0251 /* ----- */
0252
0253 /* The callout structure is for a routine
0254 * arranging to be called by the the clock interrupt
0255 * (see clock.c), with a specified argument,
0256 * within a specified amount of time.
0257 * It is used, for example, to time tab delays
0258 * on teletypes. */
0259
0260 struct callo
0261 {
0262     int c_time; /* incremental time */
0263     int c_arg; /* argument to routine */
0264     int (*c_func)(); /* routine */
0265 } callout[NCALL];
0266 /* ----- */
0267
0268 /* Mount structure: used to locate
0269 * the super block of a mounted file.
0270 */
0271
0272 struct mount
0273 {
0274     int m_dev; /* device mounted */
0275     int *m_bufp; /* pointer to superblock */
0276     int *m_inodp; /* pointer to mounted on inode */
0277 } mount[NMOUNT];
0278 /* ----- */
0279
0280
0281
0282
0283
0284
0285
0286
0287
0288
0289
0290
0291
0292
0293
0294
0295
0296
0297
0298
0299

```

```

0300
0301 /* kt-11 addresses and bits */
0302
0303
0304 #define UISD 0177600 /* first user I-space descriptor
0305                      register */
0306 #define UISA 0177640 /* first user I-space address
0307                      register */
0308 #define UDSA 0177660 /* first user D-space address
0309                      register */
0310
0311 #define UBMAP 0170200 /* access to 11/70 unibus map */
0312
0313
0314
0315 #define RO 02 /* access abilities */
0316 #define WO 04
0317 #define RW 06
0318 #define ED 010 /* expand segment downwards */
0319
0320 /* ----- */
0321
0322 int      *ka6; /* 11/40 KISA6; 11/45 KDSA6 */
0323
0324
0325
0326
0327
0328
0329
0330
0331
0332
0333
0334
0335
0336
0337
0338
0339
0340
0341
0342
0343
0344
0345
0346
0347
0348
0349

```

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```

0350 /*
0351  * One structure allocated per active
0352  * process. It contains all data needed
0353  * about the process while the
0354  * process may be swapped out.
0355  * Other per process data (user.h)
0356  * is swapped with the process.
0357  */
0358 struct      proc
0359 {
0360     char      p_stat;
0361     char      p_flag;
0362     char      p_pri; /* priority, negative is high */
0363     char      p_sig; /* signal number sent to this process */
0364     char      p_uid; /* user id, used to direct tty signals */
0365     char      p_time; /* resident time for scheduling */
0366     char      p_cpu; /* cpu usage for scheduling */
0367     char      p_nice; /* nice for scheduling */
0368     int       p_ttyp; /* controlling tty */
0369     int       p_pid; /* unique process id */
0370     int       p_ppid; /* process id of parent */
0371     int       p_addr; /* address of swappable image */
0372     int       p_size; /* size of swappable image (*64 bytes) */
0373     int       p_wchan; /* event process is awaiting */
0374     int       *p_textp; /* pointer to text structure */
0375
0376 } proc[NPROC];
0377 /* ----- */
0378
0379 /* stat codes */
0380
0381 /*      null      0      not assigned */
0382 #define SSLEEP 1 /* sleeping on high priority */
0383 #define SWAIT 2 /* sleeping on low priority */
0384 #define SRUN 3 /* running */
0385 #define SIDL 4 /* process being created */
0386 #define SZOMB 5 /* process being terminated */
0387 #define SSTOP 6 /* process being traced */
0388
0389 /* flag codes */
0390
0391 #define SLOAD 01 /* in core */
0392 #define SSYS 02 /* scheduling process */
0393 #define SLOCK 04 /* process cannot be swapped */
0394 #define SSWAP 010 /* process is being swapped out */
0395 #define STRC 020 /* process is being traced */
0396 #define SWTED 040 /* another tracing flag */
0397
0398
0399

```

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```

0400 /*
0401  * The user structure.
0402  * One allocated per process.
0403  * Contains all per process data
0404  * that doesn't need to be referenced
0405  * while the process is swapped.
0406  * The user block is USIZE*64 bytes
0407  * long; resides at virtual kernel
0408  * loc 140000; contains the system
0409  * stack per user; is cross referenced
0410  * with the proc structure for the
0411  * same process.
0412  */
0413 struct user
0414 {
0415     int u_rsav[2]; /* save r5,r6 when exchanging stacks */
0416     int u_fsav[25]; /* save fp registers */
0417     /* rsav and fsav must be first in structure */
0418     char u_segflg; /* flag for IO; user or kernel space */
0419     char u_error; /* return error code */
0420     char u_uid; /* effective user id */
0421     char u_gid; /* effective group id */
0422     char u_ruid; /* real user id */
0423     char u_rgid; /* real group id */
0424     int u_procp; /* pointer to proc structure */
0425     char *u_base; /* base address for IO */
0426     char *u_count; /* bytes remaining for IO */
0427     char *u_offset[2]; /* offset in file for IO */
0428     int *u_cdir; /* pointer to inode for current directory */
0429     char u_dbuf[DIRSIZ]; /* current pathname component */
0430     char *u_dirp; /* current pointer to inode */
0431     struct { /* current directory entry */
0432         int u_ino;
0433         char u_name[DIRSIZ];
0434     } u_dent;
0435     int *u_pdir; /* inode of parent directory of dirp */
0436     int u_uisa[16]; /* prototype segmentation addresses */
0437     int u_uids[16]; /* prototype segmentation descriptors */
0438     int u_ofile[NOFILE]; /* pointers to file structures of
0439                          open files */
0440     int u_arg[5]; /* arguments to current system call */
0441     int u_tsize; /* text size (*64) */
0442     int u_dsize; /* data size (*64) */
0443     int u_ssize; /* stack size (*64) */
0444     int u_sep; /* flag for I and D separation */
0445     int u_qsav[2]; /* label variable for quits & interrupts */
0446     int u_ssav[2]; /* label variable for swapping */
0447     int u_signal[NSIG]; /* disposition of signals */
0448     int u_utime; /* this process user time */
0449     int u_stime; /* this process system time */

```

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```

0450 int u_cutime[2]; /* sum of childs' utimes */
0451 int u_cstime[2]; /* sum of childs' stimes */
0452 int *u_ar0; /* address of users saved R0 */
0453 int u_prof[4]; /* profile arguments */
0454 char u_intflg; /* catch intr from sys */
0455 /* kernel stack per user
0456  * extends from u + USIZE*64
0457  * backward not to reach here
0458  */
0459 } u;
0460 /* ----- */
0461
0462 /* u_error codes */
0463 /* See section "INTRO(II)" of
0464  * the UNIX Programmer's manual
0465  * for the meanings of these codes. */
0466 #define EFAULT 106
0467 #define EPERM 1
0468 #define ENOENT 2
0469 #define ESRCH 3
0470 #define EINTR 4
0471 #define EIO 5
0472 #define ENXIO 6
0473 #define E2BIG 7
0474 #define ENOEXEC 8
0475 #define EBADF 9
0476 #define ECHILD 10
0477 #define EAGAIN 11
0478 #define ENOMEM 12
0479 #define EACCES 13
0480 #define ENOTBLK 15
0481 #define EBUSY 16
0482 #define EEXIST 17
0483 #define EXDEV 18
0484 #define ENODEV 19
0485 #define ENOTDIR 20
0486 #define EISDIR 21
0487 #define EINVAL 22
0488 #define ENFILE 23
0489 #define EMFILE 24
0490 #define ENOTTY 25
0491 #define ETXTBSY 26
0492 #define EFBIG 27
0493 #define ENOSPC 28
0494 #define ESPIPE 29
0495 #define EROFS 30
0496 #define EMLINK 31
0497 #define EPIPE 32
0498
0499

```

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```

0500 / low core
0501
0502 br4 = 200
0503 br5 = 240
0504 br6 = 300
0505 br7 = 340
0506
0507 . = 0^.
0508   br      1f
0509     4
0510
0511 / trap vectors
0512 trap; br7+0.      / bus error
0513 trap; br7+1.      / illegal instruction
0514 trap; br7+2.      / bpt-trace trap
0515 trap; br7+3.      / iot trap
0516 trap; br7+4.      / power fail
0517 trap; br7+5.      / emulator trap
0518 trap; br7+6.      / system entry
0519
0520 . = 40^.
0521 .globl   start, dump
0522 1: jmp    start
0523     jmp    dump
0524
0525 . = 60^.
0526   klin; br4
0527   klou; br4
0528
0529 . = 70^.
0530   pcin; br4
0531   pcou; br4
0532
0533 . = 100^.
0534   kwlp; br6
0535   kwlp; br6
0536
0537 . = 114^.
0538 trap; br7+7.      / 11/70 parity
0539
0540 . = 200^.
0541   lpou; br4
0542
0543 . = 220^.
0544   rkio; br5
0545
0546 . = 240^.
0547 trap; br7+7.      / programmed interrupt
0548 trap; br7+8.      / floating point
0549 trap; br7+9.      / segmentation violation

```

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```

0550
0551 ////////////////////////////////////////////////////
0552 /           interface code to C
0553 ////////////////////////////////////////////////////
0554
0555 .globl   call, trap
0556
0557 .globl   _klrint
0558 klin:   jsr    r0,call; _klrint
0559
0560 .globl   _klxint
0561 klou:   jsr    r0,call; _klxint
0562
0563 .globl   _pccint
0564 pcin:   jsr    r0,call; _pccint
0565
0566 .globl   _pcpint
0567 pcou:   jsr    r0,call; _pcpint
0568
0569 .globl   _clock
0570 kwlp:   jsr    r0,call; _clock
0571
0572
0573 .globl   _lpint
0574 lpou:   jsr    r0,call; _lpint
0575
0576 .globl   _rkintr
0577 rkio:   jsr    r0,call; _rkintr
0578
0579
0580
0581
0582
0583
0584
0585
0586
0587
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```

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```

0600 / machine language assist
0601 / for 11/40
0602
0603 / non-UNIX instructions
0604 mfpi      = 6500^tst
0605 mtpi      = 6600^tst
0606 wait     = 1
0607 rtt      = 6
0608 reset     = 5
0609
0610 /* ----- */
0611 .globl    start, _end, _edata, _main
0612 start:
0613 bit      $1,SSR0
0614 bne     start          / loop if restart
0615 reset
0616
0617 / initialize systems segments
0618
0619 mov     $KISA0,r0
0620 mov     $KISD0,r1
0621 mov     $200,r4
0622 clr    r2
0623 mov     $6,r3
0624 1:
0625 mov     r2,(r0)+
0626 mov     $77406,(r1)+      / 4k rw
0627 add    r4,r2
0628 sob    r3,1b
0629
0630 / initialize user segment
0631
0632 mov     $_end+63.,r2
0633 ash    $-6,r2
0634 bic    $!1777,r2
0635 mov     r2,(r0)+
0636 mov     $USIZE-1\<8|6,(r1)+ / ksr = sysu
0637
0638 / initialize io segment
0639 / set up counts on supervisor segments
0640
0641 mov     $IO,(r0)+
0642 mov     $77406,(r1)+      / rw 4k
0643
0644 / get a sp and start segmentation
0645
0646 mov     $_u+[USIZE*64.],sp
0647 inc    SSR0
0648
0649 / clear bss

```

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```

0650
0651 mov     $_edata,r0
0652 1:
0653 clr    (r0)+
0654 cmp    r0,$_end
0655 blo    1b
0656
0657 / clear user block
0658
0659 mov     $_u,r0
0660 1:
0661 clr    (r0)+
0662 cmp    r0,$_u+[USIZE*64.]
0663 blo    1b
0664
0665 / set up previous mode and call main
0666 / on return, enter user mode at OR
0667
0668 mov     $30000,PS
0669 jsr    pc,_main
0670 mov     $170000,-(sp)
0671 clr    -(sp)
0672 rtt
0673
0674 /* ----- */
0675 .globl    _clearseg
0676 _clearseg:
0677 mov     PS,-(sp)
0678 mov     UISA0,-(sp)
0679 mov     $30340,PS
0680 mov     6(sp),UISA0
0681 mov     UISD0,-(sp)
0682 mov     $6,UISD0
0683 clr    r0
0684 mov     $32.,r1
0685 1:
0686 clr    -(sp)
0687 mtpi   (r0)+
0688 sob    r1,1b
0689 mov    (sp)+,UISD0
0690 mov    (sp)+,UISA0
0691 mov    (sp)+,PS
0692 rts    pc
0693
0694 /* ----- */
0695 .globl    _copyseg
0696 _copyseg:
0697 mov     PS,-(sp)
0698 mov     UISA0,-(sp)
0699 mov     UISA1,-(sp)

```

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```

0700 mov    $30340,PS
0701 mov    10(sp),UISA0
0702 mov    12(sp),UISA1
0703 mov    UISD0,-(sp)
0704 mov    UISD1,-(sp)
0705 mov    $6,UISD0
0706 mov    $6,UISD1
0707 mov    r2,-(sp)
0708 clr    r0
0709 mov    $8192.,r1
0710 mov    $32.,r2
0711 1:
0712 mfpi   (r0)+
0713 mtpi   (r1)+
0714 sob   r2,1b
0715 mov    (sp)+,r2
0716 mov    (sp)+,UISD1
0717 mov    (sp)+,UISD0
0718 mov    (sp)+,UISA1
0719 mov    (sp)+,UISA0
0720 mov    (sp)+,PS
0721 rts    pc
0722
0723 /* ----- */
0724 .globl  _savu, _retu, _aretu
0725 _savu:
0726 bis    $340,PS
0727 mov    (sp)+,r1
0728 mov    (sp),r0
0729 mov    sp,(r0)+
0730 mov    r5,(r0)+
0731 bic    $340,PS
0732 jmp    (r1)
0733
0734 _aretu:
0735 bis    $340,PS
0736 mov    (sp)+,r1
0737 mov    (sp),r0
0738 br    1f
0739
0740 _retu:
0741 bis    $340,PS
0742 mov    (sp)+,r1
0743 mov    (sp),r0
0744 mov    $_u,r0
0745 1:
0746 mov    (r0)+,sp
0747 mov    (r0)+,r5
0748 bic    $340,PS
0749 jmp    (r1)

```

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```

0750
0751 /* ----- */
0752 .globl  trap, call
0753 /* ----- */
0754 .globl  _trap
0755 trap:
0756 mov    PS,-4(sp)
0757 tst    nofault
0758 bne    1f
0759 mov    SSR0,ssr
0760 mov    SSR2,ssr+4
0761 mov    $1,SSR0
0762 jsr    r0,call1; _trap
0763 / no return
0764 1:
0765 mov    $1,SSR0
0766 mov    nofault,(sp)
0767 rtt
0768
0769 /* ----- */
0770 .globl  _runrun, _swtch
0771 call1:
0772 tst    -(sp)
0773 bic    $340,PS
0774 br    1f
0775
0776 call:
0777 mov    PS,-(sp)
0778 1:
0779 mov    r1,-(sp)
0780 mfpi   sp
0781 mov    4(sp),-(sp)
0782 bic    $!37,(sp)
0783 bit    $30000,PS
0784 beq    1f
0785 jsr    pc,* (r0)+
0786 2:
0787 bis    $340,PS
0788 tstb   _runrun
0789 beq    2f
0790 bic    $340,PS
0791 jsr    ps,_swtch
0792 br    2b
0793 2:
0794 tst    (sp)+
0795 mtpi   sp
0796 br    2f
0797 1:
0798 bis    $30000,PS
0799 jsr    pc,* (r0)+

```

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```

0800  cmp      (sp)+, (sp)+
0801  2:
0802  mov      (sp)+, r1
0803  tst      (sp)+
0804  mov      (sp)+, r0
0805  rtt
0806  /* ----- */
0807  .globl   _fubyte, _subyte
0808  /* ----- */
0809  .globl   _fuibyte, _suibyte
0810  /* ----- */
0811  .globl   _fuword, _suword
0812  /* ----- */
0813  .globl   _fuiword, _suiword
0814  _fubyte:
0815  _fubyte:
0816  mov      2(sp), r1
0817  bic      $1, r1
0818  jsr     pc, gword
0819  cmp     r1, 2(sp)
0820  beq     1f
0821  swab   r0
0822  1:
0823  bic     $1377, r0
0824  rts    pc
0825
0826  _suibyte:
0827  _subyte:
0828  mov     2(sp), r1
0829  bic     $1, r1
0830  jsr     pc, gword
0831  mov     r0, -(sp)
0832  cmp     r1, 4(sp)
0833  beq     1f
0834  movb   6(sp), 1(sp)
0835  br     2f
0836  1:
0837  movb   6(sp), (sp)
0838  2:
0839  mov     (sp)+, r0
0840  jsr     pc, pword
0841  clr     r0
0842  rts    pc
0843
0844  _fuiword:
0845  _fuword:
0846  mov     2(sp), r1
0847  fuword:
0848  jsr     pc, gword
0849  rts    pc

```

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```

0850
0851  gword:
0852  mov     PS, -(sp)
0853  bis     $340, PS
0854  mov     nofault, -(sp)
0855  mov     $err, nofault
0856  mfp    (r1)
0857  mov     (sp)+, r0
0858  br     1f
0859
0860  _suiword:
0861  _suword:
0862  mov     2(sp), r1
0863  mov     4(sp), r0
0864  suword:
0865  jsr     pc, pword
0866  rts    pc
0867
0868  pword:
0869  mov     PS, -(sp)
0870  bis     $340, PS
0871  mov     nofault, -(sp)
0872  mov     $err, nofault
0873  mov     r0, -(sp)
0874  mtpi   (r1)
0875  1:
0876  mov     (sp)+, nofault
0877  mov     (sp)+, PS
0878  rts    pc
0879
0880  err:
0881  mov     (sp)+, nofault
0882  mov     (sp)+, PS
0883  tst     (sp)+
0884  mov     $-1, r0
0885  rts    pc
0886
0887  /* ----- */
0888  .globl   _savfp, _display
0889  _savfp:
0890  _display:
0891  rts    pc
0892
0893  /* ----- */
0894  .globl   _incupc
0895  _incupc:
0896  mov     r2, -(sp)
0897  mov     6(sp), r2 / base of prof with base, leng, off, scale
0898  mov     4(sp), r0 / pc
0899  sub     4(r2), r0 / offset

```

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```

0900  clc
0901  ror    r0
0902  mul    6(r2),r0      / scale
0903  ashc   $-14.,r0
0904  inc    r1
0905  bic    $1,r1
0906  cmp    r1,2(r2)     / length
0907  bhis   1f
0908  add    (r2),r1      / base
0909  mov    nofault,-(sp)
0910  mov    $2f,nofault
0911  mfpi   (r1)
0912  inc    (sp)
0913  mtpi   (r1)
0914  br     3f
0915 2:
0916  clr    6(r2)
0917 3:
0918  mov    (sp)+,nofault
0919 1:
0920  mov    (sp)+,r2
0921  rts    pc
0922
0923 / Character list get/put
0924
0925 /* ----- */
0926 .globl  _getc, _putc
0927 /* ----- */
0928 .globl  _cfreelist
0929
0930 _getc:
0931  mov    2(sp),r1
0932  mov    PS,-(sp)
0933  mov    r2,-(sp)
0934  bis    $340,PS
0935  bic    $100,PS      / spl 5
0936  mov    2(r1),r2     / first ptr
0937  beq    9f          / empty
0938  movb   (r2)+,r0     / character
0939  bic    $1377,r0
0940  mov    r2,2(r1)
0941  dec    (r1)+       / count
0942  bne    1f
0943  clr    (r1)+
0944  clr    (r1)+       / last block
0945  br     2f
0946 1:
0947  bit    $7,r2
0948  bne    3f
0949  mov    -10(r2),(r1) / next block

```

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```

0950  add    $2,(r1)
0951 2:
0952  dec    r2
0953  bic    $7,r2
0954  mov    _cfreelist,(r2)
0955  mov    r2,_cfreelist
0956 3:
0957  mov    (sp)+,r2
0958  mov    (sp)+,PS
0959  rts    pc
0960 9:
0961  clr    4(r1)
0962  mov    $-1,r0
0963  mov    (sp)+,r2
0964  mov    (sp)+,PS
0965  rts    pc
0966
0967 _putc:
0968  mov    2(sp),r0
0969  mov    4(sp),r1
0970  mov    PS,-(sp)
0971  mov    r2,-(sp)
0972  mov    r3,-(sp)
0973  bis    $340,PS
0974  bic    $100,PS      / spl 5
0975  mov    4(r1),r2     / last ptr
0976  bne    1f
0977  mov    _cfreelist,r2
0978  beq    9f
0979  mov    (r2),_cfreelist
0980  clr    (r2)+
0981  mov    r2,2(r1)     / first ptr
0982  br     2f
0983 1:
0984  bit    $7,r2
0985  bne    2f
0986  mov    _cfreelist,r3
0987  beq    9f
0988  mov    (r3),_cfreelist
0989  mov    r3,-10(r2)
0990  mov    r3,r2
0991  clr    (r2)+
0992 2:
0993  movb   r0,(r2)+
0994  mov    r2,4(r1)
0995  inc    (r1)        / count
0996  clr    r0
0997  mov    (sp)+,r3
0998  mov    (sp)+,r2
0999  mov    (sp)+,PS

```

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```

1000 rts pc
1001 9:
1002 mov pc,r0
1003 mov (sp)+,r3
1004 mov (sp)+,r2
1005 mov (sp)+,PS
1006 rts pc
1007
1008 /* ----- */
1009 .globl _backup
1010 /* ----- */
1011 .globl _regloc
1012 _backup:
1013 mov 2(sp),ssr+2
1014 mov r2,-(sp)
1015 jsr pc,backup
1016 mov r2,ssr+2
1017 mov (sp)+,r2
1018 movb jflg,r0
1019 bne 2f
1020 mov 2(sp),r0
1021 movb ssr+2,r1
1022 jsr pc,1f
1023 movb ssr+3,r1
1024 jsr pc,1f
1025 movb _regloc+7,r1
1026 asl r1
1027 add r0,r1
1028 mov ssr+4,(r1)
1029 clr r0
1030 2:
1031 rts pc
1032 1:
1033 mov r1,-(sp)
1034 asr (sp)
1035 asr (sp)
1036 asr (sp)
1037 bic $!7,r1
1038 movb _regloc(r1),r1
1039 asl r1
1040 add r0,r1
1041 sub (sp)+,(r1)
1042 rts pc
1043
1044 / hard part
1045 / simulate the ssr2 register missing on 11/40
1046
1047 backup:
1048 clr r2 / backup register ssr1
1049 mov $!1,bflg / clr jflg

```

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```

1050 mov ssr+4,r0
1051 jsr pc,fetch
1052 mov r0,r1
1053 ash $-11.,r0
1054 bic $!36,r0
1055 jmp *0f(r0)
1056 0: t00; t01; t02; t03; t04; t05; t06; t07
1057 t10; t11; t12; t13; t14; t15; t16; t17
1058
1059 t00:
1060 clrb bflg
1061
1062 t10:
1063 mov r1,r0
1064 swab r0
1065 bic $!16,r0
1066 jmp *0f(r0)
1067 0: u0; u1; u2; u3; u4; u5; u6; u7
1068
1069 u6: / single op, m[tf]pi, sxt, illegal
1070 bit $400,r1
1071 beq u5 / all but m[tf], sxt
1072 bit $200,r1
1073 beq 1f / mfpi
1074 bit $100,r1
1075 bne u5 / sxt
1076
1077 / simulate mtpi with double (sp)+,dd
1078 bic $4000,r1 / turn instr into (sp)+
1079 br t01
1080
1081 / simulate mfpi with double ss,-(sp)
1082 1:
1083 ash $6,r1
1084 bis $46,r1 / -(sp)
1085 br t01
1086
1087 u4: / jsr
1088 mov r1,r0
1089 jsr pc,setreg / assume no fault
1090 bis $173000,r2 / -2 from sp
1091 rts pc
1092
1093 t07: / EIS
1094 clrb bflg
1095
1096 u0: / jmp, swab
1097 u5: / single op
1098 mov r1,r0
1099 br setreg

```

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```

1100
1101 t01:      / mov
1102 t02:      / cmp
1103 t03:      / bit
1104 t04:      / bic
1105 t05:      / bis
1106 t06:      / add
1107 t16:      / sub
1108      clrb  bflg
1109
1110 t11:      / movb
1111 t12:      / cmpb
1112 t13:      / bitb
1113 t14:      / bicb
1114 t15:      / bisb
1115      mov   r1,r0
1116      ash  $-6,r0
1117      jsr  pc,setreg
1118      swab r2
1119      mov  r1,r0
1120      jsr  pc,setreg
1121
1122 / if delta(dest) is zero,
1123 / no need to fetch source
1124
1125      bit   $370,r2
1126      beq   1f
1127
1128 / if mode(source) is R,
1129 / no fault is possible
1130
1131      bit   $7000,r1
1132      beq   1f
1133
1134 / if reg(source) is reg(dest),
1135 / too bad.
1136
1137      mov   r2,-(sp)
1138      bic  $174370,(sp)
1139      cmpb 1(sp),(sp)+
1140      beq  t17
1141
1142 / start source cycle
1143 / pick up value of reg
1144
1145      mov  r1,r0
1146      ash  $-6,r0
1147      bic  $!7,r0
1148      movb _regloc(r0),r0
1149      asl  r0

```

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```

1150      add  ssr+2,r0
1151      mov  (r0),r0
1152
1153 / if reg has been incremented,
1154 / must decrement it before fetch
1155
1156      bit  $174000,r2
1157      ble  2f
1158      dec  r0
1159      bit  $10000,r2
1160      beq  2f
1161      dec  r0
1162 2:
1163
1164 / if mode is 6,7 fetch and add X(R) to R
1165
1166      bit  $4000,r1
1167      beq  2f
1168      bit  $2000,r1
1169      beq  2f
1170      mov  r0,-(sp)
1171      mov  ssr+4,r0
1172      sdd  $2,r0
1173      jsr  pc,fetch
1174      add  (sp)+,r0
1175 2:
1176
1177 / fetch operand
1178 / if mode is 3,5,7 fetch *
1179
1180      jsr  pc,fetch
1181      bit  $1000,r1
1182      beq  1f
1183      bit  $6000,r1
1184      bne  fetch
1185 1:
1186      rts  pc
1187
1188 t17:      / illegal
1189 u1:      / br
1190 u2:      / br
1191 u3:      / br
1192 u7:      / illegal
1193      incb jflg
1194      rts  pc
1195
1196 setreg:
1197      mov  r0,-(sp)
1198      bic  $!7,r0
1199      bis  r0,r2

```

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```

1200  mov    (sp)+,r0
1201  ash    $-3,r0
1202  bic    $!7,r0
1203  movb   0f(r0),r0
1204  tstb   bflg
1205  beq    1f
1206  bit    $2,r2
1207  beq    2f
1208  bit    $4,r2
1209  beq    2f
1210 1:
1211  cmp    r0,$20
1212  beq    2f
1213  cmp    r0,$-20
1214  beq    2f
1215  asl    r0
1216 2:
1217  bisb   r0,r2
1218  rts    pc
1219
1220 0: .byte 0,0,10,20,-10,-20,0,0
1221
1222 fetch:
1223  bic    $!1,r0
1224  mov    nofault,-(sp)
1225  mov    $!f,nofault
1226  mfpi   (r0)
1227  mov    (sp)+,r0
1228  mov    (sp)+,nofault
1229  rts    pc
1230
1231 1:
1232  mov    (sp)+,nofault
1233  clrb   r2                / clear out dest on fault
1234  mov    $-1,r0
1235  rts    pc
1236
1237 .bss
1238 bflg:  .+.1
1239 jflg:  .+.1
1240 .text
1241
1242 /* ----- */
1243 .globl  _copyin, _copyout
1244 _copyin:
1245  jsr    pc,copsu
1246 1:
1247  mfpi   (r0)+
1248  mov    (sp)+,(r1)+
1249  sob    r2,1b

```

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```

1250  br     2f
1251
1252 _copyout:
1253  jsr    pc,copsu
1254 1:
1255  mov    (r0)+,-(sp)
1256  mtpi   (r1)+
1257  sob    r2,1b
1258 2:
1259  mov    (sp)+,nofault
1260  mov    (sp)+,r2
1261  clr    r0
1262  rts    pc
1263
1264 copsu:
1265  mov    (sp)+,r0
1266  mov    r2,-(sp)
1267  mov    nofault,-(sp)
1268  mov    r0,-(sp)
1269  mov    10(sp),r0
1270  mov    12(sp),r1
1271  mov    14(sp),r2
1272  asr    r2
1273  mov    $!f,nofault
1274  rts    pc
1275
1276 1:
1277  mov    (sp)+,nofault
1278  mov    (sp)+,r2
1279  mov    $-1,r0
1280  rts    pc
1281
1282 /* ----- */
1283 .globl  _idle
1284 _idle:
1285  mov    PS,-(sp)
1286  bic    $340,PS
1287  wait
1288  mov    (sp)+,PS
1289  rts    pc
1290
1291 /* ----- */
1292 .globl  _spl0, _spl1, _spl4, _spl5, _spl6, _spl7
1293 _spl0:
1294  bic    $340,PS
1295  rts    pc
1296
1297 _spl1:
1298  bis    $40,PS
1299  bic    $300,PS

```

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```

1300 rts pc
1301
1302 _spl4:
1303 _spl5:
1304 bis $340,PS
1305 bic $100,PS
1306 rts pc
1307
1308 _spl6:
1309 bis $340,PS
1310 bic $40,PS
1311 rts pc
1312
1313 _spl7:
1314 bis $340,PS
1315 rts pc
1316
1317 /* ----- */
1318 .globl _dpadd
1319 _dpadd:
1320 mov 2(sp),r0
1321 add 4(sp),2(r0)
1322 adc (r0)
1323 rts pc
1324
1325 /* ----- */
1326 .globl _dpcmp
1327 _dpcmp:
1328 mov 2(sp),r0
1329 mov 4(sp),r1
1330 sub 6(sp),r0
1331 sub 8(sp),r1
1332 sbc r0
1333 bge 1f
1334 cmp r0,$-1
1335 bne 2f
1336 cmp r1,$-512.
1337 bhi 3f
1338 2:
1339 mov $-512.,r0
1340 rts pc
1341 1:
1342 bne 2f
1343 cmp r1,$512.
1344 blo 3f
1345 2:
1346 mov $512.,r1
1347 3:
1348 mov r1,r0
1349 rts pc

