Network Reliability Steering Committee

Annual Report

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 2002, as well as trends observed over the last ten years of outage reporting to the FCC. It was a year of challenge as the Telecommunications Industry addressed dimensions of reliability that were brought to the forefront following the September 11, 2001 terrorist attack. A major focus of the Network Reliability and Interoperability Council VI (NRIC VI) is Homeland Security, and the collective effort of its members and contributors has resulted in the addition of approximately 500 new Best Practices (now 750 total) in the areas of Physical Security, Cyber Security, Public Safety, and Disaster Recovery. The criticality of the nation's communications infrastructure is highlighted as never before, and the industry's cooperation and commitment to service and reliability has never been more important.

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 the continued overall reliability of telecommunications networks and services. However, further analysis shows departures from these limits in several areas. The number of outages and the aggregated outage index were lower than in any year to date. The Facility outage category had the lowest annual frequency and aggregated outage index to date, and Local Switch had the lowest annual frequency and second lowest aggregated outage index to date. Common Channel Signaling outages had the highest aggregated outage index among failure categories, the first time that any category exceeded the aggregated outage index of the Facility category. 2002 had the outage with the highest outage index to date and outage durations were significantly longer that in the Baseline Years.

Analysis of outage data over the course of the ten-year data history shows that total outage frequency has been decreasing at a rate of 16% over the last three years. Facility outage frequency has been decreasing at a rate of 9% annually over the last six years. The Facility outage aggregated outage index has been decreasing at a rate of 7% annually. Local Switch outage frequency has been decreasing at a rate of 25% annually over the last five years while Local Switch aggregated outage index has been decreasing 14% annually over the entire 10-year history. CCS outage frequency has been increasing at a rate of 13% annually over the last seven years and CCS aggregated outage index has a statistically significant increasing trend since 1994. Central Office Power outage frequency has been increasing at a rate of 7% annually. Digital Cross-connect Systems (DCS) outages have been twice more frequent in the last six years than in the first four years while DCS aggregated outage index has been significantly higher over the same period as well. Outage indexes in the last two years have been significantly higher than in the first eight years.

As in previous Annual Reports, I encourage all service providers and vendors to review the best practices documents available on the NRSC web site ("Timing Outages Task Group Report", "Fixing Facilities Damages", "Procedural Outage Reduction Report", and "NRIC IV Analysis and Recommendations on Best Practices") at http://www.atis.org/atis/nrsc/nrschome.htm and the NRIC Best Practices available on the web in searchable format at http://www.nric.org/ .

The work of the NRSC over the past ten years represents a great heritage of raising the level of the industry platform for circuit switched voice services in the United States. This process of analyzing data, conducting special studies, and making recommendations based on Best Practices is a model that can improve the platform for other communications services and industry segments. I am confident that the industry will realize tremendous benefit from this forward looking work, both because of this process that has evolved and because of the collaboration and dedication of the industry, consumer, and government representatives that make up the NRSC.

Given this rich history and the interdependency of critical infrastructures, it might also be time to reach out and share our processes and best practices with other industries beyond communications.

P.J. Aduskevicz
Chair NRSC

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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, 2002. 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 majority of the analysis results presented here are limited to those outages reported on the basis of these 30,000 customer/30 minute thresholds. The report is divided into two major sections. The first section describes network performance overall and within failure categories. The second section provides further breakdown analyses of failure subcategories and root cause categories within each failure category. In both sections, the major metrics examined are number of outages and aggregated outage index. The first section also examines the number of customers potentially affected and outage duration per outage. The report concludes with a summary of 2002 results relative to prior history.

The "Special" Outages section covers reports filed by carriers below the 30,000 customer threshold that affect major airports, major military installations, key government facilities, nuclear power plants, and 911 service, as well as fire-related incidents which impact 1,000 or more lines for 30 minutes or longer.

During 2002, members and participants in the NRSC included:

- AT&T
- BellSouth
- Consumer Representative
- CTIA
- Federal Communications Commission (FCC)
- Lucent Technologies
- National Communications System (NCS)
- Nortel Networks
- Qwest Communications
- SBC
- Sprint
- Tellabs
- Telcordia Technologies
- Union Pacific Railroad
- Verizon

MAJOR FINDINGS

In general, network performance remained within control limits in 2002. However, 2002 saw departures from these limits in several areas:

- 2002 had the lowest number of outages to date, significantly lower than the Baseline Level.
- The overall aggregated outage index dropped to its lowest annual level to date.
- Facility outages had the lowest frequency and aggregated outage index to date, both significantly lower than their Baseline Levels.
- 2002 had the lowest number of Local Switch outages to date, significantly lower than the Baseline Level.
- The number of Tandem Switch outages dropped to its lowest annual level to date.
- Common Channel Signaling (CCS) aggregated outage index reached its highest level to date, significantly higher than its Baseline Level, and had the highest aggregated outage index among failure categories.
- Outage durations were significantly longer than in the Baseline Years.

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

- Outage frequency has been decreasing at a rate of 16% annually over the last three years.
- Facility outage frequency has been decreasing at a rate of 9% annually over the last six years.
- The Facility outage aggregated outage index has been decreasing at a rate of 7% annually.
- Local Switch outage frequency has been decreasing at a rate of 25% annually over the last five years. The aggregated outage index for Local Switch outages has been decreasing 14% annually over the entire ten-year history.
- CCS outage frequency has been increasing at a rate of 13% annually over the last seven years and their aggregated outage index has a statistically significant increasing trend since 1994.
- Central Office (CO) Power outage frequency has been increasing at a rate of 7% annually.
- Outage indexes in the last two years have been significantly higher than in the first eight 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, 2002. Data from January 1, 1993 through December 31, 2001 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 2001 are referred to as the *Baseline Years*.

In general, network performance remained within control limits in 2002. However, 2002 saw departures from these limits in several areas. In particular,

- 2002 had the lowest number of outages to date, significantly lower than the Baseline Level.
- Facility outages had the lowest frequency and aggregated outage index to date, both significantly lower than their Baseline Levels.
- 2002 had the lowest number of Local Switch outages to date, significantly lower than the Baseline Level.
- Local Switch had their second lowest annual aggregated outage index, significantly lower than the Baseline Level.
- CCS outages had the highest aggregated outage index among failure categories; the first year that a category other than Facility had the highest aggregated outage index. CCS aggregated outage index reached its highest level to date, significantly higher than its Baseline Level.
- 2002 had the outage with the highest outage index to date.
- Outage durations were significantly longer than in the Baseline Years.

Network performance areas in 2002 that remained within control limits but are still noteworthy include:

- The overall aggregated outage index dropped to its lowest annual level to date.
- The number of Tandem Switch outages dropped to its lowest annual level to date.
- CO Power outage frequency dropped to its lowest annual level since 1996 and their aggregated outage index dropped to its lowest annual level since 1997.
- The median number of customers potentially affected by an outage was the lowest since 1994.

Several significant trends are noted in the 10-year report history:

- Outage frequency has been decreasing at a rate of 16% annually over the last three years.
- Facility outage frequency has been decreasing at a rate of 9% annually over the last six years.
- The Facility outage aggregated outage index has been decreasing at a rate of 7% annually.
- Local Switch outage frequency has been decreasing at a rate of 25% annually over the last five years while their aggregated outage index has been decreasing 14% annually over the entire 10-year history.
- CCS outage frequency has been increasing at a rate of 13% annually over the last seven years and their aggregated outage index has a statistically significant increasing trend since 1994.
- CO Power outage frequency has been increasing at a rate of 7% annually.
- DCS outages have been twice more frequent in the last six years than in the first four years while its aggregated outage index has been significantly higher over the same period as well.
- Outage indexes in the last two years have been significantly higher than in the first eight 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.

Performance by Outage Frequency

Annual outage frequencies are shown in **Figure 1**. The number of outages in 2002 (117) was lower than in any year to date. The Baseline Level for annual outage frequency is 171.1. The difference between the 2002 outage frequency and the Baseline Level is statistically significant.

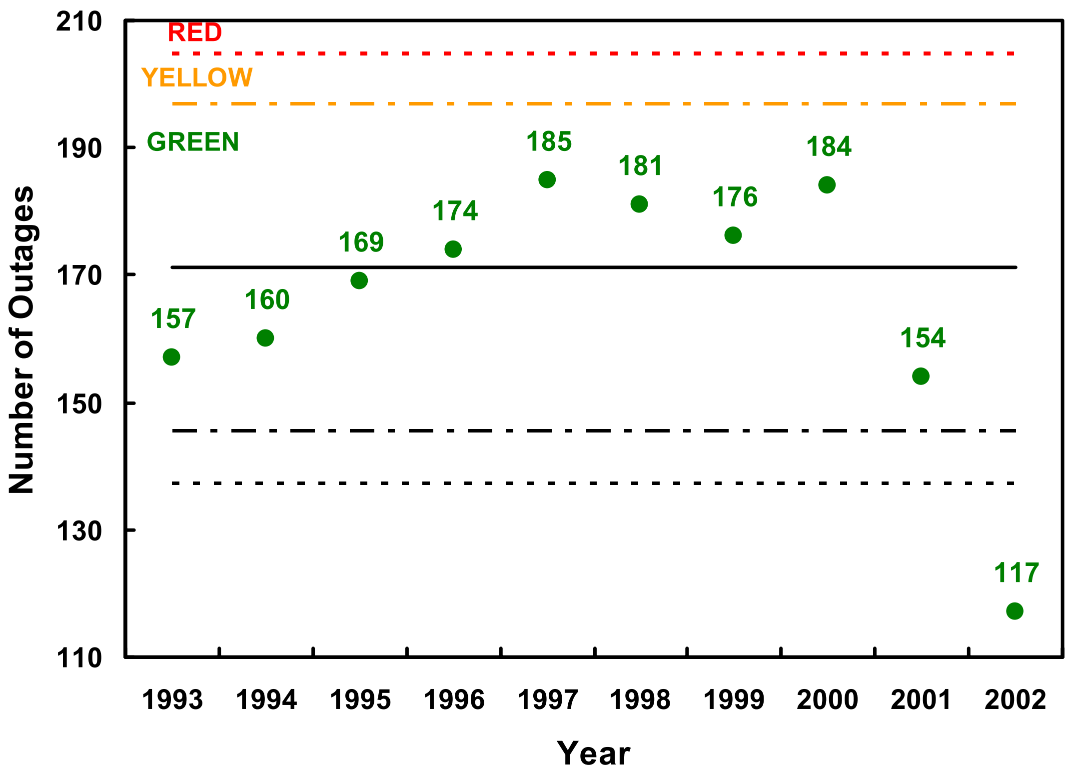


Figure 1: Annual Control Chart for Outage Frequency

Figure 2 is a control chart for outage frequency by quarter. For each quarter of 2002, the number of outages was below the Baseline Level. The blue line plotting a spline fit to the quarterly data indicates a recent decreasing trend in outage frequency. A fit to data from 2000 to 2002 indicates this decreasing trend in outage frequency (4.3% quarterly) is statistically significant. Outage frequency has been highest in the third quarter (47.4 outages per quarter on average) while the other three quarters each have about 39 outages on average; these differences in seasonal outage frequency are statistically significant.

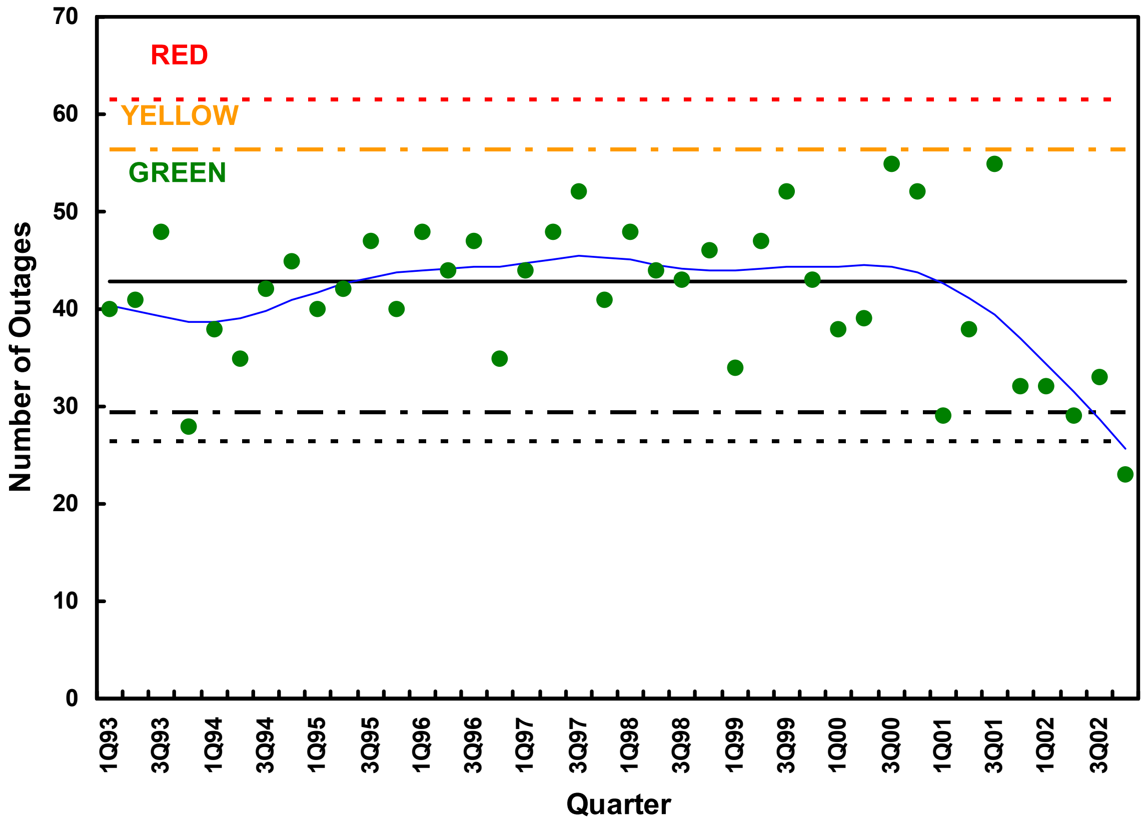


Figure 2: Quarterly Control Chart for Outage Frequency

Figure 3 provides the distribution of outage frequency by failure category: In 2002, 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 (47) dropped in 2002 to its lowest level to date. The difference from the Baseline Level (75.3) was statistically significant, below the 99% lower tolerance limit. The frequency of Facility outages demonstrates a statistically significant decreasing trend (9% annually) over the last six years. Facility outage frequencies in 2002 and over all years (72.5 outages per year, 44% of the total) are significantly higher than in any other category.

