TABLE 1

CALL DISPOSITION PROBABILITIES

Disposition	LATA Calls	IEX Calls	800 Calls
Complete	72.8%	67.7%	74.3%
No Answer	16.2	14.8	5.4
Busy	7.3	7.7	13.5
Intercept	0.9	1.0	0.4
No Circuit/ Reorder	0.2	0.7	0.2
Other EB&F	1.1	3.7	3.8
Abandon with No response	1.5	4.4	2.4

Network Response	98.5	95.6	97.6
Abandon	1.5	4.4	2.4

TABLE 2

SUMMARY STATISTICS OF DISTRIBUTIONS

	LATA Calls	IEX Calls	800 Calls
Network Response			
Mean	3.7 sec	8.1 sec	8.7 sec
Standard Deviation	5.0	6.8	5.4
Customer Abandonment			
Mean	9.1	9.4	7.4
Standard Deviation	17.0	13.1	13.7

TABLE 3

EFFECT OF PDD ON ABANDONMENT RATE

	Shift in Mean Response time	-Abandonment Probability- LATA Calls	IEX Calls	800 Calls
Abandonment Rate	0 Sec.	1.5%	4.4%	2.4%
	2 Sec.	2.5	5.6	3.0
	4 Sec.	3.5	6.8	3.7
	6 Sec.	4.8	8.0	4.4
Ratio of New to Old Abandonment %	0 Sec.	1.0	1.0	1.0
	2 Sec.	1.6	1.3	1.2
	4 Sec.	2.3	1.5	1.5
	6 Sec.	3.2	1.8	1.8

