Chapter 8

Quality-of-Service Measurement and the Federal Communications Commission

Jonathan M. Kraushaar
FCC Common Carrier Bureau

INTRODUCTION AND OVERVIEW

Collection of quality-of-service data by regulatory agencies has historically been hampered by the difficulty in establishing uniform standards and data specifications and the cost and resources needed to collect and process the data. Allocation of resources by regulatory agencies to quality-of-service data collection has been further limited by the fact that quality-of-service data used internally by the companies is often part of a feedback mechanism within the companies and as such does not usually exhibit dramatic fluctuations requiring outside intervention. As a result of fairly stable quality-of-service levels, quality-of-service monitoring efforts at the federal level have been sporadic and are usually motivated by a significant service problem or are based on a well-defined broader objective. Significant local service problems in the late 1960s, particularly with dial-tone response, recent outage problems, and the institution of price cap regulation, have motivated the most significant regulatory responses.

This chapter describes a new quality-of-service monitoring program at the Federal Communications Commission (FCC). To place the current program into perspective one needs to consider the impact of technology and the new price cap regulatory mode now in place. The present quality-of-service monitoring program was born out of a concern that regulation under price caps might motivate the companies to place less emphasis on service quality in attempts to maximize profits. Because there was limited experience with this new form of regulation and because it was known that the companies had incentives to cut

costs there was a great deal of concern as to how this might affect the level of service quality of the local operating companies.

The second factor—technology—had a dual role. First, new technologies have resulted in a higher concentration of telephone traffic on a smaller number of facilities, and outages on those facilities, although infrequent, could be disastrous. This became apparent with the large AT&T switching-system failures and other significant switching failures in the operating areas of Bell Atlantic and Pacific Telesis during 1990 and 1991. Public concern had been aroused, and a clear need for regulatory intervention existed. The regulatory vehicle being established under price caps became an ideal vehicle to address these concerns at the local operating company level. The current quality-of-service monitoring program was thus initiated both to deal with broad policy objectives and to respond to specific service problems. The current effort has thus supported the work of the Network Reliability Council, which was set up to focus on reliability issues of both local and interexchange carriers.

Although technology resulted in new kinds of service quality issues, it also has provided the tools to respond more effectively. For one thing, technology has vastly reduced the cost of the data collection and analysis process. The task of reducing all the data supplied by the companies into a summary format at the FCC, for example, was accomplished by a far smaller number of personnel than would have been required prior to the age of the personal computer. Beyond this, the availability of new means to make the source data available to the public using electronic bulletin board software and personal computer technology has added a new dimension to carrier data filings that may have far-reaching implications for the regulatory process. In short, public accountability of the companies through publicly available mechanized data has not heretofore been possible. The impact of such new approaches will become apparent in the years to come.

With this backdrop, this chapter presents an initial assessment of new quality-of-service data filed with the FCC by local telephone companies. It presents an overview of the quality-of-service information now available. The source data are summarized in greater detail in an FCC report released in February 1993.[1] Due to the newness of the data and the need to establish a baseline period for evaluating any future trends, this chapter concentrates on the characteristics of the data rather than on a detailed analysis of its implications.

HISTORICAL BACKGROUND

At the end of 1983, in conjunction with AT&T's divestiture of its local operating companies, the Commission directed the Common Carrier Bureau to establish a monitoring program that would provide a basis for detecting any adverse trends in service quality. During 1985, the quality-of-service submission requirements were modified to reduce unnecessary paperwork and to ensure that the information

needed by the Commission would be provided, where possible, in a more uniform format. The data were received semiannually, typically in March and August, and were the basis for FCC summary reports in June 1990 and July 1991.

With the implementation of price caps for local exchange carriers, several major changes were made beginning with reports filed in 1991. First, whereas quality-of-service reports had been received only from Bell operating companies, other companies subject to price caps were also required to submit reports on service quality. Thus, the operating companies owned by GTE, Contel, and United began to file reports. Second, quality-of-service reports were included as part of the Commission's Automated Reporting and Management Information System (ARMIS).[2] This system resulted initially from the Commission's revisions to its Uniform System of Accounts and was designed to allow financial records to be tracked for regulatory purposes in a mechanized format. The system has since been augmented to include information on telephone plant statistics associated with the local operating company infrastructure and the information on quality of service discussed here. Third, there was a considerable change in the data reported—with some items being deleted and new items added. For example, public concern over switching outages has been addressed by the program developed for price caps, and data associated with switching outages are presented in this chapter.

The data items now being monitored at the FCC resulted from a negotiation process between FCC staff and company representatives in a series of meetings hosted by the United States Telephone Association (USTA). The process assisted the companies in responding to the Commission price cap requirements in a manner that would minimize their cost by providing an opportunity to establish a common base of data already collected by the companies. In general, the collected data reflected already existing, company data collection processes, and the primary new requirement was to assemble the data in a single quarterly report on a state-by-state basis. This process has been greatly facilitated by modern computer software and hardware.

DATA CONTENT AND AVAILABILITY

As indicated earlier, the data being collected fulfill two roles. First, it addresses concerns associated with the price cap regulatory process. Second, it addresses public concern about switching outages that have become a more significant problem with larger switches and a more interconnected switching control network.

The raw quality-of-service data used in the preparation of this chapter is received by the Commission in what is called the ARMIS 43-05 filings, which are grouped into sections that are referred to as *tables*. The content and structure of this data is shown in Appendix A. Data items included in the Commission

report are shown in Appendix B. Summarization of the data itself is included in Appendix C. The source data along with relevant Commission reports are available to the public on an electronic bulletin board system. The bulletin board is available 24 hours a day including weekends; however, between the hours of 8 A.M. and 1:30 P.M. usage is restricted to regulatory and governmental agencies. Each user is allotted at least 30 min daily after filling out a simple registration questionnaire.

The bulletin board operates from a standard personal computer at the Federal Communications Commission, equipped as of this writing with a 14,400-baud modem. Most of the bulletin board files are available only in a compressed format to reduce the time necessary to transmit the data, to reduce computer storage requirements, and to allow related files to be grouped into single compressed files. A special file that can be downloaded is available to decompress the files. Most files are limited in size so that any file on the board can be downloaded using a 2400-baud modem in the allotted 30-min session. Download time at the 2400-baud data rate is approximately 10 kilobytes per minute. The compressed quality-of-service files described in Appendix A and referred to as the ARMIS 43-05 reports contain the raw data from which this chapter was prepared and range in size from a few thousand bytes for companies operating in a few states to sizes somewhat exceeding 80 kilobytes for companies operating in numerous states or study areas. There is a separate file within each compressed file for each state or portion of a state, which is sometimes referred to as a study area.

