United States General Accounting Office

GAO

Fact Sheet for the Chairman, Subcommittee on Telecommunications and Finance, Committee on Energy and Commerce, House of Representatives

March 1993

TELECOMMUNICATIONS

Interruptions of Telephone Service

148719

GAO/RCED-93-79FS

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-251497

March 5, 1993

The Honorable Edward J. Markey
Chairman, Subcommittee on
Telecommunications and Finance
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

Telephone network disruptions can be anything from an annoyance to a near-disaster. In the fall of 1991, a long-distance carrier suffered a massive outage in New York City that cut off most long-distance communications to and from the city. Air traffic in New York and elsewhere along the East Coast was disrupted because the air traffic control system depends on telephone lines for voice and data transmission. There was a sense that such disruptions were increasing, but no one—including the Federal Communications Commission (FCC)—knew how often major outages were occurring or how extensive they were.

You asked us to determine the frequency and the causes of outages that occurred during calendar years (CY) 1990 and 1991. In response to your request, we contacted the 15 holding companies that control over 93 percent of local telephone access lines. In addition, we contacted the three major long-distance companies that, all told, represent nearly 89 percent of the long-distance market. We asked these companies to report to us, on a questionnaire we provided, the outages that occurred in 1990 and 1991 that affected at least 10,000 customers and lasted 15 minutes or longer. All of the companies responded to our request.

In summary, we found that during 1990 and 1991 over 1,000 such outages occurred, affecting over 69 million customers. The local telephone companies experienced about 80 percent of these outages; they said that hardware problems, such as computer failure, and software problems, such as programming errors, were the main causes of the outages. Long-distance companies said that cable cuts were the main cause of their disruptions.

Discounting an ice storm outage that lasted 2 weeks, the average duration of the outages was 3.3 hours. Local telephone company outages lasted an average of 3.1 hours and long-distance company outages averaged about 5.4 hours. About half of all the outages occurred between 9 a.m. and 6 p.m.

Reasons for Outages

There were six major reasons for these outages—hardware problems, software problems, telephone company errors, cable cuts, vendor errors, and acts of God. (See app. II for descriptions of these reasons.) Outages caused by these six factors affected 65 million of the 69 million customers who temporarily lost their service. Hardware problems, although more numerous, took the shortest amount of time to fix. On the other hand, outages caused by acts of God, while less numerous, lasted longer than outages caused by the other major factors. Table 1 indicates the range and significance of the various factors.

Table 1: Major Reasons for Network Outages

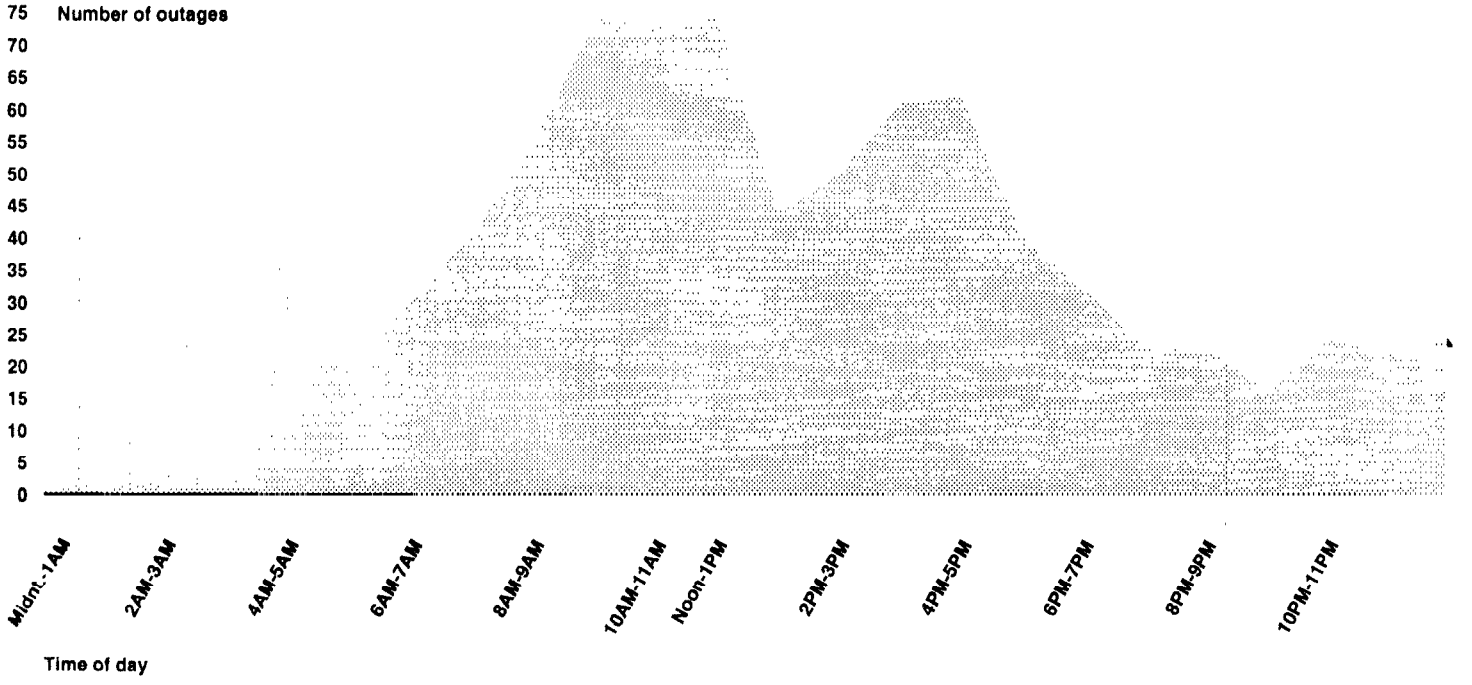
Reason for outage	Number of outages	Customers affected (millions)	Average duration (hours)
Hardware problems	273	8.0	1.8
Software problems	198	37.0	2.2
Cable cuts	157	6.4	6.7
Telephone company errors	148	10.8	3.0
Vendor errors	52	1.5	2.3
Acts of God	45	1.6	15.6[a]
Subtotal	**873**	**65.3**	**3.7**
Other	133	4.0	3.1
Total	**1006**	**69.3**	**3.6[a]**

Note: See appendix II for more detailed descriptions of these reasons.

[a]If a 2-week outage caused by an ice storm is removed from these statistics, the average duration for outages caused by acts of God drops to 8.3 hours, and the average duration for all outages drops to 3.3 hours.

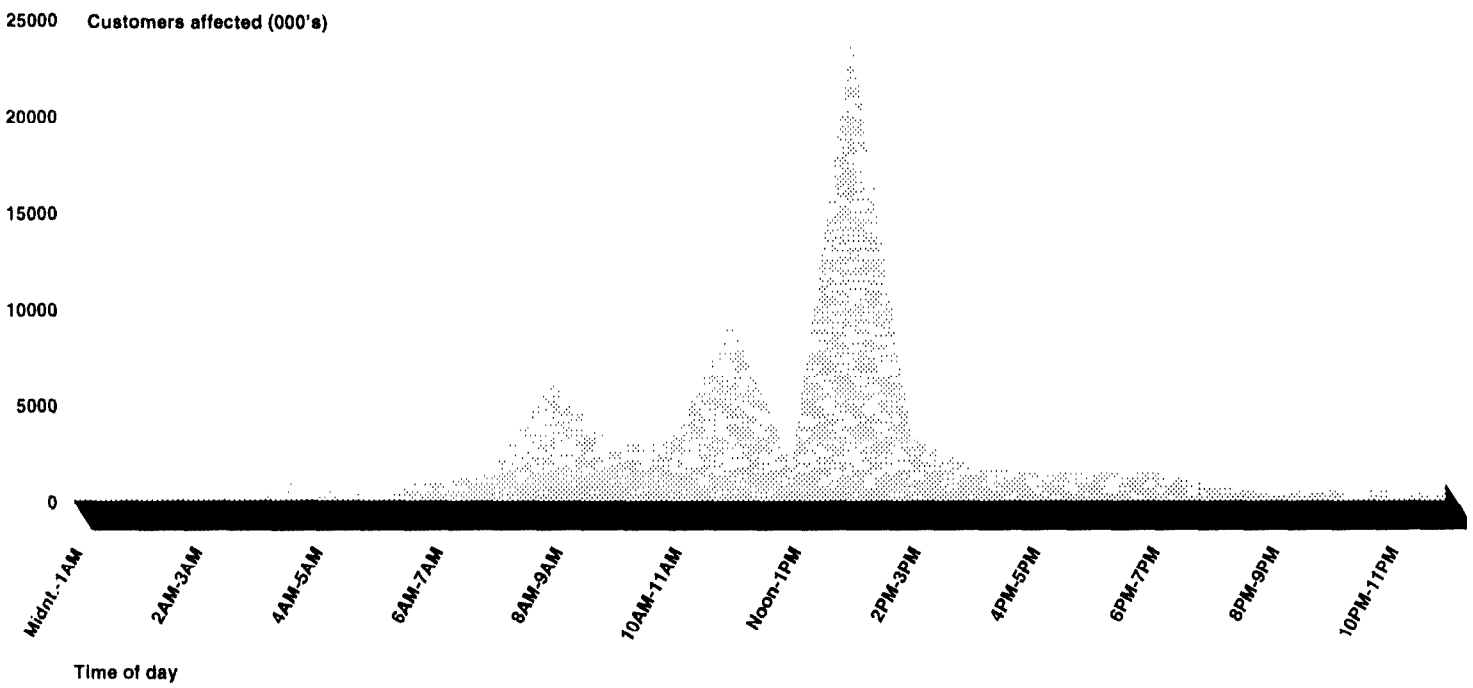
The timing of the outages was of particular significance because over half of them began during working hours and peaked between 9 a.m. and noon. Figure 1 shows the times that the outages began.

