INTERDEPARTMENTAL

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from the office of   Information Processing Center

To: Multics Administrative Distribution

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Subj: Multics Disk Requirements

This memo attempts to bring together some of our knowledge about storage requirements for Multics, and sets forth a projection of future requirements.

The following general statements should be kept in mind:

1. User demand for disk storage has up to now barely kept pace with the addition of 270's to the system.

2. Multics should make plenty of disk storage available in order to avoid discouraging current or potential users. It is preferable to have more than we need rather than to be caught short.

3. We should not allocate to users more quota space than we have actual disk.

The rest of this memorandum describes various attacks on estimating the demand for Multics storage in the coming one-year period, and recommends that we obtain one 2314 and the Datametrics controller when they become available in order to meet that demand.

Multics Disk Requirements

The CTSS experience

A record on CTSS consists of 432 36-bit words, so that a Multics page is approximately 2.5 times the size of a CTSS record. However, object programs on Multics tend to be somewhat larger, and the programmer can put only four characters per word instead of six, so that the factor should be about 1.5.

Since the average CTSS programmer can work comfortably with a quota of about 100 records, this calculation suggests that an average Multics programmer should need a quota of about 75 records (this allows for some "breakage" effect).

CTSS currently has about 100,000 records (of the 160,000 available) used by non-system programmers. This is roughly 200 records per user. The three largest information-retrieval users occupy about 25 per cent of this space.

Shared pure procedure segments reduce the overall system disk utilization on Multics noticeably. On CTSS, many users keep "SAVED" files containing core images, so that an often-used subroutine may be replicated hundreds of times in disk storage. Despite the "expansion factor" mentioned above, the average length of file on Multics is the same as that on CTSS. This suggests that the total storage requirement for the system will be reduced from that which we might calculate if we viewed the users individually. I shall assume that the "expansion" effect will be offset by sharing.

Since pages on Multics are larger than records on CTSS, a one-word segment wastes more Multics space. This "breakage" effect is hard to anticipate, since it depends on file length distribution.

The CTSS community consists of 455 registered users, most of whom we can expect to find using Multics within a year. If the foregoing estimates are correct, we would need about 40,000 pages of disk storage to provide an equivalent amount of storage. This is about one 2314, completely full, plus some DS-270 space. Of course, several factors may act to lower the estimate of 40,000 pages:

1. We may not get all of the CTSS users. Some may give up time-sharing and others may choose CP/CMS.

2. Even those users who do move from CTSS will require some time for reprogramming, so that their storage requirements will be low at first.

    3.   The "expansion factor" may turn out to be better than
        assumed above.

The combined effect of these three quibbles is not likely to reduce our
January 1971 requirement to the point where it could be met without a
2314.

