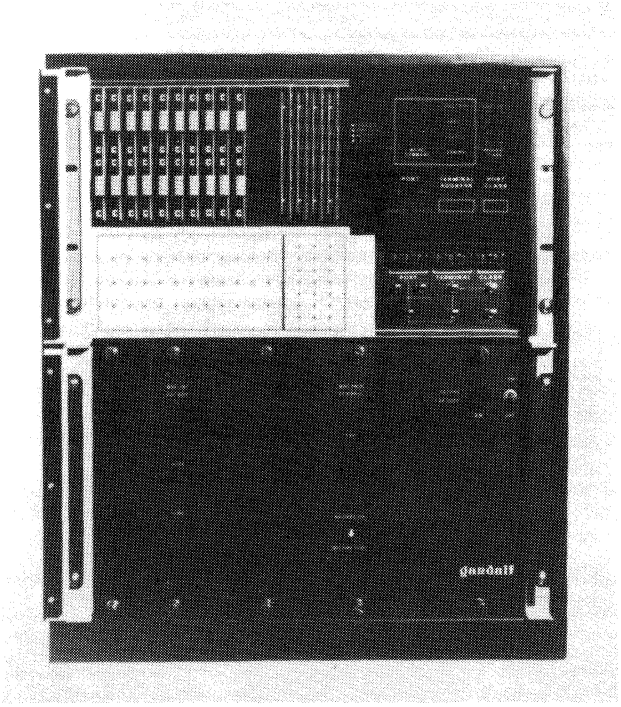
Gandalf PACX Family of Private Automatic Computer Exchanges



The MINI PACX III is shown above. The control panel, in the upper right corner, allows the operator to determine the status of line/port connections, to change a class of service, or to "force" a connection. The photograph depicts a 19-inch relay-rack unit approximately 24 inches high.

A family of electronic data switches that control port contention in single- or multiple-computer networks.

System capacities range from 48 lines by 32 ports to 512 lines by 256 ports. Depending on the model, 64 or 128 different service classes can be defined using thumb-wheel switches or keyboard entry.

A typical PACX IV system with 64 ports and 128 line connections sells for $33,900. Maintenance is not included, but is supported by customer spares and telephone consultation, as required.

MANAGEMENT SUMMARY

The PACX family consists of MINI PACX II and III, PACX II and III, Dual PACX II and III and the recently announced (but not yet delivered) PACX IV and Dual PACX IV; the basic differences are capacity and features available.

MINI PACX II handles asynchronous data at up to 9600 bps and synchronous data up to 19.2K bps; the possible contention ratio is 48 line connections by 32 port connections. MINI PACX III can accommodate the same speeds and contention ratio (48x32) but also has the capability of selecting class of service by entering a sequence of characters via the terminal keyboard. The PACX II and III have the same speed characteristics as their MINI PACX counterparts, but the possible contention ratio is increased to 254 line-side connections by 126 port-side connections.

All of the above mentioned configurations can handle up to 64 different classes of service (connection groups), based upon applications program and/or CPU desired, and the specific operating speed, protocol, and communications mode (half- or full-duplex) parameters of the terminal and front end. The desired class can be established by setting thumb-wheel switches on a separate ➢

CHARACTERISTICS

VENDOR: Gandalf Data, Inc., 1019 South Noel Avenue, Wheeling, Illinois, 60090. (312) 541-6060.

DATE OF ANNOUNCEMENT: September 1971.

DATE OF FIRST DELIVERY: September 1971.

NUMBER DELIVERED TO DATE: Over 600.

SERVICED BY: Gandalf Data, Inc.

CONFIGURATION

The various PACX configurations all have common printed-curcuit cards, such as line and port interfaces, and plug-in options (line drivers, modems, etc.). The basic differences occur in central logic and power. The central logic, including memory, is contained on one card on all PACX models except the PACX IV and Dual PACX IV, which are to have two logic cards. The central logic cards differ in the scan time required, which is a function of the system size. In all PACX systems the connect and disconnect times are the same: 600 milliseconds. During the connect cycle, several characters must be entered to identify the source terminal and to select service class. This is true whether the Thumb Wheel Dial Unit or the keyboard select feature is utilized. The time from when service is first requested until an available connection is found and made, or until service is denied, is a flat 600 milliseconds. The connect and disconnect timers are both fixed and latched functions. On the disconnect sequence, the timing is fixed to ensure that the discontinuance of service is valid (i.e., momentary loss of carrier, or a front end's scan time limitation will not cause a non-valid disconnect.) The system is supported by a battery with a 50-hour life in the case of a power failure. Power supplies differ with system size due to current drain.

Service classes are hardware programmed into the machine. During installation, the cables are routed to the appropriate computers and front ends. Up to 64 different classes of service (or 128 classes for the PACX IV configurations) can be obtained either by numerical selection on the Thumb Wheel Dialer or by keyboard select, depending upon the system components.

The contention ratios are also established at installation time, with any number of lines and ports (within system limitations) ➤

Gandalf PACX Family of Private Automatic Computer Exchanges

(Gandalf-supplied) unit co-located with the terminal. The Thumb-Wheel Dial Unit (TDU) is generally used in conjunction with a Gandalf data set or line driver; however, it may be used with independently supplied devices. Alternatively, a terminal can be dedicated to a single service class.

The port-side connection equipment can also "force" a connection to a given terminal-side device, although the line-side equipment generally initiates a service request. A forced connection from the port side is usually effected when the front end or CPU side of the machine is in a polling mode, and the line-side terminal is unattended. Provision is made to allow the port equipment to establish the operating speed and protocol, within the limits of the line-side equipment.

The PACX III has the same characteristics as the PACX II, but includes a terminal keyboard class select option and has a statistical port option. The statistical port option monitors all connections, disconnections, unsuccessful attempts, etc., accompanied by time of-day, and forwards this data to a connected device, which is usually a computer although hard-copy printers are sometimes used.

Dual PACX II and III versions are housed in two free-standing cabinets with separate power supplies, but share common control logic. The Dual PACX units have a contention ratio of 510 line connections by 254 port connections. In Dual configurations, the maximum asynchronous speed supported may be limited to 4800 bps.

All PACX II and III units require a small number of ports and lines to be dedicated for internal use; no more than four asynchronous ports and three asynchronous lines (for the Dual PACX) are required, with the requirement reduced for smaller models.

The PACX IV and Dual PACX IV offer several enhancements over their predecessors, the most significant of which are a doubling of the number of classes of service available from 64 to 128; operation of the dual configurations at 9600 bps; and enhanced control capabilities, including a more sophisticated keyboard, class select handshaking control, unlimited queueing on all classes, a keyboard-programmable variable controlled access (hierarchy) capability, user control panel and statistical reporting improvements, a keyboard-controlled panel lock, enhanced automated switch control using a separate statistics reporting channel and operator control channel, and a selectable data monitoring port for traffic monitoring. Although the physical number of port and terminal channels (256 lines by 128 ports in single configurations; 512 lines by 256 ports in dual configurations) is only slightly increased over the PACX II and III, no slots are required for internal use; all system functions are stored in electronic memory on the central logical boards.