Figure 1: Starting Times of Telephone Outages, CY 1990 and 1991



A large majority of the customers that experienced outages lost their service during the time of day when people are most affected. About 70 percent of the 69 million customers affected by the outages lost their service somewhere between 9 a.m. and 6 p.m. (see fig. 2). The average length of these outages was over 3 hours.

Figure 2: Customers Affected by Time of Day, CY 1990 and 1991



In December 1991, the FCC established the Network Reliability Council, a federal advisory committee that makes recommendations aimed at preventing telephone network outages or limiting their impact. This council comprises more than 30 leaders in the communications field, including the chief executive officers of most of the major U.S. telephone companies.

Because of growing concern about the magnitude of recent outages, the FCC adopted rules on February 13, 1992, that require local and long-distance telephone companies to notify the FCC of any outages that affect at least 50,000 customers and that last 30 minutes or longer. Companies are required to report the outage within 90 minutes of its onset and to provide a complete written report to the FCC within 30 days. Under these rules, telephone companies reported a total of 54 outages to the FCC between April and September 1992. During the same 6-month period in 1991, 43 such outages occurred; 24 occurred in the same 6-month period in 1990. Had the notification requirement been in effect during our 2-year

survey period, 121 outages affecting over 47 million customers would have been reported to FCC.

In April of 1992, for a 6-month trial period beginning in June, the council expanded the types of outages to be reported to the FCC. Under this trial, certain special outages—such as ones that affected 911 service—were reported, as were all outages that affected 30,000 or more customers. In its December 1992 meeting, the council recommended that the FCC adopt the 30,000-customer threshold.

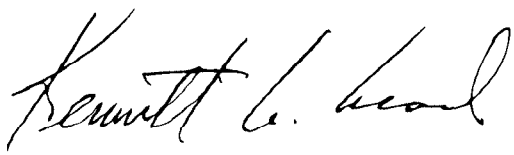
Section 1 of this report provides background information; section 2 provides data on the reasons for the outages and on the number of customers affected; section 3 identifies the places in the telephone network where the outages occurred.

To obtain the requested information, we met with FCC officials, other experts, and officials from the telephone industry to develop a questionnaire on telephone outages (see app. II). We administered this questionnaire to the major telephone companies that are responsible for 93 percent of all local telephone access lines and 89 percent of the total long-distance market. While we did not corroborate all the data provided by these companies, we did selectively verify data for major outages reported to the FCC during the time covered by our survey. We presented a draft of this report to responsible FCC officials; they agreed with the facts presented.

As arranged with your office, unless you announce its contents earlier, we plan no further distribution of this fact sheet until 30 days after the date of this letter. At that time, we will send copies to the Commissioners of FCC and other interested parties. We will make copies available to others upon request.

Please contact me on (202) 275-1000 if you or your staff have any questions. Major contributors to this report are listed in appendix IV.

Sincerely yours,



Kenneth M. Mead
Director, Transportation Issues

Contents

Abbreviations

AT&T	American Telephone & Telegraph Company
CY	calendar year
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
GAO	General Accounting Office
LINCS	Leased Interfacility NAS Communication Systems

Background

During the past decade, the telecommunications industry has changed dramatically: it has been reorganized, it has developed new technology for transmitting voice and data traffic, and its telecommunications services are in increasing demand.

On January 1, 1984, the structure of the telephone industry changed significantly. Until that time, the U.S. telecommunications industry had been dominated by the American Telephone and Telegraph Company (AT&T) and its subsidiaries, which combined formed the Bell System. In 1984, following a court-approved reorganization plan, AT&T divested itself of its local exchange companies. In the 9 years since the breakup of the Bell System, the telecommunications market has grown rapidly with the addition of a new and diverse group of providers of telecommunications services.

In addition, the technology employed by the telecommunications industry has evolved greatly during the past decade. During the 1980's, many telephone companies began using computers to handle, or "switch," calls. For example, in 1980, major local telephone companies representing 75 percent of the local telephone company access lines in the U.S. used computers to switch calls in 26 percent of their switching offices. This use of computers in switching offices is projected to increase to 94 percent by 1994. Another technological change is the increasing use of fiber optic cable, which can handle a significantly higher volume of calls than the more traditional copper cable. By the end of 1990, local exchange carriers had installed over 3 million miles of fiber optic cable, compared to 0.5 million miles in 1986. As a result, voice and data traffic are being transmitted through fewer network channels and switching facilities. However, the increased reliance on these new technologies means an increased adverse impact on customers in the event of an outage. According to one expert, a cut fiber optic cable can affect millions of customers, more than ever before.

Finally, the telecommunications industry has also changed in that its customers' use of telecommunications has increased in the past decade. For example, interstate calls have doubled since 1983. Facsimile machines are now commonplace, and services such as call waiting, caller ID, and call forwarding are becoming more prevalent. As we continue to become more dependent on networks, the consequences of telephone network failure are becoming more serious, and the need to reduce network vulnerabilities becomes a vital concern to the nation.

FCC's Role

Recent telephone outages have caused concern about telephone reliability in the United States. In June 1991, two separate telephone outages at opposite ends of the country eliminated local telephone service to 8 million people and affected emergency services. A few months later, AT&T suffered a massive outage in New York City that cut off most long-distance telephone communications to and from the city as well as air traffic to the area's major airports. The FCC noted that this outage resulted in significant loss of the Federal Aviation Administration's (FAA) radar sites, radio channels, and computer links. This resulted in 1,174 canceled or delayed flights and 85,000 inconvenienced passengers.[1] More than 7 hours passed before full service was restored.

These telephone outages were just a few of the many outages that occurred in the past three years. The magnitude and consequence of recent outages have focused attention on the reliability of the public telephone network and on the FCC's role in ensuring network reliability.

Before 1990, the FCC had played a very limited role in ensuring the reliability of the public telephone network. In recent years, however, the FCC has become increasingly more involved in the issue. The FCC said it has investigated every major telephone network outage since January 1990. In December 1991, the FCC established a federal advisory committee called the Network Reliability Council to provide recommendations designed to help prevent telephone network outages or limit their impact. This council is composed of more than 30 leaders in the communications sector, including the chief executive officers of most of the major U.S. telephone companies, principal equipment carriers, consumers, corporate and federal user representatives, and state regulatory agencies. Due to growing concern over the magnitude of recent outages, the FCC adopted rules on February 13, 1992, requiring local and long-distance telephone companies to report outages affecting at least 50,000 customers and lasting 30 minutes or longer. Companies are required to report the outage within 90 minutes of its onset and to provide a complete written report to the FCC within 30 days. In April 1992, the Council expanded—for a trial period of 6 months, beginning in June—the types of outages to be reported to include certain special outages—such as ones that affect 911 service—and all outages affecting at least 30,000 customers. In its December meeting, the council recommended to the FCC that the 30,000-customer threshold be adopted, but that companies be allowed 3 days to report such outages if they affect fewer than 50,000 customers. Before it established these

[1]FAA officials told us that this outage has prompted actions to preclude similar events in the future. FAA expects its Leased Interfacility NAS Communication Systems (LINCS) program, which is now being procured, to prevent such outages.

reporting requirements, the FCC had limited information on telephone outages.

Under the February reporting requirement, telephone companies reported to FCC a total of 54 outages affecting nearly 10 million customers from March 31 through September 30, 1992. Had the February reporting criteria been in effect during our survey period (1990-1991), 121 outages affecting a total of 47.6 million customers would have been reported. Under the 30,000-customer criterion, an additional 161 outages affecting 6.1 million customers would have been reported, for a total of 282 outages that affected 53.7 million customers.

Major Reasons for Outages and Customers Affected

Table 2.1: Major Reasons for Network Outages

Reason for outage	Number of outages	Customers affected (millions)	Average duration (hours)
Hardware problems	273	8.0	1.8
Software problems	198	37.0	2.2
Cable cuts	157	6.4	6.7
Telephone company errors	148	10.8	3.0
Vendor errors	52	1.5	2.3
Acts of God	45	1.6	15.6
Subtotal	**873**	**65.3**	**3.7**
Combination of reasons	25	0.8	4.3
Other	108	3.2	2.8
Total	**1006**	**69.3**	**3.6**

Figure 2.1: Reasons for Telephone Outages for Local and Long-Distance Companies, CY 1990 and 1991