```

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```

1350
1351 /* ----- */
1352 .globl dump
1353 dump:
1354 bit $1,SSR0
1355 bne dump
1356
1357 / save regs r0,r1,r2,r3,r4,r5,r6,KIA6
1358 / starting at abs location 4
1359
1360 mov r0,4
1361 mov $6,r0
1362 mov r1,(r0)+
1363 mov r2,(r0)+
1364 mov r3,(r0)+
1365 mov r4,(r0)+
1366 mov r5,(r0)+
1367 mov sp,(r0)+
1368 mov KISA6,(r0)+
1369
1370 / dump all of core (ie to first mt error)
1371 / onto mag tape. (9 track or 7 track 'binary')
1372
1373 mov $MTC,r0
1374 mov $60004,(r0)+
1375 clr 2(r0)
1376 1:
1377 mov $-512.,(r0)
1378 inc -(r0)
1379 2:
1380 tstb (r0)
1381 bge 2b
1382 tst (r0)+
1383 bge 1b
1384 reset
1385
1386 / end of file and loop
1387
1388 mov $60007,-(r0)
1389 br .
1390
1391 /* ----- */
1392 .globl _ldiv
1393 _ldiv:
1394 clr r0
1395 mov 2(sp),r1
1396 div 4(sp),r0
1397 rts pc
1398
1399 /* ----- */

```

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```

1400 .globl    _lrem
1401 _lrem:
1402     clr    r0
1403     mov    2(sp),r1
1404     div    4(sp),r0
1405     mov    r1,r0
1406     rts    pc
1407
1408 /* ----- */
1409 .globl    _lshift
1410 _lshift:
1411     mov    2(sp),r1
1412     mov    (r1)+,r0
1413     mov    (r1),r1
1414     ashc   4(sp),r0
1415     mov    r1,r0
1416     rts    pc
1417
1418 /* ----- */
1419 .globl    csv
1420 csv:
1421     mov    r5,r0
1422     mov    sp,r5
1423     mov    r4,-(sp)
1424     mov    r3,-(sp)
1425     mov    r2,-(sp)
1426     jsr    pc,(r0)
1427
1428 /* ----- */
1429 .globl    cret
1430 cret:
1431     mov    r5,r1
1432     mov    -(r1),r4
1433     mov    -(r1),r3
1434     mov    -(r1),r2
1435     mov    r5,sp
1436     mov    (sp)+,r5
1437     rts    pc
1438
1439 /* ----- */
1440 .globl    _u
1441 _u = 140000
1442 USIZE    = 16.
1443
1444 PS       = 177776
1445 SSR0    = 177572
1446 SSR2    = 177576
1447 KISA0   = 172340
1448 KISA6   = 172354
1449 KISD0   = 172300

```

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```

1450 MTC      = 172522
1451 UISA0    = 177640
1452 UISA1    = 177642
1453 UISD0    = 177600
1454 UISD1    = 177602
1455 IO = 7600
1456
1457 .data
1458 /* ----- */
1459 .globl    _ka6, _cputype
1460 _ka6:     KISA6
1461 _cputype:40.
1462
1463 .bss
1464 /* ----- */
1465 .globl    nofault, ssr, badtrap
1466 nofault:.=.+2
1467 ssr:     .=.+6
1468 badtrap:.=.+2
1469
1470
1471
1472
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```

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```

1500 #
1501 #include "../param.h"
1502 #include "../user.h"
1503 #include "../system.h"
1504 #include "../proc.h"
1505 #include "../text.h"
1506 #include "../inode.h"
1507 #include "../seg.h"
1508
1509 #define CLOCK1 0177546
1510 #define CLOCK2 0172540
1511 /*
1512  * Icode is the octal bootstrap
1513  * program executed in user mode
1514  * to bring up the system.
1515  */
1516 int icode[]
1517 {
1518     0104413, /* sys exec; init; initp */
1519     0000014,
1520     0000010,
1521     0000777, /* br . */
1522     0000014, /* initp: init; 0 */
1523     0000000,
1524     0062457, /* init: </etc/init\0> */
1525     0061564,
1526     0064457,
1527     0064556,
1528     0000164,
1529 };
1530 /* ----- */
1531
1532 /*
1533  * Initialization code.
1534  * Called from m40.s or m45.s as
1535  * soon as a stack and segmentation
1536  * have been established.
1537  * Functions:
1538  * clear and free user core
1539  * find which clock is configured
1540  * hand craft 0th process
1541  * call all initialization routines
1542  * fork - process 0 to schedule
1543  * - process 1 execute bootstrap
1544  *
1545  * panic: no clock -- neither clock responds
1546  * loop at loc 6 in user mode -- /etc/init
1547  * cannot be executed
1548  */
1549

```

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```

1550 main()
1551 {
1552     extern schar;
1553     register i, *p;
1554
1555     /*
1556      * zero and free all of core
1557      */
1558
1559     updlock = 0;
1560     i = *ka6 + USIZE;
1561     UISD->r[0] = 077406;
1562     for(;;) {
1563         UISA->r[0] = i;
1564         if(fuibyte(0) < 0)
1565             break;
1566         clearseg(i);
1567         maxmem++;
1568         mfree(coremap, 1, i);
1569         i++;
1570     }
1571     if(cputype == 70)
1572     for(i=0; i<62; i+=2) {
1573         UBMAP->r[i] = i<<12;
1574         UBMAP->r[i+1] = 0;
1575     }
1576     printf("mem = %l\n", maxmem*5/16);
1577     printf("RESTRICTED RIGHTS\n\n");
1578     printf("Use, duplication or disclosure is subject to\n");
1579     printf("restrictions stated in Contract with Western\n");
1580     printf("Electric Company, Inc.\n");
1581
1582     maxmem = min(maxmem, MAXMEM);
1583     mfree(swapmap, nswap, swplo);
1584
1585     /*
1586      * set up system process
1587      */
1588
1589     proc[0].p_addr = *ka6;
1590     proc[0].p_size = USIZE;
1591     proc[0].p_stat = SRUN;
1592     proc[0].p_flag = | SLOAD|SSYS;
1593     u.u_procp = &proc[0];
1594
1595     /*
1596      * determine clock
1597      */
1598
1599     UISA->r[7] = ka6[1]; /* io segment */

```

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```

1600  UISD->r[7] = 077406;
1601  lks = CLOCK1;
1602  if(fuiword(lks) == -1) {
1603      lks = CLOCK2;
1604      if(fuiword(lks) == -1)
1605          panic("no clock");
1606  }
1607  *lks = 0115;
1608
1609  /*
1610   * set up 'known' i-nodes
1611   */
1612
1613  cinit();
1614  binit();
1615  iinit();
1616  rootdir = iget(rootdev, ROOTINO);
1617  rootdir->i_flag = & ~ILOCK;
1618  u.u_cdir = iget(rootdev, ROOTINO);
1619  u.u_cdir->i_flag = & ~ILOCK;
1620
1621  /*
1622   * make init process
1623   * enter scheduling loop
1624   * with system process
1625   */
1626
1627  if(newproc()) {
1628      expand(USIZE+1);
1629      estabur(0, 1, 0, 0);
1630      copyout(icode, 0, sizeof icode);
1631      /*
1632       * Return goes to loc. 0 of user init
1633       * code just copied out.
1634       */
1635      return;
1636  }
1637  sched();
1638 }
1639 /* ----- */
1640
1641 /*
1642  * Set up software prototype segmentation
1643  * registers to implement the 3 pseudo
1644  * text,data,stack segment sizes passed
1645  * as arguments.
1646  * The argument sep specifies if the
1647  * text and data+stack segments are to
1648  * be separated.
1649  */

```

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```

1650  estabur(nt, nd, ns, sep)
1651  {
1652      register a, *ap, *dp;
1653
1654      if(sep) {
1655          if(cputype == 40)
1656              goto err;
1657          if(nseg(nt) > 8 || nseg(nd)+nseg(ns) > 8)
1658              goto err;
1659      } else
1660          if(nseg(nt)+nseg(nd)+nseg(ns) > 8)
1661              goto err;
1662      if(nt+nd+ns+USIZE > maxmem)
1663          goto err;
1664      a = 0;
1665      ap = &u.u_uisa[0];
1666      dp = &u.u_uisd[0];
1667      while(nt >= 128) {
1668          *dp++ = (127<<8) | RO;
1669          *ap++ = a;
1670          a =+ 128;
1671          nt =- 128;
1672      }
1673      if(nd) {
1674          *dp++ = ((nt-1)<<8) | RO;
1675          *ap++ = a;
1676      }
1677      if(sep)
1678          while(ap < &u.u_uisa[8]) {
1679              *ap++ = 0;
1680              *dp++ = 0;
1681          }
1682      a = USIZE;
1683      while(nd >= 128) {
1684          *dp++ = (127<<8) | RW;
1685          *ap++ = a;
1686          a =+ 128;
1687          nd =- 128;
1688      }
1689      if(nd) {
1690          *dp++ = ((nd-1)<<8) | RW;
1691          *ap++ = a;
1692          a =+ nd;
1693      }
1694      while(ap < &u.u_uisa[8]) {
1695          *dp++ = 0;
1696          *ap++ = 0;
1697      }
1698      if(sep)
1699          while(ap < &u.u_uisa[16]) {

```

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```

1700         *dp++ = 0;
1701         *ap++ = 0;
1702     }
1703     a += ns;
1704     while(ns >= 128) {
1705         a -= 128;
1706         ns -= 128;
1707         *--dp = (127<<8) | RW;
1708         *--ap = a;
1709     }
1710     if(ns) {
1711         *--dp = ((128-ns)<<8) | RW | ED;
1712         *--ap = a-128;
1713     }
1714     if(!sep) {
1715         ap = &u.u_uisa[0];
1716         dp = &u.u_uisa[8];
1717         while(ap < &u.u_uisa[8])
1718             *dp++ = *ap++;
1719         ap = &u.u_uisd[0];
1720         dp = &u.u_uisd[8];
1721         while(ap < &u.u_uisd[8])
1722             *dp++ = *ap++;
1723     }
1724     sureg();
1725     return(0);
1726
1727 err:
1728     u.u_error = ENOMEM;
1729     return(-1);
1730 }
1731 /*----- */
1732
1733 /*
1734  * Load the user hardware segmentation
1735  * registers from the software prototype.
1736  * The software registers must have
1737  * been setup prior by estabur.
1738  */
1739 sureg()
1740 {
1741     register *up, *rp, a;
1742
1743     a = u.u_procp->p_addr;
1744     up = &u.u_uisa[16];
1745     rp = &UISA->r[16];
1746     if(cputype == 40) {
1747         up -= 8;
1748         rp -= 8;
1749     }

```

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```

1750     while(rp > &UISA->r[0])
1751         *--rp = *--up + a;
1752     if((up=u.u_procp->p_textp) != NULL)
1753         a -= up->x_caddr;
1754     up = &u.u_uisd[16];
1755     rp = &UISD->r[16];
1756     if(cputype == 40) {
1757         up -= 8;
1758         rp -= 8;
1759     }
1760     while(rp > &UISD->r[0]) {
1761         *--rp = *--up;
1762         if((*rp & WO) == 0)
1763             rp[(UISA-UISD)/2] -= a;
1764     }
1765 }
1766 /* ----- */
1767
1768 /*
1769  * Return the arg/128 rounded up.
1770  */
1771 nseg(n)
1772 {
1773     return((n+127)>>7);
1774 }
1775 /* ----- */
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
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```

1800 #
1801 /*
1802 */
1803
1804 #include "../param.h"
1805 #include "../user.h"
1806 #include "../proc.h"
1807 #include "../text.h"
1808 #include "../system.h"
1809 #include "../file.h"
1810 #include "../inode.h"
1811 #include "../buf.h"
1812 /* ----- */
1813 /*
1814 * Create a new process-- the internal version of
1815 * sys fork.
1816 * It returns 1 in the new process.
1817 * How this happens is rather hard to understand.
1818 * The essential fact is that the new process is created
1819 * in such a way that it appears to have started executing
1820 * in the same call to newproc as the parent;
1821 * but in fact the code that runs is that of swtch.
1822 * The subtle implication of the return value of swtch
1823 * (see above) is that this is the value that newproc's
1824 * caller in the new process sees.
1825 */
1826 newproc()
1827 {
1828     int a1, a2;
1829     struct proc *p, *up;
1830     register struct proc *rpp;
1831     register *rip, n;
1832
1833     p = NULL;
1834     /*
1835      * First, just locate a slot for a process
1836      * and copy the useful info from this process into it.
1837      * The panic "cannot happen" because fork already
1838      * checked for the existence of a slot.
1839      */
1840     retry:
1841     mpid++;
1842     if(mpid < 0) {
1843         mpid = 0;
1844         goto retry;
1845     }
1846     for(rpp = &proc[0]; rpp < &proc[NPROC]; rpp++) {
1847         if(rpp->p_stat == NULL && p==NULL)
1848             p = rpp;
1849         if (rpp->p_pid==mpid)

```

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```

1850         goto retry;
1851     }
1852     if ((rpp = p)==NULL)
1853         panic("no procs");
1854
1855     /*
1856      * make proc entry for new proc
1857      */
1858
1859     rip = u.u_procp;
1860     up = rip;
1861     rpp->p_stat = SRUN;
1862     rpp->p_flag = SLOAD;
1863     rpp->p_uid = rip->p_uid;
1864     rpp->p_ttyp = rip->p_ttyp;
1865     rpp->p_nice = rip->p_nice;
1866     rpp->p_textp = rip->p_textp;
1867     rpp->p_pid = mpid;
1868     rpp->p_ppid = rip->p_ppid;
1869     rpp->p_time = 0;
1870
1871     /*
1872      * make duplicate entries
1873      * where needed
1874      */
1875
1876     for(rip = &u.u_ofile[0]; rip < &u.u_ofile[NOFILE];)
1877         if((rpp = *rip++) != NULL)
1878             rpp->f_count++;
1879     if((rpp=up->p_textp) != NULL) {
1880         rpp->x_count++;
1881         rpp->x_ccount++;
1882     }
1883     u.u_cdir->i_count++;
1884     /*
1885      * Partially simulate the environment
1886      * of the new process so that when it is actually
1887      * created (by copying) it will look right.
1888      */
1889     savu(u.u_rsav);
1890     rpp = p;
1891     u.u_procp = rpp;
1892     rip = up;
1893     n = rip->p_size;
1894     a1 = rip->p_addr;
1895     rpp->p_size = n;
1896     a2 = malloc(coremap, n);
1897     /*
1898      * If there is not enough core for the
1899      * new process, swap put the current process to

```

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```

1900     * generate the copy.
1901     */
1902     if(a2 == NULL) {
1903         rip->p_stat = SIDL;
1904         rpp->p_addr = a1;
1905         savu(u.u_ssav);
1906         xswap(rpp, 0, 0);
1907         rpp->p_flag |= SSWAP;
1908         rip->p_stat = SRUN;
1909     } else {
1910     /*
1911     * There is core, so just copy.
1912     */
1913         rpp->p_addr = a2;
1914         while(n--)
1915             copyseg(a1++, a2++);
1916     }
1917     u.u_procp = rip;
1918     return(0);
1919 }
1920 /* ----- */
1921
1922 /*
1923 * The main loop of the scheduling (swapping)
1924 * process.
1925 * The basic idea is:
1926 * see if anyone wants to be swapped in;
1927 * swap out processes until there is room;
1928 * swap him in;
1929 * repeat.
1930 * Although it is not remarkably evident, the basic
1931 * synchronization here is on the runin flag, which is
1932 * slept on and is set once per second by the clock routine.
1933 * Core shuffling therefore take place once per second.
1934 *
1935 * panic: swap error -- IO error while swapping.
1936 * this is the one panic that should be
1937 * handled in a less drastic way. Its
1938 * very hard.
1939 */
1940 sched()
1941 {
1942     struct proc *p1;
1943     register struct proc *rp;
1944     register a, n;
1945
1946     /*
1947     * find user to swap in
1948     * of users ready, select one out longest
1949     */

```

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```

1950
1951     goto loop;
1952
1953 loop:
1954     runin++;
1955     sleep(&runin, PSWP);
1956
1957 loop:
1958     spl6();
1959     n = -1;
1960     for(rp = &proc[0]; rp < &proc[NPROC]; rp++)
1961         if(rp->p_stat==SRUN && (rp->p_flag&SLOAD)==0 &&
1962            rp->p_time > n) {
1963             p1 = rp;
1964             n = rp->p_time;
1965         }
1966     if(n == -1) {
1967         runout++;
1968         sleep(&runout, PSWP);
1969         goto loop;
1970     }
1971
1972     /*
1973     * see if there is core for that process
1974     */
1975
1976     spl0();
1977     rp = p1;
1978     a = rp->p_size;
1979     if((rp=rp->p_textp) != NULL)
1980         if(rp->x_ccount == 0)
1981             a += rp->x_size;
1982     if((a=malloc(coremap, a)) != NULL)
1983         goto found2;
1984
1985     /*
1986     * none found,
1987     * look around for easy core
1988     */
1989
1990     spl6();
1991     for(rp = &proc[0]; rp < &proc[NPROC]; rp++)
1992         if((rp->p_flag&(SSYS|SLOCK|SLOAD))==SLOAD &&
1993            (rp->p_stat == SWAIT || rp->p_stat==SSTOP))
1994             goto found1;
1995
1996     /*
1997     * no easy core,
1998     * if this process is deserving,
1999     * look around for

```

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```

2000     * oldest process in core
2001     */
2002
2003     if(n < 3)
2004         goto sloop;
2005     n = -1;
2006     for(rp = &proc[0]; rp < &proc[NPROC]; rp++)
2007         if((rp->p_flag&(SSYS|SLOCK|SLOAD))==SLOAD &&
2008             (rp->p_stat==SRUN || rp->p_stat==SSLEEP) &&
2009             rp->p_time > n) {
2010         p1 = rp;
2011         n = rp->p_time;
2012     }
2013     if(n < 2)
2014         goto sloop;
2015     rp = p1;
2016
2017     /*
2018     * swap user out
2019     */
2020
2021     found1:
2022     slp0();
2023     rp->p_flag = & ~SLOAD;
2024     xswap(rp, 1, 0);
2025     goto loop;
2026
2027     /*
2028     * swap user in
2029     */
2030
2031     found2:
2032     if((rp=p1->p_textp) != NULL) {
2033         if(rp->x_ccount == 0) {
2034             if(swap(rp->x_daddr, a, rp->x_size, B_READ))
2035                 goto swaper;
2036             rp->x_caddr = a;
2037             a =+ rp->x_size;
2038         }
2039         rp->x_ccount++;
2040     }
2041     rp = p1;
2042     if(swap(rp->p_addr, a, rp->p_size, B_READ))
2043         goto swaper;
2044     mfree(swamap, (rp->p_size+7)/8, rp->p_addr);
2045     rp->p_addr = a;
2046     rp->p_flag = | SLOAD;
2047     rp->p_time = 0;
2048     goto loop;
2049

```

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```

2050     swaper:
2051         panic("swap error");
2052     }
2053     /* ----- */
2054
2055     /*
2056     * Give up the processor till a wakeup occurs
2057     * on chan, at which time the process
2058     * enters the scheduling queue at priority pri.
2059     * The most important effect of pri is that when
2060     * pri<0 a signal cannot disturb the sleep;
2061     * if the pri>=0 signals will be processed.
2062     * Callers of this routine must be prepared for
2063     * premature return, and check that the reason for
2064     * sleeping has gone away.
2065     */
2066     sleep(chan, pri)
2067     {
2068         register *rp, s;
2069
2070         s = PS->integ;
2071         rp = u.u_procp;
2072         if(pri >= 0) {
2073             if(issig())
2074                 goto psig;
2075             spl6();
2076             rp->p_wchan = chan;
2077             rp->p_stat = SWAIT;
2078             rp->p_pri = pri;
2079             spl0();
2080             if(runin != 0) {
2081                 runin = 0;
2082                 wakeup(&runin);
2083             }
2084             swtch();
2085             if(issig())
2086                 goto psig;
2087         } else {
2088             spl6();
2089             rp->p_wchan = chan;
2090             rp->p_stat = SSLEEP;
2091             rp->p_pri = pri;
2092             spl0();
2093             swtch();
2094         }
2095         PS->integ = s;
2096         return;
2097
2098     /*
2099     * If priority was low (>=0) and

```

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```

2100 * there has been a signal,
2101 * execute non-local goto to
2102 * the qsav location.
2103 * (see trap1/trap.c)
2104 */
2105 psig:
2106 aretu(u.u_qsav);
2107 }
2108 /*----- */
2109
2110 /*
2111 * Wake up all processes sleeping on chan.
2112 */
2113 wakeup(chan)
2114 {
2115     register struct proc *p;
2116     register c, i;
2117
2118     c = chan;
2119     p = &proc[0];
2120     i = NPROC;
2121     do {
2122         if(p->p_wchan == c) {
2123             setrun(p);
2124         }
2125         p++;
2126     } while(--i);
2127 }
2128 /*----- */
2129
2130 /*
2131 * Set the process running;
2132 * arrange for it to be swapped in if necessary.
2133 */
2134 setrun(p)
2135 {
2136     register struct proc *rp;
2137
2138     rp = p;
2139     rp->p_wchan = 0;
2140     rp->p_stat = SRUN;
2141     if(rp->p_pri < curpri)
2142         runrun++;
2143     if(runout != 0 && (rp->p_flag&SLOAD) == 0) {
2144         runout = 0;
2145         wakeup(&runout);
2146     }
2147 }
2148 /*----- */
2149

```

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```

2150 /*
2151 * Set user priority.
2152 * The rescheduling flag (runrun)
2153 * is set if the priority is higher
2154 * than the currently running process.
2155 */
2156 setpri(up)
2157 {
2158     register *pp, p;
2159
2160     pp = up;
2161     p = (pp->p_cpu & 0377)/16;
2162     p += PUSER + pp->p_nice;
2163     if(p > 127)
2164         p = 127;
2165     if(p > curpri)
2166         runrun++;
2167     pp->p_pri = p;
2168 }
2169 /*----- */
2170
2171 /*
2172 * This routine is called to reschedule the CPU.
2173 * if the calling process is not in RUN state,
2174 * arrangements for it to restart must have
2175 * been made elsewhere, usually by calling via sleep.
2176 */
2177 switch()
2178 {
2179     static struct proc *p;
2180     register i, n;
2181     register struct proc *rp;
2182
2183     if(p == NULL)
2184         p = &proc[0];
2185     /*
2186      * Remember stack of caller
2187      */
2188     savu(u.u_rsav);
2189     /*
2190      * Switch to scheduler's stack
2191      */
2192     retu(proc[0].p_addr);
2193
2194     loop:
2195         runrun = 0;
2196         rp = p;
2197         p = NULL;
2198         n = 128;

```

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```

2200 /*
2201  * Search for highest-priority runnable process
2202  */
2203 i = NPROC;
2204 do {
2205     rp++;
2206     if(rp >= &proc[NPROC])
2207         rp = &proc[0];
2208     if(rp->p_stat==SRUN && (rp->p_flag&SLOAD)!=0) {
2209         if(rp->p_pri < n) {
2210             p = rp;
2211             n = rp->p_pri;
2212         }
2213     }
2214 } while(--i);
2215 /*
2216  * If no process is runnable, idle.
2217  */
2218 if(p == NULL) {
2219     p = rp;
2220     idle();
2221     goto loop;
2222 }
2223 rp = p;
2224 curpri = n;
2225 /* Switch to stack of the new process and set up
2226  * his segmentation registers.
2227  */
2228 retu(rp->p_addr);
2229 sureg();
2230 /*
2231  * If the new process paused because it was
2232  * swapped out, set the stack level to the last call
2233  * to savu(u_ssav). This means that the return
2234  * which is executed immediately after the call to aretu
2235  * actually returns from the last routine which did
2236  * the savu.
2237  *
2238  * You are not expected to understand this.
2239  */
2240 if(rp->p_flag&SSWAP) {
2241     rp->p_flag = & ~SSWAP;
2242     aretu(u.u_ssav);
2243 }
2244 /* The value returned here has many subtle implications.
2245  * See the newproc comments.
2246  */
2247 return(1);
2248 }
2249 /* ----- */

```

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```

2250
2251 /*
2252  * Change the size of the data+stack regions of the process.
2253  * If the size is shrinking, it's easy-- just release the
2254  * extra core. If it's growing, and there is core, just
2255  * allocate it and copy the image, taking care to reset
2256  * registers to account for the fact that the system's
2257  * stack has moved.
2258  * If there is no core, arrange for the process to be
2259  * swapped out after adjusting the size requirement--
2260  * when it comes in, enough core will be allocated.
2261  * Because of the ssave and SSWAP flags, control will
2262  * resume after the swap in swtch, which executes the return
2263  * from this stack level.
2264  *
2265  * After the expansion, the caller will take care of copying
2266  * the user's stack towards or away from the data area.
2267  */
2268 expand(newsize)
2269 {
2270     int i, n;
2271     register *p, a1, a2;
2272
2273     p = u.u_procp;
2274     n = p->p_size;
2275     p->p_size = newsize;
2276     a1 = p->p_addr;
2277     if(n >= newsize) {
2278         mfree(coremap, n-newsize, a1+newsize);
2279         return;
2280     }
2281     savu(u.u_rsav);
2282     a2 = malloc(coremap, newsize);
2283     if(a2 == NULL) {
2284         savu(u.u_ssav);
2285         xswap(p, 1, n);
2286         p->p_flag |= SSWAP;
2287         swtch();
2288         /* no return */
2289     }
2290     p->p_addr = a2;
2291     for(i=0; i<n; i++)
2292         copyseg(a1+i, a2++);
2293     mfree(coremap, n, a1);
2294     retu(p->p_addr);
2295     sureg();
2296 }
2297 /* ----- */
2298
2299

```

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```

2300 #
2301 /*
2302 */
2303
2304 #include "../param.h"
2305 #include "../seg.h"
2306 #include "../buf.h"
2307 #include "../conf.h"
2308
2309 /*
2310 * Address and structure of the
2311 * KL-11 console device registers.
2312 */
2313 struct
2314 {
2315     int     rsr;
2316     int     rbr;
2317     int     xsr;
2318     int     xbr;
2319 };
2320 /* ----- */
2321
2322 /*
2323 * In case console is off,
2324 * panicstr contains argument to last
2325 * call to panic.
2326 */
2327
2328 char     *panicstr;
2329
2330 /*
2331 * Scaled down version of C library printf.
2332 * Only %s %l %d (==%l) %o are recognized.
2333 * Used to print diagnostic information
2334 * directly on console tty.
2335 * Since it is not interrupt driven,
2336 * all system activities are pretty much
2337 * suspended.
2338 * Printf should not be used for chit-chat.
2339 */
2340 printf(fmt,x1,x2,x3,x4,x5,x6,x7,x8,x9,xa,xb,xc)
2341 char fmt[];
2342 {
2343     register char *s;
2344     register *adx, c;
2345
2346     adx = &x1;
2347 loop:
2348     while((c = *fmt++) != '%') {
2349         if(c == '\0')

```

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```

2350         return
2351         putchar(c);
2352     }
2353     c = *fmt++;
2354     if(c == 'd' || c == 'l' || c == 'o')
2355         printn(*adx, c=='o'? 8: 10);
2356     if(c == 's') {
2357         s = *adx;
2358         while(c = *s++)
2359             putchar(c);
2360     }
2361     adx++;
2362     goto loop;
2363 }
2364 /* ----- */
2365
2366 /*
2367 * Print an unsigned integer in base b.
2368 */
2369 printn(n, b)
2370 {
2371     register a;
2372
2373     if(a = ldiv(n, b))
2374         printn(a, b);
2375     putchar(ldrem(n, b) + '0');
2376 }
2377 /* ----- */
2378
2379 /*
2380 * Print a character on console.
2381 * Attempts to save and restore device
2382 * status.
2383 * If the switches are 0, all
2384 * printing is inhibited.
2385 */
2386 putchar(c)
2387 {
2388     register rc, s;
2389
2390     rc = c;
2391     if(SW->integ == 0)
2392         return;
2393     while((KL->xsr&0200) ==0)
2394         ;
2395     if(rc == 0)
2396         return;
2397     s = KL->xsr;
2398     KL->xsr = 0;
2399     KL->xbr = rc;

```

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```

2400  if(rc == '\n') {
2401      putchar('\r');
2402      putchar(0177);
2403      putchar(0177);
2404  }
2405  putchar(0);
2406  KL->xsr = s;
2407  }
2408  /* ----- */
2409
2410  /*
2411   * Panic is called on unresolvable
2412   * fatal errors.
2413   * It syncs, prints "panic: mesg" and
2414   * then loops.
2415   */
2416  panic(s)
2417  char *s;
2418  {
2419      panicstr = s;
2420      update();
2421      printf("panic: %s\n", s);
2422      for(;;)
2423          idle();
2424  }
2425  /* ----- */
2426
2427  /*
2428   * prdev prints a warning message of the
2429   * form "mesg on dev x/y".
2430   * x and y are the major and minor parts of
2431   * the device argument.
2432   */
2433  prdev(str, dev)
2434  {
2435
2436      printf("%s on dev %l/%l\n", str, dev.d_major, dev.d_minor);
2437  }
2438  /* ----- */
2439
2440  /*
2441   * deverr prints a diagnostic from
2442   * a device driver.
2443   * It prints the device, block number,
2444   * and an octal word (usually some error
2445   * status register) passed as argument.
2446   */
2447  deverror(bp, o1, o2)
2448  int *bp;
2449  {

```

```

2450  register *rbp;
2451
2452  rbp = bp;
2453  prdev("err", rbp->b_dev);
2454  printf("bn%l er%o %o\n", rbp->b_blkno, o1, o2);
2455  }
2456  /* ----- */
2457
2458
2459
2460
2461
2462
2463
2464
2465
2466
2467
2468
2469
2470
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2491
2492
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2497
2498
2499

```

```

2500 #
2501 /*
2502 */
2503
2504 /*
2505 * Structure of the coremap and swapmap
2506 * arrays. Consists of non-zero count
2507 * and base address of that many
2508 * contiguous units.
2509 * (The coremap unit is 64 bytes,
2510 * the swapmap unit is 512 bytes)
2511 * The addresses are increasing and
2512 * the list is terminated with the
2513 * first zero count.
2514 */
2515 struct map
2516 {
2517     char *m_size;
2518     char *m_addr;
2519 };
2520 /* ----- */
2521
2522 /*
2523 * Allocate size units from the given
2524 * map. Return the base of the allocated
2525 * space.
2526 * Algorithm is first fit.
2527 */
2528 malloc(mp, size)
2529 struct map *mp;
2530 {
2531     register int a;
2532     register struct map *bp;
2533
2534     for (bp = mp; bp->m_size; bp++) {
2535         if (bp->m_size >= size) {
2536             a = bp->m_addr;
2537             bp->m_addr += size;
2538             if ((bp->m_size -= size) == 0)
2539                 do {
2540                     bp++;
2541                     (bp-1)->m_addr = bp->m_addr;
2542                 } while ((bp-1)->m_size = bp->m_size);
2543             return(a);
2544         }
2545     }
2546     return(0);
2547 }
2548 /*----- */
2549

```

```

2550 /*
2551 * Free the previously allocated space aa
2552 * of size units into the specified map.
2553 * Sort aa into map and combine on
2554 * one or both ends if possible.
2555 */
2556 mfree(mp, size, aa)
2557 struct map *mp;
2558 {
2559     register struct map *bp;
2560     register int t;
2561     register int a;
2562
2563     a = aa;
2564     for (bp = mp; bp->m_addr <= a && bp->m_size != 0; bp++)
2565         if (bp > mp && (bp-1)->m_addr + (bp-1)->m_size == a) {
2566             (bp-1)->m_size += size;
2567             if (a + size == bp->m_addr) {
2568                 (bp-1)->m_size += bp->m_size;
2569                 while (bp->m_size) {
2570                     bp++;
2571                     (bp-1)->m_addr = bp->m_addr;
2572                     (bp-1)->m_size = bp->m_size;
2573                 }
2574             }
2575         } else {
2576             if (a + size == bp->m_addr && bp->m_size) {
2577                 bp->m_addr -= size;
2578                 bp->m_size += size;
2579             } else if (size) do {
2580                 t = bp->m_addr;
2581                 bp->m_addr = a;
2582                 a = t;
2583                 t = bp->m_size;
2584                 bp->m_size = size;
2585                 bp++;
2586             } while (size = t);
2587         }
2588     }
2589 /*----- */
2590
2591
2592
2593
2594
2595
2596
2597
2598
2599

