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Modeling Library Communications Traffic

It exudes a state of euphoric glee—i.e., our system at work! The most recent episode of this situation comedy (called "free enterprise") was entitled: "It works, it's reliable and cheap—so let's dump it!"

Thus, it can be argued that the world's only working reliable economical telecommunications system was scrapped to satisfy the desires of a handful of entrepreneurs. Basically, individuals who had discovered that a string of radio transmitter/receiver combinations, once installed, could make money because such devices require very little attention—if done right—and would nearly run forever—just add electricity!

The telephone company, "Ma Bell"—or whatever name satisfies—knew this for years. But being a one-company monopoly, the telephone company used the high profit from their radio transmitter/receiver installations to subsidize their local service—their "direct-to-you" end user service. The result was an orderly system in which the component parts were orchestrated and did work with amazing reliability and economy. The court ordered divestiture of the telephone company into seven regional firms, plus a radio transmitter/receiver or long lines company. This latter company, once integrated into the system, became merely a competitor with the entrepreneurs who had fostered the legislative and court movement in the first place. The result is an option for the user. One can "save" money on long distance telephone service by opting for MCI or Sprint or Allnet; or pay a modest price for premium service by simply using the original long lines division of the telephone company.

And, as the situation has evolved, the cost is at an absolute premium for poor service from the now independent local telephone companies in each region as they attempt to understand and bill in harmony with their local operating expenses. An absolute premium means cost increases to the user of up to 400 percent. Concurrently, Bell Telephone, Western Electric and AT&T with their technical requirements for quality telephone service, have been shelved. By virtue of the Carterfone decision (an earlier assault on Ma Bell), and current electronic technology, one can inflict any number of substandard telephone-like toys on himself.

The episode of the telephone in America has just begun. As people throughout the world could, and will indicate, it is better and cheaper to go there in person or to write a letter than to fight the telephone. Perhaps the common experiences with telephones will one day draw the nations together in a way no political rhetoric or armed aggression has produced over the centuries.

Imagine diplomats having something in common—their respective national telephone services. Imagine diplomatic table talk such as: "Ah, Kim, I see the Chinese couldn't stop the retreat from North Korea, and now that area is independent again."

"Yes, Hakim. They were using Sprint, and just as the order to charge was given, the line went dead! I think the same thing happened to the Russians in Poland....Is it true Vladimir?"

"Nyet! Similar result, different reason. We thought we could save money on long distance calls, but those fools didn't mention the local operating company connect charges. And, to top it all off, CP Poland purchased Japanese remote hand sets, but didn't buy extra batteries. Very bad result. We ordered curfew, but no one could hear the order because of multi path and dead batteries. On top of that we had to pay the Krakow phone company for access and connect time at prime rates—dogarai!"

You see, there may be a benefit in all of this, but probably none for the library of your choosing. And, now that the die is cast, there exists an uphill struggle in library's collective future should the field pursue subsidies similar to those provided for book-rate mail service, or relief from the new tariff structures beginning to emerge.

Notwithstanding the individuals attracted to money who did this for librarians and the legislative, political and economic games which are molding the results, one does have at his/her disposal a few tools, it is hoped that will help them minimize their expenditures for such services. And, more probably, will enable one to know what is required and how to ask for it.

First, before delving into detail, all must be aware in the instance of telecommunications that time is money, as is time of day, distance and quality of service. And while no canonical form can be developed to permit one to get the most from their telecommunications dollar in all instances, a simple guideline can be proposed—"leastest is cheapest!"

Then watch out for simple guidelines. Explicit in them is a whole group of implicit meaning. To make real the prospective "leastest is cheapest," one shall have to have done his/her homework, which may include becoming political on the home front and as technical as possible with practically everyone else. And if one personally is not up to the political or the technical, one should hire people who are. Librarians, like it or not, are in the information business: telecommunications is the most important tool at their disposal now and will be with increasing emphasis in the years to come.

The telecommunications business is a technical business. As Perry has instructed earlier at this conference, select technologists wisely—unless one is an electronic engineer with a law practice, one shouldn't try to do it himself. Even if Martha at the Fangschlyster Public Library writes an article on "How We Did It Well"—don't! The Martha article will kill the budget, credibility and service. It is not a field for amateurs. And, integral with this litany, be sensitive to gadgets which are—and in greater abundance—touted as "the solution." There is no current library capable of implementing and operating its own telecommunications system using existing staff. If it did it would no longer be a library. Enough conjecture—the doxology is over—let's get ready for modeling telecommunications traffic with a quick overview of some telecommunications concepts.

