



Analysis of Major Communication Outages in California during the 2017 January-February Storms

REDACTED PUBLIC VERSION

Communications Division
Staff Report
April 2018

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I. Executive Summary

During the months of January and February 2017, California experienced the most rainfall recorded in 122 years of recordkeeping¹ which resulted in a 30% increase of communication service interruptions reported to the California Public Utilities Commission (CPUC). The severe weather also had a major impact to critical electrical infrastructure and power outages were prevalent throughout California. As a result, these power outages contributed to a significant number of telephone service interruptions and extended the restoration efforts.

Wireline, wireless, and cable communication service providers report to the CPUC communication service interruptions and these reports are important because:

- 1) When communication services are compromised, access to emergency services and first responders is lost. Customers impacted by the January and February 2017 outages included:
 - Almost 1 million Californians who were not able to call 9-1-1 during the January-February storms.
 - 791,641 consumers experienced a loss of wireline and wireless communication service.
- 2) Critical infrastructure (e.g., dams, power plants, airports) rely on working communications for both operations and monitoring.
 - CPUC data does not show which of these facilities were impacted during the storms because the reporting metrics do not specify these types of locations.
- 3) California's economy contributes \$2.5 trillion, or 13%,² of the overall national GDP and these communications links play an important role in keeping businesses connected to process financial transactions.
 - 52,296 businesses experienced a communication service interruption.

Communications Division staff analyzed the California major service outage reports for January and February 2017 and found that a total of 1,755,644 wireline and wireless customers were without service during this period. Table 1 shows the number of customers broken out by type of outage.

¹ <http://www.mercurynews.com/2017/03/08/california-storms-wettest-water-year-so-far-in-122-years-of-records/>.

² https://www.bea.gov/newsreleases/regional/gdp_state/2017/xls/qgsp0717.xlsx.

Outages Affecting	Number of Users Affected
9-1-1 Network	964,003
Access to Wireline Telephone Users (including Cable)	156,864
Access to Wireless Carrier (facilities-based)	634,777
Access to Business Service Connections (not users)	52,296

Table 1.

Many service providers submitted major service outage reports, including some of the largest carriers operating in California. As reflected in Table 1, the outages had a severe impact on 964,003 customers’ access to the 9-1-1 network. Collectively, 843,937 customers were cut-off from business service connections (known as DS3 connections), wireline connections, and wireless connections. In addition, staff tabulated the outage frequency and average duration of all outages shown in Table 2 below:

Month	Number of Outages	Average Duration
January	5 per day	4 days
February	4.6 per day	4.75 days

Table 2.

During the two-month period, wireline, wireless, and DS3 major service outage reports totaled 288 (final reports), including 15 E9-1-1 outages. The number of E9-1-1 outages reported represents a 30% increase above average levels. The reported outages presented many challenges for first responders since they depend on the emergency network for critical communications from the public and with each other.

Staff categorized the reports into four major outage causes: hardware, cable, commercial power, and other. Hardware outages are outages caused by hardware failure which could include a network card or other physical network equipment failure. Damaged facilities in interconnecting equipment (e.g., copper or fiber facilities cable failures) can cause cable failures. Commercial power failures are caused when the local electric utility provider experiences a power outage on the electric grid and there is no backup power (which can be batteries or diesel generated). In the “other” category, factors which contributed to telephone

outages were related to software, human error, and environmental conditions.³ The service providers were also impacted by third party vendor hardware reliability and availability of readily available redundant hardware systems in restoring telephone services.

Table 3 below summarizes into four major categories the causes of outages (based on number of outages):

	Hardware	Cable	Power	Other
Wireline	78%	22%	N/A	N/A
Wireless	29%	23%	39%	9%
E9-1-1	47%	27%	N/A	26%
DS3	76%	22%	N/A	2%

Table 3.

Table 3 shows that hardware issues caused the highest percentages of outages for wireline, 9-1-1, and DS3s. Wet cable failures contributed to a number of wireline outages. Wireless carriers reported 39% of their outages due to loss of commercial power.