When decompressed the raw data files for each study area range in size between 10 and 20 kilobytes or typically about 15,000 characters. The raw data files are in ASCII or text format but do not contain the data labels and headings necessary to identify each data item. Therefore, a special spreadsheet "template" file that can also be downloaded from the bulletin board along with the data is made available to view the data in tabular format with appropriate headings and data labels. More detail on the use of the board and the special files for decompressing and viewing the data offline are contained in information appearing on the board with each access. Instructions on the use of the board are available for downloading in another special file. Instructions can also be viewed online by examining selected bulletins. Broad public access by electronic means will provide greater public accountability to the process and should assist the regulatory process under price caps.[3]

DATA OVERVIEW AND OBSERVATIONS

Most quality-of-service data now being reported to the Commission appears in the ARMIS 43-05 report, which is filed quarterly. The ranges of selected data items associated with or calculated from these filings are graphically summarized in Figs. 8.1–8.6. These graphs were chosen to highlight the categories of data being received in connection with the ARMIS 43-05 report and to illustrate data

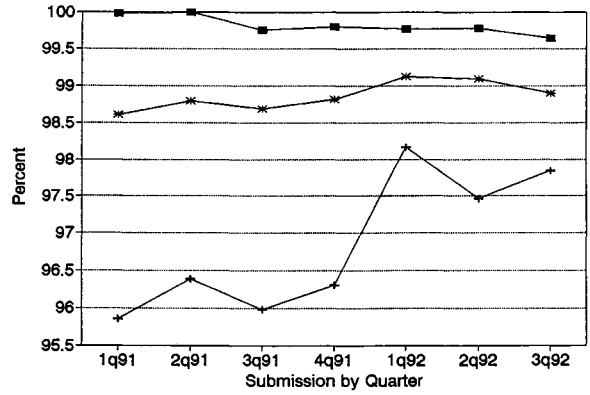

FIG. 8.1. Percentage of installation commitments met (maximum, minimum, and average reported).

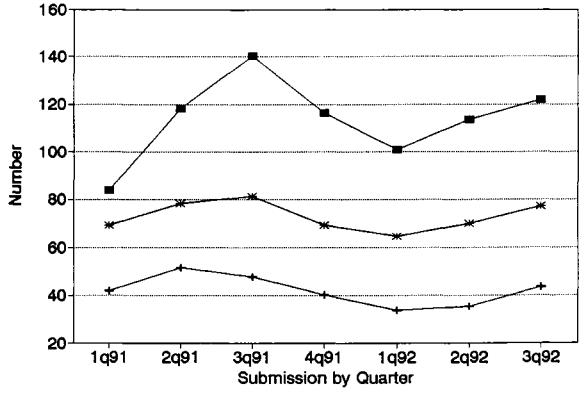

FIG. 8.2. Total trouble reports per thousand lines (maximum, minimum, and average reported).

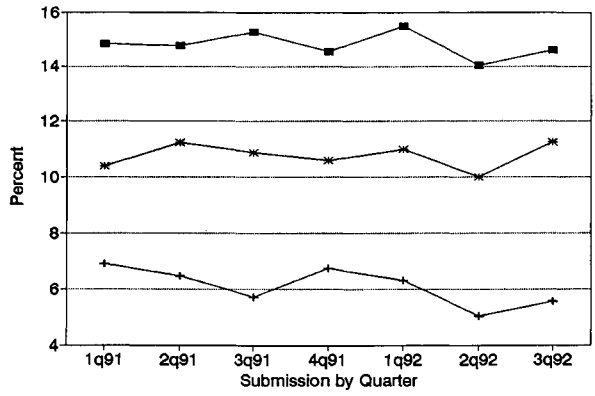

FIG. 8.3. Repeat troubles as percentage of total (maximum, minimum, and average reported).

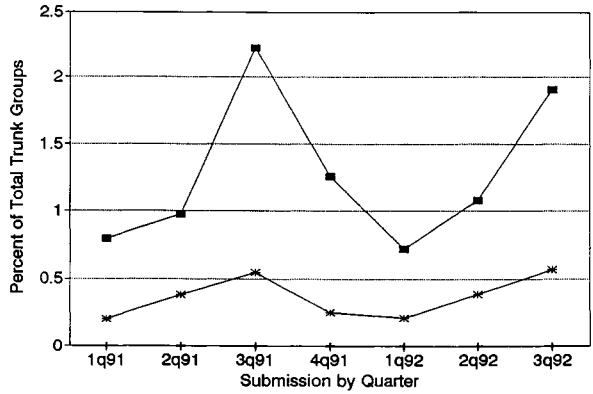

FIG. 8.4. Percentage of trunk groups over 3-month objective (maximum, minimum, and average reported).

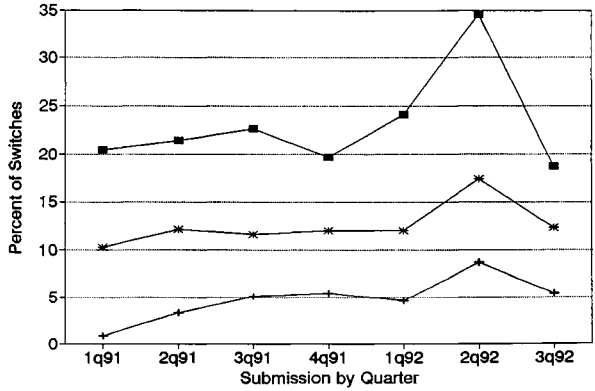

FIG. 8.5. Percentage of switches with outages (maximum, minimum, and average reported).