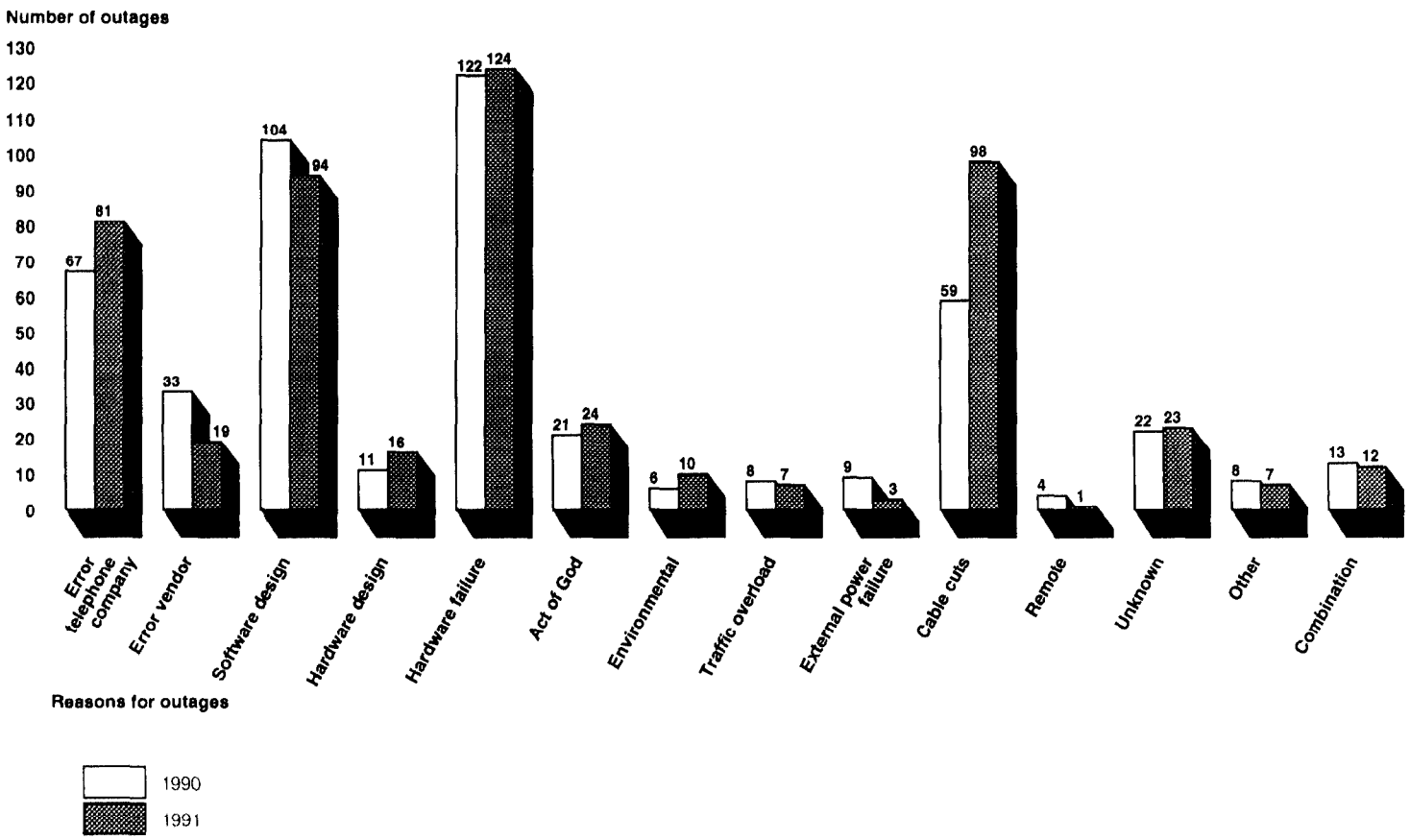


Figure 2.2: Reasons for Telephone Outages for Local Companies, CY 1990 and 1991

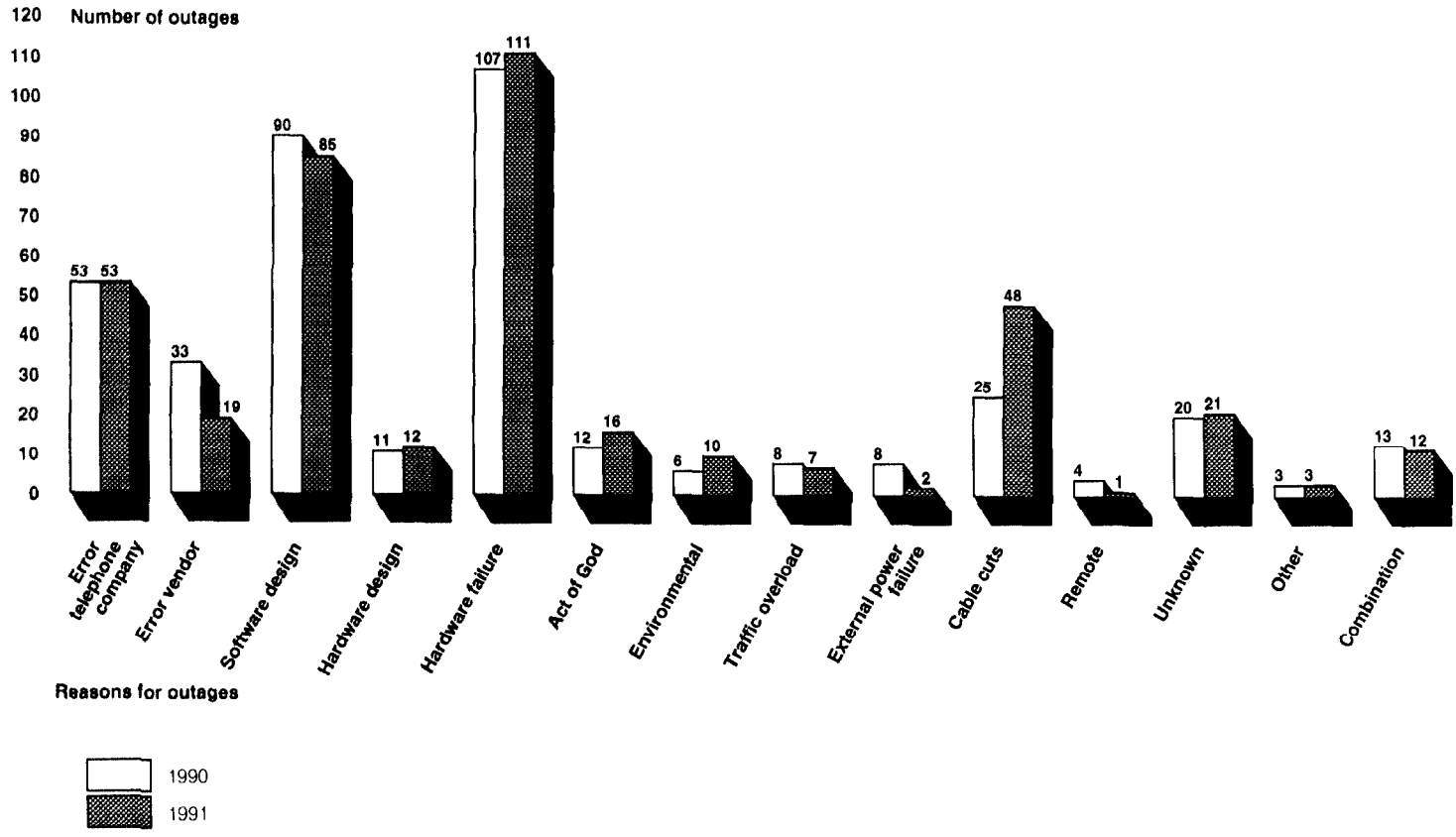


Figure 2.3: Reasons for Telephone Outages for Long-Distance Companies, CY 1990 and 1991

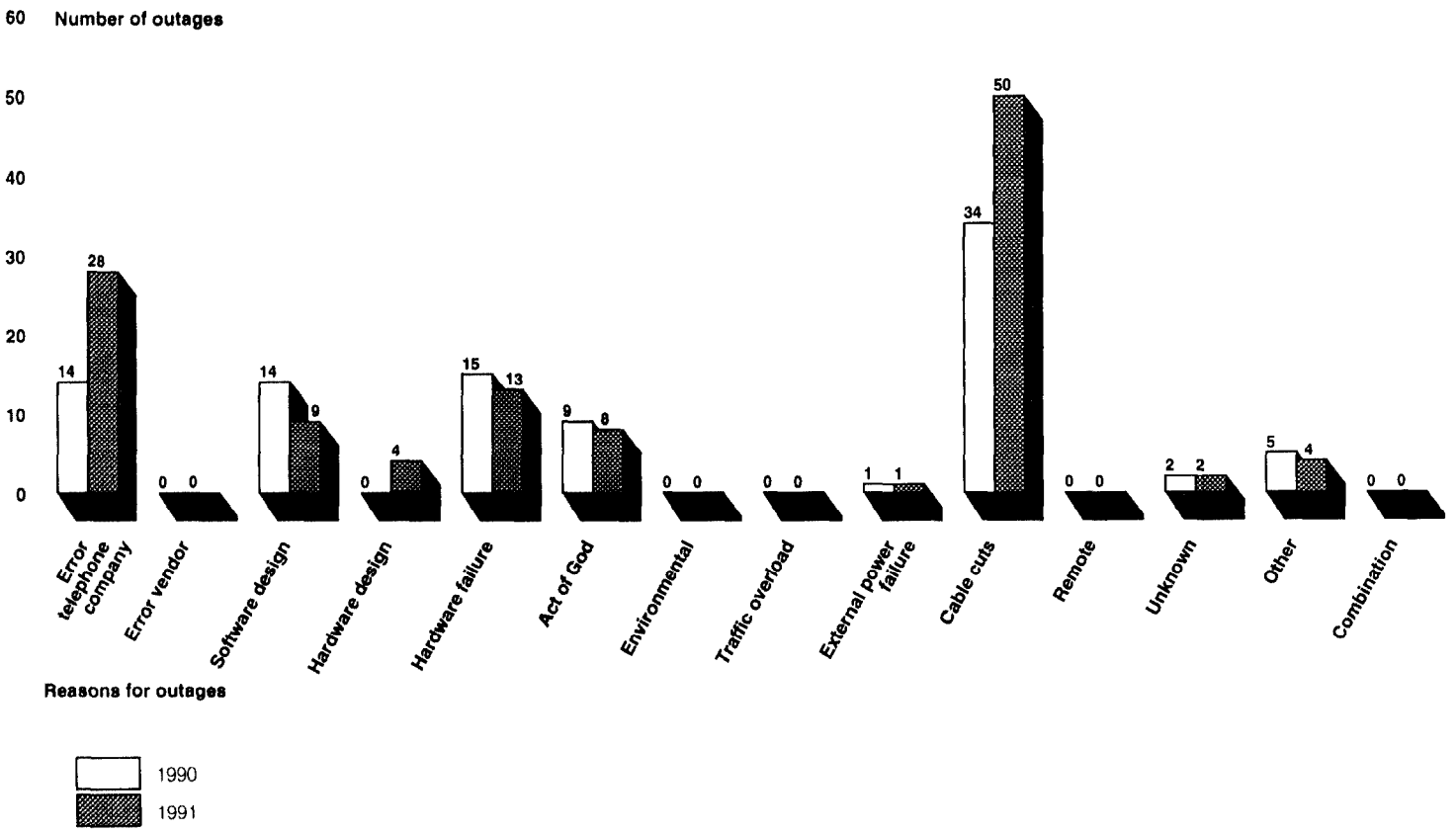


Table 2.2: Outages and Customers Affected by Major Reasons, CY 1990 and 1991

	1990		1991	
Reason for outage[a]	**Outages**	**Customers affected (millions)**	**Outages**	**Customers affected (millions)**
Hardware problems	133	3.5	140	4.4
Software problems	104	24.9(3.2)[b]	94	12.1
Telephone company errors	67	2.3	81	8.5
Cable cuts	59	2.2	98	4.1
Vendor errors	33	1.0	19	0.5
Acts of God	21	0.6	24	1.0
Total	**417**	**34.5 (12.8)[c]**	**456**	**30.6**

[a]See appendix II for a description of these reasons.