Gandalf also supplies a comprehensive line of data sets and line drivers ranging from low speed (0-300 bps, being possible. Ratios can be changed at any time by simply adding or removing cards. Line-side cards can accommodate up to four connections; port-side cards can accommodate up to eight connections. The port-side connections are not limited to hard EIA connections to front ends and may be connected to multiplexers or modems that route the data to a distant location. The only requirement in this configuration is that the ultimate terminus is a front end or intelligent device (i.e., something able to recognize a request for service and grant or deny it). The possible contention ratios are dependent upon the system installed. The MINIPACX units can service a maximum of 48 lines by 32 ports (48x32). The PACX II and III systems have a maximum contention ratio of 254x126. Dual PACX systems can service up to a 510x254 configuration. The PACX IV systems provide 256 lines for 128 ports; the Dual PACX IV systems, 512 lines for 256 ports. Within these maximums, any ratio can be established.

The accompanying configuration diagram shows a PACX III with all options and various system connections possible.

CONNECTION TO HOST COMPUTER

In the case of the PACX equipment, there is no host computer in the traditional sense because the equipment may be connected to several hosts with none of them being in control except with regard to connect/disconnect by service class. The PACX hardware appears to the host to be a modem and is physically connected via standard EIA cables.

TRANSMISSION SPECIFICATIONS

After a connection is made, the PACX is transparent to data. With the exception of some synchronous applications where the receive clock is looped back at the port board to maintain system timing (with the clock passed on to the port-side device) the PACX presents no impairment to the flow of data or control signals. Other elements of the Gandalf product line that have transmission parameters are described in the Components section of this report.

SOFTWARE

The PACX family does not have a software capability as commonly defined; rather, firmware/hardware programming exists. For special applications new ROM's are burned. This situation was discovered in several instances during Datapro's investigation for the User Reaction section of this report. All of those users were well satisfied. The PACX family has been successfully interfaced to all major computers. The most common problem that had to be solved was the timing with regard to connect/disconnect. For the majority of applications, these ROM's are off-the-shelf items and are supported by a spare-parts inventory.

COMPONENTS

The basic components of the PACX systems include mainframes (which include control logic and power supplies), line-side connection boards, port-side connection boards, PACX-housed features and remote-site options. The components of the PACX systems and related options are described in the following paragraphs.

Mainframes

The *MINI PACX II* mainframe includes cabinetry and card cages to accommodate 48 lines by 32 ports; 2 asynchronous port channels are required for internal use.

The *MINI PACX III* is the same as the MINI PACX II, but includes the keyboard select option; 4 asynchronous port channels and 1 asynchronous modem line-side channel are required for internal use.

Gandalf PACX Family of Private Automatic Computer Exchanges

103-compatible) to 19.2K bps synchronous. These items are supplied as plug-in's, for mounting in the PACX cabinet, or as stand-alone devices located at the terminal end.

Aside from the transmission devices and Thumb Wheel Dial Unit, there are several other interesting options. There are EIA-to-current-mode converters, which permit a terminal or port operating on EIA RS-232 voltage levels to connect to an AT&T 300 series data set, or a CCITT V.35 type modem operating on current interface. This item is of significant value when operating at 19.2K bps, which is within EIA RS-232 limits, but a current interface modem is required to reach the outside world. A modem sharing option is offered; this device interfaces up to four co-located terminals (within 50 feet) to one modem and allows local contention on a first-come-first-served basis; a request-to-send connects the first bidder to the modem, and the other terminals are locked out. Another option is a Terminal Control Unit that provides a method of controlling connect/disconnect for private-line modems and their associated terminals.

Another member of the product line is a Front End Switch, which is basically a fail-safe device. The Data Terminal Ready leads on all connected devices are monitored. If DTR goes down on all leads, a failure is assumed, and all channels are switched to the back-up device. Back-up switching can also be on a per channel basis; if data transitions are sensed but DTR goes down, the Front End Switch will "hunt" for a backup connection where DTR is high. The operation is similar to a telephone rotary switch except that the switching is all electronic. The standard configurations include 1x2, 1x4, and 1x8 switching capability on the back-up side for up to 126 incoming lines. Gandalf also offers a self-contained transmission test set consisting of a pseudo-random test pattern generator and a receive error detector capable of operation in either asynchronous or synchronous mode.

The Gandalf PACX and associated options are particularly suited for time sharing applications, and the firm has concentrated their marketing drive in this area. University systems are of special interest because in many cases privately owned wire is strung throughout the campus and the Gandalf line drivers are seriously considered. Many universities, and other educational institutions, also have a mixture of computers and applications, making the PACX system of special interest. The market for the Gandalf equipment is certainly not limited to educational applications, however; its customer list includes an impressive array of governmental, utility, financial, and manufacturing firms.

Gandalf Data, Inc. is an independent affiliate of Gandalf Data Communications Limited, which first introduced the PACX family in 1971. Since then approximately 600 units have been shipped, with about 150 installed in the U.S. and the remainder in Canada, England, and other overseas locations. The majority of the 600 systems were installed within the past 24 months. Gandalf Data, Inc. was formed

The *PACX II* includes cabinetry and card cages to accommodate 254 lines by 126 ports; 4 asynchronous ports are required for internal use.

The *PACX III* is the same as the PACX II, except it has keyboard select and statistics port features; it requires 4 asynchronous port channels, 1 asynchronous modem line-side channel, and two asychonrous line-side channels for internal use.

The *PACX IV* includes cabinetry and card cages to accommodate 256 lines by 128 ports, plus enhanced keyboard class select, statistics port, queueing, and control access features; no ports are required for internal use.

The *Dual PACX II* includes cabinetry and card cages to accommodate 510 lines by 254 ports; it requires 2 asynchronous ports and 2 asynchronous lines for internal use.

The *Dual PACX III* is the same as the Dual PACX II, but has the keyboard select and statistics port features; 4 asynchronous ports and 3 asynchonrous lines are required for internal use.

The *Dual PACX IV* includes cabinetry and card cages to accommodate 512 lines by 256 ports, plus enhanced keyboard class select, statistics port, queueing, and control access features; no ports are required for internal use since all features are stored in memory on the central logic boards.

Port-Side Channels

The *APB II* is an asynchronous port board that provides 8 RS-232-C (or V.24) interfaces, which appear to the port-side equipment to be modems. The Data Set Ready lead is latched HI when PACX power is on (similar to modem operation). A strap option permits the Ring Indicator lead to be latched HI upon first receipt of ring or to follow the ringing cycle until the port-side equipment raises Data Terminal Ready, which indicates availability and initiates the connect sequence. Another option is an artificial high speed clock that operates at 2400, 3600, 4800, 7200, or 9600 bps; the clock signal is passed on to the port to create the appearance of a synchronous connection. The transmit clock is crystal controlled; the receive clock is derived from incoming data in the same manner as a modem would operate. Each port connection is equipped with Light Emitting Diode (LED) indicators to show the status of Enabled, Port Ready, Active, and Latched Active conditions; the last indicates that the port has been active at least once since the indicators were last reset.

The *SPB* is a synchronous port board that provides 8 RS-232-C (or V.24) interfaces, which appear to the port side equipment as modems. A maximum operating speed of 19.2K bps is achievable depending upon the PACX model. Control lead operation and status indicators are the same as that of the APB II. The SPB requires a compatible SMTB board on the line-side of the hardware with similar strap options selected. These options include (1) constant carrier or controlled carrier (under command of the Request to Send lead from the port-side device); (2) the status of the carrier detect lead that is forwarded to the port side equipment (strapped to operate in conjunction with the constant or controlled carrier selection); and (3) half- or full-duplex mode selection. These straps affect all 8 channels on the card. In addition, each channel on the card has individual strap selections involving speed (2400, 4800, 9600 or 19.2K bps) and the selection of transmit clock source (from the PACX master clock, the connected device, or loop-back of the receive clock derived from the incoming data stream). The last transmit clock option is valuable when interfacing to

Gandalf PACX Family of Private Automatic Computer Exchanges

to increase U.S. market penetration; all manufacturing and support activity for state-side installations is provided from its plant in Wheeling, Illinois, a Chicago suburb. The total corporation employs over 550 people, with about 225 located in the growing U.S. operation. The total corporation grossed approximately $20 million last year, and U.S. sales revenue exceeded $11 million over the last 12 months.

