Network Reliability Steering Committee

Annual Report 2003

Network Reliability Steering Committee

Sponsored by the Alliance for Telecommunications Industry Solutions

DATE: **September 20, 2004**

TO: **Stakeholders of the Nation's Public Communications Networks**

Public communications networks are *vital* to our nation's social well-being, public safety, economic stability and prosperity, and defense and security. The objectives of the Network Reliability Steering Committee include reporting on the health of the nation's networks and guiding industry improvements in network reliability. This Annual Report reviews the health of the nation's wireline communications networks for the year 2003, as well as trends observed over the past eleven years of outage reporting to the FCC.

2003 was a year of considerable challenges for the communications industry as it addressed the challenge of terrorism through increased hardening of physical and cyber security for its networks, faced the challenge of an historic electricity infrastructure failure during the August Northeast Power Blackout, and weathered two major national disasters in September's Hurricane Isabel and October's Southern California wildfires.

Despite these challenges, the 2003 numbers show trends in the right direction for most categories. Throughout its history, the NRSC has used two primary metrics to get its pulse on the health of the nation's networks – one for outage frequency and one for outage impact. The latter is computed with an outage index that is based on event duration, subscriber impact and other factors. Thus, network reliability improvements include both reducing the number of outages and reducing the impact of a given outage (e.g., the number of impacted subscribers gand/or the duration of the outage). *2003 had the lowest outage frequency and the lowest aggregated outage index to date.* However, the median outage index per outage does have an increasing trend over time. For all categories, 2003 outage frequency and outage index numbers 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 the public wireline communications networks and services. As in previous Annual Reports, the NRSC encourages all service providers, network operators and equipment suppliers to review the industry's Best Practices documents available on the NRSC and NRIC web sites (www.nrsc.org/nrsc and www.nric.org).

At the writing of this letter, the industry is absorbing details of a new rulemaking regarding expanded FCC mandates for outage reporting. The NRSC is prepared to support analyses that would be expanded in other areas such as wireless and cable networks. Believing its function has been invaluable to the nation, the NRSC is hoping that the industry experts' access to the data that allows it to report on the health of the nation's networks and guide industry improvements will be allowed to continue.

The industry's recognition of its critical role in serving the nation's needs, its commitment to ensuring highly reliable networks, and its willingness to work together for the good of the nation despite a very competitive environment are as evident in the work of the NRSC as they are anywhere else. The NRSC is humbled that its methodologies are used as a model by others around the world and continues to review its processes for improvements.

KARL F. RAUSCHER
VICE CHAIR
NETWORK RELIABILITY STEERING COMMITTEE

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INTRODUCTION

This report provides an analysis of U.S. telecommunications network performance based on outage reports made by wireline service providers to the FCC from January 1, 1993 through December 31, 2003. 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 results presented here were 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 outage frequency and aggregated outage index. The first section also examines the number of customers potentially affected and outage duration per outage.

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, but less than 30,000 lines, for 30 minutes or longer.

During 2003, members and participants in the NRSC included:

- AT&T
- BellSouth
- e-Commerce & Telecommunications Users Group (ETUG)
- Federal Communications Commission (FCC)
- Juniper Networks
- Lucent Technologies
- National Communications System (NCS)
- Nortel Networks
- Qwest Communications
- Roxtel
- SBC
- Sprint
- Telcordia Technologies
- Union Pacific Railroad
- Verizon

MAJOR FINDINGS

In general, network performance remained within control limits in 2003. However, 2003 saw departures from these limits in several areas:

- 2003 had the lowest number of outages and the lowest aggregated outage index[1] to date.
- The number of outages attributable to Facility, Local Switch, Tandem Switch, and DCS were equal to or matched their lowest level to date; the number of CCS outages was the lowest since 1999; and, the number of CO Power outages was the lowest since 1993.
- Tandem Switch and DCS outages had their lowest aggregated outage index to date.
- The number of Procedural Error outages and their aggregated outage index dropped to their lowest levels to date.
- Procedural Error was the root cause for 39% of outages.
- The median number of customers potentially affected by an outage was the lowest to date.

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

- Outage frequency has been decreasing at a rate of 19% annually over the last four years.
- The median outage index per outage has an increasing trend over time (3.4% annually).
- The overall annual aggregated outage index over the last two years has been 24% less than in prior years.
- There are decreasing trends in the frequency of Facility, Local Switch, Tandem Switch, CO Power, and DCS outages.
- There are decreasing trends in the aggregated outage index for Facility (7% annually) and Local Switch (14% annually) outages over the entire 11-year history.
- Over the last four years, CCS outage frequency has been on average 49% higher than in prior years. Its aggregated outage index has been increasing 22% annually since 1994.
- Over the last four years, the annual aggregated outage index of Other outages has been 140% higher than in prior years.

[1] The aggregated outage index is the sum of the outage indexes for the individual outage reports. Consequently, the aggregated outage index is related to the number of outages.

EXTRAORDINARY EVENTS

During 2003, there were a number of extraordinary events that impacted the nation's communications system.

NORTHEAST POWER BLACKOUT

On August 14, 2003, large portions of the Midwest and the Northeast United States and Ontario, Canada, experienced an electric power blackout. The outage affected an area with an estimated 50 million people in the states of Ohio, Michigan, Pennsylvania, New York, Vermont, Massachusetts, Connecticut, New Jersey and the Canadian province of Ontario. The blackout began a few minutes after 4 pm and power was not restored for 4 days in some parts of the United States.

While less than one percent of the switches that could have experienced reportable power problems reported problems, the NRSC suspected that there could be additional insights to be gleaned from this incident. Accordingly, a study group was commissioned to further analyze the pertinent outage reports filed with the FCC. The team determined that there were eight relevant Final Reports filed with the Commission. One of these reports covered five switches in two locations, with each switch experiencing a different failure condition. The team identified a number of causes associated with these outages, to include: inadequate or missing power alarms; insufficient response to power alarms; lack of routine maintenance and testing; overloaded or undersized power equipment; lack of power diversification; and inadequate site-specific power contingency plans.

As a result of its study, the team recommended three existing Best Practices to the industry:

> Best Practice 6-6-1028 – Routine Maintenance/Testing – Service Providers and Network Operators should *engage in preventive maintenance programs* for network site support systems including emergency generators, UPS, DC plant, HVAC, and fire suppression systems.
>
> Best Practice 6-5-0662 – Full load testing needs emphasis – Service Providers should run engines for a period of at least 1 hour on a monthly basis and, at least 5 hours, *with all available loads annually*. Perform *annual evaluation/maintenance* of power equipment. Maintain the power alarms by testing the alarms on a scheduled basis.
>
> Best Practice6-5-0658 – Redundant Fuel Systems need emphasis – Maintain adequate fuel on-site and have a well-defined re-supply plan. *Improve fuel systems reliability by providing redundant pumps for day tanks and a manual-priming pump*. Whenever possible, *use dual-source generators* with direct line natural gas as the primary and liquid fuel (normally diesel) as a back-up to provide a long-term fuel source in times of long power outages.

The team also identified the following new Best Practice:

> Service Providers, Network Operators and Property Managers with *buildings serviced by more than one emergency generator, should design, install and maintain each generator as a stand alone unit that is not dependent on the operation of another generator* for proper functioning, including fuel source.

HURRICANE ISABEL

On September 18, 2003, Hurricane Isabel slammed into Eastern North Carolina and Virginia. The high winds (approximately 75 mph with gusts to 107 mph) caused widespread damage due to airborne debris and toppled trees, resulting in significant destruction and damage of aerial infrastructure. Outage reports received by the FCC indicate that more than 160,000 customers were without telephone service—but minimal compared to the 1.9 million customers without commercial power.

Local service providers immediately deployed teams across the impacted areas to do a full assessment of plant damage, as soon as possible after the storm had passed. While the assessment phase was in process, necessary resources including materials and manpower were identified and secured. Prioritization or restoration work for critical network components was completed and teams were deployed accordingly. Hundreds of additional skilled technicians from other areas, as well as outside contractors, were brought in.

Efforts to restore service where cable plant was damaged were initially delayed due to the inability of restoration teams to reach affected neighborhoods because of road closures (e.g., streets blocked by debris; blocks cordoned off/evacuated while hazards were cleared; etc.). Further delays were encountered while the power company replaced its poles and power lines. Where the aerial cable itself wasn't destroyed or damaged, the extensive and extended commercial power outages caused service disruptions to telephone customers. Telephony plant uses commercial power which is backed-up by batteries that are, in most cases, backed-up by generators. Telephone companies also maintain and deploy a large number of portable field generators for use where and as required. Nonetheless, the scope and duration of the massive commercial power failure exceeded the considerable effort to maintain telephony to the most seriously affected areas.

While natural disasters such as Hurricane Isabel are impossible to prevent, the proactive steps taken by local service providers prior to the storm (i.e., supplies ordered in advance in expectation of possible damage), during the storm (a remote switch was removed from service when flood waters breached the building, preventing long-term damage to the equipment by electrical short circuits) and after the storm allowed for generally high service levels to be maintained throughout its duration.

SOUTHERN CALIFORNIA WILDFIRES

From October 26-31, 2003, massive wildfires in Southern California resulted in the damage or destruction to aerial infrastructure in and around San Diego. The fires burned more than 738,000 acres; 3,626 homes and 1,184 other structures were destroyed; and more than 1.6 million feet of fiber/copper cable and 961 utility poles were destroyed or impaired.

Telephone plant in the affected area employs commercial power which is generally backed-up by on-site generators. In those cases where battery back-up is used, portable generators were brought on-line after commercial power was interrupted, and before those batteries were depleted. While there were widespread and extensive commercial power failures associated with this disaster, equipment and (unburned) cable plant remained energized and in service throughout.

As is the case in all such disasters, service providers immediately deployed teams across the impacted areas to do a full assessment of plant damage, as soon as possible after the fires had been brought under control. While the assessment phase was in process, necessary resources including materials and manpower were identified and secured. Prioritization of restoration work for critical network components was completed and teams were deployed accordingly.

State of the Network

The network performance described below is based on an analysis of wireline network outages reported to the FCC. The analysis compares network outage data from January 1, 1993 through December 31, 2003. Data from January 1, 1993 through December 31, 2002 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 2002 are referred to as the *Baseline Years*.

In general, network performance remained within control limits in 2003. However, 2003 saw statistically significant departures from these limits in several areas. In particular,

- 2003 had the lowest number of outages and the lowest aggregated outage index to date, 45% and 26% respectively lower than their Baseline Levels.
- The number of Facility outages dropped to its lowest level to date. The number of Facility outages and their aggregated outage index were 46% and 35% respectively lower than their Baseline Levels.
- The number of Local Switch outages and their aggregated outage index were 60% and 67% respectively lower than their Baseline Levels.
- The number of Tandem Switch outages and their aggregated outage index dropped to their lowest levels to date, 67% and 62% respectively lower than their Baseline Levels.
- DCS outages had their lowest aggregated outage index to date, 94% lower than their Baseline Level.
- The number of Procedural Error outages and their aggregated outage index dropped to their lowest levels to date, 57% and 52% respectively lower than their Baseline Levels.
- The median number of customers potentially affected by an outage was the lowest to date, 12% less than in the Baseline Years.

Network performance areas in 2003 that remained within control limits but are still noteworthy include:

- The mean outage index was the highest to date. 2003 had outages with the second and fourth largest outage indexes to date.
- The number of DCS outages matched its lowest level to date.
- The number of CO Power outages dropped to its lowest level since 1993.

Several statistically significant trends are noted:

- Outage frequency has been decreasing at a rate of 19% annually over the last four years.
- The overall annual aggregated outage index over the last two years has been 24% less than in prior years.
- Facility outage frequency has been decreasing at a rate of 11.5% annually over the last seven years. Its aggregated outage index has been decreasing at a rate of 7% annually.
- Over the last three years, Local Switch outage frequency has been on average 65% less than in prior years. Their aggregated outage index has been decreasing 14% annually over the entire 11-year history.
- Over the last four years, CCS outage frequency has been on average 49% higher than in prior years. Its aggregated outage index has been increasing 22% annually since 1994.
- Tandem Switch outage frequency has been declining 15% annually since 1998.
- CO Power outage frequency has been decreasing at a rate of 35% annually since 2001.

- DCS outage frequency has been decreasing 20% annually since 1998.
- Over the last four years, the annual aggregated outage index of Other outages has been 140% higher than in prior years.
- Outage indexes have an increasing trend over the 11-year history.

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 U.S. telecommunications network performance 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

The number of outages in each year is shown in **Figure 1**. The number of outages in 2003 (91) was lower than in any year to date. The Baseline Level for annual outage frequency is 165.7. The difference between the 2003 outage frequency and the Baseline Level is statistically significant.