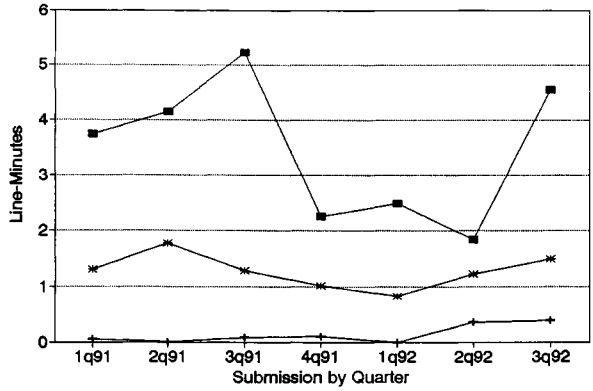

FIG. 8.6. Outage line minutes per access line (maximum, minimum, and average reported).

variability and other features of the data. The graphs include data for each major holding company (the seven Regional Bell holding companies, GTE, Contel, and the United Companies) and reflect weighted averages across individual states or study areas, along with maximums and minimums from the filed data. This type of presentation is useful in assessing the quality of the reported data and in evaluating overall trends. Given the newness of the reporting system and the sheer magnitude of the reports, there appear to be data errors, particularly in the earlier quarters. Data variability from this and other causes is demonstrated in Figs. 8.1–8.6.

The items collected by the Commission generally were selected from data sources already available within the companies and are designed to cover the major areas of quality of service affecting customers. Some items such as bit error rates on digital facilities were not included because of a lack of uniform measurements and the fact that all of the companies have not yet developed standard measurement processes.[4] Some of the items that were chosen are collected in different formats by the state regulatory commissions. Because preexisting data sources were used typically, the costs imposed on the companies consisted largely of the costs of assembling and preparing the data in a prescribed common format.

Much of the data now received, particularly the data associated with switching outages, have not been indexed or keyed to an internal company objective level. These data therefore reflect directly measured quantities. Indexed measurements or measurements tied to internal company standards are harder to standardize across companies because even if they use the same measures, the objective level on which an index is based may differ. Because indexing is used as part of well-established internal company feedback processes, index data typically exhibit small fluctuations around a well-established underlying level. Recognition of this fact and a desire to examine data closer to the measurement source led to several new data sources that were not affected by company indexing.

The overall approach was to establish a menu of quality-of-service measurements rather than trying to reduce the environment to a very small number of measurements that would tend to bias the measurements in accordance with some form of preconceived weighting scheme. The menu approach incorporating a larger number of data items is becoming more feasible because of new data processing tools and because the process was largely directed at data sources already in existence within the companies. Organization of the data along the lines of regulatory interest provides an opportunity to examine traditional areas of quality measurement from a fresh perspective utilizing a menu of data items that are available from a larger number of entities than ever before. In addition, new areas of interest relating to switching outages have been addressed.

The graphs in Figs. 8.1–8.6 highlight several normalized measurements that are of interest in a variety of areas relating to current quality-of-service measurements. Trouble reports, for example, are widely used by state regulatory agencies. Other measurements of interest depend on the perspective of the user. For example, reliability issues are addressed by the statistics such as the outage line-

minutes and percentage of switches with outages that provide a measure of the impact and frequency of outages. These statistics support the work of the Network Reliability Council. The graphs illustrate the maximum, minimum, and average value associated with the filed data. Differences in trended patterns between the maximum and minimum value reported can be used to characterize the data. Typically, the maximum and/or minimum values exhibit greater variability because they characterize data outliers. This is particularly evident in the chart depicting outage line-minute data. One should also note the apparent effect of efforts to deal with problems with the data in the latest quarters shown. This is most evident in the chart depicting the percentage of installation commitments met in which the minimum value has risen sharply from the early quarters.

Rather than presenting any definitive conclusions, the aggregation and summarization of data presented here is designed to facilitate further analysis of the quality of reported data and an assessment of the program currently in place. Data summarization should enable both the Commission and the companies to improve the massive ARMIS data collection and evaluation process. Although many obvious problems have been identified and corrected, the data are subject to future updating, which hopefully will correct errors identified by this process.

One important problem relating to quality-of-service measurement in general is the continuity of measurement. Although data continuity is an important consideration, detection of errors and changes in reporting requirements that are deemed necessary may inevitably introduce discontinuities into certain data series or may eliminate those data series entirely. It is also important to note that because quality monitoring programs impose costs on the companies, historically, the data collection efforts have been vulnerable when they are perceived as outliving their usefulness. In addition, changes in technology have led to changes in the nature of the measurements required to adequately monitor service quality. Finally, the companies themselves periodically wish to change their internal measurement procedures, affecting what is reported and increasing the difficulty of long-term measurement comparisons. These factors tend to limit the number of years of data available for tracking service-quality trends. Because the present program is an offshoot of an earlier more limited one, an attempt was made to relate measurements of the two programs. Of the five areas of measurement during the period 1985–1990, only two have survived in a form that allows a longer term trend to be established: customer perception of quality-of-service levels as surveyed by the companies, and dial-tone delay. These are illustrated in Tables 8.1–8.4 in Appendix C. These items provide a very limited view of long-term trends and reflect a possible data discontinuity beginning with the new series due to known changes in the customer perception surveys and in the way the data have been developed. As presented, these data show no obvious adverse trend over the period.

Although it is premature to draw any conclusions about data trends since 1991 with only seven quarters of data, several observations can be made (some of which

are summarized in the following paragraphs). It should be clearly understood, however, that at this point these observations remain tentative because the reliability of the reported data is subject to further review. Because of the relatively short time span and limited number of data points, the observations discussed here focus primarily on the typical ranges for some of the composite levels reported over the time period covered by the seven ARMIS 43-05 data measurements included in this report. This should provide some feel for the typical levels of the reported items and should assist in further understanding of the data. Many of the ranges presented here are illustrated graphically in Figs. 8.1–8.6.

The first data to consider are the number of trouble reports per thousand access lines. Nationwide, companies have typically experienced approximately 40 to 80 trouble reports per thousand access lines. The rate for residential lines is nearly twice the rate for businesses. Repeat occurrences tend to range between 5% and 15% of total trouble reports, with businesses experiencing what appears to be a slightly higher rate for repeat trouble reports than residences.

