Network Reliability Steering Committee

Annual Report 2001

NRSC

Network Reliability Steering Committee

ATIS

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To the Telecommunications Industry:

This Annual Report reviews the health of the wireline telecommunications networks for the year 2001, as well as trends observed over the last nine years of outage reporting to the FCC. The past year was an extraordinary one, marked by dramatic events that have highlighted the criticality of the nation's communications infrastructure. Telecommunications reliability was not only challenged by natural disasters, but also by the damage as a result of the September 11th terrorist attack. The industry's cooperation and commitment to service and reliability enabled it to meet these challenges.

During the past year the frequency of outages and the outage index, a measure of impact on customers, remained within the "green" area of the control charts. These results are consistent with those observed in recent years, and demonstrate continued overall reliability of telecommunications networks and services. However, further analysis presents a mixed message regarding network reliability performance in 2001. The number of outages was lower than in any year to date, but the aggregated outage index reached its second highest value to date. Also, the average number of customers potentially affected by an outage and the average outage index per outage were the highest to date. The Local Switch outage category had the lowest annual frequency and aggregated outage index to date. The annual aggregated outage index of Procedural Errors as a root cause of outages was the highest to date. The Other outage category had the highest annual aggregated outage index of any category to date aside from Facility.

Special note should be taken of the extraordinary events of September 11, 2001, which produced seven outage reports to the FCC. Six of the seven reports (those directly associated with damage from the attacks on New York City and the Pentagon on that day) were combined and treated as a single outage for the purposes of this study as they all occurred concurrently as the result of a common cause, and because of the extraordinary nature of the event. We are all very proud of the industry and how all pulled together to restore service in the face of unprecedented conditions.

Analysis of outage data over the course of the nine-year data history shows that total outage frequency and aggregated outage index have increased at a slower rate than standard measures of network and call volume. It should be noted that within failure categories: the outage frequency rate of increase for CO Power is 12% per year; Facility outage frequency has decreased in the last two years and its aggregated outage index in decreasing at 6% per year; the frequency of CCS outages has increased in the last two years; and Local Switch annual outage frequency aggregated outage index are decreasing at 6% and 13% respectively. The frequency of outages with a Procedural Error as a root cause is increasing at a rate of 6% per year.

In the second half of 2001, "timing" was observed to be an increasing factor in network outages. Accordingly, the NRSC established a "Timing Outages Task Group" to investigate and report its recommendations to the Committee. The Task Group's analysis of outages reported in 2000 and 2001 indicated that timing was a factor in 9.4% of all outages and 33% of all SS7 outages. As a result of its investigation, the Task group developed three new Best Practices. This investigation was the result of the industry data collected under the NRSC umbrella and the root cause may never have been uncovered except for the aggregation of the data. Kudos to the team.

As in the previous Annual Report, I encourage all service providers and vendors to review the best practices documents available on the NRSC web site at http://www.atis.org/atis/nrsc/nrschome.htm. NRIC best practices are also available on the web in searchable format at http://www.nric.org/ .

The continual effort and cooperation that that our industry has devoted to the reliability of the United States public telecommunications networks is exemplary. However, in light of recent events we must exert renewed energy and focus on a broader range of challenges. The spirit of collaboration and dedication found among the industry, consumer, and government representatives that make up the NRSC will help us prepare to meet these challenges.

PJ Aduskevicz
Chair NRSC

TABLE OF CONTENTS

INTRODUCTION

This report provides an analysis of U.S. telecommunications network performance based on outage reports made by service providers to the FCC from January 1, 1993 through December 31, 2001. While service providers are required to make such reports for outages meeting various criteria, the vast majority of reports are made for outages that potentially affect 30,000 or more customers for 30 minutes or more. The analysis presented herein is primarily focused on those outages reported on the basis of these 30,000 customer/30 minute thresholds. A discussion of other reportable incidents is included in a section on "Special Outages."

The Network Reliability Steering Committee (NRSC) was established under the auspices of the Alliance for Telecommunications Industry Solutions (ATIS) to monitor network reliability utilizing major outage reports filed with the Federal Communications Commission (FCC) pursuant to Part 63.100 of the FCC Rules. The NRSC's mission is to analyze network outage data reported by companies, to identify trends, make recommendations aimed at improving network reliability, and make the results publicly available, and where applicable refer matters to other industry fora for further action.

During 2001 members and participants in the NRSC included:

AT&T
Beacon
BellSouth
Consumer Representative
E-commerce & Telecommunications Users Group
FCC
Lucent Technologies
National Association of Regulatory Utility Commissioners (NARUC)
National Communications System (NCS)
Nortel Networks
Personal Communications Industry Association (PCIA)
Siemens ICN
SBC
Sprint
Telcordia Technologies
Union Pacific Railroad
United States Telecom Association (USTA)
Verizon

MAJOR FINDINGS

For outages reported in 2001:

- Local Switch outages had their lowest annual frequency and aggregated outage index to date.
- The annual aggregated outage index of Procedural Errors was the highest to date.
- The number of outages was lower than in any year to date. Nonetheless, the aggregated outage index reached its second highest value to date.
- The average outage index per outage was the highest to date.

Significant trends noted over the course of the nine-year data history include:

- Local switch outage annual frequency and aggregated outage index are decreasing at the rate of 6% and 13% per year respectively.
- Central Office (CO) Power outage frequency is increasing at a rate of 12% per year.
- The frequency of Facility outages has decreased in the last two years, and the Facility aggregated outage index is decreasing at a rate of 6% per year.
- The frequency of outages with a Procedural Error as a root cause is increasing at a rate of 6% per year.
- The frequency of Common Channel Signaling (CCS) outages has increased in the last two years.

STATE OF THE NETWORK

The network performance described below is based on an analysis of network outages reported to the FCC. The analysis compares network outage data from January 1, 1993 through December 31, 2001. Data from January 1, 1993 through December 31, 2000 are used as a baseline for control limits. The average value for a metric is referred to as the metric's *baseline level*. The years 1993 through 2000 are referred to as the *Baseline Years*.

In general, network performance remained within control limits in 2001. However, 2001 saw departures from these limits in several areas. In particular,

- Local Switch outages had their lowest annual frequency and aggregated outage index to date.
- The annual aggregated outage index of Procedural Errors was the highest to date.
- The Other category had the highest annual aggregated outage index of any category to date aside from Facility.

Network performance areas in 2001 that remained within control limits but are still noteworthy include:

- The number of outages was lower than in any year to date. 2001 was the first year below the baseline level since 1995.
- Despite the low number of outages, the aggregated outage index reached its second highest value to date.
- The average number of customers potentially affected by an outage was the highest to date.
- The average outage index per outage was the highest to date.

September 11th Terrorist Attack

Special note should be taken of the extraordinary events of September 11, 2001, which produced seven outage reports to the FCC. Six of the seven reports (those directly associated with damage from the attacks on New York City and the Pentagon on that day) were combined and treated as a single outage for the purposes of this study as they all occurred concurrently as the result of a common cause. This combined outage had the highest number of customers potentially affected (37,300,000) and the longest outage duration (720 hours) of all outages to date. It also had the second highest outage index (122) to date. Subsequent information suggests that the reported number of customers and outage duration associated with this event may have been overstated. Nonetheless, these are the figures contained in the reports filed with the FCC, and as such are the numbers utilized in this report.

Several significant trends are noted over the course of the nine-year data history:

- Local Switch outage annual frequency and aggregated outage index are decreasing at the rates of 6% and 13% per year respectively.
- CO Power outage frequency is increasing at a rate of 12% per year.
- Facility aggregated outage index is decreasing at a rate of 6% per year.
- The frequency of outages with a Procedural Error as a root cause is increasing at a rate of 6% per year.

- The frequency of Facility outages has decreased in the last two years. In particular, the frequency of Inadequate/No Notification as the cause of Facility Cable Dig-Up outages has decreased in this period.
- The frequency of CCS outages has increased in the last two years.

Unless specified otherwise, all statistical tests in these analyses were performed at the 0.05 level of significance. This means that statements of the form "A is statistically significant" imply that less than a 5% chance exists that A is not true. In this report, the shorter term "significantly" is applied to statements that are statistically significant.

Control charts in this section are coded to indicate whether the network is "under control." The control charts measure outages occurring in a particular quarter against normal variation in the Baseline Years. 95% and 99% tolerance limits are used for the control ranges. Values in the "Green" region (below the upper 95% tolerance limit) are "under control." Values in the "Yellow" region (between the upper 95% and 99% tolerance limits) require very close scrutiny. Values in the "Red" region (above the 99% tolerance limit) should trigger immediate investigative action by the NRSC.

The report presents results of trend analyses examining whether a quantity such as annual outage frequency is increasing (or decreasing) at a constant rate over time. Unless specified otherwise, such trend analyses are preformed using all available data.

Performance by Outage Frequency

Annual outage frequencies are shown in **Figure 1**. The number of outages in 2001 (154) was lower than in any year to date. The baseline level for annual outage frequency is 173.3. 2001 was the first year below the baseline level since 1995 and the lowest level to date.

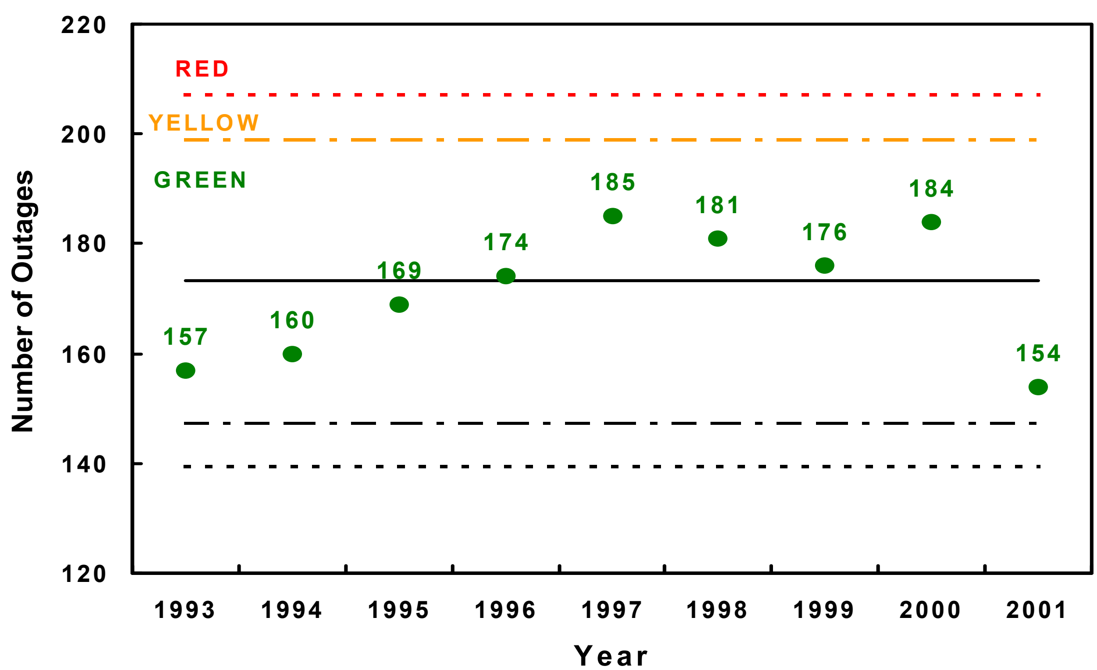


Figure 1: Annual Control Chart for Outage Frequency

Figure 2 is a control chart for outage frequency by quarter. For each quarter of 2001, the number of outages was within the acceptable range of this control chart. A fit to these data indicates an increasing trend in outage frequency over time (0.9% annually) which is not statistically significant. Outage frequency has been highest in the third quarter (49 outages per quarter on average) while the other three quarters each have about 41 outages on average. **These differences in seasonal outage frequency are statistically significant.**

