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To: MTB Distribution
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Subject: X.25 Enhancements (MTB-571)

This MTB describes enhancements to the X.25 network interface which are planned for MR10. The X.25 software was originally done as an RPQ item for General Motors and Bell Canada. MR10 will be the first general release of it as a supported product.

Overview of X.25

CCITT Recommendation X.25 is the international standard interface between computers and packet-switched networks. It has been adopted by the great majority of the public data networks. It is used by TELENET and TYMNET in the United States, DATAPAC in Canada, IPSS in the United Kingdom, and TRANSPAC in France. Providing a powerful X.25 connection capability will make Multics a more useful system in these days of distributed computing.

Current X.25 Support

The current Multics X.25 software, on which these extensions will be built, was written as a special for GM and Bell Canada. Both required the capability to interface easily with existing public data networks, TELENET and DATAPAC. Its design was based on the X.25 interface built by the University of Calgary for their Multics system, modified to use the 18X FNP instead of a PDP-11. It implements the 1977 CCITT recommendation. Only those features needed by these original customers and the Multics Development Center were implemented. This limits the current version to remote login to the Multics system and a limited "dial_out" capability.

Other Multics X.25 Implementations

Two other means of X.25 network access are used by some Multics sites. The "Bath-Bristol Special" is used by the universities in the UK to communicate with a private packet-switched network (SWUCN). It consists of Multics code and a special Level-6 front-end processor. The Level-6 handles the both frame and packet level protocols. Some French sites use the DSA-100 UNCP

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to interface with TRANSPAC through a special DAC gateway. The UNCP translates the X.25 protocols into DSA.

Overview of Proposed Enhancements

At the physical level (level one) support will be added for the Bell 30X and CCITT V.35 interfaces at data rates of 19200 to 72000 bits per second. Support for V.24 (RS232C) will be continued for data rates between 1200 and 10800 bits per second. It is not now possible to estimate the total throughput per FNP. Experiments will have to be done with the recently installed new buffer allocation strategy before we can see whether there will be any significant limitations.

The current link level (level two) implementation will be discarded and completely redesigned and reimplemented. The current design splits the functions of this level between the FNP and the Multics system. Experience has shown that the interface between these two is much more complex than originally thought. The new implementation will reside entirely in the FNP. This opportunity will be taken to also implement the LAP-B protocol in addition to LAP. LAP is retained in the current standard only for compatibility with the previous version. We should support the current standard protocols wherever possible. Support will also be added for extended packet numbering (mod 128).

Significant improvements will be made at the packet level (level three). The capability to read and write arbitrary X.25 packets for special applications will be added. The new features added by the 1980 standard, such as window and packet size negotiation, use of the 'D' bit for end-to-end acknowledgement, and extended packet numbering (mod 128) will be supported. The capability to select a specific group of listening logical channels through the use of the call data field will be provided. Permanent virtual circuits will be supported. It will be possible to configure parameters such as packet and window size separately for each logical channel. Metering code will be added to the level three programs to allow analysis of the configuration and tuning of parameters such as packet and window size.

X.25 interactive terminal users will find a greater range of Multics terminal features available. Support for lfecho mode will be improved. Output acknowledgement features (write_status and 'marks') will be enhanced to use the appropriate features of the X.29 PAD interface. Support for terminals such as 2780/3780, 3270, and HASP connected through a BPAD will also be added.

A PAD simulation mode will be added to the existing X.29 code. This will permit a Multics system to appear to a foreign system as a PAD. The "dial_out" program will be able to use this feature to permit full X.29 PAD functionality.

Priorities

It will not be possible to complete all the enhancements proposed in this document in the MR10 time frame. It is necessary to determine a set of priorities to decide what should and should not be done.

The first priority will be to support internal use of TYMNET by CISL. CISL is now almost completely dependent on TYMNET and the X.25 connections to MIT-Multics, CISL-Multics, and System-M. Support of these connections and those features of X.25 used by CISL, such as use of emacs and the video system, is critical.

Second will come support of existing users of the X.25 interface. These are General Motors, Bell Canada, NWGS, SSTD, VWA, and ASEA. They have made a significant investment in the work done so far on the interface. Work done to remedy its remaining deficiencies should have high priority.

The next to be done will be those features which will make the X.25 PSP and the Multics system more attractive to new customers. The high level of support of this standard protocol should make Multics an attractive choice to heavy users of X.25 networks.

The remaining proposed enhancements complete the implementation of the 1980 standard. While they need not be done immediately, they will increase in importance as use of the 1977 standard declines. Efforts should be made to ensure that they are made in a timely manner.