- *Local Switch*
  In 2002, Local Switch outages had their lowest annual frequency to date (10). The difference from the Baseline Level (26.6) was statistically significant, below the 99% lower tolerance limit for the second consecutive year. The frequency of Local Switch outages demonstrates a statistically significant decreasing trend (25% annually) over the last five years. Over all years, Local Switch outages have the second highest frequency (24.9 outages per year, 15% of the total), significantly higher than all categories (apart from Facility and CCS). However, since 1999, it has had a lower frequency (17.3 outages per year, 11% of the total) than any

category apart from DCS and Other.

- *Common Channel Signaling (CCS)*
  In 2002, CCS outage frequency was the second highest (26) among failure categories for the second consecutive year. CCS outages have a statistically significant increasing trend (13% annually) over the last seven years. Over the last four years, CCS outages have had the second highest frequency (26 outages per year, 16% of the total) among failure categories; this ranking is statistically significant.

- *Tandem Switch*
  The number of Tandem Switch outages dropped in 2002 to its lowest level to date (12). However, it was not significantly lower than its Baseline Level (19). Tandem Switch outages have no significant overall trend. Out of all outages, 11% are Tandem outages.

- *Central Office (CO) Power*
  In 2002, CO Power outage frequency (13) dropped to its lowest annual level since 1996. This was also the first year that CO Power outage frequency was below the Baseline Level since 1996. Over the entire 10-year history, CO Power outage frequency demonstrates a statistically significant trend (7% increase per year) and seasonality (63% of outages occur in the warmer half of the year). Out of all outages, 10% are CO Power outages.

- *Digital Cross-connect System (DCS)*
  In 2002, DCS outage frequency (7) was near its annual Baseline Level (6.3). It increased for the first year since 1998. While DCS outages have no significant overall trend, the average number of DCS outages starting in 1997 (8 annually) is significantly higher than the average of the first four years (4 annually). DCS outage frequency over all years (6.4 outages per year, 4% of the total) is significantly lower than in any other failure category (apart from Other).

- *Other*
  In 2002, Other outage frequency matched its lowest level to date (2). This was the first year it has decreased since 1998. Other outages have no significant overall trend. Other outage frequency over all years (5.6 outages per year, 3% of the total) is significantly lower than in any other failure category (apart from DCS).

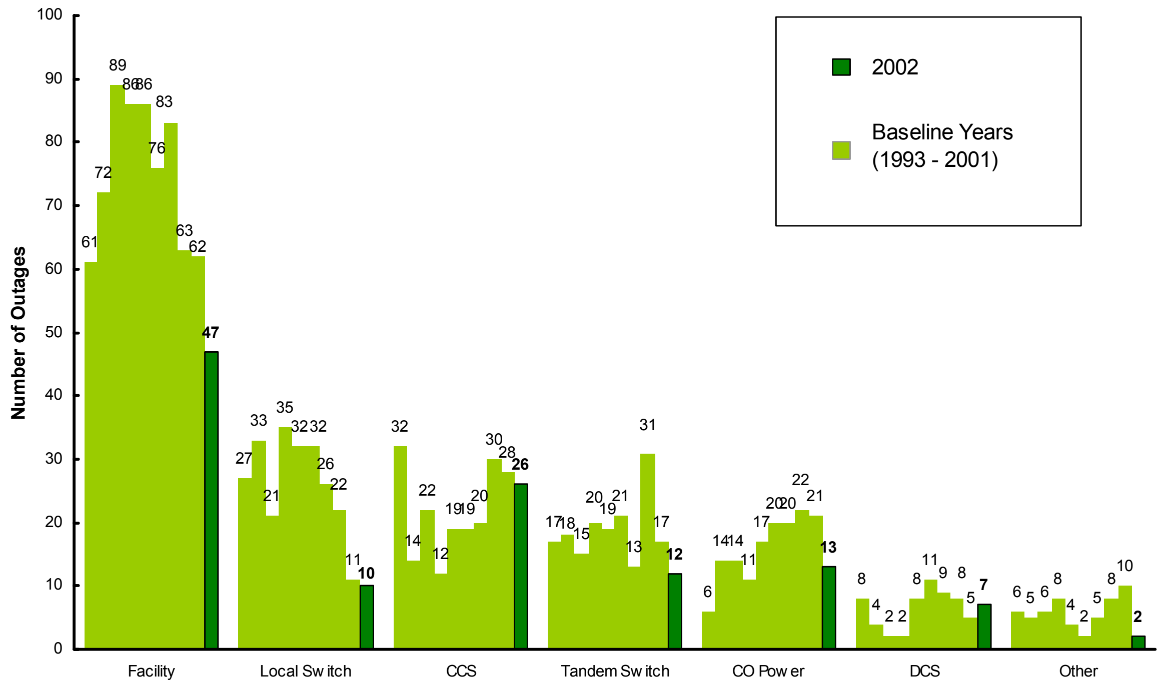


Figure 3: Number of Outages by Failure Category

Performance By Outage Duration

Figure 4 provides a summary of the distribution of outage duration for the ten 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 2002 had durations less than 11.39 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 90 hours were instrumental in producing the second highest mean duration of outages to date (11.15 hours). 2002 had the second highest median outage duration to date (3.42 hours), significantly higher than the Baseline Level (2.88 hours). Median outage duration does not demonstrate a statistically significant trend over time.

Analyses by failure category (**Figure 5)** shows 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 2002, Tandem Switch outages had their highest median duration to date (8.1 hours), significantly higher than the baseline median (2.4 hours).
- In 2002, CCS outages had their highest median duration to date (2.3 hours), significantly higher than the baseline median (1.3 hours).
- In 2002, Local Switch outages had their highest median duration to date (2.2 hours), significantly higher than the baseline median (1.3 hours).
- The duration of Facility outages over the last four years (1999-2002) has been significantly lower (4.3 hours) than in the first six years (5.2 hours).

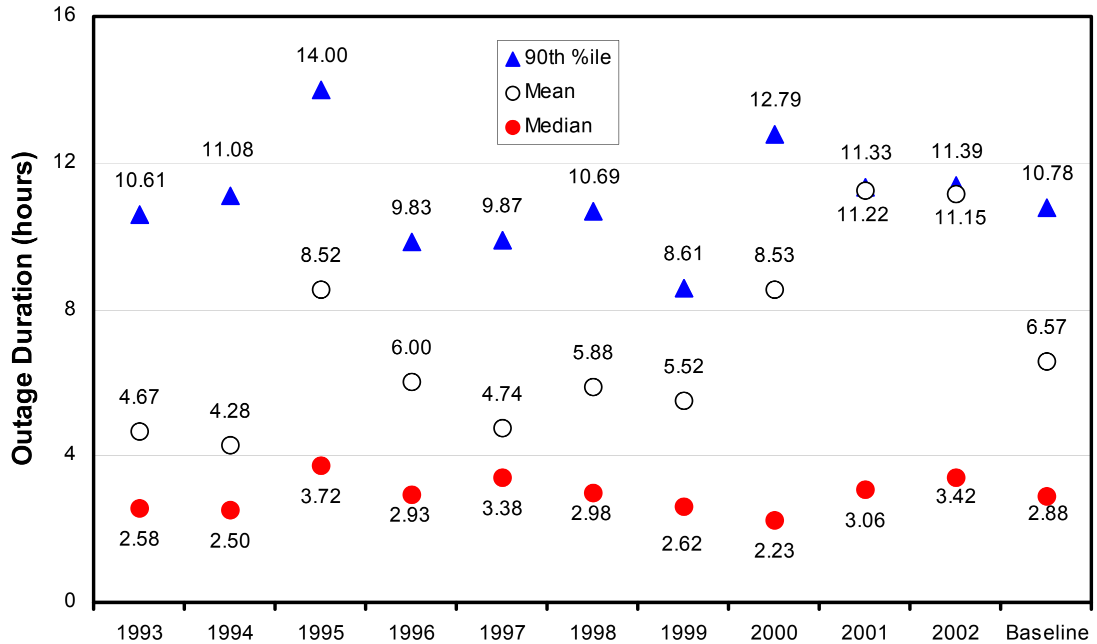


Figure 4: Annual Distributions of Outage Durations

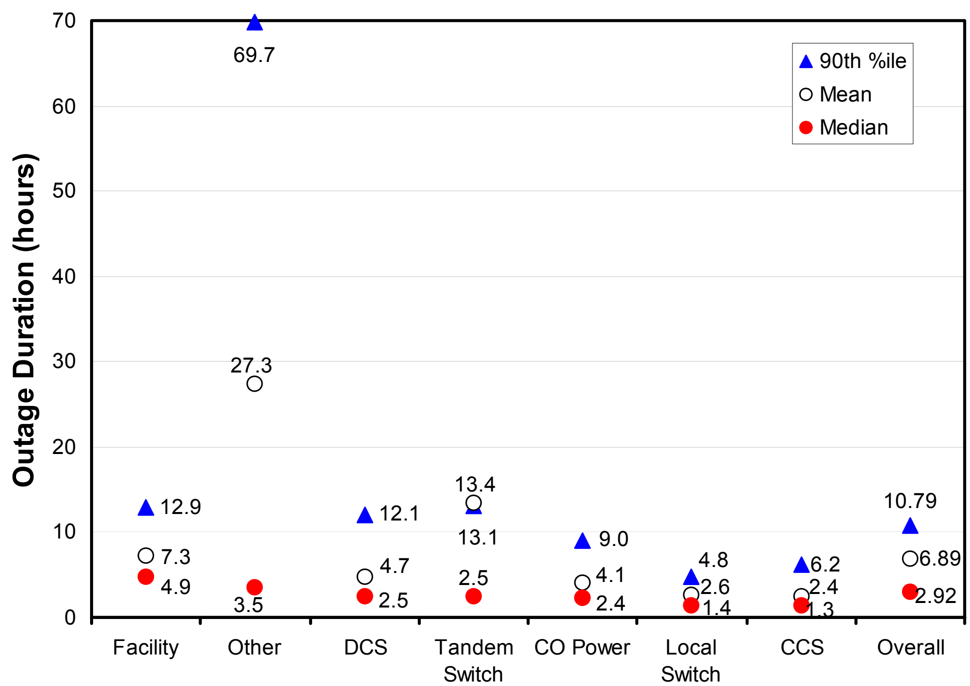


Figure 5: Distributions of Outage Durations by Failure Category

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 2002. 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 (53,500) was the lowest since 1994. Still, the distribution of customers potentially affected per outage in 2002 was not significantly different than in the Baseline Years (56,100). The median number of customers potentially affected by an outage does not demonstrate a statistically significant trend over time.