[b]This total includes one single outage affecting 21.7 million customers; without this outlier, the number of customers affected by software problems increased by nearly 400 percent (3.2 to 12.1 million) from 1990 to 1991.

[c]12.8 million without a 21.7 million outlier described in previous note.

Figure 2.4: Reasons for Telephone Outages for Local and Long-Distance Companies by Customers Affected, CY 1990 and 1991

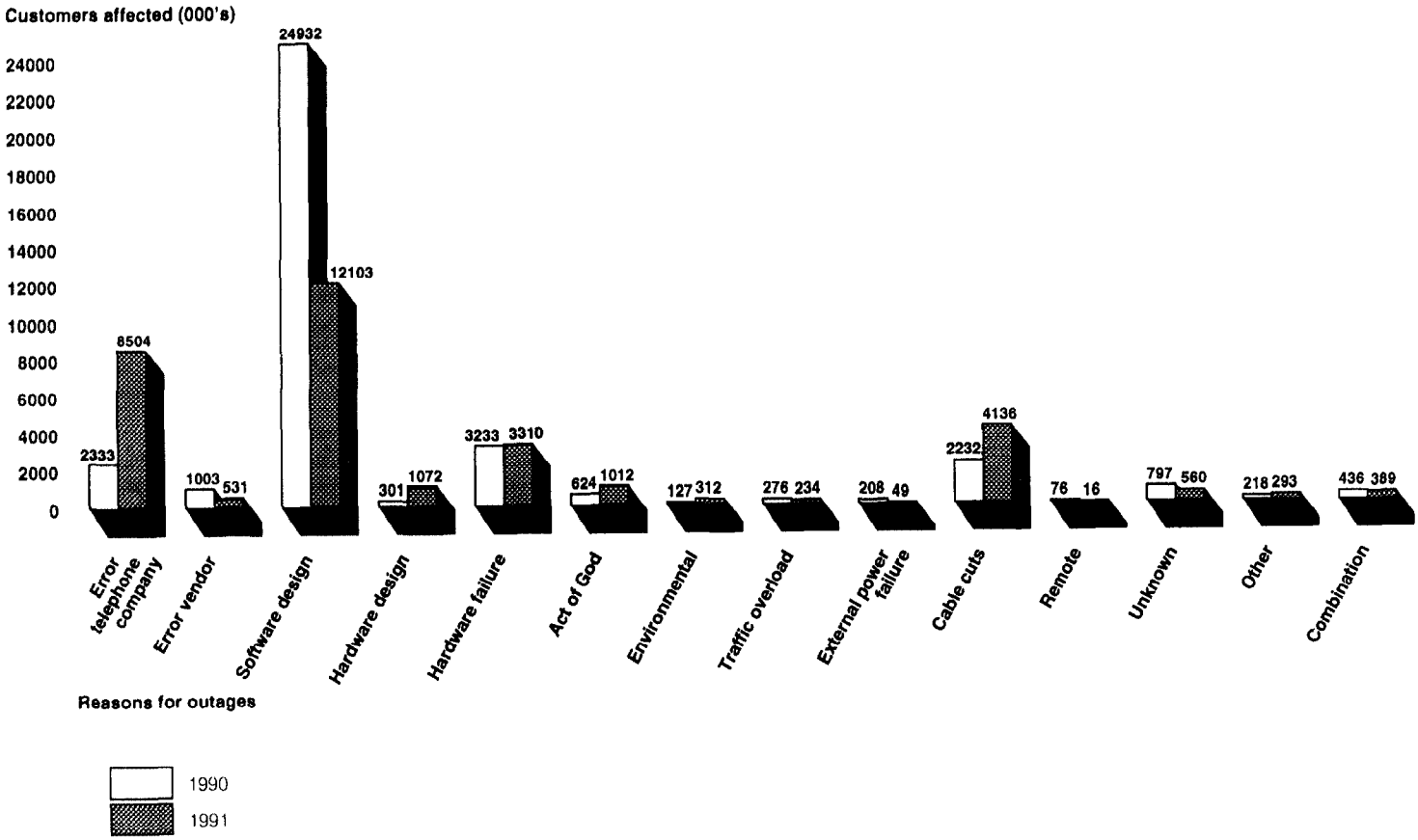


Figure 2.5: Reasons for Telephone Outages for Local Companies by Customers Affected, CY 1990 and 1991

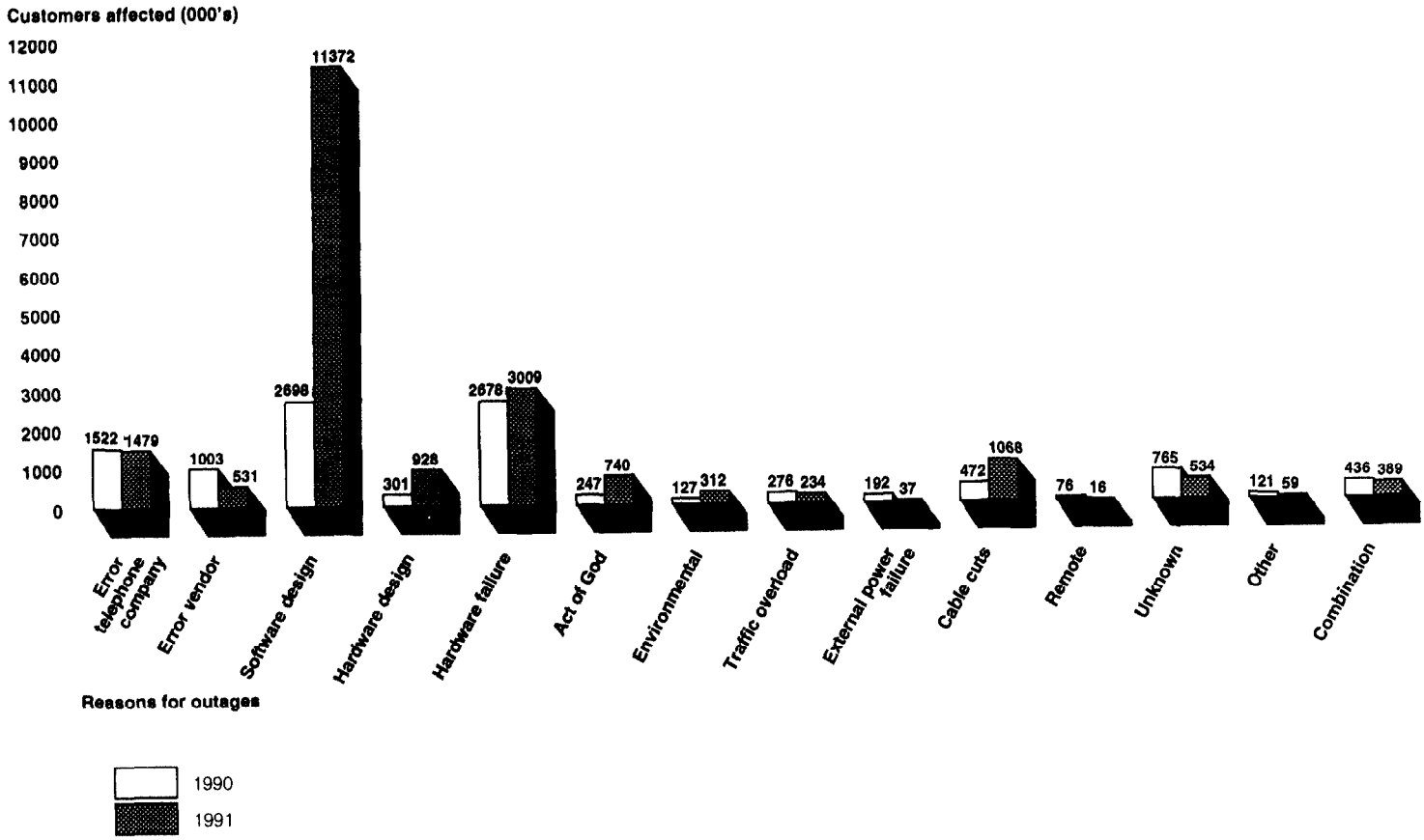


Figure 2.6: Reasons for Telephone Outages for Long-Distance Companies by Customers Affected, CY 1990 and 1991