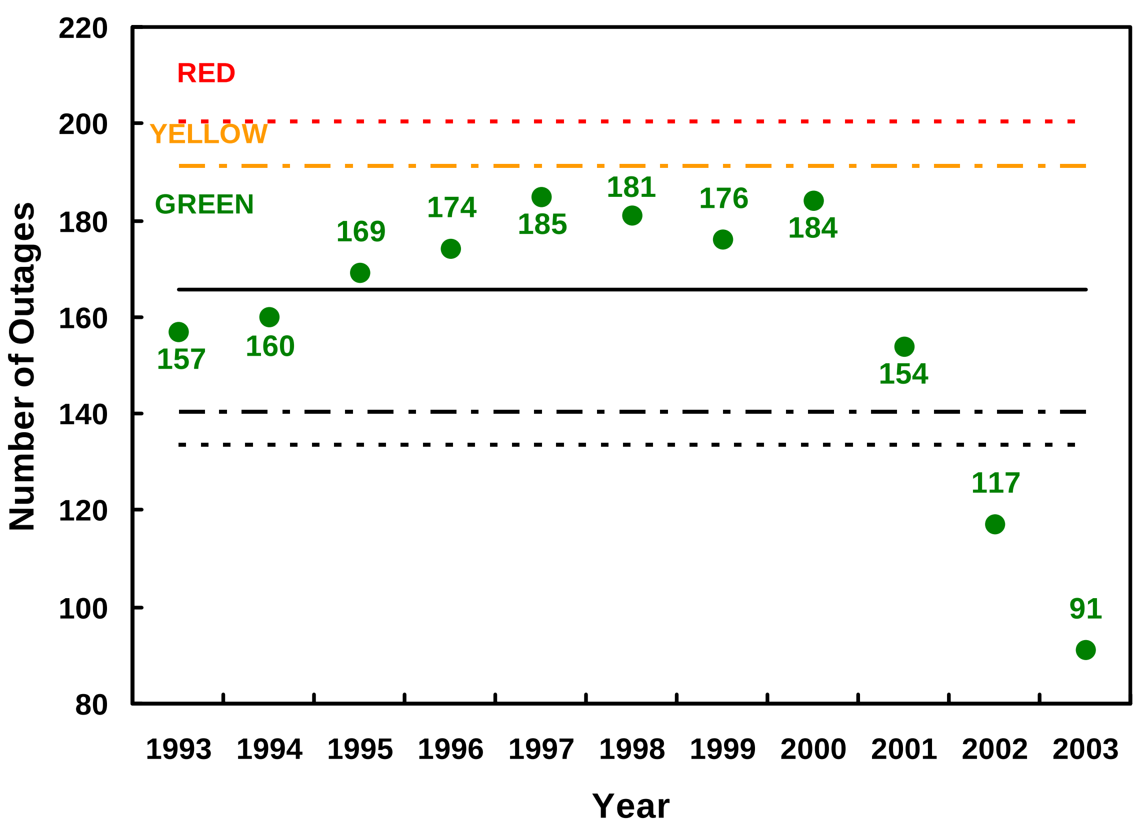


Figure 1: Annual Control Chart for Outage Frequency

Figure 2 is a control chart for outage frequency by quarter. For each quarter of 2003, the number of outages was below the lower 95% tolerance limit indicating that each quarter had outage frequency significantly below the quarterly Baseline level (41.43). The blue line plotting a spline fit to the quarterly data indicates a decreasing trend in outage frequency since 2000. A fit to data from 2000 to 2003 indicates this decreasing trend in outage frequency (5.0% quarterly) is statistically significant. Outage frequency has been highest in the third quarter (45.3 outages per quarter on average) while the other three quarters each have about 37.9 outages on average; these differences in seasonal outage frequency are statistically significant.

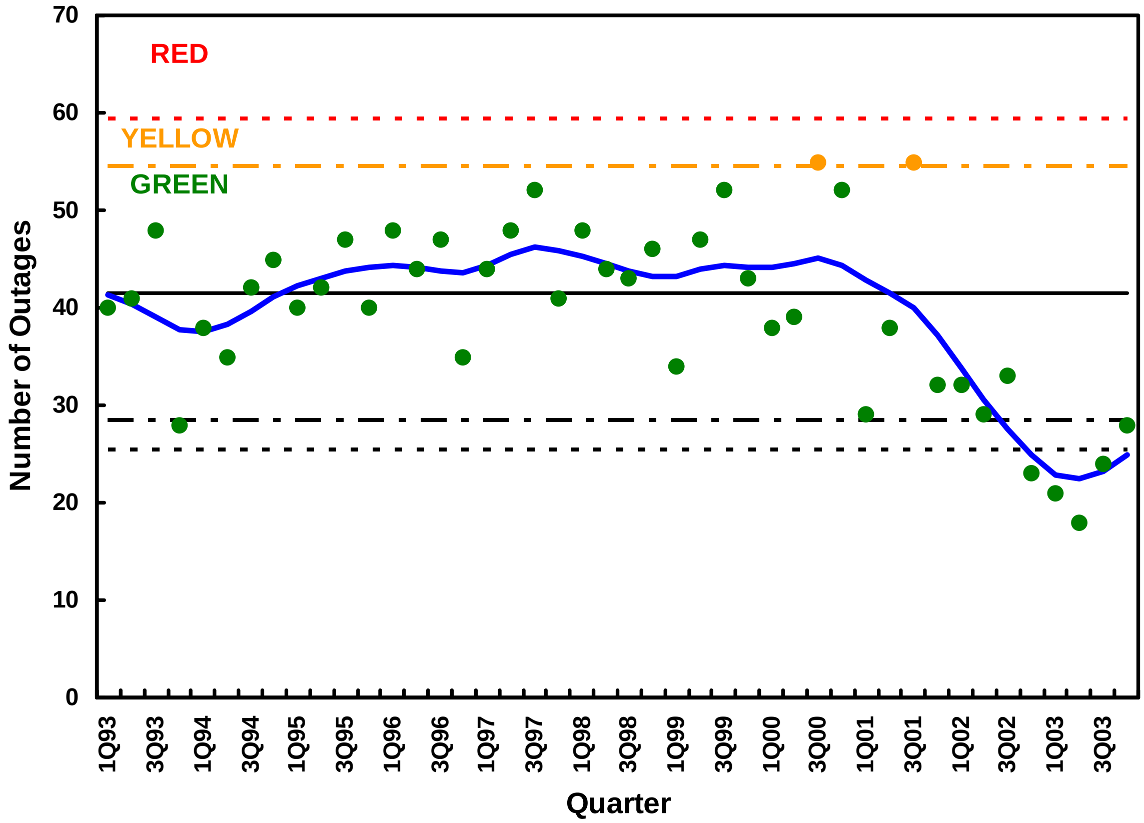


Figure 2: Quarterly Control Chart for Outage Frequency

Figure 3 provides the distribution of annual number of outages by failure category: In 2003, 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 (39) dropped in 2003 to its lowest level to date. The difference in frequency from the Baseline Level (72.5 per year) was statistically significant, below the 99% lower tolerance limit for the second consecutive year. It was below the Baseline level for the fourth consecutive year. The frequency of Facility outages demonstrates a statistically significant decreasing trend (11.5% annually) since 1997. Facility outage frequencies in 2003 and over all years (69.5 outages per year, 44% of the total) are significantly higher than in any other category.

- *Local Switch*
  In 2003, the number of Local Switch outages matched their lowest annual count to date (10). The difference in frequency from the Baseline Level (24.9) was statistically significant, below the 99% lower tolerance limit for the third consecutive year. It was below the Baseline level for the fourth consecutive year. The average annual frequency of Local Switch outages over the last three years (10.3) has been significantly less than in the first eight years (29.4). Over the 11-year reporting history, Local Switch outages have the second highest frequency (23.5 outages per year, 15% of the total), significantly higher than all categories except Facility and CCS. However, since 2000, it has had a lower frequency (13.3 outages per year, 10% of the total) than any category apart from DCS and Other.

- *Common Channel Signaling (CCS)*
  The 2003 CCS outage count (21, its lowest level since 1999) was near the Baseline level (22.2 per year). The average annual frequency of CCS outages has been significantly higher over the last four years (26.3) compared with the 1994-1999 period (17.7). In 2003, the number of CCS outages was the second highest among failure categories for the third consecutive year. CCS outage frequency has been significantly higher than any failure category (other than Facility) over the last six years (24 outages per year, 16% of all outages). CCS outages demonstrate a statistically significant seasonality effect; on average, fourth quarters have 7.2 CCS outages while the other three quarters average 5.0 CCS outages.

- *Tandem Switch*
  The number of Tandem Switch outages dropped in 2003 to its lowest level to date (6). The difference in frequency from the Baseline Level (18.3 per year) was statistically significant, below the 99% lower tolerance limit. The frequency of Tandem Switch outages demonstrates a statistically significant decreasing trend since 1998 (15% annually). Out of all outages, 11% are Tandem outages.

- *Central Office (CO) Power*
  In 2003, the number of CO Power outages (9) dropped to its lowest annual level since 1993. However, the difference in frequency from its Baseline level (15.8 per year) is not statistically significant. The frequency of CO Power outages demonstrates a statistically significant decreasing trend since 2001 (35% annually). CO Power outage frequency demonstrates a statistically significant seasonality (64% 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 2003, the number of DCS outages (2) matched its lowest level to date, its lowest level since 1996. However, the difference in frequency from its Baseline level (6.4 per year) was not statistically significant. The frequency of DCS outages has been decreasing at the statistically significant rate of 20% annually since the annual count reached its peak (11) in 1998. DCS outage frequency over all years (6 outages per year, 4% of the total) is significantly lower than in any other failure category (apart from Other).

- *Other*
  In 2003, the number of Other outages (4) was slightly below the Baseline level (5.6 per year). In the last two years, the frequency of Other outages has been significantly less (3 annually) than in the previous two-year period (9 annually). Other outage frequency over all years (5.5 outages per year, 3% of the total) is significantly lower than in any other failure category (apart from DCS).

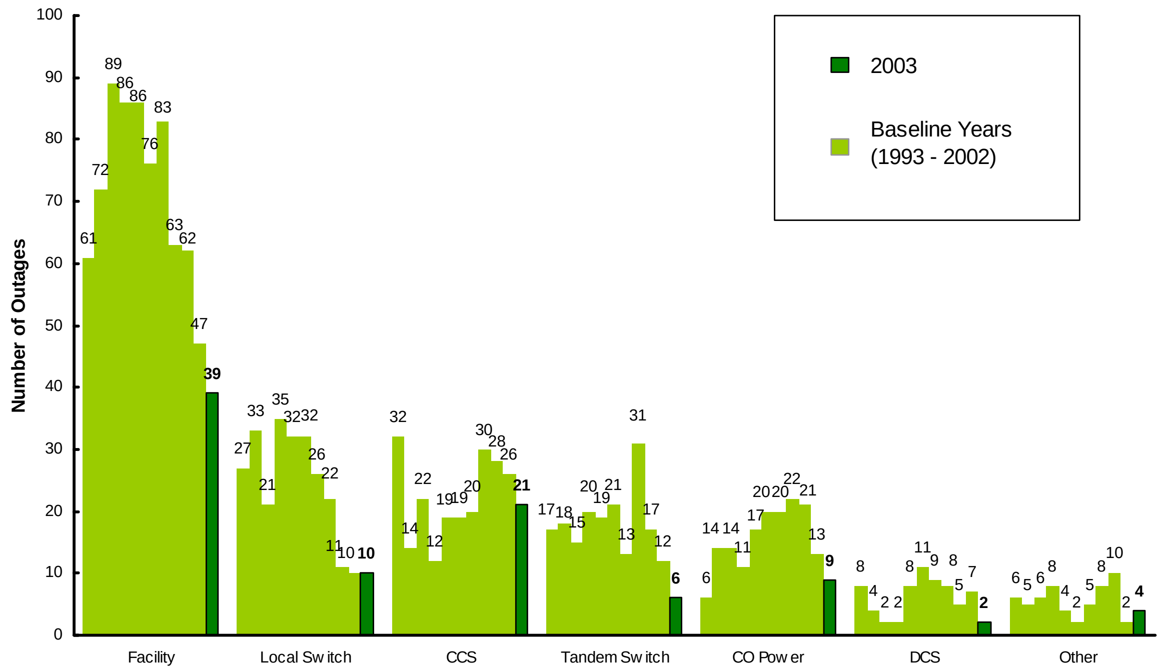


Figure 3: Annual Number of Outages by Failure Category

PERFORMANCE BY OUTAGE DURATION

Figure 4 provides a summary of the distribution of outage duration for the eleven 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 2003 had durations less than 10.98 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. In 2003, the median (3.48 hours), mean (8.71 hours), and 90th percentile (10.98 hours) values of the outage index distribution were all higher than their Baseline values (2.92, 6.86, and 10.78 hours respectively). While the median outage duration increased for the third consecutive year to its second highest annual level, it was not significantly higher than the Baseline median. Median outage duration in the last two years has been significantly higher than in 2000-2001 (3.45 versus 2.59 hours).

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 durations.

Analysis of the data provides the following additional observations:

- The median Tandem Switch outage duration over the last two years (5.9 hours) is significantly higher than over the first nine years (2.4 hours).
- In 2003, CCS outages had their second highest median duration to date (2.0 hours), significantly higher than the Baseline median (1.3 hours). The median has a statistically significant increasing trend since 1998 (about 19% per year)
- In 2003, Local Switch outages had their second highest median duration to date (2.1 hours), it was not significantly higher than their Baseline median (1.4 hours). The median duration has a statistically significant increasing trend (about 7% per year).

- While the median duration of Facility outages rose to its second highest annual level in 2003 (6.0 hours), over the last five years (1999-2003), the duration of Facility outages has been significantly lower (median 4.5 hours) than in the first six years (median 5.2 hours).
- In 2003, the median duration of CO Power outages reached its highest value to date (3.6 hours); however, it was not significantly higher than their Baseline median (2.4 hours).