```



# 2

**Traps, Interrupts  
and System Calls  
Process Management**



```

2600 /*
2601  * Location of the users' stored
2602  * registers relative to R0.
2603  * Usage is u.u_ar0[XX].
2604  */
2605 #define R0 (0)
2606 #define R1 (-2)
2607 #define R2 (-9)
2608 #define R3 (-8)
2609 #define R4 (-7)
2610 #define R5 (-6)
2611 #define R6 (-3)
2612 #define R7 (1)
2613 #define RPS (2)
2614
2615 #define TBIT 020 /* PS trace bit */
2616
2617
2618
2619
2620
2621
2622
2623
2624
2625
2626
2627
2628
2629
2630
2631
2632
2633
2634
2635
2636
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2638
2639
2640
2641
2642
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2644
2645
2646
2647
2648
2649

```

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```

2650 #
2651 #include "../param.h"
2652 #include "../system.h"
2653 #include "../user.h"
2654 #include "../proc.h"
2655 #include "../reg.h"
2656 #include "../seg.h"
2657
2658 #define EBIT 1 /* user error bit in PS: C-bit */
2659 #define UMODE 0170000 /* user-mode bits in PS word */
2660 #define SETD 0170011 /* SETD instruction */
2661 #define SYS 0104400 /* sys (trap) instruction */
2662 #define USER 020 /* user-mode flag added to dev */
2663
2664 /*
2665  * structure of the system entry table (sysent.c)
2666  */
2667 struct sysent {
2668     int count; /* argument count */
2669     int (*call)(); /* name of handler */
2670 } sysent[64];
2671 /* ----- */
2672
2673 /*
2674  * Offsets of the user's registers relative to
2675  * the saved r0. See reg.h
2676  */
2677 char regloc[9]
2678 {
2679     R0, R1, R2, R3, R4, R5, R6, R7, RPS
2680 };
2681 /* ----- */
2682
2683 /*
2684  * Called from l40.s or l45.s when a processor trap occurs.
2685  * The arguments are the words saved on the system stack
2686  * by the hardware and software during the trap processing.
2687  * Their order is dictated by the hardware and the details
2688  * of C's calling sequence. They are peculiar in that
2689  * this call is not 'by value' and changed user registers
2690  * get copied back on return.
2691  * dev is the kind of trap that occurred.
2692  */
2693 trap(dev, sp, r1, nps, r0, pc, ps)
2694 {
2695     register i, a;
2696     register struct sysent *callp;
2697
2698     savfp();
2699     if ((ps&UMODE) == UMODE)

```

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```

2700         dev = | USER;
2701     u.u_ar0 = &r0;
2702     switch(dev) {
2703
2704     /*
2705     * Trap not expected.
2706     * Usually a kernel mode bus error.
2707     * The numbers printed are used to
2708     * find the hardware PS/PC as follows.
2709     * (all numbers in octal 18 bits)
2710     *     address_of_saved_ps =
2711     *         (ka6*0100) + aps - 0140000;
2712     *     address_of_saved_pc =
2713     *         address_of_saved_ps - 2;
2714     */
2715     default:
2716         printf("ka6 = %o\n", *ka6);
2717         printf("aps = %o\n", &ps);
2718         printf("trap type %o\n", dev);
2719         panic("trap");
2720
2721     case 0+USER: /* bus error */
2722         i = SIGBUS;
2723         break;
2724
2725     /*
2726     * If illegal instructions are not
2727     * being caught and the offending instruction
2728     * is a SETD, the trap is ignored.
2729     * This is because C produces a SETD at
2730     * the beginning of every program which
2731     * will trap on CPUs without 11/45 FPU.
2732     */
2733     case 1+USER: /* illegal instruction */
2734         if(fuiword(pc-2)==SETD && u.u_signal[SIGINS]==0)
2735             goto out;
2736         i = SIGINS;
2737         break;
2738
2739     case 2+USER: /* bpt or trace */
2740         i = SIGTRC;
2741         break;
2742
2743     case 3+USER: /* iot */
2744         i = SIGIOT;
2745         break;
2746
2747     case 5+USER: /* emt */
2748         i = SIGEMT;
2749         break;

```

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```

2750
2751     case 6+USER: /* sys call */
2752         u.u_error = 0;
2753         ps = & ~EBIT;
2754         callp = &sysent[fuiword(pc-2)&077];
2755         if (callp == sysent) { /* indirect */
2756             a = fuiword(pc);
2757             pc += 2;
2758             i = fuword(a);
2759             if ((i & ~077) != SYS)
2760                 i = 077; /* illegal */
2761             callp = &sysent[i&077];
2762             for(i=0; i<callp->count; i++)
2763                 u.u_arg[i] = fuword(a += 2);
2764         } else {
2765             for(i=0; i<callp->count; i++) {
2766                 u.u_arg[i] = fuiword(pc);
2767                 pc += 2;
2768             }
2769         }
2770         u.u_dirp = u.u_arg[0];
2771         trap1(callp->call);
2772         if(u.u_intflg)
2773             u.u_error = EINTR;
2774         if(u.u_error < 100) {
2775             if(u.u_error) {
2776                 ps = | EBIT;
2777                 r0 = u.u_error;
2778             }
2779             goto out;
2780         }
2781         i = SIGSYS;
2782         break;
2783
2784     /*
2785     * Since the floating exception is an
2786     * imprecise trap, a user generated
2787     * trap may actually come from kernel
2788     * mode. In this case, a signal is sent
2789     * to the current process to be picked
2790     * up later.
2791     */
2792     case 8: /* floating exception */
2793         psignal(u.u_procp, SIGFPT);
2794         return;
2795
2796     case 8+USER:
2797         i = SIGFPT;
2798         break;
2799

```

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```

2800 /*
2801  * If the user SP is below the stack segment,
2802  * grow the stack automatically.
2803  * This relies on the ability of the hardware
2804  * to restart a half executed instruction.
2805  * On the 11/40 this is not the case and
2806  * the routine backup/l40.s may fail.
2807  * The classic example is on the instruction
2808  *      cmp      -(sp),-(sp)
2809  */
2810 case 9+USER: /* segmentation exception */
2811     a = sp;
2812     if(backup(u.u_ar0) == 0)
2813         if(grow(a))
2814             goto out;
2815     i = SIGSEGV;
2816     break;
2817 }
2818 psignal(u.u_procp, i);
2819
2820 out:
2821 if(issig())
2822     psig();
2823 setpri(u.u_procp);
2824 }
2825 /* ----- */
2826
2827 /*
2828  * Call the system-entry routine f (out of the
2829  * sysent table). This is a subroutine for trap, and
2830  * not in-line, because if a signal occurs
2831  * during processing, an (abnormal) return is simulated from
2832  * the last caller to savu(qsav); if this took place
2833  * inside of trap, it wouldn't have a chance to clean up.
2834  *
2835  * If this occurs, the return takes place without
2836  * clearing u_intflg; if it's still set, trap
2837  * marks an error which means that a system
2838  * call (like read on a typewrite) got interrupted
2839  * by a signal.
2840  */
2841 trap1(f)
2842 int (*f)();
2843 {
2844
2845     u.u_intflg = 1;
2846     savu(u.u_qsav);
2847     (*f)();
2848     u.u_intflg = 0;
2849 }

```

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```

2850 /* ----- */
2851
2852 /*
2853  * nonexistent system call-- set fatal error code.
2854  */
2855 nosys()
2856 {
2857     u.u_error = 100;
2858 }
2859 /*----- */
2860
2861 /*
2862  * Ignored system call
2863  */
2864 nullsys()
2865 {
2866 }
2867 /* ----- */
2868
2869
2870
2871
2872
2873
2874
2875
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```

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```

2900 #
2901 /*
2902 */
2903
2904 /*
2905 * This table is the switch used to transfer
2906 * to the appropriate routine for processing a system call.
2907 * Each row contains the number of arguments expected
2908 * and a pointer to the routine.
2909 */
2910 int      sysent[]
2911 {
2912     0, &nullsys,          /* 0 = indir */
2913     0, &rexite,          /* 1 = exit */
2914     0, &fork,           /* 2 = fork */
2915     2, &read,           /* 3 = read */
2916     2, &write,          /* 4 = write */
2917     2, &open,           /* 5 = open */
2918     0, &close,          /* 6 = close */
2919     0, &wait,           /* 7 = wait */
2920     2, &creat,          /* 8 = creat */
2921     2, &link,           /* 9 = link */
2922     1, &unlink,         /* 10 = ulink */
2923     2, &exec,           /* 11 = exec */
2924     1, &chdir,          /* 12 = chdir */
2925     0, &gtime,          /* 13 = time */
2926     3, &mknod,          /* 14 = mknod */
2927     2, &chmod,          /* 15 = chmod */
2928     2, &chown,          /* 16 = chown */
2929     1, &sbreak,         /* 17 = break */
2930     2, &stat,           /* 18 = stat */
2931     2, &sseek,          /* 19 = seek */
2932     0, &getpid,         /* 20 = getpid */
2933     3, &smount,         /* 21 = mount */
2934     1, &sumount,        /* 22 = unmount */
2935     0, &setuid,          /* 23 = setuid */
2936     0, &getuid,          /* 24 = getuid */
2937     0, &stime,          /* 25 = stime */
2938     3, &ptrace,         /* 26 = ptrace */
2939     0, &nosys,          /* 27 = x */
2940     1, &fstat,           /* 28 = fstat */
2941     0, &nosys,          /* 29 = x */
2942     1, &nullsys,        /* inoperative */
2943     1, &stty,           /* 31 = stty */
2944     1, &gttty,           /* 32 = gtty */
2945     0, &nosys,          /* 33 = x */
2946     0, &nice,           /* 34 = nice */
2947     0, &sslep,          /* 35 = sleep */
2948     0, &sync,           /* 36 = sync */
2949     1, &kill,           /* 37 = kill */

```

```

2950     0, &getswit,        /* 38 = switch */
2951     0, &nosys,          /* 39 = x */
2952     0, &nosys,          /* 40 = x */
2953     0, &dup,           /* 41 = dup */
2954     0, &pipe,           /* 42 = pipe */
2955     1, &times,          /* 43 = times */
2956     4, &profil,         /* 44 = prof */
2957     0, &nosys,          /* 45 = tui */
2958     0, &setgid,         /* 46 = setgid */
2959     0, &getgid,        /* 47 = getgid */
2960     2, &ssig,           /* 48 = sig */
2961     0, &nosys,          /* 49 = x */
2962     0, &nosys,          /* 50 = x */
2963     0, &nosys,          /* 51 = x */
2964     0, &nosys,          /* 52 = x */
2965     0, &nosys,          /* 53 = x */
2966     0, &nosys,          /* 54 = x */
2967     0, &nosys,          /* 55 = x */
2968     0, &nosys,          /* 56 = x */
2969     0, &nosys,          /* 57 = x */
2970     0, &nosys,          /* 58 = x */
2971     0, &nosys,          /* 59 = x */
2972     0, &nosys,          /* 60 = x */
2973     0, &nosys,          /* 61 = x */
2974     0, &nosys,          /* 62 = x */
2975     0, &nosys,          /* 63 = x */
2976 };
2977 /* ----- */
2978
2979
2980
2981
2982
2983
2984
2985
2986
2987
2988
2989
2990
2991
2992
2993
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2999

```

```

3000 #
3001 #include "../param.h"
3002 #include "../system.h"
3003 #include "../user.h"
3004 #include "../proc.h"
3005 #include "../buf.h"
3006 #include "../reg.h"
3007 #include "../inode.h"
3008
3009 /*
3010  * exec system call.
3011  * Because of the fact that an I/O buffer is used
3012  * to store the caller's arguments during exec,
3013  * and more buffers are needed to read in the text file,
3014  * deadly embraces waiting for free buffers are possible.
3015  * Therefore the number of processes simultaneously
3016  * running in exec has to be limited to NEXEC.
3017  */
3018 #define EXPRI -1
3019
3020 exec()
3021 {
3022     int ap, na, nc, *bp;
3023     int ts, ds, sep;
3024     register c, *ip;
3025     register char *cp;
3026     extern uchar;
3027
3028     /*
3029      * pick up file names
3030      * and check various modes
3031      * for execute permission
3032      */
3033
3034     ip = namei(&uchar, 0);
3035     if(ip == NULL)
3036         return;
3037     while(execnt >= NEXEC)
3038         sleep(&execnt, EXPRI);
3039     execnt++;
3040     bp = getblk(NODEV);
3041     if(access(ip, IEXEC) || (ip->i_mode&IFMT) != 0)
3042         goto bad;
3043
3044     /*
3045      * pack up arguments into
3046      * allocated disk buffer
3047      */
3048
3049     cp = bp->b_addr;

```

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```

3050     na = 0;
3051     nc = 0;
3052     while(ap = fuword(u.u_arg[1])) {
3053         na++;
3054         if(ap == -1)
3055             goto bad;
3056         u.u_arg[1] += 2;
3057         for(;;) {
3058             c = fubyte(ap++);
3059             if(c == -1)
3060                 goto bad;
3061             *cp++ = c;
3062             nc++;
3063             if(nc > 510) {
3064                 u.u_error = E2BIG;
3065                 goto bad;
3066             }
3067             if(c == 0)
3068                 break;
3069         }
3070     }
3071     if((nc&1) != 0) {
3072         *cp++ = 0;
3073         nc++;
3074     }
3075
3076     /* read in first 8 bytes
3077      * of file for segment
3078      * sizes:
3079      * w0 = 407/410/411 (410 -> RO text) (411 -> sep ID)
3080      * w1 = text size
3081      * w2 = data size
3082      * w3 = bss size
3083      */
3084
3085     u.u_base = &u.u_arg[0];
3086     u.u_count = 8;
3087     u.u_offset[1] = 0;
3088     u.u_offset[0] = 0;
3089     u.u_segflg = 1;
3090     readi(ip);
3091     u.u_segflg = 0;
3092     if(u.u_error)
3093         goto bad;
3094     sep = 0;
3095     if(u.u_arg[0] == 0407) {
3096         u.u_arg[2] += u.u_arg[1];
3097         u.u_arg[1] = 0;
3098     } else
3099     if(u.u_arg[0] == 0411)

```

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```

3100     sep++; else
3101     if(u.u_arg[0] != 0410) {
3102         u.u_error = ENOEXEC;
3103         goto bad;
3104     }
3105     if(u.u_arg[1] != 0 && (ip->i_flag & ITEXT) == 0 && ip->i_count != 1) {
3106         u.u_error = ETXTBSY;
3107         goto bad;
3108     }
3109
3110     /*
3111     * find text and data sizes
3112     * try them out for possible
3113     * exceed of max sizes
3114     */
3115
3116     ts = ((u.u_arg[1]+63)>>6) & 01777;
3117     ds = ((u.u_arg[2]+u.u_arg[3]+63)>>6) & 0177;
3118     if(estabur(ts, ds, SSIZE, sep))
3119         goto bad;
3120
3121     /*
3122     * allocate and clear core
3123     * at this point, committed
3124     * to the new image
3125     */
3126
3127     u.u_prof[3] = 0;
3128     xfree();
3129     expand(USIZE);
3130     xalloc(ip);
3131     c = USIZE+ds+SSIZE;
3132     expand(c);
3133     while(--c >= USIZE)
3134         clearseg(u.u_procp->p_addr+c);
3135
3136     /* read in data segment */
3137
3138     estabur(0, ds, 0, 0);
3139     u.u_base = 0;
3140     u.u_offset[1] = 020+u.u_arg[1];
3141     u.u_count = u.u_arg[2];
3142     readi(ip);
3143
3144     /*
3145     * initialize stack segment
3146     */
3147
3148     u.u_tsize = ts;
3149     u.u_dsize = ds;

```

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```

3150     u.u_ssize = SSIZE;
3151     u.u_sep = sep;
3152     estabur(u.u_tsize, u.u_dsize, u.u_ssize, u.u_sep);
3153     cp = bp->b_addr;
3154     ap = -nc - na*2 - 4;
3155     u.u_ar0[R6] = ap;
3156     suword(ap, na);
3157     c = -nc;
3158     while(na-->0) {
3159         suword(ap+=2, c);
3160         do
3161             subyte(c++, *cp);
3162         while(*cp++);
3163     }
3164     suword(ap+2, -1);
3165
3166     /*
3167     * set SUID/SGID protections, if no tracing
3168     */
3169
3170     if ((u.u_procp->p_flag & STRC) == 0) {
3171         if(ip->i_mode & ISUID)
3172             if(u.u_uid != 0) {
3173                 u.u_uid = ip->i_uid;
3174                 u.u_procp->p_uid = ip->i_uid;
3175             }
3176         if(ip->i_mode & ISGID)
3177             u.u_gid = ip->i_gid;
3178     }
3179
3180     /* clear sigs, regs, and return */
3181
3182     c = ip;
3183     for(ip = &u.u_signal[0]; ip < &u.u_signal[NSIG]; ip++)
3184         if((*ip & 1) == 0)
3185             *ip = 0;
3186     for(cp = &regloc[0]; cp < &regloc[6];)
3187         u.u_ar0[*cp++] = 0;
3188     u.u_ar0[R7] = 0;
3189     for(ip = &u.u_fsav[0]; ip < &u.u_fsav[25];)
3190         *ip++ = 0;
3191     ip = c;
3192
3193 bad:
3194     iput(ip);
3195     brelse(bp);
3196     if(execnt >= NEXEC)
3197         wakeup(&execnt);
3198     execnt--;
3199 }

```

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```

3200 /* ----- */
3201
3202 /* exit system call:
3203 * pass back caller's r0
3204 */
3205 rexit()
3206 {
3207
3208     u.u_arg[0] = u.u_ar0[R0] << 8;
3209     exit();
3210 }
3211 /* ----- */
3212
3213 /* Release resources.
3214 * Save u. area for parent to look at.
3215 * Enter zombie state.
3216 * Wake up parent and init processes,
3217 * and dispose of children.
3218 */
3219 exit()
3220 {
3221     register int *q, a;
3222     register struct proc *p;
3223
3224     u.u_procp->p_flag = & ~STRC;
3225     for(q = &u.u_signal[0]; q < &u.u_signal[NSIG];)
3226         *q++ = 1;
3227     for(q = &u.u_ofile[0]; q < &u.u_ofile[NOFILE]; q++)
3228         if(a = *q) {
3229             *q = NULL;
3230             closef(a);
3231         }
3232     iput(u.u_cdir);
3233     xfree();
3234     a = malloc(swapmap, 1);
3235     if(a == NULL)
3236         panic("out of swap");
3237     p = getblk(swapdev, a);
3238     bcopy(&u, p->b_addr, 256);
3239     bwrite(p);
3240     q = u.u_procp;
3241     mfree(coremap, q->p_size, q->p_addr);
3242     q->p_addr = a;
3243     q->p_stat = SZOMB;
3244
3245     loop:
3246     for(p = &proc[0]; p < &proc[NPROC]; p++)
3247         if(q->p_ppid == p->p_pid) {
3248             wakeup(&proc[1]);
3249             wakeup(p);

```

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```

3250         for(p = &proc[0]; p < &proc[NPROC]; p++)
3251             if(q->p_pid == p->p_ppid) {
3252                 p->p_ppid = 1;
3253                 if (p->p_stat == SSTOP)
3254                     setrun(p);
3255             }
3256             switch();
3257             /* no return */
3258         }
3259     q->p_ppid = 1;
3260     goto loop;
3261 }
3262 /* ----- */
3263
3264 /* Wait system call.
3265 * Search for a terminated (zombie) child,
3266 * finally lay it to rest, and collect its status.
3267 * Look also for stopped (traced) children,
3268 * and pass back status from them.
3269 */
3270 wait()
3271 {
3272     register f, *bp;
3273     register struct proc *p;
3274
3275     f = 0;
3276     loop:
3277     for(p = &proc[0]; p < &proc[NPROC]; p++)
3278         if(p->p_ppid == u.u_procp->p_pid) {
3279             f++;
3280             if(p->p_stat == SZOMB) {
3281                 u.u_ar0[R0] = p->p_pid;
3282                 bp = bread(swapdev, f=p->p_addr);
3283                 mfree(swapmap, 1, f);
3284                 p->p_stat = NULL;
3285                 p->p_pid = 0;
3286                 p->p_ppid = 0;
3287                 p->p_sig = 0;
3288                 p->p_ttyp = 0;
3289                 p->p_flag = 0;
3290                 p = bp->b_addr;
3291                 u.u_cstime[0] += p->u_cstime[0];
3292                 dpadd(u.u_cstime, p->u_cstime[1]);
3293                 dpadd(u.u_cstime, p->u_stime);
3294                 u.u_cstime[0] += p->u_cutime[0];
3295                 dpadd(u.u_cutime, p->u_cutime[1]);
3296                 dpadd(u.u_cutime, p->u_otime);
3297                 u.u_ar0[R1] = p->u_arg[0];
3298                 brelse(bp);
3299                 return;

```

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```

3300     }
3301     if(p->p_stat == SSTOP) {
3302         if((p->p_flag&SWTED) == 0) {
3303             p->p_flag |= SWTED;
3304             u.u_ar0[R0] = p->p_pid;
3305             u.u_ar0[R1] = (p->p_sig<<8) |
3306                 0177;
3307             return;
3308         }
3309         p->p_flag = && ~(STRC|SWTED);
3310         setrun(p);
3311     }
3312 }
3313 if(f) {
3314     sleep(u.u_procp, PWAIT);
3315     goto loop;
3316 }
3317 u.u_error = ECHILD;
3318 }
3319 /* ----- */
3320
3321 /* fork system call. */
3322 fork()
3323 {
3324     register struct proc *p1, *p2;
3325
3326     p1 = u.u_procp;
3327     for(p2 = &proc[0]; p2 < &proc[NPROC]; p2++)
3328         if(p2->p_stat == NULL)
3329             goto found;
3330     u.u_error = EAGAIN;
3331     goto out;
3332
3333 found:
3334     if(newproc()) {
3335         u.u_ar0[R0] = p1->p_pid;
3336         u.u_cstime[0] = 0;
3337         u.u_cstime[1] = 0;
3338         u.u_stime = 0;
3339         u.u_cutime[0] = 0;
3340         u.u_cutime[1] = 0;
3341         u.u_utime = 0;
3342         return;
3343     }
3344     u.u_ar0[R0] = p2->p_pid;
3345
3346 out:
3347     u.u_ar0[R7] += 2;
3348 }
3349 /* ----- */

```

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```

3350
3351 /* break system call.
3352 * -- bad planning: "break" is a dirty word in C.
3353 */
3354 sbreak()
3355 {
3356     register a, n, d;
3357     int i;
3358
3359     /* set n to new data size
3360     * set d to new-old
3361     * set n to new total size
3362     */
3363
3364     n = (((u.u_arg[0]+63)>>6) & 01777);
3365     if(!u.u_sep)
3366         n = - nseg(u.u_tsize) * 128;
3367     if(n < 0)
3368         n = 0;
3369     d = n - u.u_dsize;
3370     n += USIZE+u.u_ssize;
3371     if(estabur(u.u_tsize, u.u_dsize+d, u.u_ssize, u.u_sep))
3372         return;
3373     u.u_dsize += d;
3374     if(d > 0)
3375         goto bigger;
3376     a = u.u_procp->p_addr + n - u.u_ssize;
3377     i = n;
3378     n = u.u_ssize;
3379     while(n--) {
3380         copyseg(a-d, a);
3381         a++;
3382     }
3383     expand(i);
3384     return;
3385
3386 bigger:
3387     expand(n);
3388     a = u.u_procp->p_addr + n;
3389     n = u.u_ssize;
3390     while(n--) {
3391         a--;
3392         copyseg(a-d, a);
3393     }
3394     while(d--)
3395         clearseg(--a);
3396 }
3397 /* ----- */
3398
3399

```

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```

3400 #
3401 /*
3402  * Everything in this file is
3403  * a routine implementing a system call.
3404  */
3405
3406 #include "../param.h"
3407 #include "../user.h"
3408 #include "../reg.h"
3409 #include "../inode.h"
3410 #include "../system.h"
3411 #include "../proc.h"
3412
3413 getswit()
3414 {
3415     u.u_ar0[R0] = SW->integ;
3416 }
3417 /* ----- */
3418
3419 gtime()
3420 {
3421     u.u_ar0[R0] = time[0];
3422     u.u_ar0[R1] = time[1];
3423 }
3424 /* ----- */
3425
3426 stime()
3427 {
3428     if(suser()) {
3429         time[0] = u.u_ar0[R0];
3430         time[1] = u.u_ar0[R1];
3431         wakeup(tout);
3432     }
3433 }
3434 /* ----- */
3435
3436 setuid()
3437 {
3438     register uid;
3439     uid = u.u_ar0[R0].lobyte;
3440     if(u.u_ruid == uid.lobyte || suser()) {
3441         u.u_uid = uid;
3442         u.u_procp->p_uid = uid;
3443         u.u_ruid = uid;
3444     }
3445 }

```

```

3450 /* ----- */
3451
3452 getuid()
3453 {
3454     u.u_ar0[R0].lobyte = u.u_ruid;
3455     u.u_ar0[R0].hibyte = u.u_uid;
3456 }
3457 /* ----- */
3458
3459 setgid()
3460 {
3461     register gid;
3462     gid = u.u_ar0[R0].lobyte;
3463     if(u.u_rgid == gid.lobyte || suser()) {
3464         u.u_gid = gid;
3465         u.u_rgid = gid;
3466     }
3467 }
3468 /* ----- */
3469
3470 getgid()
3471 {
3472     u.u_ar0[R0].lobyte = u.u_rgid;
3473     u.u_ar0[R0].hibyte = u.u_gid;
3474 }
3475 /* ----- */
3476
3477 getpid()
3478 {
3479     u.u_ar0[R0] = u.u_procp->p_pid;
3480 }
3481 /* ----- */
3482
3483 sync()
3484 {
3485     update();
3486 }
3487 /* ----- */
3488
3489 nice()
3490 {
3491     register n;
3492     n = u.u_ar0[R0];
3493     if(n > 20)
3494         n = 20;

```

```

3500  if(n < 0 && !suser())
3501      n = 0;
3502  u.u_procp->p_nice = n;
3503 }
3504 /* ----- */
3505
3506 /*
3507  * Unlink system call.
3508  * panic: unlink -- "cannot happen"
3509  */
3510 unlink()
3511 {
3512     register *ip, *pp;
3513     extern uchar;
3514
3515     pp = namei(&uchar, 2);
3516     if(pp == NULL)
3517         return;
3518     prele(pp);
3519     ip = iget(pp->i_dev, u.u_dent.u_ino);
3520     if(ip == NULL)
3521         panic("unlink -- iget");
3522     if((ip->i_mode&IFMT)==IFDIR && !suser())
3523         goto out;
3524     u.u_offset[1] =- DIRSIZ+2;
3525     u.u_base = &u.u_dent;
3526     u.u_count = DIRSIZ+2;
3527     u.u_dent.u_ino = 0;
3528     writei(pp);
3529     ip->i_nlink--;
3530     ip->i_flag |= IUPD;
3531
3532 out:
3533     iput(pp);
3534     iput(ip);
3535 }
3536 /* ----- */
3537
3538 chdir()
3539 {
3540     register *ip;
3541     extern uchar;
3542
3543     ip = namei(&uchar, 0);
3544     if(ip == NULL)
3545         return;
3546     if((ip->i_mode&IFMT) != IFDIR) {
3547         u.u_error = ENOTDIR;
3548     bad:
3549         iput(ip);

```

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```

3550         return;
3551     }
3552     if(access(ip, IEXEC))
3553         goto bad;
3554     iput(u.u_cdir);
3555     u.u_cdir = ip;
3556     prele(ip);
3557 }
3558 /* ----- */
3559
3560 chmod()
3561 {
3562     register *ip;
3563
3564     if ((ip = owner()) == NULL)
3565         return;
3566     ip->i_mode =& ~07777;
3567     if (u.u_uid)
3568         u.u_arg[1] =& ~ISVTX;
3569     ip->i_mode = | u.u_arg[1]&07777;
3570     ip->i_flag = | IUPD;
3571     iput(ip);
3572 }
3573 /* ----- */
3574
3575 chown()
3576 {
3577     register *ip;
3578
3579     if (!suser() || (ip = owner()) == NULL)
3580         return;
3581     ip->i_uid = u.u_arg[1].lobyte;
3582     ip->i_gid = u.u_arg[1].hibyte;
3583     ip->i_flag = | IUPD;
3584     iput(ip);
3585 }
3586 /* ----- */
3587
3588 /*
3589  * Change modified date of file:
3590  * time to r0-r1; sys smdate; file
3591  * This call has been withdrawn because it messes up
3592  * incremental dumps (pseudo-old files aren't dumped).
3593  * It works though and you can uncomment it if you like.
3594  */
3595 smdate()
3596 {
3597     register struct inode *ip;
3598     register int *tp;
3599     int tbuf[2];

```

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```

3600
3601  if ((ip = owner()) == NULL)
3602      return;
3603  ip->i_flag |= IUPD;
3604  tp = &tbuf[2];
3605  *--tp = u.u_ar0[R1];
3606  *--tp = u.u_ar0[R0];
3607  iupdat(ip, tp);
3608  ip->i_flag = & ~IUPD;
3609  iput(ip);
3610 }
3611 */
3612 /* ----- */
3613
3614 ssig()
3615 {
3616     register a;
3617
3618     a = u.u_arg[0];
3619     if(a<=0 || a>=NSIG || a==SIGKIL) {
3620         u.u_error = EINVAL;
3621         return;
3622     }
3623     u.u_ar0[R0] = u.u_signal[a];
3624     u.u_signal[a] = u.u_arg[1];
3625     if(u.u_procp->p_sig == a)
3626         u.u_procp->p_sig = 0;
3627 }
3628 /* ----- */
3629
3630 kill()
3631 {
3632     register struct proc *p, *q;
3633     register a;
3634     int f;
3635
3636     f = 0;
3637     a = u.u_ar0[R0];
3638     q = u.u_procp;
3639     for(p = &proc[0]; p < &proc[NPROC]; p++) {
3640         if(p == q)
3641             continue;
3642         if(a != 0 && p->p_pid != a)
3643             continue;
3644         if(a==0&&(p->p_ttyp!=q->p_ttyp|p<=&proc[1]))
3645             continue;
3646         if(u.u_uid != 0 && u.u_uid != p->p_uid)
3647             continue;
3648         f++;
3649         psignal(p, u.u_arg[0]);

```

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```

3650     }
3651     if(f == 0)
3652         u.u_error = ESRCH;
3653 }
3654 /* ----- */
3655
3656 times()
3657 {
3658     register *p;
3659
3660     for(p = &u.u_otime; p < &u.u_utime+6;) {
3661         suword(u.u_arg[0], *p++);
3662         u.u_arg[0] += 2;
3663     }
3664 }
3665 /* ----- */
3666
3667 profil()
3668 {
3669     u.u_prof[0] = u.u_arg[0] & ~1; /* base of sample buf */
3670     u.u_prof[1] = u.u_arg[1]; /* size of same */
3671     u.u_prof[2] = u.u_arg[2]; /* pc offset */
3672     u.u_prof[3] = (u.u_arg[3]>>1) & 077777; /* pc scale */
3673 }
3674 /* ----- */
3675
3676
3677
3678
3679
3680
3681
3682
3683
3684
3685
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```

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```

3700 #
3701 #include "../param.h"
3702 #include "../system.h"
3703 #include "../user.h"
3704 #include "../proc.h"
3705
3706 #define UMODE 0170000
3707 #define SCHMAG 10
3708
3709 /*
3710 * clock is called straight from
3711 * the real time clock interrupt.
3712 *
3713 * Functions:
3714 * reprime clock
3715 * copy *switches to display
3716 * implement callouts
3717 * maintain user/system times
3718 * maintain date
3719 * profile
3720 * tout wakeup (sys sleep)
3721 * lightning bolt wakeup (every 4 sec)
3722 * alarm clock signals
3723 * jab the scheduler
3724 */
3725 clock(dev, sp, r1, nps, r0, pc, ps)
3726 {
3727     register struct callo *p1, *p2;
3728     register struct proc *pp;
3729
3730     /*
3731     * restart clock
3732     */
3733
3734     *lks = 0115;
3735
3736     /*
3737     * display register
3738     */
3739
3740     display();
3741
3742     /*
3743     * callouts
3744     * if done, just return
3745     * else update first non-zero time
3746     */
3747
3748     if(callout[0].c_func == 0)
3749         goto out;