Rainy weather, reported as a key cause of wireline outages and indirectly responsible for wireline communication outages throughout the state, resulted in two outage sub-categories for wireline service:

- Network equipment (59%)
- Loss of power (41%)

Three major outage categories of wireless communications service were as follows:

- Loss of commercial power (39%)
- Hardware issues (29%)
- Cable issues (23%)

Staff also analyzed January and February 2017 information from the CPUC Consumer Affairs Branch (CAB). The customer complaints filed with CAB during this period increased 136% above average levels. The majority of complaints involved wireline service outages. Specifically, customers filed a total of 163 informal complaints with the CPUC, as compared to an average of 69 informal complaints filed during the same two-month period for each year from 2014-2016. Out of the 163 reports filed, only three were related to wireless service.

The reliability of communication infrastructure is vital to ensuring public safety. The results of the analyses performed in this report show that during January and February 2017, wireline, wireless, and cable providers experienced major service interruptions to their communications

³ Based on evaluation of the text content from the reports.

networks in California. Many of these outages could have been prevented with better availability of backup power for wireless providers and improved reliability of cable facilities for wireline providers. This report is intended to provide information concerning the specific performance of communications networks and the service providers which maintain them.

II. Introduction

The purpose of this report is to analyze California statewide communication outages reported by wireline, wireless, and cable communication service providers during the period of January 1, 2017, to February 28, 2017, to determine whether further action by the Commission and/or service providers is warranted to ensure public safety. The CPUC is dedicated to ensuring that communication service providers provide safe and reliable service for consumers throughout California and these outages have a direct impact on the CPUC's core mission.

An outage is defined as a significant degradation in the ability of an end user to establish and maintain a channel of communications as a result of failure or degradation in the performance of a communications provider's network. Outage reporting requirements are set forth in CPUC General Order (GO) 133-D, as adopted in Decision (D.) 16-10-019. Service providers are required to report information about disruptions or outages to their communication systems.⁴ Pursuant to GO 133-D, the Commission treats these reports as confidential, and thus carrier specific information will be redacted in the public version of this report, unless the Commission subsequently orders otherwise.⁵

The CPUC communications service interruption guidelines apply to the following entities:

- a) Telephone corporations granted either a franchise or a Certificate of Public Convenience and Necessity pursuant to Public Utilities Code (PU Code) §1001;
- b) Telephone corporations registered under PU Code §1013;
- c) Telephone corporations registered with the CPUC pursuant to the Wireless Identification Registration process; and,
- d) Any entity subject to PU Code §285.

Service providers are required to submit three types of major service outage reports to the CPUC.⁶ These types are defined below:

1. **Notification** – This type of report is due within two (2) hours of discovering a reportable outage. This notification provides preliminary information that is not binding on the extent and impact of the outage.
2. **Initial** – This type of report is due within 72 hours of discovering a reportable outage. The initial report provides more detail as to the cause of the outage and extent of customers impacted and is an opportunity for the service

⁴ See GO 133-D, § 4.

⁵ See GO 133-D, § 4 d.

⁶ See GO 33-D, § 4.

provider to expand on the notification report. Voice over Internet Providers (VOIP) are not required to file initial reports.

3. **Final** – This type of report is due within 30 days of discovering a reportable outage. This report provides a full root cause analysis with a description of the problem and mitigation efforts to prevent future occurrences.

There is a fourth type of report that is optional. This report is a **Withdrawn** report and a carrier may submit one any time it does not meet the threshold reporting criteria. For this report, staff utilized the Final service outage reports sent to the CPUC to categorize all the outages by type and to categorize the reason for outages by type.

The type of wireline and wireless service outage reports submitted to the CPUC are categorized in this report as impacting residential customers, business customers, and/or 9-1-1 facilities. Each of the categories of impacted customers reviewed in this report is defined as follows:

1. Residential – An outage impacting a single wireline or wireless end-user.
2. Business – An outage impacting customers with DS3 data circuits.
3. 9-1-1 – An outage impacting any public safety answering point (PSAP).⁷

To standardize the threshold used to report an outage, the “user minutes” common metric⁸ is the standard used to analyze telephone service outages (see Table 6, p. 9) for wireline and wireless residential customers. In addition, the 1,350 DS3 minute metric⁹ is used to measure service outages on high capacity data circuits. Staff also gathered data concerning informal consumer complaints filed with CAB and mapped it to provide a visual representation of where customers reported trouble. See Discussion VI. CAB Analysis – Consumers Affair Branch, *infra*. Staff’s analysis focused on what impact the severe weather storms had in the duration of outages throughout California during the January-February 2017 period. The severe weather damaged infrastructure throughout the state of California, which in turn prompted the Governor’s Office to issue several emergency proclamations. Staff undertook this analysis to

⁷ Public Safety Answering Point personnel in call centers typically respond to 9-1-1 calls.