FIGURE 1

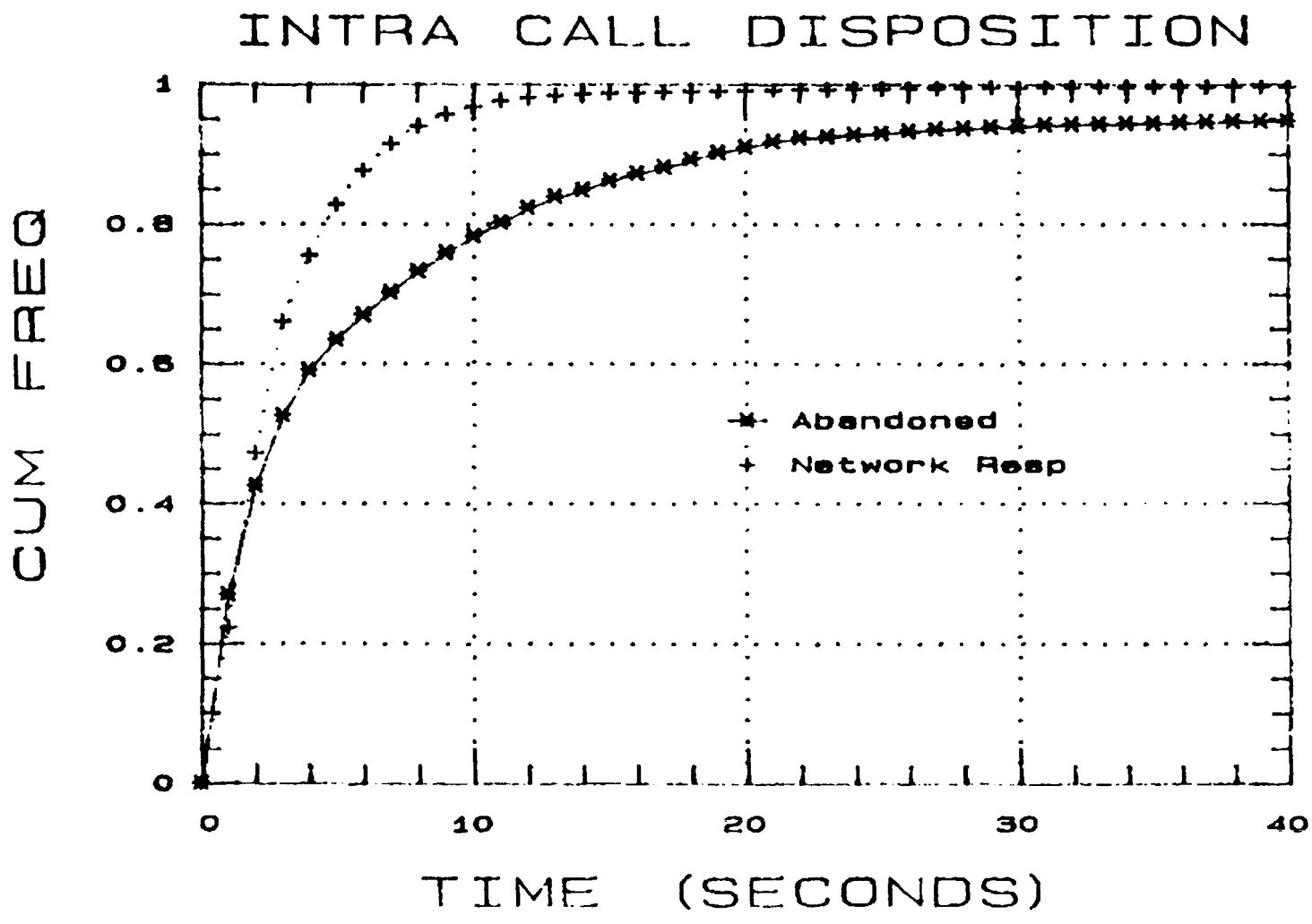

INTRA CALL DISPOSITION
CUM FREQ
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
TIME (SECONDS)
Abandoned
Network Resp