USER REACTION

In August 1980, Datapro conducted a telephone survey of 6 users who had a total of 10 PACX systems. The units have been installed for periods ranging from 9 months to 4 years, or an average of 2.5 years. Three of the users had one machine (two each had a PACX II, and one had a PACX III), two users each had two PACX III's, and one user had three units (two Dual PACX III's and one MINI PACX). The largest configuration was 452 lines by 254 ports; the smallest was 80 lines by 40 ports. Contention ratios ranged from 1.2:1 to 3:1, with approximately 2:1 being the most prevalent. The types of computers that were associated with the PACX units included Control Data, Digital Equipment, Hewlett-Packard, IBM, Prime, and Univac Systems. The number of CPU's per user ranged from 2 to 12 (no installation called had only one CPU). All users but one were passing only asynchronous data through the PACX systems; the one exception had a small amount of synchronous RJE traffic. The vendor furnished the names of all six users that were contacted. These users' ratings were as follows:

	Excellent	Good	Fair	Poor	WA*
Overall satisfaction	6	0	0	0	4.0
Ease of installation	6	0	0	0	4.0
Hardware reliability	5	1	0	0	3.8
Promptness of maintenance	2	3	0	0	3.4
Quality of maintenance	4	2	0	0	3.7
Ease of operation	4	2	0	0	3.7

*Weighted Average on a scale of 4.0 for Excellent.

One user did not rate promptness of maintenance because he had not been personally involved in overseeing and following through with the system's maintenance and repairs.

The operating environment of the users surveyed varied. The highest operating speed was 9600 bps for five of the six users; one user's highest speed was 4800 bps. Four were using a mix of rotary dial-up, leased, and directly connected lines; one was using rotary dial-up exclusively; and one was using limited distance data sets. Four of the six users were employing time division multiplexers and two of those were also using statistical multiplexers connected to their PACX lines.

All of the PACX systems were purchased outright, either through Gandalf directly, or through one of its distributors or reps. Maintenance and repairs were generally accomplished by the user, and consisted of replacing faulty boards with spares and sending the faulty boards back to

a connection requiring a master/slave timing relationship, such as the AT&T Dataphone Digital Service (DDS) network.

Terminal-Side Channels

The *AMTB* is an asynchronous modem terminal board that provides 4 RS-232-C (or V.24) interfaces for directly connected devices or external modems. Each interface appears as a business machine to the connected device. Operating speeds of up to 9600 bps are possible, depending upon the PACX model. Each channel has three LED indicators associated with it that display the status of Carrier (carrier detect from the attached modem), Connect (indicating that the line is connected to a port-side device), and Latch Connect (indicating that carrier detect has gone HI at least once since the last time the indicators were reset).

The *AMTB II* is an asynchronous modem terminal board that is the same as the AMTB, except that addtional features and options are available. These features are particularly suited for dial-up modem operation. A long-space disconnect feature is incorporated, as well as a built-in time-out that causes disconnect after approximately 10 minutes of no transitions on either transmit or receive data leads. By strap option, the class of service can be selected, and an incoming call will not be answered unless that class is available. The strap can also be set to accommodate the remote Thumb Wheel Dial Unit allowing the call to be answered and the terminal interrogated as to service request; the connection is made if the service is available or the call is dropped (disconnected) if the class is not available. This card also has the capability to interface with 20- or 60-mA current loops.

The *125TB* is a rack-mounted board housed within the PACX cabinet and incorporates four separate line drivers. Each driver can operate at up to 9600 bps asynchronously over privately owned wire or unloaded, non-amplified 3002 channels at a distance of up to 5.5 miles (26 AWG pairs). Each driver is equipped with three indicators: Receive Data, which flashes with line transitions; Receive Carrier, which indicates the presence of a received signal; and Carrier Latch, which remains lighted after carrier is detected until the indicators are reset. All indicators are LED's. These line drivers are compatible with the Gandalf LDS 125 stand-alone units located at distant terminals.

The *135TB* is also a rack-mounted board but contains four independent FSK modems that are AT&T 103 compatible for use over dedicated two-wire voice-grade (or equivalent) circuits. The modems are capable of 0 to 300 bps asynchronous operation in the answer mode only. They are compatible with the Gandalf LDS 135 stand-alone modem. Each modem is equipped with LED indicators identical in function with those on the 125TB. Each modem can be strapped to interrogate the terminal as to service requested (if the remote modems are equipped with the Thumb Wheel Dial Unit) or to respond to line transitions (which would be normal with the keyboard select option).

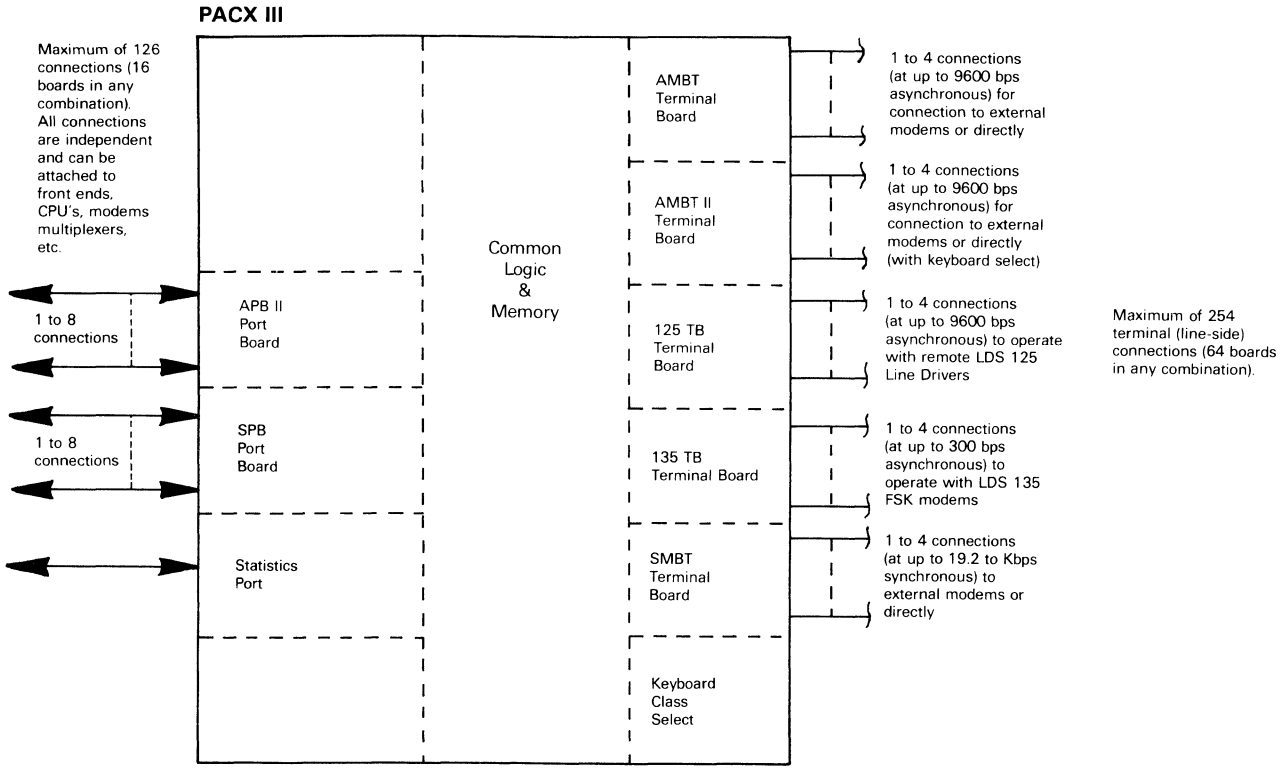
The *SMTB* is a synchronous modem terminal board that provides 4 RS-232-C (or V.24) interfaces, which appear to the line-side equipment as business machines. Use of this board requires a companion SPB synchronous port board with corresponding strap selections. Each interface is capable of operating at up to 19.2K bps and is equipped with three LED indicators identical in nomenclature and function to those found on the AMTB. The strapping options available are similar to those described for the SPB and affect all four interface circuits commonly.