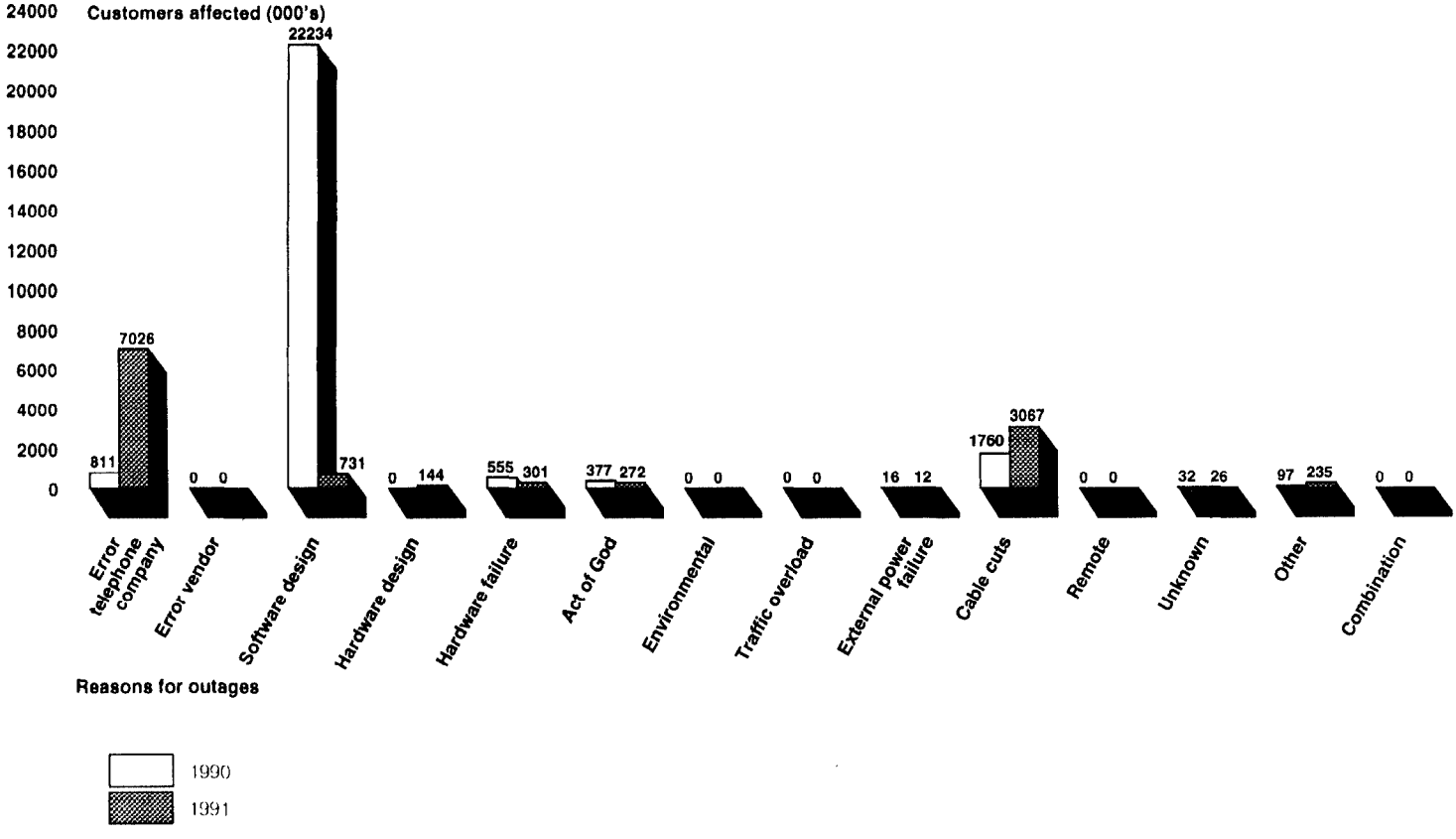


Table 2.3: Outages by Range of Customers Affected

	1990		1991		Total 1990 - 1991	
Range of customers	Outages	Customers (millions)	Outages	Customers (millions)	Total outages	Customers (millions)
10,000-49,999	421	9.3	433	9.9	854	19.2
50,000-99,999	53	3.3	68	4.3	121	7.6
100,000-499,999	11	2.0	10	3.0	21	5.0
Subtotal	**485**	**14.6**	**511**	**17.2**	**996**	**31.8**
500,000 +	**2**	**22.2[a]**	**8**	**15.3**	**10**	**37.5**
Total	**487**	**36.8**	**519**	**32.5**	**1006**	**69.3**

[a]Contains one outage that affected 21.7 million customers.

Major System Outage Locations

Table 3.1 shows the areas where outages occurred, how frequently the outages occurred, and how severe they were.

Table 3.1: Major System Outage Areas, CY 1990 and 1991

Location of outage[a]	Number of outages	Customers affected (millions)	Average duration (hours)
End office switch	618	17.2	1.8
Cable	214	15.2	7.5
Other switch	97	25.7	4.6
Signalling facility	14[b]	9.6	2.6
Subtotal	**943**	**67.7**	**3.4**
Combination of locations	25[c]	0.7	11.8
Other locations	38	0.9	3.3
Total	**1006**	**69.3**	**3.6**

[a]See appendix III for location definitions.

[b]This number contains two outages that affected a total of 7.2 million customers and that were classified by the telephone companies as located at both signaling facility and other locations.

[c]End-office switches were involved in 21 of these 25 outages that had more than one system location identified. These 21 outages affected an additional 609,000 customers.

Figure 3.1: System Locations of Telephone Outages for Local and Long-Distance Companies, CY 1990 and 1991

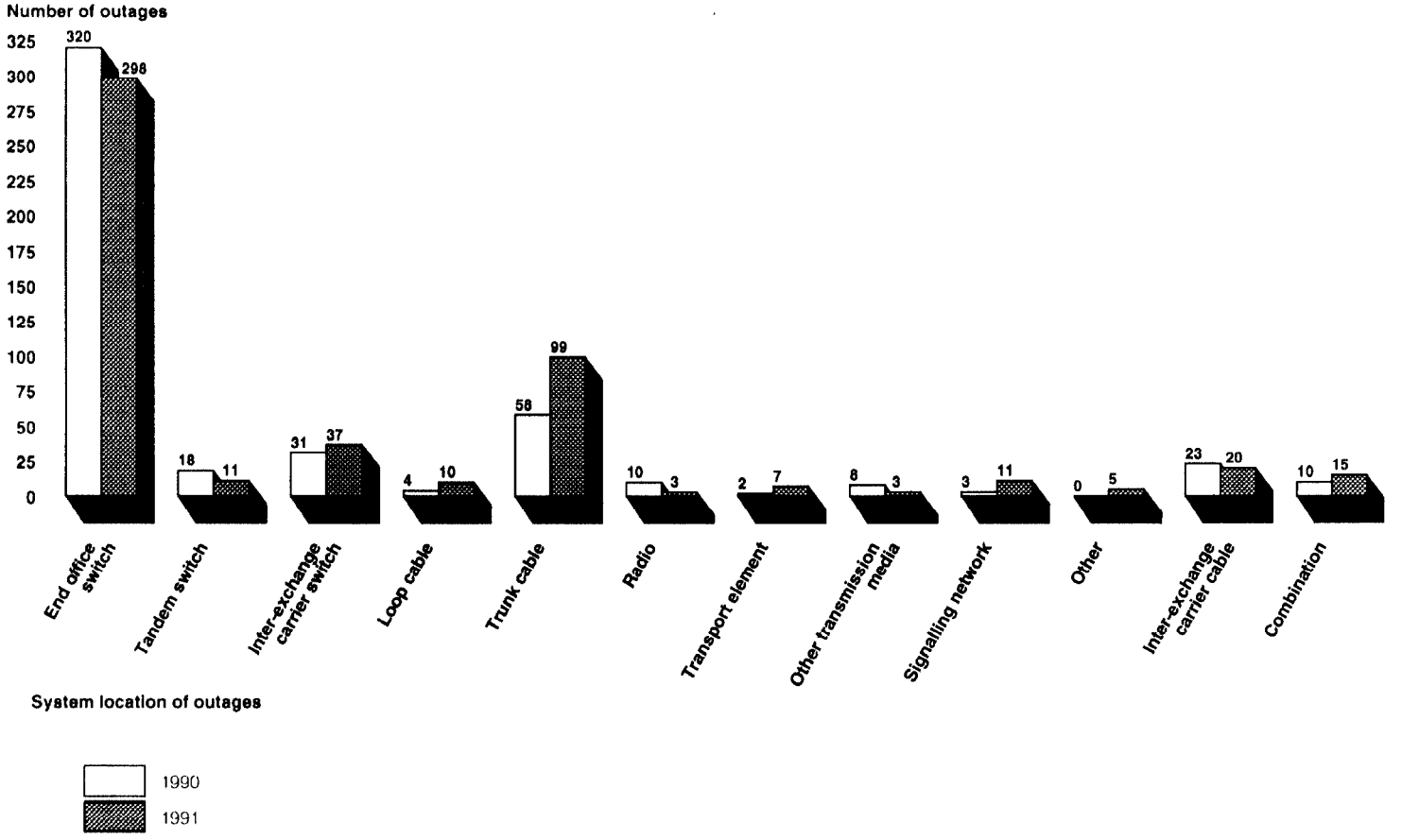


Figure 3.2: System Locations of Telephone Outages for Local Companies, CY 1990 and 1991