FIGURE 2

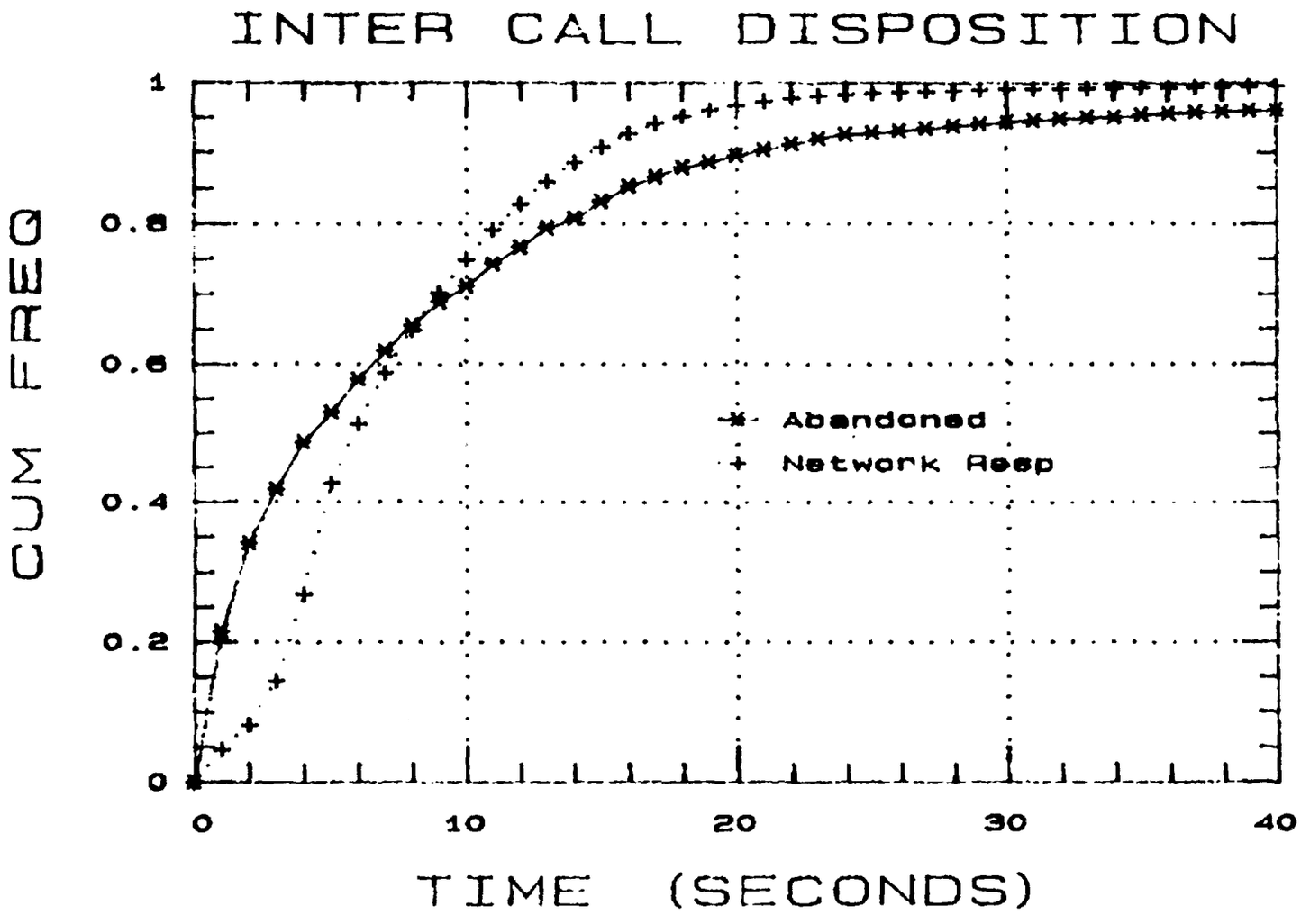
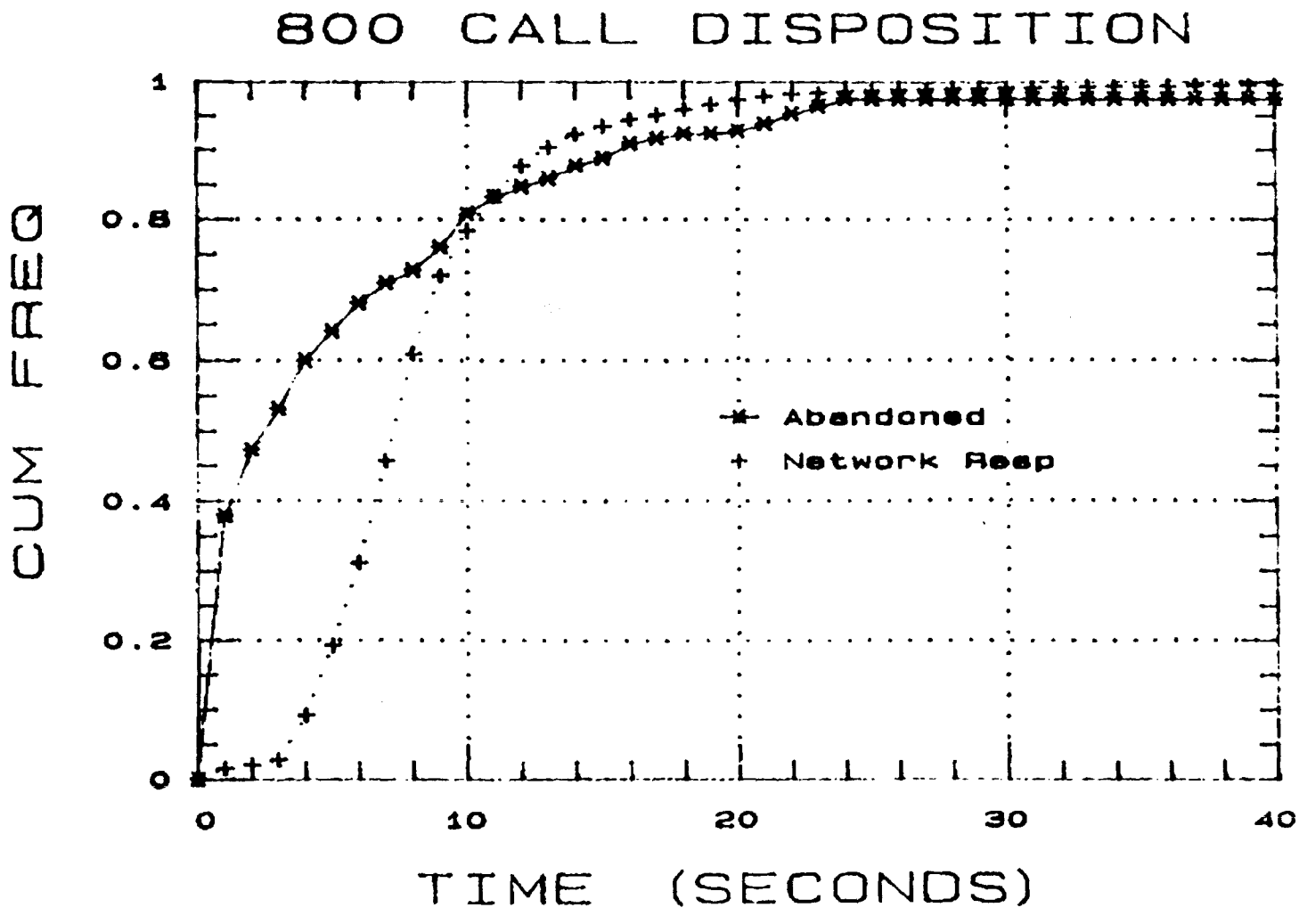