PACX-HOUSED FEATURES

The following features are optional on PACX III systems and standard on PACX IV systems:

Gandalf PACX Family of Private Automatic Computer Exchanges

Configuration



See text for configuration details of other PACX models.

Gandalf for repairs. However, one user did report that the OEM from whom he had purchased his PACX system performed on-site maintenance for him.

These users could not have been happier with their PACX systems. The reliability and simplicity of the equipment were most frequently cited as its advantages. According to these users, a PACX system is simple in design, and easy to install, use, maintain, and expand. It not only cuts cost, but makes terminal users much more powerful, since they can access multiple computers as resources on a priority basis by simply keying a class selection. The number of ports and lines available, the wide range of speeds, the diagnostic features, and the flexibility of interfacing were all mentioned as advantages. And the fact that replacement of a board does not interrupt service was considered a real plus.

Gandalf's personnel were characterized as experienced technical people who are "up front and open", and always willing to help in any way to satisfy the user.

Even when pressed, most of these users could say nothing negative about Gandalf and its PACX systems. One user felt that the size of the unit was disadvantageous, but justifiable because of the number of lines supported. Another said that certain types of failures on the terminal end can occasionally "lock up" the system, but that the problem is easily resolved once discovered. A third user felt that the system was not easily upgraded, since expansion from a single to a dual PACX III sacrifices line speed, and buying a second single PACX III is not cost-justifiable. □

The *Keyboard Class Select* feature permits an operator at a remote terminal to select a class of service (up to 64) by entering a set sequence of characters from the keyboard. Terminals supported include all ASCII units operating at 75, 110, 150, 200, 300, 600, 1200, 1800, 2400, 4800, and 9600 bps asynchronous. IBM 2741 terminals utilizing BCD, EBCDIC, or Correspondence codes as well as IBM 3767 terminals using EBCDIC or Correspondence codes are also supported. In operation, the keyboard attendant types in an access character, which the system analyzes to determine the speed and code and then returns an acknowledgement character to the terminal. The user then enters a two-digit class code to identify the service desired. Then the PACX searches for a free port of the requested type; if a matching port is found, the connection is made. If the service requested is not available, the terminal is disconnected. A status message is sent to the terminal in either case.

The *Statistics Port* feature keeps track of all connections, disconnections, unsuccessful attempts (by service class), and line/port connection status by device number. This information is delivered to a computer port or other connected device at 2400 bps, asynchronous, via a standard RS-232-C interface. Data is supplied on command of the connected device, which also has the capability to change service classes of ports or force connections.

REMOTELY LOCATED OPTIONS

The *LDS 125* is an asynchronous modem in stand-alone form that is generally co-located with the terminal in a PACX system. The transmission characteristics are the same as those of the 125TB. Thumb Wheel dials are an integral part of the unit and allow the user to select the desired class of service before bidding for connection through the PACX. The bidding occurs after setting the thumb wheels and activating a Request Connect switch. Four front-panel LED indicators are provided; a READY, that indicates a

Gandalf PACX Family of Private Automatic Computer Exchanges

successful connection when lighted; a DISC, that lights when an attempt to gain service is not successful; and transmit and receive data indicators that flash with line transitions.

The *LDS 135* is a free-standing asynchronous modem generally colocated with the terminal in a PACX system. The transmission characteristics are the same as its 135TB counterpart; the controls, indicators, and operating technique are the same as the LDS 125.

The *Thumb Wheel Dial Unit (TDU)* is a stand-alone device providing the same method of class selection as the dials on the LDS 125 and LDS 135 units. The TDU is connected in series between the terminal and a non-Gandalf modem with standard EIA interfaces. This provides a remote user that is equipped with 103's or 202's that are located beyond the range of the Gandalf offerings the same service class selection capabilities as found with the LDS 125 or 135.

The *Terminal Control Unit (TCU)* is a free standing device that also connects between a remotely located terminal and its associated modem, or directly connected into the PACX system. The purpose of the TCU is to provide the ability to bid for connections and control disconnects. A three-position switch (Request Connect/Operate/Disconnect) is provided and initiates the activities that the names indicate. An LED labeled Ready lights when a successful bid/connection has been accomplished. This unit is of particular value in systems using Break signals for bid and/or disconnect, and the associated terminals are not capable of generating these signals.

PRICING

The PACX units, and all the related options, are obtainable directly from Gandalf by purchase only; however, Gandalf will assist customers who desire lease or rental plans in arranging an agreement with a third party. The accompanying price tabulation does not include maintenance. A separate maintenance agreement is available. All Gandalf equipment carries a one-year warranty.

	Mainframes	Purchase Price
MINI PACX II	Cabinetry, power & common logic for 48x30 contention	$4500
MINI PACX III	Cabinetry, power & common logic for 47x28 contention with keyboard select option	7500
PACX II	Cabinetry, power & common logic for 254x126 contention	7500
PACX III	Cabinetry, power & common logic for 253x124 contention with keyboard select option	10,500
DUAL PACX II	Cabinetry, power & common logic for 510x254 contention	15,000
DUAL PACX III	Cabinetry, power & common logic for 509x252 contention with keyboard select option	18,000
PACX IV	Cabinetry, power & common logic for 256x128 contention; includes keyboard class select statistics port, queueing, and controlled access features	14,700
DUAL PACX IV	Cabinetry, power & common logic for 512x256 contention; includes keyboard class select statistics port, queueing, and controlled access features	20,000
	Terminal-Side Boards	
AMTB	Asynchronous modem terminal board	400
AMTB II	Asynchronous modem terminal board with options	600
125TB	Asynchronous, short-haul direct-connect line driver	400
135TB	Asynchronous, 103 compatible modulation scheme, answer mode only, private-line modem	600
SMTB	Synchronous modem terminal board	600
	Port-Side Boards	
APB II	Asynchronous port board; up to 9600 bps	800
SPB	Synchronous port board; up to 19.2K bps	1,080
	Remote Data Sets	
LDS 125	Asynchronous; short-haul line driver; free-standing	225
LDS 135	Asynchronous; 103 modulation, originate mode only, private-line	300
LDM 404B	Synchronous; 4800 bps	1,200
LDS 309/L	Synchronous; up to 9600 bps	635
LDS 309/H	Synchronous; 19.2K bps	685
	Accessories	
TDU	Thumb Wheel Dial Unit	250
TCU	Terminal Control Unit	75
TTS 400	Portable test set	785
IFC 232	Interface converter; RS-232-C to current (300 series modem)	300
IFC 300	Interface converter; current (300 series modem) to RS-232-C	300
MM4	Modem multiplier	450
	System Spares	
CB II	Common logic board for all PACX's	1,680
KCS/SO	Boards for keyboard select and statistical port features for PACX II and PACX III	2,000
	Intelligent control board for PACX IV; includes keyboard class select, statistics port, queueing, and controlled access features	5,680
	Power Supplies:	
	MINI PACX II & III	1,000
	PACX II & III	2,000
	Dual PACX II & III	2,000