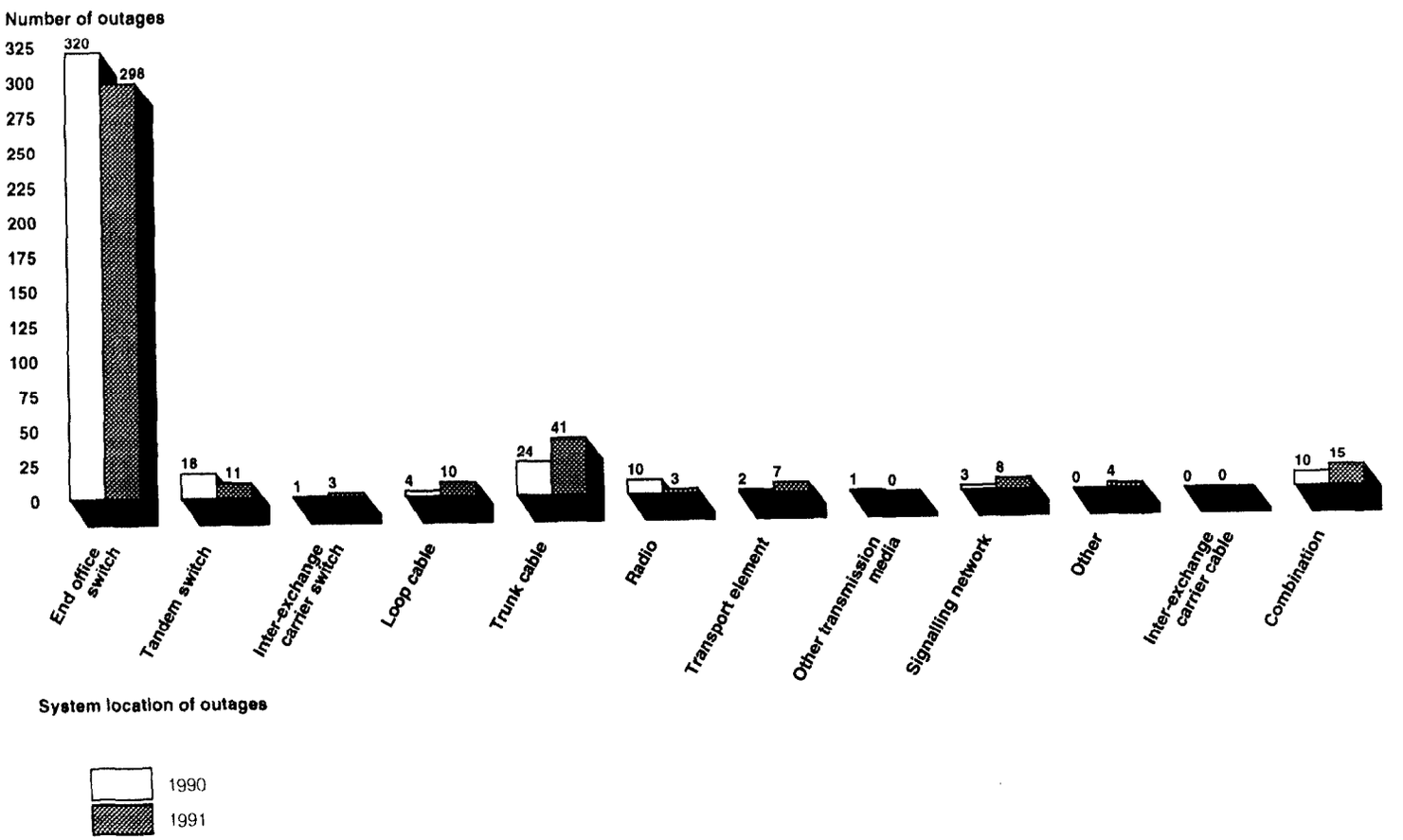


Figure 3.3: System Locations of Telephone Outages for Long-Distance Companies, CY 1990 and 1991

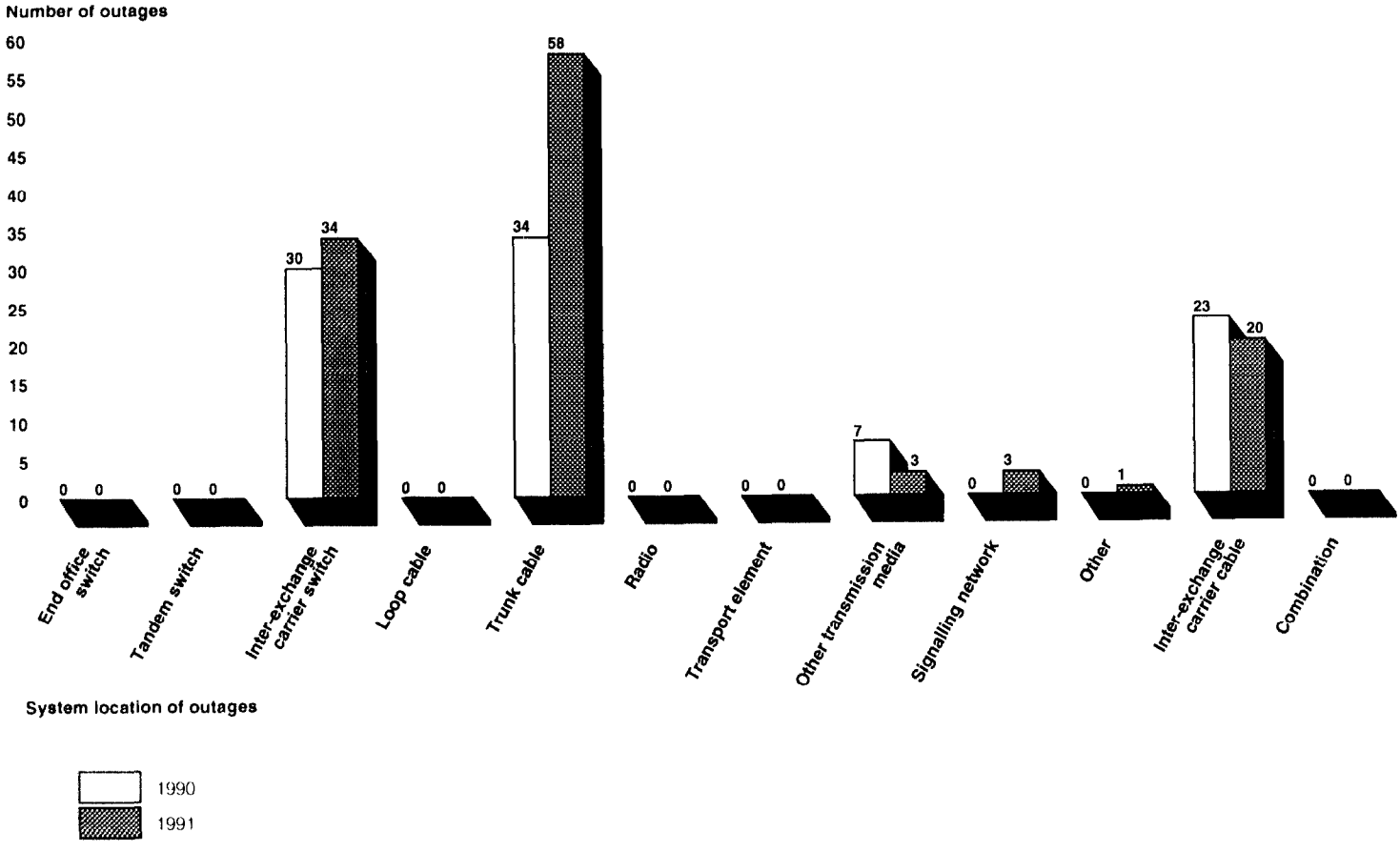


Figure 3.4: System Locations of Telephone Outages for Local and Long-Distance Companies by Customers Affected, CY 1990 and 1991

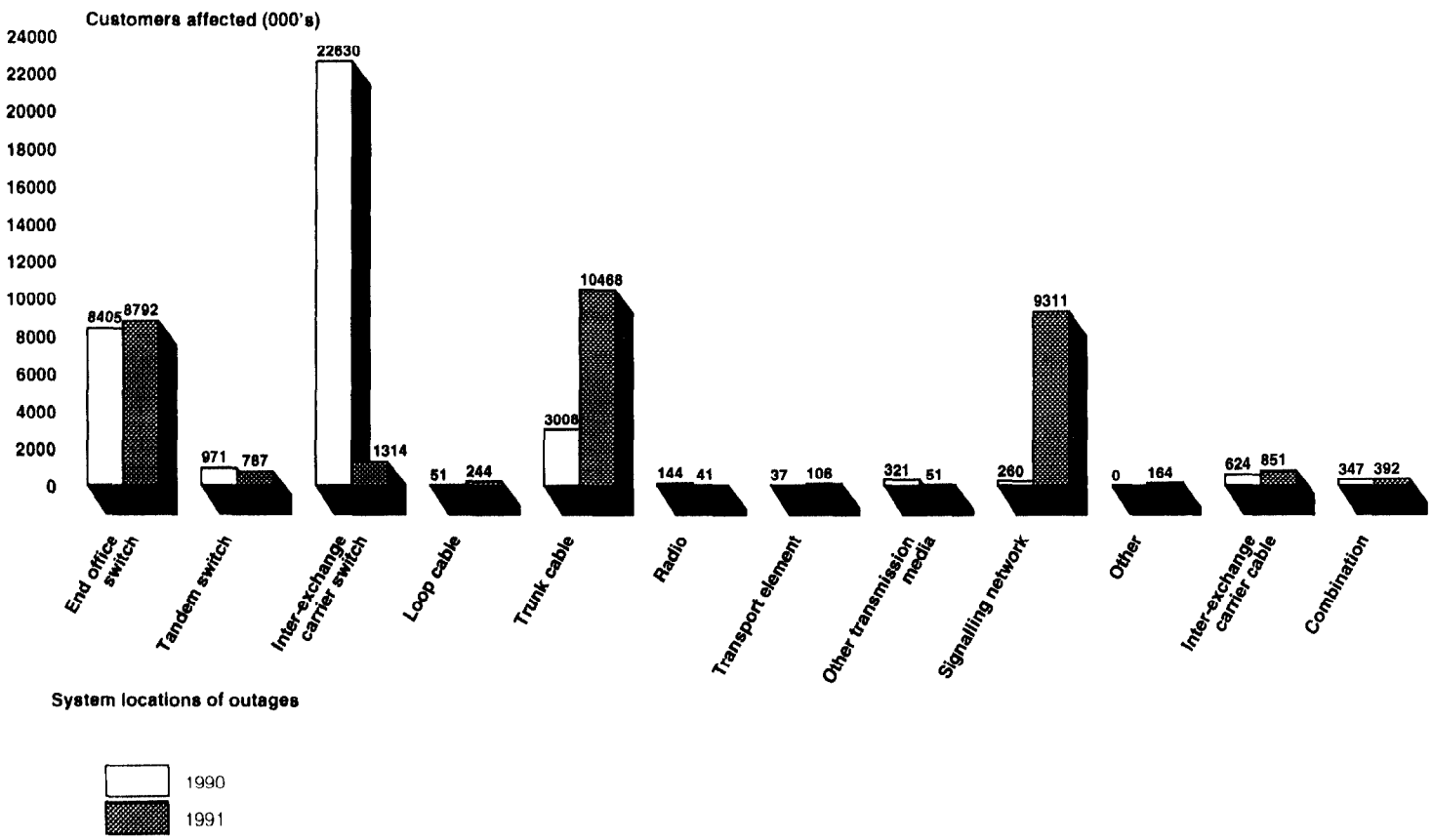


Figure 3.5: System Locations of Telephone Outages for Local Companies by Customers Affected, CY 1990 and 1991

