To:        Distribution

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Date:      10/02/80

Subject:   Communications Metering


## INTRODUCTION


It has been felt for some time that the metering information available for Multics communications, as reported by the tty_meters command, is inadequate. Although a considerable number of facts are reported, they are rather miscellaneous, and do not provide a good guide to how the communications software is actually performing; the output is poorly organized, very little throughput information is reported, and no per-channel information is available. This MTB proposes the replacement of tty_meters by two new commands, system_comm_meters and channel_comm_meters, intended to provide exhaustive measurements in a reasonably well-organized format. The information thus recorded can also be useful for the ELAN error-reporting system, and is the first step toward answering service accounting for terminal traffic.

Presumably, the output of the new metering commands can be used as a guide in determining whether a given channel configuration is appropriate, what parameters, if any, should be altered, etc. Some experience with the new meters is required before such a guide can be usefully described.


## IMPLEMENTATION CONSIDERATIONS


Current plans call for maintaining system-wide meters and logical channel meters in ring 0, and physical channel meters and some per-FNP meters in the FNP. The system_comm_meters command will operate essentially as tty_meters does today: it will copy the relevant data bases out of ring 0 when called, and if the -reset control argument is used it will keep the copy in internal static for use as a base in subsequent invocations. The channel_comm_meters command, on the other hand, will use mechanisms like those used now by debug_fnp to extract

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information from  the FNP on  demand; implementation of  a -reset
feature  becomes much  more complicated in  this environment.  In
any case,  it is not  altogether clear what -reset  would mean to
channel_comm_meters; does it reset for  all channels, or just the
one(s) specified on the command  line in which the -reset control
argument appears?   Because of a  desire not to  delay the entire
project    until    these    issues    are    resolved,    the initial
implementation of  channel_comm_meters will not  include a -reset
control argument.


It  is  proposed  that all  the  per-channel meters  for  a given
channel  be  reset  whenever  that channel  changes  hands.  This
enables  a user  to observe  the behavior  of a  channel over the
course of a  single dialup without being confused  by meters left
over from a  previous usage; it also greatly simplifies the job of
the  answering  service  in  using  these  meters  for accounting
purposes.  Some of the system-wide  meters are derived by summing
across all the channels; therefore,  cumulative system-wide totals
will be updated whenever a channel's meters are reset.


A few features that appear  attractive and useful will be omitted
from the initial implementation.  In particular, it would be nice
to  have a  way of sorting  the output  of channel_comm_meters in
such a way  as to get information on the  N most active channels,
or   those  that  have  experienced  the  greatest  numbers  of
transmission  errors.  The  precise mechanism for  doing this has
not been  worked out.  Some  analysis tools for  interpreting the
output of the  metering commands (or the raw  data) would also be
very useful; as indicated above,  such tools should probably wait
until we have a better idea of what they can tell us.


system_comm_meters COMMAND


The  system_comm_meters  command  is  a  direct  replacement  for
tty_meters -- in fact, the name  tty_meters will be retained as a
synonym  for  system_comm_meters so  that existing  exec_coms and
absentee  jobs  will continue  to  work.  It  reports system-wide
meters  derived  from information  kept in  ring 0,  primarily in
tty_buf.


channel_comm_meters COMMAND


The channel_comm_meters command  reports metering information for
individual  communications  channels.   This  includes throughput

information on a per-logical-channel basis (derived from ring 0),
and additional information for "physical" channels (i.e.,
subchannels of an FNP) concerning throughput, abnormal events,
and a few miscellaneous meters of interest primarily to
communications systems programmers. It can also be requested to
report this information for an entire FNP rather than one or more
of its subchannels, or to report the individual meters for all
channels on a specified FNP or all channels configured on the
system.


## MAM COMMUNICATIONS DOCUMENTATION


The following pages contain command documentation for the MAM
Communications (CC75).

Name: system_comm_meters

    The   system_comm_meters   command   prints   out   metering
information for ring 0 Multics Communications Management.


## Usage

    system_comm_meters {-control_args}

where control_args can be chosen from the following:

    -reset, -rs
        resets the  metering interval for  the invoking process
        so  that  the  interval  begins  at  the  last  call with
        -reset  specified.   The  metering  information  is  not
        printed.  If  -reset has never been  given in a process
        the interval begins at system initialization time.

    -report_reset, -rr
        prints  metering   information  and  then   resets  the
        metering interval.