Plan of Work

The following plan of work is based on the priorities above as well as the practical effects of the current organization of the product.

1. A substantial rewrite of x25_mpx will be done. This will provide improved performance and reliability, add support for call-data interpretation on incoming calls, add some metering code, and improve the implementation of write_status to be more accurate. The new code will be organized to ease the implementation of the other proposed level three features at a later date. (6 weeks)
2. The necessary fixes to the frame and packet levels to pass the TELENET certification tests will be made. The availability of the protocol test package developed by FSO will help here. (4 weeks, assuming ready availability of TELENET test time)
3. The necessary interfaces for 'raw' access to the packet level will be implemented. These will permit special-purpose

applications to use all features of the packet level protocol directly. (2 weeks)

4. Support for PAD simulation and 'marks' will be added to the X.29 code. The implementation of lfecho mode will be improved. This will complete the support of asynchronous PAD terminals with the X.29 protocol. (3 weeks)

5. The frame level (LAP) will be completely rewritten to reside entirely in the FNP. This will allow a significant increase in throughput, making wideband connections much more useful. LAP-B support will also be added at this time. (10 weeks)

6. Support for the rest of the 1980 packet level features (packet and window size negotiation, use of the D bit, extended packet numbering, and permanent virtual circuits) will be added. These will be useful in developing applications other than remote login to use X.25 links. The ability to configure parameters such as window and packet size, use of the D bit, and use of X.29 protocol will be made configurable on a per-channel basis. (4 weeks)

7. Support for terminals connected to a BPAD will be added. This will allow access to 2780/3780 RJE stations and 3270 terminals through an X.25 network. (4 weeks)

Release Schedule

While the final schedule for MR10 has not yet been determined, it is expected that items 1, 2, and 3 (12 weeks) will be in MR10.0 (FW 226); items 4 and 5 (13 weeks) will be in MR10.1 (FW 301); and items 6 and 7 (8 weeks) will be in MR10.2 (FW 326). It is not clear whether there is any market demand for items 6 and 7. They may be postponed indefinitely.

Documentation

Sample documentation for the MAM Communications follows.

ADMINISTRATION AND USE OF X.25 NETWORK CONNECTIONS

The Multics Communications System provides support for a connection to a Packet Switching Network through an interface complying with CCITT Recommendation X.25. This connection is made through a single HDLC communication channel.

The Multics Communication System contains a multiplexing mechanism that allows each virtual circuit through the network to be independently controlled. In this manner it is possible to configure some as login terminals, while others may be used for outgoing access.

The FNP Core Image

Support of an X.25 connection on Multics requires that the software module "x25lap_tables" be present in the FNP core image. To accomplish this, the bindfile must be changed to include x25lap_tables and a new core image must be generated. For further details see Section 6 ("FNP Core Images") and the description of the bind_fnp command in Section 7.

Definition of X.25 Channels

Two channels must be defined in the Channel Master File (CMF) for each X.25 network connection, as well as one for each subchannel which is to be configured. A sample excerpt from a CMF is shown below:

```
name: b.h102;
  baud: 9600;
  line_type: X25LAP;
  service: multiplexer;
  multiplexer_type: lap;
  terminal_type: LAP_DTE;

name: b.h102.1;
  service: multiplexer;
  multiplexer_type: x25;

name: b.h102.1.001-b.h102.1.050;
  service: login;
  terminal_type: ASCII;

name: b.h102.1.051-b.h102.1.063;
  service: autocall;
  terminal_type: none;
```

The above configuration defines a connection to the network at 9600 baud through channel b.h102. Multics will behave as the DTE

and will use the basic X.25 protocol. There are 50 inward (login) channels and 13 outward channels.

Multiplexer Terminal Types

The terminal type defined for the LAP multiplexer channel determines the parameters of the connection to the network. The following terminal type entries are defined in the standard TTF:

```
LAP_DTE
LAP_DCE
```

The LAP_* terminal types determine whether Multics will act as a DTE or a DCE in the level 2 (LAP) protocol.

The only portion of the TTF entry that is used is the "additional_info" keyword. The character string is used to specify the value of various parameters used to control multiplexer operation. The field is formatted as a series of parameter assignments, separated by spaces.