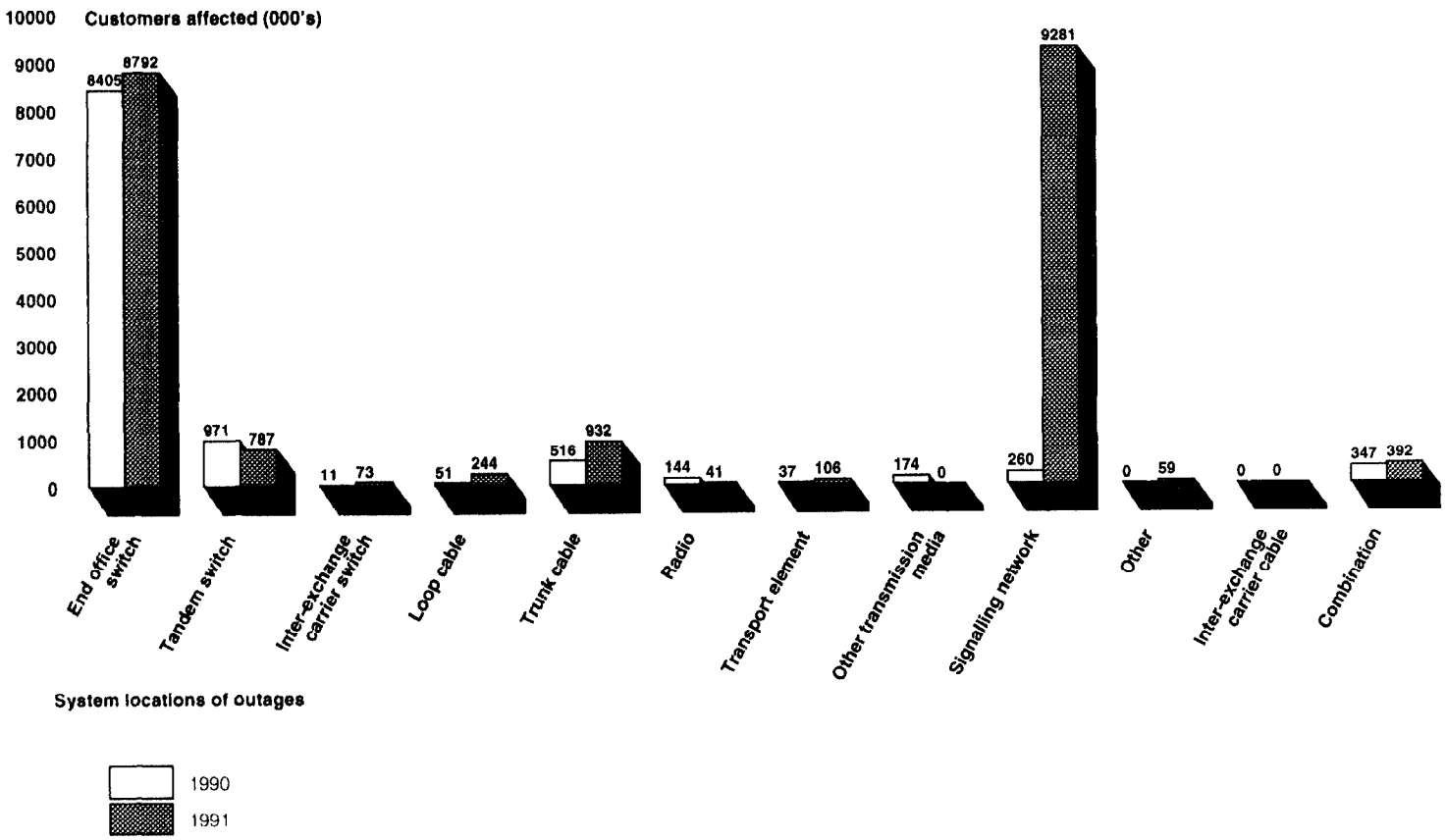
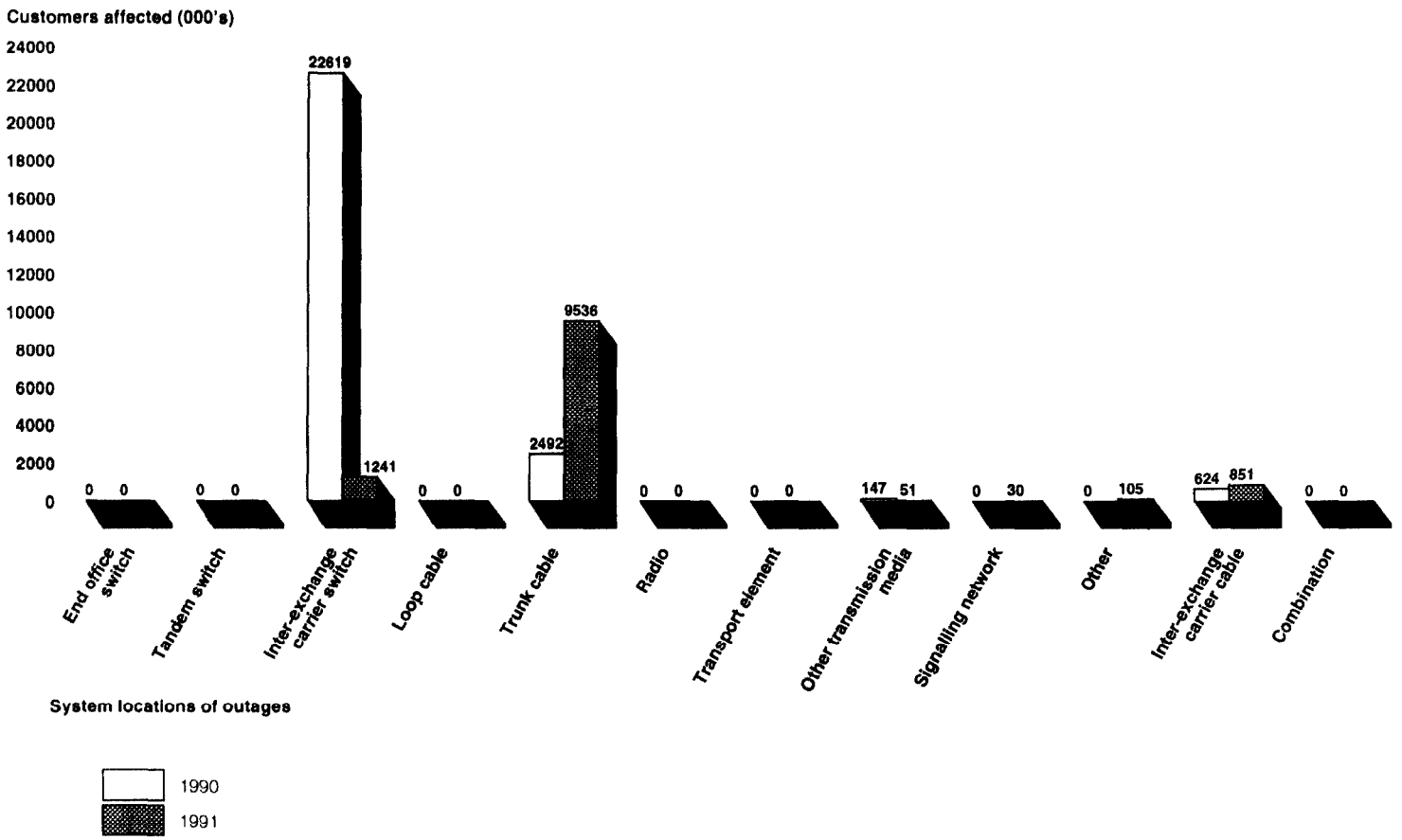


Figure 3.6: System Locations of Telephone Outages for Long-Distance Companies by Customers Affected, CY 1990 and 1991



Objectives, Scope, and Methodology

As requested, we determined the frequency and the causes of telephone outages that affected at least 10,000 customers and lasted 15 minutes or longer during calendar years 1990-1991. (The FCC uses a 50,000-customer/30-minute criteria.) As agreed with your staff, we used the 10,000-customer/15-minute criteria to collect more information on the extent of telephone service disruptions. To obtain the requested information, we met with officials from the FCC, outside experts, and officials from the telephone industry to develop a questionnaire on telephone outages.

In developing the questionnaire, we determined the system locations where outages could occur as well as the possible causes of outages by meeting with FCC officials, industry officials, and outside experts. Appendix II contains the questionnaire; appendix III contains definitions of the locations within a telephone network and a diagram depicting these locations. We obtained a list of possible reasons for telephone outages from the FCC (see the questionnaire in app. II). In meetings with telephone companies, all parties agreed that the list was understandable and reasonable.

In developing the questionnaire, we also had to determine the best way to compute the total number of customers affected by each outage. After several meetings with the FCC and telephone companies, it was agreed to equate the number of access lines affected by an outage at an end office switch or loop cable with the number of customers. Since access lines do not exist at other system locations, it was decided that another measure—Digital System Zero (DS-0) equivalents[1] —would best account for the number of customers inconvenienced.

We administered this questionnaire to major telephone companies responsible for 93 percent of local telephone access lines and 89 percent of the long-distance market. We received a 100-percent response rate from the companies in our survey. While we did not corroborate all their data, we did selectively verify that the major outages reported to the FCC during the survey period were also reported to us.

[1]According to an FCC engineer, DS-0 represents the base voice channel rate of 64 kilobits per second. This rate is used for a single voice grade circuit, commonly referred to as a voice grade equivalent.