```

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```

3750     p2 = &callout[0];
3751     while(p2->c_time<=0 && p2->c_func!=0)
3752         p2++;
3753     p2->c_time--;
3754
3755     /*
3756     * if ps is high, just return
3757     */
3758
3759     if((ps&0340) != 0)
3760         goto out;
3761
3762     /*
3763     * callout
3764     */
3765
3766     spl5();
3767     if(callout[0].c_time <= 0) {
3768         p1 = &callout[0];
3769         while(p1->c_func != 0 && p1->c_time <= 0) {
3770             (*p1->c_func)(p1->c_arg);
3771             p1++;
3772         }
3773         p2 = &callout[0];
3774         while(p2->c_func = p1->c_func) {
3775             p2->c_time = p1->c_time;
3776             p2->c_arg = p1->c_arg;
3777             p1++;
3778             p2++;
3779         }
3780     }
3781
3782     /*
3783     * lightning bolt time-out
3784     * and time of day
3785     */
3786
3787 out:
3788     if((ps&UMODE) == UMODE) {
3789         u.u_otime++;
3790         if(u.u_prof[3])
3791             incupc(ps, u.u_prof);
3792     } else
3793         u.u_stime++;
3794     pp = u.u_procp;
3795     if(++pp->p_cpu == 0)
3796         pp->p_cpu--;
3797     if(++lbolt >= HZ) {
3798         if((ps&0340) != 0)
3799             return;

```

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```

3800         lbolt =- HZ;
3801         if(++time[1] == 0)
3802             ++time[0];
3803         spl1();
3804         if(time[1]==tout[1] && time[0]==tout[0])
3805             wakeup(tout);
3806         if((time[1]&03) == 0) {
3807             runrun++;
3808             wakeup(&lbolt);
3809         }
3810         for(pp = &proc[0]; pp < &proc[NPROC]; pp++)
3811             if (pp->p_stat) {
3812                 if(pp->p_time != 127)
3813                     pp->p_time++;
3814                 if((pp->p_cpu & 0377) > SCHMAG)
3815                     pp->p_cpu -= SCHMAG; else
3816                     pp->p_cpu = 0;
3817                 if(pp->p_pri > PUSER)
3818                     setpri(pp);
3819             }
3820         if(runin!=0) {
3821             runin = 0;
3822             wakeup(&runin);
3823         }
3824         if((ps&UMODE) == UMODE) {
3825             u.u_ar0 = &r0;
3826             if(!issig())
3827                 psig();
3828             setpri(u.u_proc);
3829         }
3830     }
3831 }
3832 /* ----- */
3833
3834 /*
3835  * timeout is called to arrange that
3836  * fun(arg) is called in tim/HZ seconds.
3837  * An entry is sorted into the callout
3838  * structure. The time in each structure
3839  * entry is the number of HZ's more
3840  * than the previous entry.
3841  * In this way, decrementing the
3842  * first entry has the effect of
3843  * updating all entries.
3844  */
3845 timeout(fun, arg, tim)
3846 {
3847     register struct callout *p1, *p2;
3848     register t;
3849     int s;

```

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```

3850
3851     t = tim;
3852     s = PS->integ;
3853     p1 = &callout[0];
3854     spl7();
3855     while(p1->c_func != 0 && p1->c_time <= t) {
3856         t =- p1->c_time;
3857         p1++;
3858     }
3859     p1->c_time =- t;
3860     p2 = p1;
3861     while(p2->c_func != 0)
3862         p2++;
3863     while(p2 >= p1) {
3864         (p2+1)->c_time = p2->c_time;
3865         (p2+1)->c_func = p2->c_func;
3866         (p2+1)->c_arg = p2->c_arg;
3867         p2--;
3868     }
3869     p1->c_time = t;
3870     p1->c_func = fun;
3871     p1->c_arg = arg;
3872     PS->integ = s;
3873 }
3874 /* ----- */
3875
3876
3877
3878
3879
3880
3881
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```

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```

3900 #
3901 /*
3902 */
3903
3904 #include "../param.h"
3905 #include "../system.h"
3906 #include "../user.h"
3907 #include "../proc.h"
3908 #include "../inode.h"
3909 #include "../reg.h"
3910
3911 /*
3912  * Priority for tracing
3913 */
3914 #define IPCPRI (-1)
3915
3916 /*
3917  * Structure to access an array of integers.
3918 */
3919 struct
3920 {
3921     int     inta[];
3922 };
3923 /* ----- */
3924
3925 /*
3926  * Tracing variables.
3927  * Used to pass trace command from
3928  * parent to child being traced.
3929  * This data base cannot be
3930  * shared and is locked
3931  * per user.
3932 */
3933 struct
3934 {
3935     int     ip_lock;
3936     int     ip_req;
3937     int     ip_addr;
3938     int     ip_data;
3939 } ipc;
3940 /* ----- */
3941
3942 /*
3943  * Send the specified signal to
3944  * all processes with 'tp' as its
3945  * controlling teletype.
3946  * Called by tty.c for quits and
3947  * interrupts.
3948 */
3949 signal(tp, sig)

```

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```

3950 {
3951     register struct proc *p;
3952
3953     for(p = &proc[0]; p < &proc[NPROC]; p++)
3954         if(p->p_ttyp == tp)
3955             psignal(p, sig);
3956 }
3957 /* ----- */
3958
3959 /*
3960  * Send the specified signal to
3961  * the specified process.
3962 */
3963 psignal(p, sig)
3964 int *p;
3965 {
3966     register *rp;
3967
3968     if(sig >= NSIG)
3969         return;
3970     rp = p;
3971     if(rp->p_sig != SIGKIL)
3972         rp->p_sig = sig;
3973     if(rp->p_stat > PUSER)
3974         rp->p_stat = PUSER;
3975     if(rp->p_stat == SWAIT)
3976         setrun(rp);
3977 }
3978 /* ----- */
3979
3980 /*
3981  * Returns true if the current
3982  * process has a signal to process.
3983  * This is asked at least once
3984  * each time a process enters the
3985  * system.
3986  * A signal does not do anything
3987  * directly to a process; it sets
3988  * a flag that asks the process to
3989  * do something to itself.
3990 */
3991 issig()
3992 {
3993     register n;
3994     register struct proc *p;
3995
3996     p = u.u_proc;
3997     if(n = p->p_sig) {
3998         if (p->p_flag&STRC) {
3999             stop();

```

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```

4000             if ((n = p->p_sig) == 0)
4001                 return(0);
4002             }
4003             if((u.u_signal[n]&1) == 0)
4004                 return(n);
4005         }
4006     return(0);
4007 }
4008 /* ----- */
4009
4010 /*
4011  * Enter the tracing STOP state.
4012  * In this state, the parent is
4013  * informed and the process is able to
4014  * receive commands from the parent.
4015  */
4016 stop()
4017 {
4018     register struct proc *pp, *cp;
4019
4020 loop:
4021     cp = u.u_procp;
4022     if(cp->p_pid != 1)
4023         for (pp = &proc[0]; pp < &proc[NPROC]; pp++)
4024             if (pp->p_pid == cp->p_ppid) {
4025                 wakeup(pp);
4026                 cp->p_stat = SSTOP;
4027                 swtch();
4028                 if ((cp->p_flag&STRC)==0 || procxmt())
4029                     return;
4030                 goto loop;
4031             }
4032     exit();
4033 }
4034 /* ----- */
4035
4036 /*
4037  * Perform the action specified by
4038  * the current signal.
4039  * The usual sequence is:
4040  * if(issig())
4041  *     psig();
4042  */
4043 psig()
4044 {
4045     register n, p;
4046     register *rp;
4047
4048     rp = u.u_procp;
4049     n = rp->p_sig;

```

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```

4050     rp->p_sig = 0;
4051     if((p=u.u_signal[n]) != 0) {
4052         u.u_error = 0;
4053         if(n != SIGINS && n != SIGTRC)
4054             u.u_signal[n] = 0;
4055         n = u.u_ar0[R6] - 4;
4056         grow(n);
4057         suword(n+2, u.u_ar0[RPS]);
4058         suword(n, u.u_ar0[R7]);
4059         u.u_ar0[R6] = n;
4060         u.u_ar0[RPS] = & ~TBIT;
4061         u.u_ar0[R7] = p;
4062         return;
4063     }
4064     switch(n) {
4065
4066     case SIGQUIT:
4067     case SIGINS:
4068     case SIGTRC:
4069     case SIGIOT:
4070     case SIGEMT:
4071     case SIGFPT:
4072     case SIGBUS:
4073     case SIGSEGV:
4074     case SIGSYS:
4075         u.u_arg[0] = n;
4076         if(core())
4077             n =+ 0200;
4078     }
4079     u.u_arg[0] = (u.u_ar0[R0]<<8) | n;
4080     exit();
4081 }
4082 /* ----- */
4083
4084 /*
4085  * Create a core image on the file "core"
4086  * If you are looking for protection glitches,
4087  * there are probably a wealth of them here
4088  * when this occurs to a suid command.
4089  *
4090  * It writes USIZE block of the
4091  * user.h area followed by the entire
4092  * data+stack segments.
4093  */
4094 core()
4095 {
4096     register s, *ip;
4097     extern schar;
4098
4099     u.u_error = 0;

```

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```

4100 u.u_dirp = "core";
4101 ip = namei(&schar, 1);
4102 if(ip == NULL) {
4103     if(u.u_error)
4104         return(0);
4105     ip = maknode(0666);
4106     if(ip == NULL)
4107         return(0);
4108 }
4109 if(!access(ip, IWRITE) &&
4110 (ip->i_mode&IFMT) == 0 &&
4111 u.u_uid == u.u_ruid) {
4112     itrunc(ip);
4113     u.u_offset[0] = 0;
4114     u.u_offset[1] = 0;
4115     u.u_base = &u;
4116     u.u_count = USIZE*64;
4117     u.u_segflg = 1;
4118     writei(ip);
4119     s = u.u_procp->p_size - USIZE;
4120     estabur(0, s, 0, 0);
4121     u.u_base = 0;
4122     u.u_count = s*64;
4123     u.u_segflg = 0;
4124     writei(ip);
4125 }
4126 iput(ip);
4127 return(u.u_error==0);
4128 }
4129 /* ----- */
4130
4131 /*
4132 * grow the stack to include the SP
4133 * true return in successful.
4134 */
4135
4136 grow(sp)
4137 char *sp;
4138 {
4139     register a, si, i;
4140
4141     if(sp >= -u.u_ssize*64)
4142         return(0);
4143     si = ldiv(-sp, 64) - u.u_ssize + SINCR;
4144     if(si <= 0)
4145         return(0);
4146     if(estabur(u.u_tsize, u.u_dsize, u.u_ssize+si, u.u_sep))
4147         return(0);
4148     expand(u.u_procp->p_size+si);
4149     a = u.u_procp->p_addr + u.u_procp->p_size;

```

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```

4150     for(i=u.u_ssize; i; i--) {
4151         a--;
4152         copyseg(a-si, a);
4153     }
4154     for(i=si; i; i--)
4155         clearseg(--a);
4156     u.u_ssize += si;
4157     return(1);
4158 }
4159 /* ----- */
4160
4161 /*
4162 * sys-trace system call.
4163 */
4164 ptrace()
4165 {
4166     register struct proc *p;
4167
4168     if (u.u_arg[2] <= 0) {
4169         u.u_procp->p_flag |= STRC;
4170         return;
4171     }
4172     for (p=proc; p < &proc[NPROC]; p++)
4173         if (p->p_stat==SSTOP
4174             && p->p_pid==u.u_arg[0]
4175             && p->p_ppid==u.u_procp->p_pid)
4176             goto found;
4177     u.u_error = ESRCH;
4178     return;
4179
4180     found:
4181     while (ipc.ip_lock)
4182         sleep(&ipc, IPCPRI);
4183     ipc.ip_lock = p->p_pid;
4184     ipc.ip_data = u.u_ar0[R0];
4185     ipc.ip_addr - u.u_arg[1] & ~01;
4186     ipc.ip_req = u.u_arg[2];
4187     p->p_flag |= ~SWTED;
4188     setrun(p);
4189     while (ipc.ip_req > 0)
4190         sleep(&ipc, IPCPRI);
4191     u.u_ar0[R0] = ipc.ip_data;
4192     if (ipc.ip_req < 0)
4193         u.u_error = EIO;
4194     ipc.ip_lock = 0;
4195     wakeup(&ipc);
4196 }
4197 /* ----- */
4198
4199 /*

```

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```

4200 * Code that the child process
4201 * executes to implement the command
4202 * of the parent process in tracing.
4203 */
4204 procxmt()
4205 {
4206     register int i;
4207     register int *p;
4208
4209     if (ipc.ip_lock != u.u_procp->p_pid)
4210         return(0);
4211     i = ipc.ip_req;
4212     ipc.ip_req = 0;
4213     wakeup(&ipc);
4214     switch (i) {
4215
4216     /* read user I */
4217     case 1:
4218         if (fuibyte(ipc.ip_addr) == -1)
4219             goto error;
4220         ipc.ip_data = fuiword(ipc.ip_addr);
4221         break;
4222
4223     /* read user D */
4224     case 2:
4225         if (fubyte(ipc.ip_addr) == -1)
4226             goto error;
4227         ipc.ip_data = fuword(ipc.ip_addr);
4228         break;
4229
4230     /* read u */
4231     case 3:
4232         i = ipc.ip_addr;
4233         if (i < 0 || i >= (USIZE<<6))
4234             goto error;
4235         ipc.ip_data = u.inta[i>>1];
4236         break;
4237
4238     /* write user I (for now, always an error) */
4239     case 4:
4240         if (suiword(ipc.ip_addr, 0) < 0)
4241             goto error;
4242         suiword(ipc.ip_addr, ipc.ip_data);
4243         break;
4244
4245     /* write user D */
4246     case 5:
4247         if (suword(ipc.ip_addr, 0) < 0)
4248             goto error;
4249         suword(ipc.ip_addr, ipc.ip_data);

```

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```

4250         break;
4251
4252     /* write u */
4253     case 6:
4254         p = &u.inta[ipc.ip_addr>>1];
4255         if (p >= u.u_fsav && p < &u.u_fsav[25])
4256             goto ok;
4257         for (i=0; i<9; i++)
4258             if (p == &u.u_ar0[regloc[i]])
4259                 goto ok;
4260         goto error;
4261     ok:
4262         if (p == &u.u_ar0[RPS]) {
4263             /* assure user space */
4264             ipc.ip_data = | 0170000;
4265             /* priority 0 */
4266             ipc.ip_data = & ~0340;
4267         }
4268         *p = ipc.ip_data;
4269         break;
4270
4271     /* set signal and continue */
4272     case 7:
4273         u.u_procp->p_sig = ipc.ip_data;
4274         return(1);
4275
4276     /* force exit */
4277     case 8:
4278         exit();
4279
4280     default:
4281     error:
4282         ipc.ip_req = -1;
4283     }
4284     return(0);
4285 }
4286 /* ----- */
4287
4288
4289
4290
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# 3

**Program Swapping  
Basic Input/Output  
Block Devices**



```

4300 /*
4301  * Text structure.
4302  * One allocated per pure
4303  * procedure on swap device.
4304  * Manipulated by text.c
4305  */
4306 struct text
4307 {
4308     int      x_daddr;      /* disk address of segment */
4309     int      x_caddr;      /* core address, if loaded */
4310     int      x_size; /* size (*64) */
4311     int      *x_iptr;      /* inode of prototype */
4312     char     x_count;      /* reference count */
4313     char     x_ccount;     /* number of loaded references */
4314 } text[NTEXT];
4315 /* ----- */
4316
4317
4318
4319
4320
4321
4322
4323
4324
4325
4326
4327
4328
4329
4330
4331
4332
4333
4334
4335
4336
4337
4338
4339
4340
4341
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4344
4345
4346
4347
4348
4349

```

```

4350 #
4351 #include "../param.h"
4352 #include "../system.h"
4353 #include "../user.h"
4354 #include "../proc.h"
4355 #include "../text.h"
4356 #include "../inode.h"
4357
4358 /* Swap out process p.
4359  * The ff flag causes its core to be freed--
4360  * it may be off when called to create an image for a
4361  * child process in newproc.
4362  * Os is the old size of the data area of the process,
4363  * and is supplied during core expansion swaps.
4364  *
4365  * panic: out of swap space
4366  * panic: swap error -- IO error
4367  */
4368 xswap(p, ff, os)
4369 int *p;
4370 { register *rp, a;
4371
4372     rp = p;
4373     if(os == 0)
4374         os = rp->p_size;
4375     a = malloc(swapmap, (rp->p_size+7)/8);
4376     if(a == NULL)
4377         panic("out of swap space");
4378     xccdec(rp->p_textp);
4379     rp->p_flag |= SLOCK;
4380     if(swap(a, rp->p_addr, os, 0))
4381         panic("swap error");
4382     if(ff)
4383         mfree(coremap, os, rp->p_addr);
4384     rp->p_addr = a;
4385     rp->p_flag = & ~(SLOAD|SLOCK);
4386     rp->p_time = 0;
4387     if(runout) {
4388         runout = 0;
4389         wakeup(&runout);
4390     }
4391 }
4392 /* ----- */
4393
4394 /*
4395  * relinquish use of the shared text segment
4396  * of a process.
4397  */
4398 xfree()
4399 { register *xp, *ip;

```

```

4400
4401 if((xp=u.u_procp->p_textp) != NULL) {
4402     u.u_procp->p_textp == NULL;
4403     xccdec(xp);
4404     if(--xp->x_count == 0) {
4405         ip = xp->x_iptr;
4406         if((ip->i_mode&ISVTX) == 0) {
4407             xp->x_iptr = NULL;
4408             mfree(swapmap, (xp->x_size+7)/8,
4409                 xp->x_daddr);
4410             ip->i_flag = & ~ITEXT;
4411             iput(ip);
4412         }
4413     }
4414 }
4415 }
4416 /* ----- */
4417
4418 /* Attach to a shared text segment.
4419 * If there is no shared text, just return.
4420 * If there is, hook up to it:
4421 * if it is not currently being used, it has to be read
4422 * in from the inode (ip) and established in the swap space.
4423 * If it is being used, but not currently in core,
4424 * a swap has to be done to get it back.
4425 * The full coroutine glory has to be invoked--
4426 * see slp.c-- because if the calling process
4427 * is misplaced in core the text image might not fit.
4428 * Quite possibly the code after "out:" could check to
4429 * see if the text does fit and simply swap it in.
4430 *
4431 * panic: out of swap space
4432 */
4433 xalloc(ip)
4434 int *ip;
4435 {
4436     register struct text *xp;
4437     register *rp, ts;
4438
4439     if(u.u_arg[1] == 0) return;
4440     rp = NULL;
4441     for(xp = &text[0]; xp < &text[NTEXT]; xp++)
4442         if(xp->x_iptr == NULL) {
4443             if(rp == NULL)
4444                 rp = xp;
4445         } else
4446             if(xp->x_iptr == ip) {
4447                 xp->x_count++;
4448                 u.u_procp->p_textp = xp;
4449                 goto out;

```

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```

4450     }
4451     if((xp=rp) == NULL) panic("out of text");
4452     xp->x_count = 1;
4453     xp->x_ccount = 0;
4454     xp->x_iptr = ip;
4455     ts = ((u.u_arg[1]+63)>>6) & 01777;
4456     xp->x_size = ts;
4457     if((xp->x_daddr = malloc(swapmap, (ts+7)/8)) == NULL)
4458         panic("out of swap space");
4459     expand(USIZE+ts);
4460     estabur(0, ts, 0, 0);
4461     u.u_count = u.u_arg[1];
4462     u.u_offset[1] = 020;
4463     u.u_base = 0;
4464     readi(ip);
4465     rp = u.u_procp;
4466     rp->p_flag = | SLOCK;
4467     swap(xp->x_daddr, rp->p_addr+USIZE, ts, 0);
4468     rp->p_flag = & ~SLOCK;
4469     rp->p_textp = xp;
4470     rp = ip;
4471     rp->i_flag = | ITEXT;
4472     rp->i_count++;
4473     expand(USIZE);
4474 out:
4475     if(xp->x_ccount == 0) {
4476         savu(u.u_rsav);
4477         savu(u.u_ssav);
4478         xswap(u.u_procp, 1, 0);
4479         u.u_procp->p_flag = | SSWAP;
4480         swtch();
4481         /* no return */
4482     }
4483     xp->x_ccount++;
4484 }
4485 /* ----- */
4486
4487 /* Decrement the in-core usage count of a shared text
4488 * segment. When it drops to zero, free the core space.
4489 */
4490 xccdec(xp)
4491 int *xp;
4492 {
4493     register *rp;
4494
4495     if((rp=xp)!=NULL && rp->x_ccount!=0)
4496         if(--rp->x_ccount == 0)
4497             mfree(coremap, rp->x_size, rp->x_caddr);
4498 }
4499

```

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```

4500 /*
4501 * Each buffer in the pool is usually doubly linked into two
4502 * lists: for the device with which it is currently associat-
4503 * ed (always) and also for a list of blocks available for
4504 * allocation for other use (usually).
4505 * The latter list is kept in last-used order, and the two
4506 * lists are doubly linked to make it easy to remove
4507 * a buffer from one list when it was found by
4508 * looking through the other.
4509 * A buffer is on the available list, and is liable
4510 * to be reassigned to another disk block, if and only
4511 * if it is not marked BUSY. When a buffer is busy, the
4512 * available-list pointers can be used for other purposes.
4513 * Most drivers use the forward ptr as a link in their I/O
4514 * active queue.
4515 * A buffer header contains all the information required
4516 * to perform I/O.
4517 * Most of the routines which manipulate these things
4518 * are in bio.c.
4519 */
4520 struct buf
4521 {
4522     int     b_flags;          /* see defines below */
4523     struct buf *b_forw;      /* headed by devtab of b_dev */
4524     struct buf *b_back;     /* " */
4525     struct buf *av_forw;    /* position on free list, */
4526     struct buf *av_back;    /* if not BUSY*/
4527     int     b_dev;          /* major+minor device name */
4528     int     b_wcount;       /* transfer count (usu. words) */
4529     char    *b_addr;        /* low order core address */
4530     char    *b_xmem;        /* high order core address */
4531     char    *b_blkno;       /* block # on device */
4532     char    b_error;        /* returned after I/O */
4533     char    *b_resid;       /* words not transferred after
4534                               error */
4535 } buf[NBUF];
4536 /* ----- */
4537
4538 /*
4539 * Each block device has a devtab, which contains private
4540 * state stuff and 2 list heads: the b_forw/b_back list,
4541 * which is doubly linked and has all the buffers currently
4542 * associated with the major device;
4543 * and the d_actf/d_actl list, which is private to the
4544 * device but in fact is always used for the head and tail
4545 * of the I/O queue for the device.
4546 * Various routines in bio.c look at b_forw/b_back
4547 * (notice they are the same as in the buf structure)
4548 * but the rest is private to each device driver.
4549 */

```

```

4550
4551 struct devtab
4552 {
4553     char    d_active;       /* busy flag */
4554     char    d_errcnt;      /* error count (for recovery)*/
4555     struct buf *b_forw;    /* first buffer for this dev */
4556     struct buf *b_back;    /* last buffer for this dev */
4557     struct buf *d_actf;    /* head of I/O queue */
4558     struct buf *d_actl;    /* tail of I/O queue */
4559 };
4560 /* ----- */
4561
4562 /*
4563 * This is the head of the queue of available
4564 * buffers-- all unused except for the 2 list heads.
4565 */
4566
4567 struct     buf bfreelist;
4568
4569 /*
4570 * These flags are kept in b_flags.
4571 */
4572 #define B_WRITE 0          /* non-read pseudo-flag */
4573 #define B_READ 01         /* read when I/O occurs */
4574 #define B_DONE 02         /* transaction finished */
4575 #define B_ERROR 04        /* transaction aborted */
4576 #define B_BUSY 010        /* not on av_forw/back list */
4577 #define B_PHYS 020        /* Physical IO potentially
4578                               using the Unibus map */
4579 #define B_MAP 040         /* This block has the UNIBUS
4580                               map allocated */
4581 #define B_WANTED 0100     /* issue wakeup when
4582                               BUSY goes off */
4583 #define B_RELOC 0200      /* no longer used */
4584 #define B_ASYNC 0400     /* don't wait wait for I/O
4585                               completion */
4586 #define B_DELWRI 01000   /* don't write till block
4587                               leaves available list */
4588
4589
4590
4591
4592
4593
4594
4595
4596
4597
4598
4599

```

```

4600 /* Used to dissect integer device code
4601  * into major (driver designation) and
4602  * minor (driver parameter) parts.
4603  */
4604 struct      {
4605     char      d_minor;
4606     char      d_major;
4607 };
4608 /* ----- */
4609 /* Declaration of block device
4610  * switch. Each entry (row) is
4611  * the only link between the
4612  * main unix code and the driver.
4613  * The initialization of the
4614  * device switches is in the
4615  * file conf.c.
4616  */
4617 struct      bdevsw {
4618     int      (*d_open)();
4619     int      (*d_close)();
4620     int      (*d_strategy)();
4621     int      *d_tab;
4622 } bdevsw[];
4623 /* ----- */
4624 /* Nblkdev is the number of entries
4625  * (rows) in the block switch. It is
4626  * set in binit/bio.c by making
4627  * a pass over the switch.
4628  * Used in bounds checking on major
4629  * device numbers.
4630  */
4631 int          nblkdev;
4632
4633 /* Character device switch.
4634  */
4635 struct      cdevsw {
4636     int      (*d_open)();
4637     int      (*d_close)();
4638     int      (*d_read)();
4639     int      (*d_write)();
4640     int      (*d_sgatty)();
4641 } cdevsw[];
4642 /* ----- */
4643
4644 /* Number of character switch entries.
4645  * Set by cinit/tty.c
4646  */
4647 int          nchrdev;
4648
4649

```

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```

4650 /*
4651  * this file is created, along with the file "low.s",
4652  * by the program "mkconf.c", to reflect the actual
4653  * configuration of peripheral devices on a system.
4654  */
4655
4656 int (*bdevsw[])()
4657 {
4658     &nulldev, &nulldev, &rkstrategy, &rktab, /*rk */
4659     &nodev, &nodev, &nodev, 0, /* rp */
4660     &nodev, &nodev, &nodev, 0, /* rf */
4661     &nodev, &nodev, &nodev, 0, /* tm */
4662     &nodev, &nodev, &nodev, 0, /* tc */
4663     &nodev, &nodev, &nodev, 0, /* hs */
4664     &nodev, &nodev, &nodev, 0, /* hp */
4665     &nodev, &nodev, &nodev, 0, /* ht */
4666     0
4667 };
4668
4669 int (*cdevsw[])()
4670 {
4671     &klopen, &kfclose, &khread, &kfwrite, &klsgetty,
4672     /* console */
4673     &pcopen, &pcfclose, &pcread, &pcwrite, &nodev,
4674     /* pc */
4675     &lpopen, &lpclose, &nodev, &lpwrite, &nodev,
4676     /* lp */
4677     &nodev, &nodev, &nodev, &nodev, &nodev, /* dc */
4678     &nodev, &nodev, &nodev, &nodev, &nodev, /* dh */
4679     &nodev, &nodev, &nodev, &nodev, &nodev, /* dp */
4680     &nodev, &nodev, &nodev, &nodev, &nodev, /* dj */
4681     &nodev, &nodev, &nodev, &nodev, &nodev, /* dn */
4682     &nulldev, &nulldev, &mmread, &mmwrite, &nodev,
4683     /* mem */
4684     &nulldev, &nulldev, &rkread, &rkwrite, &nodev,
4685     /* rk */
4686     &nodev, &nodev, &nodev, &nodev, &nodev, /* rf */
4687     &nodev, &nodev, &nodev, &nodev, &nodev, /* rp */
4688     &nodev, &nodev, &nodev, &nodev, &nodev, /* tm */
4689     &nodev, &nodev, &nodev, &nodev, &nodev, /* hs */
4690     &nodev, &nodev, &nodev, &nodev, &nodev, /* hp */
4691     &nodev, &nodev, &nodev, &nodev, &nodev, /* ht */
4692     0
4693 };
4694
4695 int rootdev {(0<<8)|0};
4696 int swapdev {(0<<8)|0};
4697 int swplo 4000; /* cannot be zero */
4698 int nswap 872;
4699

```

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```

4700 #
4701 /*
4702 */
4703
4704 #include "../param.h"
4705 #include "../user.h"
4706 #include "../buf.h"
4707 #include "../conf.h"
4708 #include "../system.h"
4709 #include "../proc.h"
4710 #include "../seg.h"
4711
4712 /*
4713 * This is the set of buffres proper, whose heads
4714 * were declared in buf.h. There can exist buffer
4715 * headers not pointing here that are used purely
4716 * as arguments to the I/O routines to describe
4717 * I/O to be done-- e.g. swbuf, just below, for
4718 * swapping.
4719 */
4720 char      buffers[NBUF] [514];
4721 struct    buf      swbuf;
4722
4723 /*
4724 * Declarations of the tables for the magtape devices;
4725 * see bdwrite.
4726 */
4727 int      tmtab;
4728 int      httab;
4729
4730 /*
4731 * The following several routines allocate and free
4732 * buffers with various side effects. In general the
4733 * arguments to an allocate routine are a device and
4734 * a block number, and the value is a pointer to
4735 * the buffer header; the buffer is marked "busy"
4736 * so that no one else can touch it. If the block was
4737 * already in core, no I/O need be done; if it is
4738 * already busy, the process waits until it becomes free.
4739 * The following routines allocate a buffer:
4740 * getblk
4741 * bread
4742 * breada
4743 * Eventually the buffer must be released, possibly with the
4744 * side effect of writing it out, by using one of
4745 * bwrite
4746 * bdwrite
4747 * bawrite
4748 * brelse
4749 */

```

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```

4750
4751 /* Read in (if necessary) the block and
4752 * return a buffer pointer.
4753 */
4754 bread(dev, blkno)
4755 {
4756     register struct buf *rbp;
4757
4758     rbp = getblk(dev, blkno);
4759     if (rbp->b_flags&B_DONE)
4760         return(rbp);
4761     rbp->b_flags =| B_READ;
4762     rbp->b_wcount = -256;
4763     (*bdevsw[dev.d_major].d_strategy)(rbp);
4764     iowait(rbp);
4765     return(rbp);
4766 }
4767 /* ----- */
4768
4769 /*
4770 * Read in the block, like bread, but also start I/O on the
4771 * read-ahead block (which is not allocated to the caller)
4772 */
4773 breada(aDEV, blkno, rablkno)
4774 {
4775     register struct buf *rbp, *rabp;
4776     register int dev;
4777
4778     dev = aDEV;
4779     rbp = 0;
4780     if (!incore(dev, blkno)) {
4781         rbp = getblk(dev, blkno);
4782         if ((rbp->b_flags&B_DONE) == 0) {
4783             rbp->b_flags =| B_READ;
4784             rbp->b_wcount = -256;
4785             (*bdevsw[aDEV.d_major].d_strategy)(rbp);
4786         }
4787     }
4788     if (rablkno && !incore(dev, rablkno)) {
4789         rabp = getblk(dev, rablkno);
4790         if (rabp->b_flags & B_DONE)
4791             brelse(rabp);
4792     } else {
4793         rabp->b_flags =| B_READ|B_ASYNC;
4794         rabp->b_wcount = -256;
4795         (*bdevsw[aDEV.d_major].d_strategy)(rabp);
4796     }
4797 }
4798 if (rbp==0)
4799     return(bread(dev, blkno));

