

PERFORMANCE OF A SYSTEM WITH
MULTIPROGRAMMING VIRTUAL MACHINES

by

ROBERT ANDREW YOUNG

B. S., Kansas State University, 1975

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Computer Science

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1976

Approved by:


Major Professor

LD
2668
T4
1976
Y67
C.2

Document

TABLE OF CONTENTS

Introduction	1
Chapter I - System Environment	5
1 - Introduction	6
2 - Hardware and Software Configuration	7
3 - Initial Performance Problems	12
4 - Performance Evaluation Techniques	14
Chapter II - Prior Performance Evaluations and System Changes	17
1 - Introduction	18
2 - Initial Hypothesis	19
3 - The Accelerator	21
4 - VM/370 Software Monitor	24
5 - Initial Analysis of Data from Software Monitor	29
6 - Extended Configurations	30
7 - Reserved Page Frames Option	37
8 - Study of VM/370 Scheduling and Page Management	41
9 - Conclusions	45
Chapter III - PAGEMON Implementation and Evaluation	46
1 - Introduction	47
2 - Theoretical Basis	48
3 - Initial Implementation	51
4 - PAGEMON Implementation - Overview	53

5 - PAGEMON Implementation - Structure	58
6 - PAGEMON Implementation - Algorithmic Description of VM/370 Functions	62
7 - PAGEMON Implementation - Algorithmic Description of OS Functions	66
8 - PAGEMON Evaluation	70
 Chapter IV - Conclusions	 80
1 - General Conclusions	81
2 - Future Research	82
 References	 85
 Appendices	 88
A - Batch Job Summary	89
B - CMS Simulated Terminal Session Input	90
C - Extended Configuration Benchmarks	92
D - VM/370 PAGEMON Command Summary	93
E - OS PAGEMON Command Summary	94
F - PAGEMON Benchmark Results	95

TABLE OF FIGURES

Figure 1 - Multi-Level System Structure	11
Figure 2 - Extended Configuration Benchmark Results - Batch Resident Time	33
Figure 3 - Extended Configuration Benchmark Results - CMS Response Index	34
Figure 4 - Sample Task Deactivation in a Single-Level Environment	50
Figure 5 - PAGEMON Operation	54
Figure 6 - PAGEMON Structure	60

TABLE OF TABLES

Table 1 - Impact of CMS Users	29
Table 2 - Extended Configuration Benchmark Results	31
Table 3 - Reserved Page Frames Benchmark	38
Table 4 - PAGEMON SET Parameters	63
Table 5 - PAGEMON Performance Analysis	74
Table 6 - PAGEMON Performance Analysis	76
Table 7 - Accelerator Performance Analysis	78

Acknowledgements

The research reported in this document was sponsored by the Kansas State University Computing Center. I would like to thank the Computing Center, and particularly Dr. Tom L. Gallagher and Mr. Michael H. Miller, for this support.

I would also like to express my appreciation to Dr. Virgil E. Wallentine who served as my major professor and provided valuable input into both the research and this document. I would also like to thank the other members of my supervisory committee-- Dr. Tom L. Gallagher and Dr. Richard F. Sincovec-- for their assistance.

INTRODUCTION

Introduction

This paper deals with performance of a third generation computing system running a multi-level operating system. Specifically, the operating system in use is a conventional multiprogramming non-virtual third generation operating system (OS/MFT¹) run in a virtual machine under the control of a virtual machine monitor (VM/370²). This virtual machine runs concurrently with other virtual machines which perform other services.

The particular area to be addressed is real storage management. As is recognized both in the current literature³⁻⁷ and in commercially available virtual memory implementations^{8,9}, along with a global demand paging system such as is used by VM/370, there must be a facility to limit the level of multiprogramming to avoid the phenomenon known as thrashing. This control generally exists either in the form of a working set scheduler or in the form of more explicit controls such as process deactivation.

In this particular environment additional complications arise. The level of the operating system which has the greatest control over the multiprogramming level knows nothing about the management of real storage. Also, the level which performs management of real storage has no