## Access Required

Use  of  the  system_comm_meters  command  requires access  to  the
phcs_ gate.


## Example

The following is a sample of the output of the system_comm_meters
command.


Total metering time 05:43:27

THROUGHPUT

| | before conversion | after conversion | ratio |
|---|---|---|---|
| Total characters input | 17,234,567 | 15,543,210 | 0.90 |
| Total characters output | 168,012,345 | 185,876,543 | 1.14 |
| Average length of input | 12.3 characters | | |
| Average length of output | 59.7 characters | | |
| Input characters preconverted | 20,435 (1.2% of total) | | |

| | read | write |
|---|---|---|
| Number of calls | 1,456,789 | 26,357,924 |
| Average time per call | 6.37 msec. | 9.63 msec. |
| Average chars. processed | 13.5 | 57.8 |
| Average chars. per msec. | 2.1 | 5.8 |

## FNP CONFIGURATION

|                         | FNP A    | B    | C        | Total |
|-------------------------|----------|------|----------|-------|
| Current state           | UP       | DOWN | UP       |       |
| Has been up for         | 04:15:12 | ---- | 02:45:30 |       |
| Memory size             | 32K      | ---- | 64K      |       |
| Avg. amount of free space | 15,840 | ---- | 21,876   |       |

## FNP/HOST INTERACTION

|                          | FNP A     | B    | C       | Total     |
|--------------------------|-----------|------|---------|-----------|
| Number of interrupts     | 1,964,208 | ---- | 946,357 | 2,910,565 |
| Avg. time/interrupt(ms)  | 2.7       | ---- | 3.1     | 2.8       |
| % of total CPU time      | 1.2       | ---- | 1.1     | 2.3       |
| Mailbox transactions:    |           |      |         |           |
|   Input data             | 305,948   | ---- | 220,349 | 526,297   |
|   Output data            | 783,387   | ---- | 543,210 | 1,326,597 |
|   Input control          | 21,333    | ---- | 14,111  | 35,444    |
|   Output control         | 45,678    | ---- | 23,456  | 69,134    |
| Total                    | 1,156,346 | ---- | 801,126 | 1,957,472 |

|                            |     |      |     |
|----------------------------|-----|------|-----|
| Avg. number mbxes in use   | 2.3 | ---- | 3.1 |
| Max. number mbxes in use   | 16  | ---- | 0   |
| No mbx available           | 37  | ---- | 0   |
| Output restricted by space | 88  | ---- | 24  |

## CHANNEL INTERRUPTS

|                        | input   | output  | other   | total     |
|------------------------|---------|---------|---------|-----------|
| software "interrupts"  | 678,901 | 423,440 | 110,011 | 1,212,35  |
| average time (msec.)   | 1.34    | 0.56    | 0.23    | 1.01      |

## TTY_BUF SPACE MANAGEMENT

| Total size of buffer pool       | 11,480 words |
|---------------------------------|--------------|
| Number of channels configured   | 143          |
| Number of multiplexed channels  | 8            |

| % of buffer pool in use | current | average |
|-------------------------|---------|---------|
|   input                 | 6.9     | 6.5     |
|   output                | 13.4    | 15.6    |
|   control structures    | 15.8    | 15.3    |
|   total                 | 36.1    | 37.4    |

Smallest amount of free space ever    4,358 words (38% of buffer pool)

|                             | allocate   | free       | total      |
|-----------------------------|------------|------------|------------|
| Number of calls             | 24,657,988 | 20,665,443 | 45,323,431 |
| Average time per call (msec.) | 0.23     | 0.37       | 0.29       |
| % of total CPU              | 0.14       | 0.17       | 0.31       |

Calls requiring loop on tty_buf lock       1,249,340  (2.83% of total)
Average time spent looping on lock         0.14 msec. (0.01% of total CPU)
Number of allocation failures                      0  (0.00% of attempts)


CHANNEL LOCK CONTENTION

Number of calls to tty_lock                40,392,817
Times channel lock found locked             2,364,758 (5% of attempts)
Average time spent waiting for lock             1.8 msec.
Maximum time spent waiting for lock             3.7 msec.
Number of interrupts queued because channel locked
                                               25,437 (2.2% of interrupt


ECHO NEGOTIATION

Average time of transaction              3.2 msec.
Number of characters echoed by supervisor   21,576 (0.13% of input character
Number of characters echoed by FNPs        335,466 (1.87% of input character


ABNORMAL EVENTS

Input restarts                   12,576 (0.8% of read calls)
Output restarts                 304,289 (1.2% of write calls)
Output space overflows           16,384 (0.1% of write calls)
"needs_space" calls                   0

Input rejects            FNP  A          C          Total
  Number                      0          0          0
  % of input transactions     0.0        0.0        0

Name:  channel_comm_meters

        The   channel_comm_meters   command   prints   out   metering
information for a specified communications channel or channels.