```

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```

4800 iowait(rbp);
4801 return(rbp);
4802 }
4803 /* ----- */
4804
4805 /*
4806 * Write the buffer, waiting for completion.
4807 * The release the buffer.
4808 */
4809 bwrite(bp)
4810 struct buf *bp;
4811 {
4812     register struct buf *rbp;
4813     register flag;
4814
4815     rbp = bp;
4816     flag = rbp->b_flags;
4817     rbp->b_flags =& ~(B_READ | B_DONE | B_ERROR | B_DELWRI);
4818     rbp->b_wcount = -256;
4819     (*bdevsw[rbp->b_dev.d_major].d_strategy)(rbp);
4820     if ((flag&B_ASYNC) == 0) {
4821         iowait(rbp);
4822         brelse(rbp);
4823     } else if ((flag&B_DELWRI)==0)
4824         geterror(rbp);
4825 }
4826 /* ----- */
4827
4828 /*
4829 * Release the buffer, marking it so that if it is grabbed
4830 * for another purpose it will be written out before being
4831 * given up (e.g. when writing a partial block where it is
4832 * assumed that another write for the same block will soon
4833 * follow). This can't be done for magtape, since writes
4834 * must be done in the same order as requested.
4835 */
4836 bdwrite(bp)
4837 struct buf *bp;
4838 {
4839     register struct buf *rbp;
4840     register struct devtab *dp;
4841
4842     rbp = bp;
4843     dp = bdevsw[rbp->b_dev.d_major].d_tab;
4844     if (dp == &tmtab || dp == &httab)
4845         bawrite(rbp);
4846     else {
4847         rbp->b_flags = | B_DELWRI | B_DONE;
4848         brelse(rbp);
4849     }

```

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```

4850 }
4851 /* ----- */
4852
4853 /* Release the buffer, start I/O on it, but don't wait
4854 * for completion */
4855
4856 bawrite(bp)
4857 struct buf *bp;
4858 {
4859     register struct buf *rbp;
4860
4861     rbp = bp;
4862     rbp->b_flags = | B_ASYNC;
4863     bwrite(rbp);
4864 }
4865 /* ----- */
4866
4867 /* release the buffer, with no I/O implied.
4868 */
4869 brelse(bp)
4870 struct buf *bp;
4871 {
4872     register struct buf *rbp, **backp;
4873     register int sps;
4874
4875     rbp = bp;
4876     if (rbp->b_flags&B_WANTED)
4877         wakeup(rbp);
4878     if (bfreelist.b_flags&B_WANTED) {
4879         bfreelist.b_flags =& ~B_WANTED;
4880         wakeup(&bfreelist);
4881     }
4882     if (rbp->b_flags&B_ERROR)
4883         rbp->b_dev.d_minor = -1; /* no assoc. on error */
4884     backp = &bfreelist.av_back;
4885     sps = PS->integ;
4886     spl6();
4887     rbp->b_flags =& ~(B_WANTED|B_BUSY|B_ASYNC);
4888     (*backp)->av_forw = rbp;
4889     rbp->av_back = *backp;
4890     *backp = rbp;
4891     rbp->av_forw = &bfreelist;
4892     PS->integ = sps;
4893 }
4894 /* ----- */
4895
4896 /* See if the block is associated with some buffer
4897 * (mainly to avoid getting hung up on a wait in breada)
4898 */
4899 incore(aDEV, blkno)

```

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```

4900 {
4901     register int dev;
4902     register struct buf *bp;
4903     register struct devtab *dp;
4904
4905     dev = adev;
4906     dp = bdevsw[adev.d_major].d_tab;
4907     for (bp=dp->b_forw; bp != dp; bp = bp->b_forw)
4908         if (bp->b_blkno==blkno && bp->b_dev==dev)
4909             return(bp);
4910     return(0);
4911 }
4912 /* ----- */
4913
4914 /* Assign a buffer for the given block.  If the appropriate
4915 * block is already associated, return it; otherwise search
4916 * for the oldest non-busy buffer and reassign it.
4917 * When a 512-byte area is wanted for some random reason
4918 * (e.g. during exec, for the user arglist) getblk can be
4919 * called with device NODEV to avoid unwanted associativity.
4920 */
4921 getblk(dev, blkno)
4922 {
4923     register struct buf *bp;
4924     register struct devtab *dp;
4925     extern lbolt;
4926
4927     if(dev.d_major >= nblkdev)
4928         panic("blkdev");
4929
4930     loop:
4931     if (dev < 0)
4932         dp = &bfreelist;
4933     else {
4934         dp = bdevsw[dev.d_major].d_tab;
4935         if(dp == NULL)
4936             panic("devtab");
4937         for (bp=dp->b_forw; bp != dp; bp = bp->b_forw) {
4938             if (bp->b_blkno!=blkno || bp->b_dev!=dev)
4939                 continue;
4940             spl6();
4941             if (bp->b_flags&B_BUSY) {
4942                 bp->b_flags |= B_WANTED;
4943                 sleep(bp, PRIBIO);
4944                 spl0();
4945                 goto loop;
4946             }
4947             spl0();
4948             notavail(bp);
4949             return(bp);

```

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```

4950     }
4951 }
4952 spl6();
4953 if (bfreelist.av_forw == &bfreelist) {
4954     bfreelist.b_flags |= B_WANTED;
4955     sleep(&bfreelist, PRIBIO);
4956     spl0();
4957     goto loop;
4958 }
4959 spl0();
4960 notavail(bp = bfreelist.av_forw);
4961 if (bp->b_flags & B_DELWRI) {
4962     bp->b_flags |= B_ASYNC;
4963     bwrite(bp);
4964     goto loop;
4965 }
4966 bp->b_flags = B_BUSY | B_RELOC;
4967 bp->b_back->b_forw = bp->b_forw;
4968 bp->b_forw->b_back = bp->b_back;
4969 bp->b_forw = dp->b_forw;
4970 bp->b_back = dp;
4971 dp->b_forw->b_back = bp;
4972 dp->b_forw = bp;
4973 bp->b_dev = dev;
4974 bp->b_blkno = blkno;
4975 return(bp);
4976 }
4977 /* ----- */
4978
4979 /* Wait for I/O completion on the buffer; return errors
4980 * to the user.
4981 */
4982 iowait(bp)
4983 struct buf *bp;
4984 {
4985     register struct buf *rbp;
4986
4987     rbp = bp;
4988     spl6();
4989     while ((rbp->b_flags&B_DONE)==0)
4990         sleep(rbp, PRIBIO);
4991     spl0();
4992     geterror(rbp);
4993 }
4994 /* ----- */
4995
4996 /* Unlink a buffer from the available list and mark it busy.
4997 * (internal interface)
4998 */
4999 notavil(bp)

```

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```

5000 struct buf *bp;
5001 {
5002     register struct buf *rbp;
5003     register int sps;
5004
5005     rbp = bp;
5006     sps = PS->integ;
5007     spl6();
5008     rbp->av_back->av_forw = rbp->av_forw;
5009     rbp->av_forw->av_back = rbp->av_back;
5010     rbp->b_flags |= B_BUSY;
5011     PS->integ = sps;
5012 }
5013 /* ----- */
5014
5015 /* Mark I/O complete on a buffer, release it if i/o is
5016 * asynchronous, and wake up anyone waiting for it.
5017 */
5018 iodone(bp)
5019 struct buf *bp;
5020 {
5021     register struct buf *rbp;
5022
5023     rbp = bp;
5024     if(rbp->b_flags*B_MAP)
5025         mapfree(rbp);
5026     rbp->b_flags |= B_DONE;
5027     if (rbp->b_flags&B_ASYNC)
5028         brelse(rbp);
5029     else {
5030         rbp->b_flags =& ~B_WANTED;
5031         wakeup(rbp);
5032     }
5033 }
5034 /* ----- */
5035
5036 /* Zero the core associated with a buffer.
5037 */
5038 clrbuf(bp)
5039 int *bp;
5040 {
5041     register *p;
5042     register c;
5043
5044     p = bp->b_addr;
5045     c = 256;
5046     do
5047         *p++ = 0;
5048     while(--c);
5049 }

```

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```

5050 /* ----- */
5051
5052 /* Initialize the buffer I/O system by freeing
5053 * all buffers and setting all device buffer lists to empty.
5054 */
5055 binit()
5056 {
5057     register struct buf *bp;
5058     register struct devtab *dp;
5059     register int i;
5060     struct bdevsw *bdp;
5061
5062     bfreelist.b_forw = bfreelist.b_back =
5063         bfreelist.av_forw = bfreelist.av_back = &bfreelist;
5064     for (i=0; i<NBUF; i++) {
5065         bp = &buf[i];
5066         bp->b_dev = -1;
5067         bp->b_addr = buffers[i];
5068         bp->b_back = &bfreelist;
5069         bp->b_forw = bfreelist.b_forw;
5070         bfreelist.b_forw->b_back = bp;
5071         bfreelist.b_forw = bp;
5072         bp->b_flags = B_BUSY;
5073         brelse(bp);
5074     }
5075     i = 0;
5076     for (bdp = bdevsw; bdp->d_open; bdp++) {
5077         dp = bdp->d_tab;
5078         if(dp) {
5079             dp->b_forw = dp;
5080             dp->b_back = dp;
5081         }
5082         i++;
5083     }
5084     nblkdev = i;
5085 }
5086 /* ----- */
5087
5088 /* Device start routine for disks
5089 * and other devices that have the register
5090 * layout of the older DEC controllers (RF, RK, RP, TM)
5091 */
5092 #define IENABLE 0100
5093 #define WCOM 02
5094 #define RCOM 04
5095 #define GO 01
5096 devstart(bp, devloc, devblk, hbcom)
5097 struct buf *bp;
5098 int *devloc;
5099 {

```

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```

5100 register int *dp;
5101 register struct buf *rbp;
5102 register int com;
5103
5104 dp = devloc;
5105 rbp = bp;
5106 *dp = devblk; /* block address */
5107 *--dp = rbp->b_addr; /* buffer address */
5108 *--dp = rbp->b_wcount; /* word count */
5109 com = (hbcom<<8) | IENABLE | GO |
5110 ((rbp->b_xmem & 03) << 4);
5111 if (rbp->b_flags&B_READ) /* command + x-mem */
5112     com = | RCOM;
5113 else
5114     com = | WCOM;
5115 *--dp = com;
5116 }
5117 /* ----- */
5118
5119 /* startup routine for RH controllers. */
5120 #define RHWCOM 060
5121 #define RHRCOM 070
5122
5123 rhstart(bp, devloc, devblk, abae)
5124 struct buf *bp;
5125 int *devloc, *abae;
5126 {
5127     register int *dp;
5128     register struct buf *rbp;
5129     register int com;
5130
5131     dp = devloc;
5132     rbp = bp;
5133     if(cputype == 70)
5134         *abae = rbp->b_xmem;
5135     *dp = devblk; /* block address */
5136     *--dp = rbp->b_addr; /* buffer address */
5137     *--dp = rbp->b_wcount; /* word count */
5138     com = IENABLE | GO |
5139         ((rbp->b_xmem & 03) << 8);
5140     if (rbp->b_flags&B_READ) /* command + x-mem */
5141         com = | RHRCOM; else
5142         com = | RHWCOM;
5143     *--dp = com;
5144 }
5145 /* ----- */
5146
5147 /*
5148 * 11/70 routine to allocate the
5149 * UNIBUS map and initialize for

```

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```

5150 * a unibus device.
5151 * The code here and in
5152 * rhstart assumes that an rh on an 11/70
5153 * is an rh70 and contains 22 bit addressing.
5154 */
5155 int maplock;
5156 mapalloc(abp)
5157 struct buf *abp;
5158 {
5159     register i, a;
5160     register struct buf *bp;
5161
5162     if(cputype != 70)
5163         return;
5164     spl6();
5165     while(maplock&B_BUSY) {
5166         maplock = | B_WANTED;
5167         sleep(&maplock, PSWP);
5168     }
5169     maplock = | B_BUSY;
5170     spl0();
5171     bp = abp;
5172     bp->b_flags = | B_MAP;
5173     a = bp->b_xmem;
5174     for(i=16; i<32; i+=2)
5175         UBMAP->r[i+1] = a;
5176     for(a++; i<48; i+=2)
5177         UBMAP->r[i+1] = a;
5178     bp->b_xmem = 1;
5179 }
5180 /* ----- */
5181
5182 mapfree(bp)
5183 struct buf *bp;
5184 {
5185
5186     bp->b_flags = & ~B_MAP;
5187     if(maplock&B_WANTED)
5188         wakeup(&maplock);
5189     maplock = 0;
5190 }
5191 /* ----- */
5192
5193 /*
5194 * swap I/O
5195 */
5196 swap(blkno, coreaddr, count, rdflg)
5197 {
5198     register int *fp;
5199

```

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```

5200 fp = &swbuf.b_flags;
5201 spl6();
5202 while (*fp&B_BUSY) {
5203     *fp |= B_WANTED;
5204     sleep(fp, PSWP);
5205 }
5206 *fp = B_BUSY | B_PHYS | rdflg;
5207 swbuf.b_dev = swapdev;
5208 swbuf.b_wcount = - (count<<5); /* 32 w/block */
5209 swbuf.b_blkno = blkno;
5210 swbuf.b_addr = coreaddr<<6; /* 64 b/block */
5211 swbuf.b_xmem = (coreaddr>>10) & 077;
5212 (*bdevsw[swapdev>>8].d_strategy)(&swbuf);
5213 spl6();
5214 while((*fp&B_DONE)==0)
5215     sleep(fp, PSWP);
5216 if (*fp&B_WANTED)
5217     wakeup(fp);
5218 spl0();
5219 *fp = & ~(B_BUSY|B_WANTED);
5220 return(*fp&B_ERROR);
5221 }
5222 /* ----- */
5223
5224 /* make sure all write-behind blocks
5225 * on dev (or NODEV for all)
5226 * are flushed out.
5227 * (from umount and update)
5228 */
5229 bflush(dev)
5230 {
5231     register struct buf *bp;
5232
5233 loop:
5234     spl6();
5235     for (bp = bfreelist.av_forw; bp != &bfreelist;
5236         bp = bp->av_forw) {
5237         if (bp->b_flags&B_DELWRI &&
5238             (dev == NODEV || dev == bp->b_dev)) {
5239             bp->b_flags |= B_ASYNC;
5240             notavail(bp);
5241             bwrite(bp);
5242             goto loop;
5243         }
5244     }
5245     spl0();
5246 }
5247 /* ----- */
5248
5249 /*

```

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```

5250 * Raw I/O. The arguments are
5251 * The strategy routine for the device
5252 * A buffer, which will always be a special buffer
5253 * header owned exclusively by the device for this purpose
5254 * The device number
5255 * Read/write flag
5256 * Essentially all the work is computing physical addresses
5257 * and validating them.
5258 */
5259 physio(strat, abp, dev, rw)
5260 struct buf *abp;
5261 int (*strat)();
5262 {
5263     register struct buf *bp;
5264     register char *base;
5265     register int nb;
5266     int ts;
5267
5268     bp = abp;
5269     base = u.u_base;
5270     /*
5271     * Check odd base, odd count, and address wraparound
5272     */
5273     if (base&01 || u.u_count&01 || base>=base+u.u_count)
5274         goto bad;
5275     ts = (u.u_tsize+127) & ~0177;
5276     if (u.u_sep)
5277         ts = 0;
5278     nb = (base>>6) & 01777;
5279     /*
5280     * Check overlap with text. (ts and nb now
5281     * in 64-byte clicks)
5282     */
5283     if (nb < ts)
5284         goto bad;
5285     /*
5286     * Check that transfer is either entirely in the
5287     * data or in the stack: that is, either
5288     * the end is in the data or the start is in the stack
5289     * (remember wraparound was already checked).
5290     */
5291     if (((base+u.u_count)>>6)&01777) >= ts+u.u_dsize
5292         && nb < 1024-u.u_ssize)
5293         goto bad;
5294     spl6();
5295     while (bp->b_flags&B_BUSY) {
5296         bp->b_flags |= B_WANTED;
5297         sleep(bp, PRIBIO);
5298     }
5299     bp->b_flags = B_BUSY | B_PHYS | rw;

```

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```

5300 bp->b_dev = dev;
5301 /*
5302  * Compute physical address by simulating
5303  * the segmentation hardware.
5304  */
5305 bp->b_addr = base&077;
5306 base = (u.u_sep? UDSA: UISA)->r[nb>>7] + (nb&0177);
5307 bp->b_addr += base<<6;
5308 bp->b_xmem = (base>>10) & 077;
5309 bp->b_blkno = lshift(u.u_offset, -9);
5310 bp->b_wcount = -((u.u_count>>1) & 077777);
5311 bp->b_error = 0;
5312 u.u_procp->p_flag |= SLOCK;
5313 (*strat)(bp);
5314 spl6();
5315 while ((bp->b_flags&B_DONE) == 0)
5316     sleep(bp, PRIBIO);
5317 u.u_procp->p_flag &= ~SLOCK;
5318 if (bp->b_flags&B_WANTED)
5319     wakeup(bp);
5320 spl0();
5321 bp->b_flags &= ~(B_BUSY|B_WANTED);
5322 u.u_count = (-bp->b_resid)<<1;
5323 geterror(bp);
5324 return;
5325 bad:
5326     u.u_error = EFAULT;
5327 }
5328 /* ----- */
5329
5330 /*
5331  * Pick up the device's error number and pass it to the
5332  * user; if there is an error but the number is 0 set a
5333  * generalised code. Actually the latter is always true
5334  * because devices don't yet return specific errors.
5335  */
5336 geterror(abp)
5337 struct buf *abp;
5338 {
5339     register struct buf *bp;
5340
5341     bp = abp;
5342     if (bp->b_flags&B_ERROR)
5343         if ((u.u_error = bp->b_error)==0)
5344             u.u_error = EIO;
5345 }
5346 /* ----- */
5347
5348
5349

```

```

5350 #
5351 /*
5352 */
5353
5354 /*
5355  * RK disk driver
5356 */
5357
5358 #include "../param.h"
5359 #include "../buf.h"
5360 #include "../conf.h"
5361 #include "../user.h"
5362
5363 #define     RKADDR     0177400
5364 #define     NRK         4
5365 #define     NRKBLK     4872
5366
5367 #define     RESET      0
5368 #define     GO          01
5369 #define     DRESET     014
5370 #define     IENABLE    0100
5371 #define     DRY         0200
5372 #define     ARDY        0100
5373 #define     WLO         020000
5374 #define     CTLRDY     0200
5375
5376 struct {
5377     int rkds;
5378     int rker;
5379     int rkcs;
5380     int rkwc;
5381     int rkba;
5382     int rkda;
5383 };
5384 /* ----- */
5385
5386 struct     devtab  rktab;
5387 struct     buf      rrkbuf;
5388
5389 rkstrategy(abp)
5390 struct buf *abp;
5391 {
5392     register struct buf *bp;
5393     register *qc, *ql;
5394     int d;
5395
5396     bp = abp;
5397     if (bp->b_flags&B_PHYS)
5398         mapalloc(bp);
5399     d = bp->b_dev.d_minor-7;

```

```

5400  if(d <= 0)
5401      d = 1;
5402  if (bp->b_blkno >= NRKBLK*d) {
5403      bp->b_flags |= B_ERROR;
5404      iodone(bp);
5405      return;
5406  }
5407  bp->av_forw = 0;
5408  spl5();
5409  if (rktab.d_actf==0)
5410      rktab.d_actf = bp;
5411  else
5412      rktab.d_actl->av_forw = bp;
5413  rktab.d_actl = bp;
5414  if (rktab.d_active==0)
5415      rkstart();
5416  spl0();
5417 }
5418 /* ----- */
5419
5420 rkaddr(bp)
5421 struct buf *bp;
5422 {
5423     register struct buf *p;
5424     register int b;
5425     int d, m;
5426
5427     p = bp;
5428     b = p->b_blkno;
5429     m = p->b_dev.d_minor - 7;
5430     if(m <= 0)
5431         d = p->b_dev.d_minor;
5432     else {
5433         d = lrem(b, m);
5434         b = ldiv(b, m);
5435     }
5436     return(d<<13 | (b/12)<<4 | b%12);
5437 }
5438 /* ----- */
5439
5440 rkstart()
5441 {
5442     register struct buf *bp;
5443
5444     if ((bp = rktab.d_actf) == 0)
5445         return;
5446     rktab.d_active++;
5447     devstart(bp, &RKADDR->rkda, rkaddr(bp), 0);
5448 }
5449 /* ----- */

```

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```

5450
5451 rkintr()
5452 {
5453     register struct buf *bp;
5454
5455     if (rktab.d_active == 0)
5456         return;
5457     bp = rktab.d_actf;
5458     rktab.d_active = 0;
5459     if (RKADDR->rkcs < 0) { /* error bit */
5460         deverror(bp, RKADDR->rker, RKADDR->rkds);
5461         RKADDR->rkcs = RESET|GO;
5462         while((RKADDR->rkcs&CTLRDY) == 0) ;
5463         if (++rktab.d_errcnt <= 10) {
5464             rkstart();
5465             return;
5466         }
5467         bp->b_flags |= B_ERROR;
5468     }
5469     rktab.d_errcnt = 0;
5470     rktab.d_actf = bp->av_forw;
5471     iodone(bp);
5472     rkstart();
5473 }
5474 /* ----- */
5475
5476 rkread(dev)
5477 {
5478     physio(rkstrategy, &rrkbuf, dev, B_READ);
5479 }
5480 /* ----- */
5481
5482 rkwrite(dev)
5483 {
5484     physio(rkstrategy, &rrkbuf, dev, B_WRITE);
5485 }
5486 /* ----- */
5487
5488
5489
5490
5491
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5499

```

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# 4

**Files and Directories**  
**File Systems**  
**Pipes**





```

5500 /*
5501  * One file structure is allocated
5502  * for each open/creat/pipe call.
5503  * Main use is to hold the read/write
5504  * pointer associated with each open
5505  * file.
5506  */
5507 struct      file
5508 {
5509     char      f_flag;
5510     char      f_count;          /* reference count */
5511     int       f_inode;         /* pointer to inode structure */
5512     char      *f_offset[2];    /* read/write character pointer */
5513 } file[NFILE];
5514 /* ----- */
5515
5516 /* flags */
5517 #define      FREAD      01
5518 #define      FWRITE     02
5519 #define      FPIPE      04
5520
5521
5522
5523
5524
5525
5526
5527
5528
5529
5530
5531
5532
5533
5534
5535
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5544
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5546
5547
5548
5549

```

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```

5550 /*
5551  * Definition of the unix super block.
5552  * The root super block is allocated and
5553  * read in iinit/alloc.c. Subsequently
5554  * a super block is allocated and read
5555  * with each mount (smount/sys3.c) and
5556  * released with umount (sumount/sys3.c).
5557  * A disk block is ripped of for storage.
5558  * See alloc.c for general alloc/free
5559  * routines for free list and I list.
5560  */
5561 struct filsys
5562 {
5563     int  s_isize;          /* size in blocks of I list */
5564     int  s_fsize;        /* size in blocks of entire volume */
5565     int  s_nfree;        /* number of in core free blocks
5566                          (between 0 and 100) */
5567     int  s_free[100];    /* in core free blocks */
5568     int  s_ninode;       /* number of in core I nodes (0-100) */
5569     int  s_inode[100];   /* in core free I nodes */
5570     char s_flock;        /* lock during free list manipulation */
5571     char s_ilock;        /* lock during I list manipulation */
5572     char s_fmod;         /* super block modified flag */
5573     char s_ronly;        /* mounted read-only flag */
5574     int  s_time[2];      /* current date of last update */
5575     int  pad[50];
5576 };
5577 /* ----- */
5578
5579
5580
5581
5582
5583
5584
5585
5586
5587
5588
5589
5590
5591
5592
5593
5594
5595
5596
5597
5598
5599

```

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```

5600 /*
5601  * Inode structure as it appears on
5602  * the disk. Not used by the system,
5603  * but by things like check, df, dump.
5604  */
5605 struct      inode
5606 {
5607     int      i_mode;
5608     char     i_nlink;
5609     char     i_uid;
5610     char     i_gid;
5611     char     i_size0;
5612     char     *i_size1;
5613     int      i_addr[8];
5614     int      i_atime[2];
5615     int      i_mtime[2];
5616 };
5617 /* ----- */
5618
5619 /* modes */
5620 #define IALLOC 0100000
5621 #define IFMT 060000
5622 #define IFDIR 040000
5623 #define IFCHR 020000
5624 #define IFBLK 060000
5625 #define ILARG 010000
5626 #define ISUID 04000
5627 #define ISGID 02000
5628 #define ISVTX 01000
5629 #define IREAD 0400
5630 #define IWRITE 0200
5631 #define IEXEC 0100
5632
5633
5634
5635
5636
5637
5638
5639
5640
5641
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5643
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5646
5647
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```

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```

5650 /* The I node is the focus of all
5651  * file activity in unix. There is a unique
5652  * inode allocated for each active file,
5653  * each current directory, each mounted-on
5654  * file, text file, and the root. An inode is 'named'
5655  * by its dev/inumber pair. (iget/iget.c)
5656  * Data, from mode on, is read in
5657  * from permanent inode on volume.
5658  */
5659 struct      inode
5660 {
5661     char     i_flag;
5662     char     i_count; /* reference count */
5663     int      i_dev; /* device where inode resides */
5664     int      i_number; /* i number, 1-to-1 with device
5665                          address */
5666     int      i_mode;
5667     char     i_nlink; /* directory entries */
5668     char     i_uid; /* owner */
5669     char     i_gid; /* group of owner */
5670     char     i_size0; /* most significant of size */
5671     char     *i_size1; /* least sig */
5672     int      i_addr[8]; /* device addresses constituting file */
5673     int      i_lastr; /* last logical block read (for
5674                          read-ahead) */
5675 } inode[NINODE];
5676 /* ----- */
5677
5678 /* flags */
5679 #define ILOCK 01 /* inode is locked */
5680 #define IUPD 02 /* inode has been modified */
5681 #define IACC 04 /* inode access time to be updated */
5682 #define IMOUNT 010 /* inode is mounted on */
5683 #define IWANT 020 /* some process waiting on lock */
5684 #define ITEXT 040 /* inode is pure text prototype */
5685
5686 /* modes */
5687 #define IALLOC 0100000 /* file is used */
5688 #define IFMT 060000 /* type of file */
5689 #define IFDIR 040000 /* directory */
5690 #define IFCHR 020000 /* character special */
5691 #define IFBLK 060000 /* block special, 0 is regular */
5692 #define ILARG 010000 /* large addressing algorithm */
5693 #define ISUID 04000 /* set user id on execution */
5694 #define ISGID 02000 /* set group id on execution */
5695 #define ISVTX 01000 /* save swapped text even after use */
5696 #define IREAD 0400 /* read, write, execute permissions */
5697 #define IWRITE 0200
5698 #define IEXEC 0100
5699

```

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```

5700 #
5701 #include "../param.h"
5702 #include "../system.h"
5703 #include "../user.h"
5704 #include "../reg.h"
5705 #include "../file.h"
5706 #include "../inode.h"
5707
5708 /*
5709  * read system call
5710  */
5711 read()
5712 {
5713     rdwr(FREAD);
5714 }
5715 /* ----- */
5716
5717 /*
5718  * write system call
5719  */
5720 write()
5721 {
5722     rdwr(FWRITE);
5723 }
5724 /* ----- */
5725
5726 /*
5727  * common code for read and write calls:
5728  * check permissions, set base, count, and offset,
5729  * and switch out to readi, writei, or pipe code.
5730  */
5731 rdwr(mode)
5732 {
5733     register *fp, m;
5734
5735     m = mode;
5736     fp = getf(u.u_ar0[R0]);
5737     if(fp == NULL)
5738         return;
5739     if((fp->f_flag&m) == 0) {
5740         u.u_error = EBADF;
5741         return;
5742     }
5743     u.u_base = u.u_arg[0];
5744     u.u_count = u.u_arg[1];
5745     u.u_segflg = 0;
5746     if(fp->f_flag&FPIPE) {
5747         if(m==FREAD)
5748             readp(fp); else
5749             writep(fp);

```

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```

5750     } else {
5751         u.u_offset[1] = fp->f_offset[1];
5752         u.u_offset[0] = fp->f_offset[0];
5753         if(m==FREAD)
5754             readi(fp->f_inode); else
5755             writei(fp->f_inode);
5756         dpadd(fp->f_offset, u.u_arg[1]-u.u_count);
5757     }
5758     u.u_ar0[R0] = u.u_arg[1]-u.u_count;
5759 }
5760 /* ----- */
5761
5762 /*
5763  * open system call
5764  */
5765 open()
5766 {
5767     register *ip;
5768     extern uchar;
5769
5770     ip = namei(&uchar, 0);
5771     if(ip == NULL)
5772         return;
5773     u.u_arg[1]++;
5774     open1(ip, u.u_arg[1], 0);
5775 }
5776 /* ----- */
5777
5778 /*
5779  * creat system call
5780  */
5781 creat()
5782 {
5783     register *ip;
5784     extern uchar;
5785
5786     ip = namei(&uchar, 1);
5787     if(ip == NULL) {
5788         if(u.u_error)
5789             return;
5790         ip = maknode(u.u_arg[1]&07777&(~ISVTX));
5791         if(ip==NULL)
5792             return;
5793         open1(ip, FWRITE, 2);
5794     }
5795     open1(ip, FWRITE, 1);
5796 }
5797 /* ----- */
5798
5799 /*

```

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```

5800 * common code for open and creat.
5801 * Check permissions, allocate an open file structure,
5802 * and call the device open routine if any.
5803 */
5804 open1(ip, mode, trf)
5805 int *ip;
5806 {
5807     register struct file *fp;
5808     register *rip, m;
5809     int i;
5810
5811     rip = ip;
5812     m = mode;
5813     if(trf != 2) {
5814         if(m&FREAD)
5815             access(rip, IREAD);
5816         if(m&FWRITE) {
5817             access(rip, IWRITE);
5818             if((rip->i_mode&IFMT) == IFDIR)
5819                 u.u_error = EISDIR;
5820         }
5821     }
5822     if(u.u_error)
5823         goto out;
5824     if(trf)
5825         itrunc(rip);
5826     prele(rip);
5827     if ((fp = falloc()) == NULL)
5828         goto out;
5829     fp->f_flag = m&(FREAD|FWRITE);
5830     fp->f_inode = rip;
5831     i = u.u_ar0[R0];
5832     openi(rip, m&FWRITE);
5833     if(u.u_error == 0)
5834         return;
5835     u.u_ofile[i] = NULL;
5836     fp->f_count--;
5837
5838 out:
5839     iput(rip);
5840 }
5841 /* ----- */
5842
5843 /*
5844 * close system call
5845 */
5846 close()
5847 {
5848     register *fp;
5849

```