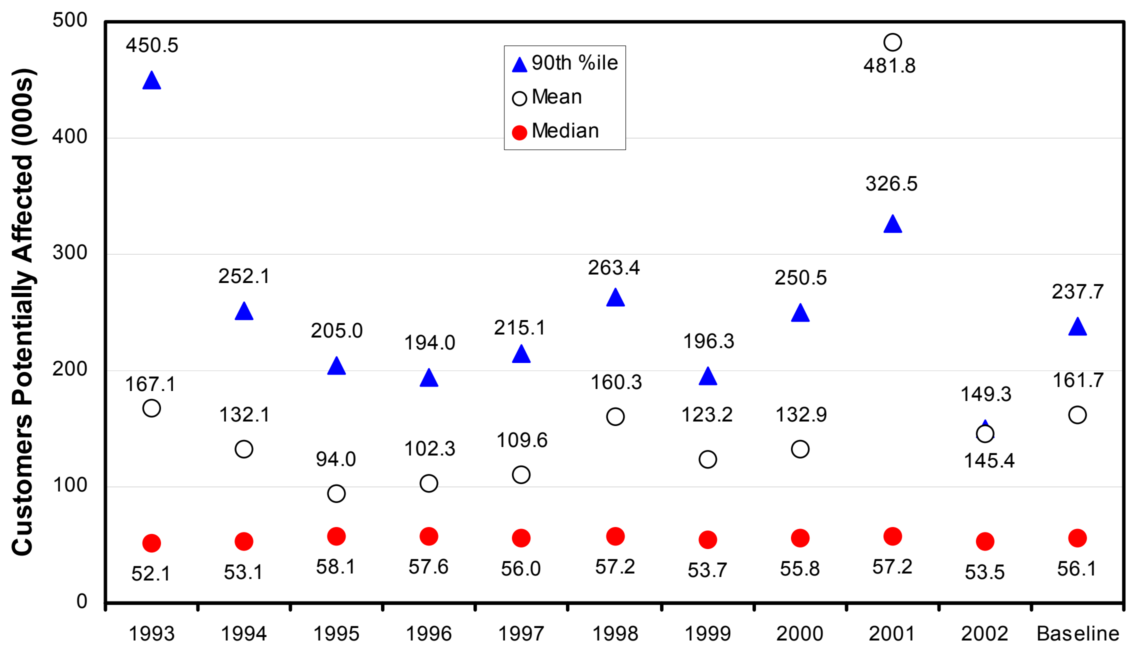


Figure 6: Annual Distributions of Customers Potentially Affected per Outage

Analyses by failure category (**Figure 7)** show that Tandem Switch 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 2002, CO Power outages had their highest median customers potentially affected to date (64,200). The median number of customers affected by CO Power outages has a statistically significant increasing trend over time.
- In 2002, Facility outages had their lowest median customers potentially affected to date (50,000), significantly lower than its Baseline Level (64,700). The median number of customers affected by Facility outages has a statistically significant decreasing trend over time.
- In 2002, Local Switch outages had their highest median customers potentially affected to date (52,000).
- In the last three 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).

- In the last two years, the number of customers potentially affected by Tandem Switch outages has been significantly greater (median 124,100) than in the first eight years (median 75,000).

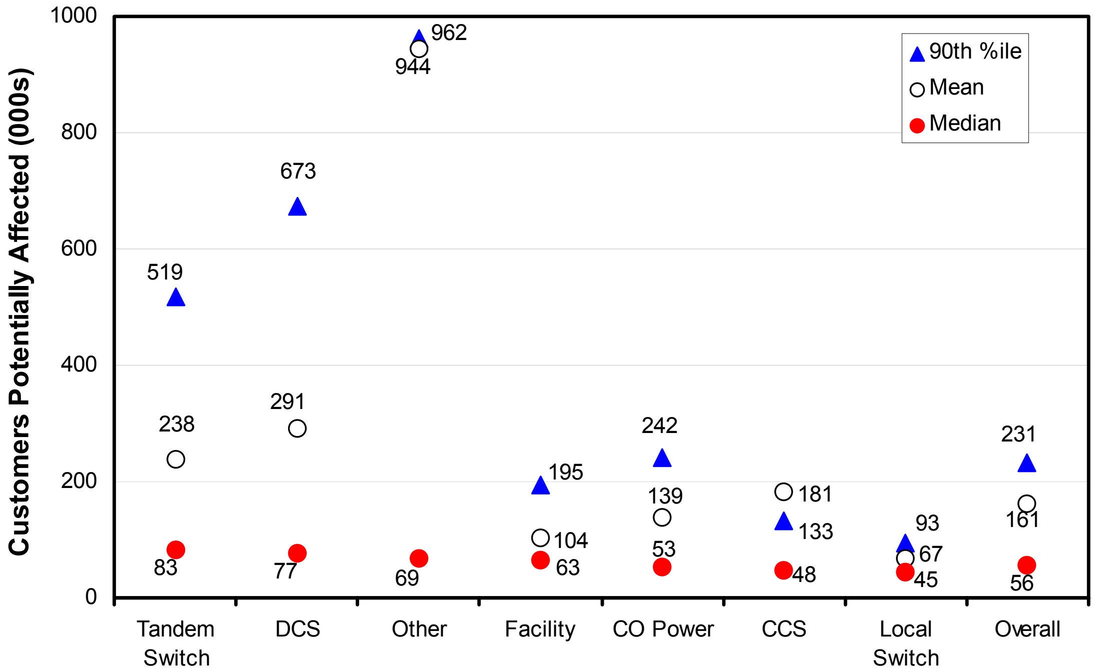


Figure 7: Distributions of Customers Potentially Affected by Failure Category

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, 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 1621. The aggregated outage index in 2002 was below this level at its lowest value to date (1298); this decrease is not statistically significant. The aggregated outage index does not have a statistically significant trend.

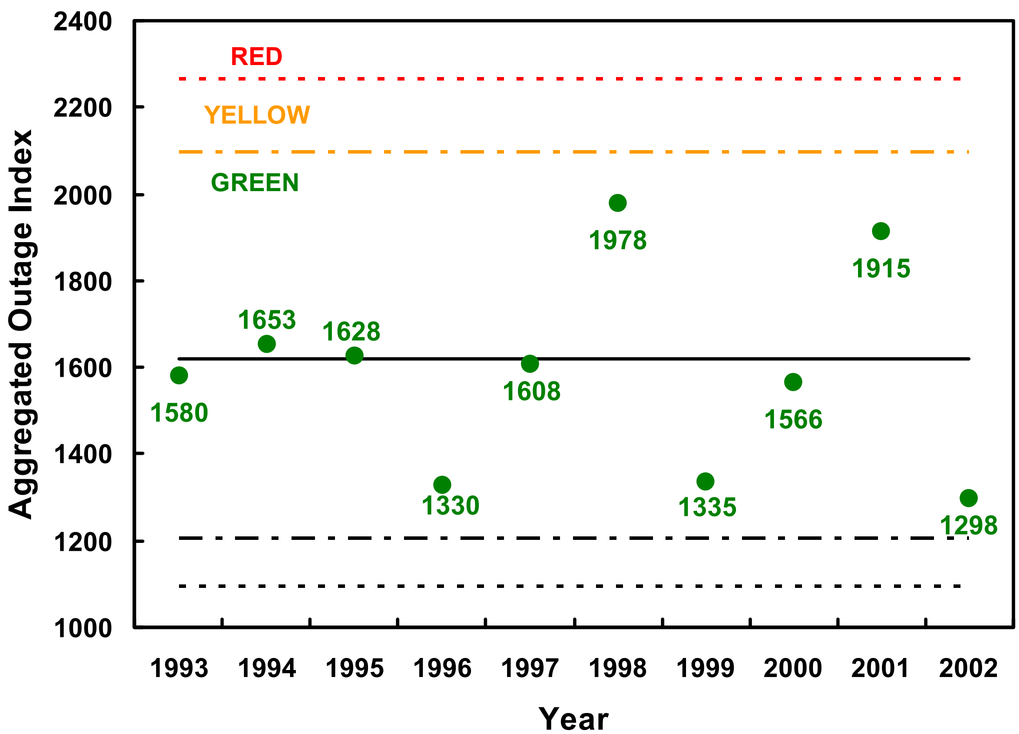


Figure 8: Annual Aggregated Outage Index Control Chart

Figure 9 provides a control chart of the quarterly aggregated outage index from 1993 to 2002. The blue line is a spline fit to the data. All four quarters of 2002 were within control.

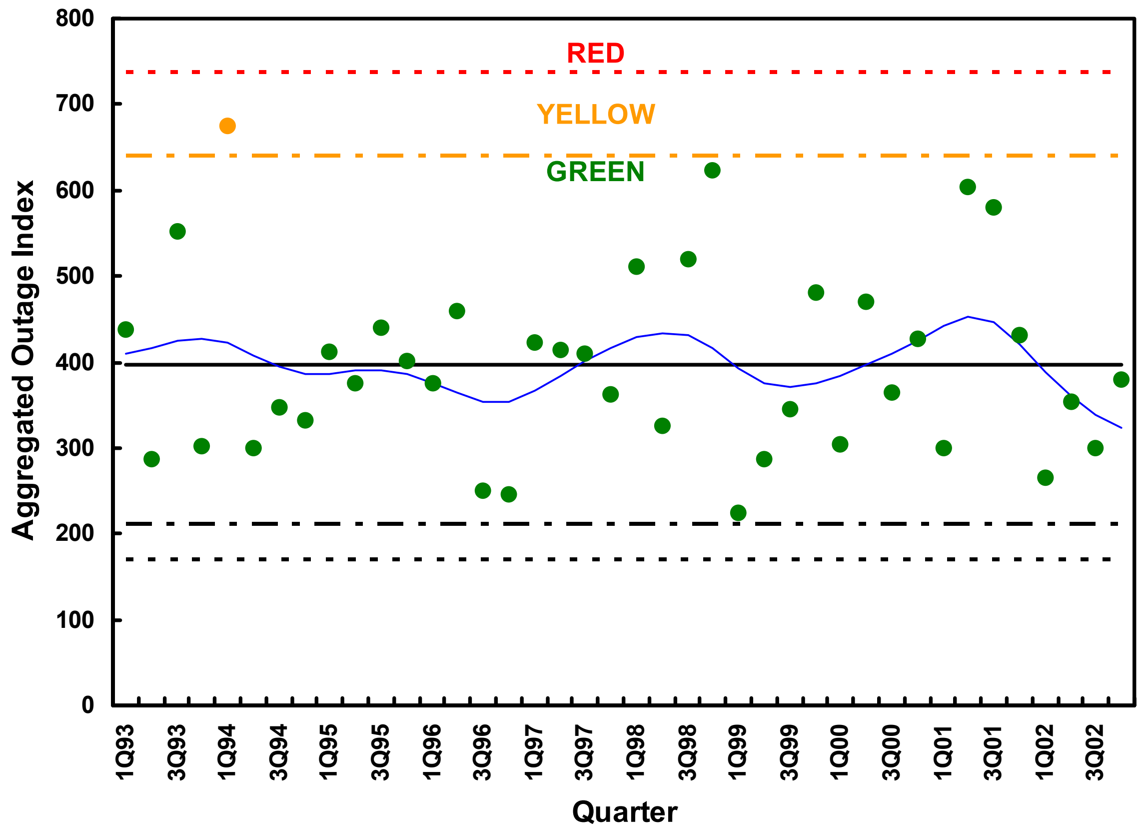


Figure 9: Quarterly Aggregated Outage Index Control Chart

The annual aggregated outage index for each failure category is given in **Figure 10**. In 2002, the aggregated outage index for each failure category (except CCS) was within its Green region. Conclusions based on these data are:

- *Facility*
  The annual aggregated outage index for Facility outages had its lowest value to date (375), significantly lower than its Baseline Level (750). It has a statistically significant decreasing trend of 7% per year over the entire 10-year history. This is the first year that Facility outages did not have the highest aggregated outage index among failure categories. Still, over the entire 10-year history, the aggregated outage index for Facility outages is significantly higher than in any other failure category (713 annually, 45% of the total).

- *Tandem Switch*
  The annual aggregated outage index for Tandem Switch outages (197) was below its Baseline Level (217) for the first year since 1999. Tandem Switch aggregated outage index has no statistically significant overall trend.

- *Central Office (CO) Power*
  CO Power aggregated outage index (132) dropped to its lowest annual level since 1997. This was also its first year below its Baseline Level (178) since 1997. CO Power aggregated

outage index has no statistically significant overall trend.

- *Common Channel Signaling (CCS)*
  CCS aggregated outage index reached its highest level to date (398). It was in the Yellow region of the control chart, significantly higher than its Baseline Level (136). The index was the highest among all failure categories for the first time. Over half of the CCS aggregated outage index was attributable to a single outage with the largest index in the entire 10-year history (206); this outage affected over 5 million customers for a period in excess of 13 hours. CCS aggregated outage index has a statistically significant increasing trend (7.5% quarterly) since 1994.

- *Other*
  Other aggregated outage index (84) dropped below its Baseline Level (134) for the first year since 1999. The aggregated outage index for Other outages has been significantly higher from 2000-2002 (223 per year) compared to 1993-1999 (89 per year).

- *Local Switch*
  Local Switch outages had their second lowest annual aggregated outage index to date (54). The difference from the Baseline Level (137) was statistically significant, below the 95% lower tolerance limit for the second consecutive year. The aggregated outage index of Local Switch outages demonstrates a statistically significant decreasing trend (14% annually) over the entire 10-year history.

- *Digital Cross-connect System (DCS)*
  DCS aggregated outage index (58) was below its annual Baseline Level (70). Over the entire 10-year history, the aggregated outage index for DCS outages (69 annually, 4% of the total) was significantly lower than in any other failure category (except Other). Despite declines in the last the last three years, the aggregated outage index for DCS outages has been significantly higher from 1997-2002 (95 per year) compared to 1993-1996 (29 per year).