A sample TTF entry for a LAP multiplexer might appear as follows:

```
terminal_type: LAP_DTE;
  additional_info: "dce_mode=no frame_size=4032";
```

The complete set of parameters that can be specified is shown below:

```
name:      dce_mode
values:    yes or no
default:   no
meaning:   controls whether the Multics system behaves as the DTE
           or DCE.

name:      disc_first
values:    yes or no
default:   no
meaning:   controls whether Multics enters the DISC SEND state.
           This is needed only for networks implementing the old
           TELENET X.25 protocols.

name:      frame_size
values:    24 through 8000 in multiples of 8
default:   8000
meaning:   specifies the maximum size, in bits, of transmitted
           frames.

name:      window_size
values:    1 through 7
default:   7
```

meaning: specifies the number of outstanding unacknowledged frames allowed.

name: n2

values: 1 through 100

default: 20

meaning: specifies the number of times a frame will be retransmitted before the link is reset.

name: t1

values: 1 through 60

default: 3

meaning: specifies the number of seconds to wait for a frame acknowledgement.

name: t3

values: 1 to 60

default: 30

meaning: specifies the number of seconds to wait for a response to a link reset.

X.25 CONFIGURATION FILE

An X.25 configuration file contains the information needed to configure an X.25 multiplexer. This file is automatically located by the system software under the name >sc1>x25>[x25_mpx_name].x25.

Syntax of the X.25 Configuration File

The X.25 configuration file consists of a series of entries, one for each logical channel or group of logical channels. Each entry consists of a series of statements that begin with a keyword and end with a semicolon. White space and PL/1-style comments enclosed by "/*" and "*/" may appear between any elements. The last entry in the file must be the "end;" statement. Global statements specifying defaults appear anywhere before the end statement; the defaults that they specify are in effect for all subsequent entries, until they are changed by subsequent global statements.

GLOBAL ENTRIES.

Descriptions of global configuration statements are given below.

Network: <net-name>;

The Network statement is optional. If given, it specifies that network-specific features for a particular network

should be enabled. Allowed values are "datapac", "telenet", and "tymnet".

Address: <local address>;

The Address statement is optional. If given, it specifies the calling DTE address to be used in Call Requests from this interface. If it is omitted, no address will be included.

X.25 LOGICAL CHANNEL ENTRIES

A description of each statement in a logical channel entry is given below.

channel: <lcen>[:<lcen>];

The channel statement is required. It specifies the logical channel number, or the range of logical channel numbers, for the channels being configured. The <lcen> must be a decimal integer between 1 and 4095.

packet_size: <bytes>;

The packet_size statement is optional. It specifies the maximum packet size to be used when sending data to the network. The default is 128 bytes.

window_size: <packets>;

The window_size statement is optional. It specifies the maximum number of outstanding data packets on the connection. The default is 2 packets.

MULTICS CHANNEL ENTRIES

A description of each statement in a Multics channel entry is given below.

name: <channel name>;

The name statement is required. It specifies the name or names of the Multics channels being configured. It must match the name given in the CMF.

service: <starname>;

The service statement is optional. It is meaningful only for slave and login service channels. When a Call Request arrives from the network, its call-data field will first be compared with the service starname for each listening channel. If one matches, that channel will receive the dialup. If there are no matches, a listening channel without a service statement will be chosen.

EXAMPLE OF CONFIGURATION FILE

```
/* This is the X.25 Configuration File for the
   CISL TYMNET connection to MIT-Multics.
   It is connected to a LAP line on channel c.h210.
   This file is in >sc1>x25>c.h210.l.x25.
*/

Network:          tymnet;
Address:          31060849;

Packet_size:     128;
Window_size:     2;

channel:         1:32;      /* 32 logical channels, all the same */

name:            imft1:imft2; /* some channels for IMFT */
service:        *.imft;

end;

/* CMF extract for the X.25 configuration at MIT */

name: c.h210.l;
service: multiplexer;
multiplexer_type: x25;
comment: "LAP subchannel";
name: c.h210.l.1001-c.h210.l.1024;
service: login;
comment: "X.25 login subchannel";
name: c.h210.l.c01-c.h210.l.c08;
service: autocal;
comment: "X.25 dial-out subchannel";
name: c.h210.l.imft1-c.h210.l.imft2;
service: slave;
comment: "X.25 IMFT subchannel";
```

Finished >udd>Multics>Hornig>work>x25.mtb.compout
Request 10006 in pica_10 queue 2 for Hornig.Multics.a
Requested: 02/11/82 0927.4 est Thu
Printed: 02/11/82 1016.6 est Thu
Printing time: 8.0 minutes
9 pages, 363 lines at \$2.75 per 1000 lines.
Cost: \$1.00

sipb_nec5525 driver: No requests, driver is idle.