Gandalf PACX Family of Private Automatic Computer Exchanges

MANAGEMENT SUMMARY

Canadian-based Gandalf Data Communications Ltd. introduced the first PACX system in 1971. Since then, approximately 150 units have been shipped, with about 100 being installed in Canada, 35 in the U.S., and 15 in Europe. All manufacturing and support for state-side installations is now accomplished in a suburban Chicago plant. The Chicago operation is an affilliate of the Canadian parent and was formed to increase U.S. market penetration, which the firm is gearing up to accomplish. The total corporation employs over 150 with about 50 located in the growing U.S. operation. The majority of the 35 systems were installed within the past 12 months. The order-input and shipping curves indicate that U.S. sales will exceed the 3.5 million-dollar level originally projected. The total corporation grossed between 11 and 12 million dollars last year.

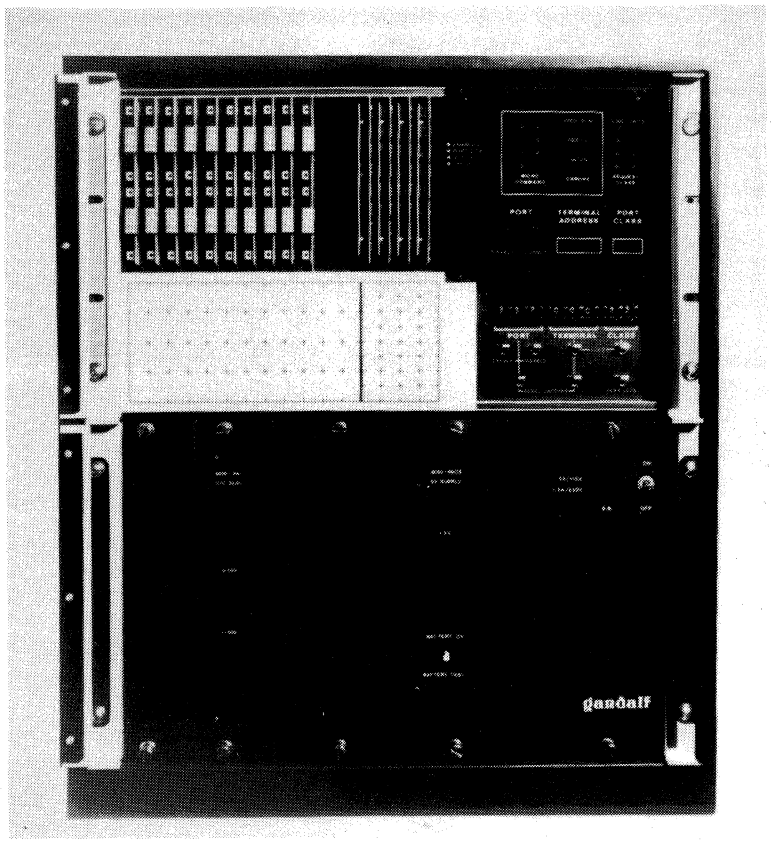
The PACX family consists of MINI PACX II and III, PACX II and III, and Dual PACX II and III; the basic differences are capacity and features available.

MINI PACX II handles asynchronous data at up to 9600 bps and synchronous data up to 19.2K bps; the possible contention ratio is 48 line connections by 32 port connections. MINI PACX III can accommodate the same speeds and contention ratio (48x32) but also ▷

A group of electronic "switches" used to control contention for available computer ports.

Up to 510 lines can contend for a maximum of 254 ports classified by service, speed, code, security considerations, etc. Up to 64 different service classes can be defined. The PACX units can be equipped with internal line drivers or modems that operate at up to 9600 bps asynchronously or 19.2K bps synchronously. Depending upon the model, class of service is selected at the terminal either by setting thumb-wheel switches or by entering appropriate characters at the keyboard. On the PACX III, a special statistics port option is available for complete event logging to be used by an attached computer or other device.

A typical PACX III system equipped with 64 ports and 128 line connections, including integral line drivers, sells for less than $30,000. Maintenance is not included, but is supported by customer spares and telephone consultation, as required.



The MINI PACX III is shown at left. The control panel, in the upper right corner, allows the operator to determine the status of line/port connections, to change a class of service, or to "force" a connection. The photograph depicts a 19-inch relay-rack unit approximately 24 inches high.

Gandalf PACX Family of Private Automatic Computer Exchanges

has the capability of selecting class of service by entering a sequence of characters via the terminal keyboard. The PACX II and III have the same speed characteristics as their MINI PACX counterparts, but the possible contention ratio is increased to 254 line-side connections by 126 port-side connections.

All of the mentioned configurations can handle up to 64 different classes of service (connection groups), based upon applications program and/or CPU desired, and the specific operating speed, protocol, and communications mode (half- or full-duplex) parameters of the terminal and front end. The desired class can be established by setting thumb-wheel switches on a separate (Gandalf-supplied) unit co-located with the terminal. The Thumb-Wheel Dial Unit (TDU) is generally used in conjunction with a Gandalf data set or line driver; however, it may be used with independently supplied devices. Alternatively, a terminal can be dedicated to a single service class.

The port-side connection equipment can also "force" a connection to a given terminal-side device, although the line-side equipment generally initiates a service request. A forced connection from the port side is usually effected when the front end or CPU side of the machine is in a polling mode, and the line-side terminal is unattended. Provision is made to allow the port equipment to establish the operating speed and protocol, within the limits of the line-side equipment.

The PACX III has the same characteristics as the PACX II, but includes a terminal keyboard class select option and has a statistical port option. The statistical port option monitors all connections, disconnections, unsuccessful attempts, etc., accompanied by time of-day, and forwards this data to a connected device, which is usually a computer although hard-copy printers are sometimes used.

Dual PACX II and III versions are housed in two free-standing cabinets with separate power supplies, but share common control logic. The Dual PACX units have a contention ratio of 510 line connections by 254 port connections.

All PACX units require a small number of ports and lines to be dedicated for internal use; no more than four asynchronous ports and three asynchronous lines (for the Dual PACX) are required, with the requirement reduced for smaller models.

Gandalf also supplies a comprehensive line of data sets and line drivers ranging from low speed (0-300 bps, 103-compatible) to 19.2K bps synchronous. These items are supplied as plug-in's, for mounting in the PACX cabinet, or as stand-alone devices located at the terminal end.

Aside from the transmission devices and Thumb Wheel Dial Unit, there are several other interesting options. There are EIA-to-current-mode converters, which permit a terminal or port operating on EIA RS232 voltage

CHARACTERISTICS

VENDOR: Gandalf Data, Inc., 1019 South Noel Avenue, Wheeling, Illinois, 60090. (312) 541-6060.

DATE OF ANNOUNCEMENT: September 1971.

DATE OF FIRST DELIVERY: September 1971.

NUMBER DELIVERED TO DATE: Over 150.