What are we dealing with? Well, it's neither smoke signals nor semaphor; but the objective is the same. So let's look at what this communication is. For example, communications could be the logical and electrical interconnection between two or more devices: logical, since these are computer gadgets, and once they are connected they should do something; electrical, since the signals passed between them will be electromagnetic (smoke signals and waving flags do not do it this season). How these devices are connected determines how they work and how much time they take to do what they do. There are many ways to connect computing devices to each other. For lack of a better approach, how about reviewing them along historical lines (which, in terms of complexity, the early history will be the simplest approach). As a serendipitous "by product," one will find from this review that most of the complexity arises from building more and more housekeeping chores into the equipment, thus relieving the operator of a variety of responsibilities ranging from decoding to redialing.

The original Morse code, hardwired point-to-point (see fig. 1) has some interesting characteristics:

—Operator encodes and decodes.
—Only one message in one direction at one time (half duplex).
—Distance limited (signals absorbed by the media).

—Speed of transmission limited to human response (10 milliseconds at best).
—Subject to environmental contamination (mechanical switches).
—Requires an operator at each terminal.
—Requires preestablished schedule so operators are ready at each terminal.
—One step up from dixie cups and strings (uses wire and switches).
—Secure communications.
—Limited primarily to point-to-point traffic.

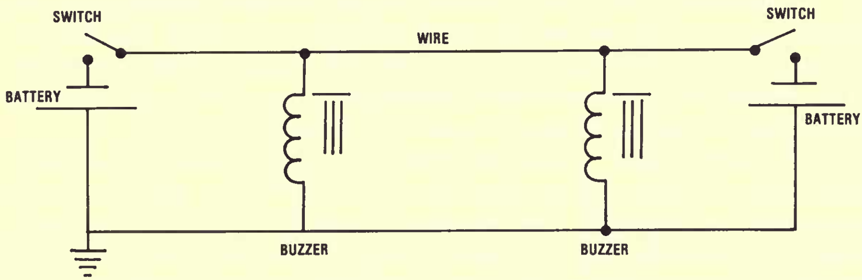

Fig. 1. The Basic Communications Circuit

It is this basic telecommunications system that can be found in essentially the same configuration with, of course, a substitution of technology here and there, on practically any ocean-going vessel, and in practically any "underdeveloped" country. In fact, basic point-to-point interconnection is found between terminals and computers. In keeping with modernism and use of polyester materials, some of the components have been "brought up-to-date," and most of the characteristics have been changed. But there has been no change to the objective nor to the basic interconnection concept.

Today's "interconnect" (see fig. 2) has these characteristics:

—Operator, when needed, keyboards and reads information.
—Operator may not be required.
—Can send and receive simultaneously (full duplex).
—Distance is unlimited (wherever a radio signal or light beam can go).
—Speed of transmission limited by electronic sensing devices (typically speed of light).
—Environmental contamination minimized (it's solid state).

—No schedule required.
—Is not limited to point-to-point traffic.
—Security of communication is not so secure.
—One could not afford one personally.

So far the basic "what" of a network has occupied us, but what about the signals—the information that goes through? Well, how about digressing for a minute to examine the part that figure 1 had, but lost in figure 2. For example, the requirement for operators to run the network on a schedule while providing the necessary coding and decoding services. A simple review of terminology will help to eliminate operators, required standards and protocols, and aid in understanding.

So let's start with a "bit." Usually the machine one is dealing with can handle so many bits-per-second, while the communications man deals in "baud" which is a contraction of Jean Maurice Émile Baudot's last name. This fellow was a pioneer French telegrapher (one of the people required to operate the system in figure 1 and who became tired of it).

The term "baud" means the maximum rate of signal transfer-per-unit-time relative to the shortest pulse time used by the apparatus to be connected. For example, if the machine creates a pulse of 0.0135 seconds, then the maximum rate of signal transfer is the reciprocal of 0.0135 second—74.2 or 72.2 baud. Thus for a 100 word-per-minute teletypewriter to convert words-per-minute to bits-per-second, he/she needs to consider that there are five information pulses-per-character for the subject teletypewriter. In addition, each character must include a "start" pulse (another 0.0135 seconds) and a "stop" pulse of 0.019 seconds (1.42 times the information pulse). Thus, each character of five bits consumes 0.1 seconds ($6 \times 0.0135 + 0.019$) for a 50 bit-per-second rate. Obviously there is a difference between baud and bits!

Typically the baud rate is the maximum signal rate for the transmission devices, while the bit rate is the number of information bits actually transmitted—the net of overhead or protocol signals. So most of us are interested in bytes. In any event the signals and their rates are a tremendous improvement over the idea—"one if by land and two if by sea!"—that all traditionally associate with signalling.