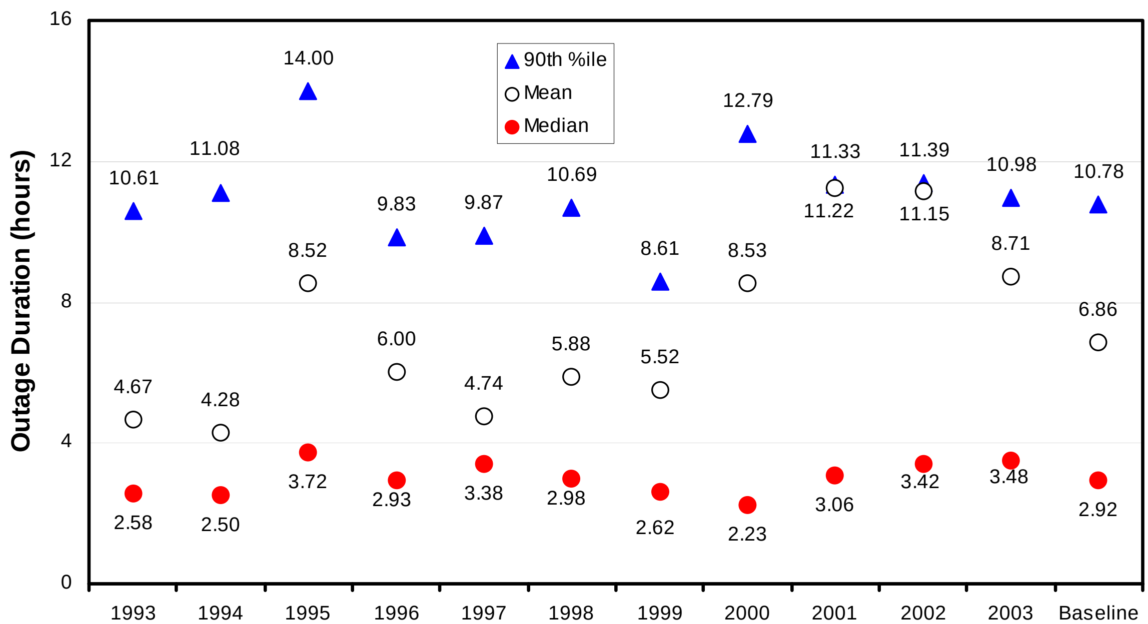


Figure 4: Annual Distributions of Outage Durations

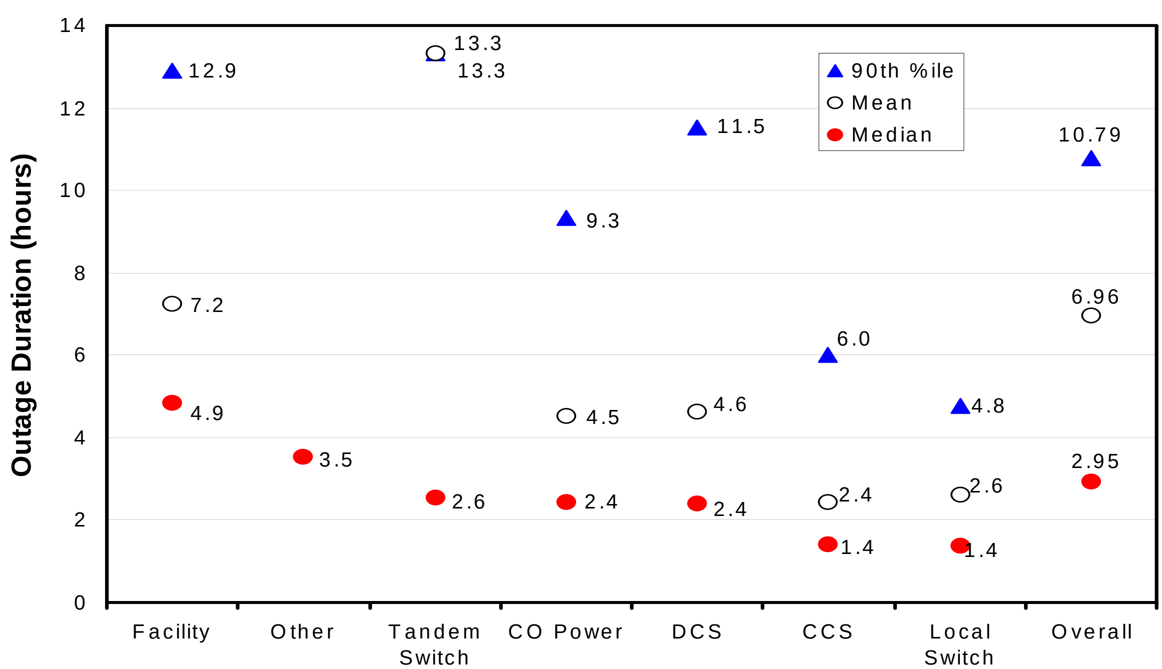


Figure 5: Distributions of Outage Durations by Failure Category (2003)
(Other Mean – 30.2 hours, Other 90th %ile – 106.5 hours)

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 2003. 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). In 2003, the median (49,400), mean (106,400), and 90th percentile (172,200) values of the customers potentially affected distribution were all lower than their Baseline values (56,000, 160,600, and 231,100 respectively). The 2003 median was the lowest annual median to date, significantly lower than the Baseline median. The number of customers potentially affected by an outage has been significantly less over the last two years (median 51,300) compared to the first nine years (median 56,100).

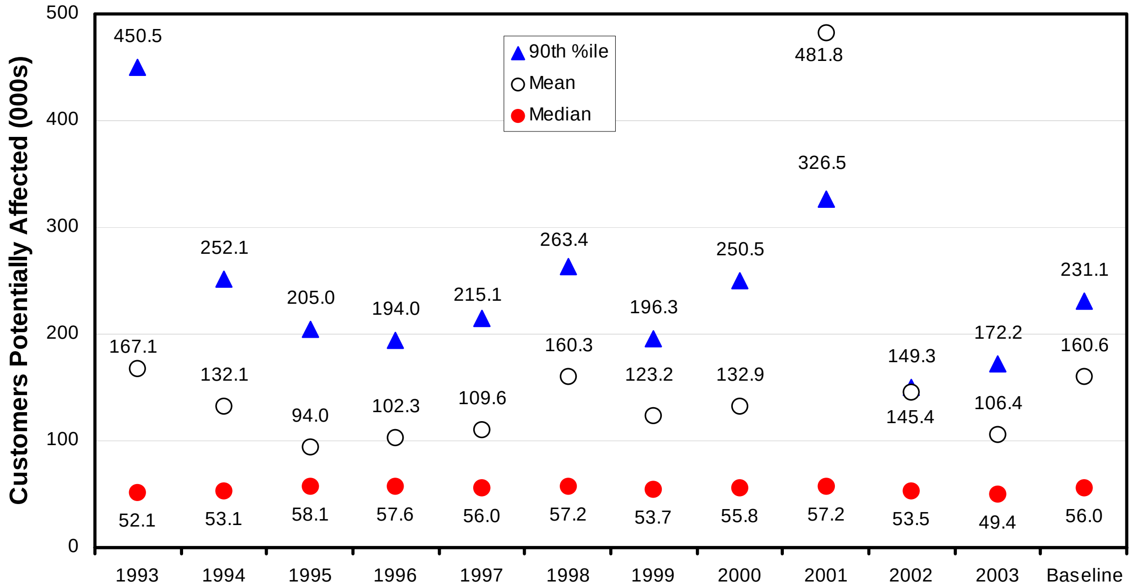


Figure 6: Annual Distributions of Customers Potentially Affected per Outage

Analyses by failure category (**Figure 7)** show that Tandem Switch and DCS 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 2003, CO Power outages had their highest median customers potentially affected to date (71,700); however, it was not significantly higher than the Baseline median (53,000). The median number of customers affected by CO Power outages has a statistically significant increasing trend over time (3.5% per year).
- In 2003, Facility outages had their second lowest median customers potentially affected to date (53,300). The median over the last two years (50,400) has been significantly less than in the first nine years (64,700). The median number of customers affected by Facility outages has a statistically significant decreasing trend over time (3% per year).
- In 2003, Local Switch outages had their lowest median customers potentially affected to date (39,500); it was not significantly lower than the Baseline median (45,200).
- In 2003, the median number of customers potentially affected in Tandem Switch outages dropped to its lowest level to date (39,400); however, it was not significantly lower than the Baseline median (83,500).

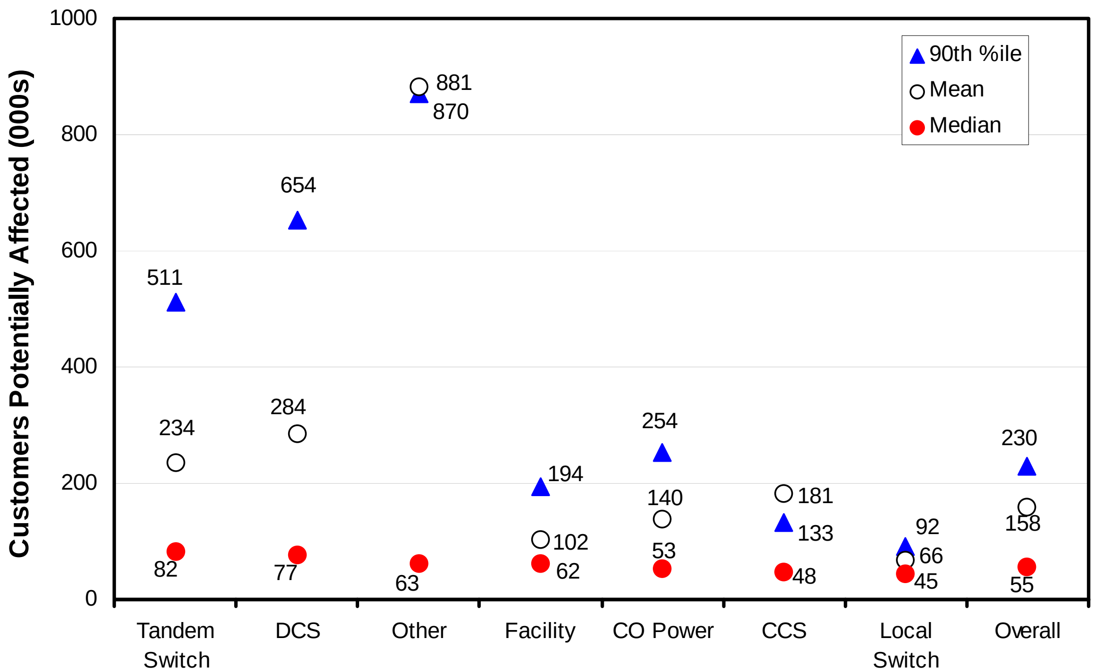


Figure 7: Distributions of Customers Potentially Affected by Failure Category (2003)

PERFORMANCE BY OUTAGE INDEX

ATIS Network Performance, Reliability and Quality of Service Committee (formerly Committee T1) Report No. 42 defines an outage index that provides 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 sum of the individual outage indexes in that collection. 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

Annual aggregated outage indexes are given in **Figure 8**. The Baseline Level for annual aggregated outage index is 1589. The aggregated outage index in 2003 was below this level at its lowest value to date (1168); this difference is statistically significant. While the aggregated outage index does not have a statistically significant trend, the annual average over the last two years (1233) has been significantly lower than in the first nine years (1621).

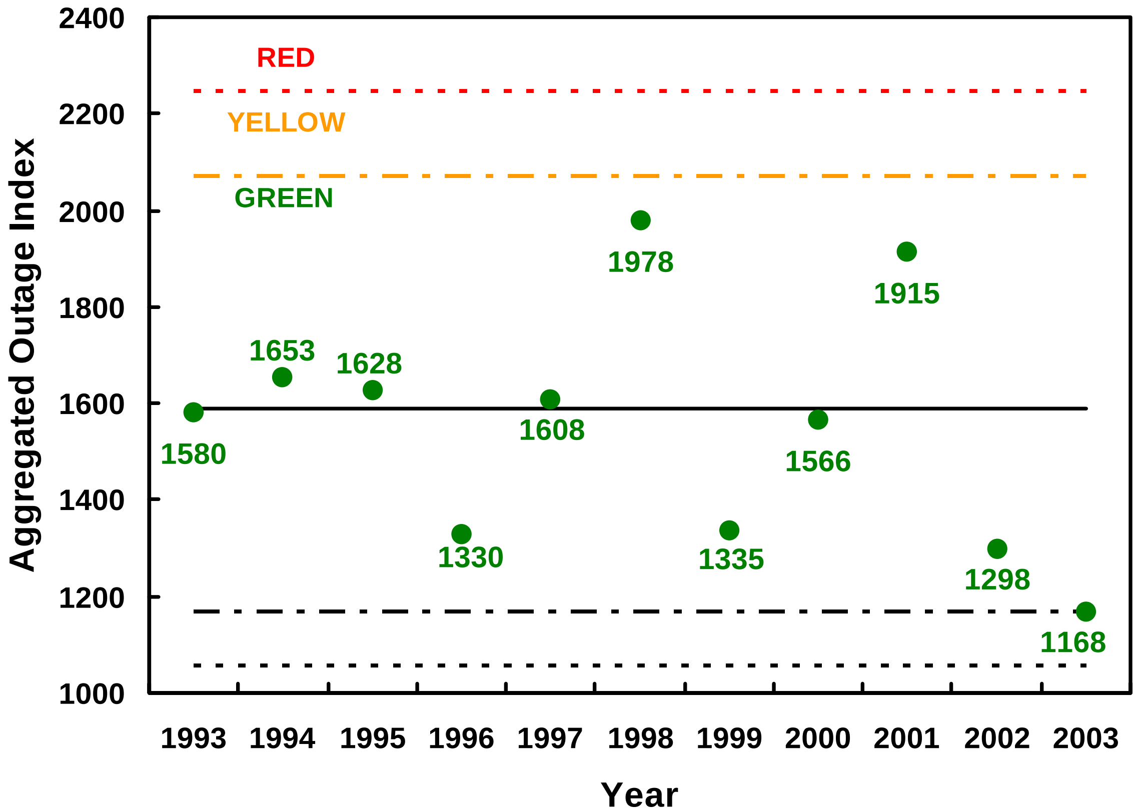


Figure 8: Annual Aggregated Outage Index Control Chart

Figure 9 provides a control chart of the quarterly aggregated outage index from 1993 to 2003. The blue line is a spline fit to the data. All four quarters of 2003 were within control and only one was above the Baseline level.

