

TO: MTB Distribution
FROM: Roger A. Roach
DATE: October 12, 1974
SUBJECT: Revision of Multics Performance Tests

I. Description of First Version

The first version of the performance test (also called the acceptance test) was written by Jayne Keller based on a similar program by Douglas Hunt. The purpose of this test was to satisfy the contractual requirements for the acceptance of the 6180 Multics. This test consisted of one script which was read through a special DIM by multiple absentee processes. This DIM is initialized by a call to `acceptance_test$init` in the script. This call also signaled the master process (one which submitted the absentee requests) and then went blocked. When the master process received a signal from each process it had started, it reset some system meters (ttm, pmlm, fsm and dvm) and then signaled the processes to start. In each process, the DIM then read a line from the script inserting a random delay (between two figures as specified by the controlling process) between each line read. This delay was intended to simulate actual think times to keep the various processes from getting in sync. (This did not perform as well as intended, see problem #1 below.) As each process finished the script, it signaled the master process that it was done, storing its total usage figures in a data array. When all processes completed, the master process printed out the system meters as well as total usage figures.

The script itself consisted of two parts. The first part was a functional test of almost all of the commands in the MPM (revision 12). The second part was a script written in an attempt to simulate actual usage of the editors, compilers, binder and debugger. The reason why a script was used instead of a random selection of commands from a table was that it was feared that unless the test was able to run for a very long period of time, the variations in the actual commands executed would be larger than the difference we were trying to measure. (Just one extra large compilation could cause the meters to vary as much as 2%.)

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Initial settings had twenty users logged in with "think" times of between two and fifteen seconds. Even with these settings, the script took over six hours to run on the 645 (as compared to 90 minutes on the 6180). Since then, this script has been used to measure performance changes in systems installed on the 6180. We have identified the following problems with this script:

1. The script did get in sync and most of the compilations were run at the same time in each process. It is felt that this problem could be greatly reduced if the processes were given interactive credit when they "wake up". Also having more than one script would help eliminate any synchronization. (It could be totally eliminated by having a unique script per process.)
2. Lack of heavy paging activity kept the script from accurately simulating actual usage. (The script only read/wrote about 5000 pages to and from the disks during the hour and a half running time.)
3. The small number of users (20) also kept the system from approaching the normal load in the scheduling area. It was recognized early that a larger number of users would be desirable, but the number could not be increased without greatly increasing the time spent on the 645 or decreasing the overall load of the test on a per process basis.
4. The tests started to show relatively large amounts of zero idle (13%) and thus changes in performance were harder to detect. (A 10% change in performance would only show as a 8% or 9% change depending on where it was located.)
5. Lack of a large working set kept the script from testing the linker under realistic conditions. This problem is hard to solve using only code installed in the system libraries. Under actual usage, the users are using their own programs and subsystems to create a much large combined working set than would be possible by using only the system commands. However, since the tests need code that will continue to work from test to test, it can not incorporate commands not installed in the system libraries.
6. Since Backup is not running during the tests, both the tape system and directory control are not measured. The reason Backup is not run is that the tests are run on the standard hierarchy and there is no "control" hierarchy that could be used to create a consistent test.

7. Since the tests are all run under absentee, the typewriter DIM is not used and thus the script can not detect changes in its performance. A way of solving this problem is to have a driving computer (perhaps the 355) feeding the input lines through the typewriter channels.

II. Description of Second Version

To help solve problem #1 above, five scripts were created out of the one script. The first portion of the old script was discarded as it was of doubtful usefulness and was difficult to maintain with changes being made to the system. Four copies of the second portion were made, each slightly different (a line was inserted at the front of each script invoking a different compiler to keep the script from getting in sync, but still keeping each script about equal in overall length). A fifth script was created with just compilations and flushes to create a heavy load on the system, especially in the paging area. This script was tuned to have it complete within fifteen minutes of the other scripts to avoid the zero idle. By reducing the size of the script (by removing the function test), the number of scripts run at a time was able to be increased to forty. This coupled with the setting of tmax at one second has helped increase the paging and scheduling load so that it more closely approximates actual usage. Problems five thru seven were deemed too difficult to solve at this time. Therefore, an attempt will be made to determine the effect of changes in the dumper or tty DIM and to change the goal by an appropriate amount.

III. Calibrating the New Tests

Exact calibration of the new test (script2) with the old test (script1) is not possible for the older systems (especially 23.3) as changes had been made in the online system which depended upon changes in the hardware system and the test uses the current hierarchy. Therefore sets of tests were made on systems 23.12 and beyond to attempt to obtain a ratio that could be used for extrapolating back to 23.3 to get revised performance goals. The goal as outlined in MTB-987 was to get a 50% improvement on system 23.3. Although this improvement is to be measured in elapsed time, it was felt useful to present the goal in terms of virtual CPU time, total CPU time, page faults and memory units. (A 50% improvement in any of these areas would be highly significant.) In order to obtain these ratios, the tests were run with identical systems and identical configurations on at least seven systems. The ratios for each run were

calculated and tabulated (see Appendix A). The highest and lowest values were discarded and then an average taken of the remainder. The results are presented below. For each of the five areas of concern, the following numbers are given: 1) the 23.3 values using the old script, 2) the ratio of the old script values to the new script values and 3) the new goal (is $.5 * 23.3$ values / ratio).