⁸ The common metric is the number of “user-minutes” potentially affected by an outage. This is defined as the result of the outage’s duration expressed in minutes and the number of users potentially affected by the outage. For example, a 30-minute outage that potentially affects 30,000 end users also affects 900,000 user-minutes (30 minutes X 30,000 users = 900,000 user-minutes). The threshold criteria are that an outage must be reported to the CPUC if (a) its duration is at least 30 minutes and (b) it potentially affects at least 900,00 user-minutes, which is the threshold adopted by the FCC.

⁹ The 1,350 figure is derived from the threshold-reporting criterion of “30,000 customers potentially affected.” Each DS3 has a capacity of 672 DS0 circuits (basically, 672 “customers”). Therefore, to determine how many DS3s are equivalent to 30,000 customers, we compute: 30,000 customers divided by the DS3 capacity of 672 DS0 circuits (customers) equals 44.6 DS3s rounded to 45. Then, 45 DS3s multiplied by 30 minutes equals 1,350 DS3 minutes.

determine the quality of service provided by wireline, wireless, and cable providers during inclement weather, including the following:

- The sources of failure for each service type (e.g., wireline, wireless, and DS3);
- Number of impacted customers by service type;
- Duration of the outages by service type; and,
- The impact to 9-1-1 services in duration of outage and minutes out of service.

In addition to summarizing the cause of outages in California, the goal of this report is to provide information for CPUC decision makers to evaluate the level of reliability of telephone carriers in California and to determine if carriers provide safe and reliable communications service.

III. Reporting of Telephone Service Outages

For the period of January through February 2017, service providers submitted over 303 reports of service interruptions for California. The CPUC collected outage information for wireline, wireless, and DS3 service lines. Staff grouped the reports into three categories for this analysis: 9-1-1, business, and residential reports. Table 4 below illustrates the breakdown by service type and category for the 303 reports:

Report	Wireline	Wireless	DS3
9-1-1	12	3	
Business			123
Residential	77	88	

Table 4.

Staff analyzed the variances of wireline and wireless reported outages and found that wireline subscribers experienced similar count of outages as wireless subscribers. For residential reported outages, Table 5 illustrates a total outage distribution of 49% for wireline customers and 51% for wireless customers.

Staff reviewed the December 2015 Form 477 data filings for service providers operating in California¹⁰ and compared the number of wireline outages relative to the number of wireline users in California. Staff found that wireline customers experienced almost 50% more outages than wireless customers during the study period. The data shows that 1 in 6 residential customers have a wireline subscription and 5 out of 6 customers have a wireless subscription. However, the ratio of wireline outages to the number of wireline subscribers is not proportional. Staff found that while 1 in 6 customers subscribe to wireline service, nearly 50% of reported outages were for wireline customers.

Table 5 below provides a summary of wireline and wireless subscription along with the number of outages.

	Wireline	Wireless
CA % of subscriptions	16%	84%
CA % of outages	49%	51%

Table 5.

¹⁰ Form 477 data provides a breakdown of how many subscribers each service provider has by type, e.g., wireline or wireless.

A. Reporting Thresholds for DS3 User Minutes and Wireline/Wireless User Minutes

Service providers use the common metric below to evaluate when to report outages to the CPUC. Because the CPUC adopted the Federal Communications Commission’s (FCC) reporting thresholds as its own, service providers subject to GO 133-D are required to submit major service outage reports to the CPUC at the same time they submit them to the FCC.¹¹ The common reporting metrics are listed below and include outages affecting special facilities, e.g., PSAPs:

1. 900,000 user-minutes.
2. 1,350 DS3 minutes.
3. DS3 simplex > greater than five days.
4. 90,000 blocked calls for > greater than 30 minutes.

For detailed information on these metrics, see Appendix B.

Table 6 below shows the GO 133-D reporting threshold using the common metric for all types of service. However, this report focuses on wireline, wireless, DS3, and 9-1-1 reported outages (highlighted in red font).