The data on switch outages indicate that nationwide, in a typical 3-month period, about 1,500 to 2,500 switching machines, representing roughly 10% to 15% of the total switches, tend to experience outages. Most of these outages last less than 2 min. The line-minutes per access line parameter was developed to compare the impact of outages lasting more than 2 min. The number of lines involved in each outage is multiplied by the outage duration and is summed over all occurrences and then is divided by the number of access lines. For example, a value of 9,000 line-minutes would be produced if a total of 9,000 lines were out of service for 1 min or if 900 lines were out of service for 10 min. The data collected thus far indicate that there have been up to 1.5 line-minutes per access line during a representative quarter. Unscheduled outage line-minutes tend to be significantly higher than the level of scheduled outage line-minutes. In addition, isolated outage levels of more than 2 line-minutes per access line have been noted in the data.

From the data one can see that installations not provided by a commitment date typically are completed up to 7 days later. However, fewer than 2% of all installations tend to be in this category. For repair of access service calls, the companies tend to respond within 5 hours for switched-access services and within 6 hours for special-access services. Response times in the 1- to 3-hour range appear frequently in the data. Data for customer complaints to regulatory agencies tend to vary widely by company. Residential complaints appear to be higher than business complaints. Finally, less than about 0.5% of the trunk groups tend to exceed the blocking objectives for the 3-month measurement period.

DATA QUALIFICATIONS AND NOTES

Although the new quality-of-service data that are being reported in the ARMIS 43-05 filings resolve many of the data concerns summarized in earlier quality-of-service reports and represent an improvement of the reporting requirements, users of these data should be aware of several pitfalls.

First, and most important, one should be aware that these data are very new. Although many problems with the data have already been identified and corrected through the many correction filings by the carriers, there are still potential flaws in the data that will only become apparent when users subject the data to further analysis or compare it to other sources. The process by which the data are checked should improve over time as the Commission and the companies progress over a normal learning curve. Although the data have been subject to an initial screening by the Commission, a number of data flaws that have not yet been corrected have been made evident by preparation of the data in this form. Holding company totals or composites and in some cases trended data items have been calculated in a consistent manner from the filed data. Some of these data items may not necessarily match company filed totals or composites. This is primarily due to different weighting methods. In addition, the carriers have updated their earlier filings numerous times. The data presented here reflect the latest updates filed with the Industry Analysis Division as of January 1993. The reader should therefore be aware that it is possible that some of the problems evident in the data presented here have already been corrected. Other problems may lead to changes in the reporting requirements themselves.

Second, although much thought has gone into the definitions of the data items, some erroneous or omitted responses have been identified. In a few instances data from subsequent quarters may reflect the correction or omission. Some of the errors may be in the process of being corrected or may not be evident until one performs further analysis with the data. Suspect data have therefore not generally been deleted or adjusted. The process of data correction should follow a normal learning curve and be resolved over time as such problems are identified and corrected. Many of the errors have been corrected by updated filings. Some of the errors have resulted from an improper reading of the instructions or a misunderstanding in the data definitions, which were worded to provide for a level of standardization without requiring costly changes to existing measurement and data collection procedures. For example, many of the companies appear to have interpreted initial trouble reports as including repeat trouble reports, even though separate categories were provided for initial and repeat trouble reports.[5]

Third, although the Commission has attempted to standardize the data requirements, one should not be lulled into the assumption that comparable data items for different companies are exactly the same. Different companies may have different procedures for collecting and presenting the data, which may affect the quality and meaning of the data provided to the Commission. Earlier quality summary reports have cautioned against direct comparisons between companies and have suggested that comparisons should be made on the basis of trends, particularly when there is little standardization in data measurement and collection procedures or when the reported data are already indexed. The current program represents a greater level of data standardization than the previous one

and contains a larger number of items that are not indexed. Nonetheless, variations in the way data was collected and assembled or in the way the definitions were interpreted would tend to make comparisons of company data on the basis of trends more meaningful than single-quarter comparisons.

Finally, one should be cautious in responding too quickly to glitches or apparent sudden changes in the data, especially before getting a sense of the data. Reliability data are expected to be somewhat more erratic than the other data items. Even here, longer term patterns may be identifiable, which could assist the companies in gaining a better insight into any identified problems. Such insights should lead to more cost-effective solutions. Although the fact that the data are now being collected on a quarterly basis which permits observation of problems sooner, it also may lead an observer to draw conclusions prematurely. For example, data errors or company responses that require more than one quarter to be implemented may result in apparent abnormalities, which in fact are normal occurrences. As more experience is gained in looking at the data, one should eventually be able to recognize anomalies from normal seasonal patterns and other patterns in the data reflecting the companies' normal response in maintaining adequate service to customers. As noted in earlier quality reports, one should continue to view the data in the context of trend analysis and consider internal company response times in dealing with problems. More experience with trended data will provide a greater understanding of the subtleties inherent in the data and may eventually suggest the applicability of certain benchmarking techniques to some of the measurements.

The data items presented in this chapter are available on a study-area basis, usually on a state or a portion of a state. Further analysis supplemented with data from state regulatory commissions may be needed to address the existence of localized problems.

CONCLUSIONS

The monitoring program described in this chapter embodies several new ideas in quality-of-service monitoring, largely made possible by today's computer technology. First, rather than combining the measurements using some kind of weighting factor, the approach has been to develop a menu of items that would provide a means to gain a better understanding of service quality trends. Second, for the first time the data are available to the public in machine-readable form using electronic bulletin board technology. Third, there are extensive new data available on switching outages. It is hoped that data on small or brief outages, which are more frequent than major ones, will provide insight into the causes and most cost-effective remedies for handling the larger outages.

The current effort was designed to detect adverse quality-of-service trends under price caps and to gain a better understanding of switching outages. An

understanding of the measurements and their role both by regulatory agencies and the public will contribute to the success of the approaches described here; however, the success of the program may in fact be measured by the lack of any unusual or adverse trends because it is hoped that the program itself will motivate the companies to more carefully scrutinize their quality of service. The experience gained through the current program will contribute to the future of such approaches. Finally, it should be understood that the future of the current quality-of-service program will be tied closely to the future of price cap regulation, which provided one of the key motivations for the program discussed here.

APPENDIX A: RAW DATA RECEIVED BY THE COMMISSION

The data items included in the raw ARMIS submissions by the companies are described next. These data are available in machine-readable form on the electronic bulletin board system described earlier.