Similarly, the way communication is handled has changed vastly and can have an impact on the budget. Therefore, some additional concepts are required. They can be presented in a more painless way as in figure 3.

There are three communication channel types and two operating modes, the essence of which can be implemented in a variety of ways. "Simplex," is just that unidirectional communications—one-half duplex, or as the telephone company may call it, a two-wire circuit, which permits one to transmit or receive, but not at the same time. One must stop talking

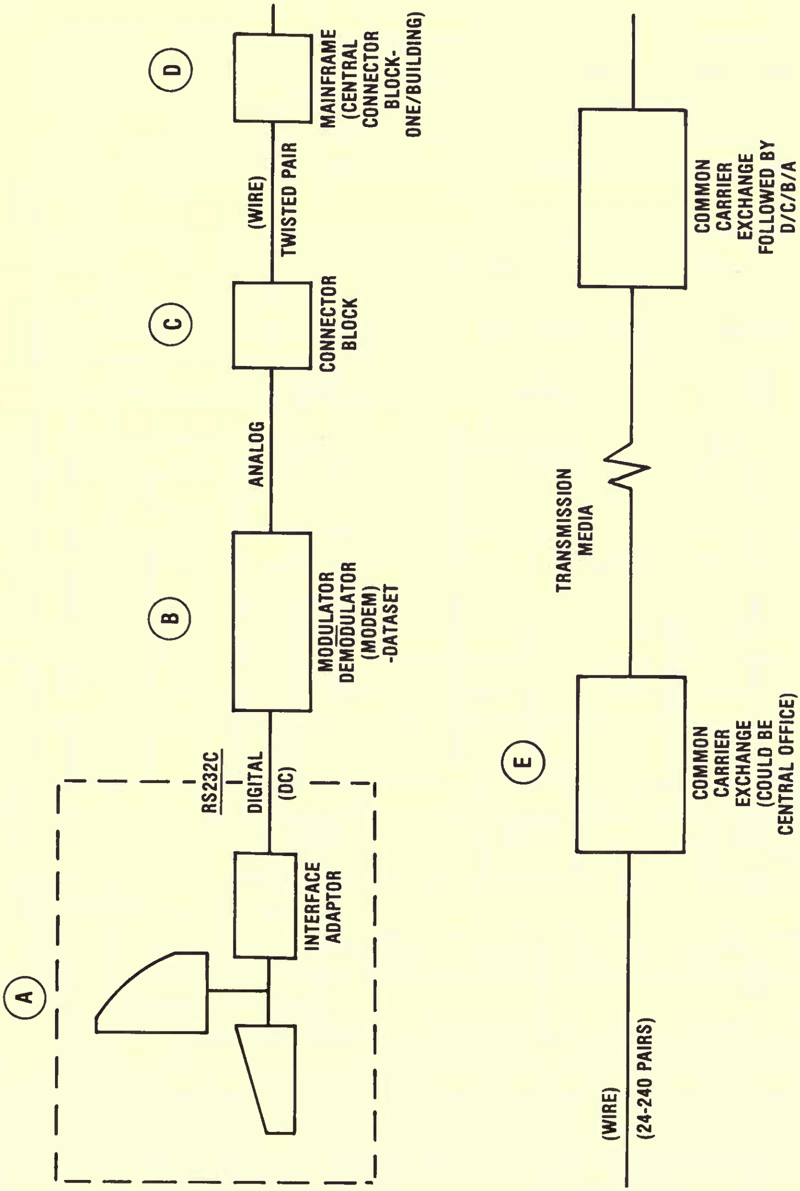

Fig. 2. The Computer Circuit

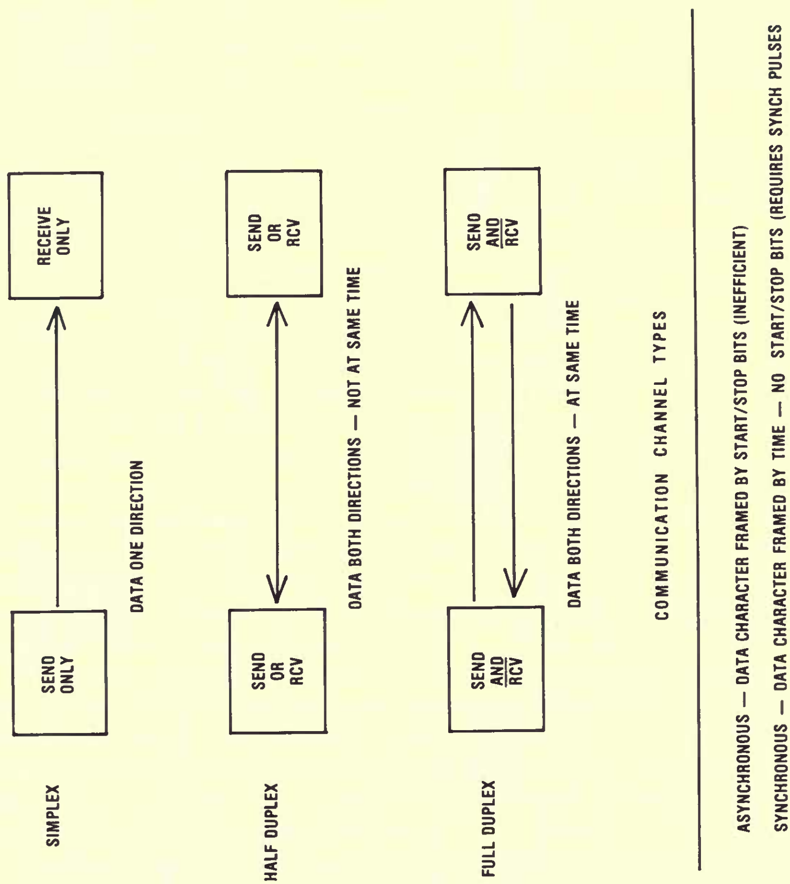

Fig. 3 Some Concepts of Communications

before he can hear the other person. Full duplex permits one to talk and listen at the same time, but requires two circuits. The two operating modes are:

> *Asynchronous*—sends one character at a time if at a terminal. Thus one can send what he wants, when he wants, as fast as the line permits (remember baud) or as slow as need be: However, what is gained in convenience is paid for in efficiency because the overhead of start/stop bits consumes a large percentage of the connect time.
>
> *Synchronous*—maintains a synchronized clock at both ends of the line with the signals being decoded correctly as they are framed between clock pulses. While more efficient, since there are no character framing start/stop bits, this mode requires sending everything at the same speed and synchronizing clocks with transmissions containing strings of "synch" pulses.

Within this framework there are codes—the familiar ASCII, BCDIC and EBCDIC and, the unfamiliar Baudot, Sitor, Amtor, Tor (7 bit) and Autodin (8 bit). There are also message formats which touch on protocols. One such format is shown in figure 4. Error detection and correction schemes also abound in number and variety and range from mathematical schemes to repetition of each character (echo back). These require twice the amount of time a simple transmission of the data would take since each character is sent back to the originator (a scheme internal to most CRT terminals visually) with the operator doing the correcting. Finally, there are data encryption techniques to ensure the security of the information being transmitted.