	900,000 user minutes	1350 DS3 minutes	DS3 Simplex > 5 days	90,000 Blocked calls >30 min
Wireline	X	X	X	
Wireless	X	X	X	
Cable telephony	X	X	X	
VOIP	X			
MSC	X	X	X	
E911	X			
SS7 MTP				X
Airport*				
Other Special	X			
Paging	X			
Satellite	X			
IXC Tandem		X	X	X

Table 6. Outage reporting thresholds for each type of service.

¹¹ See D.16-08-021, p.10.

IV. Analysis: Telephone Service Outages and Service Restoral

A. DS3 Outages of High Traffic Transport Circuits

During the January through February 2017 period, service providers reported 123 DS3¹² outages in California. DS3s are high capacity data circuits commonly referred to as business lines. Business corporations and government agencies are typical customers who buy this type of service. The number of DS3 outages refers to the number of DS3 customer lines impacted by the reported outages.

The DS3 simplex event is a reportable event,¹³ but is not included in this analysis because it does not result in an outage. A simplex event occurs when a DS3 circuit, designed with multiple paths to provide circuit resiliency, experiences a failure on one working path (see Appendix D). The following chart in Figure 1 shows a breakdown of how many DS3s were out of service for each service provider and the duration:

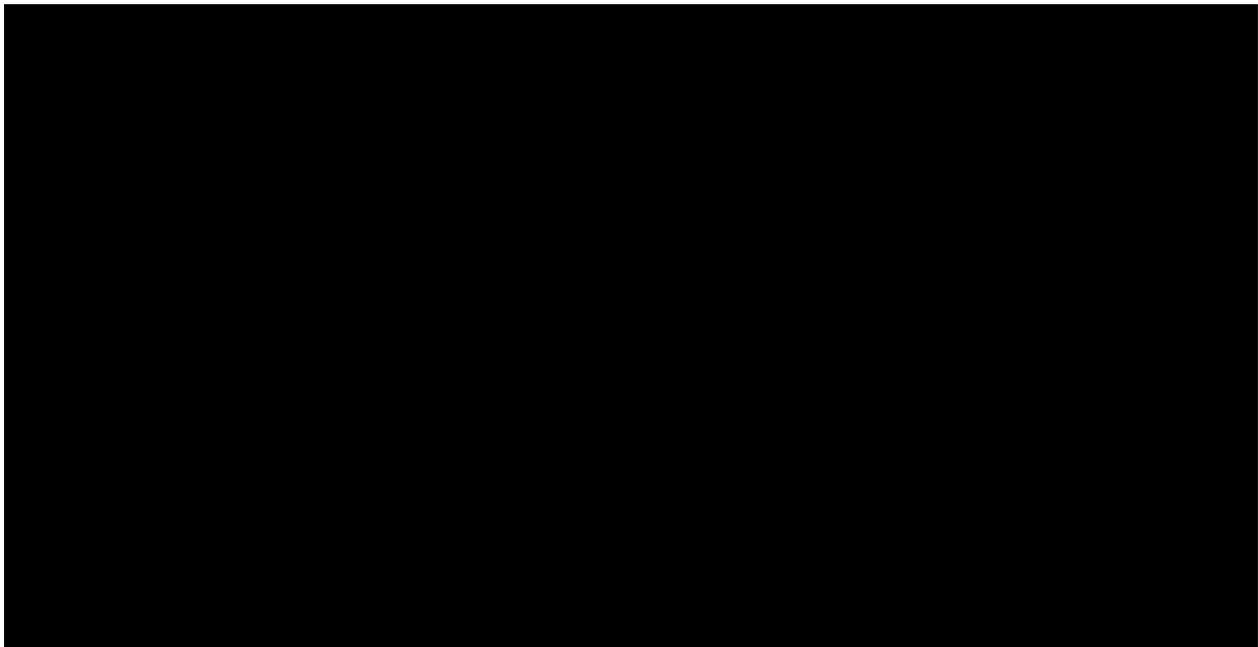


Figure 1. Total number of DS3 outages January-February 2017.

¹² A DS3 is a communications infrastructure component having significant traffic-carrying capacity. DS3s are the common denominator used throughout the communications industry as a measure of capacity. A DS3 can handle 28 DS1s (T1s) or 672 DS0s. Each DS3 contains 672 DS0 lines with each of the DS0 lines representing one telephone digital line.

¹³ <https://www.federalregister.gov/documents/2016/07/12/2016-16274/disruptions-to-communications>.