INTER CALL DISPOSITION
CUM FREQ
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
TIME (SECONDS)
Abandoned
Network Resp

FIGURE 3


800 CALL DISPOSITION
CUM FREQ
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
TIME (SECONDS)
Abandoned
Network Resp

D

Taking the pulse of the network

The No. 2 Service Evaluation System uses computerized sound recognition to automate the measurement of network performance.

S. DEAN HESTER

To ensure that customers receive quality service, Bell System Operating Companies continuously measure the performance of the telecommunications network. One very reliable measure is service evaluation—a look at how efficiently the network processes calls. Operating Companies evaluate service by randomly sampling customer-dialed calls every day and determining whether those calls reach their destinations, and if not, why not.

The results form a unique and accurate picture of how the network is used and how it performs, revealing calling patterns and specific reasons why calls sometimes do not get through. Evaluations at local switching offices assess overall network performance, since they show exactly what happens to calls from their origins to their destinations. Evaluations at toll offices follow the progress only of calls to local offices they serve; any problems detected are sure to be caused in that portion of the network.

Bell Labs engineers, in cooperation with AT&T and a panel of Bell Operating Company advisors, have now developed a new system that allows Operating Companies to perform service evaluation more efficiently and economically. The No. 2 Service Evaluation System offers state-of-the-art sound recognition that automates evaluation and enables Operating Companies to sample up to one hundred times more customer-dialed calls than possible before.

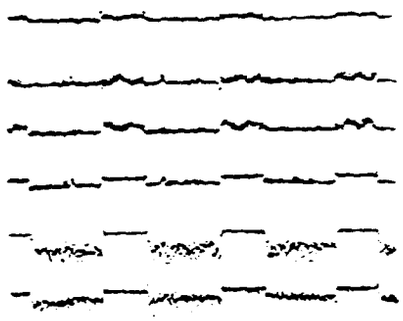
This dramatically increased amount of data

The pulses of ringing. The No. 2 Service Evaluation System analyzes several characteristics of a sound to identify it. The traces at right show the characteristics of a ringing signal. From top to bottom, the first indicates its loudness, the next three the frequencies present in it, and the last two a "buzz" typical of ringing in the North American network.

A computer that recognizes sounds

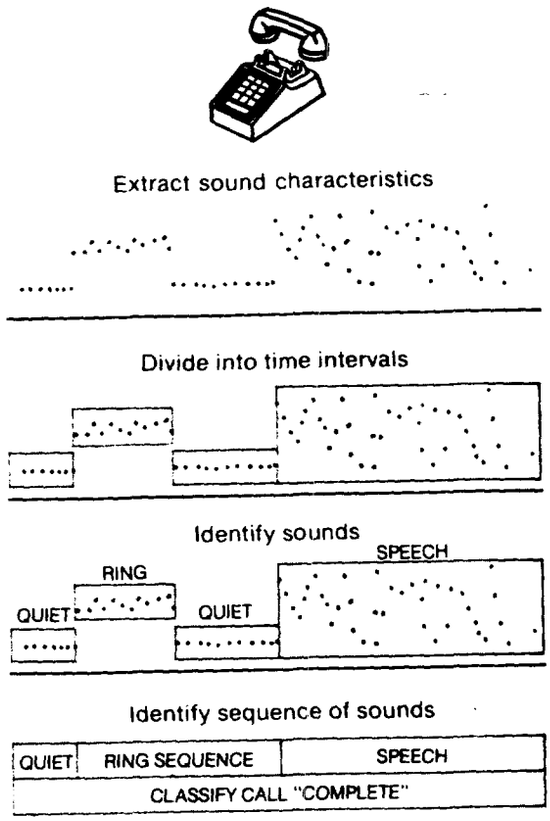
The No. 2 Service Evaluation System's call classification terminal interprets sequences of sounds from customer calls, and classifies them into categories, such as complete, no answer, busy, no ring, reorder, or one of several recorded network announcements.