	23.3 values	ratio	goal
Elapsed Time:	104.5 min	.881	59.3 min
Virtual CPU:	3844 sec	.912	2107 sec
Total CPU:	5495 sec	.813	3379 sec
Page Faults:	531088	.805	329868
Memory Units:	43282	.950	22780

N.B. The 23.3 run was made on one disk channel and with directory write-through turned on. Most runs on newer systems are run on two disk channels and without write-through.

IV. Current Status

The following table shows the current status of meeting our performance goals as of system 24.0a:

	23.3 *	goal	24.0a	% to goal
Elapsed Time:	118.6 min	59.3 min	93.1 min	43.0%
Virtual CPU:	4215 sec	2107 sec	3369 sec	40.2%
Total CPU:	6759 sec	3379 sec	5148 sec	47.7%
Page Faults:	659737	329868	522747	41.5%
Memory Units:	45560	22780	37257	36.4%

* adjusted (23.3 old script value / ratio)

Appendix A

Table of Ratios (script1/script2)

system	dates	Elapsed Time	Virtual CPU	Total CPU	Page Faults	Memory Units
23.12a	07/03 ----- 07/01	.885	.940*	.834*	.784	.948
23.13a	07/22 ----- 07/14	.896	.904	.813	.817	.950
23.13a	07/25 ----- 07/27	.864*	.900*	.795	.777	.935
23.13a	07/29 ----- 07/29	.883	.902	.791*	.771*	.927*
23.14c	08/07 ----- 08/03	.872	.917	.819	.834*	.972*
23.14c	08/07 ----- 08/08	.871	.918	.819	.832	.970
23.15a	08/24 ----- 08/25	.921*	.921	.818	.814	.948
Average ratio:		.881	.912	.813	.805	.950
Standard Deviation:		.010	.009	.010	.023	.013

* ratio discarded as being on low or high end.

Appendix B

Metering Results

The following pages contain the summaries of the metering runs. Future pages will be issued as MTB's for approximately every eight runs or whenever a significant change occurs.

Metering Comparisons for 21.3a, 21.3c, 21.4a, 21.8a, 22.0a

System:	21.3a	21.3c	21.4a	21.8a	21.8a	22.0a	22.0a
Date:	11/18/73	11/24/73	12/01/73	01/14/74	01/14/74	01/21/74	01/21/74
Write-through status:	none	dirs	none	dirs	none	none	dirs
Device Checking:	none	1	1	1	1	1	1
Reused Address Check:	OFF	OFF	OFF	OFF	OFF	OFF	OFF
TTY tracing:	2	OFF	OFF	OFF	OFF	OFF	OFF
Paging Device Size:	2048K	2048K	2048K	2048K	2048K	2048K	2048K
Elapsed Time:	91.6 min	96.1 min	92.6 min	93.0 min	91.7 min	93.3 min	94.3 min
Costs (shift 1):	\$733.14	\$784.72	\$770.05	\$764.71	\$750.63	\$762.83	\$779.41
Costs (shift 2):	\$670.54	\$721.46	\$707.93	\$702.62	\$688.59	\$700.86	\$717.25
Costs (shift 3):	\$576.65	\$626.58	\$614.74	\$609.49	\$595.52	\$607.90	\$624.01
CPU, total:	4805 sec	5081 sec	4864 sec	4975 sec	4871 sec	4896 sec	5041 sec
CPU, virtual:	3756 sec	3795 sec	3727 sec	3725 sec	3722 sec	3718 sec	3729 sec
CPU, good (1):	3876 sec	3933 sec	3823 sec	3830 sec	3799 sec	3752 sec	3787 sec
Memory Units:	30098	33338	32700	32354	31429	32264	33313
Page Faults:	375078	408798	396836	400224	390169	400351	418517

ttm meters:

Page Faults:	16.62%	19.46%	18.27%	19.52%	18.52%	18.61%	20.11%
Getwork:	1.64%	1.37%	1.38%	1.39%	1.38%	1.35%	1.38%
Seg Faults:	0.08%	0.04%	0.34%	0.23%	0.34%	0.98%	0.81%
Bound Faults:	-0.03%	-0.02%	0.01%	-0.04%	-0.01%	0.01%	0.01%
Interrupts:	1.47%	2.22%	1.25%	2.00%	1.32%	1.36%	2.10%
Idle, zero:	9.53%	8.55%	9.86%	8.10%	9.27%	10.55%	8.47%
Idle, MP:	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%
Idle, NMP:	0.14%	0.14%	0.12%	0.14%	0.10%	0.09%	0.19%
Idle, total:	9.67%	8.70%	9.98%	8.24%	9.37%	10.64%	8.67%
Other (good):	70.55%	68.24%	68.78%	68.65%	69.07%	67.05%	66.94%

dvm meters:

Bulk Reads:	381857	420245	401757	405714	393699	402044	423363
Bulk Writes:	168767	173475	174689	168641	174484	175675	174484
Bulk ATB I/O:	10.000	9.756	9.653	9.724	9.697	9.698	9.480
Bulk Avg. Page Wait:	.588	.655	.575	.650	.588	.587	.652
D190 Reads:	5277	5438	5584	5614	5925	6681	6672
D190 Writes:	3709	38839	3853	36811	4184	4222	37145
D190 ATB I/O:	612.758	130.817	589.628	131.651	545.020	513.860	129.346
D190 Avg. Page Wait:	30.833	37.500	30.643	41.099	30.620	30.851	46.136

Notes:

(1) Based on Elapsed Time * percentage good (ttm meters)

