

December 16, 1968

TO: Multics Review Committee
FROM: J.H. Saltzer and R.M. Graham
SUBJ: Annotated Bibliography of Multics

Enclosed is a rather long bibliography of Multics documentation. Since the volume of material precludes casual reading, the following short ordered list of especially relevant documents may be useful. (See the full bibliography for notes and comments on each.)

1. 1965 FJCC papers.
2. Definition of Initial Multics (C. Clingen).
3. Comparison of the Multics System and CTSS (Corbató).
4. Most recent bi-weekly progress report from the Multics Planning Notebook and draft copy of Multics section of MAC Progress Report 1967 to 1968.
5. Multics Condensed Guide.
6. Subsystem writer's Guide to Multics (E. Organick).
7. Overviews from the Multics System Programmer's Manual.
8. Reprints of recent talks and papers.

Personal copies of each of the above eight items are included in this notebook; at least one copy of each of the remaining documents is available in Room 528 or can be located upon request.

April 16, 1969

TO: Distribution
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External documents:

1. Multics System Programmers' Manual (MSPM). The Ultimate reference for details of the design of Multics. Although it is continually being updated, many sections are not current. As a general rule, the sections labeled "overview" are accurate in at least general philosophy and overall strategy, although they may be behind the current design in detail.
2. EPL User's Reference Manual. Describes how to program in the compiler language which is used for most of the Multics System.
3. Multics Operating System. An early attempt to provide an overview of Multics, culled from now-obsolete MSPM overviews.
4. 645 System Manual. A slick GE publication describing the objectives of the overall system. (Out of print.)
5. EPLBSA User's Reference Handbook. Description of the assembly language used for "hand-coded" Multics subroutines, and used as an intermediate step by the compiler for EPL.
6. Handbook of Operating Information. A collection of hardware word formats and status bit interpretation, primarily for the I/O and debugging specialist.
7. Initial Multics Console User's Manual. An early attempt to provide a guide to the use of Multics. Obsoleted by the Multics Condensed Guide.
8. Guide for Subsystem Writers, by E.I. Organick. (In preparation) Chapters 1-3 have been widely distributed, and chapters 4-6 are in draft form. This guide provides a tutorial description of the aspects of Multics which are of most interest to a system programmer whose job it is to embed a subsystem within Multics. Put another way, this is a user's manual for sophisticated users.
9. FL/I Manual. Description of a macro-assembler planned for the 645.
10. Fortran IV Manual. The usual.
11. Multics Condensed Guide. A pocket-sized handbook to be carried to the console, containing a list of frequently used commands and how to use them.
12. Multics Operator's Guide. (In draft.) A guide for the machine room operator, telling him what buttons to push to get Multics started, etc.
13. Project MAC Progress Report, II, III, and IV. This yearly report of Project MAC contains a section describing in overview the significant events of the Multics project during the year. The Multics section of Progress Report V is available, although the full report has not yet been published.
14. Multics User's Manual. (In very early draft--barely begun, but the table of contents indicates well its intended scope.) The ordinary

Multics user will find this Manual his primary source of both overview information and reference information as he uses Multics as a programming tool.

15. Multics System, by J.H. Saltzer. Complete overview of the Multics design as of July, 1966, as transcribed from lectures and translated into Japanese.

Published papers:

1. Introduction and Overview of the Multics System, F.J. Corbató, V. Vyssotsky, 1965 FJCC.
2. System Design of a Computer for Time-Sharing Applications, E.L. Glaser, J.F. Couleur and G.A. Oliver, 1965 FJCC.
3. Structure of the Multics Supervisor, V.A. Vyssotsky, F.J. Corbató, and R.M. Graham, 1965 FJCC.
4. A General-Purpose File System for Secondary Storage, R.C. Daley, P.G. Neumann, 1965 FJCC.
5. Communications and Input/Output Switching in a Multiplex Computing System, J.F. Ossanna, L.E. Mikus and S.D. Dunten, 1965 FJCC.
6. Some Thoughts About the Social Implications of Accessible Computing, E.E. David, Jr., R.M. Fano, 1965 FJCC.

The above six papers lay out the original objectives for Multics and the original plans for achieving those objectives. Although many of the proposed implementation details described here have been replaced by improved strategies, the overviews and descriptions of objectives are still basically current.

7. Protection in an Information Processing Utility, R.M. Graham, May, 1968, ACM Communications.

A description of the Multics protection ring scheme. This paper describes an advanced hardware design, not actually implemented on the GE 645 computer.

8. Virtual Memory, Processes, and Sharing in Multics, R.C. Daley, J.B. Dennis, May, 1968, ACM Communications.

Moderately detailed description of how segmentation is implemented and used in Multics.

9. Some Considerations of Supervisor Program Design for Multiplexed Computer Systems, F.J. Corbató, J.H. Saltzer, 1968 IFIP.

Overview paper giving some broad insights which have been acquired while designing Multics.

10. A Paging Experiment with the Multics System, to be published in a festschrift for P.M. Morse.

A description of the current page removal selection algorithm, and some experiments in generalizing it.

11. PL/I as a Tool for System Programming, F.J. Corbató.

Edited transcription of a talk given describing the experience of having used PL/I in the implementation of Multics.

12. Sensitive Issues in the Design of Multi-Use Systems, F.J. Corbató.

Edited transcription of a talk on the subject of managing the development of Multics-sized systems.