```

5850     fp = getf(u.u_ar0[R0]);
5851     if(fp == NULL)
5852         return;
5853     u.u_ofile[u.u_ar0[R0]] = NULL;
5854     closef(fp);
5855 }
5856 /* ----- */
5857
5858 /*
5859 * seek system call
5860 */
5861 seek()
5862 {
5863     int n[2];
5864     register *fp, t;
5865
5866     fp = getf(u.u_ar0[R0]);
5867     if(fp == NULL)
5868         return;
5869     if(fp->f_flag&FPIPE) {
5870         u.u_error = ESPIPE;
5871         return;
5872     }
5873     t = u.u_arg[1];
5874     if(t > 2) {
5875         n[1] = u.u_arg[0]<<9;
5876         n[0] = u.u_arg[0]>>7;
5877         if(t == 3)
5878             n[0] = & 0777;
5879     } else {
5880         n[1] = u.u_arg[0];
5881         n[0] = 0;
5882         if(t!=0 && n[1]<0)
5883             n[0] = -1;
5884     }
5885     switch(t) {
5886
5887     case 1:
5888     case 4:
5889         n[0] += fp->f_offset[0];
5890         dpadd(n, fp->f_offset[1]);
5891         break;
5892
5893     default:
5894         n[0] += fp->f_inode->i_size0&0377;
5895         dpadd(n, fp->f_inode->i_size1);
5896
5897     case 0:
5898     case 3:
5899         ;

```

```

5900 }
5901 fp->f_offset[1] = n[1];
5902 fp->f_offset[0] = n[0];
5903 }
5904 /* ----- */
5905
5906
5907 /* link system call
5908 */
5909 link()
5910 {
5911     register *ip, *xp;
5912     extern uchar;
5913
5914     ip = namei(&uchar, 0);
5915     if(ip == NULL)
5916         return;
5917     if(ip->i_nlink >= 127) {
5918         u.u_error = EMLINK;
5919         goto out;
5920     }
5921     if((ip->i_mode&IFMT)==IFDIR && !suser())
5922         goto out;
5923     /*
5924      * ulock to avoid possible hanging in namei
5925      */
5926     ip->i_flag =& ~ILOCK;
5927     u.u_dirp = u.u_arg[1];
5928     xp = namei(&uchar, 1);
5929     if(xp != NULL) {
5930         u.u_error = EEXIST;
5931         iput(xp);
5932     }
5933     if(u.u_error)
5934         goto out;
5935     if(u.u_pdir->i_dev != ip->i_dev) {
5936         iput(u.u_pdir);
5937         u.u_error = EXDEV;
5938         goto out;
5939     }
5940     wdir(ip);
5941     ip->i_nlink++;
5942     ip->i_flag |= IUPD;
5943
5944 out:
5945     iput(ip);
5946 }
5947 /* ----- */
5948
5949 /*

```

```

5950 * mknod system call
5951 */
5952 mknod()
5953 {
5954     register *ip;
5955     extern uchar;
5956
5957     if(suser()) {
5958         ip = namei(&uchar, 1);
5959         if(ip != NULL) {
5960             u.u_error = EEXIST;
5961             goto out;
5962         }
5963     }
5964     if(u.u_error)
5965         return;
5966     ip = maknode(u.u_arg[1]);
5967     if (ip==NULL)
5968         return;
5969     ip->i_addr[0] = u.u_arg[2];
5970
5971 out:
5972     iput(ip);
5973 }
5974 /* ----- */
5975
5976 /* sleep system call
5977 * not to be confused with the sleep internal routine.
5978 */
5979 sslep()
5980 {
5981     char *d[2];
5982
5983     spl7();
5984     d[0] = time[0];
5985     d[1] = time[1];
5986     dpadd(d, u.u_ar0[R0]);
5987
5988     while(dpcmp(d[0], d[1], time[0], time[1]) > 0) {
5989         if(dpcmp(tout[0], tout[1], time[0], time[1]) <= 0 ||
5990            dpcmp(tout[0], tout[1], d[0], d[1]) > 0) {
5991             tout[0] = d[0];
5992             tout[1] = d[1];
5993         }
5994         sleep(tout, PSLEP);
5995     }
5996     spl0();
5997 }
5998 /* ----- */
5999

```

```

6000 #
6001 #include "../param.h"
6002 #include "../system.h"
6003 #include "../reg.h"
6004 #include "../buf.h"
6005 #include "../filsys.h"
6006 #include "../user.h"
6007 #include "../inode.h"
6008 #include "../file.h"
6009 #include "../conf.h"
6010
6011 /*
6012  * the fstat system call.
6013  */
6014 fstat()
6015 {
6016     register *fp;
6017
6018     fp = getf(u.u_ar0[R0]);
6019     if(fp == NULL)
6020         return;
6021     stat1(fp->f_inode, u.u_arg[0]);
6022 }
6023 /* ----- */
6024
6025 /*
6026  * the stat system call.
6027  */
6028 stat()
6029 {
6030     register ip;
6031     extern uchar;
6032
6033     ip = namei(&uchar, 0);
6034     if(ip == NULL)
6035         return;
6036     stat1(ip, u.u_arg[1]);
6037     iput(ip);
6038 }
6039 /* ----- */
6040
6041 /*
6042  * The basic routine for fstat and stat:
6043  * get the inode and pass appropriate parts back.
6044  */
6045 stat1(ip, ub)
6046 int ip;
6047 {
6048     register i, *bp, *cp;
6049

```

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```

6050     iupdat(ip, time);
6051     bp = bread(ip->i_dev, ldiv(ip->i_number+31, 16));
6052     cp = bp->b_addr + 32*lrem(ip->i_number+31, 16) +24;
6053     ip = &(ip->i_dev);
6054     for(i=0; i<14; i++) {
6055         suword(ub, *ip++);
6056         ub =+ 2;
6057     }
6058     for(i=0; i<4; i++) {
6059         suword(ub, *cp++);
6060         ub =+ 2;
6061     }
6062     brelse(bp);
6063 }
6064 /* ----- */
6065
6066 /*
6067  * the dup system call.
6068  */
6069 dup()
6070 {
6071     register i, *fp;
6072
6073     fp = getf(u.u_ar0[R0]);
6074     if(fp == NULL)
6075         return;
6076     if ((i = ufallloc()) < 0)
6077         return;
6078     u.u_ofile[i] = fp;
6079     fp->f_count++;
6080 }
6081 /* ----- */
6082
6083 /*
6084  * the mount system call.
6085  */
6086 smount()
6087 {
6088     int d;
6089     register *ip;
6090     register struct mount *mp, *smp;
6091     extern uchar;
6092
6093     d = getmdev();
6094     if(u.u_error)
6095         return;
6096     u.u_dirp = u.u_arg[1];
6097     ip = namei(&uchar, 0);
6098     if(ip == NULL)
6099         return;

```

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```

6100 if(ip->i_count!=1 || (ip->i_mode&(IFBLK&IFCHR))!=0)
6101     goto out;
6102 smp = NULL;
6103 for(mp = &mount[0]; mp < &mount[NMOUNT]; mp++) {
6104     if(mp->m_bufp != NULL) {
6105         if(d == mp->m_dev)
6106             goto out;
6107     } else
6108         if(smp == NULL)
6109             smp = mp;
6110 }
6111 if(smp == NULL)
6112     goto out;
6113 (*bdevsw[d.d_major].d_open)(d, !u.u_arg[2]);
6114 if(u.u_error)
6115     goto out;
6116 mp = bread(d, 1);
6117 if(u.u_error) {
6118     brelse(mp);
6119     goto out1;
6120 }
6121 smp->m_inodp = ip;
6122 smp->m_dev = d;
6123 smp->m_bufp = getblk(NODEV);
6124 bcopy(mp->b_addr, smp->m_bufp->b_addr, 256);
6125 smp = smp->m_bufp->b_addr;
6126 smp->s_ilock = 0;
6127 smp->s_flock = 0;
6128 smp->s_ronly = u.u_arg[2] & 1;
6129 brelse(mp);
6130 ip->i_flag |= IMOUNT;
6131 prele(ip);
6132 return;
6133
6134 out:
6135 u.u_error = EBUSY;
6136 out1:
6137 iput(ip);
6138 }
6139 /* ----- */
6140 /*
6141 * the umount system call.
6142 */
6143 */
6144 sumount()
6145 {
6146     int d;
6147     register struct inode *ip;
6148     register struct mount *mp;
6149

```

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```

6150     update();
6151     d = getmdev();
6152     if(u.u_error)
6153         return;
6154     for(mp = &mount[0]; mp < &mount[NMOUNT]; mp++)
6155         if(mp->m_bufp!=NULL && d==mp->m_dev)
6156             goto found;
6157     u.u_error = EINVAL;
6158     return;
6159
6160 found:
6161     for(ip = &inode[0]; ip < &inode[NINODE]; ip++)
6162         if(ip->i_number!=0 && d==ip->i_dev) {
6163             u.u_error = EBUSY;
6164             return;
6165         }
6166     (*bdevsw[d.d_major].d_close)(d, 0);
6167     ip = mp->m_inodp;
6168     ip->i_flag |= ~IMOUNT;
6169     iput(ip);
6170     ip = mp->m_bufp;
6171     mp->m_bufp = NULL;
6172     brelse(ip);
6173 }
6174 /* ----- */
6175 /*
6176 * Common code for mount and umount.
6177 * Check that the user's argument is a reasonable thing
6178 * on which to mount, and return the device number if so.
6179 */
6180 */
6181 getmdev()
6182 {
6183     register d, *ip;
6184     extern uchar;
6185
6186     ip = namei(&uchar, 0);
6187     if(ip == NULL)
6188         return;
6189     if((ip->i_mode&IFMT) != IFBLK)
6190         u.u_error = ENOTBLK;
6191     d = ip->i_addr[0];
6192     if(ip->i_addr[0].d_major >= nblkdev)
6193         u.u_error = ENXIO;
6194     iput(ip);
6195     return(d);
6196 }
6197 /* ----- */
6198
6199

```

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```

6200 #
6201 /*
6202 */
6203
6204 #include "../param.h"
6205 #include "../inode.h"
6206 #include "../user.h"
6207 #include "../buf.h"
6208 #include "../conf.h"
6209 #include "../system.h"
6210
6211 /*
6212  * Read the file corresponding to
6213  * the inode pointed at by the argument.
6214  * the actual read arguments are found
6215  * in the variables:
6216  * u_base      core address for destination
6217  * u_offset    byte offset in file
6218  * u_count     number of bytes to read
6219  * u_segflg   read to kernel/user
6220  */
6221 readi(aip)
6222 struct inode *aip;
6223 {
6224     int *bp;
6225     int lbn, bn, on;
6226     register dn, n;
6227     register struct inode *ip;
6228
6229     ip = aip;
6230     if(u.u_count == 0)
6231         return;
6232     ip->i_flag |= IACC;
6233     if((ip->i_mode&IFMT) == IFCHR) {
6234         (*cdevsw[ip->i_addr[0].d_major].d_read)(ip->i_addr[0]);
6235         return;
6236     }
6237
6238     do {
6239         lbn = bn = lshift(u.u_offset, -9);
6240         on = u.u_offset[1] & 0777;
6241         n = min(512-on, u.u_count);
6242         if((ip->i_mode&IFMT) != IFBLK) {
6243             dn = dpcmp(ip->i_size0&0377, ip->i_size1,
6244                 u.u_offset[0], u.u_offset[1]);
6245             if(dn <= 0)
6246                 return;
6247             n = min(n, dn);
6248             if ((bn = bmap(ip, lbn)) == 0)
6249                 return;

```

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```

6250         dn = ip->i_dev;
6251     } else {
6252         dn = ip->i_addr[0];
6253         rablock = bn+1;
6254     }
6255     if (ip->i_lastr+1 == lbn)
6256         bp = breada(dn, bn, rablock);
6257     else
6258         bp = bread(dn, bn);
6259     ip->i_lastr = lbn;
6260     iomove(bp, on, n, B_READ);
6261     brelse(bp);
6262 } while(u.u_error==0 && u.u_count!=0);
6263 }
6264 /* ----- */
6265
6266 /*
6267  * Write the file corresponding to
6268  * the inode pointed at by the argument.
6269  * the actual read arguments are found
6270  * in the variables:
6271  * u_base      core address for source
6272  * u_offset    byte offset in file
6273  * u_count     number of bytes to write
6274  * u_segflg   write to kernel/user
6275  */
6276 writei(aip)
6277 struct inode *aip;
6278 {
6279     int *bp;
6280     int lbn, bn, on;
6281     register dn, n;
6282     register struct inode *ip;
6283
6284     ip = aip;
6285     ip->i_flag |= IACC|IUPD;
6286     if((ip->i_mode&IFMT) == IFCHR) {
6287         (*cdevsw[ip->i_addr[0].d_major].d_write)(ip->i_addr[0]);
6288         return;
6289     }
6290     if (u.u_count == 0)
6291         return;
6292
6293     do {
6294         bn = lshift(u.u_offset, -9);
6295         on = u.u_offset[1] & 0777;
6296         n = min(512-on, u.u_count);
6297         if((ip->i_mode&IFMT) != IFBLK) {
6298             if ((bn = bmap(ip, bn)) == 0)
6299                 return;

```

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```

6300         dn = ip->i_dev;
6301     } else
6302         dn = ip->i_addr[0];
6303     if(n == 512)
6304         bp = getblk(dn, bn); else
6305         bp = bread(dn, bn);
6306     iomove(bp, on, n, B_WRITE);
6307     if(u.u_error != 0)
6308         brelse(bp); else
6309     if ((u.u_offset[1]&0777)==0)
6310         bawrite(bp); else
6311         bdwrite(bp);
6312     if(dpcmp(ip->i_size0&0377, ip->i_size1,
6313         u.u_offset[0], u.u_offset[1]) < 0 &&
6314         (ip->i_mode&(IFBLK&IFCHR)) == 0) {
6315         ip->i_size0 = u.u_offset[0];
6316         ip->i_size1 = u.u_offset[1];
6317     }
6318     ip->i_flag |= IUPD;
6319 } while(u.u_error==0 && u.u_count!=0);
6320 }
6321 /* ----- */
6322
6323 /* Return the logical maximum
6324 * of the 2 arguments.
6325 */
6326 max(a, b)
6327 char *a, *b;
6328 {
6329
6330     if(a > b)
6331         return(a);
6332     return(b);
6333 }
6334 /* ----- */
6335
6336 /* Return the logical minimum
6337 * of the 2 arguments.
6338 */
6339 min(a, b)
6340 char *a, *b;
6341 {
6342
6343     if(a < b)
6344         return(a);
6345     return(b);
6346 }
6347 /* ----- */
6348
6349

```

```

6350 /* Move 'an' bytes at byte location
6351 * &bp->b_addr[o] to/from (flag) the
6352 * user/kernel (u.segflg) area starting at u.base.
6353 * Update all the arguments by the number
6354 * of bytes moved.
6355 *
6356 * There are 2 algorithms,
6357 * if source address, dest address and count
6358 * are all even in a user copy,
6359 * then the machine language copyin/copyout
6360 * is called.
6361 * If not, its done byte-by-byte with
6362 * cpass and passc.
6363 */
6364 iomove(bp, o, an, flag)
6365 struct buf *bp;
6366 {
6367     register char *cp;
6368     register int n, t;
6369
6370     n = an;
6371     cp = bp->b_addr + o;
6372     if(u.u_segflg==0 && ((n | cp | u.u_base)&01)==0) {
6373         if (flag==B_WRITE)
6374             cp = copyin(u.u_base, cp, n);
6375         else
6376             cp = copyout(cp, u.u_base, n);
6377         if (cp) {
6378             u.u_error = EFAULT;
6379             return;
6380         }
6381         u.u_base += n;
6382         dpadd(u.u_offset, n);
6383         u.u_count -= n;
6384         return;
6385     }
6386     if (flag==B_WRITE) {
6387         while(n--) {
6388             if ((t = cpass()) < 0)
6389                 return;
6390             *cp++ = t;
6391         }
6392     } else
6393         while (n--)
6394             if (passc(*cp++) < 0)
6395                 return;
6396 }
6397 /* ----- */
6398
6399

```

```

6400 #
6401 #include "../param.h"
6402 #include "../conf.h"
6403 #include "../inode.h"
6404 #include "../user.h"
6405 #include "../buf.h"
6406 #include "../system.h"
6407
6408 /* Bmap defines the structure of file system storage
6409  * by returning the physical block number on a device given
6410  * the inode and the logical block number in a file.
6411  * When convenient, it also leaves the physical
6412  * block number of the next block of the file in rablock
6413  * for use in read-ahead.
6414  */
6415 bmap(ip, bn)
6416 struct inode *ip;
6417 int bn;
6418 {
6419     register *bp, *bap, nb;
6420     int *nbp, d, i;
6421
6422     d = ip->i_dev;
6423     if(bn & ~077777) {
6424         u.u_error = EFBIG;
6425         return(0);
6426     }
6427     if((ip->i_mode&ILARG) == 0) {
6428         /* small file algorithm */
6429
6430         if((bn & ~7) != 0) {
6431             /* convert small to large */
6432
6433             if ((bp = alloc(d)) == NULL)
6434                 return(NULL);
6435             bap = bp->b_addr;
6436             for(i=0; i<8; i++) {
6437                 *bap++ = ip->i_addr[i];
6438                 ip->i_addr[i] = 0;
6439             }
6440             ip->i_addr[0] = bp->b_blkno;
6441             bdwrite(bp);
6442             ip->i_mode |= ILARG;
6443             goto large;
6444         }
6445         nb = ip->i_addr[bn];
6446         if(nb == 0 && (bp = alloc(d)) != NULL) {
6447             bdwrite(bp);

```

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```

6450         nb = bp->b_blkno;
6451         ip->i_addr[bn] = nb;
6452         ip->i_flag |= IUPD;
6453     }
6454     rablock = 0;
6455     if (bn<7)
6456         rablock = ip->i_addr[bn+1];
6457     return(nb);
6458 }
6459
6460 /* large file algorithm */
6461
6462     large:
6463     i = bn>>8;
6464     if(bn & 0174000)
6465         i = 7;
6466     if((nb=ip->i_addr[i]) == 0) {
6467         ip->i_flag |= IUPD;
6468         if ((bp = alloc(d)) == NULL)
6469             return(NULL);
6470         ip->i_addr[i] = bp->b_blkno;
6471     } else
6472         bp = bread(d, nb);
6473     bap = bp->b_addr;
6474
6475     /* "huge" fetch of double indirect block */
6476
6477     if(i == 7) {
6478         i = ((bn>>8) & 0377) - 7;
6479         if((nb=bap[i]) == 0) {
6480             if((nbp = alloc(d)) == NULL) {
6481                 brelse(bp);
6482                 return(NULL);
6483             }
6484             bap[i] = nbp->b_blkno;
6485             bdwrite(bp);
6486         } else {
6487             brelse(bp);
6488             nbp = bread(d, nb);
6489         }
6490         bp = nbp;
6491         bap = bp->b_addr;
6492     }
6493
6494     /* normal indirect fetch */
6495
6496     i = bn & 0377;
6497     if((nb=bap[i]) == 0 && (nbp = alloc(d)) != NULL) {
6498         nb = nbp->b_blkno;
6499         bap[i] = nb;

```

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```

6500         bdwrite(nbp);
6501         bdwrite(bp);
6502     } else
6503         brelse(bp);
6504     rablock = 0;
6505     if(i < 255)
6506         rablock = bap[i+1];
6507     return(nb);
6508 }
6509 /* ----- */
6510
6511 /* Pass back c to the user at his location u_base;
6512  * update u_base, u_count, and u_offset. Return -1
6513  * on the last character of the user's read.
6514  * u_base is in the user address space unless u_segflg
6515  * is set.
6516  */
6517 passc(c)
6518 char c;
6519 {
6520
6521     if(u.u_segflg)
6522         *u.u_base = c; else
6523         if(subyte(u.u_base, c) < 0) {
6524             u.u_error = EFAULT;
6525             return(-1);
6526         }
6527     u.u_count--;
6528     if(++u.u_offset[1] == 0)
6529         u.u_offset[0]++;
6530     u.u_base++;
6531     return(u.u_count == 0? -1: 0);
6532 }
6533 /* ----- */
6534
6535 /*
6536  * Pick up and return the next character from the user's
6537  * write call at location u_base;
6538  * update u_base, u_count, and u_offset. Return -1
6539  * when u_count is exhausted. u_base is in the user's
6540  * address space unless u_segflg is set.
6541  */
6542 cpass()
6543 {
6544     register c;
6545
6546     if(u.u_count == 0)
6547         return(-1);
6548     if(u.u_segflg)
6549         c = *u.u_base; else

```

```

6550         if((c=fubyte(u.u_base)) < 0) {
6551             u.u_error = EFAULT;
6552             return(-1);
6553         }
6554     u.u_count--;
6555     if(++u.u_offset[1] == 0)
6556         u.u_offset[0]++;
6557     u.u_base++;
6558     return(c&0377);
6559 }
6560 /* ----- */
6561
6562 /*
6563  * Routine which sets a user error; placed in
6564  * illegal entries in the bdevsw and cdevsw tables.
6565  */
6566 nodev()
6567 {
6568     u.u_error = ENODEV;
6569 }
6570 /* ----- */
6571
6572 /*
6573  * Null routine; placed in insignificant entries
6574  * in the bdevsw and cdevsw tables.
6575  */
6576 nulldev()
6577 {
6578 }
6579 /* ----- */
6580
6581 /*
6582  * copy count words from from to to.
6583  */
6584 bcopy(from, to, count)
6585 int *from, *to;
6586 {
6587     register *a, *b, c;
6588
6589     a = from;
6590     b = to;
6591     c = count;
6592     do
6593         *b++ = *a++;
6594     while(--c);
6595 }
6596 /* ----- */
6597
6598
6599

```

```

6600 #
6601 /*
6602 */
6603
6604 #include "../param.h"
6605 #include "../user.h"
6606 #include "../filsys.h"
6607 #include "../file.h"
6608 #include "../conf.h"
6609 #include "../inode.h"
6610 #include "../reg.h"
6611
6612 /*
6613  * Convert a user supplied
6614  * file descriptor into a pointer
6615  * to a file structure.
6616  * Only task is to check range
6617  * of the descriptor.
6618  */
6619 getf(f)
6620 {
6621     register *fp, rf;
6622
6623     rf = f;
6624     if(rf<0 || rf>=NOFILE)
6625         goto bad;
6626     fp = u.u_ofile[rf];
6627     if(fp != NULL)
6628         return(fp);
6629 bad:
6630     u.u_error = EBADF;
6631     return(NULL);
6632 }
6633 /* ----- */
6634
6635 /*
6636  * Internal form of close.
6637  * Decrement reference count on
6638  * file structure and call closei
6639  * on last closef.
6640  * Also make sure the pipe protocol
6641  * does not constipate.
6642  */
6643 closef(fp)
6644 int *fp;
6645 {
6646     register *rfp, *ip;
6647
6648     rfp = fp;
6649     if(rfp->f_flag&FPIPE) {

```

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```

6650         ip = rfp->f_inode;
6651         ip->i_mode =& ~(IREAD|IWRITE);
6652         wakeup(ip+1);
6653         wakeup(ip+2);
6654     }
6655     if(rfp->f_count <= 1)
6656         closei(rfp->f_inode, rfp->f_flag&FWRITE);
6657     rfp->f_count--;
6658 }
6659 /* ----- */
6660
6661 /*
6662  * Decrement reference count on an
6663  * inode due to the removal of a
6664  * referencing file structure.
6665  * On the last closei, switchout
6666  * to the close entry point of special
6667  * device handler.
6668  * Note that the handler gets called
6669  * on every open and only on the last
6670  * close.
6671  */
6672 closei(ip, rw)
6673 int *ip;
6674 {
6675     register *rip;
6676     register dev, maj;
6677
6678     rip = ip;
6679     dev = rip->i_addr[0];
6680     maj = rip->i_addr[0].d_major;
6681     if(rip->i_count <= 1)
6682         switch(rip->i_mode&IFMT) {
6683
6684     case IFCHR:
6685         (*cdevsw[maj].d_close)(dev, rw);
6686         break;
6687
6688     case IFBLK:
6689         (*bdevsw[maj].d_close)(dev, rw);
6690     }
6691     iput(rip);
6692 }
6693 /* ----- */
6694
6695 /*
6696  * openi called to allow handler
6697  * of special files to initialize and
6698  * validate before actual IO.
6699  * Called on all sorts of opens

```

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```

6700 * and also on mount.
6701 */
6702 openi(ip, rw)
6703 int *ip;
6704 {
6705     register *rip;
6706     register dev, maj;
6707
6708     rip = ip;
6709     dev = rip->i_addr[0];
6710     maj = rip->i_addr[0].d_major;
6711     switch(rip->i_mode&IFMT) {
6712
6713     case IFCHR:
6714         if(maj >= nchrdev)
6715             goto bad;
6716         (*cdevsw[maj].d_open)(dev, rw);
6717         break;
6718
6719     case IFBLK:
6720         if(maj >= nblkdev)
6721             goto bad;
6722         (*bdevsw[maj].d_open)(dev, rw);
6723     }
6724     return;
6725
6726 bad:
6727     u.u_error = ENXIO;
6728 }
6729 /* ----- */
6730
6731 /*
6732 * Check mode permission on inode pointer.
6733 * Mode is READ, WRITE, or EXEC.
6734 * In the case of WRITE, the
6735 * read-only status of the file
6736 * system is checked.
6737 * Also in WRITE, prototype text
6738 * segments cannot be written.
6739 * The mode is shifted to select
6740 * the owner/group/other fields.
6741 * The super user is granted all
6742 * permissions except for EXEC where
6743 * at least one of the EXEC bits must
6744 * be on.
6745 */
6746 access(aip, mode)
6747 int *aip;
6748 {
6749     register *ip, m;

```

```

6750
6751     ip = aip;
6752     m = mode;
6753     if(m == IWRITE) {
6754         if(getfs(ip->i_dev)->s_ronly != 0) {
6755             u.u_error = EROFS;
6756             return(1);
6757         }
6758         if(ip->i_flag & ITEXT) {
6759             u.u_error = ETXTBSY;
6760             return(1);
6761         }
6762     }
6763     if(u.u_uid == 0) {
6764         if(m == IEXEC && (ip->i_mode &
6765             (IEXEC | (IEXEC>>3) | (IEXEC>>6))) == 0)
6766             goto bad;
6767         return(0);
6768     }
6769     if(u.u_uid != ip->i_uid) {
6770         m =>> 3;
6771         if(u.u_gid != ip->i_gid)
6772             m =>> 3;
6773     }
6774     if((ip->i_mode&m) != 0)
6775         return(0);
6776
6777 bad:
6778     u.u_error = EACCES;
6779     return(1);
6780 }
6781 /* ----- */
6782
6783 /*
6784 * Look up a pathname and test if
6785 * the resultant inode is owned by the
6786 * current user.
6787 * If not, try for super-user.
6788 * If permission is granted,
6789 * return inode pointer.
6790 */
6791 owner()
6792 {
6793     register struct inode *ip;
6794     extern uchar();
6795
6796     if ((ip = namei(uchar, 0)) == NULL)
6797         return(NULL);
6798     if(u.u_uid == ip->i_uid)
6799         return(ip);

```

```

6800  if (suser())
6801      return(ip);
6802  iput(ip);
6803  return(NULL);
6804 }
6805 /* ----- */
6806
6807 /*
6808  * Test if the current user is the
6809  * super user.
6810  */
6811 suser()
6812 {
6813
6814     if(u.u_uid == 0)
6815         return(1);
6816     u.u_error = EPERM;
6817     return(0);
6818 }
6819 /* ----- */
6820
6821 /*
6822  * Allocate a user file descriptor.
6823  */
6824 ufalloc()
6825 {
6826     register i;
6827
6828     for (i=0; i<NOFILE; i++)
6829         if (u.u_ofile[i] == NULL) {
6830             u.u_ar0[R0] = 1;
6831             return(i);
6832         }
6833     u.u_error = EMFILE;
6834     return(-1);
6835 }
6836 /* ----- */
6837
6838 /*
6839  * Allocate a user file descriptor
6840  * and a file structure.
6841  * Initialize the descriptor
6842  * to point at the file structure.
6843  *
6844  * no file -- if there are no available
6845  * file structures.
6846  */
6847 falloc()
6848 {
6849     register struct file *fp;

```

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```

6850     register i;
6851
6852     if ((i = ufalloc()) < 0)
6853         return(NULL);
6854     for (fp = &file[0]; fp < &file[NFILE]; fp++)
6855         if (fp->f_count==0) {
6856             u.u_ofile[i] = fp;
6857             fp->f_count++;
6858             fp->f_offset[0] = 0;
6859             fp->f_offset[1] = 0;
6860             return(fp);
6861         }
6862     printf("no file\n");
6863     u.u_error = ENFILE;
6864     return(NULL);
6865 }
6866 /* ----- */
6867
6868
6869
6870
6871
6872
6873
6874
6875
6876
6877
6878
6879
6880
6881
6882
6883
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6894
6895
6896
6897
6898
6899

```

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```

6900 #
6901 /*
6902 */
6903
6904 #include "../param.h"
6905 #include "../system.h"
6906 #include "../filesystem.h"
6907 #include "../conf.h"
6908 #include "../buf.h"
6909 #include "../inode.h"
6910 #include "../user.h"
6911
6912 /*
6913  * iinit is called once (from main)
6914  * very early in initialization.
6915  * It reads the root's super block
6916  * and initializes the current date
6917  * from the last modified date.
6918  *
6919  * panic: iinit -- cannot read the super
6920  * block. Usually because of an IO error.
6921  */
6922 iinit()
6923 {
6924     register *cp, *bp;
6925
6926     (*bdevsw[rootdev.d_major].d_open)(rootdev, 1);
6927     bp = bread(rootdev, 1);
6928     cp = getblk(NODEV);
6929     if(u.u_error)
6930         panic("iinit");
6931     bcopy(bp->b_addr, cp->b_addr, 256);
6932     brelse(bp);
6933     mount[0].m_bufp = cp;
6934     mount[0].m_dev = rootdev;
6935     cp = cp->b_addr;
6936     cp->s_flock = 0;
6937     cp->s_iloc = 0;
6938     cp->s_ronly = 0;
6939     time[0] = cp->s_time[0];
6940     time[1] = cp->s_time[1];
6941 }
6942 /* ----- */
6943 /* ----- */
6944
6945 /*
6946  * alloc will obtain the next available
6947  * free disk block from the free list of
6948  * the specified device.
6949  * The super block has up to 100 remembered

```

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```

6950 * free blocks; the last of these is read to
6951 * obtain 100 more . . .
6952 *
6953 * no space on dev x/y -- when
6954 * the free list is exhausted.
6955 */
6956 alloc(dev)
6957 {
6958     int bno;
6959     register *bp, *ip, *fp;
6960
6961     fp = getfs(dev);
6962     while(fp->s_flock)
6963         sleep(&fp->s_flock, PINOD);
6964     do {
6965         if(fp->s_nfree <= 0)
6966             goto nospace;
6967         bno = fp->s_free[--fp->s_nfree];
6968         if(bno == 0)
6969             goto nospace;
6970     } while (badblock(fp, bno, dev));
6971     if(fp->s_nfree <= 0) {
6972         fp->s_flock++;
6973         bp = bread(dev, bno);
6974         ip = bp->b_addr;
6975         fp->s_nfree = *ip++;
6976         bcopy(ip, fp->s_free, 100);
6977         brelse(bp);
6978         fp->s_flock = 0;
6979         wakeup(&fp->s_flock);
6980     }
6981     bp = getblk(dev, bno);
6982     clrbuf(bp);
6983     fp->s_fmod = 1;
6984     return(bp);
6985
6986 nospace:
6987     fp->s_nfree = 0;
6988     prdev("no space", dev);
6989     u.u_error = ENOSPC;
6990     return(NULL);
6991 }
6992 /*----- */
6993 /*----- */
6994
6995 /*
6996  * place the specified disk block
6997  * back on the free list of the
6998  * specified device.
6999 */