A.1 Table 1

This group of data covers interexchange-switched, high-speed special, and all special-access services. Data items include:

1. Total Number of Orders or Circuits: Total installation orders or circuits for the reporting period.
2. Percentage of Commitments Met: Percentage of total installation orders met by the commitment date.
3. Average Missed Commitment in days: Average interval in calendar days between the commitment date and the day of service for all commitments not met during the reporting period.
4. Total Trouble Reports: Total number of circuit-specific trouble reports during the current reporting period.
5. Average Repair Interval: Average interval in hours to the nearest tenth from the time of the reporting carrier's receipt of the trouble report to the time of acceptance by the complaining interexchange carrier or customer.

A.2 Table 2

This group of data covers local service installations for residence and business customers subcategorized by the MSA (Metropolitan Statistical Area or area including at least one city with a population of 50,000 or an urbanized area of a population of 50,000 in an area of at least 100,000 population) and non-MSA. Data items include:

1. Installation Orders: Local Service orders or circuits.
2. Percentage of Commitments Met: Percentage of service orders completed by the commitment date.
3. Average Missed Commitment: Average interval in days from commitment date to provision of service.
4. Total Access Lines: All classifications of local-access lines including individual lines, party lines, PBX and Centrex access, coin access, foreign exchange, and WATS access.
5. Initial Trouble Reports: Complaints concerning service quality made by customers or users to local exchange carrier.
6. Repeat Trouble Reports: Trouble reports remaining unresolved within 30 days of the initial trouble report.
7. No Trouble Found: Trouble report investigation finding no discernible problem.

A.3 Table 3

These data report trunk-group blockage that prevents call completion. Data items include:

1. Total Trunk Groups: Total common trunk groups between local exchange carrier end-office and access tandem-carrying feature group B, C, or D or access traffic for which the reporting carrier is responsible.

2. Groups Measured: Common trunk groups measured during current reporting period.

3. Groups Exceeding Servicing Threshold for 3 Months: Number of common trunk groups exceeding access-tariff-measured blocking threshold (usually 2% for equal-access and 3% for non-equal-access trunks) for 3 or more consecutive months.

4. Groups Exceeding Servicing Threshold for 1 Month: Number of common trunks exceeding access-tariff-measured blocking threshold for current month.

5. Groups Exceeding Design Blocking Objectives for 3 Months: Common trunk groups exceeding equipment design blocking objectives (.5% to 1% during time-consistent busy hour of busy season) for 3 or more consecutive months.

A.4 Table 4

These data report Total Switch Downtime which includes the time when the call-processing capability for an end-office is lost, the number of incidents of less than 2 min duration, the number of switches experiencing downtime, and the number and percentage of incidents of less than 2 min duration that are not scheduled. The data are reported in the following categories:

1. Categorized by MSA and non-MSA.
2. Categorized by Switch Size: Under 1,000 lines, 1,000 to 4,999 lines, 5,000 to 9,999 lines, 10,000 to 19,999 lines, and over 20,000 lines.

Table 4a reports itemized occurrences of more than 2-min duration downtime and includes the following:

1. Explanation: Cause of downtime or scheduled or unscheduled.
2. Switch Identification: CLLI or commn language identification of switch.
3. Access Lines: Access lines served by switches and affected.
4. MSA: Y if in MSA, n if not in MSA.
5. Duration: Duration of outage in minutes to nearest tenth.

A.5 Table 5

This table reports data on Service Quality Complaints that are made to federal or state regulatory agencies categorized by MSA, non-MSA, and the total for both categories. It includes the following:

1. Business access lines in thousands.
2. Federal complaints—business users.
3. State complaints—business users.
4. Residential access lines in thousands.
5. Federal complaints—residential users.
6. State complaints—residential users.

APPENDIX B: DATA COMPONENTS INCLUDED IN THE FCC REPORT

The data summarized in the Commission report released on February 26, 1993, reflects the current emphasis on data that are closer to the measurement source. For example, rather than simply collecting data on the percentage of installations made by a commitment date, the report also reflects the number of days the company missed its commitment. These data have been derived from individual study-area data submitted by the companies by adding the numerical quantities and appropriately weighting the percentage figures. For example, the percentage of commitments met is weighted by the corresponding number of orders provided in the filed data. The summarized items included in the Commission report are as follows:

1. *Percentage of installation commitments met:* This data item provides the percentage of installations that were met by the date promised by the company

to the customer. It is shown separately for residential and business customers' local service and separately for access services provided to carriers.

2. *Average missed installation in days:* This is the average number of days beyond the commitment date that the missed installations were late. It is shown separately for access services provided to carriers and for residential and business customers' local service.

3. *Average repair interval:* This data item is the average time (in hours) for the company to repair access lines and includes subcategories for switched-access, high-speed special-access, and all special-access services. Only data for switched and special-access services provided to carriers are shown.

4. *Trouble reports per thousand access lines:* This data item is calculated as 1,000 times the sum of what was reported as "initial trouble reports" and "repeat trouble reports" divided by the number of access lines. (See endnote 5 in the text.) This item is subcategorized by MSA, non-MSA, Residence, and Business.

5. *Troubles found per thousand access lines:* This data item is calculated as described in item 4 and represents the number of trouble reports in which the company identified a problem.

6. *Repeat trouble as a percentage of trouble reports:* This data item is calculated as the number of repeat trouble reports divided by the total number of trouble reports as determined earlier. It provides a measure of the effectiveness of the company in resolving troubles at the outset. This item is subcategorized by MSA, non-MSA, Residence, and Business.

7. *Complaints per million access lines:* These data items provide the number of residential and business customer complaints per million access lines conveyed to state or federal regulatory bodies during the reporting period.

8. *Number of access lines, trunk groups and switches:* These data items provide the underlying counts of access lines in thousands, trunk groups, and switches.

9. *Switches with downtime:* This data item provides the number of switches experiencing downtime and the percentage of the total number of network switches experiencing downtime.

10. *Average switch downtime in sec per switch:* Total switch downtime divided by the total number of company switches indicates the average switch downtime in seconds per switch. It is shown for all occurrences and for occurrences greater than 2 min.