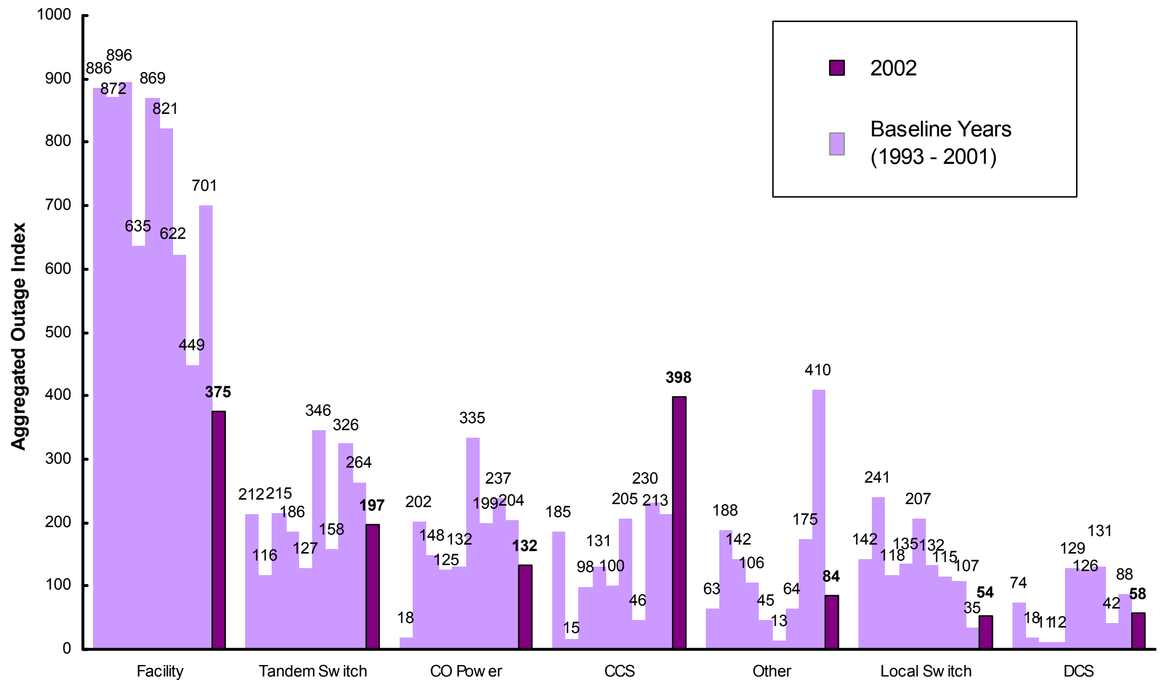


Figure 10: Annual Aggregated Outage Index by Failure Category

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 2002, the median (4.6), mean (11.1), and 90th percentile (31.7) values of the outage index distribution were all higher than their baseline values (3.9, 9.5, and 26.9 respectively). Still, the outage index per outage in 2002 was not statistically different than in the Baseline Years. However, the median outage index per outage in the last two years (4.7) was statistically greater than that in the period from 1993 to 2000 (3.8).

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

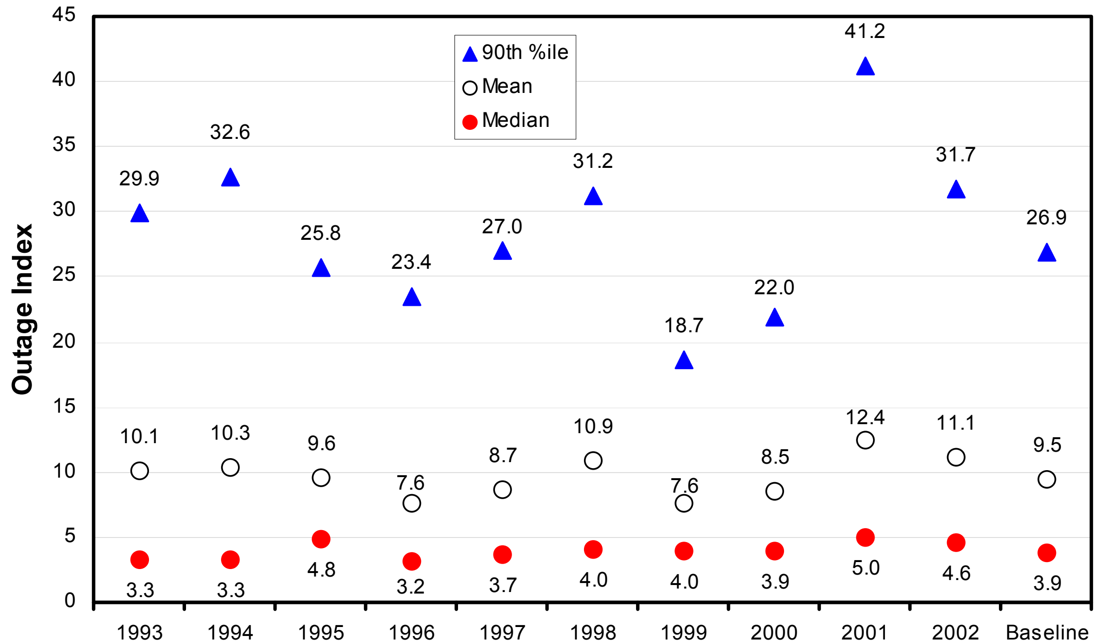


Figure 11: Annual Distributions of Outage Index per Outage

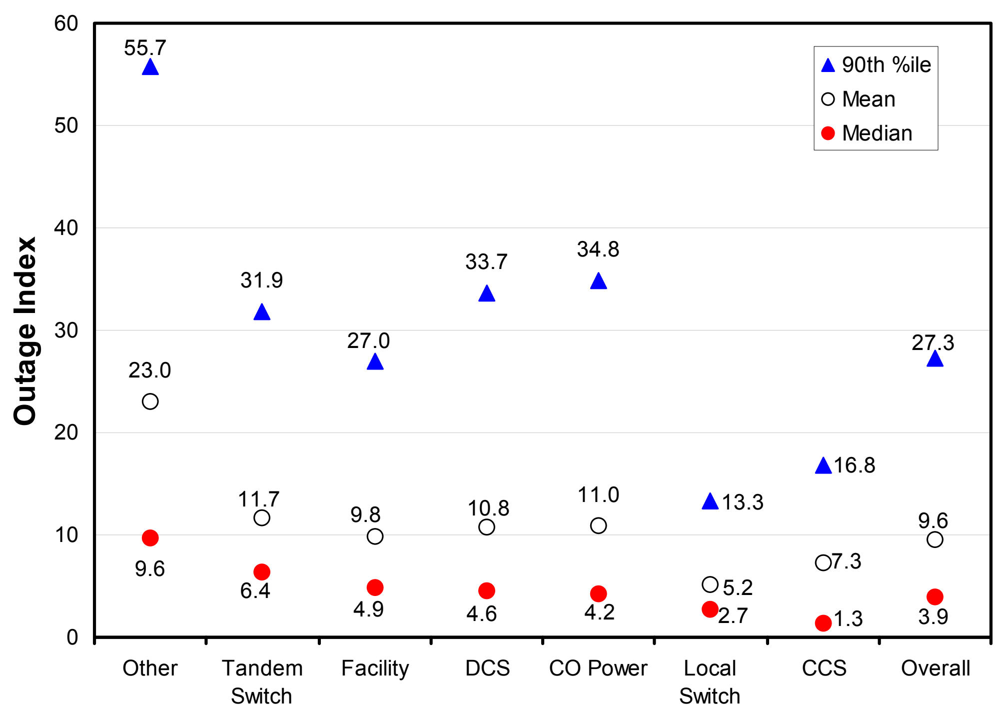


Figure 12: Distributions of Outage Index by Failure Category

Analysis of the data provides the following additional observations:

- In 2002, CCS outages had their highest median outage index (3.2). In the last three years, the median index for CCS outages was 2.3 as opposed to 0.4 in the first seven years; this difference is statistically significant.
- In 2002, Local Switch outages had their highest median outage index (4.5).
- Other and CO Power outages demonstrate a statistically significant increasing trend in median outage index.

OUTAGE METRICS RELATIVE TO NETWORK GROWTH

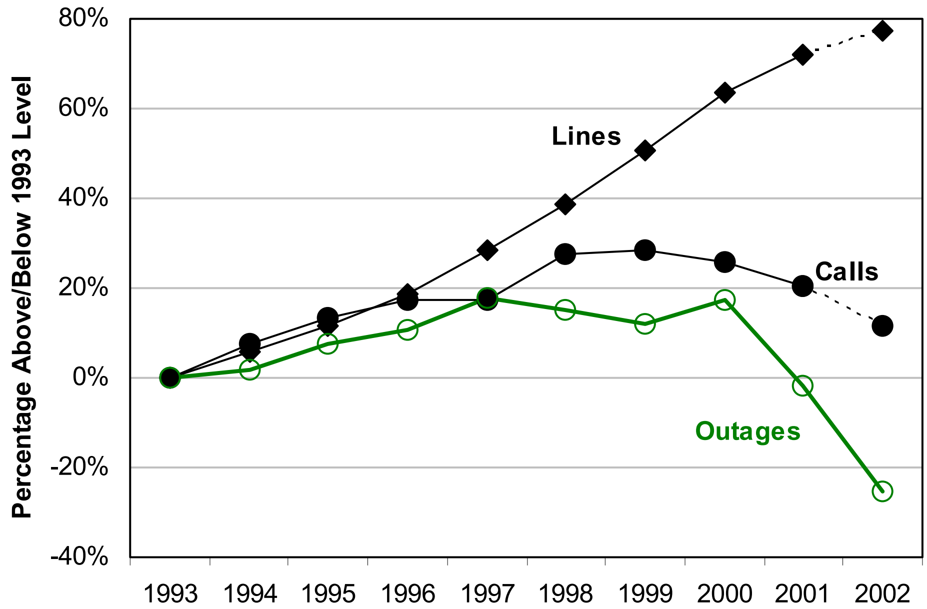
The public telecommunications network is continually growing and changing. More lines and facilities are added, switches are centralized or decentralized, the signaling network is expanding, etc. **Table 1** presents two metrics (lines and calls) for network growth in absolute terms. These two metrics 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. No data is available on CLEC calls. Since CLEC data was incomplete, this analysis was performed with respect only to ILEC network growth. As such, the results are conservative in the sense that network growth is slightly underestimated.

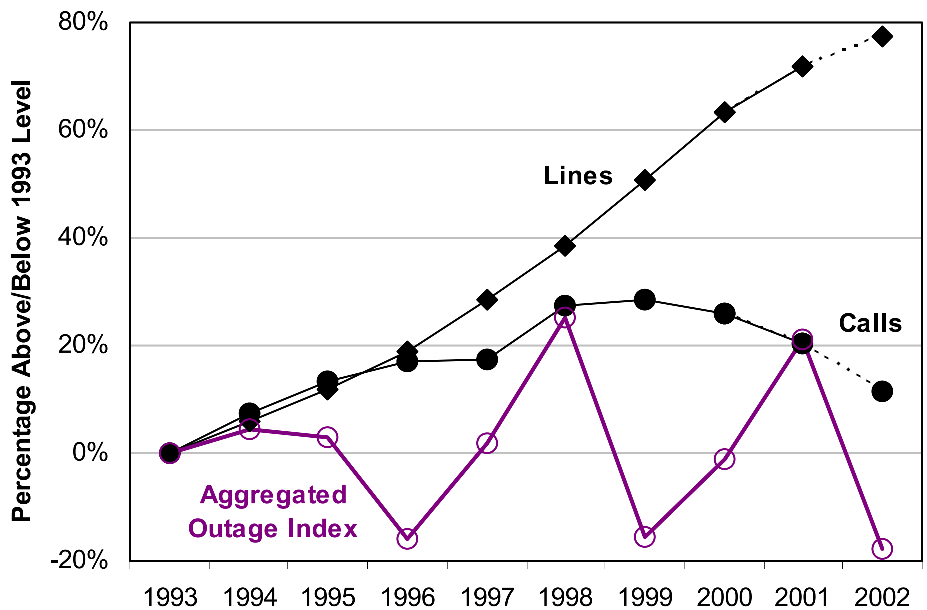
Table 1: Network Growth Metrics

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
2001	252.8	613,200

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 1; 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 2002.) 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

In 1995, Working Group T1A1.2 developed normalization techniques that adjusted overall outage frequency and aggregated outage index subject to network growth. These adjustments allowed the direct comparison of these metrics independent of the change in network size. The concept is similar in spirit to the way economists adjust prices or costs for inflation across years. These techniques were published in Committee T1 Technical Report No. 42 "A Technical Report on Enhanced Analysis of

FCC-Reportable Service Outage Data." Past ATIS/NRSC annual reports from 1994 through 1997 provided normalized outage frequency and aggregated outage index using these techniques.

This report provides a normalized outage frequency and a normalized aggregated outage index for 2002. The normalization was performed relative to calendar year 1993.[1] That is, the 2002 normalized outage frequency may be compared to the 1993 outage frequency and the 2002 normalized aggregated outage index may be compared to the 1993 aggregated outage index. Normalizing relative to 1993, the Call Normalization Factor (CNF) is the total number of calls in 2002 divided by the total number of calls in 1993:

$$CNF = 568.4 \text{ billion} / 510.0 \text{ billion} = 1.115$$

and the Line Normalization Factor (LNF) is the total number of lines in mid-2002 divided by the total number of lines in mid-1993:

$$LNF = 256.6 \text{ million} / 144.7 \text{ million} = 1.774.$$

CNF and LNF are used to normalize the reporting thresholds for customers affected assuming that the thresholds were created based on the percentage of all customers in the nation affected. Under normalization, only those outages in which at least

$$30{,}000 \times LNF = 30{,}000 \times 1.774 = 53{,}220 \text{ subscriber lines were affected}$$

or

$$90{,}000 \times CNF = 90{,}000 \times 1.115 = 100{,}350 \text{ calls were blocked}$$

are counted in the 2002 normalized outage frequency. Only these outages are used in calculating the 2002 normalized outage index. In addition, each outage index is normalized by dividing CNF or LNF into customers affected in the determination of the Magnitude Weight. The 2002 normalized aggregated outage index is the sum of these individually normalized outage indexes.