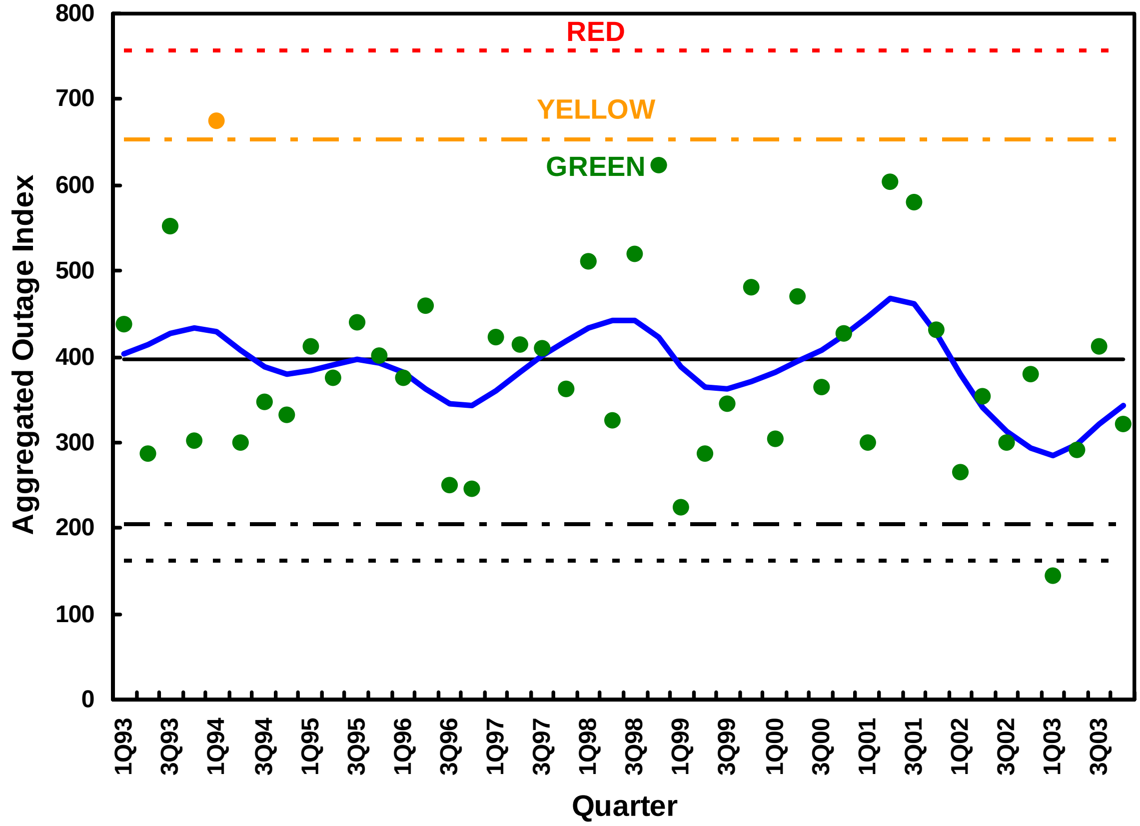


Figure 9: Quarterly Aggregated Outage Index Control Chart

The annual aggregated outage index for each failure category is given in **Figure 10**. In 2003, the aggregated outage index for each failure category was within its Green region. Conclusions based on these data are:

- *Facility*
  The annual aggregated outage index for Facility outages (461) was significantly lower than its Baseline Level (713 per year) for the fifth consecutive year. It has a statistically significant decreasing trend of 7% per year over the entire 11-year history. The aggregated outage index for Facility outages is significantly higher than in any other failure category (690 annually, 44% of the total).

- *Tandem Switch*
  The annual aggregated outage index for Tandem Switch outages declined for the third consecutive year and reached its lowest level to date (82), significantly below its Baseline Level (215 per year). Tandem Switch aggregated outage index has no statistically significant overall trend, but in the last two years, the annual average has been significantly lower (139) than it was in 2000 – 2001 (295).

- *Central Office (CO) Power*
  CO Power aggregated outage index (215) was not significantly greater than its Baseline level (173 per year). CO Power aggregated outage index has no statistically significant overall trend, but its annual value has been above the Baseline level in five of the last six years.

- *Common Channel Signaling (CCS)*
  CCS aggregated outage index (177) was slightly above the Baseline level (162 per year). It has been above the Baseline level in each of the last four years. Its annual aggregated outage index has been increasing at the statistically significant rate of 22%annually since 1994.

- *Other*
  Other aggregated outage index (188) was not significantly greater than its Baseline Level (129 per year). The average annual aggregated outage index for Other outages has been significantly higher over the last four years (214) compared to the first seven years (89).

- *Local Switch*
  Local Switch outages had their second lowest annual aggregated outage index to date (42). The difference from the Baseline Level (129 per year) was statistically significant. The Local Switch annual aggregated outage index has a statistically significant decreasing trend of 14% per year over the entire 11-year history. Since 1995, the Local Switch aggregated outage index (105 annually, 7% of the total) has been significantly lower than all failure categories except DCS and Other.

- *Digital Cross-connect System (DCS)*
  DCS aggregated outage index dropped to its lowest level to date (4), significantly below its annual Baseline Level (69 per year). Over the entire 11-year history, the aggregated outage index for DCS outages (63 annually, 4% of the total) was significantly lower than in any other failure category. Over the last four years, the average annual DCS aggregated outage index has been significantly lower (48) compared to its peak years 1997-1999 (128).

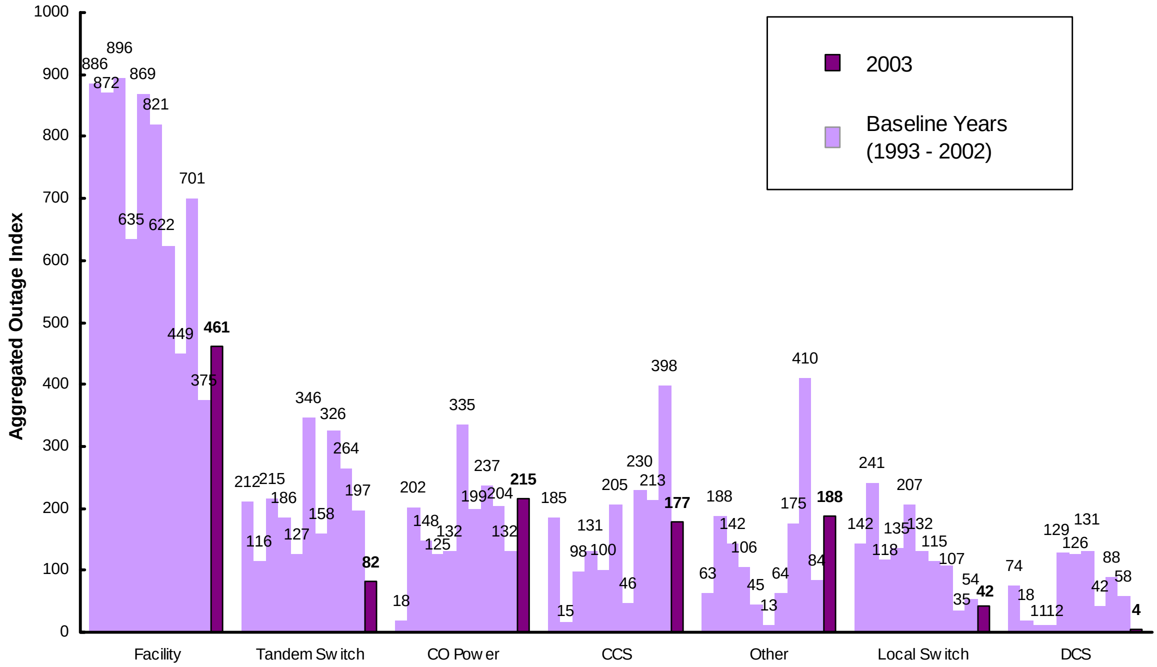


Figure 10: Annual Aggregated Outage Index by Failure Category

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 2003, the median (4.8), mean (12.8), and 90th percentile (31.8) values of the outage index distribution were all higher than their Baseline values (3.9, 9.6, and 27.3 respectively). Nevertheless, the outage index per outage in 2003 was not statistically different than in the Baseline Years. The median outage index per outage has a statistically significant increasing trend over time (3.4% annually).

The mean outage index in 2003 was the highest in any year to date. This is somewhat attributable to the occurrence of outages with the second and fourth highest outage indexes to date:

- Northeast power outage in August 2003 (152)
- Hurricane Isabel in September 2003 (129).

The highest outage index to date is 206.

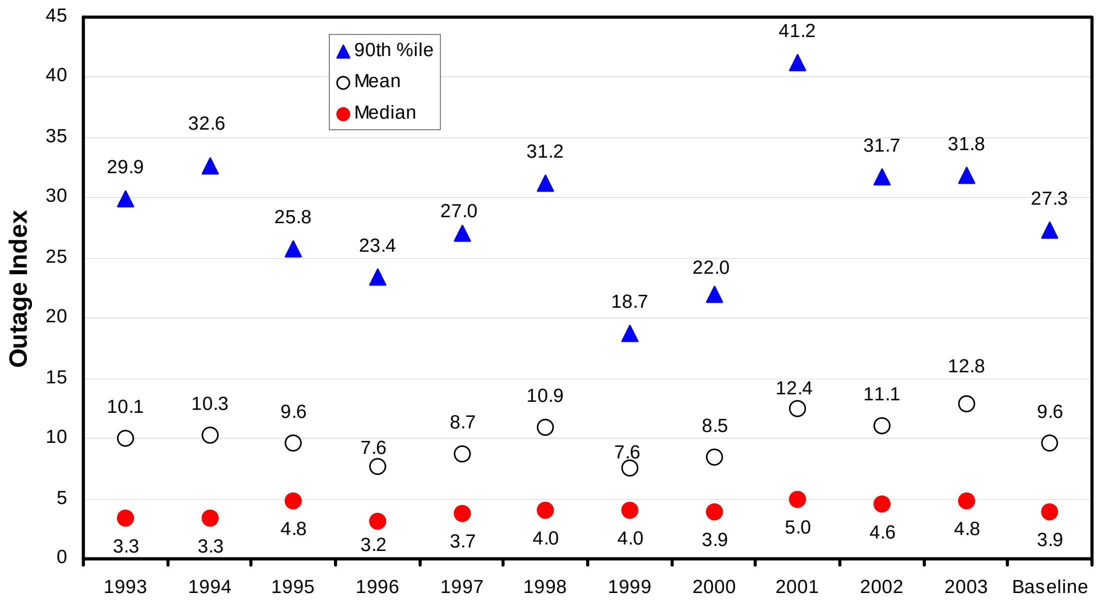


Figure 11: Annual Distributions of Outage Index per Outage

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

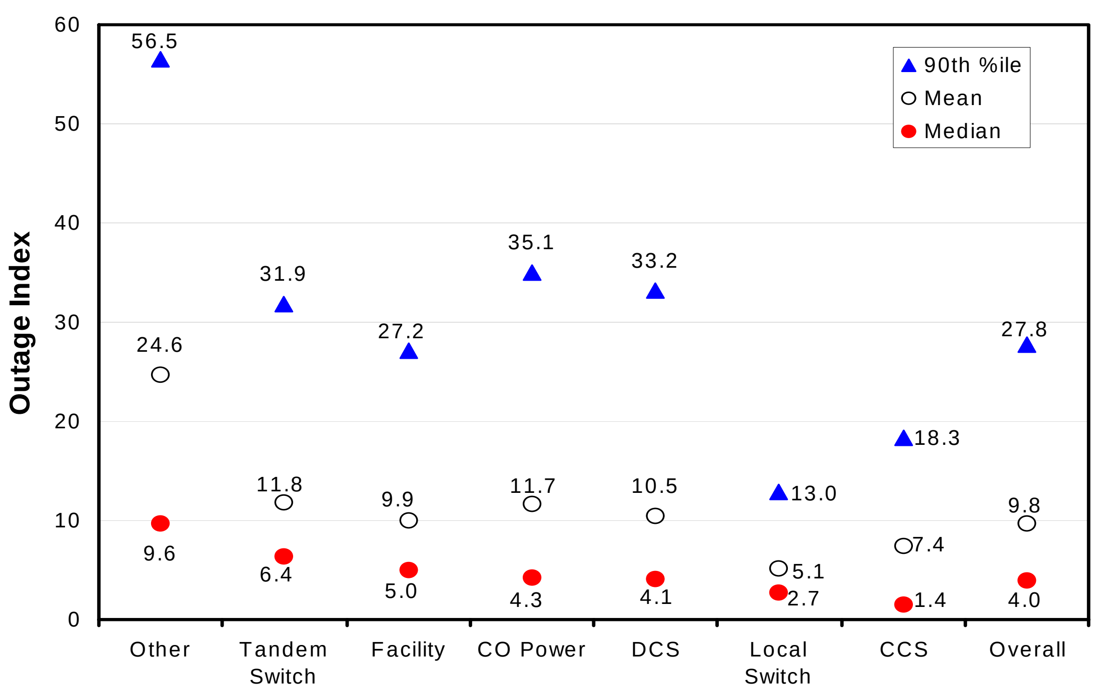


Figure 12: Distributions of Outage Index by Failure Category

Analysis of the data provides the following additional observations:

- In 2003, CCS outages had their highest median outage index (4.5), significantly higher than their Baseline median (1.3). Since 1999, the median index for CCS outages has increased each year from 0.2 to 4.5; this increasing trend is statistically significant.
- Over the last three years, the median index for Other outages (34.5) was significantly greater than in the first eight years (7.2).
- In 2003, Facility outages had their highest median outage index since 1993 (8.2); however, it was not significantly higher than their Baseline median (4.9).
- The median index for Tandem Switch outages over the last three years (8.5) has been significantly higher than over the first eight years (5.4).
- In 2003, CO Power outages had their highest median outage index (7.0); however, it was not significantly higher than their Baseline median (4.2). The median index for CO Power outages has a statistically significant increasing trend over time (about 8% annually).