Figure 1 shows that *** [REDACTED] *** had 28,310 DS3s out of service followed by *** [REDACTED] *** with 11,932 and *** [REDACTED] *** with 11,904 DS3s. The remaining service providers combined totaled 150 DS3s out of service. *** [REDACTED] *** and *** [REDACTED] *** had the most minutes out of service with a total of 136,142 and 36,785 minutes, respectively. The duration of outage times indicate *** [REDACTED] *** and *** [REDACTED] *** took longer to restore services than their competitors. Conversely, even though *** [REDACTED] *** had the most DS3s out of service, it had lower minutes out of service than *** [REDACTED] *** and *** [REDACTED] ***. The lower number of out of service minutes for *** [REDACTED] *** indicates a better response rate in restoring outages when compared to *** [REDACTED] *** and *** [REDACTED] ***.

Key Finding: * [REDACTED] *** and *** [REDACTED] *** took longer to restore DS3 services than their competitors.**

The common metric used to help further analyze the impact of DS3 outages is the 1,350 DS3 minute metric. In 2004, the FCC required outage reporting for communication disruptions impacting major transport facilities and created a metric and threshold for this outage reporting in standards defined in impacts to DS3 circuits. The FCC adopted DS3 as the base metric and 1,350 DS3 minutes as the reporting threshold (see Appendix B, part b). The 1,350 DS3 threshold is a metric defined by the number of DS3s out of service and the duration out of service.

For example, *** [REDACTED] ***. Figure 2 below illustrates that *** [REDACTED] ** and *** [REDACTED] *** had the most DS3 minutes for the two-month period.

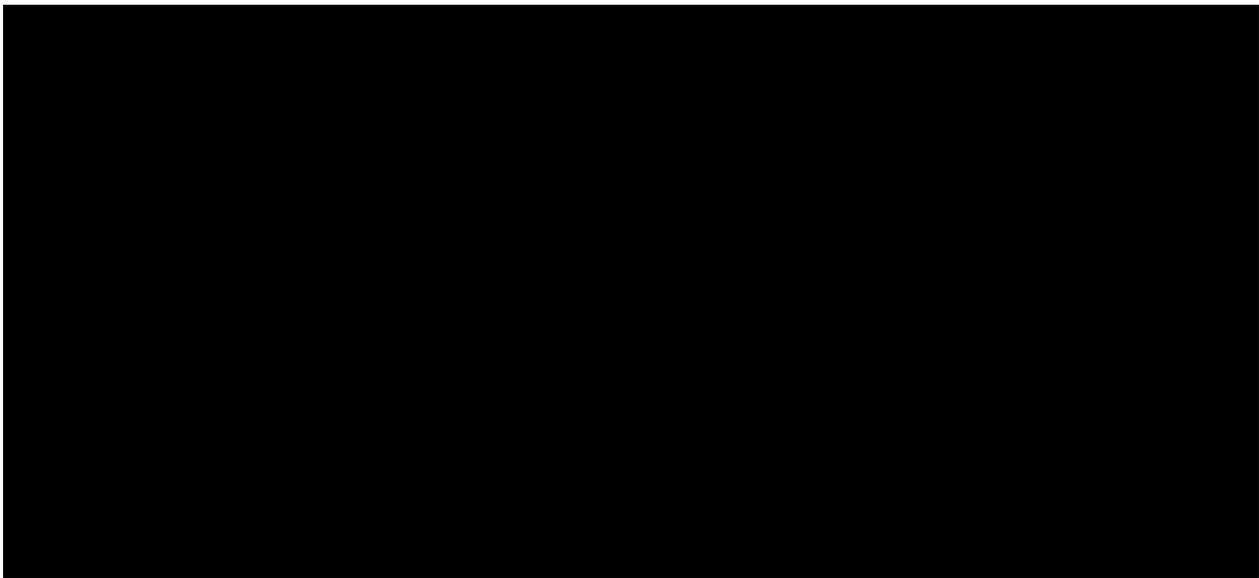


Figure 2. Total DS3 minutes out of service for January-February 2017. ***

For this time period, the three primary reported causes for DS3 failure are:

1. Hardware – Network component failures (examples include circuit cards, routers, etc.);
2. Cable – Failure in fiber or copper elements due to damage or defective components; and,
3. Software – Refers to internal errors in the software under normal operating conditions.

