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February 14, 1970CONSIDERATIONS IN THE CHOICE OF TYPEWRITER TERMINALS
FOR USE WITH MULTICS

by

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In general, a user of Multics will find that he will want to acquire private typewriter terminals to make most effective use of the system. Except for a few public "typewriter pool" rooms maintained by Information Processing Services, and Project MAC, each is on his own in choosing a model of terminal and in arranging for installation*. This memorandum describes a number of issues with respect to choice of typewriter terminal types for use with the Multics system.

Multics currently supports six varieties of typewriter terminals, several of which are in wide use throughout M.I.T.: Modified versions of the IBM model 2741 and 1050, the Teletype model 37, the General Electric Terminet 300 (at present at 15 characters/second only), the Execuport, and the Computer Displays model ARDS-100. Multics is organized to permit additional varieties of typewriter terminals to be added as they become interesting. These various alternatives will be discussed one at a time, following a few general considerations of character set problems and terminals-computer interconnection.**

* The M.I.T. Telecommunications Office is a clearinghouse which makes all actual orders to insure that certain Institute wide standards of compatibility are met. That office is also available for consultation on the subject.

** The comments made here about Multics features are based on a newly revised typewriter control package which should be installed in the system sometime in the second quarter of 1970. With a few exceptions, most of these comments apply to the present typewriter control software as well.

Character Set

Multics uses as its standard character set the 94-graphic "USA Standard Code for Information Interchange" (USASCII, or ASCII). This character set includes both upper and lower case letters, digits, and a useful collection of other graphics. Since in general all characters of that set are used freely by the system as delimiters, etc., in order for a terminal to be usable with Multics, it must be possible to type in and print out all of the characters of ASCII. For this reason, typewriters with an abbreviated character set, such as the model 33 and 35 teletypes, and the Telex, are not easily adaptable to use with Multics. Character escape conventions are defined for any device which does not have the full ASCII set (for example, six escape conventions are defined for the IBM 2741 which has only 88 graphic characters) but use of a severely handicapped device in this way is quite painful. All of the devices currently permitted on Multics are quite usable in this respect, and the available character set is probably not a significant aspect in making a choice among them.*

Terminal-Computer Interconnection

At present, all connections to the Multics computer are made via the "Data switch", a small, Bell-System supplied private branch telephone exchange located in M.I.T. building 10 which permits dialing among terminals or to any of a variety of computers on the M.I.T. campus. A limited number of access paths to this exchange are available via tie lines to the M.I.T. voice exchange (and then to the general public dial network, via the M.I.T. operator),

* It is expected that a limited use of Multics (e.g., write and debug FORTRAN programs only) will be possible and painless from a teletype model 33 or 35. This capability will be added to the system sometime in 1970.

to the Lincoln Laboratory data exchange, and to Bell Telephone Laboratories, Murray Hill, New Jersey. Any new usage of Multics via these tie lines other than for casual experimentation or demonstrations should be cleared with the M.I.T. Telecommunications office, to find if sufficient capacity will be available when needed.

The M.I.T. Telecommunications office requires users of the dataswitch to help defray its rental cost by paying a monthly "dataswitch attachment charge" for each telephone line connected to it.

All connections to the dataswitch are made using standard telephone company Dataphone modulator-demodulator units (modems), which translate and decode data bits to and from tones for transmission through the telephone system. The teletype, 1050, and 2741 use Dataphone models 103A or equivalent; the ARDS uses model 202C which has a 1200 bit per second transmission rate.

It is possible to use any other commercial or home-built modem which is compatible with these Dataphone models, and such usage may be substantially cheaper, although problems of maintenance, and difficulty in pinpointing which component of a multi-supplier system has failed, must be considered. The only operational experience that has been gained with non-Bell System modems is with acoustic couplers; in some situations they have worked well, in others not at all. Direct attachment of foreign modems is in principle possible under the new Bell System "foreign attachment" tariff. Note that some non-Bell modems may have lower tolerances with respect to line balance, noise level, or signal level than do Bell modems, and convincing the telephone company to upgrade a line to support a non-Bell modem with narrow tolerances could prove to be a challenge.

Experience suggests a lead time of several months is involved in orders for the telephone company model 202C Dataphone. A shorter (typically one month) lead time accompanies installation of telephone lines and 103A Dataphones.