OUTAGE METRICS RELATIVE TO NETWORK CHANGE

The public telecommunications network is continually 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 change 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 change. As such, the results are conservative in the sense that network growth is slightly underestimated.

Table 1: Network Change 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
2002	262.2[2]	549,300[3]

[2] Federal Communications Commission, March 2, 2004, Statistics of Communications Common Carriers 2002/2003 Edition, Table 2.6 Operating Statistics of Reporting Incumbent Local Exchange Carriers as of December 31, 2002, Total Access Lines (Switched and Special)

[3] Federal Communications Commission, March 2, 2004, Statistics of Communications Common Carriers 2002/2003 Edition, Table 2.6 Operating Statistics of Reporting Incumbent Local Exchange Carriers as of December 31, 2002, Local Calls, IntraLATA Toll Calls Completed (Originating), and InterLATA Toll Calls Completed (Interstate and Intrastate)

Figure 13 plots the annual network change 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 2003.[4]) Figure 13a indicates that, in every year, the annual number of outages 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.

In 1995, Working Group T1A1.2 developed normalization techniques that adjusted overall outage frequency and aggregated outage index subject to network change. 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 (plus 2002) provided normalized outage frequency and aggregated outage index using these techniques.

This report provides a normalized outage count and a normalized aggregated outage index for 2003. The normalization was performed relative to calendar year 1993.[5] That is, the 2003 normalized outage count may be compared to the 1993 outage count and the 2003 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 2003 divided by the total number of calls in 1993:

$$\text{CNF} = 513.7 \text{ billion} / 510.0 \text{ billion} = 1.007$$

and the Line Normalization Factor (LNF) is the total number of lines in mid-2003 divided by the total number of lines in mid-1993:

$$\text{LNF} = 268.34 \text{ million} / 144.66 \text{ million} = 1.855.$$

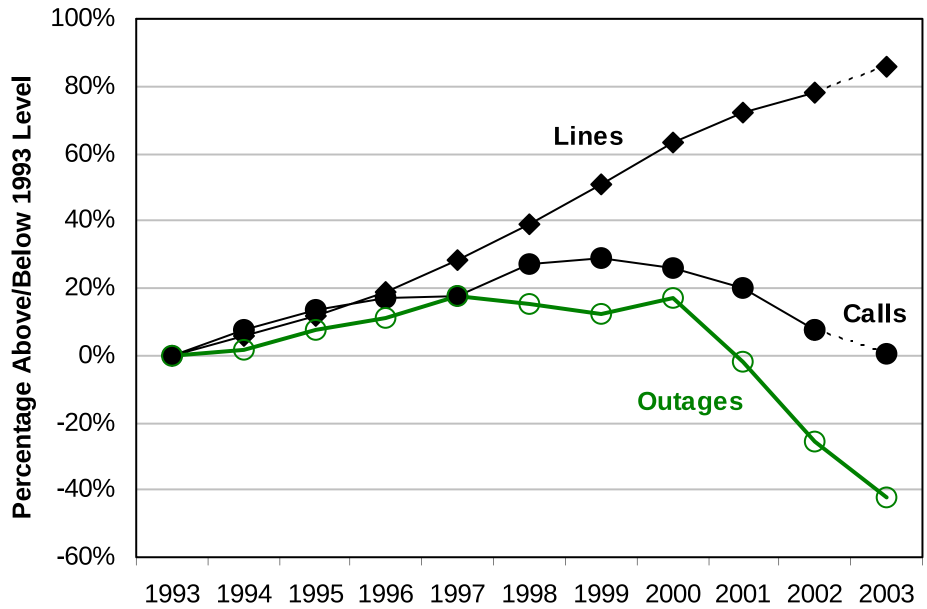
CNF and LNF are used to normalize the reporting thresholds for customers affected assuming that the thresholds were created based on the percentage of all customers in the nation affected. Under normalization, only those outages in which at least

30,000 x LNF = 30,000 x 1.855 = 55,650 subscriber lines were affected
or
90,000 x CNF = 90,000 x 1.007 = 90,630 calls were blocked

are included in the 2003 normalized outage count. Only these outages are used in calculating the 2003 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 2003 normalized aggregated outage index is the sum of these individually normalized outage indexes.

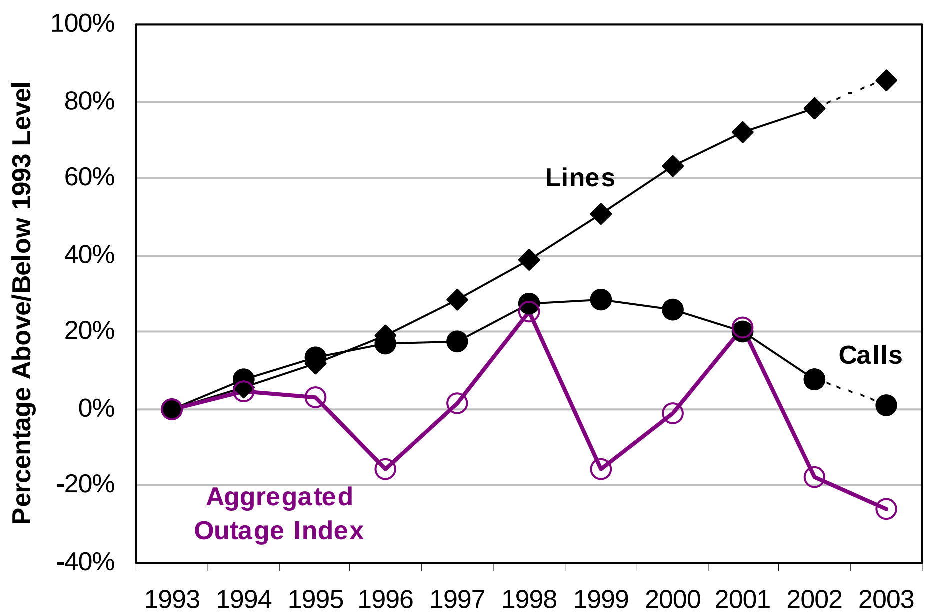
[4] The extrapolation is based solely on data from past years in Table 1. The representative of one service provider has indicated that preliminary data from 2003 shows a decline in lines for that service provider.

[5] The normalization of outage count 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.



(a) Outage Frequency and Network Change

Figure 13: Annual Network Change and Outage Metrics over Time



(b) Aggregated Outage Index and Network Change

Figure 13: Annual Network Change and Outage Metrics over Time

Table 2 presents the results of normalization on 2002 and 2003 outage frequency and aggregated outage index. The results indicate that while 2003 demonstrated substantial improvement over 1993 and 2002 based on the standard metrics, this improvement is even greater when adjustment is made for change in the network.

Table 2: 2002 and 2003 Normalization of Outage Counts and Aggregated Outage Index

Year	Method	Number of Outages	Aggregated Outage Index
1993	Standard/Normalized	157	1580
2002	Standard	117	1298
	Normalized	91	950
2003	Standard	91	1168
	Normalized	64	834

ROOT CAUSE ANALYSIS

This section provides a root cause analysis of outages in the major failure categories (Facility, Local Switch, CCS, Tandem Switch, CO Power, and DCS failures) as well as outages 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[6].

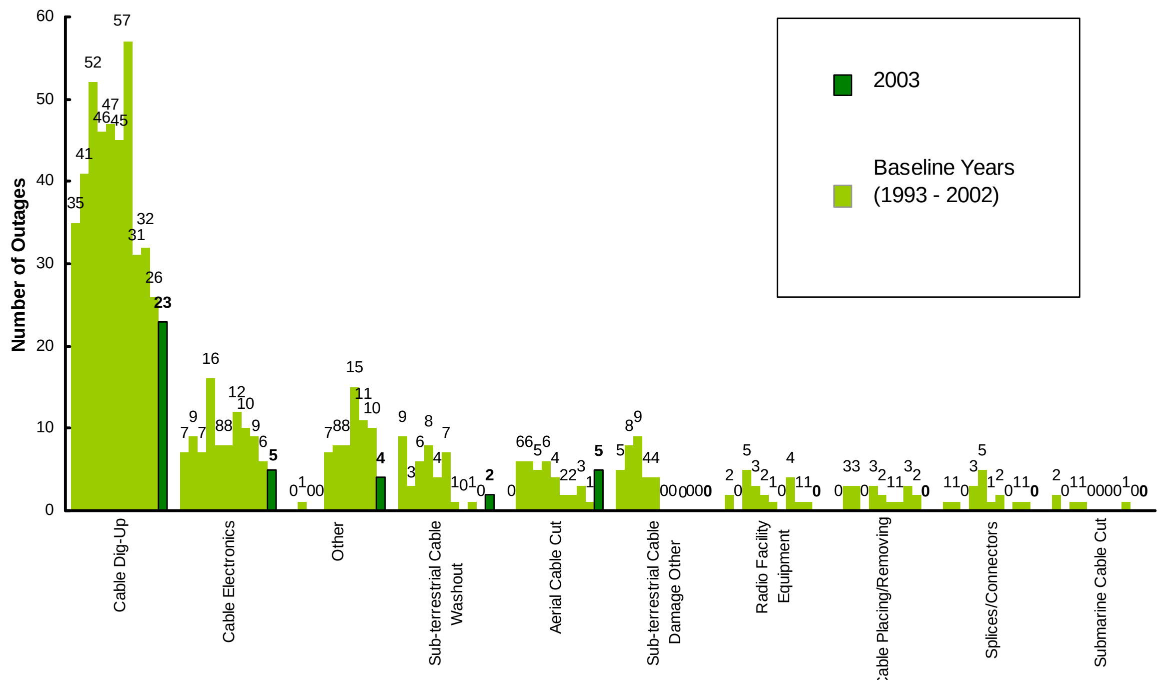


Figure 14: Annual Number of Outages by Facility Failure Subcategory

Over the 11-year history, Cable Dig-up (57%), Cable Electronics (13%), and Other (8%) have been the dominant Facility failure subcategories. While they continued to dominate in 2003, the Cable Dig-up (DU) subcategory had its lowest annual number of outages to date (23), significantly

[6] The NRSC defines "Facility" outages as those involving all wiring/cable, associated electronics and hardware (excluding DCSs) and any related work activities associated with these items, from the switch itself to the main frame and from there to and including all outside plant. Some specific examples include but are not limited to: aerial, underground and submarine cable, radio facilities, repeaters, multiplexers, demultiplexers, regenerators, timing source interface unit, "BITS" interface card, and voltage control oscillator fuses.

lower than its Baseline level (41 per year). The frequency of Cable DUs demonstrates a statistically significant seasonality effect; 35% less Cable DU outages occur in the first quarter as compared to the rest of the year. In the last four years, the frequency of Cable Dig-Up outages has been significantly less (28 per year) than in the first seven years of reporting (46 per year). Passage of One-Call legislation in June 1998, resulting in the establishment of the Common Ground Alliance, is a likely factor in this decrease. 2003 was the sixth consecutive year with no Sub-terrestrial Cable Damage Other outages; its outage frequency has declined at the statistically significant annual rate of 46% since the start of the Baseline Years. 2003 had the fewest Cable Electronics outages to date (5); its frequency has dropped at the statistically significant rate of 20% annually since 1999. In the last five years, the frequency of Sub-terrestrial Cable Washout outages (0.8 per year) has been significantly lower than in the first six years (6.2 per year); over the 11-year history, this subcategory demonstrates a statistically significant seasonality effect; first quarters have 2.1 such outages per year, second quarters 0.5 per year, third quarters 0.8 per year, and fourth quarters 0.3 per year. In 2003, the number of Other subcategory outages dropped to its lowest number (4) since 1996; its frequency was significantly lower than its average in 2000–2002 (12 per year). Nevertheless, the frequency of Other subcategory outages has been significantly greater over the last seven years than over the first four years (9.0 versus 0.3 per year). In the last seven years, more Facility outages have occurred in the Other subcategory than in any other subcategory aside from Cable DU. In 2003, the number of Aerial Cable Cut outages rose to its highest level (5) since 1997; still, over that period (1998 – 2003), the frequency of Aerial Cable Cut outages has been significantly lower than in the period 1994 – 1997 (2.8 versus 5.8 per year). The Radio Facility Equipment subcategory had no outages in 2003; since reaching its peak in 1995 (5 outages), its frequency has declined at the statistically significant rate of 21% annually. 2003 was the first year since 1996 with no Cable Placing/Removing subcategory outages. The frequency of Splices/Connectors subcategory outages has a statistically significant decreasing rate of 30% per year since 1996. The frequency of Submarine Cable Cut outages has decreased at the statistically significant rate of 24% annually over the eleven-year history.