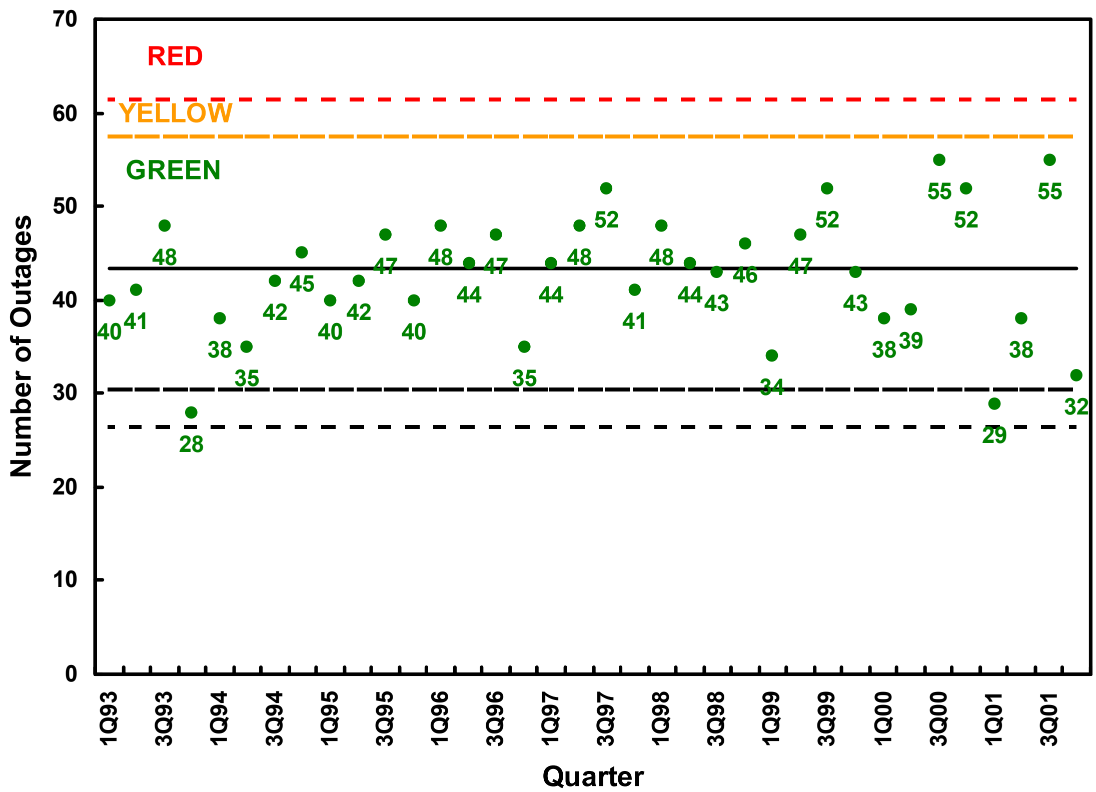


Figure 2: Quarterly Control Chart for Outage Frequency

Figure 3 provides the distribution of outage frequency by failure category: In 2001, the number of outages for each failure category was within its Green region. Conclusions based on these data are:

- *Facility*
  The number of Facility outages (62) dropped in 2001 to the lowest level since 1993. Facility outages do not have a statistically significant overall trend and display no significant seasonality effects. However, the average number of Facility outages in 2000 and 2001 (62.5) is significantly lower than the average of the first seven years (79). Facility outage frequencies in 2001 and over all years (75 outages per year) are significantly higher than in any other category.

- *Local Switch*
  In 2001, Local Switch outages had their lowest annual frequency (11) to date, almost 50% lower than in any other year. It was below the 99% lower tolerance limit established from the Baseline Years. For the fifth consecutive year, the number of Local Switch outages has decreased or remained the same from the previous year. Local Switch outage frequency demonstrates a statistically significant overall decreasing trend (5.7% annually). Nonetheless, Local Switch outage frequencies over all years (26.6 outages per year) remain significantly higher than in any other category (apart from Facility).

- *Common Channel Signaling (CCS)*
  In 2001, CCS outage frequency was the second highest (28) among failure categories for the first year since 1993. CCS outages have no significant overall trend. However, the average number of CCS outages in 2000 and 2001 (29) is significantly higher than the average of the first seven years (19.7). Over the last four years, CCS outages have had the second highest frequency (24.3 outages per year) among failure categories.

- *Tandem Switch*
  After a peak of 31 outages in 2000, Tandem Switch outage frequency returned to a more typical annual level (17) in 2001. Tandem Switch outages have no significant overall trend.

- *Central Office (CO) Power*
  In 2001, CO Power outage frequency reached its second highest annual level to date (21). This was the fifth consecutive year that CO Power outage frequency was above the baseline level. CO Power outage frequency demonstrates a statistically significant trend (12.1% increase per year) and seasonality (63% of outages occur in the warmer half of the year).

- *Digital Cross-connect System (DCS)*
  In 2001, DCS outage frequency (5) was less than in any other failure category. It decreased for the third consecutive year to its lowest level since 1996. Over the last three years, DCS outages have had the lowest frequency (7.3 outages per year) among failure categories. While DCS outages have no significant overall trend, the average number of DCS outages starting in 1997 (8.2 annually) is significantly higher than the average of the first four years (4 annually). DCS outage frequency over all years (6.3 outages per year) is significantly lower than in any other failure category (apart from Other).

- *Other*
  In 2001, Other outage frequency increased for the third consecutive year to its highest level (10) to date. Other outages have no significant overall trend. Other outage frequency over all years (6 outages per year) is significantly lower than in any other failure category (apart from DCS).

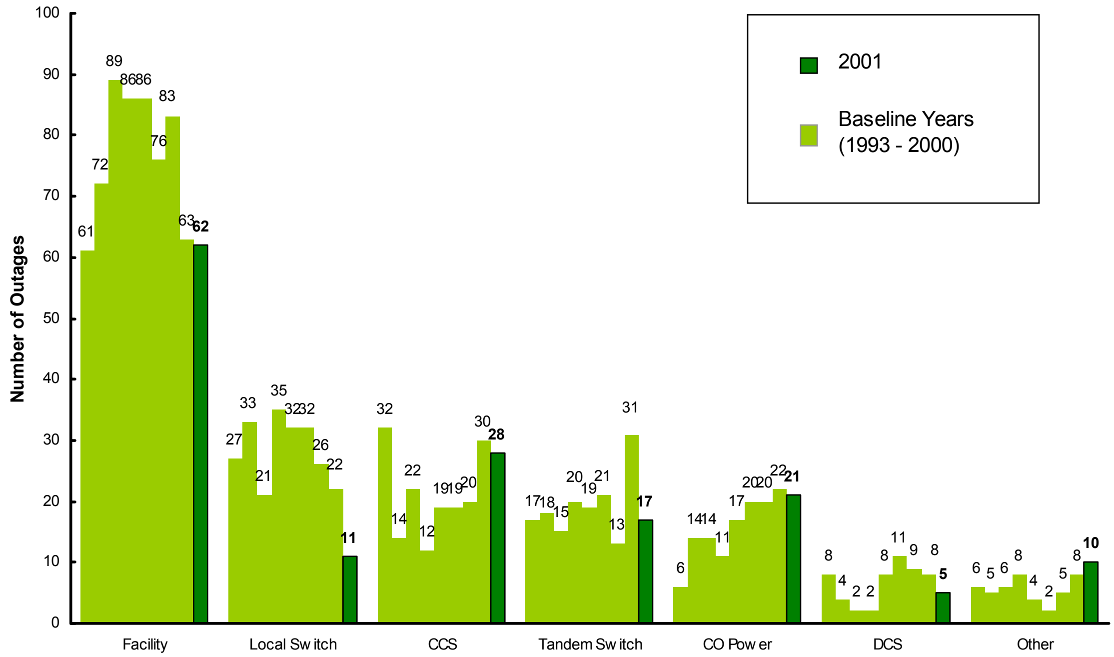


Figure 3: Number Of Outages By Failure Category

PERFORMANCE BY OUTAGE DURATION

Figure 4 provides a summary of the distribution of outage duration for the nine years of reporting. A percentile indicates what percent of the outages have duration less than that value. For example, 90% of FCC-reportable outages in 2001 had durations less than 11.33 hours. Percentiles of the outage distribution are used because statistics like the mean outage duration are severely altered by one or two very long outages. Three very long outages over 100 hours (including one on September 11 with a duration of 720 hours) were instrumental in producing the highest mean duration of outages to date (11.22 hours). Still, the distribution of outage durations in 2001 was not significantly different than in the Baseline Years.

Analyses by failure category (**Figure 5)** show that Facility outages have significantly longer durations than outage durations in other failure categories while Local Switch and CCS outages have significantly shorter outages.

Analysis of the data provides the following additional observations:

- In 2001, DCS outages had their highest median duration to date (9.9 hours), significantly higher than the baseline median (2.4 hours).
- In 2001, Facility outages had their lowest median duration to date (4.2 hours). The duration of Facility outages over the last three years (1999-2001) has been significantly lower (4.3 hours) than in the first six years (5.2 hours).

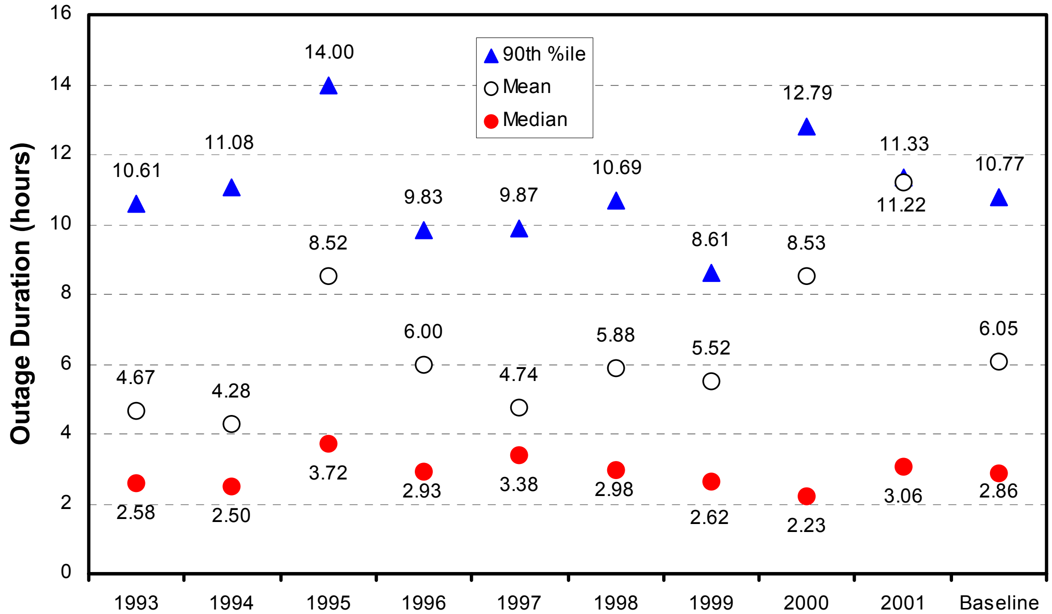


Figure 4: Annual Distributions of Outage Durations

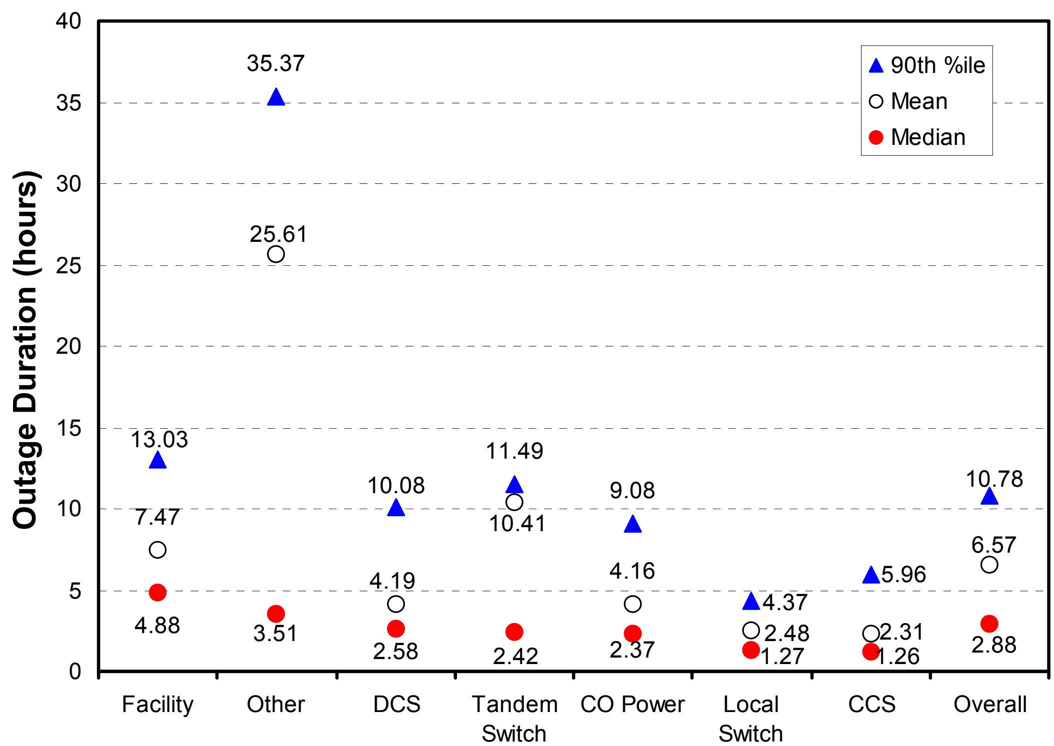


Figure 5: Distributions of Outage Durations
By Failure Category (1993 – 2001)

PERFORMANCE BY CUSTOMERS POTENTIALLY AFFECTED

Figure 6 depicts the major statistics for the number of customers potentially affected per outage for each year from 1993 to 2001. The median describes the number of customers potentially affected in a typical outage. The 90th percentile measures the number of customers affected for a relatively large outage (an outage bigger than 90% of all outages). The median (57,700) was the second highest to date and the mean (485,100) was the highest to date. The outages with the two highest numbers of customers potentially affected both occurred in 2001. If the outage from the September 11 attacks is excluded, the mean is 216,300, which would still be the highest annual mean to date. The number of customers potentially affected does not demonstrate a statistically significant change over time. In addition, the distribution of customers potentially affected per outage in 2001 was not significantly different than in the Baseline Years.