Because "least is best" for communications, an awareness of these topics, so very briefly covered above, can keep one out of high rent arrangements. It is advised that a little reading be done if one wishes to go into details. But the majority get hooked with what's available, or at least we did when Ma Bell ran the show.

But Ma Bell doesn't run the show any more. Consider the above topics for review, as the terms *bypass, gateway* and *open system* become prominent in the months to come.

And now the modeling. Armed with the brief vocabulary above, let's see what a model is. Well, a model should consist of the acquisition of quantitative data about an object in such detail and with such identified relationships as to permit one to change the relationships and/or the quantities, and examine the impact of such changes (modeling) before one does do it for real and has to feel the impact of the real changes. Following are some ideas of computer applications in the library: So, model the

S O M	PP	S P	Address	E O A	Originator Address	S T X	Text	E T X	Trace & Time	E O T

SOM — Start of Message (character)

SP — Space (character)

PP — Message Priority

ADDRESS — Message Routing

EOA — End of Address (character)

ORIGINATOR — ID of Source

STX — Start Text (character)

TEXT — The Information

ETX — End Text (character)

TRACE & TIME — Terminal ID for Transmitter & Receiver

— Input message sequence number

— Output message sequence number

— Time Received — mm/dd/hr/min)

— Time Delivered — (mm/dd/hr/min)

EOT — End of message

Fig. 4. Typical Data Communications Format

communications traffic for circulation control, excluding file maintenance for patron records and the brief bibliographic descriptors used in the circulation of library materials. The use of the word "circulation" shows the conviction that OCLC, or the bibliographic utility of a libraries persuasion, will take care of cataloging.

Basically, for this model, twelve functions are required to support "online" circulation control. These are enumerated in figure 5. Seven of these functions deal directly with the circulation function itself, two deal with interlibrary loan, and three deal with user and item file maintenance.