To accurately measure network performance, service evaluation data must reflect the true proportion of calls in each category within a fraction of one percent. The No. 2 system's call classification terminal meets these accuracy requirements with an advanced sound recognition technique. The terminal first analyzes the sounds on a telephone line during call set-up, and extracts nine sound characteristics. Shown below are six characteristics extracted during twenty seconds of ringing.



The first trace shows the signal power—how loud the signal is. In this example, the signal power alone does not clearly indicate ringing. The second and third traces are general measures of the frequencies present; the fourth trace shows signal power in a frequency band likely to contain ringing and busy tones. The last two traces indicate the presence of a "buzz," a sound that characterizes ringing, busy, and reorder signals in the North American telephone network. The other sound characteristics that the terminal extracts are used to detect Special Information Tones, which are being recorded on announcement systems throughout the country to allow mechanized identification of network announcements.

Classifying a call



After extracting the sound characteristics, the terminal divides the call into time intervals, each likely to contain a single type of sound: ringing, busy or reorder, Special Information Tones, data set tones, quiet, clicks, and speech. (The system detects the presence of speech, but cannot interpret it.)

The terminal then identifies the sounds—a step crucial to call classification accuracy. The terminal first compares the sound characteristics in an interval with expected characteristics—for example, frequencies present in precise ring tones. If the characteristics match, the sound is identified. If they don't, the terminal checks to see if the sound recurs during the call. If it does, it may be a ringing, busy, or reorder tone, even though its characteristics don't match the expected ones.

Finally, the sequences of sounds are compared with many expected sequences to classify the call.

In the field. Each of the three call classification terminals in Southern Bell's Atlanta Service Evaluation Center simultaneously evaluates calls from 32 switching systems. The cabinets shown house the satellite processors and microprocessors of two of those terminals. The operator is seated at a maintenance terminal.

will permit Operating Companies to use the information in new ways. Such a large amount of data will quickly reveal faults in the network that a lesser amount might only indicate over time or perhaps not at all. For example, the No. 2 system could efficiently pinpoint too many unsuccessful call attempts to a large business customer, such as an airline or hotel. That business could then be informed of the problem and of any ways to eliminate it.

The No. 2 system could also measure service from toll offices to exchange offices, a useful gauge of the quality of exchange access.

Today most service evaluation is performed with the computer-based No. 1A Service Evaluation System, which mechanizes many service evaluation tasks. It randomly selects calls, and stores and reports manually entered service evaluation data. It does not automatically determine what happens to calls; this is a manual activity. (For more information about the No. 1A Service Evaluation System, see *A better way to measure the quality of telephone service*, RECORD, July/August 1981.)

The No. 2 Service Evaluation System automates the classification of customer-dialed calls. It uses a special call classification terminal to recognize the sounds in a telephone call (for example, speech, ringing, or busy signals). Based on the sequence of those sounds, it then determines what happens to the call and, within seconds, records the call classification. A complete call, for example, would generally consist of a quiet-ring-speech sequence of sounds. (See the panel on facing page.) A complete call to a private branch exchange answered first by an attendant and then by the called party would consist of a quiet-ring-speech-ring-speech sequence. Other possible classifications include busy, no ring, no answer, reorder, or one of several network announcements.

The No. 2 system can sample calls from switching systems of any size. Today's standard calls for measurement of those with 3000 or more main stations. Located in or near the Operating Company's Service Evaluation Center, it is connected to the switching systems—which may be near or some distance away—through the same network of dedicated voice and data circuits used with the No. 1A system.

The No. 2 system consists of a central computer and, depending on the size of the Operating Company, one or more call classification terminals. (See the panel on page 74.) Service evaluation personnel use the central computer to schedule call sampling, maintain the service evaluation equipment, and request reports. The call classification terminals are controlled by the central computer.