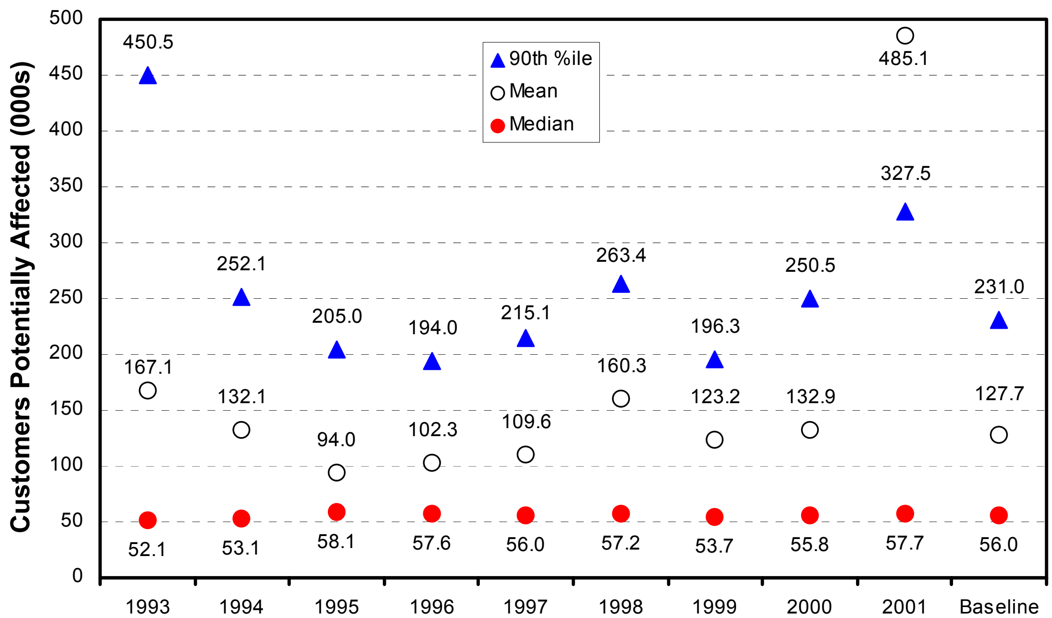


Figure 6: Annual Distributions of Customers Potentially Affected per Outage

Analyses by failure category (**Figure 7)** show that Tandem Switch, DCS, and Facility outages potentially affect significantly more customers than do outages in other failure categories while Local Switch and CCS outages affect significantly less customers.

Analysis of the data provides the following additional observations:

- In 2001, DCS outages had their highest median customers potentially affected to date (314,000).
- In 2001, Local Switch outages had their lowest median customers potentially affected to date (40,000).
- The number of customers affected by Other outages in 2001 (median 124,000) was significantly higher than in the Baseline Years (median 55,000). The Other outage category has had its two highest median customers potentially affected in 2000 and 2001. In these last two years, the number of customers potentially affected by Other outages has been significantly greater (median 124,000) than in the first seven years (median 50,000).

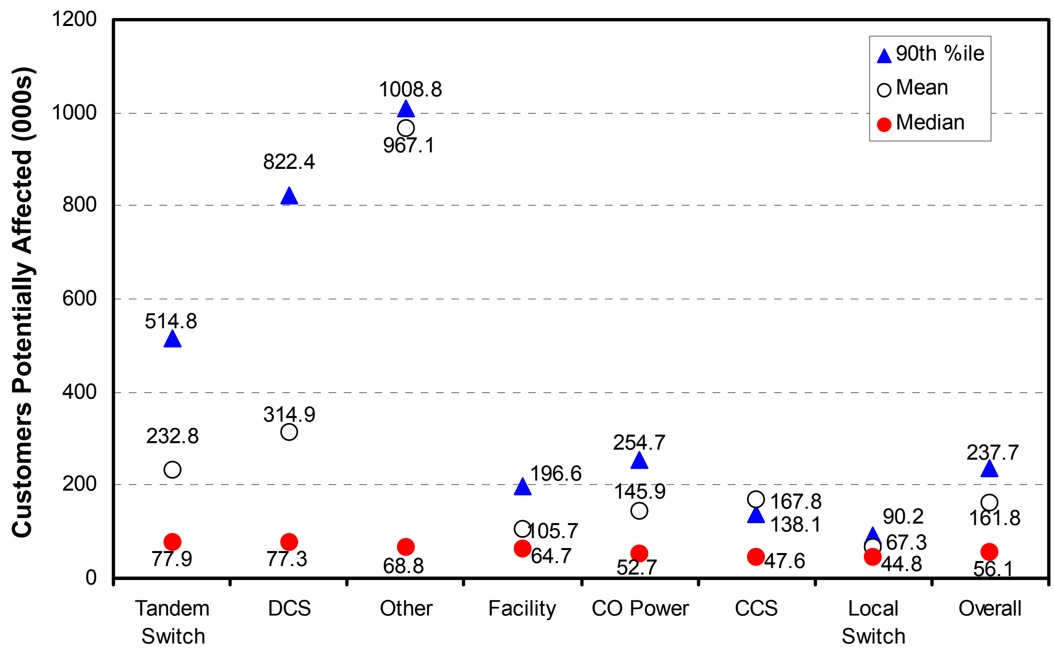


Figure 7: Distributions Of Customers Potentially Affected By Failure Category (1993 – 2001)

Performance by Outage Index

Committee T1 Report No. 42 defined an outage index created by Working Group T1A1.2 to provide a single measure that describes the overall severity of a single outage or collection of outages. The index combined the duration of the outage, the number of customers affected, and the services affected into a single measure. Also, the outage indexes of a collection of outages can be summed to provide a measure of the collection's severity.

In this report, *outage index* will be used for the severity of an individual outage. *Aggregated outage index* will be used for the severity of a collection of outages. The outage index is calculated using the following data items:

- Outage duration
- Customers potentially affected
- Date and time that the outage started
- Services affected (i.e., intraoffice, interoffice intraLATA, interoffice intraLATA, and 911).

The outage index is a quantitative scale measuring outage impact. A higher number indicates a more severe outage (e.g., an outage with an index of 8 is twice as bad as one with an index of 4). To obtain a feeling for the index, note the following:

- The maximum possible index for an outage is 333.33.
- An outage of a Local Switch with 30,000 lines in which all services (intraLATA intraoffice, intraLATA interoffice, interLATA interoffice, and 911) are lost for 30 minutes during daytime hours of a weekday has an outage index of 1.92.
- A Tandem Switch outage that blocks 90,000 interLATA interoffice calls over a period of 30 minutes has an outage index of 0.48.
- A Facility outage that blocks 220,000 intraLATA interoffice and interLATA interoffice calls over a period of 5.5 hours has an outage index of 6.06.

AGGREGATED OUTAGE INDEX DISTRIBUTIONS

Annual aggregated outage indexes are given in **Figure 8**. The baseline level for annual aggregated outage index is 1585. The aggregated outage index in 2001 was above this level at its second highest value to date but the increase is not statistically significant. The aggregated outage index does not have a statistically significant trend.

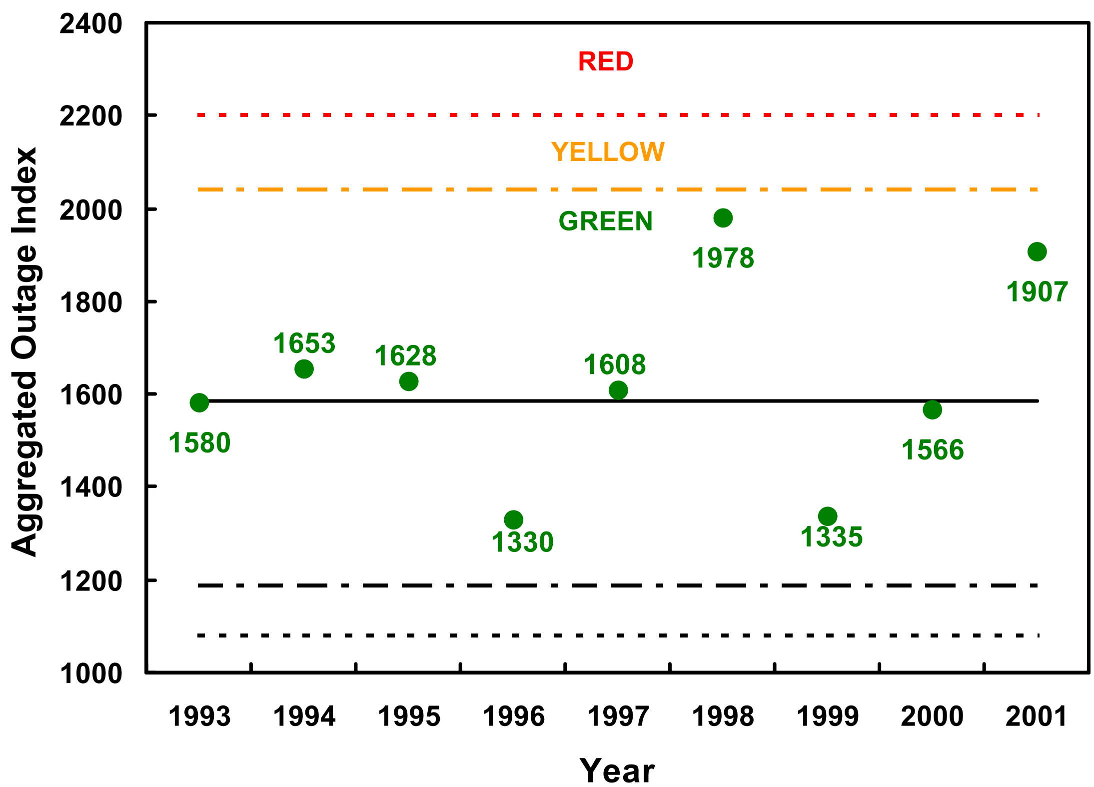


Figure 8: Annual Aggregated Outage Index Control Chart

Figure 9 provides a control chart of the quarterly aggregated outage index from 1993 to 2001. All four quarters of 2001 were within control.

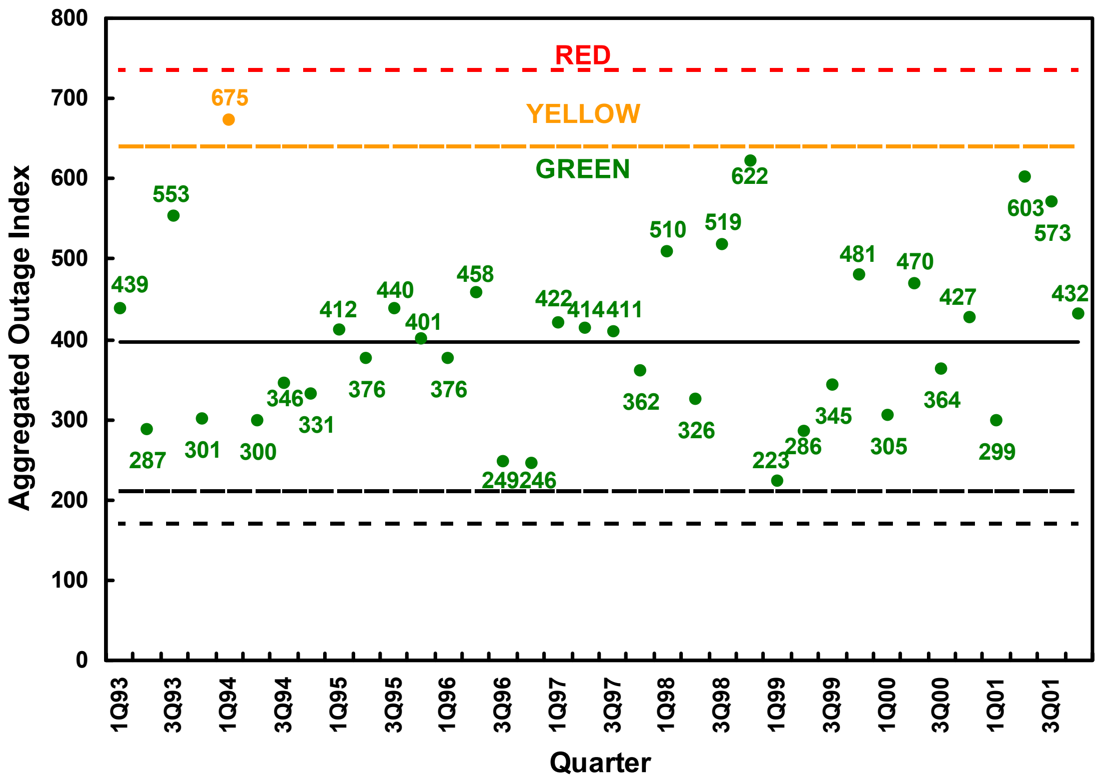


Figure 9: Quarterly Aggregated Outage Index Control Chart

The annual aggregated outage index for each failure category is given in **Figure 10**. The annual aggregated outage index for Facility outages has a statistically significant decreasing trend of 5.5% per year. In 2001, Local Switch outages had its lowest annual aggregated outage index to date (35); it was significantly lower than the baseline level. The decreasing trend (12.6% per year) for the annual aggregated outage index of Local Switch outages is statistically significant. In 2001, the Other category also had its highest annual aggregated outage index to date, including (402) or excluding (280) the September 11 Other outage; the 402 value is significantly greater than the baseline level and is the highest annual aggregated outage index for any failure category (apart from Facility) to date.