Function	Transaction	Message (fields)	Bytes
Charge	validate user	XMIT (AC)	32
		RCV-GO (AE)	64
		RCV-NG (AEH)	124
	validate item	XMIT (AB)	32
		RCV-GO (ADI)	305
		RCV-NG (ADH)	255
Discharge	validate item	XMIT (AB)	32
		RCV (ADHI)	365
Place Hold	validate user	XMIT (AC)	32
		RCV-GO (AE)	64
		RCV-NG (AEH)	124
	enquire item	XMIT (ADJK)	206
	fetch item	RCV-GO-STACK (AF)	507
		RCV-GO-HOLD (AH)	78
		RCV-NG (AH)	78
Trap Hold	validate item	XMIT (AB)	32
	route item	RCV-GO (ADHI)	365
Place ILL	validate user	XMIT (AC)	32
		RCV-GO (AE)	64
		RCV-NG (AEH)	124
	enquire item	XMIT (ADJ)	205
		RCV-GO-STACK (AF)	507
		RCV-GO-LOCAL (AH)	78
		RCV-GO-DONOR (AFEHI)	720
		RCV-NG (AH)	78
		RCV-NG-DONOR USE (AFEHI)	720
Trap ILL	validate item	XMIT (AB)	32
	route item	RCV-GO (ADHI)	365
Renew	validate user	XMIT (AC)	32
		RCV-GO (AE)	64
		RCV-NG (AEH)	124
	validate item	XMIT (AB)	32
		RCV-GO (ADI)	305
		RCV-NG (ADH)	255
Department Loan	validate user	XMIT (AC)	32
	(1:5000 item)	RCV-GO (AE)	64
		RCV-NG (AEH)	124
	validate item	XMIT (AB)	32
		RCV-GO (AD)	195
		RCV-NG (ADH)	255
Enter Bad Guy	validate user	XMIT (AEE)	46
		RCV-GO (AEH)	124
		RCV-NG (AH)	78
Clear Bad Guy	validate user	XMIT (AEE)	46
		RCV-GO (AEHI)	434
	clear	XMIT (ACLB)	214
		RCV-GO (ABLHI)	588
		RCV-NG (AH)	78
Item Enquire	validate item	XMIT (AD)	195
		RCV-GO (AF)	507
		RCV-NG (AH)	78
User Enquire	validate user	XMIT (AEE)	46
		RCV-GO (AGDH)	1,138
		RCV-NG (AH)	78

Fig. 5 Central Circulation Communications

Internal to these functions, assume also that there are twelve data elements which are logically combined to form the functions (see fig. 5). Each of these data elements contain from 1 to 168 characters (see fig. 6). The frequency or percent of occurrence of these functions-per-unit-circulated is shown in figure 7. The combination of these data elements into messages and subsequently into dialog is shown in figure 8 for the "charge" function. Having determined the types, frequency and size of the messages, it is then possible to apply these factors to a hypothetical data communications system.

Four examples of these combinations are shown in figures 9 through 12. The hourly multiplier numbers represent, in the examples indicated, library measured statistics for the activities which have been prorated by the percentage of occurrence for the functions comprising those activities in figure 7. Because communications is a two-way street, both transmitting and receiving data rates are shown.

It is interesting that the old adage about it being better to give than to receive doesn't work in the world of telecomputing—at least for circulation control—because for each library initialized action, the library receives more than it gives. Which serendipitously suggests two communications channels—a high speed and a low speed one. But, the model assumes a supercomputer is handling everything for everybody. Should these libraries "talk" to each other, then that receiving rate becomes the transmitting rate. And low-speed communications channels mean little rate. They mean little anyway because the communication channels provided will probably be the same speed regardless of how much information will be chosen to send down to them.

Bauds are the speed which the connection or circuit will support with ASCII being the code used for transmission. Baud rates, or the speed at which a device can function, are usually standardized by the manufacturer. Thus, a selection of standard values is usually provided for on the typical terminal. We are going to use the asynchronous mode of transmission.

So look at some of the examples. The first is the Bakersfield, California figure (see fig. 9). The peak-received-data-rate-in-bits-per-second is 149.52, net of character framing bits. And because it will be using asynchronous ASCII, it is easier to use characters/second (most tables are set up that way). With the use of standard baud rates eighteen or nineteen characters/second, a 300 baud line will be more than adequate.

For the Northridge example (see fig. 12) one can apply the same arithmetic, and discover that the line required will be 1200 baud; the same as required for Los Angeles (see fig. 11) in a typical situation. However, at their communications traffic peak a 2400 baud line will be needed for both Long Beach (see fig. 10) and Los Angeles.