Three main categories of reports are produced by the No. 2 Service Evaluation System, either periodically or on demand:

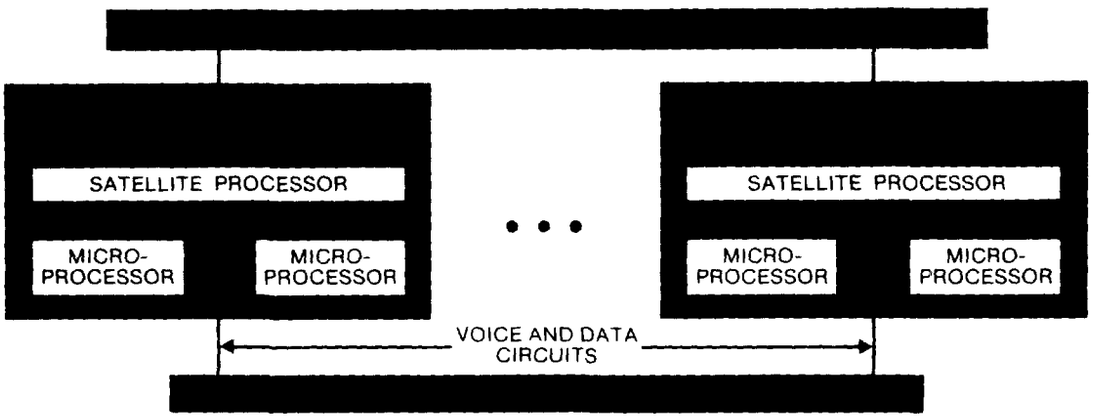
- Reports targeted to the Operating Companies and to AT&T that present an overall picture of network performance.
- Reports targeted to the Network Service

A unique computer architecture

A great deal of computing power is required for automatic call classification. The No. 2 Service Evaluation System provides this computing power with an economical and easily expandable multiprocessor architecture. It consists of three processor levels:

- *Thirty-two to 512 microprocessors* per system sample data from the telephone lines, and extract the sound characteristics needed to classify calls. Each high-speed, 16-bit microprocessor performs over 24,000 multiplications and additions per second. The microprocessors provide these data to the next processor level—satellite processors.
- *One to 16 satellite processors* per system control the selection of calls for service evaluation, collect call-progress data from the switching systems and microprocessors, and classify calls. Each processor is equipped to perform the extensive computations required for call classification.
- *A central processor* controls the satellite processors, stores and retrieves data, processes operator commands and generates reports, and interfaces with other systems that use service evaluation data. The central processor continuously monitors the operation of the satellite processors. If one stops functioning because of a power interruption or some other problem, the central processor either restarts it or notifies the system's operators.

The central and satellite processors both offer the capabilities of the *UNIX*™ operating system. These capabilities were carefully incorporated into the system to expedite development and testing, and to use computing resources most efficiently.



Centers that provide an up-to-date view of how each Center's area of the network is performing.

- Reports targeted to the Service Evaluation Center that show the amount of data being collected by the system and the performance of the service evaluation equipment.

To help ensure the correct operation of the No. 2 Service Evaluation System, a maintenance subsystem is built into it. This performs nightly preventive maintenance tests, alerting the system's operators when a major fault occurs (like the crash of a call classification terminal). If it detects a fault that could distort the data, such as a noisy voice circuit, the maintenance subsystem automatically alerts the operators and suspends operation of that equipment.

The first generic of the No. 2 Service Evaluation System, introduced in 1981, is highly compatible with the No. 1A system. It is operated by the same people, and typically shares the same space. Both systems run under the Bell Laboratories-developed *UNIX*™ operating system.

The second and third generics of the system, currently under development, will also automatically measure transmission quality. To ease the implementation of these generics, a new procedure structures the software in accordance with documented agreements about what the system should do initially and in the future.

Currently in use in Southern Bell and Northwestern Bell, the No. 2 Service Evaluation System is available to all Operating Companies. It greatly reduces the cost of collecting service evaluation data, and opens new ways of using the data to improve the performance of the network. □

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WRITER'S DIRECT DIAL NUMBER

(202) 342-6795

September 9, 1993

Via Facsimile and Federal Express
(415) 543-0418

Nancy Woolf, Esq.
Pacific Bell
Legal Department
140 New Montgomery Street
San Francisco, California 94105

Dear Nancy:

The purpose of this letter is to summarize our telephone conversation from yesterday. First, TMC and Pacific Bell ("PBT") agree to exchange documents on Friday, September 10 at the Settlement Conference. We recognize that by September 10 you may not have some of the documents you have agreed to provide, particularly the access minutes studies, but that PBT has committed that these documents will be forthcoming as soon as they are available.