Survey of Local and Long Distance Telephone Outages in 1990-1991

Introduction

At the request of the U.S. Congress, the General Accounting Office is collecting historical information on telephone outages. We need your help to identify the number and causes of these outages.

Your participation in this effort is critical for us to provide the Congress with the most complete and accurate information possible. Your responses will be summarized along with those of other telephone companies and will be available to the Congress.

Information Needed on Outages

For the purposes of our review, an *outage* is "a significant degradation in the ability of a user to establish and maintain a channel of communications as a result of failure in a carrier's network." Our use of "significant degradation" is intended to be consistent with FCC reporting requirements.

For each operating company under your control, please identify each outage that occurred from January 1, 1990 through December 31, 1991, in which service to at least 10,000 access lines (for end office switches and loop cables) or DS0 equivalents (for other outage locations) was significantly degraded for 15 minutes or longer. (Intermittent downtimes resulting from a single outage should be summed.)

For each outage you have identified, please answer the 8 questions on this survey form.

We would appreciate your response by May 15th so that we may provide timely information for Congressional needs. If you have any questions, feel free to call Anthony Carlo at 212-264-6472 or William Cronin at 518-452-4984.

Responses should be delivered to:

Mr. Anthony Carlo
U.S. General Accounting Office
441 G Street, N.W., Room 1826
Washington, D.C. 20548

Instructions for Responding

Please provide your responses *for each outage* in one of the following formats:

(1) One completed copy of this survey for each outage.

(2) A standard data file (ASCII) on a P.C. diskette, with one record for each outage. Please use the record layout suggested on Attachment B.

(3) A handwritten or typed table with responses for each outage on a separate line.

If you have any questions about the format for responding, please call Carolyn Boyce at 202-275-4950.

Thank you for your assistance.

Survey Questions

1. Which operating company had the outage? *(Enter identification code from Attachment A.)* (1-2)

   _____

2. When did the outage occur? *(Enter date and time of commencement of the outage.)* (3-12)

   ____/____/____ _____
   (month, day, year) (time—use military clock)

3. About how long did the outage last? That is, how much time elapsed from the commencement of the outage until restoration of full service? If outage was intermittent, sum actual downtimes. *(Enter number.)* (13-16)

   _____ minutes

4. Where was the outage primarily located? *(Check all that apply.)* (17-27)

Switches

1. ☐ End office (e.g., Class 5)
2. ☐ Tandem
3. ☐ Inter-Exchange Carrier (IXC)

Transmission media

4. ☐ Loop cable
5. ☐ Trunk cable
6. ☐ Radio
7. ☐ Transport element
8. ☐ Other (please footnote)

Other

9. ☐ Signalling facility or network
10. ☐ Other (please footnote)

5. In what state and county was the source of the outage (e.g., switch) located? *(Enter names.)* (28-44)

State: _____ County:_____

6. For about how many access lines (for end office switches and loop cables) or DS0 equivalents (for other outage locations) was service significantly degraded by the outage? *(Enter number.)*

_____ access lines (45-50)

_____ DS0 equivalents (51-56)

7. Was the outage scheduled or unscheduled? Scheduled downtime includes scheduled or planned manual initializations. This includes such activities as parameter loads, software/firmware changes, etc. *(Check one.)* (57)

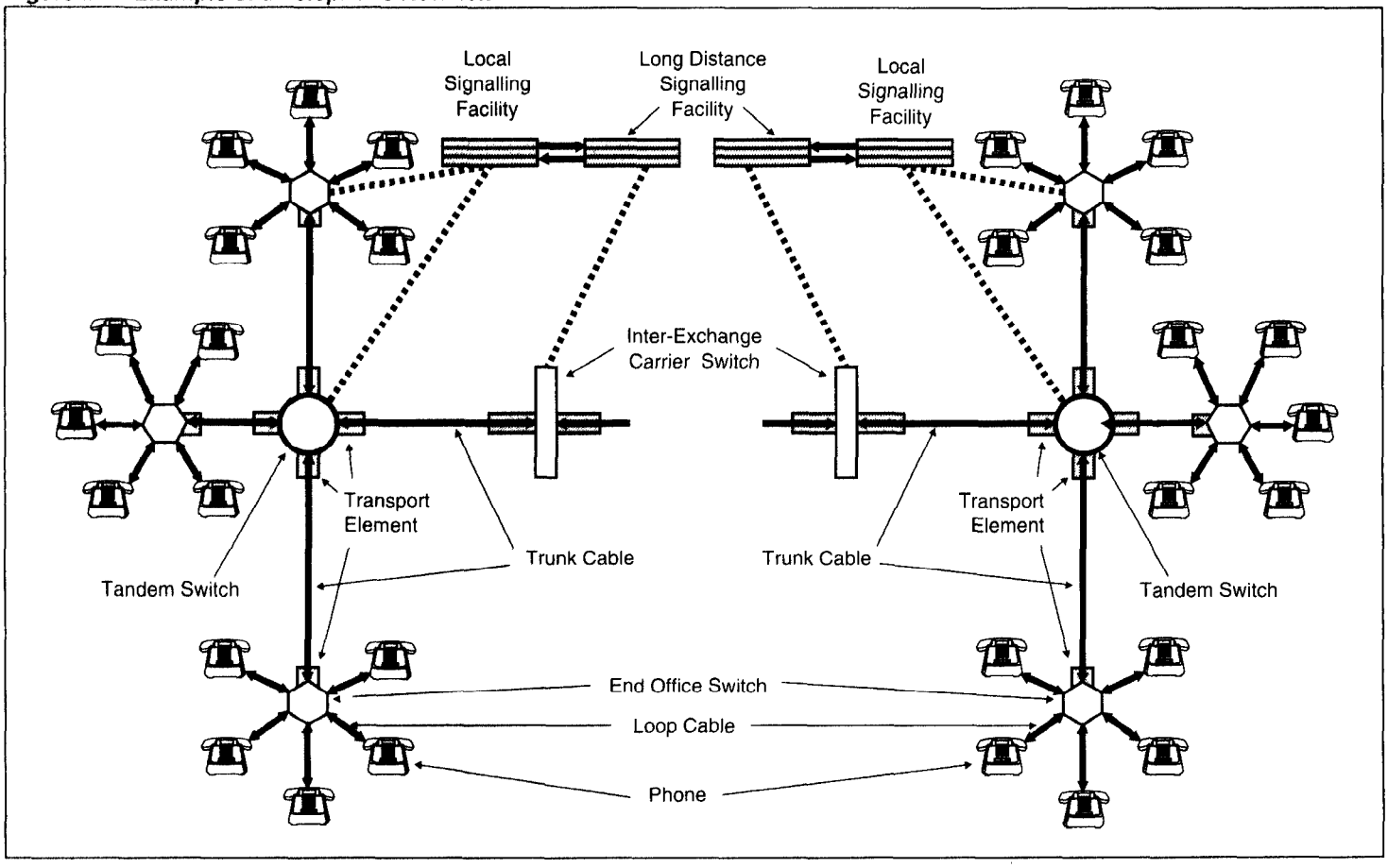
1. ☐ Scheduled
2. ☐ Unscheduled

8. Which of the following best describes the cause of the outage? *(Check all that apply.)* (58-74)

1. ☐ **Procedural Error of Telephone Company** (includes installation or maintenance related errors, deviations from established procedures, human errors within established procedures and failures to respond)
2. ☐ **Procedural Error of Vendor** (includes documentation and instruction errors; vendors include system and others, e.g., independent installation vendors, contractors, etc.)
3. ☐ **Software Design** (i.e., faulty or ineffective design, including faulty patches or software overrides provided by vendor)
4. ☐ **Hardware Design** (i.e., design deficiency or error; does not include product change notice —PCN— inappropriately delayed by vendor, which is a procedural error of vendor, or PCN inappropriately delayed or waived by phone company, which is their procedural error)
5. ☐ **Hardware Failure** (i.e., random hardware failure not related to design but due to inherent unreliability of system components)
6. ☐ **Acts of God** (e.g., natural disaster, weather such as lightning, but not if lightning's effect is due to bonding or grounding violations, which would be a procedural error)
7. ☐ **Environmental** (e.g., contamination, leaks, temperature, etc.)
8. ☐ **Traffic Overload** (i.e., traffic load exceeds engineered capacity of system due to unforeseen external condition; not if due to system trouble, inadequate engineering or network management or system design deficiency)
9. ☐ **External Power Failure** (loss of commercial power;does not include failures of converters, inverters internal to phone company)
10. ☐ **Cable Cuts** (from vandalism, construction, farming, etc.; not dig-up by phone company or vendor which is their procedural error)
11. ☐ **Remote** (Loss of facilities between host and remote if due to activities internal to host or remote; if external, assign other cause)
12. ☐ **Unknown Cause**
13. ☐ **Other Cause** (please specify)

Diagram and System Location Definitions of a Telephone Network

Figure III.1: Example of a Telephone Network



System Location Definitions of a Telephone Network

End Office Switch

A local central office switch that serves as the network entry point for telephones via loop cables. This local switch is sometimes known as a "Class-5 Switch."

Tandem Switch	A switch that connects one switch with another. For example, it connects an end office switch with another end office switch or an end office switch with a inter-exchange carrier switch.
Inter-Exchange Carrier Switch	A switch used by long-distance telephone companies for long-distance voice and nonvoice traffic between user locations.
Loop Cable	The cable that connects customers' telephones with the end office switch.
Trunk Cable	Trunk cables connect switches with other switches.
Radio	Transmission sent by radio waves in lieu of cable. Typically, this type of transmission is used in regions where cable is difficult to install, such as mountainous regions.
Transport Element	A transport element interfaces cables with switches and assists in the transmission of phone calls.
Signalling Facility	A part of a separate computer network that actually sets up the call (establishes a path). It enables telephone companies to anticipate whether a call will get through before it actually sends the transmission. In addition, signalling facilities enable telephone companies to perform special services such as call waiting and caller ID.

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