Since 1993,

- The aggregated outage index for Facility outages is significantly higher than in any other failure category.
- The aggregated outage index for DCS outages was significantly lower than in any other failure category (except Other).

In addition:

- The aggregated outage index for DCS outages has been significantly higher from 1997-2001 (103 per year) compared to 1993-1996 (29 per year).
- The aggregated outage index for CO Power outages has been significantly higher from 1998-2001 (244 per year) compared to 1993-1997 (125 per year).
- The aggregated outage index for Tandem Switch outages has been significantly higher from 1998-2001 (273 per year) compared to 1993-1997 (171 per year).

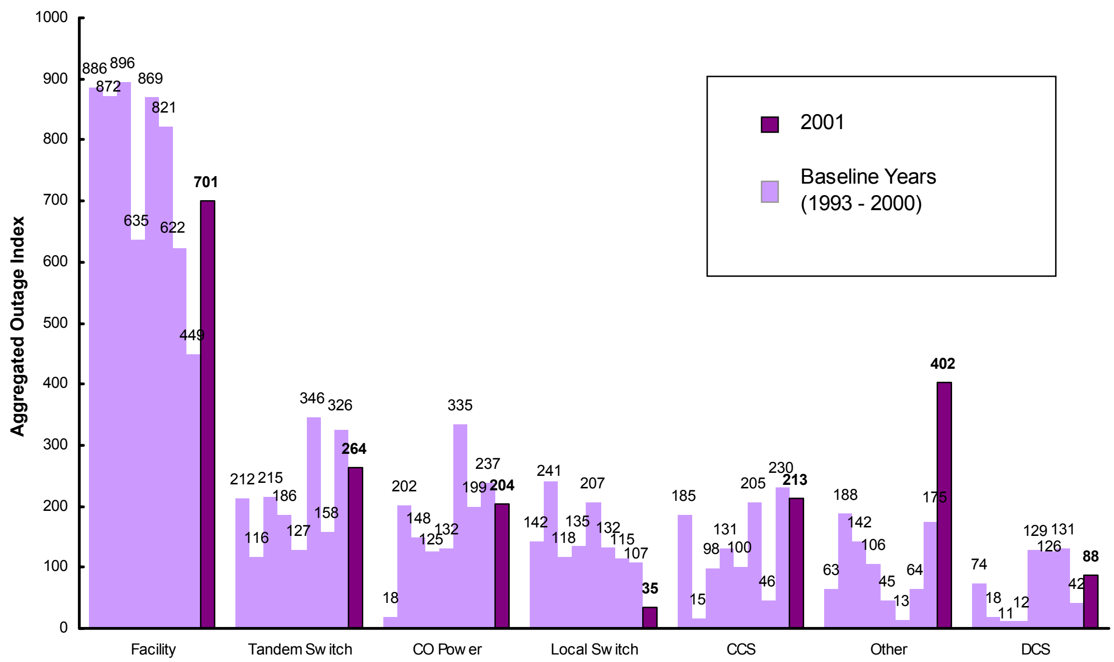


Figure 10: Annual Aggregated Outage Index By Failure Category

OUTAGE INDEX DISTRIBUTIONS

Assuming that a FCC-reportable outage occurs, an important question is whether the severity of that outage has changed over the years. The outage index for an outage measures the severity of that outage. **Figure 11** presents summaries of the outage index distribution by year. In 2001, the median (5.0), mean (12.4), and 90th percentile (41.2) values of the outage index distribution were all at their highest annual levels to date. Still, the outage index per outage in 2001 was not statistically different than in the Baseline Years. Overall, there has been no statistically significant difference in the outage index per outage in the period from 1993 to 2001.

Analyses by failure category (**Figure 12)** show that Tandem Switch, Other, and Facility outages have significantly higher indexes than do outages in other failure categories, while Local Switch and CCS outages have significantly lower indexes.

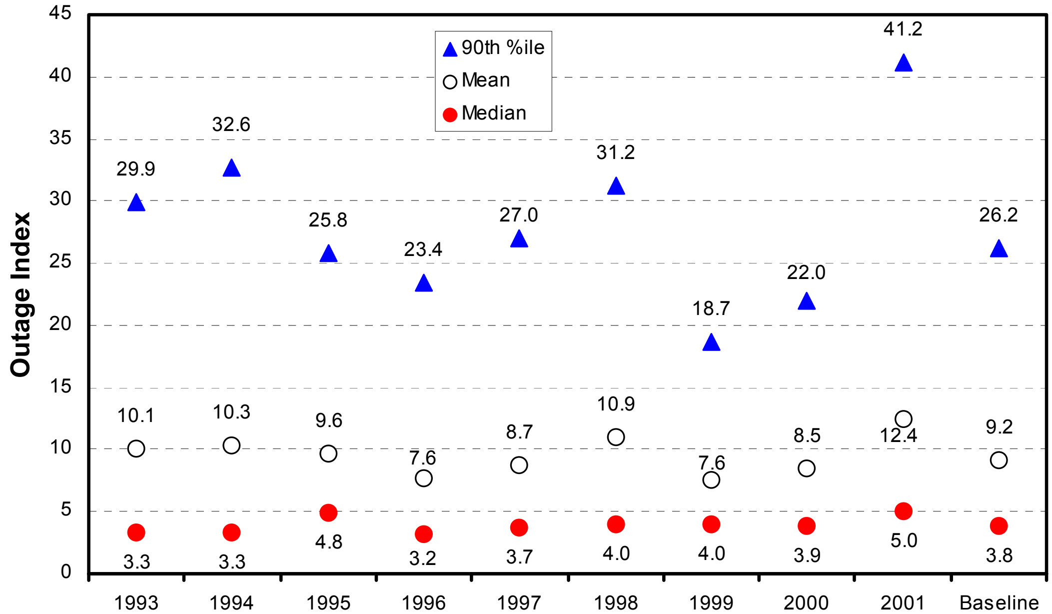


Figure 11: Annual Distributions of Outage Index per Outage

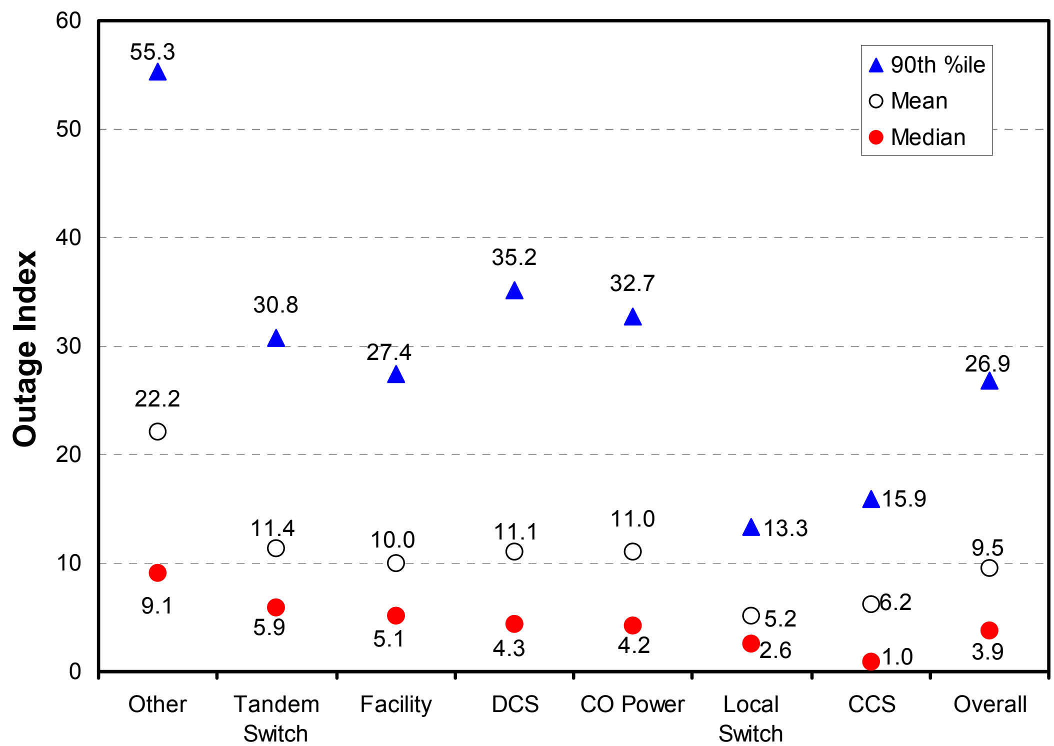


Figure 12: Distributions of Outage Index By Failure Category (1993 – 2001)

Analysis of the data provides the following additional observations:

- In 2001, DCS outages had their highest median outage index (13.8).
- In 2001, Local Switch outages had their lowest median outage index (1.7).
- In 2001, Other outages had their highest median outage index (31.2). This is the fourth consecutive year that the median index has increased.
- This is the third consecutive year that the Facility median index has increased.

OUTAGE METRICS RELATIVE TO NETWORK GROWTH

The public telecommunications network is continually growing and changing. More lines and facilities are added, switches are centralized or decentralized, the signaling network is expanding, etc. **Table 1** presents two metrics (lines and calls) for network growth in absolute terms. These two metrics are relevant particularly to FCC-reportable outages because of the use of subscriber lines potentially affected and blocked calls in determining the reportable status of outages relative to FCC-defined thresholds.

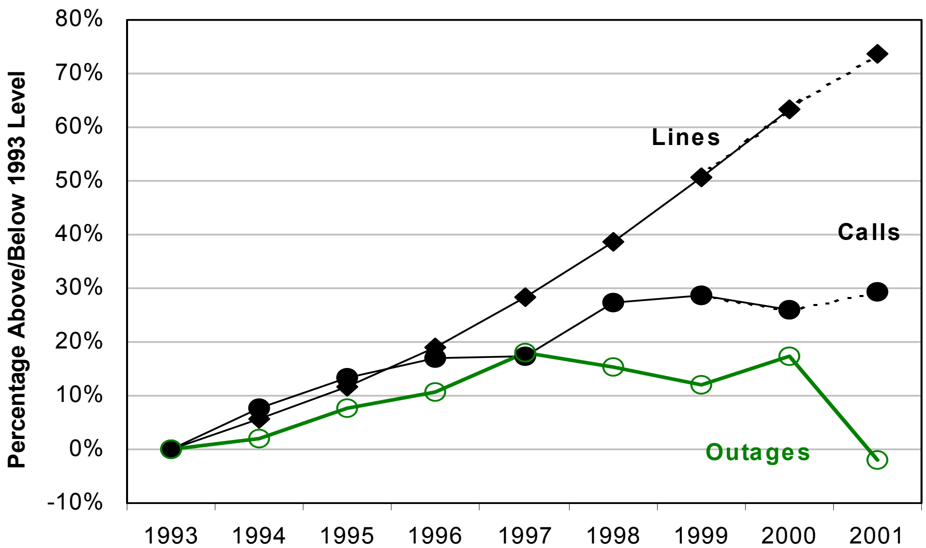
The data in Table 1 reflects lines and calls reported exclusively by Incumbent Local Exchange Carriers (ILECs). Only recently have lines data from Competitive Local Exchange Carriers (CLECs) become available. If CLECs are included, the size of the network (in lines) was 236.1 million in 1999 and 259.7 million in 2000. No data is available on CLEC calls. Since CLEC data was incomplete, this analysis was performed with respect only to ILEC network growth. The leveling off of calls in the late 1990s can be partially explained by the increasing use of cellular services. For example, in 2001 the Cellular Telecommunications and Internet Association (CTIA) estimates that 180 billion cellular calls were made in the U.S., up from 40 billion in 1998. While wireless service outages are excluded from reporting and thus this analysis, it should be noted that the increase in cellular usage does place additional call processing loads on the equipment and networks being monitored. These numbers are not reflected in Table 1 or Figure 13. As such, the results are conservative in the sense that network growth is slightly underestimated.

Table 1: Network Growth Metrics

Year	Total (Millions)	
	Lines (on 12/31)	Calls (1/1 - 12/31)
1992	140.3	505,700
1993	149.0	510,000
1994	157.2	548,600
1995	166.0	578,200
1996	177.9	597,300
1997	193.6	598,400
1998	207.7	649,500
1999	227.9	656,100
2000	244.8	642,500

Figure 13 plots the annual network growth data in Table 1 and annual network outage metrics from Figures 1 and 4 (relative to their 1993 levels) versus year. The 1993 call level (510 billion calls) is taken directly from Table 7; the 1993 line level is the average of the number of lines on December 31, 1992 and December 31, 1993 (144.7 million lines). (The dashed lines indicate extrapolation to the year 2001.) Figure 13a indicates that, in every year, annual outage frequency has been less than network size as measured by the number of subscriber lines after these values have been scaled relative to 1993 levels. This statement also holds with respect to the number of calls in every year

except 1997. Figure 13b indicates that, in every year, the annual aggregated outage index has been less than network size as measured by the number of subscriber lines or by annual call volume after these values have been scaled relative to 1993 levels. Generally, the figure indicates that network outage measures have increased at a slower rate than standard measures of network size and call volume since 1993.



