INTERDEPARTMENTAL

MASSACHUSETTS INSTITUTE OF TECHNOLOGY *CAMBRIDGE 39, MASS.*

from the office of Information Processing Services

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To: Multics Administrative Distribution

From: J. M. Grochow

Subject: On the Calculation of "MTBF"

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In trying to arrive at some meaningful comparison statistics of Multics operation, I have found that Mean Time Between Failure, as currently defined, is a very misleading indicator of Multics reliability.

Firstly, let us define the various statistics that can be presented. Note that "crash" includes unscheduled shutdowns:

MTBF - mean time between failure. This is computed as follows:

$$\frac{\text{(total number of hours in the relevant period)}}{\text{(number of crashes in that period + 1)}}$$

MTBS - mean time between shutdowns, calculated:

$$\frac{\text{(total number of hours in the relevant period)}}{\text{(total number of shutdowns (crashes or normal) + 1)}}$$

MLSS - mean length of scheduled sessions, calculated:

$$\frac{\text{(total number of "user available" hours in the relevant period)}}{\text{(total number of crashes + 1)}}$$

MLUS - mean length of useful service. This is computed as follows:

$$\frac{\text{(total number of "user available" hours in the relevant period)}}{\text{(total number of shutdowns (crashes or normal) + 1)}}$$

In all cases, the relevant time period can be any of the following:

month (m)
7-day week (7)
5-day (Monday-Friday) week (5)
1st shift week (8 am-4 pm Monday-Friday) (S1)
2nd shift week (4 pm-Midnight Monday-Friday) (S2)
3rd shift week (Midnight-8 am Monday-Friday) (S3)
4th shift week (all day Saturday and Sunday) (S4)

In referring to a particular statistic, I will add the appropriate suffix, e. g. MLSS-m is currently reported in the IPC Bulletin, although it is labeled Mean Time Between Failures.

It appears to me that all these statistics have their various meanings and purposes:

MTBF - a general indicator of the time period between failures. Useful only because "everyone knows what MTBF means". It tends to "hide" the actual number of crashes in a numerical manipulation.

MTBS - sometimes erroneously used when talking about MLUS.

MLSS - assuming that scheduled shutdowns do not adversely affect the user, MLSS can be viewed as a measure of how the user sees the system. (My personal opinion is that MLUS is better for this purpose but this can be argued.)

MLUS - this number can be viewed as a measure of user satisfaction. Each user should interpret this in the context of his particular usage patterns (short sessions, long sessions, and so forth).

It has also been suggested that rather than all these "fancy" numbers we simply tell users three things:

- the number of crashes per month
- the percentage of user logins terminating in a crash
- the number of user available hours per month
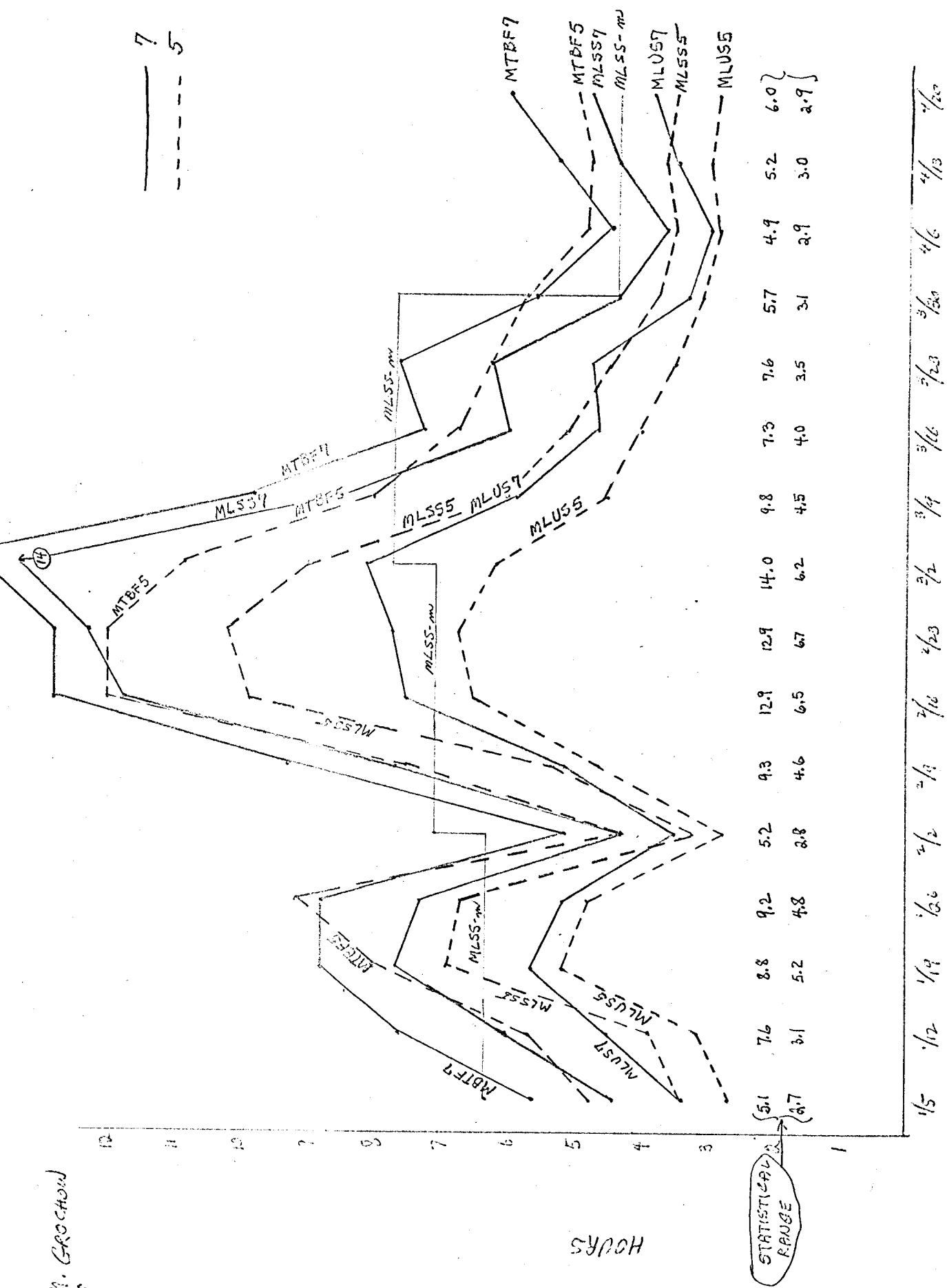
From these, he can compute his own statistics.

In line with our goal formation process, I think that adopting MTBF and MLUS as standard statistics calculated periodically, we can better set improvement goals and keep track of our progress.

The following graphs and charts show the different pictures that can be presented by using different statistics. On the basis of this analysis, I suggest that, for planning purposes, MTBF5 and MLUS5 be used as indicators of Multics reliability. For statistical reporting to users, I also suggest that we include the three "raw" numbers mentioned above.

Attachment (1)

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IPS

Legend: —— 7 ／ - - - 5

HOURS

STATISTICAL RANGE

WEEK BEGINNING ON

Curve labels: MTBF7, MTBF5, MLSS7, MLSS-m, MLUS7, MLSS5, MLUS5

Week beginning	1/5	1/12	1/19	1/26	2/2	2/9	2/16	2/23	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20
	5.1	7.6	8.8	9.2	5.2	9.3	12.1	12.9	14.0	9.8	7.3	7.6	5.7	4.9	5.2	6.0
	4.7	3.1	5.2	4.8	2.8	4.6	6.5	6.7	6.2	4.5	4.0	3.5	3.1	2.9	3.0	2.9

$MTBF = \dfrac{TOTAL\ HOURS}{TOTAL\ CRASHES+1}$ (2 DAY, 5 DAY WEEKLY)

$MLUS = \dfrac{TOTAL\ AVAILABLE\ HOURS}{TOT.\ CRASHES+NORMAL\ SHUTDOWNS}$ (2 DAY, 5 DAY WEEKLY)

MLSS: $\dfrac{AVAIL\ HRS}{CRASHES+1}$ (MONTHLY)