	Field (source)	Data Elements		Characters
A.	Preamble (keyboard/generated)	Message Type		1
		Function Code		2
		Library ID		4
		Terminal ID		1
		Date/Time		10
			subtotal	18
B.	Level 1 Item (label)	Book ID		10
		Library ID (for book)		4
			subtotal	14
C.	Level 1 User (badge)	Patron ID		9
		Library ID (for users)		4
		Status		1
			subtotal	14
D.	Level 2 Item (keyboard/file)	Citation		62
		Edition		47
		Call Number		68
			subtotal	177
E.	Level 2 User (keyboard/file)	Patron ID		9
		Name		32
		Zip Code		5
			subtotal	46
F.	Level 3 Item (keyboard/file)	Citation		62
		Edition		47
		Call Numbers (5 max.)		340
		Copies (10 max.)		30
		Statuses (1 per copy)		10
			subtotal	489
G.	Level 3 User (keyboard/file) Patron (all data elements)			168
H.	CRT Comment (system generated from function & transaction type & user or item status)			60
I.	Ticket Printer (system generated from function & transaction type & user or item status)			110
J.	Cut Off Date/Time (keyboard)			10
K.	Queue Type (date or time based)			1
L.	Amount (keyboard by supervisor)			6

Fig. 6. Online Data Elements (Interactive Processing)

Function	% Used for Calculation
Charge	100.0
Discharge	99.9
Place Hold	2.0
Trap Hold	2.0
Place ILL	1.2
Trap ILL	1.2
Renew	14.9
DPT. Loan	8.9
Enter Bad Guy	1.4
Clear Bad Guy	1.4
Item Enquire	2.9
User Enquire	1.5

Fig. 7. Percentage Occurence of Circulation Control Functions

So now the peak data rates have been determined (characters are easier than bits—but bits are more impressive). And now one can call the communications people and tell them what the line requirements are for a given data type, how they are to be encoded in a certain way, etc. One can also study the transaction types and note by batching certain ones how the speed of the required line is reduced. This is what models are for—to tinker and optimize.

Why, because "leastest is cheapest" which leads to the pricing structure of telecommunications circuits regardless of who is providing what. And, as mentioned earlier, pricing for telecommunicating is based on four factors: time—how much is consumed and when; type—private line or dial line; quality—how much conditioning is used and/or bandwidth; and distance—how far the impulse travels through how many changes.

Function:

Charge

Transaction Type	Message Type	Message Fields/Bytes (Ex-Protocol)	Max. Bytes/Transaction
validate user	transmit	Preamble/18 Level 1 User/14	32
	receive (go)	Preamble/18 Level 2 User/46	64
	receive (no go)	Preamble/18 Level 2 User/46 CRT Comment/60	124
validate item	transmit	Preamble/18 Level 1 Item/14	32
	receive (go)	Preamble/18 Level 2 Item/177 Ticket Printer/110	305
	receive (no go)	Preamble/18 Level 2 Item/177 CRT Comment/60	255

Fig. 8

Site Level	Traffic			Bytes	Hourly Multiplier	XMIT/Hour	RCV/Hour
Bakersfield I	Charge	Patron validate	XMIT	32	30.00	960.00	
(quarter)	(all media, RBR and renew)	GO	RCV	64	29.58		1,893.12
		No Go	RCV	124	0.42		52.08
		Item validate	XMIT	32	75.00	2,400.00	
		GO	RCV	305	73.50		22,417.50
Peak:		No Go	RCV	255	1.50		382.50
Month October							
Day Tuesday	Place Hold	Patron validate	XMIT	32	1.00	32.00	
Hour 11 am		GO	RCV	64	0.99		63.36
		No Go	RCV	124	0.01		1.24
Avg. items/patron		Item enquire	XMIT	205	0.99	202.95	
2.5:1		Go-Stack	RCV	507	0.23		116.61
Nominal chg. period		Go-Hold	RCV	78	0.75		58.50
2 wks		No Go	RCV	78	0.01		0.78
Annual Circulation							
(1974-75)	Place ILL	Patron validate	XMIT	32	0.90	28.8	
63,334		GO	RCV	64	0.89		56.96
Annual hours open		No Go	RCV	124	0.01		1.24
4,082		Item enquire	XMIT	205	0.89	182.45	
		Go-Stack	RCV	507	0.01		5.07
		Go-Hold (local)	RCV	78	0.21		16.38
		Go-Donor	RCV	720	0.66		950.40*
		No Go	RCV	78	0.01		0.78
	Clear Bad Guy	Patron validate	XMIT	46	0.42	19.32	
		Go	RCV	434	0.42		182.28
		Clear	XMIT	214	0.42	89.88	
		Go	RCV	588	0.415		241.08
		No Go	RCV	78	0.01		0.78
	Item Enquire	Item validate	XMIT	195	1.00	195.00	
		Go	RCV	507	0.99		501.93
		No Go	RCV	78	0.01		0.78
	Patron Enquire	Patron validate	XMIT	46	6.00	276.00	
		Go	RCV	1,138	5.88		6.691.44
		No Go	RCV	78	0.12		9.36
			TOTALS:	Hourly:		4,386.40	33,844.17
				Peak per second:		2.44	18.69
				Peak bits per second:		19.52	149.52

