Saltzer

MPL-53

TO: Multics Performance Log

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SUBJECT: Overhead Measurements of System 14

Seven measurement runs (MPM115 through MPM121) were exercised on the Multics Standard Service System 14 (14.0 through 14.12) which was in operation during the period starting on January 11 and ending on April 17. Most of the runs were made when the system was under a full load. The system was configured either with 1 CPU 256 Kword memory, 1 CPU 384 Kword memory, or 2 CPU 384 Kword memory. The results to be described are solely based on the "ttm" metering results obtained as part of the above measurement.

The capacity of the processing system is generally consumed by (1) the system program overheads (processing needed by page faults, getworks, drum interrupts, segment faults, gate crossing faults, and etc.), (2) the useful work for users, and (3) the system idling. Table 1 shows the system capacity used for the processing of each of the above events, for three system configurations. Comparing the two configurations (256K and 384K memory cases) of the single processor system, we see that the idle time and the overheads associated with page faults, getworks, and drum interrupts decreased drastically when an extra 128K core memory was added to the normal 256K core memory single processor system. As a result, the percentage of the useful work for users (i.e., the percentile throughput) has increased from 46.7% to 66.6%. However, these overheads again increased much when another processor was added to this 384K core memory system, as shown in the last column of the same table. The percentile throughput for this full configuration was measured to be 41.8%.

Table 2 shows how frequently each of these events occurs (in real time) on a per processor basis. It is seen that the drastic increase of the percentile throughput caused by adding the extra 128K core memory was due to the much longer time between events (page faults, getworks, and drum interrupts) of the 384K core memory system. Because drum interrupts and getworks are most frequently caused by page faults, the throughput increase was actually caused by the longer time between page faults (TBPF). However, if the system has two processors the paging traffic correspondingly increases.

Configuration / Event	1 CPU 256K core	1 CPU 384K core	2 CPU 384K core
Page Fault	11.3%	6.4%	13.0%
Getwork	10.5	8.2	9.8
Drum IT	5.6	3.4	6.5
IT	6.0	6.7	5.1
Seg. Fault	2.6	3.1	3.5
Gate Fault	3.4	3.7	2.5
Idle	13.7	1.9	17.8
Useful Work	46.7	66.6	41.8
Saturated	Yes	Yes	Yes
# of users	40	41	48
Ave. eligible	4.50	5.26	5.79
MPM	116, 121	115	118, 119, 120

Table 1 System Capacity Breakdown

Configuration / Event	1 CPU 256K core	1CPU 384K core	2 CPU 384K core
			(per processor)
Page Fault	17.2 msec.	35.1 msec.	33.2 msec.
Getwork	9.4	20.2	14.5
Drum IT	19.6	42.9	40.0
IT	56.5	61.9	82.6
Seg. Fault	591.	532.	448.
Gate Fault	108.	99.4	147.

Table 2 Mean Time Between Events
(in real time)

Finally, it was examined if the overhead time required to process an event is dependent on the system configuration. The result is given in Table 3. It is clearly seen that the overhead times (per event) of page faults, getworks, and drum interrupts drastically increase especially when the system moves from the 1 CPU 256 Kword memory configuration to the 2 CPU 384 Kword memory configuration. It is the product of this overhead time per event and the frequency of each event that determines the system capacity breakdown shown in Table 1. The overhead increases, mentioned above, are considered to be due to (1) memory cycle interference, i.e., the occasional conflict of two processors for memory cycles of a particular memory box and (2) data base lockout, i.e., the problem which occurs whenever both processors attempt to modify supervisory data, such as resource tables and supervisory queues, which does not allow simultaneous modifications. The details of these problems are being analyzed and are to be reported shortly.

Configuration / Event	1 CPU 256K core	1 CPU 384K core	2CPU 384K core
Page Fault	1.95 msec.	2.24 msec.	4.31 msec.
Getwork	.99	1.65	1.42
Drum IT	1.10	1.44	2.60
IT	3.41	4.15	4.18
Seg. Fault	15.37	16.63	15.62
Gate Fault	3.67*	3.67*	3.67*

* Only these values are not measured ones but estimates.

Table 3 Average Overhead Time