"Hard-wiring" of terminals direct to the computer, avoiding both the data switch and the modems, in principle offers a way of economizing. This technique is practical only when the terminal is located within a short distance (100 feet) of the computer, and when the terminal will be used a high fraction of the time. Such attachment has so far not been explored for Multics. Longer distances require additional electronics in the form of "black boxes" which really begins to open the modem question again. Note also that hard-wiring may prevent usage of Multics when it is being operated in "Backup" mode, a degraded service used when one of the major I/O controllers is down.

IBM models 1050 and 2741

These two models look like elaborate versions of the familiar IBM "Selectric" or "golf-ball" office typewriter. The 1050 is the earlier technology version of the two. Since it is both equivalent to and more expensive than the 2741, most 1050's are headed for replacement and probably should not be the subject of new orders.

In order to be usable on Multics, a 2741 must have two optional features and one special order feature (RPQ). In addition, Multics is capable of making effective use of four further special order features (RPQ's) if they happen to be available. The required items are:

- . "Dial-up" feature. Required to permit attachment to Telephone Company 103A (or equivalent) modems.

- . "Interrupt" feature. Required to permit the user to interrupt the computer during output.
- . "Receive Interrupt" RPQ. Required to permit the computer to interrupt the user during input.

A 2741 without all of the above features is, for all practical purposes, unusable with Multics. The last two features taken together permit implementation of "type-ahead," an important property of an interactive system, and most system-provided programs presume that type-ahead is in use.

The four optional features which Multics can make use of are the following:

- . "Automatic Address Answerback" RPQ. This feature allows the computer to ask the 2741 for an identification code. If this feature is available, the console may be registered with the Multics system. Some system services related to privacy (e.g., ability to restrict access to some files or to the system to users from designated consoles) are usable only by owners of registered consoles. Registration also automatically allows use of all available console features. Upon dial-up, Multics will automatically perform an experiment to discover whether or not this RPQ is installed on the 2741.
- . "Print Inhibit" RPQ. This feature allows the computer to turn off the console printer, for example, during typing of the user's password. If the feature is not known to be available on the machine, Multics will generally type out a collection of random overstruck characters over which the user can type his password.

- . "Auto-EOT" RPQ. This feature allows the user to begin typing a second line of input without waiting for a computer response to the first one. If the feature is missing, his keyboard will lock whenever he types a carriage return. Multics will respond immediately with a "keyboard unlock" sequence, but the resulting 200 ms. mechanical delay is quite noticeable to the typist. By examining the input data stream, Multics can determine whether or not this RPQ is installed on the 2741.

- . "Red Ribbon Shift" RPQ. This feature permits use of a two-color ribbon. A number of popularly used Multics commands make use of ribbon shifts to highlight or accentuate warning comments, but this feature is certainly not essential to the user on a tight budget.

Finally, in the area of options, a platen width should be chosen which permits typing at least 120 characters on a single line. The 13 1/8" pin-feed platen meets this requirement.

When used with the 963 print element (golf-ball) the 2741 and 1050 have 88 of the 94 ASCII characters. The remaining 6, which are not frequently used by Multics or any of its originally supplied subsystems, can be input by means of double-character ("escape") sequences.

In general, these terminals resemble an office typewriter in appearance and "feel" and most experienced typists report that they are quite easy to use.

The pipeline on 2741's is quite long, sometimes taking as much as a year from placing the order.

In addition to the 1050 or 2741, a model 103A Dataphone or equivalent modem is required.

Several "2741-like" terminals made by competing manufacturers have recently come on the market. Experience with these terminals is limited, and the potential buyer is warned to be wary.

Model 37 teletype

This terminal is reliable, uses the full ASCII character set, and is supplied by the same telephone company which supplies the telephone lines and modems, a circumstance which can ease maintenance. Although it is a fairly new offering of the Teletype corporation, it has shaken down rather quickly and experience with it is mostly favorable. At 150 bits per second, this machine is substantially faster than the older teletype models 33 and 35, and about equal to the 1050/2741 speed. There are a number of drawbacks to this device, however:

- . Lead time on orders has sometimes been quite long.
- . Currently, models are available only with a narrow platen--with either 72 or 84 characters across.
- . The machine does not "feel" like an office typewriter--an experienced typist may feel ill at ease using it, at least at first.
- . Availability of this device after the acquisition by Western Union Company of the Bell System typewriter exchange service is in question. The device may be available only by direct purchase from Teletype corporation after that date, in which case separate maintenance arrangements would be required.