XMIT: Transmit from library
RCV: Receive in library
*Two messages received: one at initiating site; one at donor site

Fig. 9

Site Level	Traffic		Bytes		Hourly Multiplier	XMIT/Hour	RCV/Hour
Long Beach V	Charge	Patron validate	XMIT	32	112.00	3,584.00	
(semester)	(all media, RBR and renew)	GO	RCV	64	110.43		7,067.52
		No Go	RCV	124	1.57		194.68
		Item validate	XMIT	32	560.00	17,920.00	
		GO	RCV	305	548.00		167,384.00
Peak:		No Go	RCV	255	11.20		2,856.00
Month October							
Day Monday	Place Hold	Patron validate	XMIT	32	10.00	320.00	
Hour 1 pm		GO	RCV	64	9.86		631.04
		No Go	RCV	124	0.14		17.36
Avg. items/patron		Item enquire	XMIT	205	9.86	2,021.30	
5:1		Go-Stack	RCV	507	2.47		1,252.29
Nominal chg. period		Go-Hold	RCV	78	7.30		569.40
3 wks		No Go	RCV	78	0.09		7.02
Annual Circulation							
(1974-75)	Place ILL	Patron validate	XMIT	32	10.00	320.00	
785,071		GO	RCV	64	9.80		627.20
Annual hours open		No Go	RCV	124	0.20		24.80
4,134		Item enquire	XMIT	205	9.80	2,009.00	
		Go-Stack	RCV	507	0.30		152.10
		Go-Hold (local)	RCV	78	0.10		7.80
		Go-Donor	RCV	720	9.30		13,392.00*
		No Go	RCV	78	0.10		7.80
	Clear Bad Guy	Patron validate	XMIT	46	7.84	360.64	
		Go	RCV	434	7.84		3,402.56
		Clear	XMIT	214	7.84	1,677.76	
		Go	RCV	588	7.76		4,562.88
		No Go	RCV	78	0.08		6.24
	Item Enquire	Item validate	XMIT	195	20.00	3,900.00	
		Go	RCV	507	19.60		9,937.20
		No Go	RCV	78	0.40		31.20
	Patron Enquire	Patron validate	XMIT	46	8.40	386.40	
		Go	RCV	1,138	8.32		9,468.16
		No Go	RCV	78	0.08		6.24
			TOTALS:	**Hourly:**		**32,499.10**	**221,605.49**
				Peak per second:		**18.08**	**123.11**
				Peak bits per second:		**144.48**	**984.88**

XMIT: Transmit from library
RCV: Receive in library
*Two messages received: one at initiating site; one at donor site

Fig. 10

Site Level	Traffic				Hourly Multiplier	XMIT/Hour	RCV/Hour
			Bytes				
Los Angeles IV	Charge	Patron validate	XMIT	32	120.00	3,840.00	
(quarter)	(all media, RBR and renew)	GO	RCV	64	118.32		7,572.48
		No Go	RCV	124	1.68		208.32
		Item validate	XMIT	32	300.00	9,600.00	
		GO	RCV	305	294.00		89,670.00
Peak:		No Go	RCV	255	6.00		1,530.00
Month April							
Day Wednesday	Place Hold	Patron validate	XMIT	32	6.00	192.00	
Hour 1 pm		GO	RCV	64	5.92		378.88
		No Go	RCV	124	0.08		9.92
Avg. items/patron		Item enquire	XMIT	205	5.92	1,213.60	
2.5:1		Go-Stack	RCV	507	0.24		121.68
Nominal chg. period		Go-Hold	RCV	78	5.68		443.04
term		No Go	RCV	78	0.01		0.78
Annual Circulation							
(1974-75)	Place ILL	Patron validate	XMIT	32	30.00	960.00	
506,145		GO	RCV	64	29.58		1,893.12
Annual hours open		No Go	RCV	124	0.42		52.08
4,875		Item enquire	XMIT	205	29.58	6,063.90	
		Go-Stack	RCV	507	0.30		152.10
		Go-Hold (local)	RCV	78	1.18		92.04
		Go-Donor	RCV	720	27.80		40,032.00*
		No Go	RCV	78	0.30		23.40
	Clear Bad Guy	Patron validate	XMIT	46	10.00	460.00	
		Go	RCV	434	10.00		4,340.00
		Clear	XMIT	214	10.00	2,140.00	
		Go	RCV	588	9.99		5,874.12
		No Go	RCV	78	0.01		0.78
	Item Enquire	Item validate	XMIT	195	25.00	4,875.00	
		Go	RCV	507	24.50		12,421.50
		No Go	RCV	78	0.50		39.00
	Patron Enquire	Patron validate	XMIT	46	50.00	2,300.00	
		Go	RCV	1,138	49.30		56,103.40
		No Go	RCV	78	0.70		54.60
			TOTALS:	Hourly:		31,644.50	221,013.24
				Peak per second:		17.58	122.54
				Peak bits per second:		140.64	980.32