(a) Outage Frequency and Network Growth

(b) Aggregated Outage Index and Network Growth

Figure 13: Annual Network Growth And Outage Metrics Over Time

Root Cause Analysis

This section provides a root cause analysis of the major failure categories (Facility, Local Switch, CCS, Tandem Switch, CO Power, and DCS failures) as well as failures from procedural errors. Steps to prevent recurrence of these failures are identified in:

- the FCC's Network Reliability Council (NRC) "Network Reliability: A Report to the Nation," and "Network Reliability: The Path Forward"
- the ATIS/NRSC "Keeping the Network Alive and Well -- Solving the Problem of Cable Dig-Ups," and "Fixing Facility Outages -- Building Tools to Make it Happen."

Facility

Figures 14 and **15** display the annual number of outages and annual aggregated outage index with respect to Facility failure subcategories.

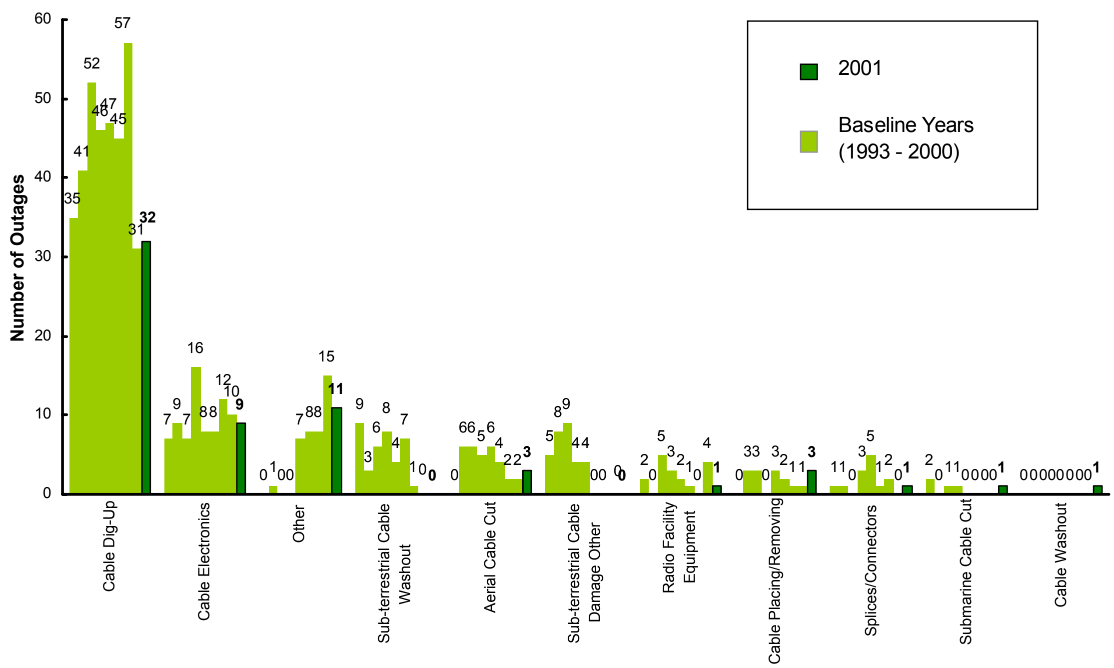


Figure 14: Number of Outages by Facility Failure Subcategory

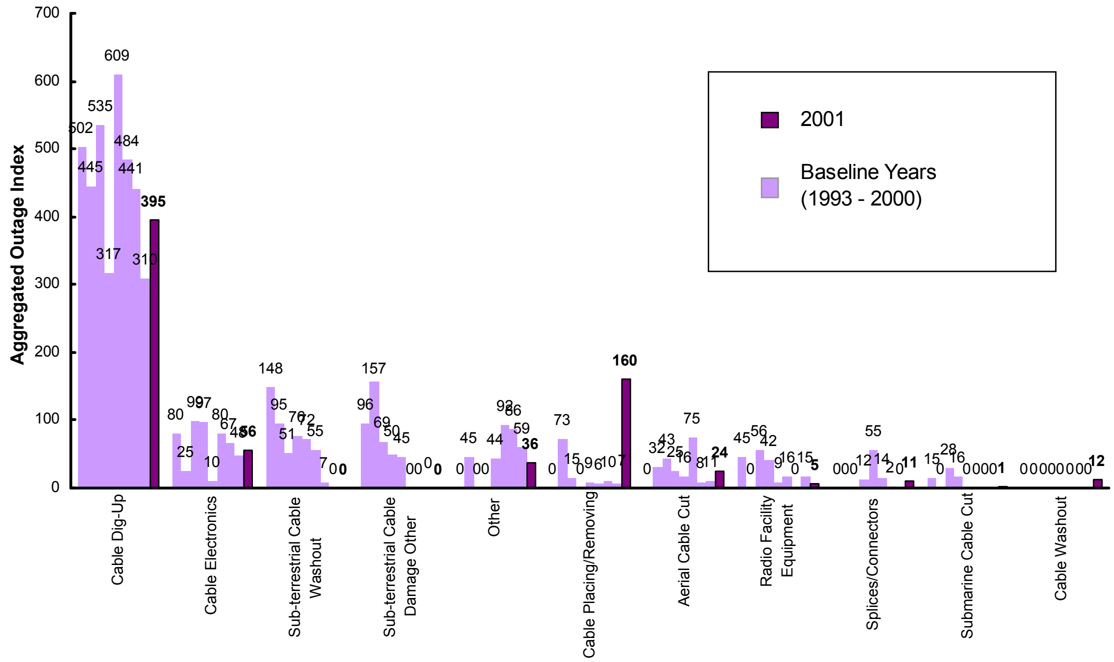


Figure 15: Outage Index Aggregated Annually By Facility Failure Subcategory

While they continued to dominate Facility failure subcategories in 2001, the Cable Dig-up (DU) subcategory remained at a relatively low annual frequency (32). Cable DUs demonstrate a statistically significant seasonality effect; about 1/3 less Cable DU outages occur in the first quarter as compared to the rest of the year. In the last two years, the frequency of Cable Dig-Up outages has been significantly less (32 per year) than in the first seven years of reporting (46 per year). The Sub-terrestrial Cable Damage Other subcategory has a statistically significant decreasing trend in outages since 1993 (33% decline per year). The Sub-terrestrial Cable Washout subcategory demonstrates a statistically significant seasonality effect; first quarters have about 2.5 such outages per year, third quarters about 1 per year, and second and fourth quarters about .5 per year. Sub-terrestrial Cable Washout also has a statistically significant decreasing trend in outage frequency (21% decline per year). In the last five years, the Other subcategory has averaged 10 outages per year compared to 0.3 per year in the first four years; this difference is statistically significant. In the last five years, more Facility outages have occurred in the Other subcategory than in any other subcategory aside from Cable DU.

Cable DUs dominate Facility outages from the outage index perspective as well (60% over nine years of reporting). In 2001, the annual aggregated outage index (160) for Cable Placing/Removing outage was significantly higher than its baseline level (15 per year); it was the highest annual aggregated outage index for any subcategory observed to date (aside from Cable Dig-Up). The Facility aggregated outage index attributed to the Sub-terrestrial Cable subcategories (Damage Other and Washout) has been significantly lower in the last four years as compared to the first five years (16 versus 172 per year).

The dominant root cause categories with respect to frequency are Cable Damage (52%), Procedural Service Provider (17%), and External Environment (14%). In 2001, Cable Damage had its lowest annual frequency to date (20), significantly lower than its baseline level (41.3 per year); this is the first year that Cable Damage was not the dominant root cause category. In the last two years, the number of Cable Damage outages has been significantly less than in the first seven years (21 versus 44 per year). In 2001, the number of Procedural Service Provider outages had its highest annual frequency to date (25), significantly higher than its baseline level (11.5 per year. The frequency of Procedural Service Provider outages has a statistically significant increasing annual rate (20%). The frequency of External Environment outages has a statistically significant decreasing annual rate (8.6%). In 2001, Design Hardware frequency (1) was significantly less than its baseline level (5.8 per year); this frequency has been decreasing at the statistically significant annual rate of 13.4%. The frequency of Facility outages attributed to Hardware Failure has been increasing at the statistically significant annual rate of 29%.

The same three root causes are dominant with respect to the aggregated outage index: Cable Damage (54%), External Environment (16%), and Procedural Service Provider (14%). However, as with frequency, 2001 was the first year that Cable Damage was not the dominant root cause and the first year that Procedural Service Provider was. In 2001, the Procedural Service Provider aggregated outage index reached its highest level to date (280), significantly higher than its baseline level (84); in the last two years, its aggregated outage index has been significantly greater than the first seven years (169 versus 87 per year). In the last two years, the aggregated outage index of Cable Damage outages has been significantly less than in the first seven years (261 versus 445 per year). In the last three years, the aggregated outage index of Cable Damage outages has been significantly less than in the first six years (45 versus 162 per year). Over the last four years, the aggregated outage index of Design Hardware outages has been significantly less than in the first five years (14 versus 86 per year).

Cable Dig-Up

Cable Damage was by far (86%) the largest root cause of Cable Dig-Up incidents during the nine-year reporting history. However, in 2000 and 2001, Cable Damage frequency and aggregated outage index were significantly lower than in the previous seven years (42 per year); on the other hand, Procedural Service Provider frequency in 2000 and 2001 (9.5 per year) was significantly higher than in the first seven years (1.6 per year) as was the aggregated outage index (77 versus 14 per year). In 2001, the Procedural Service Provider aggregated outage index (108) was significantly higher than its baseline level (18 per year). It must be noted, however, that in mid-year 2000 the NRSC changed its classification rules such that the root cause subcategories of Inaccurate Cable Locate and Cable Unlocated are now considered to have a root cause of Procedural Service Provider rather than Cable Damage.

Looking at the root cause subcategories of Cable Damage Facility outages, Inadequate/No Notification has been the biggest contributor (43%). However, in 2001, the number of Cable Damage outages attributed to Inadequate/No Notification was at its lowest level (5) to date; this is significantly lower than the baseline level (17). In the last two years, the frequency of Inadequate/No Notification outages has been significantly less than in the first seven years (7 versus 18.1 per year). Digging Error has been the second biggest contributor to Cable Damage Facility outages (34%). In 2001, Digging Error caused the majority of such Cable Damage outages. However, among all Cable Dig-Up Facility outages, Inaccurate Cable Locate was the root cause subcategory in 9 outages, slightly above the baseline level (7.1).

With respect to the Cable Damage Facility aggregated outage index, the dominant root cause subcategories are: Inadequate/No Notification (45%), Digging Error (34%), and Inaccurate Cable Locate (15%). The aggregated outage index for Inadequate/No Notification also was at its lowest level to date (59) in 2001; over the last two years, it has been significantly lower than in the first seven years (71 versus 196 per year). Over the last five years, the Digging Error annual aggregated outage index has been significantly higher than in the first four years (167 versus 81 per year). **Figures 16** and **17** present the number of outages and aggregated outage index for the Cable Damage root causes of Cable DU.

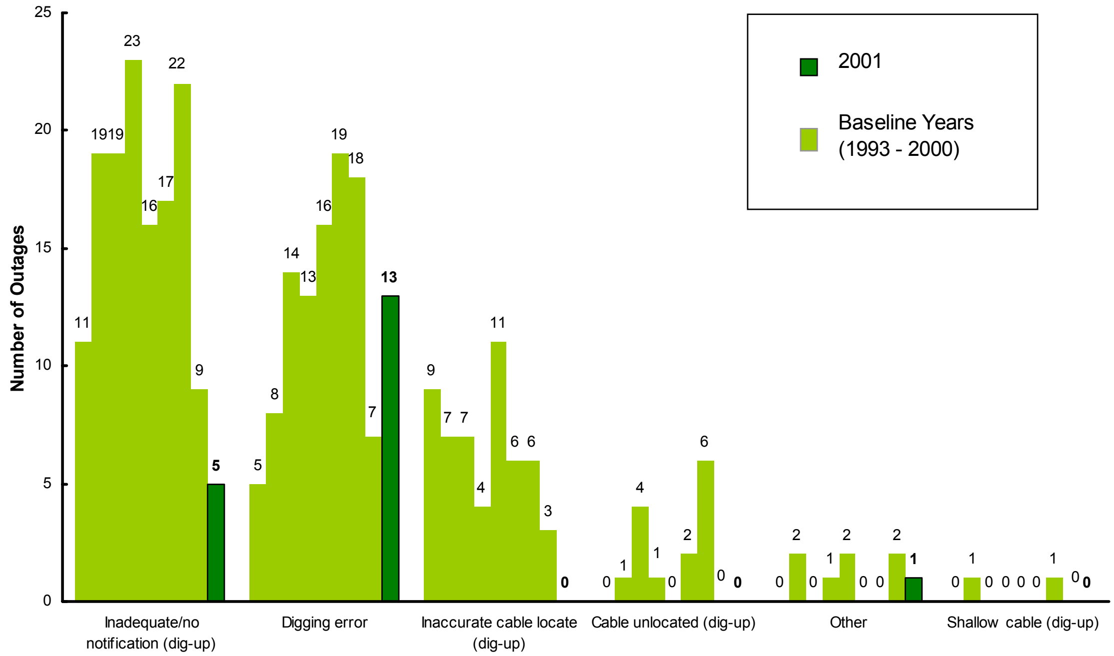


Figure 16: Number of Outages
By Cable Damage Root Cause Subcategories of Cable Dig-Up (DU) Facility Outages
(Note: Beginning in mid-year 2000 the root cause subcategories of Inaccurate Cable Locate and Cable Unlocated are now considered to have a root cause of Procedural Service Provider rather than Cable Damage.)