11. *Unscheduled downtime over 2 min per occurrence:* These data items provide the number of occurrences of more than 2-min duration that were unscheduled, the number of occurrences per million access lines, the average number of minutes per occurrence, the average number of lines affected per occurrence, the average number of line-minutes per occurrence in thousands, and the outage line-minutes per access line. For each outage, the number of lines affected was multiplied by the duration of the outage to provide the "line-minutes" of outage. The resulting sum of these represents the total outage line-minutes. This number

was divided by the total number of access lines to provide the line-minutes per access line and by the number of occurrences to provide the line-minutes per occurrence. This categorizes the normalized magnitude of the outage in two ways and provides a more realistic means to compare the impact of such outages between companies. A separate table is provided for each company showing the number of outages and outage line-minutes by cause.

12. *Scheduled downtime over 2 min per occurrence:* This item is identical to item 11, except it consists of scheduled occurrences rather than unscheduled occurrences.

13. *Trunk groups with blocking over 3-month objective as a percentage of total trunk groups:* This data item provides the percentage of trunk groups exceeding the objective for blocking for 3 consecutive months.

APPENDIX C: DATA SUMMARIZED IN THE FCC REPORT

Tables 8.1 through 8.4, included in this Appendix, summarize data received since 1985. Table 8.5 is an example of the data presented in the recent quality-of-service summary issued by the Commission. A similar presentation for the Bell operating companies, the GTE companies, the CONTEL companies, and the UNITED companies is presented in the Commission report. Data on dial-tone response filed since 1985 now appear in the ARMIS 43-06 filing. Paper copies of the customer perception survey data are still filed, but these data are not contained in the mechanized ARMIS reporting formats.

The impact of new technology is reducing the significance of some of the measurements filed since 1985. For example, the dial-tone delay measurement is becoming less useful with the increasing number of digital switches, in which service is unlikely to be affected by slowed dial-tone response.

The all-company composites shown in Tables 8.1 through 8.4 are calculated in a manner consistent with earlier reports as the unweighted average of the available data compiled for the individual Bell Holding Companies. One should note that data for 1991 and 1992 may differ from the earlier part of the series. Such discontinuity is due to changes in reporting procedures. Bell Atlantic has reported changes to its customer perception surveys, which are being reflected in post-1990 data and may have resulted in data discontinuities. Other companies, including NYNEX and Pacific Telesis, have indicated that they have made or are planning similar changes.

Tables 8.1 through 8.3 cover customer satisfaction surveys performed by the companies. Table 8.4 shows the percentage of offices providing less than a 3-sec dial-tone delay. Transmission quality data have not been included in this report as they do not cover transmission quality on the increasing number of digital transmission facilities that presently comprise over 95% of the interoffice facility

TABLE 8.1
Percentage of Customers Satisfied—Residential

Company	1985	1986		1987		1988		1989		1990		1991		1992
		1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H
AMERITECH	92.8	94.8	94.0	94.7	94.1	95.0	94.2	94.8	93.6	94.4	94.3	95.3	94.9	95.4
BELL ATLANTIC	92.4	93.4	93.0	94.4	90.2	92.3	92.1	91.8	93.3	94.6	93.9	95.6	95.7	94.9
BELLSOUTH	92.0	92.8	92.8	94.2	94.0	93.9	93.6	94.1	93.2	94.9	94.9	95.5	NA	92.7
NYNEX	93.7	93.5	92.9	93.6	93.6	94.5	94.0	94.2	94.1	92.8	93.7	94.7	93.6	92.6
PACIFIC TELESIS	94.1	93.0	94.4	95.6	96.1	95.8	95.7	96.9	96.0	96.5	95.5	96.7	96.7	95.5
SOUTHWESTERN	97.6	97.6	95.5	96.1	95.8	96.3	96.3	96.5	96.4	96.8	96.6	96.8	96.5	96.6
U S WEST	91.9	92.7	92.4	93.3	94.1	93.3	93.3	92.1	91.4	91.8	91.2	93.6	93.1	92.4
COMPOSITE	93.5	94.0	93.6	94.5	94.0	94.4	94.2	94.3	94.0	94.5	94.3	95.5	95.1	94.3

Note. Holding company data in this table are derived as an unweighted average of available operating company results. Composites are unweighted averages of holding companies. Please refer to text for accompanying notes and data qualifications.[1]

TABLE 8.2
Percentage of Customers Satisfied—Small Business

Company	1985	1986		1987		1988		1989		1990		1991		1992
		1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H
AMERITECH	90.6	93.8	93.8	94.4	94.4	94.6	93.9	94.6	94.0	94.6	94.9	95.7	95.4	95.8
BELL ATLANTIC	89.9	91.9	91.7	93.3	90.7	92.3	92.0	NA	NA	NA	NA	94.9	95.1	93.8
BELLSOUTH	92.0	93.3	93.3	94.5	94.5	95.0	94.8	94.7	94.7	95.2	95.7	94.9	NA	94.5
NYNEX	91.6	91.6	91.2	92.3	92.2	93.9	93.4	93.7	93.5	91.9	92.7	93.9	92.9	92.2
PACIFIC TELESIS	94.2	91.7	93.4	94.5	94.0	93.9	94.1	95.6	95.3	95.9	94.9	96.1	96.1	94.0
SOUTHWESTERN	97.1	97.0	94.6	95.0	95.0	95.8	95.6	95.8	95.5	95.9	95.7	96.4	96.2	96.4
U S WEST	89.4	91.1	91.1	92.1	93.5	92.6	92.4	90.4	89.8	90.7	89.8	92.1	90.7	92.2
COMPOSITE	92.1	92.9	92.7	93.7	93.5	94.0	93.7	94.1	93.8	94.0	94.0	94.9	94.4	94.1

Note. Holding company data in this table are derived as an unweighted average of available operating company results. Composites are unweighted averages of holding companies. Please refer to text for accompanying notes and data qualifications.[1]

TABLE 8.3
Percentage of Customers Satisfied—Large Business

Company	1985	1986		1987		1988		1989		1990		1991		1992
		1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H
AMERITECH	89.1	90.7	90.2	90.0	91.4	95.1	93.6	93.9	94.7	94.7	95.1	95.9	96.2	96.2
BELL ATLANTIC	93.1	93.3	94.0	94.0	95.0	96.0	95.7	98.0	96.0	97.3	97.0	97.6	97.1	98.2
BELLSOUTH	89.9	94.2	94.2	95.0	94.9	95.4	93.9	93.9	94.1	94.6	94.6	95.8	NA	94.8
NYNEX	94.8	96.5	97.0	91.5	91.6	93.3	92.0	94.0	93.5	93.5	93.2	94.2	94.1	90.9
PACIFIC TELESIS	90.4	92.0	95.9	94.3	93.3	92.7	94.7	95.0	95.0	93.0	94.0	94.3	94.3	90.0
SOUTHWESTERN	91.3	91.4	92.3	93.9	94.4	95.4	95.4	94.3	94.0	94.6	95.3	97.4	97.3	96.6
U S WEST	92.2	NA	95.1	NA	96.3	NA	95.5	92.1	89.0	91.1	92.4	NA	NA	NA
COMPOSITE	91.5	93.0	94.1	93.1	93.8	94.6	94.4	94.5	93.8	94.1	94.5	95.9	95.8	94.5