MIT Theses Related to Multics

Completed:

1. Traffic Control in a Multiplexed Computer System, S.H. Saltzer, Sc.D., 1966 (MAC-TR-30).

Design of the processor multiplexing section of Multics. Includes an overview of the entire system.

2. Implementing Multi-Process Primitives in a Multiplexed Computer System, R. Rappaport, S.M., 1968.

Implementation experiences in the processor multiplexing section of Multics, including insights into the topics of process creation and initialization of the address space.

3. Absentee Computations in a Multiple-Access Computer System, H. Deitel, S.M., 1968.

Design of the planned (but not-yet installed) absentee user facility of Multics.

4. A Simulator of Multiple Interactive Users to Drive a Time-Shared Computer System, H. Greenbaum, S.M., 1968.

A PDP-8 program which sends commands down several telephone lines, with "think time" pauses between, thereby providing repeatable simulations of a user load on the time-sharing system.

5. The Graphic Display as an Aid in the Monitoring of a Time-Shared Computer System, J. Grochow, S.M., 1968.

A PDP-8 program which spies on Multics via a special interface, and displays (after interpreting) information it has found.

6. A Compiler for MAD-Based Language on Multics, E.I. Ancona, S.M., 1968.
7. A Reduction Analysis System for Parsing PL/I, D. Clark, S.M., 1968.

These two are self-explanatory.

Theses in progress:

1. A General Translator from an Intermediate Language to a Machine Language, D. Walden, S.M., 1969 (est).

Goes with the Clark thesis, above, to provide a complete, modern compiler for the PL/I language (in principle).

2. Classroom Model of an Information and Computing Service, M. Schroeder, S.M., 1969 (est).

A model on paper, suitable for presentation to a class, of a system like Multics, only simpler. Many unnecessary complications of Multics (e.g., ability to run GECOS programs) are not present in this paper system, and the hardware presumed for it has been modified where necessary to make the operating program simpler.

Internal Documents; Technical:

1. Multics Checkout Bulletins. A series of bulletins distributed to all programmers telling them of current status of systems, lists of segments on current libraries, changes to the standard system, etc. A majority of these have a useful lifetime of about 1 week.
2. Multics Operating Staff Notes. A series of bulletins directed to the operators who man the 645 machine room. These contain timely information, usually installation-dependent, which does not appropriately fit in the operators guide to Multics.
3. The Repository. Three series of documents, mostly technical, issued by the three organizations, MIT, BTL, and GE. The Repository has been a home for design proposals, bright ideas, and things which it seemed should be recorded somewhere but did not have any other logical home. As the design has become complete, more and more documents have fallen into the specific documentation areas (e.g., Multics System Programmer's Manual) and the repository has been less and less used. Included in the GE series are the hardware specifications for the 645 processor, general I/O controller, system controller, and clock.
4. Design Notebook. A set of about 20 documents, since placed in the repository, which were the earliest design proposals for Multics. By now they are only of historical interest.
5. Definition of Initial Multics, by C.T. Clingen. A list of functional capabilities, and performance and reliability targets for the initial version of Multics.
6. Comparison of the Multics System and CTSS, by F.J. Corbató. A brief list of the important features of Multics in a side-by-side comparison with their counterparts (if any) in CTSS.

Internal Documents, Project Control:

1. Multics Planning Notebook. Currently the primary project control document. It contains a detailed list of tasks in progress, with estimated schedules and reports on their progress. It also is the home for personnel lists, performance reports, and reports on the current status of hardware. This notebook is updated every second week, with a planning meeting called to review the nature of the changes, and examine overall strategy.
2. Weekly Task Report Summaries. A single notebook containing reports from each project leader of the progress of all tasks under his control. This weekly report is the raw data base out of which a bi-weekly progress report for the entire project is made up and filed in the Multics Planning Notebook.
3. Operations Daily Report. A series of daily reports from the operating staff, detailing amount of hardware, up and down time, and special problems encountered.
4. Task Notebook. Now obsolete, the predecessor of the Multics Planning Notebook, containing a monthly list of tasks in progress.
5. Bootload Log. Now obsolete, a record of each and every attempt to bootload Multics, along with success or failure information. This record was kept temporarily during a period when an excessive amount of scarce 645 time was going into failed bootload attempts. As the system became more stable (both hardware and software) the bootload log was dropped.

Background Information on paper:

1. Checker Listings. Each time a Multics System Tape is made standard, a program checks the contents of the tape and produces a printed summary of its contents, including lists of subroutines and summaries of total core used, etc.
2. System Listings. (For the specialist only.) Complete program listings of every subroutine in Multics are maintained in several locations at M.I.T. and at Bell Laboratories in Murray Hill.
3. Bar Graphs. During the time when the only visible progress on Multics was the increasing depth of the pile of system listings, a set of bar graphs, updated monthly, allowed both the programming staff and management to establish whether the rate of progress was changing. These bar graphs recorded the number of pages of code so far coded, so far checked out, and so far thought to be needed but uncoded yet. As the first draft of system code became complete and a substantial effort began to move into second draft work, reports on operations of Multics itself became more meaningful and the bar graphs were dropped.
4. Console Session Results. Efforts to document the reliability and usability of console sessions are just now beginning to show useful measurements; a weekly report displays a record of just how useable the system was during the week.

5. Hardware On-Site List. This document provides a list of the individual hardware items on site at M.I.T.