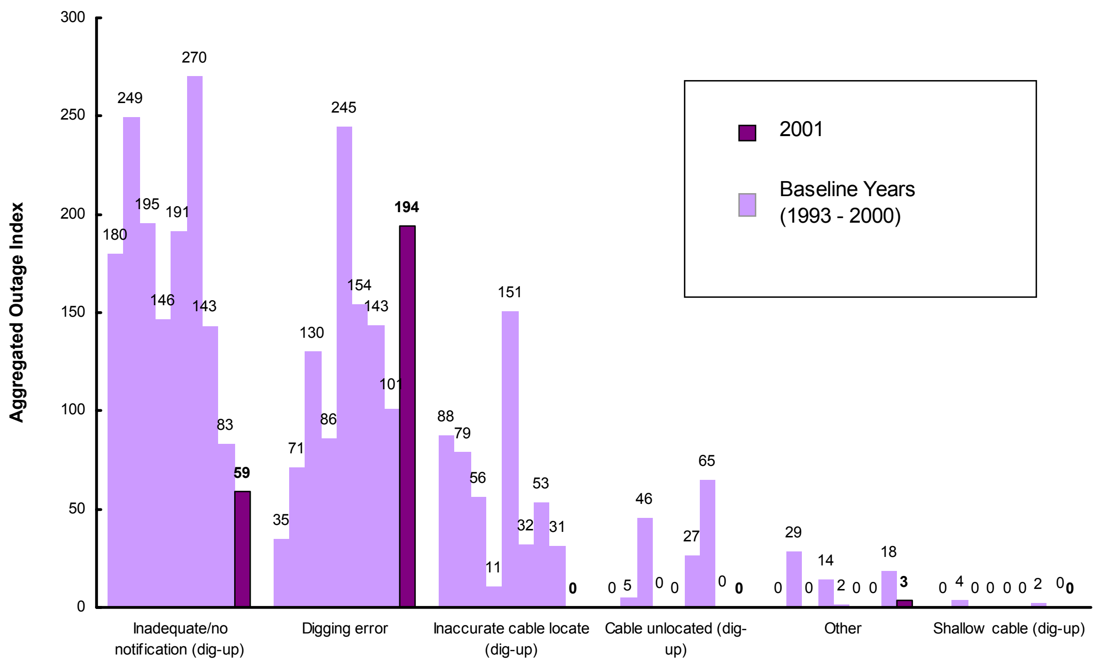


Figure 17: Annual Aggregated Outage Index For
Cable Damage Root Cause Subcategories of Cable Dig-Up (DU) Facility Failures

Cable Electronics

The major root causes of the Cable Electronics[1] attributed facility outages are: Procedural Errors (45%), Design Hardware (17%), Hardware Failure (17%), and Design Software (12%). Design Hardware frequency has been significantly lower in the last four years (0.5 per year) than in the first five years (2.6 per year). Hardware Failure outage frequency has been significantly higher in the last four years (3 per year) than in the first five years (0.6 per year). When considering the aggregated outage index, Procedural Service Provider is the dominant root cause (55%) followed by Design Hardware (25%) and Hardware Failure (10%).

LOCAL SWITCH

The major failure subcategories for Local Switch outages have been Hardware (45%), Software (26%), and Translations (21%). In 2001, Hardware and Software outages had their lowest frequencies to date (7 and 1 respectively); in the case of Software outages, this was significantly lower than its baseline level (7.8). Hardware and Software frequencies demonstrate statistically significant decreasing trends of 7.4% and 11.0% per year respectively. Other outages have occurred significantly more frequently in the past three years than in the first five years (3.8 versus 0.8 per year).

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[1] The Cable Electronics failure subcategory includes repeaters, multiplexers (add/drop, M31, SONET), demultiplexers, regenerators, timing source interface unit, BITS interface card, voltage control oscillator (VCXO) fuses, power unit for facility, etc.

The annual aggregated outage index for Hardware, Software, and Translations all had their lowest values to date (21, 5, and 8 respectively). The annual aggregated outage index for Hardware outages demonstrates a statistically significant decreasing trend over the course of the nine-year history.

Procedural Errors have been the major root cause of Local Switch outages from both the outage frequency and the outage index perspective (52% and 50% respectively). However, in 2001, the number of Procedural Error outages and their aggregated outage index declined to their lowest levels to date (4 and 14 respectively). The frequency was significantly below its baseline level (15.1) as was its aggregated outage index (75 baseline level). In the last two years, Procedural Error frequency and aggregated outage index have been significantly less (6.5 and 28 per year respectively) than in the previous seven years (16 and 79 per year respectively). Design Software had its lowest frequency and aggregated outage index (1 and 1 respectively) to date. In the last five years, Design Software frequency has been significantly less than in the first four years (3 versus 7 per year); its aggregated outage index has also been significantly less (18 versus 52 per year).

Common Channel Signaling (CCS)

Isolation is the dominant failure subcategory (71%) for CCS outages, followed by Link(set)s (12%), STP Equipment (9%), and SCP Equipment (6% each). The number of CCS failures attributed to Isolation over the last two years (39) was greater than in any other two-year period (see **Figure 18**). The number of CCS outages attributed to Link(set)s reached its highest level to date in 2001 (7); it was significantly higher than its baseline level (2). The frequency of CCS outages attributed to Link(set)s has been increasing at the statistically significant rate of 37.3% per year.

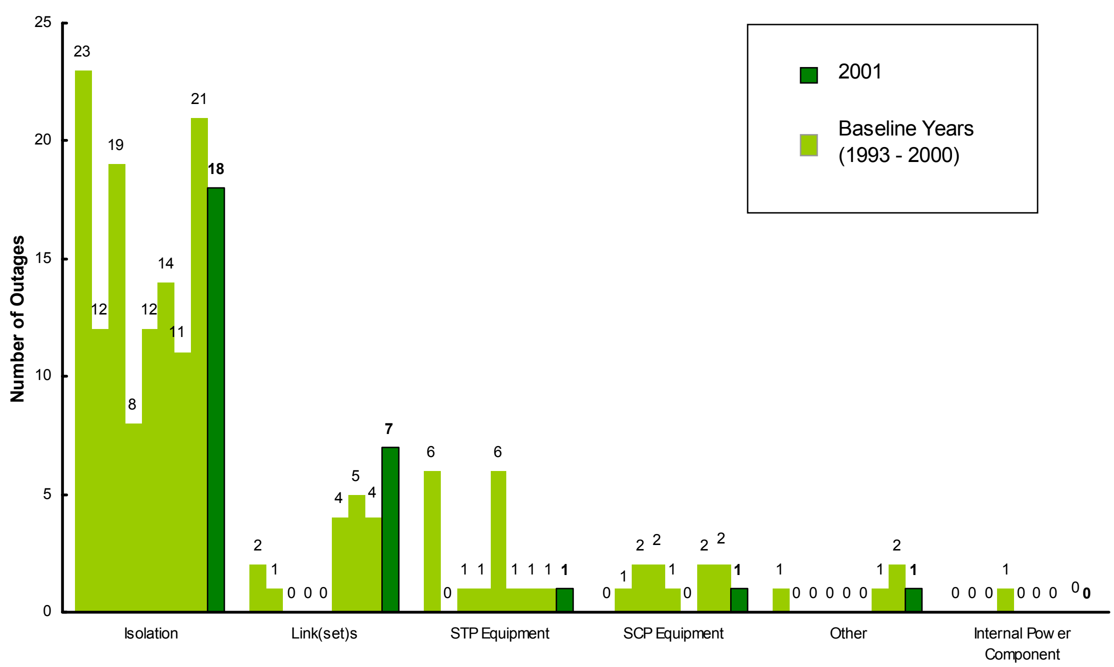

Figure 18: Number of Outages By CCS Failure Subcategory

From the outage index perspective (see **Figure 19**), Isolation (41%), STP Equipment (24%), and SCP Equipment (19%) are the dominant failure subcategories over the nine-year history. However, in 2001, the CCS aggregated outage index was dominated by the SCP Equipment (63), the Link(set)s (48), and Other (55) subcategories, each of which was greater than the Isolation (37) and STP Equipment (10) subcategories. Over the last two years, the CCS aggregated outage index attributed to SCP Equipment has been significantly greater than in the first seven years (63 versus 16 per year). In 2001, the CCS aggregated outage index attributed to Link(set)s (48) was significantly higher than the baseline level (8.5 per year). Over the last four years, the CCS aggregated outage index attributed to Link(set)s has been significantly greater than in the first five years (29 versus 0.3 per year).

Procedural Error (46%), Design Software (19%), Design Hardware (15%), and Hardware Failure (11%) have been the dominant root cause categories. In the last five years, the number of CCS outages attributed to Procedural Error has been significantly greater than in the first four years (12.2 versus 7.3 per year). Design Software has been declining as a root cause category at the statistically significant rate of 20% per year. Design Hardware has been increasing as a root cause category at the statistically significant rate of 21% per year. In 2001, more CCS outages were attributed to Hardware Failure (4) than in any prior year to date.

With respect to the outage index, Procedural Error (54%), Design Software (24%), and Design Hardware (10%) have been dominant. In 2001, the CCS aggregated outage indexes attributed to Design Hardware (38) and Hardware Failure (20) were each higher than in any previous year, significantly higher than their baseline levels (10 and 5 per year respectively). Over the last two years, the CCS aggregated outage index attributed to Design Hardware has been significantly greater than in the first seven years (31 versus 8 per year).

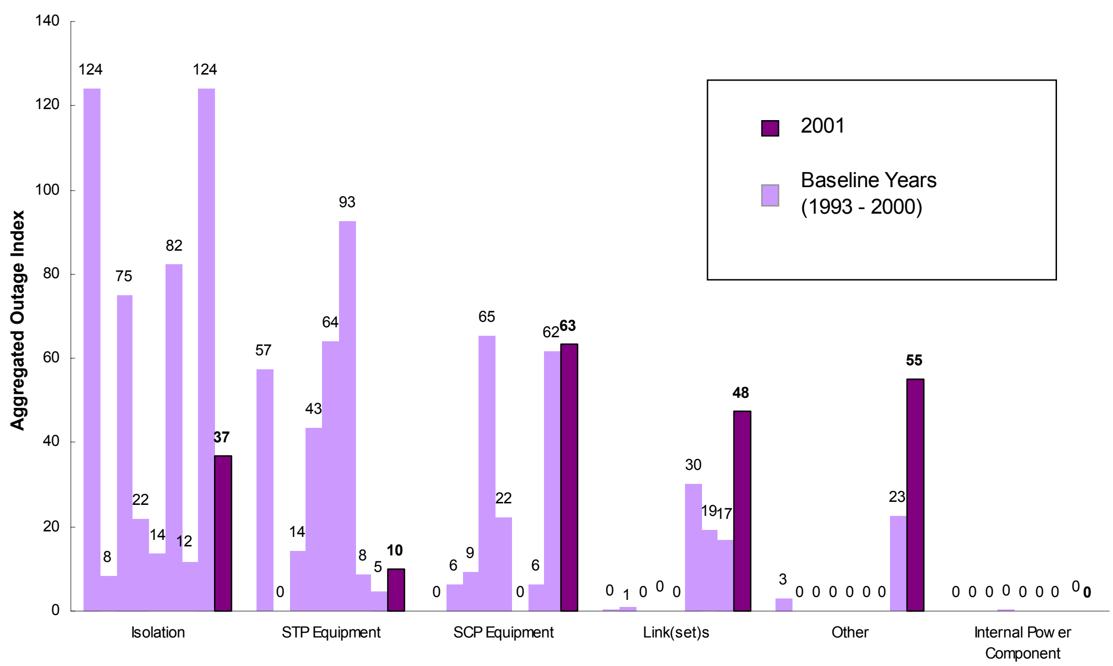

Figure 19: Annual Aggregated Outage Index By CCS Failure Subcategory

TANDEM SWITCH

Software is the major failure subcategory (41%) of Tandem Switch outages followed by Translations (30%) and Hardware (23%). In 2001, Software reached its highest level to date (11) while Hardware had its lowest frequency to data (1). Software is the major failure subcategory (40%) with respect to the aggregated outage index for Tandem Switches followed by Translations (36%), and Hardware (20%). In 2001, the Tandem Switch aggregated outage index attributed to Translations (176) was significantly higher than its baseline level (66 per year); over the last four years, this aggregated outage index has been significantly greater than it was over the first five years (133 versus 34 per year).