Note. Holding company data in this table are derived as an unweighted average of available operating company results. Composites are unweighted averages of holding companies. Please refer to text for accompanying notes and data qualifications.[1]

TABLE 8.4
Percentage of Offices Providing Dial Tone in Less Than 3 Sec

	1985	1986		1987		1988		1989		1990		1991		1992
Company		1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H
AMERITECH	98.2	98.3	98.6	98.6	99.1	99.0	99.6	99.4	99.0	98.3	98.2	99.4	98.8	99.5
BELL ATLANTIC	97.8	98.2	98.6	97.8	98.8	99.0	99.3	99.3	99.1	98.4	99.2	99.5	99.6	99.8
BELLSOUTH	96.8	96.3	96.3	95.0	96.0	97.4	97.6	97.8	98.2	98.4	98.0	99.2	99.2	99.3
NYNEX	96.6	98.5	99.7	99.8	99.6	99.7	99.7	99.8	99.8	99.5	99.7	100.0	99.6	99.8
PACIFIC TELESIS	100.0	99.9	100.0	99.7	99.7	99.7	99.7	99.7	99.1	99.7	99.6	99.7	99.7	100.0
SOUTHWESTERN	97.9	98.3	97.9	98.4	98.1	99.3	99.4	99.3	99.4	99.2	99.3	97.8	97.7	98.1
U S WEST	96.7	97.8	97.2	98.2	98.4	98.8	99.1	98.9	99.4	99.0	98.9	99.3	99.2	99.6
COMPOSITE	97.7	98.2	98.3	98.2	98.5	99.0	99.2	99.2	99.1	98.9	99.0	99.3	99.1	99.4

Note. Holding company data in this table are derived as an unweighted average of available operating company results. Composites are unweighted averages of holding companies. Please refer to text for accompanying notes and data qualifications.[1]

TABLE 8.5a
Ameritech—Installation, Maintenance, and Customer Complaints

	Reporting Period						
	1Q'91	2Q'91	3Q'91	4Q'91	1Q'92	2Q'92	3Q'92
ACCESS SERVICES PROVIDED TO CARRIERS—SWITCHED ACCESS							
Percentage of Installation Commitments Met	99.5%	99.9%	100.0%	99.5%	99.3%	98.6%	99.5%
Average Missed Installation (days)	NA	0.7	0.4	0.8	3.3	1.9	4.2
Average Repair Interval (hours)	2.3	2.6	2.5	1.8	1.6	1.5	1.6
ACCESS SERVICES PROVIDED TO CARRIERS—SPECIAL ACCESS							
Percentage of Installation Commitments Met	99.8%	99.9%	99.4%	99.8%	99.8%	99.9%	99.8%
Average Missed Installation (days)	0.1	1.6	1.8	5.2	3.0	3.4	5.0
Average Repair Interval (hours)	2.2	2.4	2.4	2.2	2.2	2.2	2.3
LOCAL SERVICES PROVIDED TO RESIDENTIAL AND BUSINESS CUSTOMERS							
Percentage of Installation Commitments Met	99.6%	99.6%	99.5%	99.6%	99.7%	99.7%	99.6%
Residence	99.6%	99.6%	99.6%	99.6%	99.7%	99.7%	99.7%
Business	99.4%	99.4%	99.3%	99.5%	99.4%	99.4%	99.3%
Average Missed Installation (days)	2.8	2.8	2.8	3.0	3.0	2.7	3.2
Residence	2.7	2.5	2.8	2.6	2.8	2.5	2.7
Business	3.4	3.3	2.8	3.6	2.4	2.2	2.8
Trouble Reports per Thousand Lines	68.1	85.7	78.0	69.1	54.6	79.4	71.6
Total MSA	NA	NA	NA	NA	66.4	78.7	70.9
Total non-MSA	NA	NA	NA	NA	64.2	86.1	78.8
Total Residence	97.8	123.6	113.0	100.1	78.3	96.7	89.1
Total Business	7.5	8.5	7.8	7.4	40.9	43.1	35.4
Troubles Found per Thousand Lines	51.0	66.0	59.2	52.1	34.7	58.1	45.2
Repeat Troubles as a Pct. of Trouble Reports	10.2%	10.1%	9.8%	10.1%	11.5%	9.5%	14.6%
Total Residence	10.3%	10.1%	9.8%	10.1%	9.8%	9.7%	15.0%
Total Business	9.7%	10.0%	10.0%	9.8%	8.3%	8.5%	12.7%
Customer Complaints per Million Access Lines							
Residential	4.2	5.0	2.9	2.3	2.8	2.6	5.2
Business	1,001.7	712.2	2.2	1.1	0.9	0.7	1.7

Note. Please refer to text for notes and data qualifications.[1]