```

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```

7000 free(dev, bno)
7001 {
7002     register *fp, *bp, *ip;
7003
7004     fp = getfs(dev);
7005     fp->s_fmod = 1;
7006     while(fp->s_flock)
7007         sleep(&fp->s_flock, PINOD);
7008     if (badblock(fp, bno, dev))
7009         return;
7010     if(fp->s_nfree <= 0) {
7011         fp->s_nfree = 1;
7012         fp->s_free[0] = 0;
7013     }
7014     if(fp->s_nfree >= 100) {
7015         fp->s_flock++;
7016         bp = getblk(dev, bno);
7017         ip = bp->b_addr;
7018         *ip++ = fp->s_nfree;
7019         bcopy(fp->s_free, ip, 100);
7020         fp->s_nfree = 0;
7021         bwrite(bp);
7022         fp->s_flock = 0;
7023         wakeup(&fp->s_flock);
7024     }
7025     fp->s_free[fp->s_nfree++] = bno;
7026     fp->s_fmod = 1;
7027 }
7028 /* ----- */
7029 /* ----- */
7030
7031 /*
7032  * Check that a block number is in the
7033  * range between the I list and the size
7034  * of the device.
7035  * This is used mainly to check that a
7036  * garbage file system has not been mounted.
7037  *
7038  * bad block on dev x/y -- not in range
7039  */
7040 badblock(afp, abn, dev)
7041 {
7042     register struct filsys *fp;
7043     register char *bn;
7044
7045     fp = afp;
7046     bn = abn;
7047     if (bn < fp->s_ysize+2 || bn >= fp->s_fsize) {
7048         prdev("bad block", dev);
7049         return(1);

```

```

7050     }
7051     return(0);
7052 }
7053 /* ----- */
7054 /* ----- */
7055
7056 /*
7057  * Allocate an unused I node
7058  * on the specified device.
7059  * Used with file creation.
7060  * The algorithm keeps up to
7061  * 100 spare I node in the
7062  * super block. When this runs out,
7063  * a linear search through the
7064  * I list is instituted to pick
7065  * up 100 more.
7066  */
7067 ialloc(dev)
7068 {
7069     register *fp, *bp, *ip;
7070     int i, j, k, ino;
7071
7072     fp = getfs(dev);
7073     while(fp->s_iloc)
7074         sleep(&fp->s_iloc, PINOD);
7075 loop:
7076     if(fp->s_ninode > 0) {
7077         ino = fp->s_inode[--fp->s_ninode];
7078         ip = iget(dev, ino);
7079         if (ip==NULL)
7080             return(NULL);
7081         if(ip->i_mode == 0) {
7082             for(bp = &ip->i_mode; bp < &ip->i_addr[8];)
7083                 *bp++ = 0;
7084             fp->s_fmod = 1;
7085             return(ip);
7086         }
7087     }
7088     /*
7089     * Inode was allocated after all.
7090     * Look some more.
7091     */
7092     iput(ip);
7093     goto loop;
7094 }
7095 fp->s_iloc++;
7096 ino = 0;
7097 for(i=0; i<fp->s_ysize; i++) {
7098     bp = bread(dev, i+2);
7099     ip = bp->b_addr;
7100     for(j=0; j<256; j+=16) {

```



```

7100         ino++;
7101         if(ip[j] != 0)
7102             continue;
7103         for(k=0; k<NINODE; k++)
7104             if(dev == inode[k].i_dev &&
7105                ino == inode[k].i_number)
7106                 goto cont;
7107         fp->s_inode[fp->s_ninode++] = ino;
7108         if(fp->s_ninode >= 100)
7109             break;
7110         cont:;
7111     }
7112     brelse(bp);
7113     if(fp->s_ninode >= 100)
7114         break;
7115 }
7116 fp->s_ilock = 0;
7117 wakeup(&fp->s_ilock);
7118 if (fp->s_ninode > 0)
7119     goto loop;
7120 prdev("Out of inodes", dev);
7121 u.u_error = ENOSPC;
7122 return(NULL);
7123 }
7124 /* ----- */
7125 /* ----- */
7126
7127 /*
7128  * Free the specified I node
7129  * on the specified device.
7130  * The algorithm stores up
7131  * to 100 I nodes in the super
7132  * block and throws away any more.
7133  */
7134 ifree(dev, ino)
7135 {
7136     register *fp;
7137
7138     fp = getfs(dev);
7139     if(fp->s_ilock)
7140         return;
7141     if(fp->s_ninode >= 100)
7142         return;
7143     fp->s_inode[fp->s_ninode++] = ino;
7144     fp->s_fmod = 1;
7145 }
7146 /* ----- */
7147 /* ----- */
7148
7149 /*

```

```

7150 * getfs maps a device number into
7151 * a pointer to the incore super
7152 * block.
7153 * The algorithm is a linear
7154 * search through the mount table.
7155 * A consistency check of the
7156 * in core free-block and i-node
7157 * counts.
7158 *
7159 * bad count on dev x/y -- the count
7160 * check failed. At this point, all
7161 * the counts are zeroed which will
7162 * almost certainly lead to "no space"
7163 * diagnostic
7164 * panic: no fs -- the device is not mounted.
7165 * this "cannot happen"
7166 */
7167 getfs(dev)
7168 {
7169     register struct mount *p;
7170     register char *n1, *n2;
7171
7172     for(p = &mount[0]; p < &mount[NMOUNT]; p++)
7173         if(p->m_bufp != NULL && p->m_dev == dev) {
7174             p = p->m_bufp->b_addr;
7175             n1 = p->s_nfree;
7176             n2 = p->s_ninode;
7177             if(n1 > 100 || n2 > 100) {
7178                 prdev("bad count", dev);
7179                 p->s_nfree = 0;
7180                 p->s_ninode = 0;
7181             }
7182             return(p);
7183         }
7184     panic("no fs");
7185 }
7186 /* ----- */
7187 /* ----- */
7188
7189 /*
7190 * update is the internal name of
7191 * 'sync'. It goes through the disk
7192 * queues to initiate sandbagged IO;
7193 * goes through the I nodes to write
7194 * modified nodes; and it goes through
7195 * the mount table to initiate modified
7196 * super blocks.
7197 */
7198
7199

```

```

7200
7201 update()
7202 {
7203     register struct inode *ip;
7204     register struct mount *mp;
7205     register *bp;
7206
7207     if(updlock)
7208         return;
7209     updlock++;
7210     for(mp = &mount[0]; mp < &mount[NMOUNT]; mp++)
7211         if(mp->m_bufp != NULL) {
7212             ip = mp->m_bufp->b_addr;
7213             if(ip->s_fmod==0 || ip->s_ilock!=0 ||
7214                ip->s_flock!=0 || ip->s_ronly!=0)
7215                 continue;
7216             bp = getblk(mp->m_dev, 1);
7217             ip->s_fmod = 0;
7218             ip->s_time[0] = time[0];
7219             ip->s_time[1] = time[1];
7220             bcopy(ip, bp->b_addr, 256);
7221             bwrite(bp);
7222         }
7223     for(ip = &inode[0]; ip < &inode[NINODE]; ip++)
7224         if((ip->i_flag&ILOCK) == 0) {
7225             ip->i_flag |= ILOCK;
7226             iupdat(ip, time);
7227             prele(ip);
7228         }
7229     updlock = 0;
7230     bflush(NODEV);
7231 }
7232 /* ----- */
7233 /* ----- */
7234
7235
7236
7237
7238
7239
7240
7241
7242
7243
7244
7245
7246
7247
7248
7249

```

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```

7250 #
7251 #include "../param.h"
7252 #include "../system.h"
7253 #include "../user.h"
7254 #include "../inode.h"
7255 #include "../filesystem.h"
7256 #include "../conf.h"
7257 #include "../buf.h"
7258
7259 /*
7260 * Look up an inode by device, inumber.
7261 * If it is in core (in the inode structure),
7262 * honor the locking protocol.
7263 * If it is not in core, read it in from the
7264 * specified device.
7265 * If the inode is mounted on, perform
7266 * the indicated indirection.
7267 * In all cases, a pointer to a locked
7268 * inode structure is returned.
7269 *
7270 * printf warning: no inodes -- if the inode
7271 * structure is full
7272 * panic: no imt -- if the mounted file
7273 * system is not in the mount table.
7274 * "cannot happen"
7275 */
7276 iget(dev, ino)
7277 {
7278     register struct inode *p;
7279     register *ip2;
7280     int *ip1;
7281     register struct mount *ip;
7282
7283     loop:
7284     ip = NULL;
7285     for(p = &inode[0]; p < &inode[NINODE]; p++) {
7286         if(dev==p->i_dev && ino==p->i_number) {
7287             if((p->i_flag&ILOCK) != 0) {
7288                 p->i_flag |= IWANT;
7289                 sleep(p, PINOD);
7290                 goto loop;
7291             }
7292             if((p->i_flag&IMOUNT) != 0) {
7293                 for (ip = &mount[0];
7294                    ip < &mount[NMOUNT]; ip++)
7295                     if (ip->m_inodp == p) {
7296                         dev = ip->m_dev;
7297                         ino = ROOTINO;
7298                         goto loop;
7299                     }

```

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```

7300             panic("no imt");
7301         }
7302         p->i_count++;
7303         p->i_flag |= ILOCK;
7304         return(p);
7305     }
7306     if(ip==NULL && p->i_count==0)
7307         ip = p;
7308 }
7309 if((p=ip) == NULL) {
7310     printf("Inode table overflow\n");
7311     u.u_error = ENFILE;
7312     return(NULL);
7313 }
7314 p->i_dev = dev;
7315 p->i_number = ino;
7316 p->i_flag = ILOCK;
7317 p->i_count++;
7318 p->i_lastr = -1;
7319 ip = bread(dev, ldiv(ino+31,16));
7320 /*
7321  * Check I/O errors
7322  */
7323 if (ip->b_flags&B_ERROR) {
7324     brelse(ip);
7325     iput(p);
7326     return(NULL);
7327 }
7328 ip1 = ip->b_addr + 32*lrem(ino+31, 16);
7329 ip2 = &p->i_mode;
7330 while(ip2 < &p->i_addr[8])
7331     *ip2++ = *ip1++;
7332 brelse(ip);
7333 return(p);
7334 }
7335 /* ----- */
7336 /*
7337  * Decrement reference count of
7338  * an inode structure.
7339  * On the last reference,
7340  * write the inode out and if necessary,
7341  * truncate and deallocate the file.
7342  */
7343 iput(p)
7344 struct inode *p;
7345 {
7346     register *rp;
7347     rp = p;

```

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```

7350     if(rp->i_count == 1) {
7351         rp->i_flag |= ILOCK;
7352         if(rp->i_nlink <= 0) {
7353             itrunc(rp);
7354             rp->i_mode = 0;
7355             ifree(rp->i_dev, rp->i_number);
7356         }
7357         iupdat(rp, time);
7358         prele(rp);
7359         rp->i_flag = 0;
7360         rp->i_number = 0;
7361     }
7362     rp->i_count--;
7363     prele(rp);
7364 }
7365 /* ----- */
7366 /*
7367  * Check accessed and update flags on
7368  * an inode structure.
7369  * If either is on, update the inode
7370  * with the corresponding dates
7371  * set to the argument tm.
7372  */
7373 iupdat(p, tm)
7374 int *p;
7375 int *tm;
7376 {
7377     register *ip1, *ip2, *rp;
7378     int *bp, i;
7379     rp = p;
7380     if((rp->i_flag&(IUPD|IACC)) != 0) {
7381         if(getfs(rp->i_dev)->s_ronly)
7382             return;
7383         i = rp->i_number+31;
7384         bp = bread(rp->i_dev, ldiv(i,16));
7385         ip1 = bp->b_addr + 32*lrem(i, 16);
7386         ip2 = &rp->i_mode;
7387         while(ip2 < &rp->i_addr[8])
7388             *ip1++ = *ip2++;
7389         if(rp->i_flag&IACC) {
7390             *ip1++ = time[0];
7391             *ip1++ = time[1];
7392         } else
7393             ip1 += 2;
7394         if(rp->i_flag&IUPD) {
7395             *ip1++ = *tm++;
7396             *ip1++ = *tm;
7397         }
7398     }
7399 }

```

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```

7400         bwrite(bp);
7401     }
7402 }
7403 /* ----- */
7404
7405 /*
7406 * Free all the disk blocks associated
7407 * with the specified inode structure.
7408 * The blocks of the file are removed
7409 * in reverse order. This FILO
7410 * algorithm will tend to maintain
7411 * a contiguous free list much longer
7412 * than FIFO.
7413 */
7414 itrunc(ip)
7415 int *ip;
7416 {
7417     register *rp, *bp, *cp;
7418     int *dp, *ep;
7419
7420     rp = ip;
7421     if((rp->i_mode&(IFCHR&IFBLK)) != 0)
7422         return;
7423     for(ip = &rp->i_addr[7]; ip >= &rp->i_addr[0]; ip--)
7424     if(*ip) {
7425         if((rp->i_mode&ILARG) != 0) {
7426             bp = bread(rp->i_dev, *ip);
7427             for(cp = bp->b_addr+512; cp >= bp->b_addr;
7428                cp--)
7429                 if(*cp) {
7430                     if(ip == &rp->i_addr[7]) {
7431                         dp = bread(rp->i_dev, *cp);
7432                         for(ep = dp->b_addr+512;
7433                            ep >= dp->b_addr; ep--)
7434                             if(*ep)
7435                                 free(rp->i_dev, *ep);
7436                         brelse(dp);
7437                     }
7438                     free(rp->i_dev, *cp);
7439                 }
7440             brelse(bp);
7441         }
7442         free(rp->i_dev, *ip);
7443         *ip = 0;
7444     }
7445     rp->i_mode = & ~ILARG;
7446     rp->i_size0 = 0;
7447     rp->i_size1 = 0;
7448     rp->i_flag = | IUPD;
7449 }

```

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```

7450 /* ----- */
7451
7452 /*
7453 * Make a new file.
7454 */
7455 maknode(mode)
7456 {
7457     register *ip;
7458
7459     ip = ialloc(u.u_pdir->i_dev);
7460     if (ip==NULL)
7461         return(NULL);
7462     ip->i_flag = | IACC|IUPD;
7463     ip->i_mode = mode|IALLOC;
7464     ip->i_nlink = 1;
7465     ip->i_uid = u.u_uid;
7466     ip->i_gid = u.u_gid;
7467     wdir(ip);
7468     return(ip);
7469 }
7470 /* ----- */
7471
7472 /*
7473 * Write a directory entry with
7474 * parameters left as side effects
7475 * to a call to namei.
7476 */
7477 wdir(ip)
7478 int *ip;
7479 {
7480     register char *cp1, *cp2;
7481
7482     u.u_dent.u_ino = ip->i_number;
7483     cp1 = &u.u_dent.u_name[0];
7484     for(cp2 = &u.u_dbuf[0]; cp2 < &u.u_dbuf[DIRSIZ];)
7485         *cp1++ = *cp2++;
7486     u.u_count = DIRSIZ+2;
7487     u.u_segflg = 1;
7488     u.u_base = &u.u_dent;
7489     writei(u.u_pdir);
7490     iput(u.u_pdir);
7491 }
7492 /* ----- */
7493
7494
7495
7496
7497
7498
7499

```

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```

7500 #
7501 #include "../param.h"
7502 #include "../inode.h"
7503 #include "../user.h"
7504 #include "../system.h"
7505 #include "../buf.h"
7506
7507 /*
7508  * Convert a pathname into a pointer to
7509  * an inode. Note that the inode is locked.
7510  *
7511  * func = function called to get next char of name
7512  * &uchar if name is in user space
7513  * &schar if name is in system space
7514  * flag = 0 if name is sought
7515  * 1 if name is to be created
7516  * 2 if name is to be deleted
7517  */
7518 namei(func, flag)
7519 int (*func)();
7520 {
7521     register struct inode *dp;
7522     register c;
7523     register char *cp;
7524     int eo, *bp;
7525
7526     /*
7527     * If name starts with '/' start from
7528     * root: otherwise start from current dir.
7529     */
7530
7531     dp = u.u_cdir;
7532     if((c=(*func)()) == '/');
7533         dp = rootdir;
7534     iget(dp->i_dev, dp->i_number);
7535     while(c == '/')
7536         c = (*func)();
7537     if(c == '\0' && flag != 0) {
7538         u.u_error = ENOENT;
7539         goto out;
7540     }
7541
7542 cloop:
7543     /*
7544     * Here dp contains pointer
7545     * to last component matched.
7546     */
7547
7548     if(u.u_error)
7549         goto out;

```

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```

7550     if(c == '\0')
7551         return(dp);
7552
7553     /*
7554     * If there is another component,
7555     * dp must be a directory and
7556     * must have x permission.
7557     */
7558
7559     if((dp->i_mode&IFMT) != IFDIR) {
7560         u.u_error = ENOTDIR;
7561         goto out;
7562     }
7563     if(access(dp, IEXEC))
7564         goto out;
7565
7566     /* Gather up name into
7567     * users' dir buffer.
7568     */
7569
7570     cp = &u.u_dbuf[0];
7571     while(c != '/' && c != '\0' && u.u_error == 0) {
7572         if(cp < &u.u_dbuf[DIRSIZ])
7573             *cp++ = c;
7574         c = (*func)();
7575     }
7576     while(cp < &u.u_dbuf[DIRSIZ])
7577         *cp++ = '\0';
7578     while(c == '/')
7579         c = (*func)();
7580     if(u.u_error)
7581         goto out;
7582
7583     /* Set up to search a directory. */
7584
7585     u.u_offset[1] = 0;
7586     u.u_offset[0] = 0;
7587     u.u_segflg = 1;
7588     eo = 0;
7589     u.u_count = ldiv(dp->i_size1, DIRSIZ+2);
7590     bp = NULL;
7591
7592 eloop:
7593
7594     /*
7595     * If at the end of the directory,
7596     * the search failed. Report what
7597     * is appropriate as per flag.
7598     */
7599

```

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```

7600 if(u.u_count == 0) {
7601     if(bp != NULL)
7602         brelse(bp);
7603     if(flag==1 && c=='\0') {
7604         if(access(dp, IWRITE))
7605             goto out;
7606         u.u_pdir = dp;
7607         if(eo)
7608             u.u_offset[1] = eo-DIRSIZ-2; else
7609             dp->i_flag |= IUPD;
7610         return(NULL);
7611     }
7612     u.u_error = ENOENT;
7613     goto out;
7614 }
7615
7616 /*
7617  * If offset is on a block boundary,
7618  * read the next directory block.
7619  * Release previous if it exists.
7620  */
7621
7622 if((u.u_offset[1]&0777) == 0) {
7623     if(bp != NULL)
7624         brelse(bp);
7625     bp = bread(dp->i_dev,
7626         bmap(dp, ldiv(u.u_offset[1], 512)));
7627 }
7628
7629 /* Note first empty directory slot
7630  * in eo for possible creat.
7631  * String compare the directory entry
7632  * and the current component.
7633  * If they do not match, go back to eloop.
7634  */
7635
7636 bcopy(bp->b_addr+(u.u_offset[1]&0777), &u.u_dent,
7637     (DIRSIZ+2)/2);
7638 u.u_offset[1] += DIRSIZ+2;
7639 u.u_count--;
7640 if(u.u_dent.u_ino == 0) {
7641     if(eo == 0)
7642         eo = u.u_offset[1];
7643     goto eloop;
7644 }
7645 for(cp = &u.u_dbuf[0]; cp < &u.u_dbuf[DIRSIZ]; cp++)
7646     if(*cp != cp[u.u_dent.u_name - u.u_dbuf])
7647         goto eloop;
7648
7649

```

```

7650 /* Here a component matched is a directory.
7651  * If there is more pathname, go back to
7652  * cloop, otherwise return.
7653  */
7654
7655 if(bp != NULL)
7656     brelse(bp);
7657 if(flag==2 && c=='\0') {
7658     if(access(dp, IWRITE))
7659         goto out;
7660     return(dp);
7661 }
7662 bp = dp->i_dev;
7663 iput(dp);
7664 dp = iget(bp, u.u_dent.u_ino);
7665 if(dp == NULL)
7666     return(NULL);
7667 goto cloop;
7668
7669 out:
7670 iput(dp);
7671 return(NULL);
7672 }
7673 /* ----- */
7674
7675 /*
7676  * Return the next character from the
7677  * kernel string pointed at by dirp.
7678  */
7679 schar()
7680 {
7681     return(*u.u_dirp++ & 0377);
7682 }
7683 /* ----- */
7684
7685 /* Return the next character from the
7686  * user string pointed at by dirp.
7687  */
7688 uchar()
7689 {
7690     register c;
7691
7692     c = fubyte(u.u_dirp++);
7693     if(c == -1)
7694         u.u_error = EFAULT;
7695     return(c);
7696 }
7697 /* ----- */
7698
7699

```

```

7700 #include "../param.h"
7701 #include "../system.h"
7702 #include "../user.h"
7703 #include "../inode.h"
7704 #include "../file.h"
7705 #include "../reg.h"
7706
7707 /* Max allowable buffering per pipe.
7708 * This is also the max size of the
7709 * file created to implement the pipe.
7710 * If this size is bigger than 4096,
7711 * pipes will be implemented in LARGE
7712 * files, which is probably not good.
7713 */
7714
7715 #define PIPSIZ 4096
7716
7717 /* The sys-pipe entry.
7718 * Allocate an inode on the root device.
7719 * Allocate 2 file structures.
7720 * Put it all together with flags.
7721 */
7722
7723 pipe()
7724 {
7725     register *ip, *rf, *wf;
7726     int r;
7727
7728     ip = ialloc(rootdev);
7729     if(ip == NULL)
7730         return;
7731     rf = falloc();
7732     if(rf == NULL) {
7733         iput(ip);
7734         return;
7735     }
7736     r = u.u_ar0[R0];
7737     wf = falloc();
7738     if(wf == NULL) {
7739         rf->f_count = 0;
7740         u.u_ofile[r] = NULL;
7741         iput(ip);
7742         return;
7743     }
7744     u.u_ar0[R1] = u.u_ar0[R0];
7745     u.u_ar0[R0] = r;
7746     wf->f_flag = FWRITE|FPIPE;
7747     wf->f_inode = ip;
7748     rf->f_flag = FREAD|FPIPE;
7749     rf->f_inode = ip;

```

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```

7750     ip->i_count = 2;
7751     ip->i_flag = IACC|IUPD;
7752     ip->i_mode = IALLOC;
7753 }
7754 /* ----- */
7755
7756 /* Read call directed to a pipe.
7757 */
7758 readp(fp)
7759 int *fp;
7760 {
7761     register *rp, *ip;
7762
7763     rp = fp;
7764     ip = rp->f_inode;
7765 loop:
7766     /* Very conservative locking.
7767     */
7768     plock(ip);
7769     /* If the head (read) has caught up with
7770     * the tail (write), reset both to 0.
7771     */
7772     if(rp->f_offset[1] == ip->i_size1) {
7773         if(rp->f_offset[1] != 0) {
7774             rp->f_offset[1] = 0;
7775             ip->i_size1 = 0;
7776             if(ip->i_mode & IWRITE) {
7777                 ip->i_mode = & ~IWRITE;
7778                 wakeup(ip+1);
7779             }
7780         }
7781
7782         /* If there are not both reader and
7783         * writer active, return without
7784         * satisfying read.
7785         */
7786         prele(ip);
7787         if(ip->i_count < 2)
7788             return;
7789         ip->i_mode = | IREAD;
7790         sleep(ip+2, PPIPE);
7791         goto loop;
7792     }
7793     /* Read and return
7794     */
7795     u.u_offset[0] = 0;
7796     u.u_offset[1] = rp->f_offset[1];
7797     readi(ip);
7798     rp->f_offset[1] = u.u_offset[1];
7799     prele(ip);

```

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```

7800 }
7801 /* ----- */
7802
7803 /* Write call directed to a pipe.
7804 */
7805 writep(fp)
7806 {
7807     register *rp, *ip, c;
7808
7809     rp = fp;
7810     ip = rp->f_inode;
7811     c = u.u_count;
7812 loop:
7813     /* If all done, return.
7814     */
7815     plock(ip);
7816     if(c == 0) {
7817         prele(ip);
7818         u.u_count = 0;
7819         return;
7820     }
7821     /* If there are not both read and
7822     * write sides of the pipe active,
7823     * return error and signal too.
7824     */
7825     if(ip->i_count < 2) {
7826         prele(ip);
7827         u.u_error = EPIPE;
7828         psignal(u.u_procp, SIGPIPE);
7829         return;
7830     }
7831     /* If the pipe is full,
7832     * wait for reads to delete
7833     * and truncate it.
7834     */
7835     if(ip->i_size1 == PIPISIZ) {
7836         ip->i_mode |= IWRITE;
7837         prele(ip);
7838         sleep(ip+1, PPIPE);
7839         goto loop;
7840     }
7841     /* Write what is possible and
7842     * loop back.
7843     */
7844     u.u_offset[0] = 0;
7845     u.u_offset[1] = ip->i_size1;
7846     u.u_count = min(c, PIPISIZ-u.u_offset[1]);
7847     c -= u.u_count;
7848     writei(ip);
7849     prele(ip);

```

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```

7850     if(ip->i_mode&IREAD) {
7851         ip->i_mode =& ~IREAD;
7852         wakeup(ip+2);
7853     }
7854     goto loop;
7855 }
7856 /* ----- */
7857
7858 /* Lock a pipe.
7859 * If its already locked,
7860 * set the WANT bit and sleep.
7861 */
7862 plock(ip)
7863 int *ip;
7864 {
7865     register *rp;
7866
7867     rp = ip;
7868     while(rp->i_flag&ILOCK) {
7869         rp->i_flag |= IWANT;
7870         sleep(rp, PPIPE);
7871     }
7872     rp->i_flag |= ILOCK;
7873 }
7874 /* ----- */
7875
7876 /* Unlock a pipe.
7877 * If WANT bit is on,
7878 * wakeup.
7879 * This routine is also used
7880 * to unlock inodes in general.
7881 */
7882 prele(ip)
7883 int *ip;
7884 {
7885     register *rp;
7886
7887     rp = ip;
7888     rp->i_flag =& ~ILOCK;
7889     if(rp->i_flag&IWANT) {
7890         rp->i_flag =& ~IWANT;
7891         wakeup(rp);
7892     }
7893 }
7894 /* ----- */
7895
7896
7897
7898
7899

```

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# 5

**Character Oriented  
Special Files**



```

7900 /*
7901 * A clist structure is the head
7902 * of a linked list queue of characters.
7903 * The characters are stored in 4-word
7904 * blocks containing a link and 6 characters.
7905 * The routines getc and putc (m45.s or m40.s)
7906 * manipulate these structures.
7907 */
7908 struct clist
7909 {
7910     int     c_cc;           /* character count */
7911     int     c_cf;           /* pointer to first block */
7912     int     c_cl;           /* pointer to last block */
7913 };
7914 /* ----- */
7915
7916 /*
7917 * A tty structure is needed for
7918 * each UNIX character device that
7919 * is used for normal terminal IO.
7920 * The routines in tty.c handle the
7921 * common code associated with
7922 * these structures.
7923 * The definition and device dependent
7924 * code is in each driver (kl.c dc.c dh.c)
7925 */
7926 struct tty
7927 {
7928     struct clist t_rawq; /* input chars right off device */
7929     struct clist t_canq; /* input chars after erase and kill */
7930     struct clist t_outq; /* output list to device */
7931     int     t_flags; /* mode, settable by stty call */
7932     int     *t_addr; /* device address (register or
7933                     startup fcn) */
7934     char     t_delct; /* number of delimiters in raw q */
7935     char     t_col; /* printing column of device */
7936     char     t_erase; /* erase character */
7937     char     t_kill; /* kill character */
7938     char     t_state; /* internal state, not visible
7939                     externally */
7940     char     t_char; /* character temporary */
7941     int     t_speeds; /* output+input line speed */
7942     int     t_dev; /* device name */
7943 };
7944 /* ----- */
7945
7946
7947 char partab[]; /* ASCII table: parity, character class */
7948
7949

```

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```

7950
7951 #define     TTIPRI 10
7952 #define     TTOPRI 20
7953
7954 #define     CERASE '#' /* default special characters */
7955 #define     CEOT 004
7956 #define     CKILL '@'
7957 #define     CQUIT 034 /* FS, cntl shift L */
7958 #define     CINTR 0177 /* DEL */
7959
7960 /* limits */
7961 #define     TTHIWAT 50
7962 #define     TTLOWAT 30
7963 #define     TTYHOG 256
7964
7965 /* modes */
7966 #define     HUPCL 01
7967 #define     XTABS 02
7968 #define     LCASE 04
7969 #define     ECHO 010
7970 #define     CRMOD 020
7971 #define     RAW 040
7972 #define     ODDP 0100
7973 #define     EVENP 0200
7974 #define     NLDELAY 001400
7975 #define     TBDELAY 006000
7976 #define     CRDELAY 030000
7977 #define     VTDELAY 040000
7978
7979 /* Hardware bits */
7980 #define     DONE 0200
7981 #define     IENABLE 0100
7982
7983 /* Internal state bits */
7984 #define     TIMEOUT 01 /* Delay timeout in progress */
7985 #define     WOPEN 02 /* Waiting for open to
7986                     complete */
7987 #define     ISOPEN 04 /* Device is open */
7988 #define     SSTART 010 /* Has special start routine
7989                     at addr */
7990 #define     CARR_ON 020 /* Software copy of
7991                     carrier-present */
7992 #define     BUSY 040 /* Output in progress */
7993 #define     ASLEEP 0100 /* Wakeup when output done */
7994
7995
7996
7997
7998
7999

```

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```

8000 #
8001 /* KL/DL-11 driver */
8002 #include "../param.h"
8003 #include "../conf.h"
8004 #include "../user.h"
8005 #include "../tty.h"
8006 #include "../proc.h"
8007 /* base address */
8008 #define KLADDR 0177560 /* console */
8009 #define KLBASE 0176500 /* kl and dl11-a */
8010 #define DLBASE 0175610 /* dl-e */
8011 #define NKL11 1
8012 #define NDL11 0
8013 #define DSRDY 02
8014 #define RDRENB 01
8015 struct tty kl11[NKL11+NDL11];
8016 struct kregs {
8017     int klrcsr;
8018     int klrbuf;
8019     int kltcsr;
8020     int kltbuf;
8021 }
8022 /* ----- */
8023 klopen(dev, flag)
8024 { register char * addr;
8025   register struct tty *tp;
8026   if(dev.d_minor >= NKL11+NDL11) {
8027       u.u_error = ENXIO;
8028       return;
8029   }
8030   tp = &kl11[dev.d_minor];
8031   if (u.u_procp->p_ttyp == 0) {
8032       u.u_procp->p_ttyp = tp;
8033       tp->t_dev = dev;
8034   }
8035   /* set up minor 0 to address KLADDR
8036      * set up minor 1 thru NKL11-1 to address from KLBASE
8037      * set up minor NKL11 on to address from DLBASE
8038      */
8039   addr = KLADDR + 8*dev.d_minor;
8040   if(dev.d_minor)
8041       addr += KLBASE-KLADDR-8;
8042   if(dev.d_minor >= NKL11)
8043       addr += DLBASE-KLBASE-8*NKL11+8;
8044   tp->t_addr = addr;
8045   if ((tp->t_state&ISOPEN) == 0) {
8046       tp->t_state = ISOPEN|CARR_ON;
8047       tp->t_flags = XTABS|LCASE|ECHO|CRMOD;
8048       tp->t_erase = CERASE;
8049       tp->t_kill = CKILL;