If possible, we request that as some of the access minute study information becomes available you send it immediately. It is not necessary for us to receive all of the reports at the same time.

TMC also agrees that it is acceptable for PBT to provide the access minute information in three levels of aggregation, i.e.

TMC's access minutes, all interexchange carriers' access minutes, and all interexchange carriers' access minutes except AT&T's, MCI's and Sprint's.

Concerning PBT's access tariffs, we agreed that PBT need only provide copies of the tariffs' table of contents. If TMC requires specific tariff sections we will request them.

Regarding TMC's request that PBT provide "Documents relating to the coordination of trunk provisioning to end offices to affect equal access conversion during 1985-1988," I clarified that we want information concerning the coordination of PBT's equal access implementation in LATA 6. Accordingly, TMC's request is rephrased as "Project management reports and/or other documents concerning the progress of Pacific Bell's implementation of equal access in LATA 6 from 1984 to 1988."

TMC also requests that PBT provide Service Evaluation System II ("SES II") reports and Incoming Trunk Service Evaluation data for the years 1984 - 1988. Additionally, TMC requests that PBT provide any documents which discuss and/or analyze the results of both the SES II and the Incoming Trunk Service Evaluation data for LATA 6.

The SES II and Incoming Trunk Service Evaluation reports were identified in a study titled "The Effects of Changing Post-Dial Delay on Customer Abandonments and Perceptions of Service" (the "PacBell Study"), co-authored by Dr. Robert Mercer of Hatfield Associates and Drs. Frederick Chang and William Edwards of Pacific Bell. The PacBell Study was provided as an attachment to PBT's Direct Case that was filed with the FCC on April 21, 1989 in CC Docket No. 88-287.

According to the PacBell Study, SES II "can provide data on actual network response and customer abandonment time distributions." PacBell Study at 2. "SES II is a mechanized process by which call attempts are monitored from the time the customer goes off-hook until the attempt is either completed or abandoned. The time sequence of several events during the attempt is recorded, including end of dialing, first network response, answer by called party, and customer abandonment on unsuccessful attempts. The dialed digits are also recorded, and the attempt is classified into Intra-LATA, Inter-LATA/Intra-State, and Inter-LATA/Inter-State." Id. at 3. "SES II has a sophisticated and accurate ability to recognize network tones and speech, and is thus able to record the call disposition as well." Id.

The PacBell Study further states that, "[i]n Pacific Bell, SES II data is . . . collected in 500 end offices. With a bogey of 500 dial line observations per office per month, in excess of 250,000 observation per month are recorded." Id.

The Incoming Trunk Service Evaluation report provides data "in which call attempts are picked up at the point they are incoming to a terminating tandem switch and followed from there to their final disposition." Id. at fn 1. The PacBell Study was based on data from the SES II report, collected during March and April, 1987. As this data was clearly compiled and utilized by PacBell for purposes of preparing its study, at an absolute minimum we expect that PBT will provide us the reports for these months.

During our conversation yesterday, in response to this request, you indicated that obtaining this information may be difficult because it may be hard to identify those individuals who can provide these reports. For your information, the "Acknowledgements" section of the PacBell Study mentions the following PacBell employees who aided in the study:

Clarice Davis
Dana Martin
Steve Simon
Dahn Lai
W.S. Burgers
R.M. Douglas

Also, PBT's direct case was filed by James Tuthill, Lucille Mates and Stanley Moore.

You also indicated that you could not spend a great deal of time to locate this information and that TMC has had over four years to obtain this data. As I stated during our conversation, if PBT does not voluntarily provide this information, we will subpoena it for production at trial.

Moreover, your assertion that we have had four years to obtain this information is disingenuous. The reality is that TMC requested this type of information four years ago and your client was not forthcoming in producing it. Indeed, on May 15, 1989 TMC propounded 24 Interrogatories on PBT of which at least two requested information to which the SES II and the Incoming Trunk Service Evaluation data were directly relevant and responsive.