Metering Comparisons for 22.0a, 23.2, 23.3, 23.4a, 23.5b

System:	22.0a	23.2	23.3	23.4a	23.5b	23.5b	23.5b	23.5b	23.5b
Date:	01/21/74	02/25/74	02/25/74	02/28/74	03/11/74	03/13/74	03/16/74	03/17/74	03/18/74
Write-through status:	dirs	dirs	dirs	dirs	dirs	dirs	dirs	dirs	dirs
Device Checking:	1	1	1	1	1	1	1	1	1
Disk Channels:	1	2	2	2	2	2	2	2	2
SYST card:	0	0	0	0	2	2	0	0	0
TEFIRST	1	1	1	1	1	1	2	1	1
TELAST	1	1	1	1	1	1	2	1	1
Interface:	none	none	none	none	none	2-way	none	none	2-way
Paging Device Size:	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K
Elapsed Time:	94.3 min	102.7 min	104.5 min	104.2 min	104.4 min	104.4 min	100.3 min	101.6 min	100.9 min
Costs (shift 1):	\$779.41	\$859.81	\$937.56	\$946.99	\$960.34	\$949.59	\$900.21	\$959.42	\$942.07
Costs (shift 2):	\$717.25	\$796.33	\$873.49	\$882.89	\$896.42	\$885.91	\$837.40	\$896.05	\$879.31
Costs (shift 3):	\$624.01	\$701.10	\$777.38	\$786.74	\$800.55	\$790.39	\$743.17	\$800.99	\$785.17
CPU, total:	5041 sec	5323 sec	5495 sec	5583 sec	5568 sec	5566 sec	5326 sec	5494 sec	5413 sec
CPU, virtual:	3729 sec	3809 sec	3844 sec	3845 sec	3835 sec	3821 sec	3769 sec	3803 sec	3766 sec
CPU, good (1):	3787 sec	3837 sec	3860 sec	3905 sec	3949 sec	3943 sec	3893 sec	3924 sec	3871 sec
Memory Units:	33313	38276	43282	43903	44848	44202	41169	44949	43977
Page Faults:	418517	474469	531088	541744	551310	553807	505820	547945	538499

ftm meters:

Page Faults:	20.11%	20.57%	22.39%	23.18%	23.88%	24.07%	22.86%	24.50%	23.93%
Getwork:	1.38%	1.28%	1.33%	1.47%	1.61%	1.56%	1.23%	1.34%	1.33%
Seg Faults:	0.81%	0.39%	0.33%	0.28%	-0.07%	-0.10%	0.24%	0.25%	0.18%
Bound Faults:	0.01%	-0.01%	-0.01%	-0.02%	-0.08%	-0.06%	-0.05%	-0.03%	-0.04%
Interrupts:	2.10%	2.46%	2.36%	3.29%	2.56%	2.47%	2.38%	2.31%	2.25%
Idle, zero:	8.47%	12.74%	11.60%	9.05%	8.82%	9.00%	8.36%	6.99%	8.18%
Idle, MP:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Idle, NMP:	0.19%	0.34%	0.41%	0.31%	0.20%	0.12%	0.25%	0.29%	0.25%
Idle, total:	8.67%	13.08%	12.01%	9.36%	9.02%	9.12%	8.61%	7.28%	8.43%
Other (good):	66.94%	62.24%	61.57%	62.44%	63.06%	62.93%	64.72%	64.36%	63.92%

dvm meters:

Bulk Reads:	423363	490611	552235	574167	559446	561864	517298	557376	544759
Bulk Writes:	174484	196770	214950	221333	212674	211561	196270	209788	208442
Bulk ATB I/O:	9.480	9.356	8.605	8.291	8.127	8.118	8.437	7.955	8.048
Bulk Avg. Page Wait:	.652	.654	.654	.654	.655	.661	.653	.657	.657
Bulk EDAC Corr Errors:	0	18863	14609	0	0	0	0	0	0
D190 Reads:	6672	8180	9208	9248	9303	8992	8529	9098	8928
D190 Writes:	37145	43831	46999	48911	47143	48958	44749	47523	46760
D190 ATB I/O:	129.346	123.650	117.455	113.410	111.165	108.340	113.003	107.786	108.851
D190 Avg. Page Wait:	46.136	43.657	45.411	43.638	42.820	39.963	39.962	43.646	42.453

Notes:

(1) Based on Elapsed Time * percentage good (ftm meters)

Metering Comparisons for 23.5b, 23.6, 23.7

System:	23.5b	23.6	23.6	23.6	23.6	23.7	23.6	23.6
Date:	03/18/74	03/21/74	03/24/74	03/25/74	04/03/74	04/04/74	04/06/74	04/07/74
Write-through status:	dirs	dirs	dirs	dirs	dirs	dirs	dirs	dirs
Device Checking:	1	1	1	1	1	1	1	1
Disk Channels:	2	1	2	2	2	2	2	2
SYST Card:	0	0	0	0	0	0	0	0
TEFIRST:	1	1	1	1	1	1	1	1
TELAST:	1	1	1	1	1	1	1	1
Reset Working Set:	on	on	off	on	on	on	on	on
External Interface:	2-way	none	none	none	none	none	none	none
Paging Device Size:	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K

