Management Plan for Project MAC
with Special Reference to Multics

Introduction

At the beginning of 1969, Project MAC is at a critical

juncture. During the last two or three years, more and more

of the resources of Project MAC have gone into the Multics

effort. During 1968, Multics used $2.1 million of the

$3.0 million of Project MAC's general (Task 1) funds and of

the $3.7 million total.* At the end of 1968, the Multics

operating system was beginning to function well enough that

some Multics system programming could be carried out within

the Multics system, but the bulk of the Multics programming

was still being done on CTSS. According to an estimate made

by the Multics Group, a convincing operational demonstration

of Multics could be made sometime between the middle and the

end of 1969. If Multics were opened to general use during

1969, perhaps two years of user-oriented support programming

(problem-oriented languages, program packages, etc.) would

be required to bring the Multics software base up to a level

rivalling that of CTSS. Thus, as seen from one point of view,

Multics seems to be late, still in the mid-course of develop-

ment, and so expensive as to have seriously distorted the

research effort of Project MAC.

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*The G.E. 645 computer system is costing about $1.0 per year,
 rental.

On the other hand, the technical goals of Multics are widely recognized to be extremely important. The recent ARPA Review Committee appreciated the goals and attested to the importance of the Multics software design and the Multics operating-system software. The Review Committee obviously considered the Multics software to be very valuable -- so valuable that it was willing to consider the Multics effort already a success -- so valuable that the Review Committee turned its attention during the second day of its visit from the problems of development of Multics to the problems of "exploitation," i.e., of making Multics available and useful to the world outside M.I.T.

Although the formal report of the Review Committee is not yet available, the review has had a major effect. It has lifted the attention of the Multics Group and the administration of Project MAC up from the problems and difficulties of carrying forward the development of Multics, day by day and week by week, to broader issues -- especially to the question of making Multics come into being in such a form as to ensure to it a wide availability and the advantages of modern technology, high performance, and low cost. In short, the Review Committee stretched the time scale of optimization of Multics from the few weeks before the next test point to the few years before Multics will be used by a hundred organizations. At the same time, the Review Committee

called attention to the imbalance in the over-all research

program of Project MAC caused by putting such a large fraction

of the over-all funding into the computer system research

(Multics) effort.

There may or may not appear to be an inconsistency in the

preceding trio of sentences: Ensure a useful long-term future

to a very valuable software development -- and economize in the

short term. Whether or not those courses appear to be -- or

are in fact -- inconsistent depends upon several factors that

will be discussed later.

Guidelines and Constraints

Because Multics is at present such a large part of

Project MAC, planning for Multics implies planning for MAC.

That planning should be guided by a recognition of certain

guidelines and constraints and by a wariness of being misguided

or inappropriately inhibited by others. What are the valid

guidelines and constraints?

1. A main objectives is to make a "Multics"

   a. Widely available

   b. With a high ratio of performance to cost

      (which implies advanced technology and/or

      low pricing)

   c. Soon.

2. The essential thing is to achieve a "desirable

   subset" of the Multics goals.* We should define

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*For present purposes, the "desirable subset" will define "Multics."

"desirable subset." It is not essential or

a priori grounds to implement all 30 of the

features in Corbato's list, but it may be (or:

and it may not be) easier/quicker to implement

them all than to implement only a subset.

3.   The GE 645 computer does not satisfy item 1.6

We cannot continue to use the 645, under the

present charging schedule, past the middle of

1969.*

4.   General Electric might develop a computer

(Let us call it the "655.") that would satisfy

item 1. It would make sense to continue with

the 645 and to order a 655 follow-on if:

    a. G.E. assured/convinced** M.I.T. and ARPA

    (and BTL if BTL is interested) that G.E. will

    develop such a machine with advanced technology

    and that it would make it widely available at

    an early date (to be specified) and at a price

    consistent with a low level of G.E.-prepared

    software support -- i.e., with the fact that

    much of the software support would have been

    paid for by ARPA.

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*Unless ARPA provides additional money for that purpose.

**We should specify what assurance would convince us.

b. For the interim, G.E. reduced the cost to
M.I.T. of the 645 computer -- say, to one-half
its present rental cost or to a direct sale cost
of a million dollars plus a yearly maintenance
contract cost of $100,000. (Those figures are
for discussion.)

5. We are in the process of approaching G.E. to
discuss the foregoing points. We should approach
other computer manufacturers in the near future --
but not until discussing our management plan with
ARPA. We should make a list of manufacturers to
approach: DEC, Univac, IBM, Burroughs, SDS,... .
What we need from each/some manufacturer is an
assurance, convincing to M.I.T. and ARPA, of
advanced technology and performance, wide availability,
low price, good maintenance, and early delivery. We
must decide what those attributes mean in terms of
specific criterion values.

6. To cover the likely possibility that no manufacturer
will meet the criteria, we should investigate the use
(with modification if/as necessary) of an existing
computer, other than the 645, for further development
of Multics. We understand that following this course
at M.I.T. (beyond just investigating it) would probably
mean losing not only "momentum" but a large part of the

Multics team. We should therefore assess the chances

that another contractor could carry through to success

along this course. We should also determine whether

we would, if Multics terminated, want to undertake a

new project aimed at realizing a limited ("Subdesirable?")

subset of the Multics objectives on a low-cost computer

with assured performance and availability.

7.   If we have a consensus, we should develop a state-

ment on the subject of "code compatability."

8.   We should develop a good projection of Project MAC's

need for computer access during the next two or three

years. This projection should take into account the

conditionabilities of Multics. It should also take into

account the plans of others to use CTSS and other

available computers.