Table 2 presents the results of normalization on 2002 outage frequency and aggregated outage index. The results indicate that while 2002 demonstrated substantial improvement over 1993 based on the standard metrics, this improvement is even greater when adjustment is made for growth in the network.

Table 2: 2002 Normalization of Outage Frequency and Aggregated Outage Index

Year	Method	Number of Outages	Aggregated Outage Index
1993	Standard	157	1580
2002	Standard	117	1298
	Normalized	90	931

[1] The normalization of outage frequency and aggregated outage index in the 1994 through 1997 annual reports was performed relative to the Baseline Year (July 1, 1992 through June 30, 1993). Since then, the annual reports have shifted to a calendar year basis.

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.

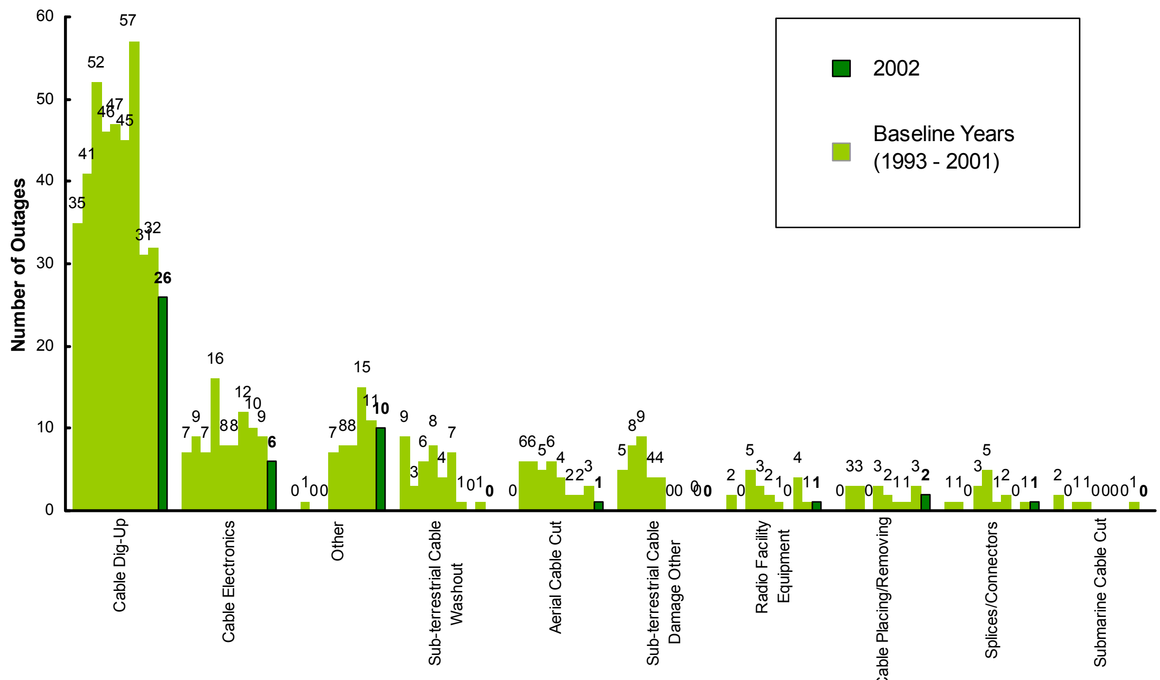


Figure 14: Number of Outages by Facility Failure Subcategory

While they continued to dominate Facility failure subcategories in 2002, the Cable Dig-up subcategory had its lowest annual frequency to date (26). Cable Dig-ups demonstrate a statistically significant seasonality effect; about 1/3 less Cable Dig-up outages occur in the first quarter as compared to the rest of the year. In the last three years, the frequency of Cable Dig-Up outages has been significantly less (30 per year) than in the first seven years of reporting (46 per year). Passage of One-Call legislation in June 1998 is a likely factor in this decrease. The Sub-terrestrial Cable Damage Other subcategory has a statistically significant decreasing trend in outages since the start of the Baseline Years (34% decline per year). 2002 had the fewest Cable Electronics outages to date (6). In 2002, no Facility outages were attributed to Sub-terrestrial Cable Washout, significantly below the Baseline Level (4.3 outages per year).The Sub-terrestrial Cable Washout subcategory demonstrates a statistically significant seasonality effect; first quarters have about 2.3 such outages per year, third quarters about 1 per year, and second and fourth quarters about .4 per year. Sub-terrestrial Cable Washout also has a statistically significant decreasing trend in outage frequency (22% decline per year). The Other subcategory has a statistically significant increasing trend of 35% per year over the 10-year history. In the last six years, more Facility outages have occurred in the Other subcategory than in any other subcategory aside from Cable DU. In 2002, Aerial Cable Cut outage frequency dropped to its lowest level (1) since 1993; this outage frequency has a statistically significant decreasing trend since 1994 (16% annually).

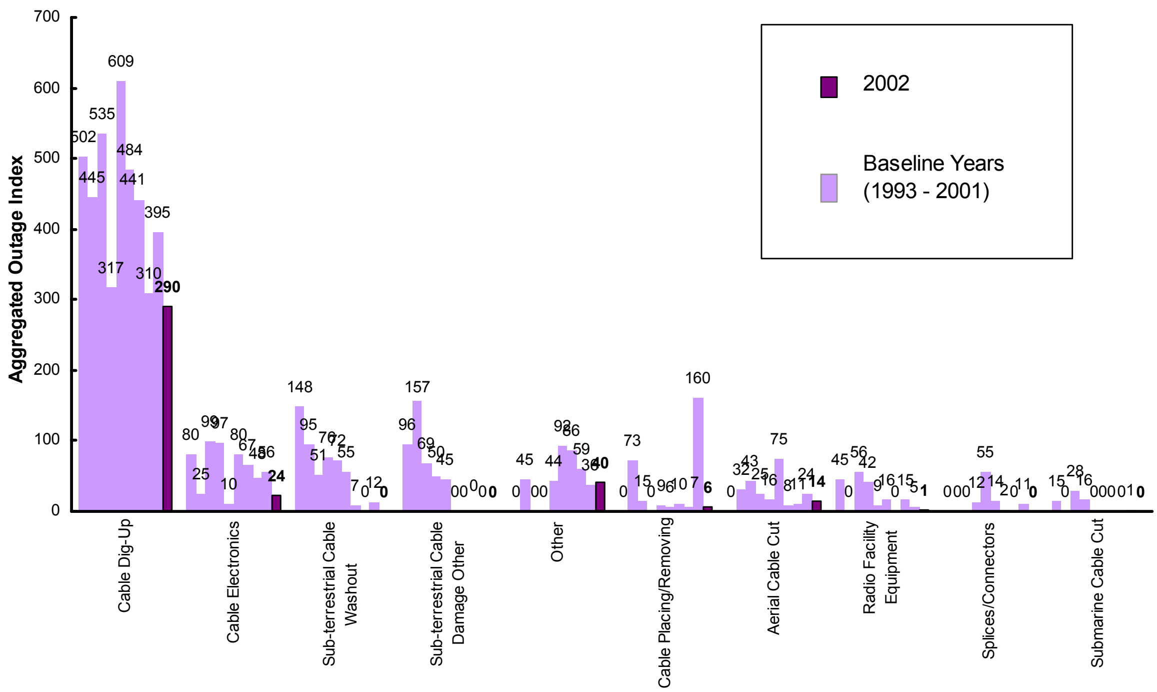


Figure 15: Outage Index Aggregated Annually by Facility Failure Subcategory

Cable Dig-ups dominate Facility outages from the outage index perspective as well (61% over ten years of reporting). In 2002, Cable Dig-ups had their lowest aggregated outage index to date (290). In the last three years, the aggregated outage index of Cable Dig-Up outages has been significantly less (331 per year) than in the first seven years of reporting (476 per year). The annual aggregated outage index for Cable Placing/Removing outage was significantly higher in the last two years than in the first eight years (83 versus 15 per year). The Facility aggregated outage index attributed to the Sub-terrestrial Cable Washout subcategory has been significantly lower in the last four years as compared to the first six years (5 versus 83 per year). The Sub-terrestrial Cable Damage Other subcategory aggregated outage index has been significantly lower in the last six years as compared to the first four years (8 versus 93 per year). The Radio Facility Equipment subcategory aggregated outage index has been significantly lower in the last six years than in the first four years (8 versus 36 per year).

The dominant root cause categories with respect to frequency are Cable Damage (41%), Procedural Service Provider (28%), and External Environment (14%).[2] In 2002, Cable Damage had its lowest annual frequency to date (15), significantly lower than its Baseline Level (31.4 per year). In the last three years, the number of Cable Damage outages has been significantly less than in the first seven years (18 versus 35 per year). In 2002, the number of Procedural Service Provider outages had its lowest annual frequency since 1996 (16). Despite this decline, Procedural Service Provider was the dominant root cause category among Facility outages for the third consecutive year; their frequency in the last six years has been significantly higher than in the first four years (22.8 versus 16.3 per year). In 2002, the frequency of External Environment outages matched its lowest annual value to date (4); over the last four years, its frequency has been significantly lower than in the first six years (5.3 versus 13.2 per year). In 2002, Design Hardware had its highest frequency (6) since 1997; nevertheless, its frequency has been significantly lower over the last five years than over the first five years (2.8 versus 7.8 per year). The frequency of Facility outages attributed to Hardware Failure matched its highest annual level to date (5); it has been increasing at the statistically significant annual rate of 26%.

The same three root causes are dominant with respect to the aggregated outage index: Cable Damage (44%), Procedural Service Provider (25%), and External Environment (16%). Cable Damage had its lowest aggregated outage index to date (139), significantly lower than its Baseline Level (333); since 1997, this index has demonstrated a statistically significant decreasing trend of 21% per year. For the second consecutive year, Procedural Service Provider had the highest aggregated outage index among root cause categories. In 2002, External Environment had its lowest aggregated outage index to date (21); it has a statistically significant decreasing trend of 22% annually. In 2002, the aggregated outage index of Design Hardware outages had its highest value since 1997; still, it has been significantly less in the last five years than in the first five years (20 versus 86 per year).

Cable Dig-Up

Cable Damage (67%) and Procedural Service Provider (26%) are the dominant root causes of Cable Dig-Up outages. However, over the last three years, Cable Damage frequency (17 per year) was significantly lower than in the previous seven years (32 per year); its aggregated outage index has a statistically significant decreasing trend of 20% per year.

Looking at the root cause subcategories of Cable Damage Facility outages, Inadequate/No Notification (54%) and Digging Error (42%) have been the biggest contributors. In the last three years, the frequency of Inadequate/No Notification outages has been significantly less than in the first seven years (8 versus 18 per year). In 2002, Digging Error caused the fewest Cable Damage outages to date (4), significantly less than the Baseline Years average (12.6 per year). The frequency of Digging Errors has a statistically significant decreasing trend (26% annually) since its peak in 1998.

With respect to the Cable Damage Facility aggregated outage index, the dominant root cause subcategories are also Inadequate/No Notification (57%), Digging Error (41%). The aggregated outage index for Inadequate/No Notification has a statistically significant decreasing trend over the 10-year history (9% annually). In 2002, Digging Error had its lowest aggregated outage index to date (22), significantly less than the Baseline Years average (129 per year). This was an abrupt change in Digging Error aggregated outage index which had demonstrated a statistically significant increasing

[2] In 2002, all outages with the Inaccurate Cable Locate and Cable Unlocated root cause subcategories were re-classified as having a Procedural Service Provider root cause category. This re-classification produced several changes in this annual report relative to prior annual reports, particularly with respect to Facility outages and Procedural Error outages.

trend prior to 2002. **Figures 16** and **17** present the number of outages and aggregated outage index for the Cable Damage root causes of Cable DU.