Elapsed Time:	100.9 min	104.8 min	102.3 min	101.1 min	101.4 min	101.0 min	100.0 min	96.9 min
Costs (shift 1):	\$942.07	\$959.87	\$947.30	\$936.65	\$940.71	\$946.18	\$987.30	\$887.98
Costs (shift 2):	\$879.31	\$896.33	\$884.39	\$873.70	\$878.00	\$883.34	\$926.70	\$827.01
Costs (shift 3):	\$785.17	\$801.01	\$790.01	\$779.29	\$783.94	\$789.08	\$835.80	\$735.57
CPU, total:	5413 sec	5538 sec	5419 sec	5409 sec	5387 sec	5416 sec	5408 sec	5201 sec
CPU, virtual:	3766 sec	3813 sec	3775 sec	3776 sec	3763 sec	3770 sec	3636 sec	3658 sec
CPU, good (1):	3871 sec	3932 sec	3886 sec	3887 sec	3879 sec	3878 sec	3744 sec	3733 sec
Memory Units:	43977	44928	44278	43560	43901	44227	47640	40909
Page Faults:	538499	552578	537923	534128	530239	534925	578445	499525

tfm meters:

Page Faults:	23.93%	24.01%	23.57%	23.73%	23.43%	23.64%	25.97%	23.21%
Getwork:	1.33%	1.33%	1.32%	1.36%	1.30%	1.43%	1.38%	1.33%
Seg Faults:	0.18%	0.19%	0.23%	0.17%	0.24%	0.11%	0.17%	0.26%
Bound Faults:	-0.04%	-0.04%	-0.05%	-0.02%	-0.02%	-0.04%	-0.04%	-0.03%
Interrupts:	2.25%	2.46%	2.21%	2.23%	2.24%	2.39%	2.54%	2.13%
Idle, zero:	8.18%	9.27%	9.15%	8.18%	8.76%	8.19%	7.24%	8.60%
Idle, MP:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Idle, NMP:	0.25%	0.26%	0.25%	0.24%	0.31%	0.29%	0.34%	0.27%
Idle, total:	8.43%	9.53%	9.40%	8.42%	9.07%	8.48%	7.58%	8.87%
Other (good):	63.92%	62.51%	63.30%	64.11%	63.74%	64.00%	62.40%	64.23%

dvm meters:

Bulk Reads:	544759	562434	545682	541447	537481	541493	587324	502501
Bulk Writes:	208442	214052	208686	207953	204277	207285	225226	198879
Bulk ATB I/O:	8.048	8.120	8.144	8.473	8.208	8.105	7.392	8.301
Bulk Avg. Page Wait:	.657	.657	.653	.654	.654	.650	.654	.653
D191 Reads:	8928	9467	8661	9037	8652	8890	9398	8281
D191 Writes:	46760	47760	47015	46556	46597	46844	50177	43587
D191 ATB I/O:	108.851	110.176	110.342	110.044	110.200	108.895	100.822	112.252
D191 Avg. Page Wait:	42.453	45.065	45.101	41.423	42.211	41.910	49.355	39.814

Notes:

(1) Based on Elapsed Time * percentage good (tfm meters)

Metering Comparisons for 23.6, 23.7, 23.8, 23.9, 23.9a

System:	23.6	23.6	23.7	23.8	23.8	23.8	23.9T	23.9a
Date:	04/07/74	04/08/74	04/14/74	04/20/74	04/21/74	04/23/74	04/28/74	05/05/74
Write-through status:	dirs	dirs	dirs	dirs	dirs	dirs	dirs	dirs
Device Checking:	1	1	1	1	1	1	1	1
CPU:	B	A	A	A	A	A	A	A
Memories:	A,B	A,B	A,B	A,B	A,B	A,B	A,B	A,B
External Interlace:	none	none	none	none	none	none	none	none
Paging Device Size:	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K
Disk Channels:	2	2	2	2	2	2	2	2
Online EIS Operators:	no	no	yes	yes	no	no	no	no

Elapsed Time:	96.9 min	96.2 min	96.2 min	93.7 min	93.6 min	95.0 min	91.8 min	89.2 min
Costs (shift 1):	\$887.98	\$889.39	\$884.30	\$881.58	\$859.59	\$846.79	\$794.81	\$798.35
Costs (shift 2):	\$827.01	\$829.00	\$824.22	\$823.24	\$801.40	\$788.59	\$736.80	\$742.49
Costs (shift 3):	\$735.57	\$738.43	\$734.10	\$735.72	\$714.12	\$701.30	\$649.79	\$658.69
CPU, total:	5201 sec	5160 sec	5111 sec	5045 sec	4993 sec	4975 sec	4782 sec	4696 sec
CPU, virtual:	3658 sec	3623 sec	3605 sec	3501 sec	3491 sec	3492 sec	3480 sec	3352 sec
CPU, good (1):	3733 sec	3713 sec	3718 sec	3446 sec	3436 sec	3451 sec	3402 sec	3274 sec
Memory Units:	40909	41178	40929	41269	39850	38994	35585	36464
Page Faults:	499525	504261	494747	510085	495276	486576	425098	439061

ttm meters:

Page Faults:	23.21%	23.41%	22.85%	24.22%	23.56%	22.93%	20.76%	22.04%
Getwork:	1.33%	1.34%	1.38%	1.34%	1.34%	1.35%	1.34%	1.39%
Seg Faults:	0.26%	0.28%	0.10%	2.69%	2.79%	2.65%	2.99%	2.92%
Bound Faults:	-0.03%	-0.01%	-0.05%	0.22%	0.23%	0.22%	0.22%	0.22%
Interrupts:	2.13%	2.11%	2.15%	2.14%	2.20%	2.27%	2.08%	2.07%
Idle, zero:	8.60%	7.11%	9.00%	7.90%	8.44%	9.81%	10.71%	10.00%
Idle, MP:	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Idle, NMP:	0.27%	1.42%	0.15%	0.23%	0.25%	0.24%	0.13%	0.21%
Idle, total:	8.87%	8.54%	9.15%	8.13%	8.69%	10.05%	10.84%	10.21%
Other (good):	64.23%	64.35%	64.41%	61.26%	61.20%	60.53%	61.76%	61.15%

dvm meters:

Bulk Reads:	502501	509032	501663	516618	503086	495879	432869	444506
Bulk Writes:	198879	201225	194680	200553	191728	190599	171040	176510
Bulk ATB I/O:	8.301	8.137	8.295	7.853	8.090	8.311	9.126	8.633
Bulk Avg. Page Wait:	.653	.652	.646	.649	.649	.649	.645	.647
D191 Reads:	8281	8048	6813	7721	7627	7845	5971	6962
D191 Writes:	43587	44137	43544	44798	43628	43004	38375	38842
D191 ATB I/O:	112.252	110.753	114.707	107.241	109.665	112.206	124.283	117.043
D191 Avg. Page Wait:	39.814	46.795	35.807	41.071	41.559	38.601	31.460	38.052

Notes:

(1) Based on Elapsed Time * percentage good (ttm meters)

(2) The EIS fortran and PL/I compilers were installed May 1, 1974

Metering Comparisons for 23.9a, 23.10, 23.10a

System:	23.9a	23.9a	23.10	23.10a
Date:	05/05/74	05/12/74	05/18/74	06/01/74
Write-through status:	dirs	dirs	dirs	dirs
Device Checking:	1	1	1	1
CPU:	A	A	A	A
Memories:	A,B	A,B	A,B	A,B
External Interface:	none	none	none	none
Paging Device Size:	2048K	2048K	2048K	2048K
Disk Channels:	2	2	2	2
Online EIS Operators:	no	no	no	no
Elapsed Time:	89.2 min	87.5 min	86.8 min	87.8 min
Costs (shift 1):	\$798.35	\$801.36	\$767.10	\$765.47
Costs (shift 2):	\$742.49	\$745.78	\$711.06	\$709.16
Costs (shift 3):	\$658.69	\$662.39	\$627.01	\$624.69
CPU, total:	4696 sec	4661 sec	4498 sec	4508 sec
CPU, virtual:	3352 sec	3335 sec	3362 sec	3379 sec
CPU, good (1):	3274 sec	3273 sec	3224 sec	3253 sec
Memory Units:	36464	36748	34329	34138
Page Faults:	439061	437423	415164	411510

tfm meters:

Page Faults:	22.04%	22.35%	19.19%	18.97%
Getwork:	1.39%	1.30%	1.49%	2.10%
Seg Faults:	2.92%	2.96%	2.96%	2.92%
Bound Faults:	0.22%	0.23%	0.29%	0.30%
Interrupts:	2.07%	2.11%	1.95%	2.01%
Idle, zero:	10.00%	8.46%	12.04%	11.73%
Idle, MP:	0.00%	0.00%	0.00%	0.02%
Idle, NMP:	0.21%	0.23%	0.16%	0.22%
Idle, total:	10.21%	8.69%	12.20%	11.97%
Other (good):	61.15%	62.36%	61.92%	61.75%

dvm meters:

Bulk Reads:	444506	445862	420287	421177
Bulk Writes:	176510	174049	219487	222737
Bulk ATB I/O:	8.633	8.479	8.143	8.185
Bulk Avg. Page Wait:	.647	.646	.633	.616
D191 Reads:	6962	6088	6602	6646
D191 Writes:	38842	38979	28392	27216
D191 ATB I/O:	117.043	116.628	148.875	155.653
D191 Avg. Page Wait:	38.052	39.414	36.121	41.789

Notes:

(1) Based on Elapsed Time * percentage good (tfm meters)

Metering Comparisons for 23.12a, 23.13, 23.13a

System:	23.12a	23.12a	23.12a	23.12a	23.13	23.13a	23.13a	23.13a	23.13a
Date:	07/01/74	07/03/74	07/06/74	07/07/74	07/11/74	07/13/74	07/14/74	07/14/74	07/22/74
Script:	script2	script1	script2	script2	script2	script1	script2	script2	script1
Write-through status:	dirs	dirs	none	dirs	none	none	dirs	dirs	dirs
Device Checking:	1	1	1	1	1	1	1	1	1
CPU:	A	A	A	B	B	A	A	A	A
Memories:	A,B	A,B	B,C	B,C	B,C	A,B	A,B	A,B	A,B
External Interface:	off	off	off	off	off	off	off	off	off
Paging Device Size:	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K
Disk Channels:	2,4	2,4	2,4	2,4	2,4	2,4	2,4	2,8	2,8
Elapsed Time:	97.8 min	86.6 min	95.6 min	99.7 min	97.7 min	83.5 min	96.1 min	97.2 min	87.1 min
Costs (shift 1):	\$976.96	\$923.81	\$988.86	\$995.41	\$1020.83	\$883.29	\$977.86	\$977.88	\$915.20
Costs (shift 2):	\$804.17	\$760.47	\$814.18	\$819.47	\$840.76	\$727.24	\$805.06	\$805.07	\$753.79
Costs (shift 3):	\$420.92	\$398.09	\$426.33	\$429.02	\$440.46	\$380.80	\$421.51	\$421.51	\$394.91
CPU, total:	5443 sec	4542 sec	5358 sec	5569 sec	5453 sec	4216 sec	5318 sec	5403 sec	4394 sec
CPU, virtual:	3589 sec	3372 sec	3555 sec	3614 sec	3575 sec	3179 sec	3536 sec	3539 sec	3198 sec
CPU, good (1):	3528 sec	3260 sec	3508 sec	3573 sec	3503 sec	3053 sec	3479 sec	3495 sec	3068 sec
Memory Units:	37662	35710	38477	38566	40161	34352	37953	37943	36040
Page Faults:	545980	427964	555215	561393	573269	408233	524773	530750	433491

tfm meters:

Page Faults:	26.52%	19.90%	26.76%	27.25%	27.24%	18.85%	26.04%	27.26%	20.35%
Getwork:	2.40%	2.16%	2.50%	2.42%	2.47%	2.15%	2.46%	2.40%	2.19%
Seg Faults:	2.58%	2.88%	2.59%	2.54%	2.75%	2.96%	2.61%	2.59%	2.98%
Bound Faults:	0.50%	0.29%	0.50%	0.49%	0.50%	0.31%	0.50%	0.50%	0.30%
Interrupts:	4.62%	2.06%	4.00%	4.85%	4.15%	1.35%	4.59%	4.41%	1.97%
Idle, zero:	0.23%	9.77%	0.13%	0.29%	0.41%	13.22%	0.23%	0.33%	13.31%
Idle, MP:	2.81%	0.01%	2.17%	2.24%	2.49%	0.02%	3.06%	2.41%	0.03%
Idle, NMP:	0.02%	0.21%	0.04%	0.04%	0.03%	0.16%	0.04%	0.02%	0.21%
Idle, Loading:	0.20%	0.00%	0.17%	0.19%	0.20%	0.00%	0.16%	0.15%	0.00%
Idle, total:	3.26%	9.99%	2.51%	2.76%	3.19%	13.40%	3.49%	2.90%	13.55%
Other (good):	60.13%	62.72%	61.15%	59.70%	59.76%	60.98%	60.31%	59.93%	58.67%

dvm meters:

Bulk Reads:	548743	439352	561271	568411	580431	418634	531407	540665	442886
Bulk Writes:	300168	223214	300035	305814	308525	213215	286231	292691	227555
Bulk ATB I/O:	6.925	7.857	6.662	6.858	6.608	7.930	7.071	7.004	7.802
Bulk Avg. Page Wait:	.625	.619	.572	.629	.577	.557	.620	.633	.632
D191 Reads:	51519	6738	54003	55701	55983	5854	49038	49610	7199
D191 Writes:	73681	28647	48316	77823	50131	4624	70901	71067	29621
D191 ATB I/O:	46.955	147.129	56.079	44.905	55.361	478.257	48.207	48.368	142.072
D191 Avg. Page Wait:	48.704	39.435	42.900	47.594	44.244	30.201	49.180	47.969	40.186

Notes:

(1) Based on Elapsed Time * percentage good (tfm meters)

Metering Comparisons for 23.13a, 23.13b, 23.14a, 23.14c

System:	23.13a	23.13b	23.13a	23.13b	23.13b	23.14a	23.14a	23.14a	23.14c
Date:	07/22/74	07/25/74	07/27/74	07/29/74	07/29/74	07/31/74	08/01/74	08/03/74	08/07/74
Script:	script1	script1	script2	script1	script2	script2	script2	script2	script1
Write-through status:	dirs	none	none	dirs	dirs	none	dirs	none	none
Device Checking:	1	1	1	1	1	1	1	1	1
CPU:	A	A	A	A	A	B	B	A	A
Memories:	A,B	A,B	A,B	A,B	A,B	A,B	A,B	A,B	A,B
External Interlace:	off	off	off	off	off	off	off	off	off
Paging Device Size:	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K
Disk Channels:	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,8
Elapsed Time:	87.1 min	82.5 min	95.5 min	87.2 min	98.7 min	96.1 min	99.3 min	94.8 min	82.7 min
Costs (shift 1):	\$915.20	\$911.07	\$985.44	\$913.79	\$993.39	\$997.75	\$985.10	\$973.60	\$930.01
Costs (shift 2):	\$753.79	\$750.36	\$811.36	\$752.64	\$818.01	\$821.51	\$810.96	\$801.54	\$766.02
Costs (shift 3):	\$394.91	\$393.10	\$424.85	\$394.33	\$428.42	\$430.19	\$424.55	\$419.66	\$401.36
CPU, total:	4394 sec	4272 sec	5376 sec	4384 sec	5544 sec	5361 sec	5524 sec	5296 sec	4339 sec
CPU, virtual:	3198 sec	3190 sec	3543 sec	3186 sec	3533 sec	3579 sec	3585 sec	3524 sec	3233 sec
CPU, good (1):	3068 sec	3057 sec	3480 sec	3055 sec	3471 sec	3508 sec	5903 sec	3457 sec	3096 sec
Memory Units:	36040	35844	38344	36015	38833	38860	38130	37775	36699
Page Faults:	433491	426160	548588	433825	562663	525823	531525	518887	432924

tfm meters:

Page Faults:	20.35%	19.95%	27.40%	20.36%	28.54%	26.39%	27.29%	26.58%	20.20%
Getwork:	2.19%	2.20%	2.45%	2.16%	2.44%	2.62%	2.63%	2.63%	2.38%
Seg Faults:	2.98%	3.08%	2.70%	2.91%	2.50%	2.60%	2.56%	2.69%	3.19%
Bound Faults:	0.30%	0.32%	0.50%	0.29%	0.49%	0.49%	0.49%	0.50%	0.31%
Interrupts:	1.97%	1.30%	3.80%	2.01%	4.64%	3.76%	4.55%	3.87%	1.32%
Idle, zero:	13.31%	11.22%	0.31%	13.65%	0.37%	0.16%	0.38%	0.00%	9.85%
Idle, MP:	0.03%	0.02%	1.95%	0.02%	2.21%	2.91%	2.82%	2.79%	0.06%
Idle, NMP:	0.21%	0.17%	0.02%	0.24%	0.04%	0.03%	0.04%	0.00%	0.21%
Idle, Loading:	0.00%	0.00%	0.16%	0.00%	0.17%	0.20%	0.22%	0.19%	0.00%
Idle, total:	13.55%	11.41%	2.44%	13.91%	2.79%	3.30%	3.46%	2.98%	10.12%
Other (good):	58.67%	61.75%	60.71%	58.36%	58.60%	60.83%	59.03%	60.75%	62.41%

dvm meters:

Bulk Reads:	442886	434883	552615	443752	565318	531359	537605	523620	443061
Bulk Writes:	227555	220040	300038	228178	307263	287152	295351	288480	222989
Bulk ATB I/O:	7.802	7.565	6.728	7.794	6.791	7.050	7.154	7.011	7.452
Bulk Avg. Page Wait:	0.632	0.557	0.571	0.635	0.639	0.574	0.644	0.573	0.561
D191 Reads:	7199	6773	53412	7317	56216	51399	54163	54513	6989
D191 Writes:	29621	5212	46390	29632	77807	46211	76438	48484	5330
D191 ATB I/O:	142.072	413.398	57.486	141.739	44.216	59.125	45.631	55.286	402.931
D191 Avg. Page Wait:	40.186	31.421	43.056	39.640	47.702	43.964	47.474	39.893	32.727

Notes:

(1) Based on Elapsed Time * percentage good (tfm meters)

Metering Comparisons for 23.14c, 23.15, 23.15a, 23.16a

System:	23.14c	23.14c	23.15	23.15a	23.15a	23.15a	23.16a	23.16a
Date:	08/07/74	08/08/74	08/12/74	08/19/74	08/24/74	08/25/74	09/02/74	09/07/74
Script:	script1	script2	script2	script2	script1	script2	script1	script2
Write-through status:	none	none	none	none	none	none	none	none
Device Checking:	1	1	1	1	1	1	1	1
CPU:	A	A	A	A	A	A	A	A
Memories:	A,B	A,B	A,B	A,B	B,C	B,C	B,C	B,C
External Interfaces:	off	off	off	off	off	off	off	off
Paging Device Size:	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K
Disk Channels:	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,8
Elapsed Time:	82.7 min	95.0 min	91.1 min	95.2 min	86.3 min	93.7 min	85.6 min	96.2 min
Costs (shift 1):	\$930.01	\$974.33	\$983.29	\$984.72	\$921.86	\$980.32	\$918.70	\$983.16
Costs (shift 2):	\$766.02	\$802.16	\$809.60	\$810.78	\$758.79	\$807.19	\$756.66	\$809.42
Costs (shift 3):	\$401.36	\$419.99	\$423.94	\$424.56	\$397.52	\$422.72	\$396.41	\$423.79
CPU, total:	4339 sec	5295 sec	5294 sec	5351 sec	4324 sec	5287 sec	4315 sec	5370 sec
CPU, virtual:	3233 sec	3521 sec	3530 sec	3536 sec	3226 sec	3504 sec	3215 sec	3557 sec
CPU, good (1):	3096 sec	3435 sec	3323 sec	3451 sec	3086 sec	3404 sec	3073 sec	3475 sec
Memory Units:	36699	37828	38283	38339	36247	38238	36156	38154
Page Faults:	432924	520152	523713	534962	424266	521467	424601	526810

tfm meters:

Page Faults:	20.28%	26.52%	26.44%	26.98%	19.14%	26.75%	19.31%	26.70%
Getwork:	2.38%	2.65%	2.60%	2.65%	2.32%	2.72%	2.37%	2.72%
Seg Faults:	3.19%	2.64%	2.57%	2.59%	3.15%	2.69%	3.14%	2.67%
Bound Faults:	0.31%	0.50%	0.51%	0.50%	0.31%	0.49%	0.31%	0.49%
Interrupts:	1.32%	3.85%	3.78%	3.83%	1.35%	3.96%	1.36%	3.91%
Idle, zero:	9.85%	0.00%	0.10%	0.01%	13.94%	0.10%	13.48%	0.01%
Idle, MP:	0.06%	3.38%	3.00%	2.79%	0.05%	2.52%	0.05%	3.09%
Idle, NMP:	0.21%	0.01%	0.02%	0.02%	0.15%	0.02%	0.13%	0.00%
Idle, Loading:	0.00%	0.21%	0.20%	0.21%	0.00%	0.18%	0.00%	0.20%
Idle, total:	10.12%	3.60%	3.32%	3.03%	14.14%	2.82%	13.66%	3.30%
Other (good):	62.41%	60.25%	60.79%	60.42%	59.60%	60.57%	59.85%	60.20%

dvm meters:

Bulk Reads:	443061	523230	529434	536666	434509	524184	434760	530568
Bulk Writes:	222989	289264	290465	294026	223337	288277	223533	294944
Bulk ATB I/O:	7.452	7.023	6.955	6.880	7.874	6.920	7.803	6.995
Bulk Avg. Page Wait:	0.561	0.573	0.569	0.572	0.558	0.570	0.558	0.572
D191 Reads:	6989	53002	51958	54132	6852	52574	6743	52783
D191 Writes:	5330	48065	46805	47715	5299	47366	5274	46369
D191 ATB I/O:	402.931	56.464	57.743	56.121	426.341	56.257	427.474	58.246
D191 Avg. Page Wait:	32.727	45.805	44.566	43.553	30.375	39.693	32.097	43.595

Notes:

(1) Based on Elapsed Time * percentage good (tfm meters)

Metering Comparisons for 23.16a, 23.17a, 23.18a, 23.19a, 23.20a, 24.0a

System:	23.16a	23.17a	23.18a	23.19a	23.19a	23.20a	23.20a	24.0a	24.0a
Date:	09/07/74	09/08/74	09/26/74	09/28/74	09/30/74	10/02/74	10/06/74	10/07/74	10/10/74
Script:	script2	script1	script2	script1	script2	script2	script2	script2	script2
Write-through status:	none	none	none	none	none	none	none	none	none
Device Checking:	1	1	1	1	1	1	1	1	1
SYST:	0	0	2	2	2	2	2	0	2
CPU:	A	B	A	A	A	A	A	A	B
Memories:	B,C	B,C	A,B	A,B	A,B	A,B	C,B	A,B	B,C
External Interface:	off	off	off	off	off	off	off	off	off
Paging Device Size:	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K	2048K
Disk Channels:	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,8	2,8
Elapsed Time:	96.2 min	85.9 min	96.5 min	82.1 min	91.3 min	93.3 min	93.5 min	93.3 min	93.1 min
Costs (shift 1):	\$983.16	\$915.48	\$965.51	\$978.16	\$942.26	\$951.48	\$947.52	\$954.04	\$951.42
Costs (shift 2):	\$809.42	\$753.92	\$794.67	\$806.54	\$775.89	\$783.53	\$780.26	\$785.64	\$783.49
Costs (shift 3):	\$423.79	\$394.91	\$415.88	\$423.27	\$406.34	\$410.39	\$408.66	\$411.50	\$410.37
CPU, total:	5370 sec	4358 sec	5356 sec	4272 sec	5101 sec	5168 sec	5160 sec	5161 sec	5148 sec
CPU, virtual:	3557 sec	3231 sec	3573 sec	3096 sec	3358 sec	3372 sec	3365 sec	3380 sec	3369 sec
CPU, good (1):	3475 sec	3085 sec	3493 sec	2961 sec	3283 sec	3273 sec	3285 sec	3281 sec	3290 sec
Memory Units:	38154	35903	37097	40010	36801	37248	37061	37353	37257
Page Faults:	526810	428298	512297	462285	515566	527493	520608	520255	522747

ftm meters:

Page Faults:	26.70%	19.53%	26.05%	21.50%	26.86%	27.06%	27.05%	27.17%	27.08%
Getwork:	2.72%	2.45%	2.79%	2.64%	2.88%	2.90%	2.94%	2.70%	2.83%
Seg Faults:	2.67%	3.11%	2.66%	3.10%	2.54%	2.71%	2.72%	2.77%	2.70%
Round Faults:	0.49%	0.32%	0.49%	0.29%	0.51%	0.48%	0.48%	0.48%	0.49%
Interrupts:	3.91%	1.60%	4.02%	1.56%	4.01%	4.14%	4.51%	3.98%	4.08%
Idle, zero:	0.01%	12.89%	0.09%	10.48%	0.05%	0.15%	0.13%	0.19%	0.21%
Idle, MP:	3.09%	0.07%	3.39%	0.07%	2.96%	3.82%	3.36%	3.80%	3.43%
Idle, NMP:	0.00%	0.20%	0.00%	0.25%	0.01%	0.01%	0.02%	0.02%	0.05%
Idle, Loading:	0.20%	0.00%	0.20%	0.00%	0.24%	0.28%	0.24%	0.27%	0.25%
Idle, total:	3.30%	13.16%	3.68%	10.80%	3.26%	4.26%	3.75%	4.28%	3.94%
Other (good):	60.20%	59.85%	60.31%	60.11%	59.94%	58.46%	58.54%	58.61%	58.88%

dvm meters:

Bulk Reads:	530568	438986	518082	472987	519532	530984	531750	524972	530927
Bulk Writes:	294944	224055	290996	232249	284287	296377	298138	295739	297000
Bulk ATB I/O:	6.995	7.781	7.162	6.988	6.816	6.771	6.767	6.825	6.753
Bulk Avg. Page Wait:	0.572	0.561	0.576	0.561	0.571	0.572	0.568	0.568	0.566
D191 Reads:	52783	7084	51117	7499	52851	55479	56898	56245	53336
D191 Writes:	46369	5686	46461	5621	48446	50656	51904	51396	48867
D191 ATB I/O:	58.246	404.024	59.388	375.642	54.092	52.783	51.621	52.040	54.708
D191 Avg. Page Wait:	43.595	33.786	45.847	31.123	41.824	46.747	41.116	45.635	45.479

Notes:

(1) Based on Elapsed Time * percentage good (ftm meters)