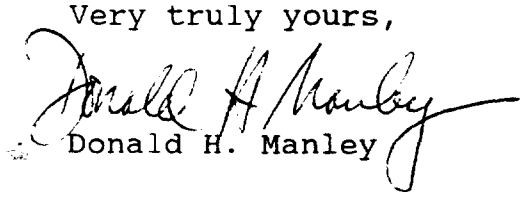
Specifically, Interrogatory 4 requested information concerning "diagnostic tests applied from PacBell's Network Control Center and/or any other location to the . . . 90T . . .

or any central office . . . beginning on the date the Tandem first became operational and continuing through the end of 1988 . . . . According to the PacBell Study, the SES II data is used "on a routine basis to monitor and try to correct situations where high rates of Equipment Blockage and Failure dispositions are occurring." PacBell Study at 3 (emphasis added.)

Further, Interrogatory 16 requested information concerning "any other access time studies relating to the use of the Tandem in LATA No. 732 . . . ." This is precisely the type of information that the PacBell Study indicates is provided by the Incoming Trunk Service Evaluation report. See PacBell Study at fn 1.

The fact that PBT's attorney, James Tuthill, participated in filing the PacBell Study with the FCC just a few weeks prior to the time TMC's first set of interrogatories were filed destroys any claim that PBT was unaware of these reports and their relevance to TMC's complaint. We are confident that you will advise your client of the absolute necessity to make these reports available to TMC as soon as possible.

Very truly yours,



Donald H. Manley

DHM/sh

cc: Thomas D. Wyatt, Esq.
Walter C. Miller, Administrative Law Judge

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Attachment F

DECLARATION

I, Donald H. Manley, hereby state and declare as follows:

1. I am an attorney with Galland, Kharasch, Morse and Garfinkle, P.C.. I have entered an appearance on behalf of Clark-Bader, Inc. d/b/a TMC Long Distance ("TMC") in the Matter of Clark-Bader, Inc. d/b/a TMC Long Distance v. Pacific Bell Telephone Company, CC Docket No. 93-161, File No. E-89-85.

2. On September 8, 1993 I notified Pacific Bell's counsel, Nancy Woolf, by telephone conversation that I had discovered information concerning the existence of the Service Evaluation System II ("SES II") monitoring system in the course of my research for the instant case. The SES II system was mentioned in a study titled "The Effects of Changing Post-Dial Delay on Customer Abandonments and Perceptions of Service" (the "Pacific Bell Study") co-authored by Dr. Robert Mercer of Hatfield Associates and Drs. Frederick Chang and William Edwards of Pacific Bell.

3. I stated to Ms. Woolf that TMC desired to obtain SES II information and its component Incoming Trunk Service Evaluation ("ITSE") report for the entire period covered in the instant complaint (1985 to 1988). Ms. Woolf indicated that she could not spend a great deal of time to locate this information and that TMC has had over four years to obtain this data. I explained to Ms. Woolf that if Pacific Bell refused to provide this information, TMC would subpoena it for production at trial.

4. By letter dated September 9, 1993, I requested that Pacific Bell provide the SES II data and also data from the Incoming Trunk Service Evaluation system which is a component of the SES II system. I also requested that Pacific Bell provide "any documents which discuss and/or analyze the results of both the SES II and the Incoming Trunk Service Evaluation data for LATA 6."

5. I contacted Ms. Woolf by telephone again on September 13, 1993, about consenting to an extension of time to file Direct Cases until her client produced this vital evidence and TMC had time to review it and incorporate it into its direct case. Ms. Woolf responded that she would not agree to such an extension.

6. Approximately one hour later, Ms. Woolf called me and stated that the data I had requested had been destroyed and that no data prior to January 1, 1989, exists. I told Ms. Woolf that TMC nevertheless wanted Pacific Bell to determine whether the more limited information for the two months in 1987 that the Pacific Bell Study was based upon is still available from the researchers who produced the study. Ms. Woolf agreed to inquire about this information with the researchers who developed the Pacific Bell Study and indicated that she would call me back when she determined whether or not the information still exists. Ms. Woolf did not indicate whether her client would provide any documents analyzing or discussing the SES II and ITSE data for LATA 6.

I declare under penalty of perjury that the foregoing is true and correct. Executed this 14th day of September, 1993.

Donald H. Manley