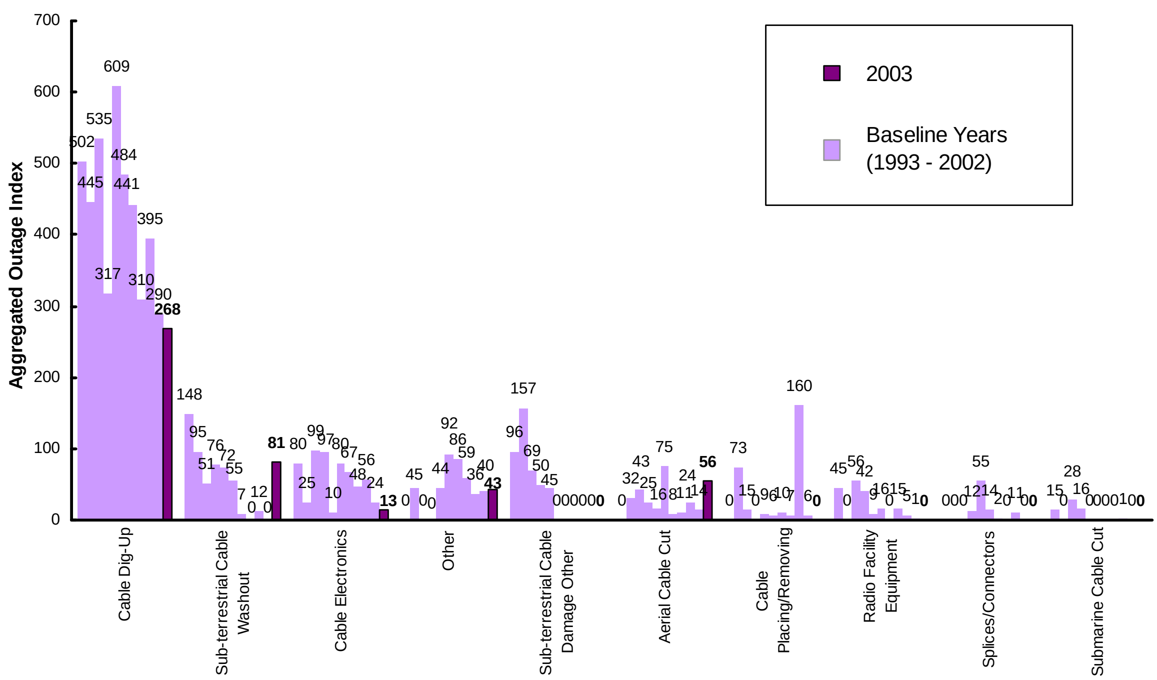


Figure 15: Annual Aggregated Outage Index by Facility Failure Subcategory

Cable DUs dominate Facility outages from the outage index perspective as well (61% over 11 years of reporting). In 2003, Cable DUs had their lowest aggregated outage index to date (268); it was not significantly less than its Baseline level (433 per year). The aggregated outage index of Cable Dig-Up outages has been decreasing at the statistically significant annual rate of 5%. In 2003, the Sub-terrestrial Cable Damage Washout aggregated outage index reached its highest level since 1994 (81); it was not significantly greater than its Baseline average (52 per year), but it was significantly higher than its average in 1999 – 2002 (5 per year). Despite this increase, the average Sub-terrestrial Cable Damage Washout aggregated outage index over the last five years (20 per year) remains significantly less than it was in the first six years (83 per year). The Other subcategory aggregated outage index has been significantly higher over the last seven years than it was over the first four years (57 versus 11 per year). The Aerial Cable Cut subcategory aggregated outage index rose to its highest level since 1998 and its second highest to date (56); it was significantly higher than the average in the prior 4-year period 1999 - 2002 (14 per year). The Radio Facility Equipment subcategory aggregated outage index has been significantly lower in the last seven years than in the first four years (7 versus 36 per year).

The dominant root cause categories with respect to frequency are Cable Damage (42%), Procedural Service Provider (27%), and External Environment (14%);[7] these differences are statistically significant. However, over the last four years, the frequencies of Cable Damage and Procedural Service Provider outages are not significantly different (18.5 versus 17.8 per year respectively). In the last four years, the frequency of Cable Damage outages has been significantly less than in the first seven years (18.5 versus 34.9 per year). In 2003, the number of Procedural Service Provider outages had its lowest annual count to date (4); its frequency was significantly lower than its Baseline level (20.2 per year). This is the second consecutive annual decline in Procedural Service Provider outages after reaching a peak of 27 in 2001; the frequency of Procedural Service Provider outages over the last two years (10 per year) has been significantly lower than over the first nine years (20.7 per year). Over the last five years, the frequency of External Environment outages has been significantly lower than in the first six years (5.6 versus 13.2 per year). Design Hardware outage frequency has been significantly lower over the last six years than over the first five years (2.5 versus 7.8 per year). The number of Facility outages attributed to Hardware Failure matched its highest annual level to date for the second consecutive year (5); its frequency has been increasing at the statistically significant annual rate of 22%.

The same three root causes are dominant with respect to the aggregated outage index: Cable Damage (44%), Procedural Service Provider (24%), and External Environment (17%). The average Cable Damage aggregated outage index over the last two years (190 per year) has been significantly lower than over the first nine years (333 per year). In 2003, Procedural Service Provider had its lowest aggregated outage index to date (35), significantly lower than its Baseline level. Despite increasing to its highest level (133) since 1998, the External Environment annual aggregated outage index has a statistically significant decreasing trend of 15% annually. In 2003, the aggregated outage index of Design Hardware outages had its second lowest value to date (0.4), significantly lower than its Baseline level (53 per year); it has been significantly less in the last six years than in the first five years (17 versus 86 per year).

Cable Dig-Up

Cable Damage (68%) and Procedural Service Provider (26%) are the dominant root causes of Cable Dig-Up outages. However, over the last four years, Cable Damage frequency (17.5 per year)

[7] 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.

was significantly lower than in the previous seven years (32.4 per year); its annual aggregated outage index has been significantly lower over the same periods (206 versus 327 per year).

Looking at the root cause subcategories of Cable Damage Facility outages, Inadequate/No Notification (53%) and Digging Error (42%) have been the biggest contributors; there is no significant difference in the frequencies of these two subcategories over the 11-year history. In 2003, the number of Inadequate/No Notification outages (7) was significantly lower than its Baseline level (15.1 per year); over the last four years, the frequency of these outages has been significantly less than in the first seven years (8 versus 18 per year). The frequency of Digging Errors has a statistically significant decreasing trend (19% annually) since its peak (19) in 1998.

With respect to the Cable Damage Facility aggregated outage index, the dominant root cause subcategories are also Inadequate/No Notification (56%) and Digging Error (40%). Over the last five years, the aggregated outage index for Inadequate/No Notification has been significantly less (105 per year) than in the first six years (205 per year). The Digging Error aggregated outage index has a statistically significant decreasing trend (21% annually) since 1997. **Figures 16** and **17** present the annual number of outages and aggregated outage index for the Cable Damage root causes of Cable DU.

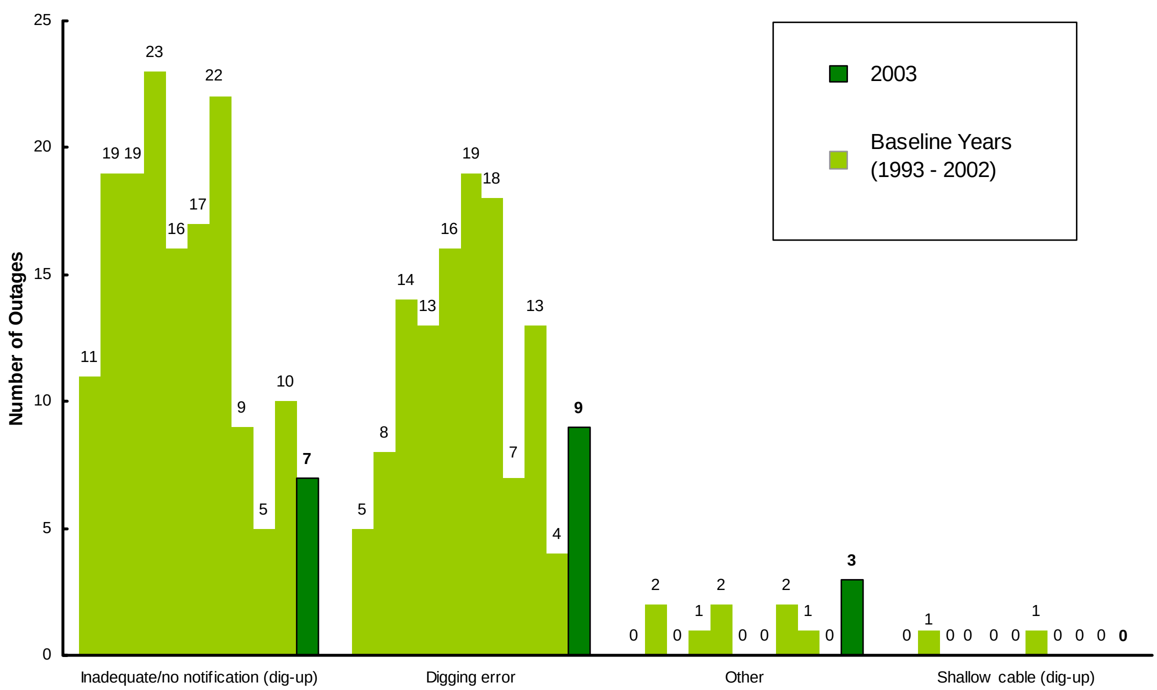


Figure 16: Annual Number of Outages by Cable Damage Root Cause Subcategories of Cable Dig-Up (DU) Facility Outages

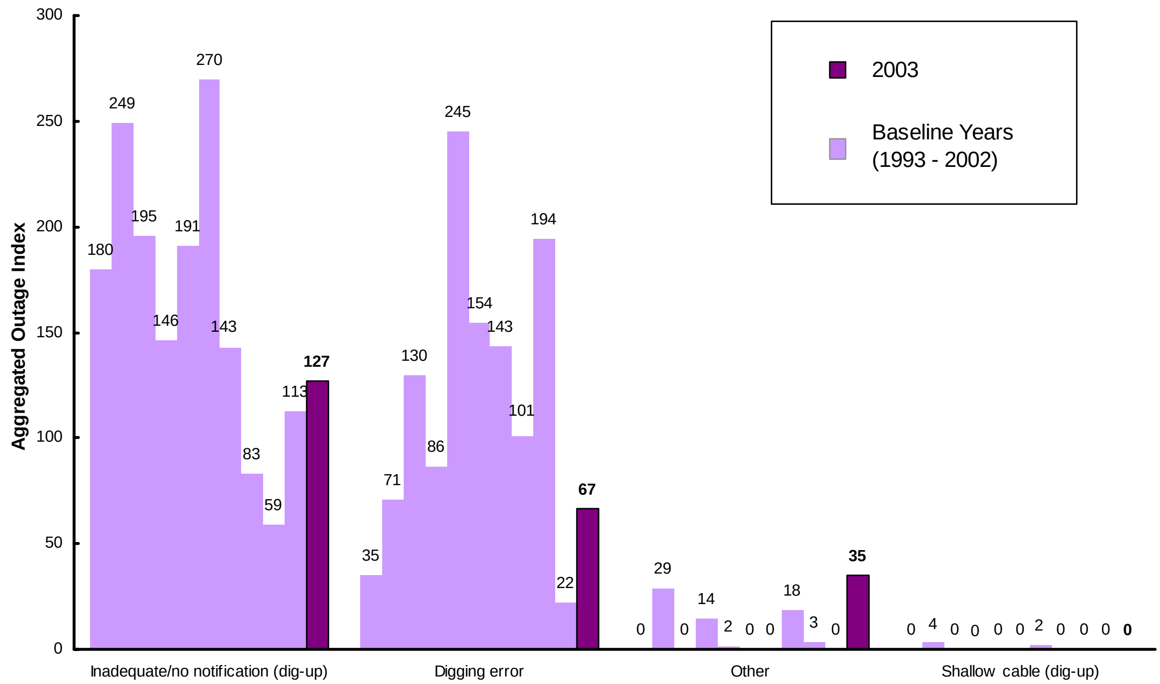


Figure 17: Annual Aggregated Outage Index for Cable Damage Root Cause Subcategories of Cable Dig-Up (DU) Facility Failures

Cable Electronics

The major root causes of the Cable Electronics[8] attributed Facility outages are: Procedural Errors (41%), Hardware Failure (23%), Design Hardware (18%), and Design Software (11%). However, over the last five years, Hardware Failure has had the highest percentage of these outages (38%). 2003 was the first year in which no Cable Electronics attributed Facility outage had a Procedural Error as its root cause, significantly lower than its Baseline level (4). Over the last two years, the frequency of such Procedural Error outages has been significantly less than in the first nine years (0.5 versus 4.3 per year). Hardware Failure outage frequency has a statistically significant increasing trend (21% per year). Design Hardware frequency has been significantly lower in the last six years (0.7 per year) than in the first five years (2.6 per year). When considering the aggregated outage index, Procedural Service Provider is the dominant root cause (53%) followed by Design Hardware (23%) and Hardware Failure (14%).

LOCAL SWITCH

The dominant failure subcategory for Local Switch outages is Hardware (44%), which has significantly more outages than the Software (27%), Translations (20%), and Other (9%) failure subcategories. In 2003, the number of Hardware outages matched their lowest annual count to date (3) significantly lower than its Baseline Level (11.1 per year). The frequency of Hardware outages has been decreasing at the statistically significant rate of 12% annually. Over the last five years, Software outage frequencies (3.4 per year) have been significantly less than in the first six years (8.8 per year). Over the last three years, the frequency of Translations outages (1.7 per year) has been

[8] 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.

significantly less than in the first eight years (5.9 per year). Over the last six years, Other outage frequency (3.2 per year) has been significantly greater than in the first five years (0.8 per year).

Hardware outages are less dominant with respect to aggregated outage index: Hardware (39%), Software (31%), Translations (24%), and Other (6%). The annual aggregated outage index for Hardware outages had its lowest value to date in 2003 (4), significantly lower than its Baseline level (51 per year). The annual aggregated outage index for Hardware outages demonstrates a statistically significant decreasing trend over the course of the 11-year history (26% per year). The aggregated outage index for Translation outages in the last four years (11 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 (51% and 48% respectively). However, over the last three years, the percentage of Local Switch outages attributed to a Procedural Error (35%) has not been significantly higher than the percentages of those attributed to Design Software (26%) and Hardware Failure (29%). In 2003, the number of Procedural Error outages dropped to its lowest level to date (3), significantly lower than its Baseline level (12.9 per year). Procedural Error frequency has a statistically significant decreasing trend since its peak in 1998 (36% annually). The aggregated outage index of Procedural Error outages in 2003 (17) was also significantly lower than its Baseline level (62 per year); over the last three years, its annual aggregated outage index (15 per year) has been significantly lower than in the first eight years (75 per year). In 2003, Hardware Failure had its lowest aggregated outage index to date (4.3); its aggregated outage index has a significant decreasing rate of 21% per year since reaching its peak in 1994 (48). In the last two years, the frequency of Hardware Failure outages has been significantly less than in the eight years after 1993 (2 versus 6.3 per year). Over the last seven years, the frequency (3.1 per year) and average aggregated outage index (20 per year) of Design Software outages has been significantly less than in the first four years (7 and 52 respectively per year).