Procedural Service Provider (44%) and Design Software (34%) have been the dominant root causes of Tandem Switch outages. In the last two years, the frequency of Tandem Switch outages attributed to Design Software has been significantly greater than in the previous seven years (10 versus 5.4 per year). Procedural Service Provider (47%) and Design Software (31%) are also dominant with respect to aggregated outage index. In 2001, the Tandem Switch aggregated outage index attributed to Procedural Service Provider (208) was significantly greater than its baseline level (89 per year); over the last four years, this aggregated outage index has been significantly higher than in the first five years (158 versus 58 per year).

CENTRAL OFFICE (CO) POWER

The distribution of outages across CO Power subcategories shows that the major contributors are: DC Plant (30%), DC Distribution (25%), Other (19%), Standby Generator (13%), and Building AC (10%). In 2001, more CO Power outages were attributed to DC Plant (8) than to any other subcategory in any year to date. For the last four years, the frequency of CO Power outages attributed to Standby Generator is significantly greater than for the first five years (3.8 versus 0.8 per year).

The major contributors, by failure subcategory, to the CO Power aggregated outage index are: DC Plant (33%), DC Distribution (21%), and Standby Generator (19%). In 2001, the CO Power aggregated outage index attributed to DC Plant had the highest value for any annual value in any category to date (134).

Commercial and/or Back-Up Power Failure (37%) and Procedural Service Provider (35%) are the primary root cause categories among CO Power outages. However, when all three Procedural Error root causes are combined, Procedural Errors cause a majority (52%) of CO Power outages. In 2001, the number of outages attributed to Procedural Service Provider was at its lowest level to date (2) while the numbers attributed to Procedural System Vendor and Procedural Other Vendor reached their highest levels to date (4 each); in the case of Procedural Other Vendor, this was significantly higher than its baseline level (0.8 per year). The frequency of CO Power outages attributed to Procedural System Vendor has been rising at the statistically significant rate of 37% per year. The frequency of Commercial and/or Back-Up Power Failure outages has been increasing at the statistically significant rate of 27% per year.

With respect to the aggregated outage index, Commercial and/or Back-Up Power Failure is the dominant root cause category (45%) followed by Procedural Service Provider (25%). Over the last four years, the CO Power aggregated outage index attributed to Commercial and/or Back-Up Power Failure has been significantly higher than in the first five years (161 versus 16 per year).

DIGITAL CROSS-CONNECT SYSTEMS (DCSS)

Hardware (53%) and Software (32%) are the two major failure subcategories for DCS outages. In 2001, all five DCS outages were attributed to Hardware. With respect to the aggregated outage index, the three major failure subcategories are Hardware (54%), Software (24%), and Other (18%). Over the last four years, the DCS aggregated outage index attributed to Hardware has been significantly higher than in the first five years (66 versus 15 per year).

Looking at the root causes of DCS outages, 28% are attributed to Design Software, 25% to Procedural System Vendor, 18% to Procedural Service Provider, and 12% to Hardware Failure. Over the last four years, Design Software has caused 3 DCS outages per year compared to 0.8 per year in the first five years; this is a statistically significant difference. Also, in the last four years, Hardware Failure has caused 1.8 DCS outages per year compared to none in the first five years; this is a statistically significant difference. With respect to the aggregated outage index, Design Software accounts for 40% of the DCS aggregated outage index, Procedural Service Provider 24%, Procedural System Vendor 10%, and Design Hardware 10%. Over the last four years, the DCS aggregated outage index attributed to Design Software has been significantly higher than in the first five years (52 versus 9 per year).

PROCEDURAL ERROR OUTAGES

Three root cause categories can be grouped as *Procedural Errors (PE)*: Procedural Service Provider, Procedural System Vendor, and Procedural Other Vendor. Procedural Error root cause categories account for 36% of the number of outages and 31% of the aggregated outage index. The significantly largest share of the PE outages is attributable to the Procedural Service Provider (79%) as opposed to the Procedural System Vendor (17%) or Procedural Other Vendor (4%); their shares of the aggregated outage index are close to these values as well.

Figure 20 presents the number of Procedural Error outages in each year. In 2001, Procedural Error outage frequency (63) was in the Green region; it was slightly above the baseline level (60.8), but this difference is not statistically significant. The frequencies of PE outages have been increasing at the statistically significant rate of 6% annually. Their frequency also has a statistically significant seasonality effect. The frequency is high in third quarters (18.4), low in fourth quarters (13.1), and near average in first and second quarters (15.0 and 14.4 respectively).

Figure 21 shows the frequency of PE outages by root cause subcategory. The three major root cause subcategories are Insufficient Supervision/Control (36%), Documentation/Procedures (unavailable, unclear, incomplete) (26%), and Insufficient Training (25%). In 2001, the number of PE outages caused by Insufficient Supervision/Control (33) was significantly higher than its baseline level (20.3). The frequency of PE outages caused by Insufficient Supervision/Control has been rising at the statistically significant rate of 22% per year. On the other hand, Documentation/Procedures (unavailable, unclear, incomplete) outage frequency has been declining at the statistically significant rate of 9% per year. In 2001, PE outages caused by Insufficient Training occurred less frequently than in any other year (6), significantly lower than its baseline level (16.1). In the last two years, 4 PE outages were attributed to Cable Unlocated and 13 to Inaccurate Cable Locate while none were reported in any prior years. This appears to be the result of a change in the classification paradigm. In 2001, all Cable Unlocated and Inaccurate Cable Locate outages were placed in a Procedural Error root cause category. Prior to 2000, all such outages were placed in the Cable Damage root cause category.

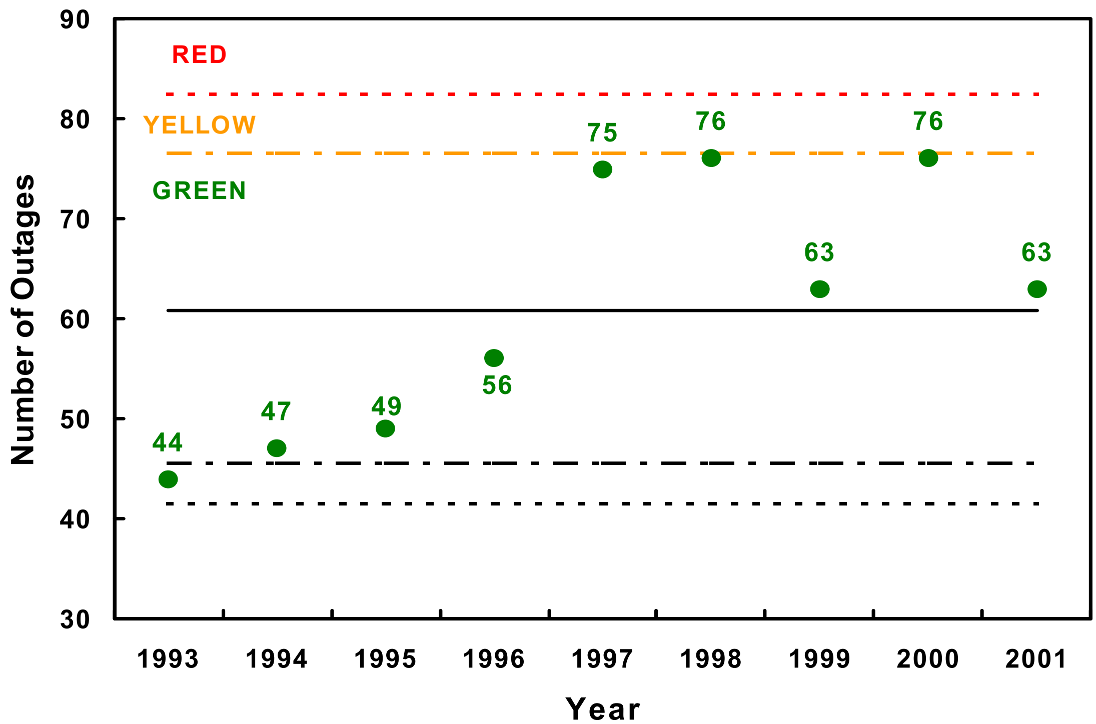

Figure 20: Annual Frequency Control Chart for Procedural Error Outages

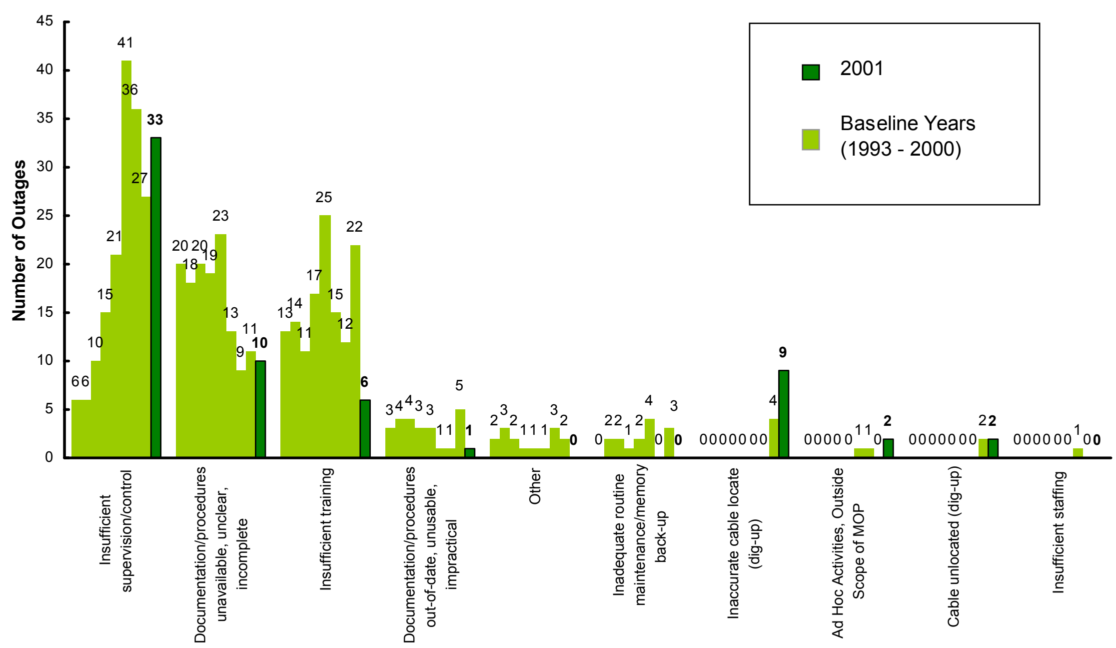

Figure 21: Number Of Outages By Procedural Error Root Cause Subcategory

(Note: Beginning in mid-year 2000 the root cause subcategories of Inaccurate Cable Locate and Cable Unlocated are now considered to have a root cause of Procedural Service Provider rather than Cable Damage.)

In 2001, the annual aggregated outage index of Procedural Errors was the highest to date (820), significantly higher than the baseline level (471) (**Figure 22**). In the last two years, the PE aggregated outage index has been significantly higher than in the first seven years (720 versus 450 per year). The dominant root cause subcategories of Procedural Error outages are Insufficient Supervision/Control (38%), Documentation/Procedures (unavailable, unclear, incomplete) (30%), and Insufficient Training (19%). In 2001, he annual aggregated outage index of Insufficient Supervision/Control outages reached its highest level to date (491) significantly higher than its baseline level (154); it has risen at the statistically significant rate of 46% annually. In the last three years, the annual aggregated outage index of Documentation/Procedures (out-of-date, unusable, impractical) outages has been significantly less than in the first six years (82 versus 189 per year).