Projected number of users

The accompanying graph (figure 1) shows the growth in the number of
users registered on Multics since October 1969. The "projected"
portion of the curve is based on the assumptions that we can't expect
the current rate of growth to continue, and that the usual seasonal variations
will occur. We have no information to help us make a more accurate
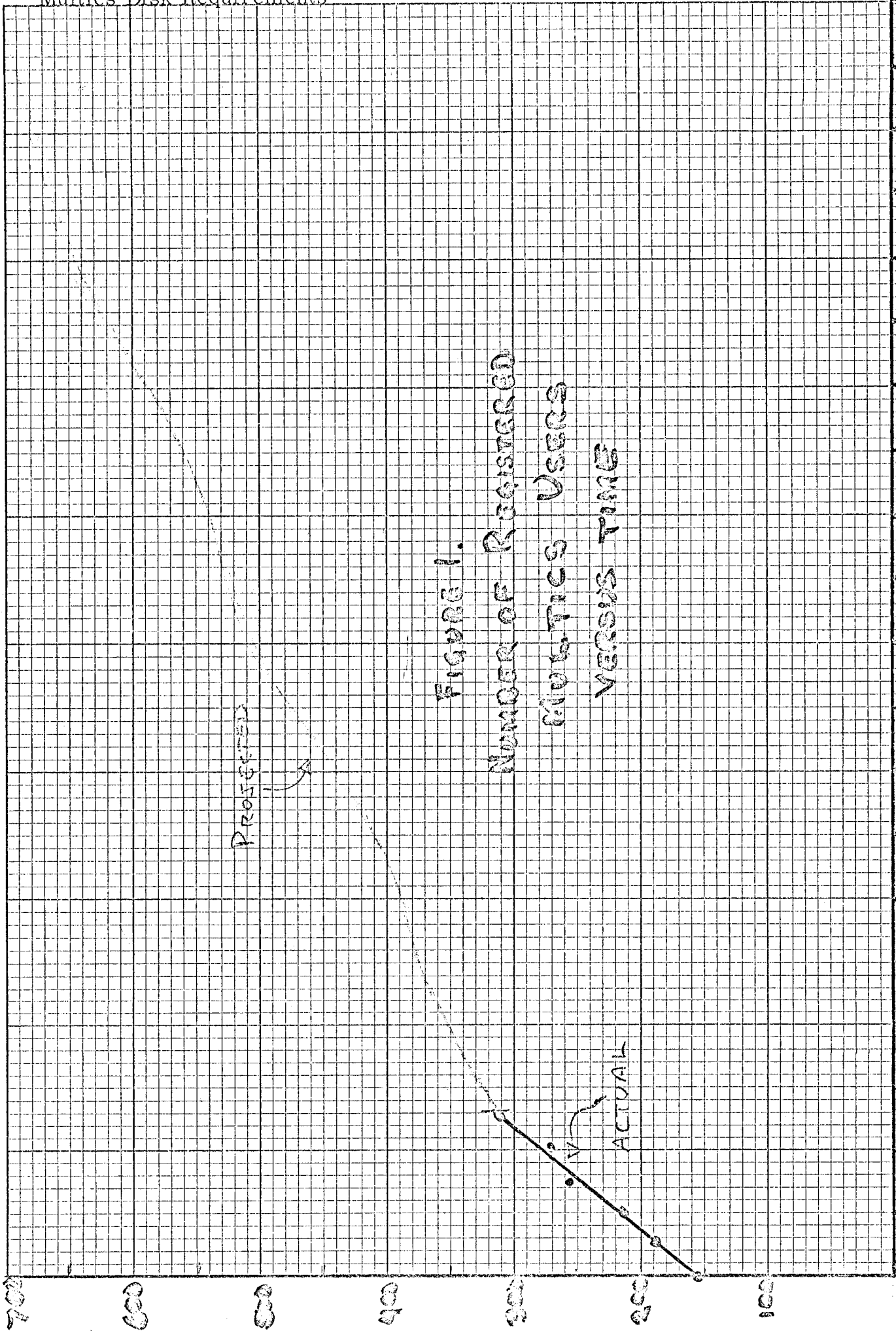curve.

Multics Disk Requirements

Figure 1.

Number of Registered
Multics Users
Versus Time

Multics Disk Requirements

Increase in capacity

The current capacity of the Multics system is 30 simultaneous users. This number is expected to increase to 60 by the end of 1970, and to attain 90 by the end of 1972. The CTSS configuration at Project MAC, supporting 30 simultaneous users, had 32 million words of storage available, and disk was scarce. The current 30-user IPC CTSS has 64 million words available (same capacity as two 2314 files), and disk is becoming less scarce. If there is a linear relation between disk requirement and the number of simultaneous users a system can support, then Multics should have at least two 2314's by January 1971, even if we disregard the "expansion factor" mentioned earlier.

Some useful numbers

as of 2/26/70

	CTSS	Multics	
registered users	550	300	(including system)
number of files	13,000	5,000	
files/user	23	17	
average file length (words)	3,230	3,270	

Timing

As I understand the situation, we can get both a controller and a 2314 in May, 1970. If we don't take the 2314 then, it's not clear we can get another in less than a year. Checkout and updating the file system and BOS to handle a 2314 will take a non-trivial effort - at least a month, perhaps more.