COMMON CHANNEL SIGNALING (CCS)

Isolation is the dominant failure subcategory (72%) for CCS outages, significantly greater that other failure subcategories; it is followed by Link(set)s (11%), STP Equipment (8%), and SCP Equipment (5%). Over the last four years, the number of CCS outages attributed to Isolation (19.3 per year) has been significantly higher than in the previous four years (11.3 per year from 1996 through 1999) (see **Figure 18**). 2003 was the first year since 1997 with no CCS outages attributed to Link(set)s; nevertheless, the number of Link(set)s outages has been significantly higher over the last six years than over the first five years (4.0 versus 0.6 per year). No CCS outages were attributed to STP Equipment for the first year since 1994.

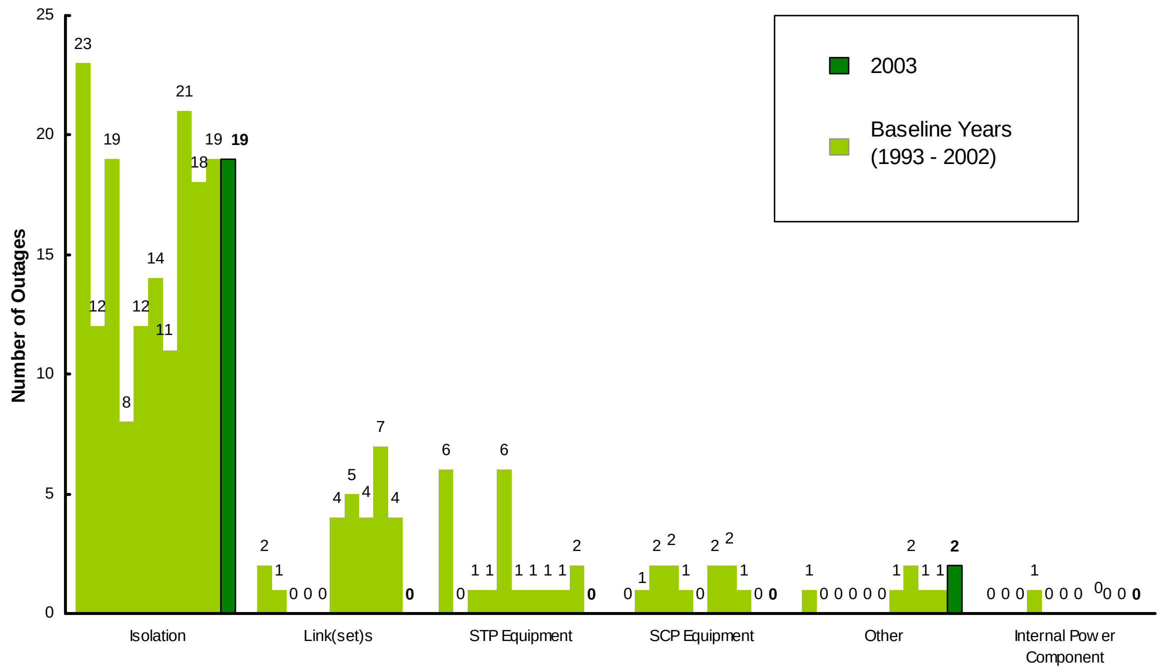


Figure 18: Annual Number of Outages by CCS Failure Subcategory

From the outage index perspective (see **Figure 19**), Isolation (50%), STP Equipment (19%), SCP Equipment (13%), and Link(set)s (10%) are the dominant failure subcategories over the eleven-year history. Over the last two years, the aggregated outage index of CCS outages attributed to Isolation (203 per year) has been significantly higher than in the first nine years (55 per year). Over the last six years, the CCS aggregated outage index attributed to Link(set)s has been significantly greater than in the first five years (28 versus 0.3 per year).

Procedural Error (46%), Design Software (20%), Design Hardware (16%)[9], and Hardware Failure (11%) have been the dominant root cause categories. In the last seven years, the frequency of CCS outages attributed to Procedural Error has been significantly greater than in the first four years (11.7 versus 7.3 per year). In particular, the frequency of Procedural Other Vendor outages has been significantly higher over the last four years than over the first seven years (1.8 versus 0.3 per year). The frequency of CCS outages attributed to Design Software declined significantly over the first four years from a peak of 11 to a low of 1 in 1996, but since then has risen at a statistically significant rate of 18% per year. Despite a decrease to 3 outages in 2003, the frequency of CCS outages attributed to Design Hardware has been significantly higher over the last four years (6.3 per year) than over the first seven years (2 per year). In 2003, the number of CCS outages attributed to Hardware Failure matched its highest value to date (4).

With respect to the outage index, Procedural Error (49%), Design Software (21%), Traffic/System Overload (14%), and Design Hardware (8%) have been dominant. The Procedural Error aggregated outage index has been increasing at the statistically significant rate of 17% annually since 1994. The aggregated outage index for Hardware Failure outages reached its highest value to date in 2003 (39), significantly higher than its Baseline level (5.7 per year); over the last three years,

[9] Included in the Design Hardware root cause category are those outages with a root cause subcategory of insufficient redundancy/diversity, to include system design with unnecessary aggregation of component features and network design with unnecessary aggregation of systems or system/network deployment with single-point-of-failure configurations.

the Hardware Failure annual aggregated outage index (19.9 per year) has been significantly higher than over the first eight years (4.5 per year).

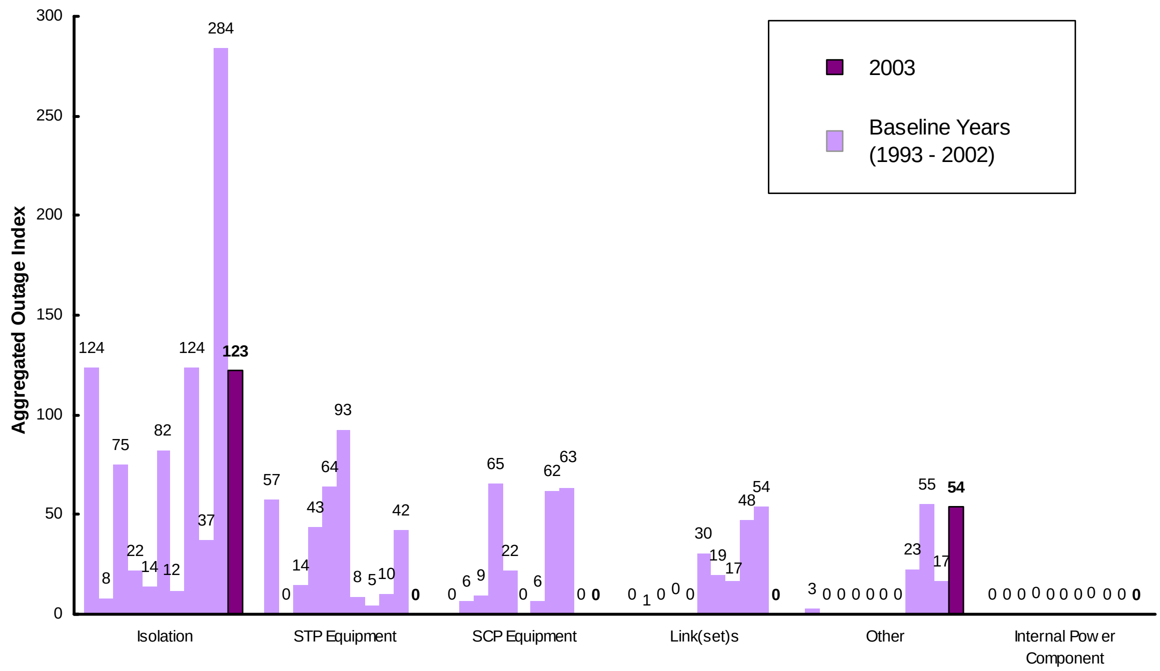


Figure 19: Annual Aggregated Outage Index by CCS Failure Subcategory

TANDEM SWITCH

The major failure subcategories of Tandem Switch outages are Software (38%), Translations (31%) and Hardware (25%). The aggregated outage index has a similar distribution among failure subcategories: Software (39%), Translations (35%), and Hardware (23%). 2003 was the first year with no Tandem Switch outages attributed to Software, significantly lower than its Baseline level (7.3 per year); over the last two years, the frequency of Software outages (1.5 per year) has been significantly less than in the first nine years (7.8 per year). The number of Hardware outages in 2003 matched its lowest level to date (1). Tandem Switch aggregated outage index attributed to Translations has been significantly greater over the last six years than over the first five years (101 versus 34 per year).

Procedural Service Provider (44%), Design Software (33%), Hardware Failure (10%), and Procedural System Vendor (7%) have been the major root causes of Tandem Switch outages. The aggregated outage index has a similar distribution among failure subcategories: Procedural Service Provider (47%), Design Software (31%), Hardware Failure (9%), and Procedural System Vendor (7%). Since its peak of 15 in 1998, the frequency of Tandem Switch outages attributed to Procedural Service Provider has declined at the statistically significant rate of 22% annually. 2003 was the first year with no Tandem Switch outages attributed to Design Software, significantly lower than its Baseline level (6.3 per year); since its peak (11) in 2000, the frequency of Design Software outages has decreased at the statistically significant rate of 48% annually. 2003 was the third consecutive year in which no Tandem Switch outages were attributed to Procedural System Vendor; over this period, the frequency was significantly less than in the first eight years (1.8 per year).

CENTRAL OFFICE (CO) POWER

The distribution of outages across CO Power subcategories shows that the major contributors are: DC Plant (29%), DC Distribution (26%), Other (21%), Standby Generator (13%), and Building AC (10%). In 2003, the number of CO Power outages attributed to DC Plant dropped to its lowest level to date (1); over the last two years, the frequency of DC Plant outages (2 per year) has been significantly less than in its peak years 1999-2001 (6.7 per year). In 2003, the number of CO Power outages attributed to DC Distribution dropped to its lowest level since 1996 (2). Over the last three years, the frequency of CO Power outages attributed to Standby Generator (1 per year) has been significantly less than in its peak years 1998-2000 (4.7 per year).

The major contributors, by failure subcategory, to the CO Power aggregated outage index are: DC Plant (29%), DC Distribution (22%), Standby Generator (24%), and Other (15%). In 2003, the CO Power aggregated outage index attributed to Standby Generator had its highest value to date (157), significantly higher than its Baseline level (30.4 per year); most of this aggregated outage index was from a single event, the Northeast power outage in August 2003.

Commercial and/or Back-Up Power Failure (37%) and Procedural Service Provider (34%) are the primary root cause categories among CO Power outages. In 2003, the number of outages attributed to Procedural Errors declined to its lowest level to date (3); over the last two years, the frequency of Procedural Error outages (4 per year) has been significantly less than in the first nine years (8.3 per year). Since reaching its peak (10) in1997, the frequency of outages attributed to Procedural Service Provider has declined at the statistically significant rate of 22% annually. In 2003, the number of outages attributed to Commercial and/or Back-Up Power Failure was at its lowest level since 1993 (2). Since reaching its peak (13) in 2000, the frequency of Commercial and/or Back-Up Power Failure outages has decreased at the statistically significant rate of 43% annually. In 2003, the number of CO Power outages attributed to Hardware Failure was the highest to date (3), significantly higher than its Baseline level (0.6 per year).

With respect to the aggregated outage index, Commercial and/or Back-Up Power Failure is the dominant root cause category (47%) followed by Procedural Service Provider (23%). In 2003, the aggregated outage index of Procedural Service Provider dropped to its lowest level to date (12). The CO Power aggregated outage index attributed to Commercial and/or Back-Up Power Failure has been significantly higher in the last six years than in the first five years (141 versus 16 per year). .

DIGITAL CROSS-CONNECT SYSTEMS (DCSS)

Hardware (53%), Software (30%), and Other (12%) are the major failure subcategories for DCS outages. With respect to the aggregated outage index, the three major failure subcategories are Hardware (55%), Software (24%), and Other (17%). 2003 was the first year in which no DCS outages were attributed to Hardware, significantly less than in the peak period 1997-2002 (4.2 per year). It was also the first year in which all DCS outages were attributed to Other. In the last three years, the frequency of DCS outages attributed to Software has been significantly less than in the peak years 1997-2000 (0.7 versus 3.5 outages per year).

Looking at the root causes of DCS outages, 24% are attributed to Design Software, 24% to Procedural System Vendor, 18% to Procedural Service Provider, and 14% to Hardware Failure. Since 1998, the frequency of DCS outages attributed to Design Software has declined at the statistically significant rate of 39% annually. In the last four years, the frequency of DCS outages attributed to a Procedural Error was significantly lower than in the peak years 1997-1999 (1.5 versus 4.7 outages per year). Despite a drop to no outages in 2003, in the last six years, Hardware Failure has caused 1.5 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 24%, 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 39% of the number of outages and 35% of the aggregated outage index. The breakdown by Failure Category is as follows:

Facility – 28% of the number of outages and 25% of the aggregated outage index
Local Switch – 51% of the number of outages and 48% of the aggregated outage index
CCS – 46% of the number of outages and 49% of the aggregated outage index
Tandem Switch – 52% of the number of outages and 54% of the aggregated outage index
Central Office Power – 50% of the number of outages and 38% of the aggregated outage index
DCS – 42% of the number of outages and 34% of the aggregated outage index
Other – 28% of the number of outages and 21% 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 2003, the number of Procedural Error outages dropped to its lowest annual level to date (28). It was below the Baseline Level (65.8 outages per year); this difference is statistically significant. The frequency of PE outages has demonstrated a statistically significant decline of 14% 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 (18.5 per quarter), low in fourth quarters (13.6 per quarter), and near average in first and second quarters (15.5 and 14.8 respectively per quarter).