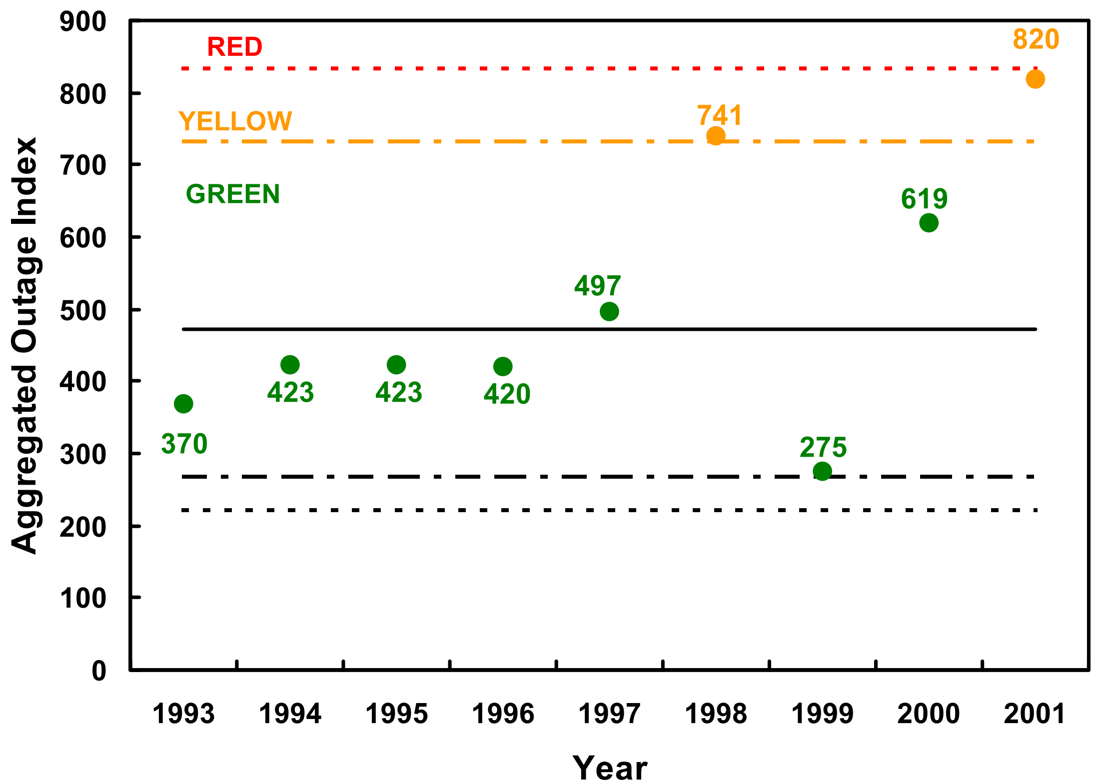

Figure 22: Annual Aggregated Outage Index Control Chart for Procedural Error Outages

"SPECIAL" OUTAGES

In addition to those outages that impact 30,000 or more customers for more than 30 minutes, carriers are also required to report outages below the 30,000 customer threshold that affect major airports, major military installations, key government facilities, nuclear power plants, and 911 service. Carriers are also required to report fire-related incidents which impact 1,000 or more lines for 30 minutes or longer. During 2001 there were fifteen (15) outages that fell in these categories.

Of these fifteen outages, two (2) were reportable because of their impact on major airports, one (1) was reportable because of its impact to 911 service, and twelve (12) were reportable fire-related incidents. A PASP isolation, which separately would not have been reportable, also occurred during one of the fire-related outages.

One of the outages affecting a major airport occurred when a contractor cut the fiber cable serving the Air Route Traffic Control Center affecting air to ground communication. The cable locate had been performed properly and the cable was in the public right of way. The duration of this incident was 7 hours and 50 minutes. The second outage impacting a major airport occurred when the FAA circuits began taking "hits" for approximately 3 hours and 30 minutes. Investigation by the carrier did not result in a confirmed cause of the incident. However, findings by the investigation team indicated that the trouble could not have been within the carrier's network. The carrier never initiated or performed any repair or restorative activity on these circuits or any system related to these circuits. The duration of this incident was 3 hours and 30 minutes.

The one outage that was reportable because of its impact to 911 service occurred as the result of a hardware failure. This failure rendered an OC-48 card into a "hard Fault" condition and unable to switch service to the protection card. The carrier has since deployed alternate routes to attain proper physical diversity from the primary route. The duration of this incident was 2 hours and 23 minutes.

Of the twelve (12) outages caused by fire, three (3) were the result of vandalism; three (3) were due to vehicle fire/explosion; two (2) were the result of a fire/explosion in an adjacent electric manhole; two (2) were caused by wildfire/controlled burns; one was weather related; and one was due to a natural gas explosion in a remote central office. The average duration of these outages was in excess of 69 hours, far more than the 7.47 hours average for the larger Facility outages. In almost all cases multiple cables had to be replaced and in many cases repairs were delayed when local public safety officials delayed access to the area. The average number of customers affected was 2,329. By definition, these outages affect less than 30,000 customers and therefore comparison of the number of customers impacted to larger reported outages is meaningless.

THE NRSC TIMING OUTAGES TASK GROUP

Over the years, the NRSC has chartered a number of teams to address identified "hot spots" that appear in the course of its outage analysis. Most notable among these have been its Facilities Solution Team, the Procedural Error Team and the Internet Study Team. In the second half of 2001, "timing" was observed to be an increasing factor in network outages. Accordingly, the NRSC established a "Timing Outages Task Group" to investigate and report its recommendations to the Committee.

The Task Group's analysis of outages reported in 2000 and 2001 indicated that timing was a factor in 9.4% of all outages and 33% of all SS7 outages. As a result of its investigation, the Task group developed the following three new Best Practices:

- Network Operators and Service Providers should insure that engineering, design, and installation processes address how new network elements are integrated into the office synchronization plan.
- Network Operators and Service Providers should develop management and records keeping tools that accurately track the diversity of internal wiring for office synchronization, including timing leads and power.
- Network operators and Service Providers should conduct periodic verification of the office synchronization plan and the diversity of timing links, power feeds and alarms.

In addition to these best practices, the Task Group also makes the following recommendations regarding office inspections and new procedures:

- Upgrade all BITS clocks to models capable of full A/B power redundancy.
- Verify that BITS is on fully protected power (UPS) with generator, and fed separately (A/B).
- If D4 channel banks are used for transporting common channel signaling, there are special timing considerations:
  - Redundant SS7 links should be timed from redundant timing sources (e.g., from different BITS timing output cards)
  - Typically, all D4 shelves (e.g., six) can be "daisy chained" with the same BITS clock lead. As such, the redundant SS7 links should terminate on bays or shelves with different timing sources.
- Periodic tests for BITS switchover should be executed where applicable
  - Power (A/B)
  - Input (redundant clock cards)
  - Output (redundant timing output cards
  - Alarms (e.g., power, input, output, fuse)
- A one-time physical audit of timing redundancy, with special attention to SS7 link diversity should be conducted.

- Any outages, which are determined to have BITS clock as a contributing cause, whether supplier/service provider/or other attributable, should be shared with the BITS clock supplier to assist that supplier in improving the quality of its product.

The NRSC supports the Best Practices and Recommendations of its Timing Outages Task Group, and further recommends that Service Providers and Network Operators conduct office inspections of BITS and intra-office facilities on a priority basis. The complete NRSC Timing Outages Task Group Report may be found at www.atis.org/atis/nrsc/nrschome.htm.

THE NETWORK RELIABILITY (AND INTEROPERABILITY) COUNCILS

Following the major network disruptions of 1991, the Network Reliability Council (NRC) was established by the FCC to bring together leaders of the telecommunications industry and experts from academia and consumer groups to explore and recommend measures that would enhance network reliability. At the end of its term in June 1993, the original NRC published *"Network Reliability: A Report to the Nation,"* a compendium of technical papers prepared by the various NRC Focus Groups. This compendium became known as the "Purple Book" and the recommendations therein became known as "Best Practices." The NRC encouraged the industry to study and assess the applicability of these recommendations for implementation in their companies. It was at the request of the NRC that ATIS established the NRSC in May 1993. The final report of NRC-I may be found at www.nric.org.

In April 1996, the second NRC published another compendium of technical papers, *"Network Reliability: The Path Forward."* This report was prepared in response to the question "How do we continue to keep the public switched network reliable and, at the same time, accomplish increased interconnection, and introduce major new technologies into the network?" The first of these papers was prepared by a group composed of the NRSC and augmented by participants from cellular, cable, and satellite service providers. The final report of NRC-II may be found at www.nric.org.

In July 1997, the third NRC (now renamed the Network Reliability and Interoperability Council (NRIC)) produced a report on implementing Section 256 of the Telecommunications Act of 1996. Section 256 has as its fundamental purpose the promotion of additional competition, innovation, and deregulation in telecommunications. The report entitled *"Network Interoperability: The Key to Competition"* presents findings and recommendations related to network connectivity and planning oversight, and the FCC's role in the standards setting process. The final report of NRIC-III may be found at www.nric.org.

In October 1998 NRIC-IV was launched. The primary role of this effort was to provide advice to the FCC on Year 2000 issues affecting telecommunications. However, other national network reliability issues were also addressed. The first of these was to report on the reliability of public telecommunications network services in the United States; the second was to determine whether "Best Practices" previously recommended should be modified or supplemented; and the third was to develop a proposal to extend these best practices to other industry segments not presently included in the current practices. Among the final recommendations of this Council was one to conduct a voluntary outage reporting trial with participation by service providers of CMRS (Commercial Mobile Radio Services), satellite, cable, data networking and Internet Service Providers (ISPs) to alert the National Communications systems/National Coordinating Center for Telecommunications

(NCS/NCC) of outages that are likely to have significant public impact. A process for reporting data during the voluntary trial was also addressed and included in the Final Report. (See also NRIC-V and NRIC-VI below.) The results of these efforts may be found on the NRSC web page at www.atis.org/atis/nricgr3.htm.

The Fifth Council (NRIC-V) began in March 2000. For the first time since the inception of the NRIC, the FCC included in the charter of the Council the mandate to address the unique issues arising from the interconnection of circuit-switched and packet-switched networks. The Council accomplished this through the efforts of its Focus Groups on Best Practices and Data Reporting and Analysis, both of which addressed their work from both the circuit and packet perspective. Other Focus Groups considered issues related to wireline network spectral integrity, and network interoperability. The voluntary outage reporting trial recommended by NRIC-IV was also implemented during this Council. However, for various reasons (as enumerated in the Final Report of this Council) there was limited participation in the trial and the Council's recommendation in this regard was that the trial be terminated (see also NRIC-IV above and NRIC-VI below). The final report of NRIC-V may be found at www.nric.org.

The first meeting of the Sixth Council (NRIC-VI) was held in March 2002. The scope of the Sixth Council encompasses recommendations that would ensure the security and sustainability of public telecommunications networks throughout the United States; ensure the availability of adequate public telecommunications capacity during events or periods of exceptional stress due to natural disaster, terrorist attacks or similar occurrences; and facilitating the rapid restoration of telecommunications services in the event of widespread or major disruptions in the provision of telecommunications services. The Council will address topics in the following areas: Homeland Security (physical security, cyber security, public safety, disaster recovery and mutual aid), Network Reliability (voice, data and video), Network Interoperability, and Broadband. Although the final report from NRIC-V recommended that the voluntary outage reporting trial begun during that Council be terminated, the FCC asked that the trial be continued, the results analyzed, and be used in the development of an outage reporting process for all parts of the communications industry. Further information on the Sixth Council may be found at www.nric.org.

CONCLUSION

Through the NRSC, the communications industry and other stakeholder representatives collectively take great care in making observations, conducting analyses and identifying the key insights from the major network outages that occur in the U.S. The NRSC 2001 Annual Report provides both a summary and detailed review of this work. As with previous annual reports the 2001 messages reflect a degree of complexity.

The NRSC's primary measures, overall outage frequency and overall outage index, yield five key insights:

i. Long Term Overall Outage Frequency is increasing, but at a statistically insignificant rate
ii. Long Term Overall Outage Index exhibits neither an increasing nor decreasing trend
iii. 2001 Total Number of Reported Outages was the lowest of any year to date
iv. 2001 Outage Index was the second highest to date
v. 2001 Average Outage Index was the highest to date

None of these observations are strong (statistically significant) trends, yet they demonstrate a "feel of the pulse" – the ability to monitor and detect possible future directions. For example, the stand alone 2001 data points may be an early indication of major network outages that are less frequent but more potent in impact. It should also be noted that the long term insights are not adjusted (to be more positive) for the long term expansion in size (lines) and increased usage (calls) of the U.S. public switched networks, which some believe would give a better relative description of how the subscriber population experiences reliability.

Four outage categories also yield a number of key insights:

i. Facility Outages
   - the number of outages dropped in 2001 to the lowest level since 1993
   - the average number of Facility Outages in 2000 and 2001 is significantly lower than the previous seven years
ii. CCS Outages
   - the average number of CCS Outages in 2000 and 2001 have increased and are significantly higher than the average of the previous seven years
   - a study by the NRSC determined that all CCS Outages in that study could have been prevented if Best Practices were implemented
iii. Local Switch Outages
   - had their lowest annual frequency to date
   - for the fifth consecutive year decreased or remained the same from the previous year
iv. Central Office Power Outages
   - frequency reached its second highest level to date
   - 2001 marked the fifth consecutive year above the baseline level
   - when emphasized, Best Practices have been shown to be effective in preventing power outages

The NRSC is encouraged by the fact that for the two categories of concern—CCS and CO Power—the industry knows how to address the problem: implement existing, applicable Best Practices. Implementation of Best Practices is invaluable in preventing and mitigating outages and, taken as a whole, will sustain and continuously improve network reliability. In order to promote better Best Practices implementation, NRIC recently improved the accessibility and usability of industry Best Practices (www.nric.org). However, each service provider, network operator and equipment supplier needs to continuously review—and in some cases place immediate emphasis on—Best Practices, and apply as appropriate.