Usage

        channel_comm_meters -control_args

where control_args may be chosen from among the following:

        -channel STR, -chn STR
            prints information  for the channel whose  name is STR.
            If STR  specifies the name  of an FNP,  totals for that
            FNP  are reported.   If STR is  a starname, information
            for  every  channel matching  the starname  is printed.
            This control argument is required.

        -brief, -bf
            causes  a reduced  amount of information  to be printed
            for each specified channel.

        -error
            causes  only those  meters to  be printed  that reflect
            error conditions.


Notes

        If a single channel is  specified, the caller must either be
the current user  of the specified channel or  have access to the
phcs_  gate.   If a  starname  is specified,  the user  must have
access to the phcs_ gate.

        If -brief and  -error are  both specified,  then only those
error indications that would be  printed with -brief are printed.
See the example below.


Example

        In  the  example below,  code characters  appear  at  the
beginning of  some lines; these  characters do not  appear in the
actual  output  of  the  command.   The  interpretation  of  the
characters is as follows:

        A -- this line appears for asynchronous channels only
        S -- this line appears for synchronous channels only
        B -- this line is among those printed if -brief is specified
        E -- this line is among those printed if -error is specified

Only lines  marked with both  B and E  are printed if  -brief and
-error are both specified.


!      channel_comm_meters -channel a.h000

       Total metering time 01:45:13

       a.h000

[The following meters are printed for all channels]

|   |                       | before conversion | after conversion | ratio |
|---|-----------------------|-------------------|------------------|-------|
| B | Total characters input | 984 | 935 | 0.95 |
| B | Total characters output | 10,540 | 11,400 | 1.09 |
| B | Average length of input | 8.7 | 8.3 | |
| B | Average length of output | 63.1 | 69.4 | |

|                              | read | write | control | total |
|------------------------------|------|-------|---------|-------|
| Number of calls | 175 | 194 | 53 | 422 |
| Average time per call (msec.) | 2.3 | 5.8 | 1.7 | 4.1 |
| Average chars. processed per call | 5.6 | 56.1 | | |

|                              | input | output | other | total |
|------------------------------|-------|--------|-------|-------|
| Number of software interrupts | 113 | 163 | 28 | 304 |
| Average time per interrupt (msec.) | 1.6 | 2.3 | 0.8 | 2.0 |

| B | Effective speed (bps) | 1.6 | 17.5 |
|---|-----------------------|-----|------|

       Characters passed with average input interrupt  8.7

[The following meters are printed for physical FNP channels only]

|    |                       | input | output |
|----|-----------------------|-------|--------|
| SB | Messages transmitted | 240 | 224 |
| SB | Minimum message length | 5 | 12 |
| SB | Maximum message length | 143 | 508 |
| SB | Average message length | 10.3 | 57.6 |

| SBE | Invalid input messages | 6 (2.5% of total) |
|-----|-------------------------|-------------------|
| SBE | Output messages retransmitted | 8 (1.6% of total) |
| SBE | Timeout waiting for acknowledge | 2 (0.4% of output messages) |

       Output overlaps in FNP                127
       Average length of DIA request queue   1.7 entries

| A |   | Pre-exhaust status | 12 |
|---|---|--------------------|----|
| A | E | Exhaust status | 7 |
| A | E | Software transfer timing errors | 0 |
| A | E | Bell/quits | 8 |
| A | E | Echo buffer overflows | 2 |
|   | E | Parity errors | 0 |

```
      Avg. number of pending status events    1.9
    E Software status queue overflows         1
    E Hardware status queue overflows         0
    E Input buffer allocation failures        1
```

[The following meters are printed for an entire FNP]

```
    B  Number of channels configured        88
    B  Average number dialed up             43.7
    B  FNP idle                             74.9%
       Average inbound mailboxes in use      1.1
     E Abnormal DIA status events            3
     E Memory parity errors                  0

    B  Total available buffer pool       6,360 words
    B  Average % of buffer pool available   34.7
    BE Buffer allocation failures           12
```