```

```

8050     }
8051     addr->klrcsr = | IENABLE|DSRDY|RDRENB;
8052     addr->kltcsr = | IENABLE;
8053 }
8054 /* ----- */
8055 klclose(dev)
8056 { register struct tty *tp;
8057   tp = &kl11[dev.d_minor];
8058   wflushtty(tp);
8059   tp->t_state = 0;
8060 }
8061 /* ----- */
8062 klread(dev)
8063 { ttread(&kl11[dev.d_minor]);
8064 }
8065 /* ----- */
8066 klwrite(dev)
8067 { ttwrite(&kl11[dev.d_minor]);
8068 }
8069 /* ----- */
8070 klxint(dev)
8071 { register struct tty *tp;
8072   tp = &kl11[dev.d_minor];
8073   ttstart(tp);
8074   if (tp->t_outq.c_cc == 0 || tp->t_outq.c_cc == TTLOWAT)
8075       wakeup(&tp->t_outq);
8076 }
8077 /* ----- */
8078 klrint(dev)
8079 { register int c, *addr;
8080   register struct tty *tp;
8081   tp = &kl11[dev.d_minor];
8082   addr = tp->t_addr;
8083   c = addr->klrbuf;
8084   addr->klrcsr = | RDRENB;
8085   if ((c&0177)==0)
8086       addr->kltbuf = c; /* hardware botch */
8087   ttyinput(c, tp);
8088 }
8089 /* ----- */
8090 klsgetty(dev, v)
8091 int *v;
8092 { register struct tty *tp;
8093   tp = &kl11[dev.d_minor];
8094   ttystty(tp, v);
8095 }
8096 /* ----- */
8097
8098
8099

```

```

8100 # /* general TTY subroutines */
8101
8102 #include "../param.h"
8103 #include "../system.h"
8104 #include "../user.h"
8105 #include "../tty.h"
8106 #include "../proc.h"
8107 #include "../inode.h"
8108 #include "../file.h"
8109 #include "../reg.h"
8110 #include "../conf.h"
8111
8112 /* Input mapping table-- if an entry is non-zero, when the
8113 * corresponding character is typed preceded by "\" the
8114 * escape sequence is replaced by the table value.
8115 * Mostly used for upper-case only terminals.
8116 */
8117 char      maptab[]
8118 {
8119     000,000,000,000,000,004,000,000,000,
8120     000,000,000,000,000,000,000,000,000,
8121     000,000,000,000,000,000,000,000,000,
8122     000,000,000,000,000,000,000,000,000,
8123     000,'|',000,'#',000,000,000,000,000,
8124     '{','}',000,000,000,000,000,000,000,
8125     000,000,000,000,000,000,000,000,000,
8126     000,000,000,000,000,000,000,000,000,
8127     '@',000,000,000,000,000,000,000,000,
8128     000,000,000,000,000,000,000,000,000,
8129     000,000,000,000,000,000,000,000,000,
8130     000,000,000,000,000,000,000,'~',000,
8131     000,'A','B','C','D','E','F','G',
8132     'H','I','J','K','L','M','N','O',
8133     'P','Q','R','S','T','U','V','W',
8134     'X','Y','Z',000,000,000,000,000,
8135 };
8136 /* ----- */
8137 /* The actual structure of a clist block manipulated by
8138 *getc and putc (mch.s)
8139 */
8140 struct cblock {
8141     struct cblock *c_next;
8142     char info[6];
8143 };
8144 /* ----- */
8145 /* The character lists-- space for 6*NCLIST characters */
8146 struct cblock cfree[NCLIST];
8147
8148 /* List head for unused character blocks. */
8149 struct cblock *cfreelist;

```

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```

8150 /* structure of device registers for KL, DL, and DC
8151 * interfaces-- more particularly, those for which the
8152 * SSTART bit is off and can be treated by general routines
8153 * (that is, not DH).
8154 */
8155 struct {
8156     int ttrcsr;
8157     int ttrbuf;
8158     int tttcsr;
8159     int tttbuf;
8160 };
8161 /* ----- */
8162 /* The routine implementing the gtty system call.
8163 * Just call lower level routine and pass back values.
8164 */
8165 gtty()
8166 {
8167     int v[3];
8168     register *up, *vp;
8169
8170     vp = v;
8171     sgTTY(vp);
8172     if (u.u_error)
8173         return;
8174     up = u.u_arg[0];
8175     suword(up, *vp++);
8176     suword(++up, *vp++);
8177     suword(++up, *vp++);
8178 }
8179 /* ----- */
8180 /* The routine implementing the stty system call.
8181 * Read in values and call lower level.
8182 */
8183 stty()
8184 {
8185     register int *up;
8186
8187     up = u.u_arg[0];
8188     u.u_arg[0] = fuword(up);
8189     u.u_arg[1] = fuword(++up);
8190     u.u_arg[2] = fuword(++up);
8191     sgTTY(0);
8192 }
8193 /* ----- */
8194 /* Stuff common to stty and gtty.
8195 * Check legality and switch out to individual
8196 * device routine.
8197 * v is 0 for stty; the parameters are taken from u.u_arg[].
8198 * c is non-zero for gtty and is the place in which the
8199 * device routines place their information.

```

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```

8200 */
8201 sgtty(v)
8202 int *v;
8203 {
8204     register struct file *fp;
8205     register struct inode *ip;
8206     if ((fp = getf(u.u_ar0[R0])) == NULL)
8207         return;
8208     ip = fp->f_inode;
8209     if ((ip->i_mode&IFMT) != IFCHR) {
8210         u.u_error = ENOTTY;
8211         return;
8212     }
8213     (*cdevsw[ip->i_addr[0].d_major].d_sgtty)(ip->i_addr[0],v);
8214 }
8215 /* ----- */
8216 /* Wait for output to drain, then flush output waiting. */
8217 wflushtty(atp)
8218 struct tty *atp;
8219 {
8220     register struct tty *tp;
8221     tp = atp;
8222     spl5();
8223     while (tp->t_outq.c_cc) {
8224         tp->t_state = ASLEEP;
8225         sleep(&tp->t_outq, TTOPRI);
8226     }
8227     flushtty(tp);
8228     spl0();
8229 }
8230 /* ----- */
8231 /* Initialize clist by freeing all character blocks, & count
8232 * number of character devices. (Once-only routine)
8233 */
8234 cinit()
8235 {
8236     register int ccp;
8237     register struct cblock *cp;
8238     register struct cdevsw *cdp;
8239     ccp = cfree;
8240     for (cp=(ccp+07)&~07; cp <= &cfree[NCLIST-1]; cp++) {
8241         cp->c_next = cfreelist;
8242         cfreelist = cp;
8243     }
8244     ccp = 0;
8245     for(cdp = cdevsw; cdp->d_open; cdp++)
8246         ccp++;
8247     nchrdev = ccp;
8248 }
8249 /* ----- */

```

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```

8250 /* flush all TTY queues
8251 */
8252 flushtty(atp)
8253 struct tty *atp;
8254 {
8255     register struct tty *tp;
8256     register int sps;
8257     tp = atp;
8258     while (getc(&tp->t_canq) >= 0);
8259     while (getc(&tp->t_outq) >= 0);
8260     wakeup(&tp->t_rawq);
8261     wakeup(&tp->t_outq);
8262     sps = PS->integ;
8263     spl5();
8264     while (getc(&tp->t_rawq) >= 0);
8265     tp->t_delct = 0;
8266     PS->integ = sps;
8267 }
8268 /* ----- */
8269 /* transfer raw input list to canonical list,
8270 * doing erase-kill processing and handling escapes.
8271 * It waits until a full line has been typed in cooked mode,
8272 * or until any character has been typed in raw mode.
8273 */
8274 canon(atp)
8275 struct tty *atp;
8276 {
8277     register char *bp;
8278     char *bp1;
8279     register struct tty *tp;
8280     register int c;
8281
8282     tp = atp;
8283     spl5();
8284     while (tp->t_delct==0) {
8285         if ((tp->t_state&CARR_ON)==0)
8286             return(0);
8287         sleep(&tp->t_rawq, TTIPRI);
8288     }
8289     spl0();
8290 loop:
8291     bp = &canonb[2];
8292     while ((c=getc(&tp->t_rawq)) >= 0) {
8293         if (c==0377) {
8294             tp->t_delct--;
8295             break;
8296         }
8297         if ((tp->t_flags&RAW)==0) {
8298             if (bp[-1]!='\\') {
8299                 if (c==tp->t_erase) {

```

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```

8300             if (bp > &canonb[2])
8301                 bp--;
8302             continue;
8303         }
8304         if (c==tp->t_kill)
8305             goto loop;
8306         if (c==CEOT)
8307             continue;
8308     } else
8309     if (maptab[c] && (maptab[c]==c || (tp->t_flags&LCASE))) {
8310         if (bp[-2] != '\\')
8311             c = maptab[c];
8312         bp--;
8313     }
8314     }
8315     *bp++ = c;
8316     if (bp>=canonb+CANBSIZ)
8317         break;
8318 }
8319 bp1 = bp;
8320 bp = &canonb[2];
8321 c = &tp->t_cang;
8322 while (bp<bp1)
8323     putc(*bp++, c);
8324 return(1);
8325 }
8326 /* ----- */
8327 /* Place a character on raw TTY input queue, putting in
8328 * delimiters and waking up top half as needed.
8329 * Also echo if required.
8330 * The arguments are the character and the appropriate
8331 * tty structure.
8332 */
8333 ttyinput(ac, atp)
8334 struct tty *atp;
8335 {
8336     register int t_flags, c;
8337     register struct tty *tp;
8338
8339     tp = atp;
8340     c = ac;
8341     t_flags = tp->t_flags;
8342     if ((c == 0177) == '\r' && t_flags&CRMOD)
8343         c = '\n';
8344     if ((t_flags&RAW)==0 && (c==CQUIT || c==CINTR)) {
8345         signal(tp, c==CINTR? SIGINT:SIGQUIT);
8346         flushtty(tp);
8347         return;
8348     }
8349     if (tp->t_rawq.c_cc>=TTYHOG) {

```

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```

8350         flushtty(tp);
8351         return;
8352     }
8353     if (t_flags&LCASE && c>='A' && c<='Z')
8354         c += 'a'-'A';
8355     putc(c, &tp->t_rawq);
8356     if (t_flags&RAW || c=='\n' || c==004) {
8357         wakeup(&tp->t_rawq);
8358         if (putc(0377, &tp->t_rawq)==0)
8359             tp->t_delct++;
8360     }
8361     if (t_flags&ECHO) {
8362         ttyoutput(c, tp);
8363         ttstart(tp);
8364     }
8365 }
8366 /* ----- */
8367 /* put character on TTY output queue, adding delays,
8368 * expanding tabs, and handling the CR/NL bit.
8369 * It is called both from the top half for output, and from
8370 * interrupt level for echoing.
8371 * The arguments are the character and the tty structure.
8372 */
8373 ttyoutput(ac, tp)
8374 struct tty *tp;
8375 {
8376     register int c;
8377     register struct tty *rtp;
8378     register char *colp;
8379     int ctype;
8380
8381     rtp = tp;
8382     c = ac&0177;
8383     /* Ignore EOT in normal mode to avoid hanging up
8384      * certain terminals.
8385     */
8386     if (c==004 && (rtp->t_flags&RAW)==0)
8387         return;
8388     /* Turn tabs to spaces as required
8389     */
8390     if (c=='\t' && rtp->t_flags&XTABS) {
8391         do
8392             ttyoutput(' ', rtp);
8393         while (rtp->t_col&07);
8394         return;
8395     }
8396     /* for upper-case-only terminals,
8397      * generate escapes.
8398     */
8399     if (rtp->t_flags&LCASE) {

```

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```

8400     colp = "({})!^~'\";
8401     while(*colp++)
8402         if(c == *colp++) {
8403             ttyoutput('\\"', rtp);
8404             c = colp[-2];
8405             break;
8406         }
8407     if ('a'<=c && c<='z')
8408         c += 'A' - 'a';
8409 }
8410 /* turn <nl> to <cr><lf> if desired.
8411 */
8412 if (c=='\n' && rtp->t_flags&CRMOD)
8413     ttyoutput('\r', rtp);
8414 if (putc(c, &rtp->t_outq))
8415     return;
8416 /* Calculate delays.
8417 * The numbers here represent clock ticks
8418 * and are not necessarily optimal for all terminals.
8419 * The delays are indicated by characters above 0200,
8420 * thus (unfortunately) restricting the transmission
8421 * path to 7 bits.
8422 */
8423 colp = &rtp->t_col;
8424 ctype = partab[c];
8425 c = 0;
8426 switch(ctype&077) {
8427 /* ordinary */
8428 case 0:
8429     (*colp)++;
8430 /* non-printing */
8431 case 1:
8432     break;
8433 /* backspace */
8434 case 2:
8435     if (*colp)
8436         (*colp)--;
8437     break;
8438 /* newline */
8439 case 3:
8440     ctype = (rtp->t_flags >> 8) & 03;
8441     if(ctype == 1) { /* tty 37 */
8442         if (*colp)
8443             c = max((*colp>>4) + 3, 6);
8444         } else
8445         if(ctype == 2) { /* vt05 */
8446             c = 6;
8447         }
8448     *colp = 0;
8449     break;

```

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```

8450 /* tab */
8451 case 4:
8452     ctype = (rtp->t_flags >> 10) & 03;
8453     if(ctype == 1) { /* tty 37 */
8454         c = 1 - (*colp | ~07);
8455         if(c < 5)
8456             c = 0;
8457     }
8458     *colp = | 07;
8459     (*colp)++;
8460     break;
8461 /* vertical motion */
8462 case 5:
8463     if(rtp->t_flags & VTDELAY) /* tty 37 */
8464         c = 0177;
8465     break;
8466 /* carriage return */
8467 case 6:
8468     ctype = (rtp->t_flags >> 12) & 03;
8469     if(ctype == 1) { /* tn 300 */
8470         c = 5;
8471     } else
8472     if(ctype == 2) { /* ti 700 */
8473         c = 10;
8474     }
8475     *colp = 0;
8476 }
8477 if(c)
8478     putc(c|0200, &rtp->t_outq);
8479 }
8480 /* ----- */
8481 /* Restart typewriter output following a delay
8482 * timeout.
8483 * The name of the routine is passed to the timeout
8484 * subroutine and it is called during a clock interrupt.
8485 */
8486 ttrstrt(atp)
8487 {
8488     register struct tty *tp;
8489
8490     tp = atp;
8491     tp->t_state = & ~TIMEOUT;
8492     ttstart(tp);
8493 }
8494 /* ----- */
8495 /* Start output on the typewriter. It is used from the top
8496 * half after some characters have been put on the output
8497 * queue, from the interrupt routine to transmit the next
8498 * character, and after a timeout has finished.
8499 * If the SSTART bit is off for the tty the work is done

```

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```

8500 * here, using the protocol of the single-line interfaces
8501 * (kl, dl, dc); otherwise the address word of the tty
8502 * structure is taken to be the name of the device-dependent
8503 * start-up routine.
8504 */
8505 ttstart(atp)
8506 struct tty *atp;
8507 {
8508     register int *addr, c;
8509     register struct tty *tp;
8510     struct { int (*func)(); };
8511
8512     tp = atp;
8513     addr = tp->t_addr;
8514     if (tp->t_state&SSTART) {
8515         (*addr.func)(tp);
8516         return;
8517     }
8518     if ((addr->tttcsr&DONE)==0 || tp->t_state&TIMEOUT)
8519         return;
8520     if ((c=getc(&tp->t_outq)) >= 0) {
8521         if (c<=0177)
8522             addr->tttbuf = c | (partab[c]&0200);
8523         else {
8524             timeout(ttrstrt, tp, c&0177);
8525             tp->t_state |= TIMEOUT;
8526         }
8527     }
8528 }
8529 /* ----- */
8530 /* Called from device's read routine after it has
8531 * calculated the tty-structure given as argument.
8532 * The pc is backed up for the duration of this call.
8533 * In case of a caught interrupt, an RTI will re-execute.
8534 */
8535 ttread(atp)
8536 struct tty *atp;
8537 {
8538     register struct tty *tp;
8539
8540     tp = atp;
8541     if ((tp->t_state&CARR_ON)==0)
8542         return;
8543     if (tp->t_canq.c_cc || canon(tp))
8544         while (tp->t_canq.c_cc && passc(getc(&tp->t_canq))>=0);
8545 }
8546 /* ----- */
8547 /* Called from the device's write routine after it has
8548 * calculated the tty-structure given as argument.
8549 */

```

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```

8550 ttwrite(atp)
8551 struct tty *atp;
8552 {
8553     register struct tty *tp;
8554     register int c;
8555     tp = atp;
8556     if ((tp->t_state&CARR_ON)==0)
8557         return;
8558     while ((c=cpass())>=0) {
8559         spl5();
8560         while (tp->t_outq.c_cc > TTHIWAT) {
8561             ttstart(tp);
8562             tp->t_state |= ASLEEP;
8563             sleep(&tp->t_outq, TTOPRI);
8564         }
8565         spl0();
8566         ttyoutput(c, tp);
8567     }
8568     ttstart(tp);
8569 }
8570 /* ----- */
8571 /* Common code for gtty and stty functions on typewriters.
8572 * If v is non-zero then gtty is being done and information
8573 * is passed back therein;
8574 * if it is zero stty is being done and the input inform-
8575 * ation is in the u_arg array.
8576 */
8577 ttystty(atp, av)
8578 int *atp, *av;
8579 {
8580     register *tp, *v;
8581     tp = atp;
8582     if (v = av) {
8583         *v++ = tp->t_speeds;
8584         v->lobyte = tp->t_erase;
8585         v->hibyte = tp->t_kill;
8586         v[1] = tp->t_flags;
8587         return(1);
8588     }
8589     wflushtty(tp);
8590     v = u.u_arg;
8591     tp->t_speeds = *v++;
8592     tp->t_erase = v->lobyte;
8593     tp->t_kill = v->hibyte;
8594     tp->t_flags = v[1];
8595     return(0);
8596 }
8597 /* ----- */
8598
8599

```

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```

8600 #
8601 /* PC-11 Paper tape reader/punch driver */
8602
8603 #include "../param.h"
8604 #include "../conf.h"
8605 #include "../user.h"
8606
8607 #define PCADDR 0177550
8608
8609 #define CLOSED 0
8610 #define WAITING 1
8611 #define READING 2
8612 #define EOF 3
8613
8614 #define RDRENB 01
8615 #define IENABLE 0100
8616 #define DONE 0200
8617 #define BUSY 04000
8618 #define ERROR 0100000
8619
8620 #define PCIPRI 30
8621 #define PCOPRI 40
8622 #define PCOLWAT 50
8623 #define PCOHWAT 100
8624 #define PCIHWAT 250
8625
8626 struct {
8627     int pcrcsr;
8628     int pcrbuf;
8629     int pcpcsr;
8630     int pcpbuf;
8631 };
8632 /* ----- */
8633
8634 struct clist {
8635     int cc;
8636     int cf;
8637     int cl;
8638 };
8639 /* ----- */
8640
8641 struct pc11 {
8642     int pcstate;
8643     struct clist pcin;
8644     struct clist pcout;
8645 } pc11;
8646 /* ----- */
8647
8648 pccopen(dev, flag)
8649 {

```

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```

8650     extern lbolt;
8651
8652     if (flag==0) {
8653         if (pc11.pcstate!=CLOSED) {
8654             u.u_error = ENXIO;
8655             return;
8656         }
8657         pc11.pcstate = WAITING;
8658         while(pc11.pcstate==WAITING) {
8659             PCADDR->pcrcsr = IENABLE|RDRENB;
8660             sleep(&lbolt, PCIPRI);
8661         }
8662     } else {
8663         PCADDR->pcpcsr = IENABLE;
8664         pcleader();
8665     }
8666 }
8667 /* ----- */
8668
8669 pcclose(dev, flag)
8670 {
8671     if (flag==0) {
8672         spl4();
8673         while (getc(&pc11.pcin) >= 0);
8674         PCADDR->pcrcsr = 0;
8675         pc11.pcstate = CLOSED;
8676         spl0();
8677     } else
8678         pcleader();
8679 }
8680 /* ----- */
8681
8682 pccread()
8683 {
8684     register int c;
8685
8686     spl4();
8687     do {
8688         while ((c = getc(&pc11.pcin)) < 0) {
8689             if (pc11.pcstate==EOF)
8690                 goto out;
8691             if ((PCADDR->pcrcsr&(ERROR|BUSY|DONE))==0)
8692                 PCADDR->pcrcsr = IENABLE|RDRENB;
8693             sleep(&pc11.pcin, PCIPRI);
8694         }
8695     } while (passc(c)>=0);
8696 out:
8697     spl0();
8698 }
8699 /* ----- */

```

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```

8700
8701 pcwrite()
8702 {
8703     register int c;
8704
8705     while ((c=cpass())>=0)
8706         pcoutput(c);
8707 }
8708 /* ----- */
8709
8710 pcstart()
8711 {
8712     register int c;
8713
8714     if (PCADDR->pcpcsr&DONE && (c = getc(&pc11.pcout)) >= 0)
8715         PCADDR->pcpbuf = c;
8716 }
8717 /* ----- */
8718
8719 pprint()
8720 {
8721     if (pc11.pcstate==WAITING) {
8722         if (PCADDR->pcrcsr&ERROR)
8723             return;
8724         pc11.pcstate = READING;
8725     }
8726     if (pc11.pcstate==READING) {
8727         if (PCADDR->pcrcsr&ERROR)
8728             pc11.pcstate = EOF;
8729         else {
8730             putc(PCADDR->pcrbuf, &pc11.pcin);
8731             if (pc11.pcin.cc < PCIHWAT)
8732                 PCADDR->pcrcsr = | IENABLE|RDRENB;
8733         }
8734         wakeup(&pc11.pcin);
8735     }
8736 }
8737 /* ----- */
8738
8739 pcpint()
8740 {
8741
8742     pcstart();
8743     if (pc11.pcout.cc <= PCOLWAT)
8744         wakeup(&pc11.pcout);
8745 }
8746 /* ----- */
8747
8748 pcoutput(c)
8749 {

```

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```

8750     if (PCADDR->pcpcsr&ERROR) {
8751         u.u_error = EIO;
8752         return;
8753     }
8754     if (pc11.pcout.cc >= PCOHWAT)
8755         sleep(&pc11.pcout, PCOPRI);
8756     putc(c, &pc11.pcout);
8757     spl4();
8758     pcstart();
8759     spl0();
8760 }
8761 /* ----- */
8762
8763 pcleader()
8764 {
8765     register int i;
8766
8767     i = 100;
8768     do
8769         pcoutput(0);
8770     while (--i);
8771 }
8772 /* ----- */
8773
8774
8775
8776
8777
8778
8779
8780
8781
8782
8783
8784
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```

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```

8800 #
8801 /*
8802 */
8803
8804 /*
8805 * LP-11 Line printer driver
8806 */
8807
8808 #include "../param.h"
8809 #include "../conf.h"
8810 #include "../user.h"
8811
8812 #define LPADDR 0177514
8813
8814 #define IENABLE 0100
8815 #define DONE 0200
8816
8817 #define LPPRI 10
8818 #define LPLWAT 50
8819 #define LPHWAT 100
8820 #define EJLINE 60
8821 #define MAXCOL 80
8822
8823 struct {
8824     int lpsr;
8825     int lpbuf;
8826 };
8827 /* ----- */
8828
8829 struct {
8830     int cc;
8831     int cf;
8832     int cl;
8833     int flag;
8834     int mcc;
8835     int ccc;
8836     int mlc;
8837 } lp11;
8838 /* ----- */
8839
8840 #define CAP 01 /* Set to 0 for 96-char printer,
8841                else to 01 */
8842 #define EJECT 02
8843 #define OPEN 04
8844 #define IND 010 /* Set to 0 for no indent,
8845                 else to 010 */
8846
8847 #define FORM 014
8848
8849

```

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```

8850 lpopen(dev, flag)
8851 {
8852
8853     if(lp11.flag & OPEN || LPADDR->lpsr < 0) {
8854         u.u_error = EIO;
8855         return;
8856     }
8857     lp11.flag |= (IND|EJECT|OPEN);
8858     LPADDR->lpsr |= IENABLE;
8859     lpcanon(FORM);
8860 }
8861 /* ----- */
8862
8863 lpclose(dev, flag)
8864 {
8865     lpcanon(FORM);
8866     lp11.flag = 0;
8867 }
8868 /* ----- */
8869
8870 lpwrite()
8871 {
8872     register int c;
8873
8874     while ((c=cpass())>=0)
8875         lpcanon(c);
8876 }
8877 /* ----- */
8878
8879 lpcanon(c)
8880 {
8881     register c1, c2;
8882
8883     c1 = c;
8884     if(lp11.flag&CAP) {
8885         if(c1>='a' && c1<='z')
8886             c1 =+ 'A'-'a'; else
8887         switch(c1) {
8888
8889             case '{':
8890                 c2 = '(';
8891                 goto esc;
8892
8893             case '}':
8894                 c2 = ')';
8895                 goto esc;
8896
8897             case '`':
8898                 c2 = '\';
8899                 goto esc;

```

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```

8900
8901     case '|':
8902         c2 = '!';
8903         goto esc;
8904
8905     case '~':
8906         c2 = '^';
8907
8908     esc:
8909         lp canon(c2);
8910         lp11.ccc--;
8911         c1 = '-';
8912     }
8913 }
8914
8915 switch(c1) {
8916
8917 case '\t':
8918     lp11.ccc = (lp11.ccc+8) & ~7;
8919     return;
8920
8921 case FORM:
8922 case '\n':
8923     if((lp11.flag&EJECT) == 0 ||
8924         lp11.mcc!=0 || lp11.mlc!=0) {
8925         lp11.mcc = 0;
8926         lp11.mlc++;
8927         if(lp11.mlc >= EJLINE && lp11.flag&EJECT)
8928             c1 = FORM;
8929         lpoutput(c1);
8930         if(c1 == FORM)
8931             lp11.mlc = 0;
8932     }
8933
8934 case '\r':
8935     lp11.ccc = 0;
8936     if(lp11.flag&IND)
8937         lp11.ccc = 8;
8938     return;
8939
8940 case 010:
8941     if(lp11.ccc > 0)
8942         lp11.ccc--;
8943     return;
8944
8945 case ' ':
8946     lp11.ccc++;
8947     return;
8948
8949 default:

```

```

8950     if(lp11.ccc < lp11.mcc) {
8951         lpoutput('\r');
8952         lp11.mcc = 0;
8953     }
8954     if(lp11.ccc < MAXCOL) {
8955         while(lp11.ccc > lp11.mcc) {
8956             lpoutput(' ');
8957             lp11.mcc++;
8958         }
8959         lpoutput(c1);
8960         lp11.mcc++;
8961     }
8962     lp11.ccc++;
8963 }
8964 }
8965 /* ----- */
8966
8967 lpstart()
8968 {
8969     register int c;
8970
8971     while (LPADDR->lpsr&DONE && (c = getc(&lp11)) >= 0)
8972         LPADDR->lpbuf = c;
8973 }
8974 /* ----- */
8975
8976 lpint()
8977 {
8978     register int c;
8979
8980     lpstart();
8981     if (lp11.cc == LPLWAT || lp11.cc == 0)
8982         wakeup(&lp11);
8983 }
8984 /* ----- */
8985
8986 lpoutput(c)
8987 {
8988     if (lp11.cc >= LPHWAT)
8989         sleep(&lp11, LPPRI);
8990     putc(c, &lp11);
8991     spl4();
8992     lpstart();
8993     spl0();
8994 }
8995 /* ----- */
8996
8997
8998
8999

```

```

9000 #
9001 /*
9002 */
9003
9004 /*
9005  * Memory special file
9006  * minor device 0 is physical memory
9007  * minor device 1 is kernel memory
9008  * minor device 2 is EOF/RATHOLE
9009 */
9010
9011 #include "../param.h"
9012 #include "../user.h"
9013 #include "../conf.h"
9014 #include "../seg.h"
9015
9016 mmread(dev)
9017 {
9018     register c, bn, on;
9019     int a, d;
9020
9021     if(dev.d_minor == 2)
9022         return;
9023     do {
9024         bn = lshift(u.u_offset, -6);
9025         on = u.u_offset[1] & 077;
9026         a = UISA->r[0];
9027         d = UISD->r[0];
9028         spl7();
9029         UISA->r[0] = bn;
9030         UISD->r[0] = 077406;
9031         if(dev.d_minor == 1)
9032             UISA->r[0] = (ka6-6)->r[(bn>>7)&07]
9033                 + (bn & 0177);
9034         c = fuibyte(on);
9035         UISA->r[0] = a;
9036         UISD->r[0] = d;
9037         spl0();
9038     } while(u.u_error==0 && passc(c)>=0);
9039 }
9040 /* ----- */
9041
9042 mmwrite(dev)
9043 {
9044     register c, bn, on;
9045     int a, d;
9046
9047     if(dev.d_minor == 2) {
9048         c = u.u_count;
9049         u.u_count = 0;

```

```

9050     u.u_base += c;
9051     dpadd(u.u_offset, c);
9052     return;
9053 }
9054 for(;;) {
9055     bn = lshift(u.u_offset, -6);
9056     on = u.u_offset[1] & 077;
9057     if ((c=cpass())<0 || u.u_error!=0)
9058         break;
9059     a = UISA->r[0] = bn;
9060     d = UISD->r[0] = 077406;
9061     spl7();
9062     UISA->r[0];
9063     UISD->r[0];
9064     if(dev.d_minor == 1)
9065         UISA->r[0] = (ka6-6)->r[(bn>>7)&07]
9066             + (bn & 0177);
9067     suibyte(on, c);
9068     UISA->r[0] = a;
9069     UISD->r[0] = d;
9070     spl0();
9071 }
9072 }
9073 /* ----- */
9074
9075
9076
9077
9078
9079
9080
9081
9082
9083
9084
9085
9086
9087
9088
9089
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```