9.   In connection with item 8, we should examine the

availability and usefulness to others in Project MAC

of the PDP-6/10 system operated by the Artificial

Intelligence/Intelligent Automata group. The PDP-10

should be gotten into a useful state as soon as possible,

and full advantage should be taken by Project MAC of the

PDP-6/10 resource. A plan should be made for connecting

the PDP-10 into the currently operating PDP-6 time-sharing

system and/or for connecting it, if the new PDP-/10

materializes, into a new PDP-10 system that we have

proposed to ARPA for development as a special facility

for interactive dynamic modeling.*

10.   The over-all cost of computer support should not

exceed 1/3 of the total budget of Project MAC.   In

figuring the over-all cost, purchased computers will

be amortized over over 60 months.   It is fair for the

System Research Group to use more than a pro-rate share

of computer support, but see item 11.

11.   Unless ARPA decides to provide special funds for

continuation of the Multics effort, the Computer

Systems Research Group will have to retrench gradually

to a level at which its total annual cost, including

computer support, is not greater than $1 million.

That figure is conditional upon ARPA's continuing to

fund the main task of Project MAC at $3 million per year.

12.   A plan will be made (and incorporated into the

over-all management plan) to intensify research in

other areas in order to round out a balanced program

of research in Project MAC.

13.   A proposal should be prepared to continue Multics

at a high rate and to achieve the objectives specified

in item 1.   One version of this proposal should be

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*This facility would be made available to the behavioral-science
 group that is proposing to use CTSS extensively in data-base work.

prepared for ARPA. Another should be prepared

for G.E. We should decide whether other sources

are likely enough to be worth approaching.

14. The "M.I.T. community" of computer users,

including users outside Project MAC, is vital

to our having a success with Multics comparable

to the success we had with CTSS. The needs of

the community now include "exportability."

Project MAC's plans that involve the community

should ensure that ~~their~~ its exportability needs

will be met.

15. Project MAC's computer plans and operations

almost necessarily interact with other computer

plans and operations at M.I.T. Our management

plan therefore has to have the approval of the

Provost and, if he so indicates, of the Information

Processing Board.

16. The Multics concepts and software must be

organized and documented and/or published.

Alternative Courses of Action

Several different courses of action are in keeping with the foregoing guidelines and constraints. Some of them are:

G.E. All the Way with ARPA Support. We approach G.E. now (we are doing so.) re items 1, 3, and 4. G.E. agrees by March 1 to meet the conditions. The rental cost of the 645 comes down to $500,000 per year. The use of CTSS declines to zero. The other costs of the Computer System Research Group come down to $500,000. The overly intense pressure of recent months decreases to a level of mere urgency. G.E.'s assurances meet (to a sufficient extent) the needs of members of the M.I.T. community for exportability. Development of Multics continues on the G.E. 645 for the G.E. 655.

G.E. All the Way with G.E. Support. Assume the beginning of the foregoing scenario except that G.E.'s assurances, while satisfactory to M.I.T., are not satisfactory to ARPA -- which may be unlikely. Assume further that G.E. is convinced of the value of Multics and is willing to finance continuation of the Multics effort. ARPA cuts support of Project MAC to about $2 million, eliminating Multics but permitting Project MAC to develop its program in other areas. G.E. takes on support of Multics. Then there are two alternative courses.

On one, the Computer System Research Group stays at
approximately present size and Multics develops in such
a way as to involve the M.I.T. community. On the other,
most of the Multics effort moves into G.E. while the
principles of the Computer System Research Group concern
themselves with organization and publication of the Multics
concepts.

Switch to Another Computer and Develop Multics for it on
the G.E. 645. Assume beginning of first scenario except
another manufacturer's computer is selected. Assume ARPA
makes additional funds available so that G.E. 645 may be
retained during interim. Then there are two or more courses
(how many?), depending upon degree of "code compatibility."
If code compatibility is essentially complete, the Multics
effort continues without much change -- other than to adjust
to the cost guideline -- and the software is transferred when
the new machine is ready. If the new machine is not code-
compatible with the 645, work has to be undertaken to develop
an EPL translator (compilers) for the new machine, and someone
has to worry about conversion of non-EPL code.

A New Computer But No 645. As I understand it, this is viewed
by the Multics Group not as a continuation of the present effort
with a sidestep, but as a new project. The 645 leaves -- three
months, I think it is, after we give notice to G.E. Some of
the members of the Computer Systems Research Group leave,

discouraged or at any rate no longer interested. Presumably

G.E. and B.T.L. do not join the new effort, but let us not

assume (without finding out) that they do not. Either we

obtain a Multics-adapted computer from a manufacturer or

we obtain a Multics-adaptible computer computer and adapt

it, ourselves or with help from Lincoln or a subcontractor.

If possible, we make arrangements for a computer -- same

type except not Multics-adapted -- for interim use in

Project MAC, and we program the new system on it. If the

new machine is not 645-code-compatible, we introduce as

much simplification as possible into the design of the

Multics software and begin the programming more or less

from scratch -- wiser but without any/much transferable code.

If the new machine is 645-code-compatible, then it is such

a bad thing, not to have the 645 that we insist on keeping

the 645, which nullifies the defining assumption of this

scenario, or we go to B.T.L. to use a 645 there, or (with

nothing to program on) a few key people use the interim to

organize, document, and publish and to make any changes in

design that seem very important on the basis of experience.

Under no interpretation does this latter version, based on

a 645-code-compatible follow-on but no interim 645, make

much sense. The former version -- for example, modifying

a PDP-10 and in the interim programming on an unmodified

PDP-10 -- was, however, regarded as reasonable by some

member of the Review Committee, and we should have a

clear position vis-a-vis it.