SERVICED BY: Gandalf Data, Inc.

CONFIGURATION

The various PACX configurations all have common printed-circuit cards, such as line and port interfaces, and plug-in options (line drivers, modems, etc.). The basic differences occur in central logic and power. The central logic, including memory, is contained on one card regardless of the PACX model. The central logic cards differ in the scan time required, which is a function of the system size. In all PACX systems the connect and disconnect times are the same: 600 milliseconds. During the connect cycle, several characters must be entered to identify the source terminal and to select service class. This is true whether the Thumb Wheel Dial Unit or the keyboard select feature is utilized. The time from when service is first requested until an available connection is found and made, or until service is denied, is a flat 600 milliseconds. The connect and disconnect timers are both fixed and latched functions. On the disconnect sequence, the timing is fixed to ensure that the discontinuance of service is valid (i.e., momentary loss of carrier, or a front end's scan time limitation will not cause a non-valid disconnect.) The memory technology utilized in all PACX systems is solid state. The system is supported by a battery with a 50-hour life in the case of a power failure. Power supplies differ with system size due to current drain.

Service classes are hardware programmed into the machine. During installation, the cables are routed to the appropriate computers and front ends. Up to 64 different classes of service can be obtained either by numerical selection on the Thumb Wheel Dialer or by keyboard select, depending upon the system components.

The contention ratios are also established at installation time, with any number of lines and ports (within system limitations) being possible. Ratios can be changed at any time by simply adding or removing cards. Line-side cards can accommodate up to four connections; port-side cards can accommodate up to eight connections. The port-side connections are not limited to hard EIA connections to front ends and may be connected to multiplexers or modems that route the data to a distant location. The only requirement in this configuration is that the ultimate terminus is a front end or intelligent device (i.e., something able to recognize a request for service and grant or deny it). The possible contention ratios are dependent upon the system installed. The MINIPACX units can service a maximum of 48 lines by 32 ports (48x32). The PACX II and III systems have a maximum contention ratio of 254x126. Dual PACX systems can service up to a 510x254 configuration. Within these maximums, any ratio can be established.

The accompanying configuration diagram shows a PACX III with all options and various system connections possible.

CONNECTION TO HOST COMPUTER

In the case of the PACX equipment, there is no host computer in the traditional sense because the equipment may be connected to several hosts with none of them being in control except with regard to connect/disconnect by service class. The PACX hardware appears to the host to

Gandalf PACX Family of Private Automatic Computer Exchanges

levels to connect to an AT&T 300 series data set, or a CCITT V.35 type modem operating on current interface. This item is of significant value when operating at 19.2K bps, which is within EIA RS232 limits, but a current interface modem is required to reach the outside world. A modem sharing option is offered; this device interfaces up to four co-located terminals (within 50 feet) to one modem and allows local contention on a first-come-first-served basis; a request-to-send connects the first bidder to the modem, and the other terminals are locked out. Another option is a Terminal Control Unit that provides a method of controlling connect/disconnect for private-line modems and their associated terminals.

Another member of the product line is a Front End Switch, which is basically a fail-safe device. The Data Terminal Ready leads on all connected devices are monitored. If DTR goes down on all leads, a failure is assumed, and all channels are switched to the back-up device. Back-up switching can also be on a per channel basis; if data transitions are sensed but DTR goes down, the Front End Switch will "hunt" for a backup connection where DTR is high. The operation is similar to a telephone rotary switch except that the switching is all electronic. The standard configurations include 1x2, 1x4, and 1x8 switching capability on the back-up side for up to 126 incoming lines. Gandalf also offers a self-contained transmission test set consisting of a pseudo-random test pattern generator and a receive error detector capable of operation in either asynchronous or synchronous mode.

The Gandalf PACX and associated options are particularly suited for time sharing applications, and the firm has concentrated their marketing drive in this area. University systems are of special interest because in many cases privately owned wire is strung throughout the campus and the Gandalf line drivers are seriously considered. Many universities, and other educational institutions, also have a mixture of computers and applications, making the PACX system of special interest. The market for the Gandalf equipment is certainly not limited to educational applications, however; its customer list includes an impressive array of governmental, utility, financial, and manufacturing firms.

USER REACTION

In May of 1978, Datapro conducted a telephone survey of nine users of various PACX configurations. Five client names were supplied by the vendor with the remainder discovered by Datapro. One user had two machines; the rest had one. In many cases the installation consisted of a dual configuration. The majority of those surveyed had PACX II or III systems with a contention ratio (incoming lines to outgoing ports) of about 1.5 to 1. This ratio cannot be compared to a classical contention ratio because the number of classes of service must be considered as some sort of a multiplier. In the lowest contention ratio found (1.2 to 1), there were 29 separate service classes.

be a modem and is physically connected via standard EIA cables.

TRANSMISSION SPECIFICATIONS

After a connection is made, the PACX is transparent to data. With the exception of some synchronous applications where the receive clock is looped back at the port board to maintain system timing (with the clock passed on to the port-side device) the PACX presents no impairment to the flow of data or control signals. Other elements of the Gandalf product line that have transmission parameters are described in the Components section of this report.

SOFTWARE

The PACX family does not have a software capability as commonly defined; rather, firmware/hardware programming exists. For special applications new ROM's are burned. This situation was discovered in several instances during Datapro's investigation for the User Reaction section of this report. All of those users were well satisfied. The PACX family has been successfully interfaced to all major computers. The most common problem that had to be solved was the timing with regard to connect/disconnect. For the majority of applications, these ROM's are off-the-shelf items and are supported by a spare-parts inventory.

COMPONENTS

The basic components of the PACX systems include mainframes (which include control logic and power supplies), line-side connection boards, port-side connection boards, and remote-site options. The components of the PACX systems and related options are described in the following paragraphs.

Mainframes

The *MINI PACX II* mainframe includes cabinetry and card cages to accommodate 48 lines by 32 ports; 2 asynchronous port channels are required for internal use.

The *MINI PACX III* is the same as the MINI PACX II, but includes the keyboard select option; 4 asynchronous port channels and 1 asynchronous modem line-side channel are required for internal use.

The *PACX II* includes cabinetry and card cages to accommodate 254 lines by 126 ports; 4 asynchronous ports are required for internal use.

The *PACX III* is the same as the PACX II, except it has keyboard select and statistics port features; it requires 4 asynchronous port channels, 1 asynchronous modem line-side channel, and two asychonrous line-side channels for internal use.

The *Dual PACX II* includes cabinetry and card cages to accommodate 510 lines by 254 ports; it requires 2 asynchronous ports and 2 asynchronous lines for internal use.

The *Dual PACX III* is the same as the Dual PACX II, but has the keyboard select and statistics port features; 4 asynchronous ports and 3 asynchonrous lines are required for internal use.

Port-Side Channels

The *APB II* is an asynchronous port board that provides 8 RS 232C (or V.24) interfaces, which appear to the port-side equipment to be modems. The Data Set Ready lead is latched HI when PACX power is on (similar to modem operation). A strap option permits the Ring Indicator lead to be latched HI upon first receipt of ring or to follow the ringing cycle until the port-side equipment raises Data

Gandalf PACX Family of Private Automatic Computer Exchanges

The types of computers and front ends that were connected to the PACX units included IBM, Digital Equipment, Univac, Xerox, RCA, Burroughs, Honeywell, Control Data, Hewlett Packard, and Harris as well as some home-grown systems. The ratings given are as follows:

	Excellent	Good	Fair	Poor	WA*
Overall Satisfaction	9	0	0	0	4.0
Ease of installation	8	1	0	0	3.9
Hardware reliability	7	2	0	0	3.8
Promptness of maintenance	6	0	0	0	4.0
Quality of maintenance	7	0	0	0	4.0
Ease of expansion	9	0	0	0	4.0

*Weighted Average based on 4.0 for Excellent.