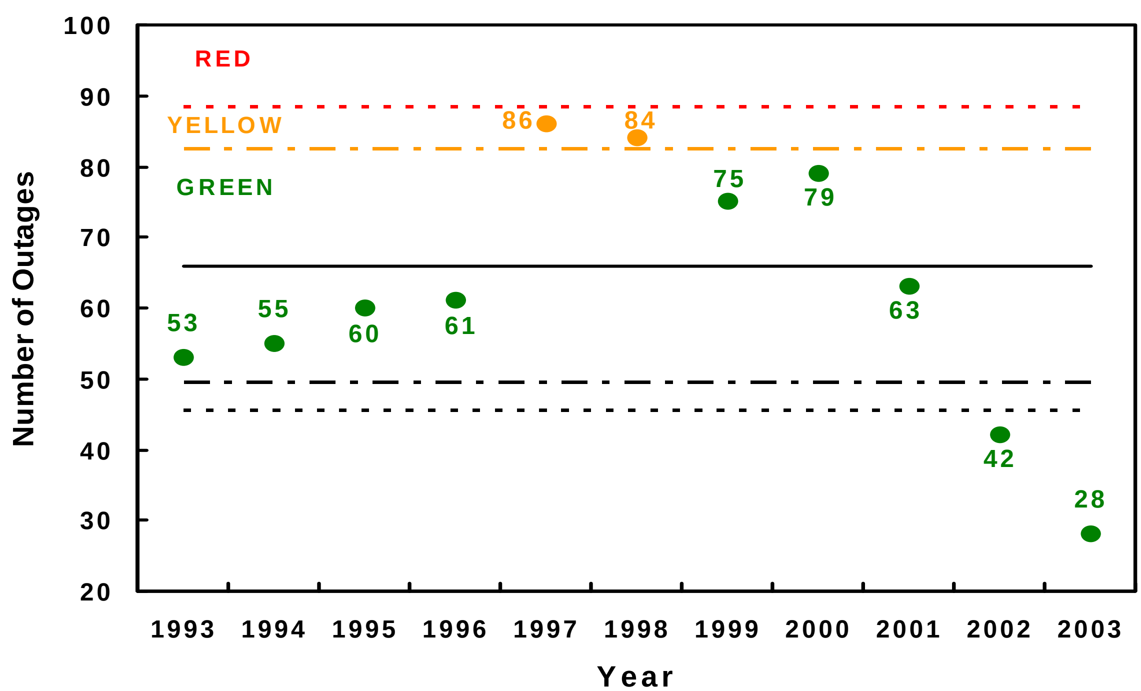


Figure 20: Annual Frequency Control Chart for Procedural Error Outages

Figure 21 shows the annual number 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 (22%), and Inaccurate Cable Locate (11%). In 2003, the number of PE outages caused by Insufficient Supervision/Control (12) was the lowest number since 1995, significantly lower than the Baseline level (21.7 per year); since rising to its peak (41) in 1998, this frequency has been decreasing at the statistically significant rate of 17% per year. The number of Documentation/Procedures (unavailable, unclear, incomplete) outages in 2003 matched its lowest level to date (4 in 2002), significantly lower than its Baseline Level (14.7 per year); this frequency has been declining at the statistically significant rate of 23% per year since reaching its peak (23) in 1997. Over the last three years, the frequency of PE outages caused by Insufficient Training (7.3 per year) has been significantly less than in the first eight years (16.1 per year). The number of Inaccurate Cable Locate outages in 2003 dropped to its lowest value to date (2); over the last two years, this frequency has been significantly less than in the first nine years (3 versus 7.3 outages per year). 2003 was the first year with no PE outages caused by documentation/procedures being out-of-date, unusable, or impractical. It was also the third consecutive year with no PE outages caused by inadequate routine maintenance/memory back-up, significantly less than its frequency over the first eight years (1.8 per year).

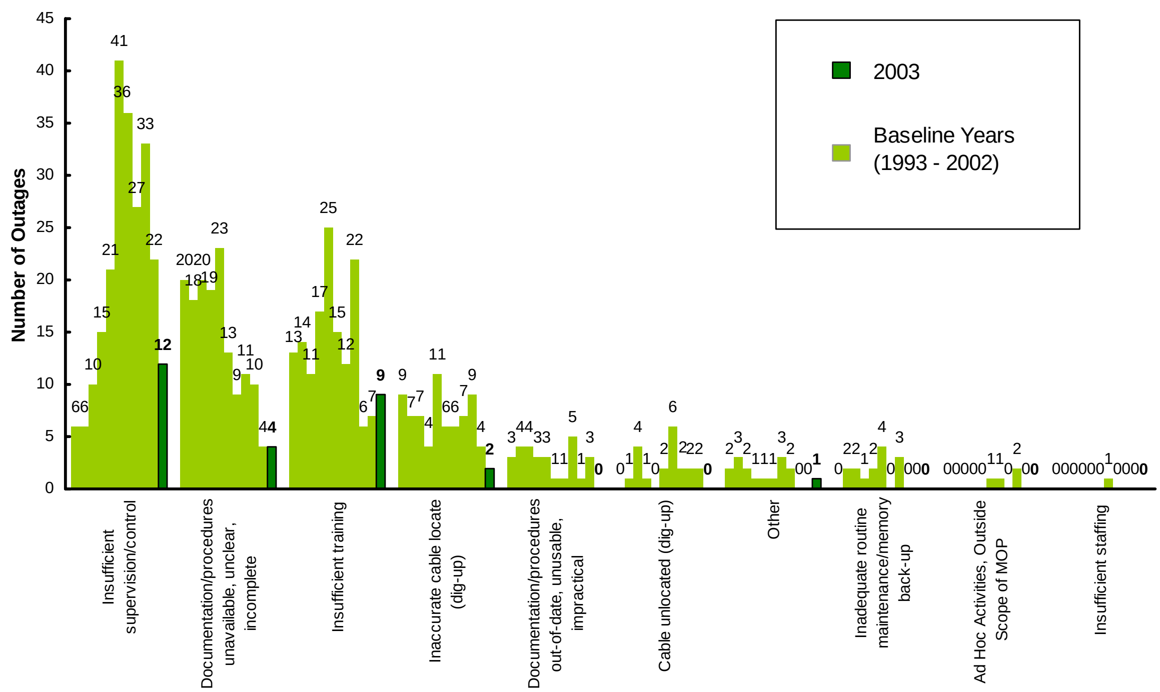


Figure 21: Annual Number of Outages by Procedural Error Root Cause Subcategory

In 2003, the aggregated outage index of Procedural Error outages dropped to its lowest level to date (271), significantly below its Baseline level (563 per year). Over the last two years, the annual aggregated outage index of Procedural Error outages (334 per year) has been significantly lower than in the first nine years (581 per year). With respect to aggregated outage index, the major root cause subcategories of Procedural Error outages are Insufficient Supervision/Control (36%), Documentation/Procedures (unavailable, unclear, incomplete) (25%), Insufficient Training (16%), and Inaccurate Cable Locate (12%). Over the last two years, the annual aggregated outage index of Insufficient Supervision/Control outages (194 per year) has been significantly less than its 2001 peak (491). The annual aggregated outage index of Documentation/Procedures (unavailable, unclear, incomplete) outages has decreased at the statistically significant rate of 14% annually over the 11-year history. Over the last three years, the annual aggregated outage index of Insufficient Training has been significantly less than in the first eight years (39 versus 103 per year).

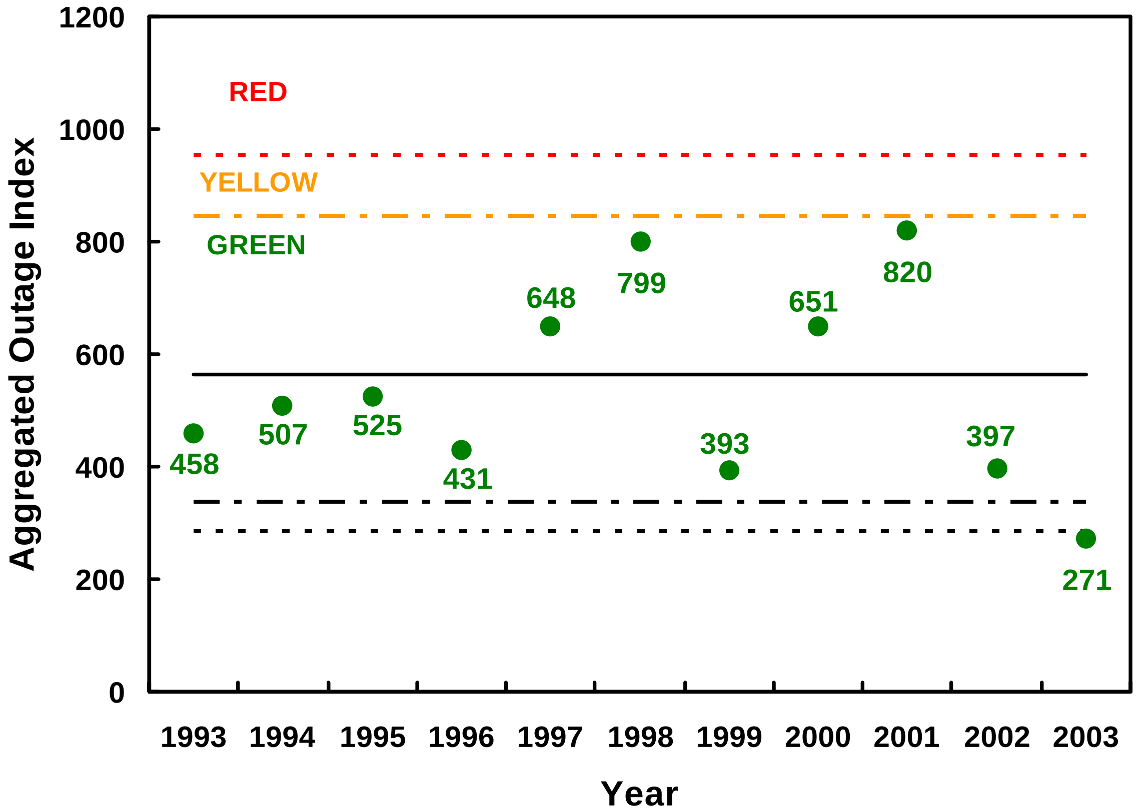


Figure 22: Annual Aggregated Outage Index Control Chart for Procedural Error Outages

"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 2003 there were twelve outages reported to the FCC that fell in these categories. Of these, two were reportable because of their impact to 911 services, eight were reportable fire-related incidents, one was reportable because it affected FAA circuits, and one was not a reportable incident per FCC rules.

Of the two outages which impacted 911 services, one was as the result of a fiber cable dig-up where the cable was located properly prior to the incident. In the second incident, the service provider discovered that 6 T1 lines and both SS7 links between its central office and its STP were out of service. The duration and customers impacted for these outages were respectively 199 minutes and 15,669 customers, and 66 minutes and 4,513 customers.

The incident that was reportable because of the impact to FAA circuits was as a result of a cable cut by the local municipality. The call had been made to the one-call center; the cable was marked; and, the cable route was visible and posted with signage. This outage impacted five FAA circuits for 148 minutes.

Of the eight outages caused by fire, none occurred in or on the premise of a service provider. Three (3) of these outages occurred when a structure fire burned through nearby aerial fiber and/or copper cables; one was as the result of a "controlled" burn in an apple orchard; one occurred when a tanker truck exploded after being struck by an SUV, burning several exchange cables; one occurred when a tree branch severed a primary power feed which then contacted and burned an aerial cable; one occurred when transients set a fire near a manhole; and, one occurred as a result of the California wildfires (see page 4). The duration of these outages ranged from 40 minutes to 18 days. Excluding the 18 day impact of the Southern California wildfires, the average duration of these outages was approximately 20 hours, far more than the 8.71 hours for the larger outages (those greater than 30,000 customers and 30 minutes). In many cases, these outages required the replacement of multiple cables, and in some repairs were delayed when local public safety officials delayed access to the area.

SUMMARY AND CONCLUSION

Table 3 provides a summary of the degree to which all outages, all failure subcategories, and Procedural Error outages in 2003 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 2003 was significantly below, below, above, or significantly above its Baseline Level. "I" presents a similar indication for the aggregated outage index.

Overall, outage frequency and aggregated outage index showed a significant improvement over prior years. Procedural Error outages showed a similar pattern of improvement. Among failure categories, Facility, Local Switch, and Tandem Switch outages also showed significant improvement with respect to frequency and aggregated outage index. All failure categories had frequencies below their Baseline Levels. DCS also had an aggregated outage index significantly below its Baseline Level. CCS, CO Power, and Other had aggregated outage indexes above their Baseline Levels although not significantly.

Table 3: Summary of 2003 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				
Tandem Switch	F I				
DCS	I	F			
CCS		F	I		
CO Power		F	I		
Other		F	I		
Procedural Error	F I				

The NRSC expects that its quarterly and annual monitoring and analysis of outages, identification of Best Practices, and interactions with other industry groups (e.g., the FCC's Network Reliability and Interoperability Council (NRIC), the ATIS Network Performance, Reliability and Quality of Service Committee (formerly T1A1), etc.) will lead to a reduction in both the frequency and impact of outages. Results for 2003 show that the industry has made significant progress in reducing the frequency of outages—2003 had the lowest number of outages to date—but has been less successful in reducing the impact of those outages—the median outage index per outage has been increasing over time. Similarly, the only three areas that were above Baseline levels in 2003 were all related to the outage index. The NRSC has long espoused the value of Best Practices in preventing outages and mitigating their impact. The industry has done well in its application of those Best Practices that prevent outages; it now needs to focus on efforts that reduce their impact.