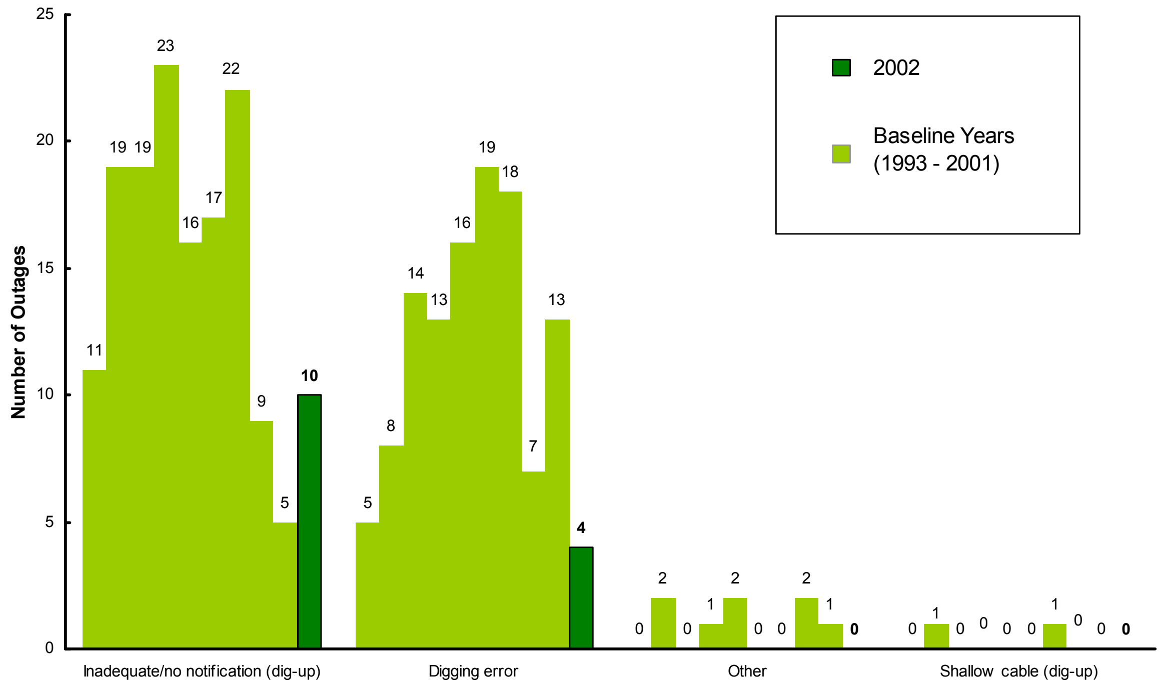


Figure 16: Number of Outages
by Cable Damage Root Cause Subcategories of Cable Dig-Up (DU) Facility Outages

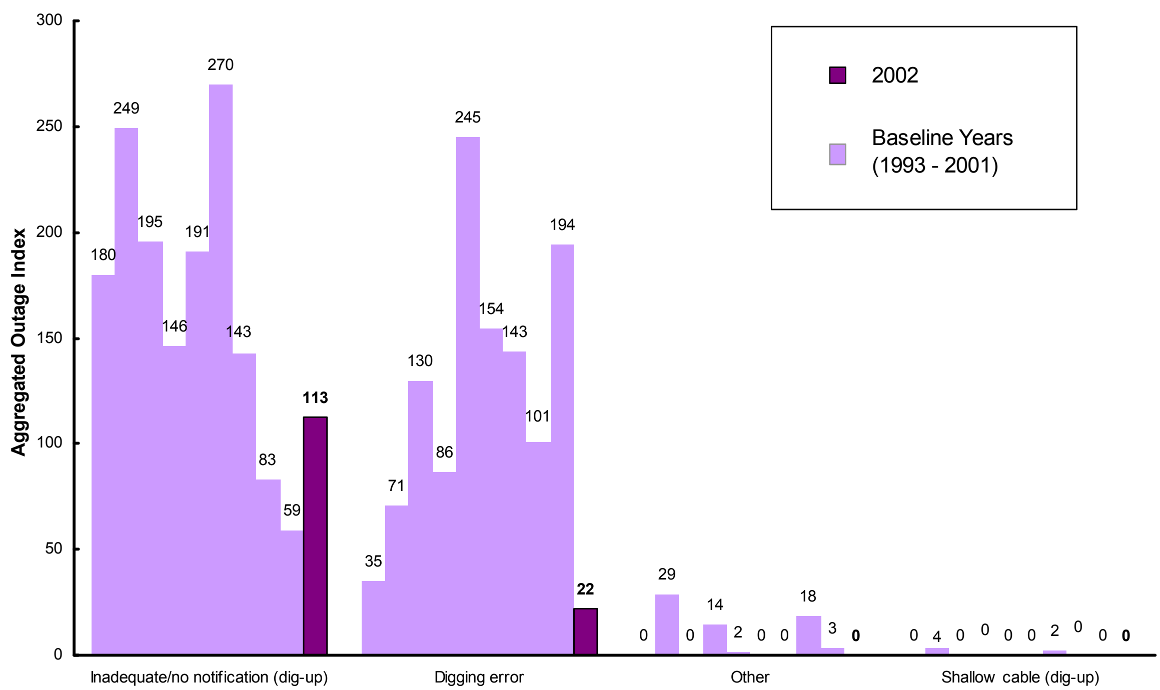


Figure 17: Annual Aggregated Outage Index for Cable Damage Root Cause Subcategories of Cable Dig-Up (DU) Facility Failures

Cable Electronics

The major root causes of the Cable Electronics[3] attributed facility outages are: Procedural Errors (43%), Hardware Failure (20%), Design Hardware (18%), and Design Software (11%). In 2002, Procedural Errors were the root cause of the fewest number of Cable Electronics Facility outages to date (1). Design Hardware frequency has been significantly lower in the last five years (0.8 per year) than in the first five years (2.6 per year). Hardware Failure outage frequency has a statistically significant increasing trend (22% per year). Design Software frequency has a statistically significant decreasing trend (54% per year) since reaching its peak (3) in 1999. When considering the aggregated outage index, Procedural Service Provider is the dominant root cause (55%) followed by Design Hardware (25%) and Hardware Failure (12%).

LOCAL SWITCH

The major failure subcategories for Local Switch outages have been Hardware (45%), Software (27%), and Translations (20%). In 2002, Hardware and Translations outages had their lowest frequencies to date (3 and 1 respectively); in the case of Hardware outages, this was significantly lower than its Baseline Level (12 per year). 2002 was the first year to date that more Local Switch outages were Software outages (4) than any other failure subcategory. Hardware and Software frequencies demonstrate statistically significant decreasing trends of 10% and 11% per year respectively. Translations and Other frequencies have statistically significant decreasing trends (40% and 31% per year respectively) since reaching their peaks (9 and 7 respectively) in 1998.

The annual aggregated outage indexes for Hardware and Translations had their lowest values to date in 2002 (13 and 5 respectively). The annual aggregated outage index for Hardware outages demonstrates a statistically significant decreasing trend over the course of the ten-year history (19% per year). The aggregated outage index for Translation outages in the last three years (9 per year) has been significantly lower than in the first seven years (39 per year).

Procedural Errors have been the major root cause of Local Switch outages from both the outage frequency and the outage index perspective (52% and 49% respectively). However, in 2002, the number of Procedural Error outages and their aggregated outage index matched their lowest levels to date (4 and 14 respectively). Procedural Error frequency has a statistically significant decreasing trend since its peak in 1998 (38% annually); its aggregated outage index also has decreased at the statistically significant rate of 38% since 1997. In 2002, Hardware Failure had its lowest frequency and aggregated outage index to date (1 and 5 respectively). Since 1994, Design Software frequency has a statistically significant decreasing trend of 14% annually.

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 (5%). The number of CCS failures attributed to Isolation has been increasing at the statistically significant rate of 14% annually since 1996 (see

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[3] 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.

Figure 18). The frequency of CCS outages attributed to Link(set)s has been significantly higher over the last five years than over the first five years (4.8 versus 0.6 per year).

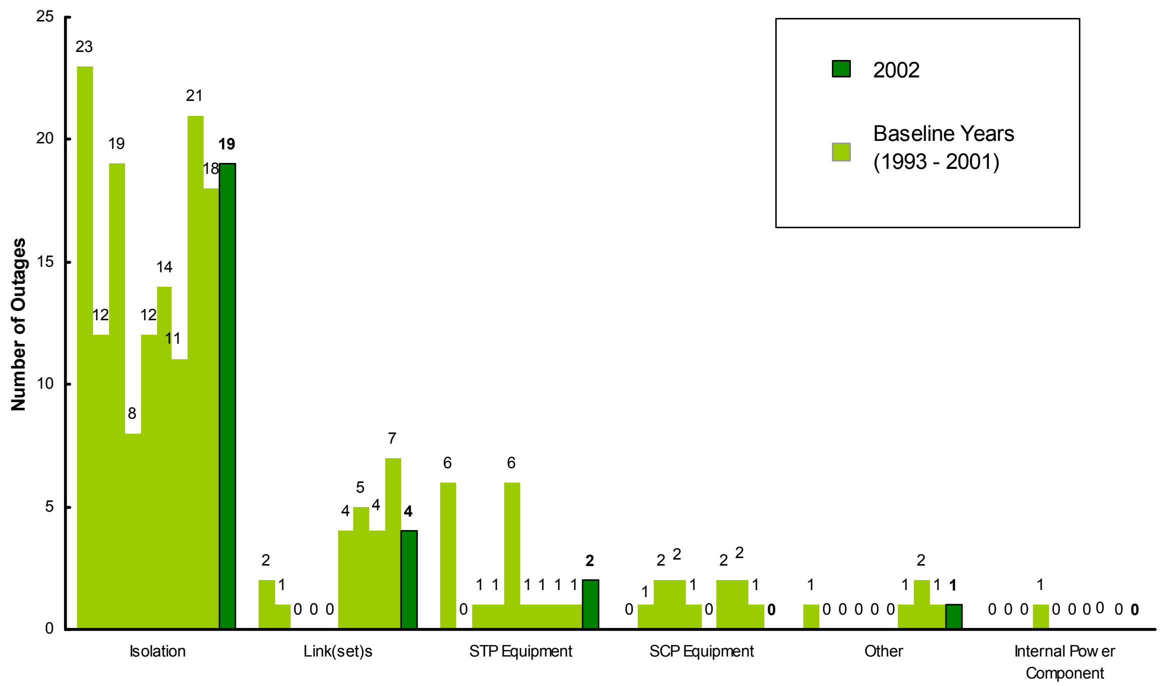


Figure 18: Number of Outages by CCS Failure Subcategory

From the outage index perspective (see **Figure 19**), Isolation (48%), STP Equipment (21%), and SCP Equipment (14%), and Link(set)s (10%) are the dominant failure subcategories over the ten-year history. In 2002, Isolation had its highest aggregated outage index to date (284), most of which was attributable to a single large outage; this total was significantly higher than the Baseline Level (55). In 2002, the CCS aggregated outage index attributed to Link(set)s (54) was significantly higher than the Baseline Level (13 per year). Over the last five years, the CCS aggregated outage index attributed to Link(set)s has been significantly greater than in the first five years (34 versus 0.3 per year).

Procedural Error (45%), Design Software (20%), Design Hardware (16%), and Hardware Failure (10%) 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 five years (12.2 versus 8.0 per year). In 2002, Procedural Other Vendor had its highest frequency to date (3), significantly higher than its Baseline Level (0.6 per year); over the last three year, its frequency has been higher than in the first seven years (2 versus 0.3 per year). While Design Software in 2002 had the highest number of CCS outages (6) since 1995, it has declined as a root cause category at the statistically significant rate of 12% per year over the 10-year history. Design Hardware has been increasing as a root cause category at the statistically significant rate of 20% per year. In 2002, less CCS outages were attributed to Hardware Failure (1) than in any year since 1995.

With respect to the outage index, Procedural Error (48%), Design Software (22%), Traffic/System Overload (16%), and Design Hardware (9%) have been dominant. The Procedural Error aggregated outage index has been increasing at the statistically significant rate of 22% annually since 1994. Traffic/System Overload had the highest annual aggregated outage index of any CCS root cause category to date (206); the total was attributable to one large outage.