TABLE 8.5b
Ameritech—Switch Downtime and Trunk Blocking

	Reporting Period						
	1Q'91	*2Q'91*	*3Q'91*	*4Q'91*	*1Q'92*	*2Q'92*	*3Q'92*
Total Access Lines in Thousands	16,586	16,584	16,772	16,825	16,634	16,658	16,780
Total Trunk Groups	1,207	1,176	1,172	1,146	1,153	1,146	1,143
Total Switches	1,396	1,368	1,384	1,420	1,422	1,440	1,443
Switches with Downtime							
Number of Switches	41	45	105	245	138	205	271
As a Percentage of Total Switches	2.9%	3.3%	7.6%	17.3%	9.7%	14.2%	18.8%
Average Switch Downtime in sec per Switch							
For All Occurrences	5.9	22.6	28.1	56.0	63.0	66.1	204.2
For Unscheduled Occurrences More than 2 min.	1.5	17.4	13.4	38.3	55.6	50.3	173.3
For Unscheduled Downtime More than 2 min.							
Number of Occurrences	11	20	43	28	37	44	68
Occurrences per Million Access Lines	0.66	1.21	2.56	1.66	2.22	2.64	4.05
Average Outage Duration in Minutes	3.2	19.8	7.2	32.4	35.6	27.5	61.3
Average Lines Affected per Occurrence in Thousands	25.5	35.1	24.1	13.8	7.0	7.2	14.2
Outage Line Minutes per Occurrence in Thousands	75	756	149	275	332	156	1,122
Outage Line Minutes per Thousand Access Lines	50	912	381	458	739	412	4,546
For Scheduled Downtime More than 2 Min							
Number of Occurrences	32	38	84	63	32	71	118
Occurrences per Million Access Lines	1.93	2.29	5.01	3.74	1.92	4.26	7.03
Average Outage Duration in Minutes	3.2	3.2	4.0	3.6	3.0	3.4	4.3
Average Lines Affected per Occurrence in Thousands	38.6	25.2	19.6	19.5	21.1	20.5	10.9
Outage Line Minutes per Occurrence in Thousands	93	80	74	70	57	63	47
Outage Line Minutes per Thousand Access Lines	180	184	369	262	109	269	328
Pct. Trunk Grps. Exceeding Blocking Obj. 3 Months	0.66%	0.51%	0.68%	0.09%	0.17%	0.26%	0.35%

Note. Please refer to text for notes and data qualifications.[1]

TABLE 8.5c
Ameritech—Switch Downtime Causes

	Reporting Period						
	1Q'91	*2Q'91*	*3Q'91*	*4Q'91*	*1Q'92*	*2Q'92*	*3Q'92*
TOTAL NUMBER OF OUTAGES							
1. Scheduled	NA	NA	NA	NA	32	71	118
2. Procedural Errors—Telco. (Install./Maint.)	NA	NA	NA	NA	2	1	1
3. Procedural Errors—Telco. (Other)	NA	NA	NA	NA	3	0	2
4. Procedural Errors—System Vendors	NA	NA	NA	NA	2	1	4
5. Procedural Errors—Other Vendors	NA	NA	NA	NA	1	1	1
6. Software Design	NA	NA	NA	NA	2	4	8
7. Hardware Design	NA	NA	NA	NA	1	1	0
8. Hardware Failure	NA	NA	NA	NA	7	12	33
9. Acts of G-d	NA	NA	NA	NA	4	1	0
10. Traffic Overload	NA	NA	NA	NA	0	0	1
11. Environmental	NA	NA	NA	NA	0	1	0
12. External Power Failure	NA	NA	NA	NA	0	0	0
13. Massive Line Outage	NA	NA	NA	NA	0	0	0
14. Remote	NA	NA	NA	NA	12	13	13
15. Other/Unknown	NA	NA	NA	NA	3	9	5

(Continued)

TABLE 8.5c
(Continued)

	Reporting Period						
	1Q'91	*2Q'91*	*3Q'91*	*4Q'91*	*1Q'92*	*2Q'92*	*3Q'92*
TOTAL OUTAGE LINE MINUTES PER THOUSAND ACCESS LINES							
1. Scheduled	NA	NA	NA	NA	109.3	269.3	327.8
2. Procedural Errors—Telco. (Install./Maint.)	NA	NA	NA	NA	5.2	2.6	10.4
3. Procedural Errors—Telco. (Other)	NA	NA	NA	NA	8.0	0.0	543.8
4. Procedural Errors—System Vendors	NA	NA	NA	NA	216.6	4.5	21.0
5. Procedural Errors—Other Vendors	NA	NA	NA	NA	1.6	1.7	1.2
6. Software Design	NA	NA	NA	NA	1.6	3.6	246.5
7. Hardware Design	NA	NA	NA	NA	0.3	13.3	0.0
8. Hardware Failure	NA	NA	NA	NA	168.8	320.6	3,639.1
9. Acts of G-d	NA	NA	NA	NA	26.2	3.0	0.0
10. Traffic Overload	NA	NA	NA	NA	0.0	0.0	43.4
11. Environmental	NA	NA	NA	NA	0.0	2.4	0.0
12. External Power Failure	NA	NA	NA	NA	0.0	0.0	0.0
13. Massive Line Outage	NA	NA	NA	NA	0.0	0.0	0.0
14. Remote	NA	NA	NA	NA	310.0	43.8	33.9
15. Other/Unknown	NA	NA	NA	NA	1.1	16.7	6.4

Note. Please refer to text for notes and data qualifications.[1]

mileage as reported to the Commission by the companies. Furthermore, these data exhibited a larger data discontinuity from the earlier data series than the data shown in Tables 8.1–8.3. This appears to have resulted from changes in reporting procedures and data formats. Data on blocking and on-time installations have been modified considerably and are not comparable to the prior data series.

ACKNOWLEDGMENT

The views expressed are those of the author and do not necessarily reflect the views of the Federal Communications Commission.

ENDNOTES

1. Kraushaar, J., *Quality of Service for the Local Operating Companies Aggregated to the Holding Company Level*, Common Carrier Bureau, Federal Communications Commission, Washington, DC, February 1993.
2. The ARMIS database includes a variety of financial and infrastructure company-mechanized reports in addition to the quality-of-service reports. Data are available disaggregated to a study area or state level.
3. Individuals wishing to access the bulletin board may do so by dialing (202) 418-0241 from an appropriately equipped personal computer.
4. The Exchange Carriers Standards Association T1Q1.4 Committee is addressing performance limits for digital-transmission quality parameters.
5. The companies apparently count all trouble reports associated with a single unresolved trouble as a single initial trouble. A trouble recurring after it is initially resolved or after a specified time is reported as a repeat trouble, but many of the companies also count this as a new initial trouble. Due to a misunderstanding associated with this, at least some of the trouble report data in the Commission report in effect may reflect a double counting of repeat trouble reports. Although errors associated with this misunderstanding are also reflected in the figures shown in this chapter, the data fluctuations displayed shown would still properly reflect any trend or lack thereof because consistent procedures were used to assemble and format the data. This and other issues involving the data, the definitions, and improvements to the process are part of the Commission's ongoing evaluation.