With regard to the maintenance categories, three users declined to rate promptness because they had not had occasion to call on service personnel. One of these, however, wished to rate quality of maintenance as Excellent due to the responsiveness and cooperation he received through telephone consultation. The ratings obviously speak highly of the PACX family, but more importantly, most users also had various models of Gandalf data sets, and they found it virtually impossible to rate the listed categories except on a total system basis. Consequently, the ratings show a high regard for most, if not all, of the Gandalf product line.

One user did not feel qualified to rate the hardware because it was not on his premises, and he had not participated in the equipment selection or installation. However, he did say "reliable hardware; does the job; since it impacts revenues, it has been carefully monitored—it's good." This attitude was prevalent among those surveyed.

Two users complained about the lack of a maintenance contract. (Gandalf said it is working on one, and it should be available in the next 60 to 90 days.) Considering that Gandalf does not have third-party maintenance yet, the ratings applying to the maintenance activity are indicative of the firm's responsiveness and ability to localize and identify problems remotely. Most customers have a full set of spare boards and perform their own maintenance, resorting to telephone troubleshooting as required. Defective boards are forwarded to the factory for repair. The average turnaround time, including mailing, was indicated to be two or three weeks, but many instances of overnight support were cited.□

Terminal Ready, which indicates availability and initiates the connect sequence. Another option is an artificial high speed clock that operates at 2400, 3600, 4800, 7200, or 9600 bps; the clock signal is passed on to the port to create the appearance of a synchronous connection. The transmit clock is crystal controlled; the receive clock is derived from incoming data in the same manner as a modem would operate. Each port connection is equipped with Light Emitting Diode (LED) indicators to show the status of Enabled, Port Ready, Active, and Latched Active conditions; the last indicates that the port has been active at least once since the indicators were last reset.

The *SPB* is a synchronous port board that provides 8 RS 232C (or V.24) interfaces, which appear to the port side equipment as modems. A maximum operating speed of 19.2K bps is achievable depending upon the PACX model. Control lead operation and status indicators are the same as that of the APB II. The SPB requires a compatible SMTB board on the line-side of the hardware with similar strap options selected. These options include (1) constant carrier or controlled carrier (under command of the Request to Send lead from the port-side device); (2) the status of the carrier detect lead that is forwarded to the port side equipment (strapped to operate in conjunction with the constant or controlled carrier selection); and (3) half- or full-duplex mode selection. These straps affect all 8 channels on the card. In addition, each channel on the card has individual strap selections involving speed (2400, 4800, 9600 or 19.2K bps) and the selection of transmit clock source (from the PACX master clock, the connected device, or loop-back of the receive clock derived from the incoming data stream). The last transmit clock option is valuable when interfacing to a connection requiring a master/slave timing relationship, such as the AT&T Dataphone Digital Service (DDS) network.

Terminal-Side Channels

The *AMTB* is an asynchronous modem terminal board that provides 4 RS 232C (or V.24) interfaces for directly connected devices or external modems. Each interface appears as a business machine to the connected device. Operating speeds of up to 9600 bps are possible, depending upon the PACX model. Each channel has three LED indicators associated with it that display the status of Carrier (carrier detect from the attached modem), Connect (indicating that the line is connected to a port-side device), and Latch Connect (indicating that carrier detect has gone HI at least once since the last time the indicators were reset).

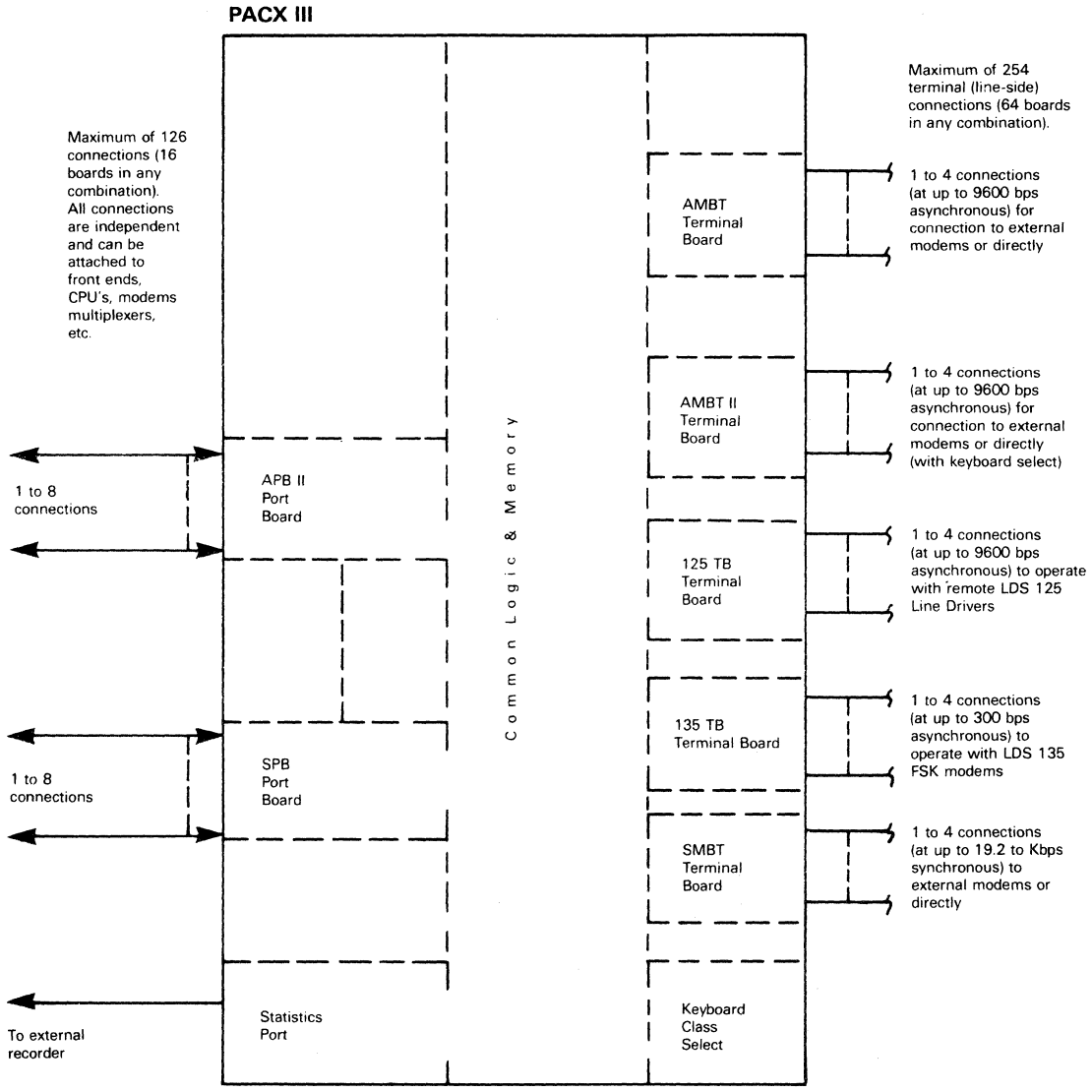
The *AMTB II* is an asynchronous modem terminal board that is the same as the AMTB, except that addtional features and options are available. These features are particularly suited for dial-up modem operation. A long-space disconnect feature is incorporated, as well as a built-in time-out that causes disconnect after approximately 10 minutes of no transitions on either transmit or receive data leads. By strap option, the class of service can be selected, and an incoming call will not be answered unless that class is available. The strap can also be set to accommodate the remote Thumb Wheel Dial Unit allowing the call to be answered and the terminal interrogated as to service request; the connection is made if the service is available or the call is dropped (disconnected) if the class is not available. This card also has the capability to interface with 20- or 60-ma current loops.