As rented from the telephone company, a 103A-compatible Dataphone is installed inside the teletype cabinet. It is also possible to purchase the model 37

directly from Teletype corporation, without the modem. Separate availability of the modems has not been explored.

For use with Multics two standard options are required:

- . redefinition of "New Line" to mean "carrier return and line feed".
The communications version of the model 37 uses the definition "line feed only".
- . Horizontal tabulate, used to speed up printing.

General Electric Terminet 300

This terminal device is electrically very similar, though not identical, to the model 37 Teletype when operated at 150 bits per second, and initial use with Multics is in this mode. The device can also operate at 300 bits per second, giving it a substantial typing speed advantage over the teletype. It is easy to use and quite quiet. It also requires use of a Dataphone model 103A or equivalent modem. Sometime in 1970 it is hoped that 300 bit per second use will be possible.

Execuport

This terminal device also looks logically, to a fair approximation, like a Model 37 teletype with a built-in acoustically coupled modem. This last feature, coupled with a carrying case to achieve portability, means that the Execuport can be utilized with a minimum of bother anyplace a telephone is available. Although capable of 300 bit per second use, at present it is used at 150 bits per second with Multics (see comments about the Terminet 300 re 300 bps use.) It achieves speed with quiet by utilizing a special paper; its printed characters are rather stylized patterns of dots; lower case letters are printed as small upper case letters; its representation of the USACII characters is nonstandard; and

input typing is hampered by lack of a horizontal tab character. Despite these minor flaws, there are some applications where its portability is a sufficiently valuable asset that the machine is quite acceptable.

Computer Displays ARDS terminal

This terminal is a low cost, soft copy only, display device based on a Tektronix storage tube and capable of both character and graphic drawing input and output. It operates at 1200 bits per second when used with the 202C Dataphone, well below its maximum speed of about 5000 bits per second, but higher-speed modems are at present disproportionately expensive. Multics will initially provide the ability to use the ARDS as a high speed typewriter, and to "get at" raw display controlling capabilities. A library of display constructing subroutines will probably appear in mid-1970.

The ARDS terminal brings into focus a problem which also exists for the other terminals: obtaining hardcopy output in bulk inappropriate for a typewriter terminal. Multics provides a high speed line printer which prints the full USASCII character set for this purpose. Console commands are used to request that a file containing output be added to the queue of work for the printer; the printer is driven by a Multics process whenever Multics is in operation.

At least two competitors for the ARDS terminal are now on the market; no experience has yet been acquired in use of either of these competitors on Multics.

Appendix I: Limitations of present Multics typewriter control software.

The following limitations on the above comments should be noted. They will apply until sometime in second quarter 1970, when a revised typewriter control package will be installed.

1. ARDS Terminal support not available.
2. IBM 2741 must have automatic address answerback, auto-EOT inhibit, and print inhibit RPQ's, in addition to required list above.
3. Execuport is handled as a M37 Teletype, with no consideration given to lack of horizontal tab, or non-standard graphics (circumflex prints as up-arrow, underscore prints as left arrow, left accent does not print at all.)
4. Console "registration" is not applicable, since all consoles must have automatic address answerback.

Appendix II: Prices

The following prices are for comparison only. Installation and first-time charges may also apply; check with the M.I.T. Telecommunications office for full details.

IBM 2741: (prices are monthly rental and include 10% educational discount)

Basic Terminal	\$85.50
Dial-up feature	2.70
Interrupt feature	2.25
Receive Interrupt RPQ	<u>7.20</u>
Minimum Terminal Price	\$97.65
Automatic address answerback	10.80
Print Inhibit RPQ	9.00
Auto-EOT RPQ	9.00
Red Ribbon shift RPQ	<u>9.00</u>
Fully equipped terminal price	\$135.45
103A data set	25.00
Data switch connection charge	<u>5.50</u>
Minimum Terminal & Communications	\$128.15

Model 37 Teletype: (Monthly rental, no discounts available)

Terminal with dataset	\$120.00
Data switch ^v connection charge	<u>5.50</u>
Terminal and communications	125.50

Terminet 300:

Terminal	
103A dataset	
Data switch connection charge	
Terminal and Communication	

Execuport: (Available for purchase only)

Terminal with acoustic coupler built in

ARDS-100 (Available for purchase only)

prices begin about \$8k purchase,
depending on graphics options wanted.

202C Dataset costs \$45/morth.