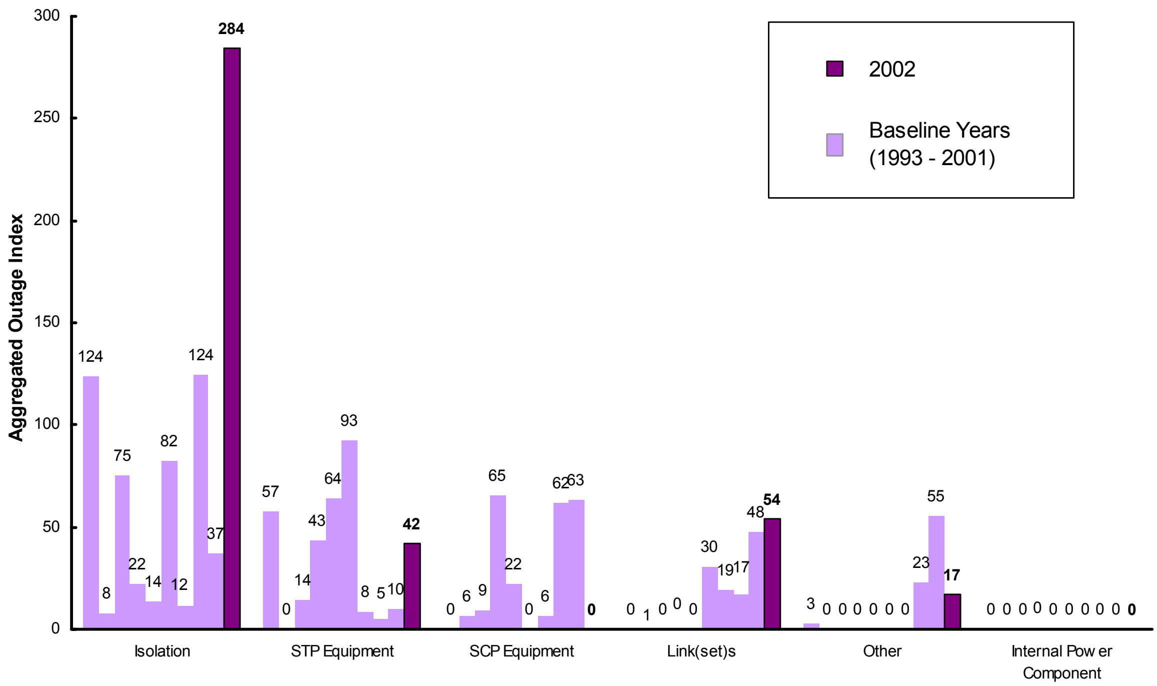


Figure 19: Annual Aggregated Outage Index by CCS Failure Subcategory

TANDEM SWITCH

Software is the major failure subcategory (40%) of Tandem Switch outages followed by Translations (29%) and Hardware (26%). In 2002, Software frequency declined to its lowest level to date (3); this frequency is significantly less than the peak of 10.5 such outages per year established in 2000-2001. Translations frequency in 2002 matched its lowest level to date (1 in 1993), significantly lower than its Baseline Level (5.8 per year). On the other hand, Hardware frequency reached its highest level since 1993 (8). Software is the major failure subcategory (40%) with respect to the aggregated outage index for Tandem Switches followed by Translations (33%), and Hardware (23%). Despite declining to its lowest level (1 in 2002) since 1993, Tandem Switch aggregated outage index attributed to Translations has been significantly greater over the last five years than over the first five years (107 versus 34 per year). Hardware had its highest aggregated outage index to date (121), significantly higher than its Baseline Level (42).

Procedural Service Provider (43%) and Design Software (34%) have been the dominant root causes of Tandem Switch outages. In 2002, the frequency of Procedural Service Provider outages dropped to its lowest level to date (3); since its peak of 15 in 1998, this outage frequency has declined at the statistically significant rate of 26% annually. Procedural Service Provider (45%) and Design Software (33%) are also dominant with respect to aggregated outage index. Despite a decline to 51 in 2002, the Tandem Switch aggregated outage index attributed to Procedural Service Provider has been significantly greater over the last five years than in the first five years (137 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 (26%), Other (20%), Standby Generator (12%), and Building AC (10%). In 2002, the number of CO Power outages attributed to DC Plant matched its lowest level to date (3). In 2002, no CO Power outages were attributed to Standby Generator for the first year since 1996; the Standby Generator frequency has declined at the statistically significant rate of 40% per year since reaching its peak (6) in 1998.

The major contributors, by failure subcategory, to the CO Power aggregated outage index are: DC Plant (32%), DC Distribution (23%), Standby Generator (18%), and Other (16%). In 2002, the CO Power aggregated outage index attributed to DC Distribution had its highest value (62) since reaching its peak (99) in 1998.

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 (51%) of CO Power outages. In 2002, the number of outages attributed to Procedural errors matched its lowest level to date (5 in 1993). Since reaching its peak (10) in1997, the number of outages attributed to Procedural Service Provider has declined at the statistically significant rate of 22% annually. Despite declining to its lowest level (1) since 1998, the number of outages attributed to Procedural System Vendor has been significantly greater in the last four years than in the first six years (2.8 versus 0.7 outages per year). In 2002, the number of outages attributed to Commercial and/or Back-Up Power Failure was at its lowest level since 1997 (5). The frequency of Commercial and/or Back-Up Power Failure outages has been significantly greater in the last five years than in the first five years (9.2 versus 2.6 outages per year).

With respect to the aggregated outage index, Commercial and/or Back-Up Power Failure is the dominant root cause category (44%) followed by Procedural Service Provider (26%). All three Procedural Error root cause categories combined account for 41% of the CO Power aggregated outage index. Despite dropping to its lowest level (33) since 1997, the CO Power aggregated outage index attributed to Commercial and/or Back-Up Power Failure has been significantly higher in the last five years than in the first five years (135 versus 16 per year). The CO Power aggregated outage index attributed to Design Hardware had its highest value to date (43), significantly higher than the Baseline Level (5).

DIGITAL CROSS-CONNECT SYSTEMS (DCSS)

Hardware (55%) and Software (31%) are the two major failure subcategories for DCS outages. In the last five years, the number of DCS outages attributed to Hardware has been significantly greater than in the first five years (4.8 versus 2.2 outages per year).With respect to the aggregated outage index, the three major failure subcategories are Hardware (55%), Software (24%), and Other (16%). Over the last five years, the DCS aggregated outage index attributed to Hardware has been significantly higher than in the first five years (61 versus 15 per year).

Looking at the root causes of DCS outages, 25% are attributed to Design Software, 23% to Procedural System Vendor, 17% to Procedural Service Provider, and 14% to Hardware Failure. 2002 is the first year with no DCS outages attributed to Design Software since 1996; since 1998, the frequency of these outages has declined at the statistically significant rate of 33% annually. The frequency of Procedural Service Provider outages has declined at the statistically significant rate of 36% annually since reaching its peak (4 outages) in 1997. Also, in the last five 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 37% of the DCS aggregated outage index, Procedural Service Provider 25%, Design Hardware 11%, and Procedural System Vendor 10%.

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 40% of the number of outages and 35% of the aggregated outage index. The significantly largest share of the PE outages is attributable to the Procedural Service Provider (81%) as opposed to the Procedural System Vendor (15%) 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 2002, Procedural Error outage frequency dropped to its lowest annual level to date (42). It was below the Baseline Level (68.4 outages per year); this difference is statistically significant. The frequency of PE outages has demonstrated a statistically significant decline of 11% per year since reaching its peak (86 outages) in 1997. The frequency also has a statistically significant seasonality effect. The frequency is high in third quarters (20.0), low in fourth quarters (14.1), and near average in first and second quarters (15.9 and 15.8 respectively).

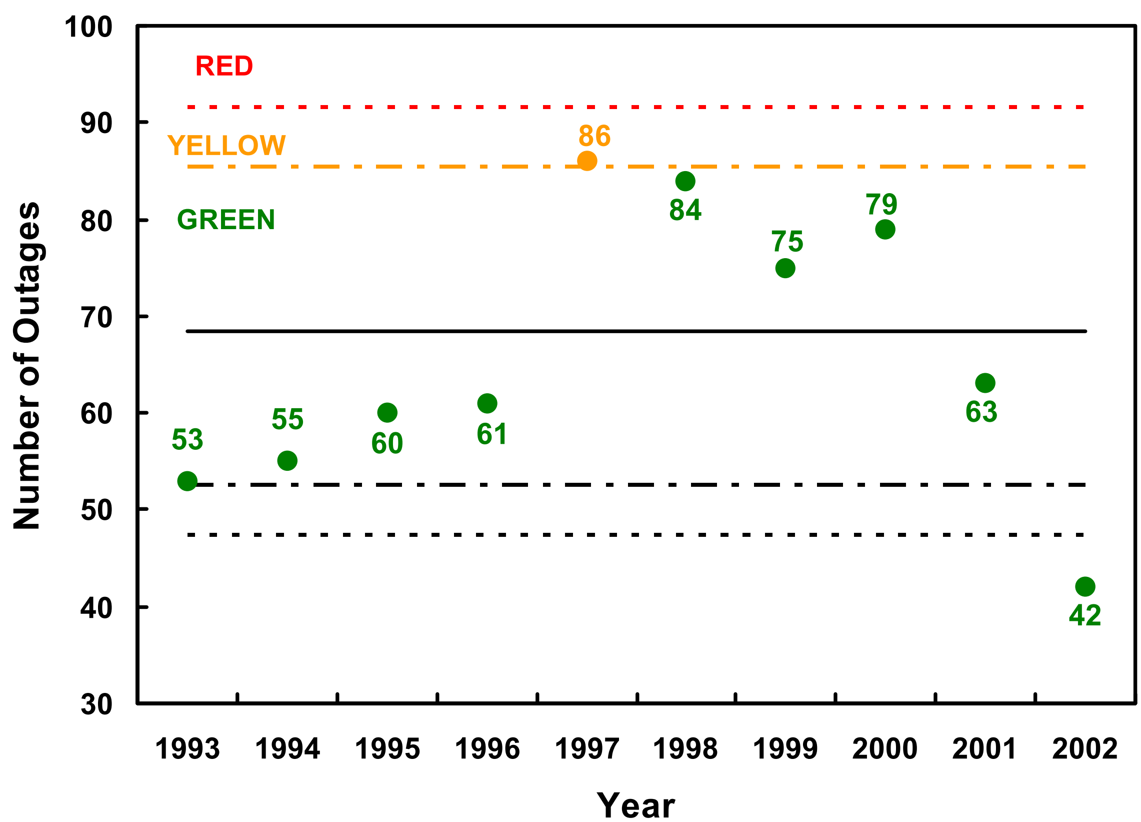


Figure 20: Annual Frequency Control Chart for Procedural Error Outages

Figure 21 shows the frequency of PE outages by root cause subcategory. The three major root cause subcategories are Insufficient Supervision/Control (33%), Documentation/Procedures (unavailable, unclear, incomplete) (22%), Insufficient Training (21%), and Inaccurate Cable Locate (11%). In 2002, the number of PE outages caused by Insufficient Supervision/Control (22) was the lowest number since 1997; since rising to its peak (41) in 1998, this frequency has been decreasing at the statistically significant rate of 12% per year. Documentation/Procedures (unavailable, unclear, incomplete) outage frequency in 2002 dropped to its lowest level to date (4), significantly lower than its Baseline Level (15.9 outages per year); this frequency has been declining at the statistically significant rate of 23% per year since reaching its peak (23) in 1997. In 2002, PE outages caused by Insufficient Training matched its lowest frequency to date (6), significantly lower than its Baseline Level (15.0 outages per year); this frequency has been declining at the statistically significant rate of 21% per year since reaching its peak (25) in 1997. The number of Inaccurate Cable Locate outages in 2002 matched its lowest value to date (4).

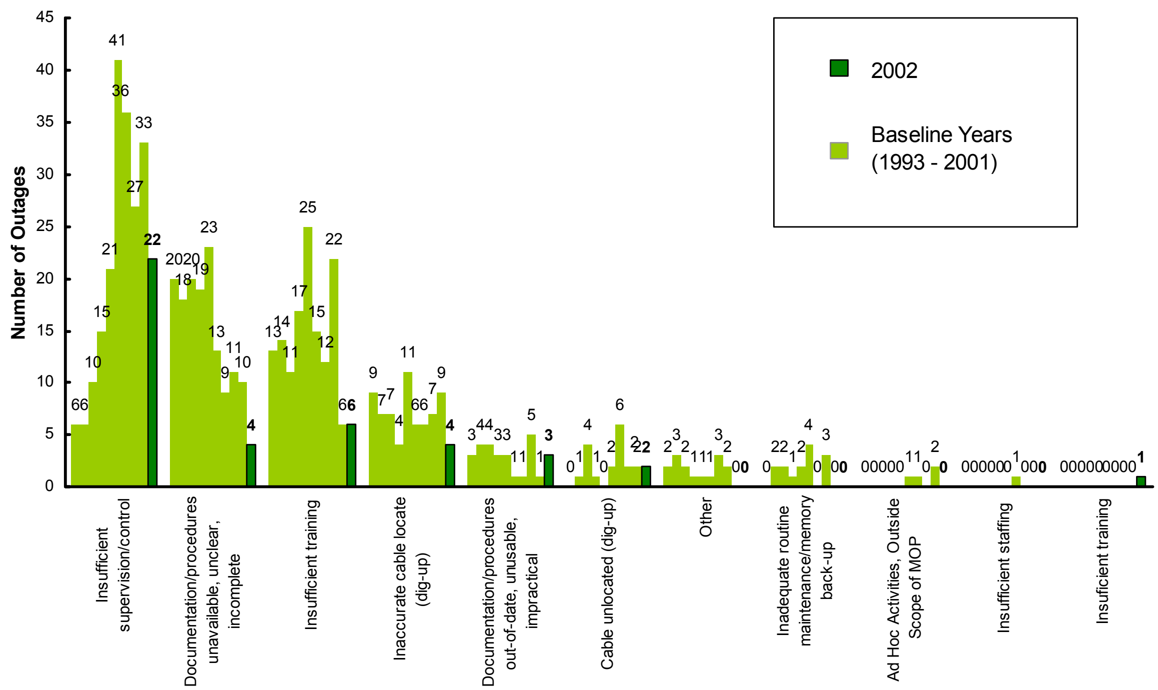


Figure 21: Number of Outages by Procedural Error Root Cause Subcategory

In 2002, the annual aggregated outage index of Procedural Errors had its lowest value since 1999 (397) (**Figure 22**). It was below the Baseline Level (581), but this difference was not statistically significant. The aggregated outage index displays no statistically significant trend. The dominant root cause subcategories of Procedural Error outages are Insufficient Supervision/Control (35%), Documentation/Procedures (unavailable, unclear, incomplete) (25%), Insufficient Training (16%), and Inaccurate Cable Locate (12%). The annual aggregated outage index of Insufficient Supervision/Control outages has risen at the statistically significant rate of 41% annually over the 10-year history. The annual aggregated outage index of Documentation/Procedures (unavailable, unclear, incomplete) outages has decreased at the statistically significant rate of 13% annually over the 10-year history. In 2002, the annual aggregated outage index of Insufficient Training dropped to its lowest level to date (13); in the last two years, this annual aggregated outage index has been significantly less than in the first eight years (29 versus 103 per year).