The *125TB* is a rack-mounted board housed within the PACX cabinet and incorporates four separate line drivers. Each driver can operate at up to 9600 bps asynchronously over privately owned wire or unloaded, non-amplified 3002 channels at a distance of up to 5.5 miles (26 AWG pairs). Each driver is equipped with three indicators: Receive Data, which flashes with line transitions; Receive Carrier, which indicates the presence of a received signal; and Carrier Latch, which remains lighted after carrier is detected until the indicators are reset. All indicators are LED's. These line drivers are compatible with the Gandalf LDS 125 stand-alone units located at distant terminals.

The *135TB* is also a rack-mounted board but contains four independent FSK modems that are AT&T 103 compatible for use over dedicated two-wire voice-grade (or equivalent) circuits. The modems are capable of 0 to 300 bps asynchronous operation in the answer mode only. They are compatible with the Gandalf LDS 135 stand-alone modem. Each modem is equipped with LED indicators identical in

Gandalf PACX Family of Private Automatic Computer Exchanges

Configuration



See text for configuration details of other PACX models.

function with those on the 125TB. Each modem can be strapped to interrogate the terminal as to service requested (if the remote modems are equipped with the Thumb Wheel Dial Unit) or to respond to line transitions (which would be normal with the keyboard select option).

The *SMTB* is a synchronous modem terminal board that provides 4 RS 232C (or V.24) interfaces, which appear to the line-side equipment as business machines. Use of this board requires a companion SPB synchronous port board with corresponding strap selections. Each interface is capable of operating at up to 19.2K bps and is equipped with three LED indicators identical in nomenclature and function to those found on the AMTB. The strapping options available are similar to those described for the SPB and affect all four interface circuits commonly.

PACX-HOUSED OPTIONS

The *Keyboard Class Select* option permits an operator at a remote terminal to select a class of service (up to 64) by entering a set sequence of characters from the keyboard. Terminals supported include all ASCII units operating at 75, 110, 150, 200, 300, 600, 1200, 1800, 2400, 4800, and 9600 bps asynchronous. IBM 2741 terminals utilizing BCD, EBCDIC, or Correspondence codes as well as IBM 3767 terminals using EBCDIC or Correspondence codes are also supported. In operation, the keyboard attendant types in an access character, which the system analyzes to determine the speed and code and then returns an acknowledgement character to the terminal. The user then enters a two-digit class code to identify the service desired. Then the PACX searches for a free port of the requested type; if a matching port is found, the connection is made. If the service requested is not available, the terminal is disconnected. A status message is sent to the terminal in either case.

The *Statistics Port* option keeps track of all connections, disconnections, unsuccessful attempts (by service class), and line/port connection status by device number. This information is delivered to a computer port or other connected device at 2400 bps, asynchronous, via a standard RS 232C interface. Data is supplied on command of the connected device, which also has the capability to change service classes of ports or force connections.

REMOTELY LOCATED OPTIONS

The *LDS 125* is an asynchronous modem in stand-alone form that is generally co-located with the terminal in a PACX system. The transmission characteristics are the same as those of the 125TB. Thumb Wheel dials are an integral part of the unit and allow the user to select the desired

Gandalf PACX Family of Private Automatic Computer Exchanges

class of service before bidding for connection through the PACX. The bidding occurs after setting the thumb wheels and activating a Request Connect switch. Four front-panel LED indicators are provided; a READY, that indicates a successful connection when lighted; a DISC, that lights when an attempt to gain service is not successful; and transmit and receive data indicators that flash with line transitions.

The *LDS 135* is a free-standing asynchronous modem generally colocated with the terminal in a PACX system. The transmission characteristics are the same as its 135TB counterpart; the controls, indicators, and operating technique are the same as the LDS 125.

The *Thumb Wheel Dial Unit (TDU)* is a stand-alone device providing the same method of class selection as the dials on the LDS 125 and LDS 135 units. The TDU is connected in series between the terminal and a non-Gandalf modem with standard EIA interfaces. This provides a remote user that is equipped with 103's or 202's that are located beyond the range of the Gandalf offerings the same service class selection capabilities as found with the LDS 125 or 135.

The *Terminal Control Unit (TCU)* is a free standing device that also connects between a remotely located terminal and its associated modem, or directly connected into the PACX system. The purpose of the TCU is to provide the ability to bid for connections and control disconnects. A three-position switch (Request Connect/Operate/Disconnect) is provided and initiates the activities that the names indicate. An LED labeled Ready lights when a successful bid/connection has been accomplished. This unit is of particular value in systems using Break signals for bid and/or disconnect, and the associated terminals are not capable of generating these signals.

PRICING

The PACX units, and all the related options, are obtainable only by purchase at this time; lease and rental agreements are being prepared. The accompanying price tabulation does not include maintenance. A separate maintenance agreement is being drawn up and should be available by October 1978. All Gandalf equipment carries a one-year warranty.

	Mainframes	Purchase Price
MINI PACX II	Cabinetry, power & common logic for 48x30 contention	$4500
MINI PACX III	Cabinetry, power & common logic for 47x28 contention with keyboard select option	7500
PACX II	Cabinetry, power & common logic for 254x126 contention	7500
PACX III	Cabinetry, power & common logic for 253x124 contention with keyboard select option	10,500
DUAL PACK II	Cabinetry, power & common logic for 510x254 contention	15,000
DUAL PACX III	Cabinetry, power & common logic for 509x252 contention with keyboard select option	18,000
	Terminal-Side Boards	
AMTB	Asynchronous modem terminal board	400
AMTB II	Asynchronous modem terminal board with options	600
125TB	Asynchronous, short-haul direct-connect line driver	400
135TB	Asynchronous, 103 compatible modulation scheme, answer mode only, private-line modem	600
SMTB	Synchronous modem terminal board	600
	Port-Side Boards	
APB II	Asynchronous port board; up to 9600 bps	800
SPB	Synchronous port board; up to 19.2K bps	1,080
	Remote Data Sets	
LDS 125	Asynchronous; short-haul line driver; free-standing	225
LDS 135	Asynchronous; 103 modulation, originate mode only, private-line	300
LDM 404B	Synchronous; 4800 bps	1,200
LDS 309/L	Synchronous; up to 9600 bps	635
LDS 309/H	Synchronous; 19.2K bps	685
	Accessories	
TDU	Thumb Wheel Dial Unit	250
TCU	Terminal Control Unit	75
TTS 400	Portable test set	785
IFC 232	Interface converter; RS 232C to current (300 series modem)	300
IFC 300	Interface converter; current (300 series modem) to RS 232C	300
MM4	Modem multiplier	450
	System Spares	
CB II	Common logic board for all PACX's	1,680
KCS/SO	Boards for keyboard select and statistical port features	2,000
	Power Supplies:	
	MINI PACX II & III	1,000
	PACX II & III	2,000
	Dual PACX II & III	2,000■