XMIT: Transmit from library
RCV: Receive in library
*Two messages received: one at initiating site; one at donor site

Fig. 11

Site Level	Traffic		Bytes		Hourly Multiplier	XMIT/Hour	RCV/Hour
Northridge III	Charge	Patron validate	XMIT	32	100.00	3,200.00	
(semester)	(all media, RBR and renew)	GO	RCV	64	98.60		6,310.40
		No Go	RCV	124	1.40		173.60
		Item validate	XMIT	32	300.00	9,600.00	
		GO	RCV	305	294.00		89,670.00
Peak:		No Go	RCV	255	6.00		1,530.00
Month May							
Day Monday	Place Hold	Patron validate	XMIT	32	9.00	288.00	
Hour		GO	RCV	64	8.87		567.68
		No Go	RCV	124	0.13		16.12
Avg. Items/patron		Item enquire	XMIT	205	8.87	1,818.35	
		Go-Stack	RCV	507	0.35		177.45
Nominal chg. period		Go-Hold	RCV	78	8.50		633.00
2 wks		No Go	RCV	78	0.02		1.56
Annual Circulation							
(1974-75)	Place ILL	Patron validate	XMIT	32	3.60	115.20	
315,849		GO	RCV	64	3.55		227.20
Annual hours open		No Go	RCV	124	0.05		6.20
4,329		Item enquire	XMIT	205	3.55	727.75	
		Go-Stack	RCV	507	0.04		20.28
		Go-Hold (local)	RCV	78	0.14		10.92
		Go-Donor	RCV	720	3.33		4,795.20*
		No Go	RCV	78	0.04		3.12
	Clear Bad Guy	Patron validate	XMIT	46	4.20	193.20	
		Go	RCV	434	4.20		1,822.80
		Clear	XMIT	214	4.20	898.80	
		Go	RCV	588	4.14		2,434.32
		No Go	RCV	78	0.06		4.68
	Item Enquire	Item validate	XMIT	195	10.00	1,950.00	
		Go	RCV	507	9.80		4,968.60
		No Go	RCV	78	0.20		15.60
	Patron Enquire	Patron validate	XMIT	46	7.00	322.00	
		Go	RCV	1,138	6.90		7,852.20
		No Go	RCV	78	0.10		7.80
			TOTALS:	**Hourly:**		**19,113.30**	**121,278.73**
				Peak per second:		**10.62**	**67.38**
				Peak bits per second:		**84.96**	**539.04**

XMIT: Transmit from library
RCV: Receive in library
*Two messages received: one at initiating site; one at donor site

Fig. 12

Please note that how much time is used or is required to be used depends on what is being communicated and how fast it must be communicated. These, in turn, are a function of the quality of the line used.

Returning to the four examples, and assuming a conditioned, private line was rented, it would cost four times as much to handle the communication traffic from a large campus as it would to handle that for a small campus. This is the cost of quality.

And, to digress and review the relative cost of line quality, at a nominal fifty bits-per-second the cost-per-mile-per-month let's say is *x* cents. Then, the cost for 150 bits-per-second would be 4*x* and the cost for one megabit-per-second (the "T1" circuit) would be 800*x* And, naturally, there will be a library or two somewhere that will require the high speed, "T1" channel!

An alternative to one "T1 channel" might be several channels of lower quality, and that's what models are for. In this instance, more lines mean more monthly access charges. Others will review the Centrex/PBX/E-PABX situation and the rate increases targeted for them. They resemble the confusion in rate changes and in the regulations surrounding telecommunications in general. At least librarians will be able to spot the trouble spots before they explode, by understanding how a simple check-out transaction can be translated into a specification for a communication line.