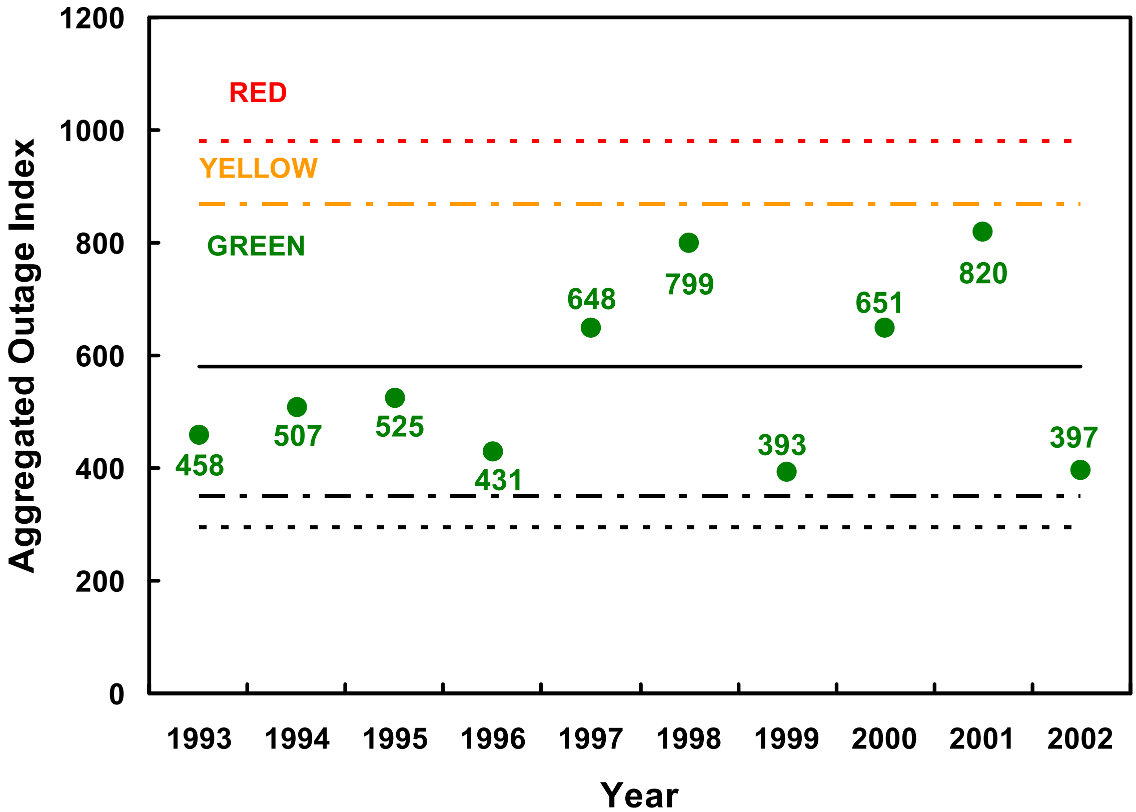


Figure 22: Annual Aggregated Outage Index Control Chart for Procedural Error Outages

"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 2002 there were eleven outages reported to the FCC that fell in these categories. Of these, five were reportable because of their impact to 911 services, and six were reportable fire-related incidents.

Of the five outages which impacted 911 services, three (3) were the result of Central Office (CO) Power problems; one (1) was the result of a hardware failure; and one (1) occurred when a fiber cable was severed as the result of a digging error. In all three instances where the outage was due to a CO Power problem, the office battery system was unable to carry a sufficient charge to sustain dial tone. In two of those cases new systems were installed; the other was as the result of a procedural error requiring implementation and training of new procedures. The one outage due to hardware failure occurred in a remote central office in Alaska. A new rectifier card had to be delivered via Federal

Express, and the repair was further delayed due to wiring differences between the original and replacement cards. The duration of this one outage was 78 hours. The average duration of the remaining four outages was 4 hours and 1 minute. The average number of customers affected by these five outages was 4,216.

None of the six outages caused by fire occurred in or on the premise of a service provider; two (2) occurred as the result of fires started by homeless individuals; two (2) were due to residential/commercial building fires; one (1) was as the result of a vehicle fire; and one (1) occurred when a tree limb came into contact with electric lines that grounded to a fiber cable. The average duration of these outages was in excess of 57 hours, far more than the average of 4.3 hours experienced over the last four years 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 by these six outages was 3,448. 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 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.

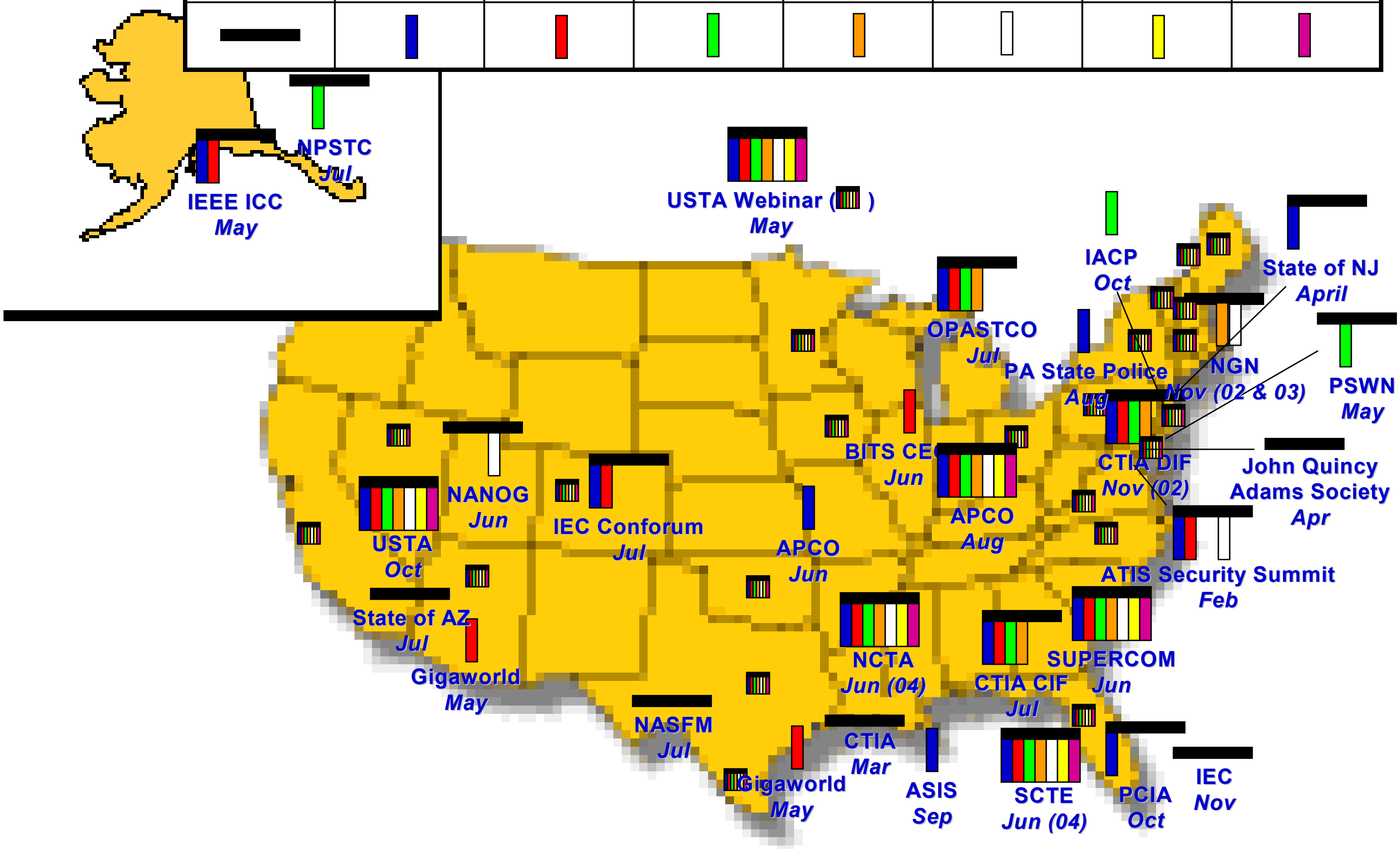
In October 1998 NRIC-IV was launched. The primary role of this effort was to provide advice to the FCC on Year 2000 issues affecting telecommunications. However, other national network reliability issues were also addressed. The first of these was to report on the reliability of public telecommunications 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 Sixth Council (NRIC-VI) began its deliberations 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 is currently addressing 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. Approximately 750 Homeland Security Best Practices have been developed by the Physical Security, Cyber Security, Public Safety, and Disaster Recovery focus groups. 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 segments of the communications industry. A shift in focus of NRIC VI has been to move from best practices development to sharing and promoting adoption. This has been accomplished through written articles, press releases, DVD/Video, the NRIC.ORG Web Site, Webinar, as well as panel and individual presentations. The target audience includes: wireline, wireless, ISP, telecom service providers; local, state and municipal government; and Public Safety officials The purpose of the Outreach is to share Best Practices, encourage adoption of Best Practices, and offer a model for improvement through use of Best Practices. Further information on the Sixth Council may be found at www.nric.org.

NRIC VI Outreach Program

Overview	Physical Security	Cyber Security	Public Safety	Business Continuity	Network Reliability	Network Interoperability	Broadband Deployment



SUMMARY AND 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 2002 Annual Report provides both a summary and detailed review of this work. As with previous annual reports the 2002 messages reflect a degree of complexity.

Table 3 provides a summary of the degree to which all outages, all failure subcategories, and Procedural Error outages in 2002 compared to the Baseline Years with respect to frequency and aggregated outage index. For each such group of outages, "F" indicates whether the frequency of those outages in 2002 was significantly below, below, above, or significantly above its Baseline Level. "I" presents a similar indication for the aggregated outage index.

Overall, outage frequency showed a significant improvement over prior years; overall aggregated outage index was below the Baseline Level although not significantly so. Procedural Error outages showed a similar pattern of improvement. Among failure subcategories, Facility and Local Switch outages demonstrated the greatest improvement; both showed significant improvement with respect to frequency and aggregated outage index. CCS was the only failure category which was significantly worse than its Baseline Level; its aggregated outage index was significantly higher than its Baseline Level. CCS outage frequency was also higher than its Baseline Level although not significantly. The remaining failure categories showed no significant difference from their Baseline Levels.

Table 3: Summary of 2002 Relative to the Baseline Years

	GREEN			YELLOW	RED
Relative to Baseline Level	**Significantly Below**	**Below**	**Above**	**Significantly Above**	
All	F	I			
Facility	F I				
Local Switch	F I				
CO Power		F I			
Other		F I			
Tandem Switch		F I			
DCS		I	F		
CCS			F	I	
Procedural Error	F	I			

The NRSC recognizes that the underlying causes of outage trends are of interest. In the case when a (negative) trend of increasing frequency is observed within a category, the Committee identifies direct and root causes of the individual events and assesses whether existing NRIC Best Practices, if implemented, would have prevented the outages. A special task group may be formed.

These analyses continue to confirm the value of existing Best Practices and occasionally yield other insights. On the other hand, when a (positive) trend of decreasing outage frequency is observed, the Committee abstains from interpreting the primary influences. However, the Committee has assembled factors that can contribute to positive trends. The NRSC used the FCC Network Reliability and Interoperability Council (NRIC) communications infrastructure framework to systematically review the network elements and identify possible influences (either a negative or positive) on national network outage trends. Table 4, Systematic Review of Infrastructure Elements, summarizes these factors.

Table 4: Systematic Review of Infrastructure Elements

Elements of Communications Infrastructure	Potential Factors Having Influence
Power (internal systems)	decreasing expertise (per NRIC VI Area for Attention, Dec 2002 FG 1A Report)
Environment (buildings, etc.)	less maintenance, fewer alterations, changes in physical security, construction trends
Software	fewer upgrades; fewer new features; offshore outsourcing (less control over design, development and testing); cyber (software) vulnerabilities, worms, viruses
Hardware	fewer upgrades, outsourcing (less control over design, development and testing)
Payload	trends in traffic, abnormal traffic patterns, rapid growth of specific services
Networks	less growth, evolution (technology), concentration of traffic
Human	less training, less staff, longer hours, more stress, increased mechanization
Policy	increased security, activities at the sub-federal level, dig-ups (one-call legislation, partnering with gas, oil, railroad), less resource investment in Standards Development Organizations (SDOs)

The NRSC is encouraged by the fact that in 2002 only three areas were above Baseline Levels—DCS frequency, CCS frequency, and CCS outage index—and that only one of these, the CCS outage index, was significantly above. The NRSC has conducted several investigations in these and other outage areas, and in all cases has determined that the industry knows how to address the problem: implementing 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. **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.**