Staff used these three categories for classifying the causes of a service outage because they help identify:

- a) What failed in order to cause the outage;
- b) Why the outage occurred; and,
- c) Who was responsible for the outage.

Figure 3 shows the three major causes of failure for DS3s by service provider.

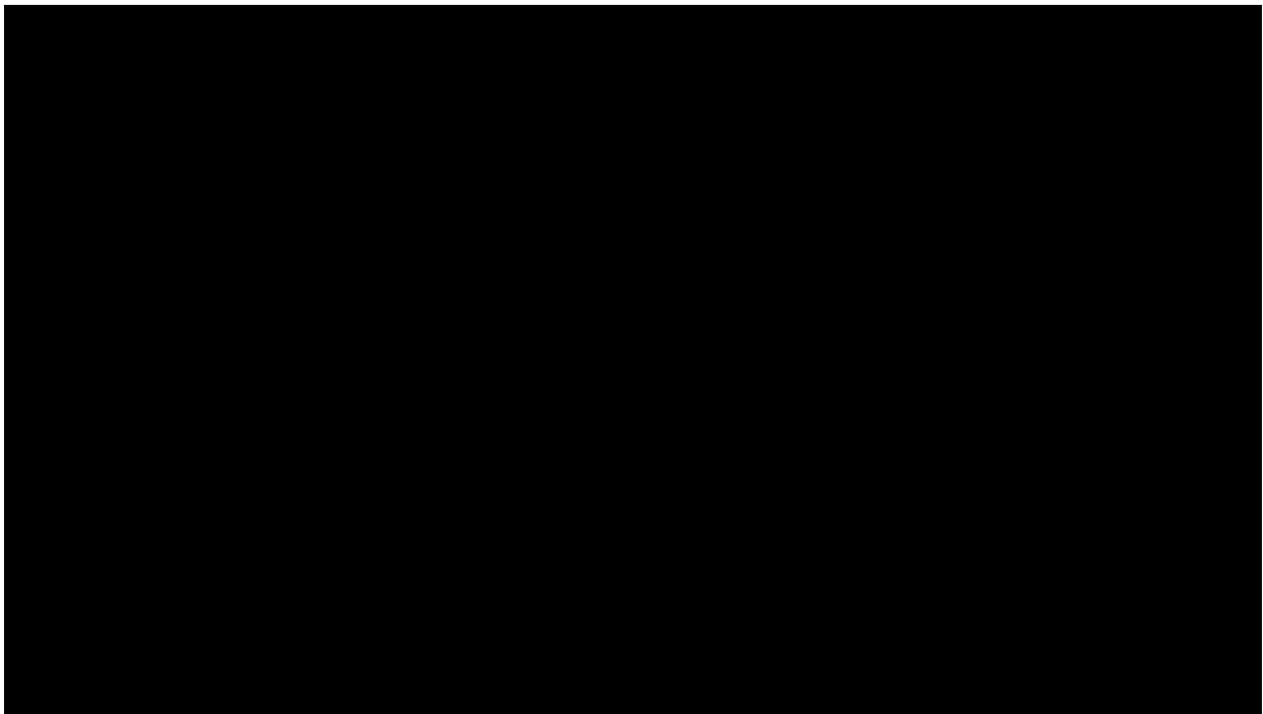


Figure 3. Root cause of DS3 failures by type.

Figure 3 shows that hardware failures account for 76% of all DS3 failures. This is somewhat surprising because there are over 100 hardware manufacturers worldwide and the level of competition in this space should be driving higher reliability.

Key Finding: Staff observed a higher trend in the number of hardware failures for service providers in the DS3 space that merits further study.

The 22% cable failure rates point to a significant number of preventable outages because these failures are primarily due to fiber cuts. While 25% of the cable outages are due to cable component failure, 75% of the cable failures were due to accidental fiber cuts. These accidental cable failures are preventable by following the rules of the national “Call Before You Dig” program.¹⁴ The 811 “Call Before You Dig” program provides a nationwide, easily accessible resource for anyone involved in digging work.

Key Finding: Cable cuts appear to be preventable outages based on the number of accidental fiber cuts reported. Accidental cuts account for approximately 3/4 of cable cuts.

Software issues caused only 2% of DS3 failures reported. This result is surprising, considering the inherent interactions of hardware and software in telecommunications equipment. One reason could be that carriers may be generally classifying the majority of failures as hardware when the root cause is actually software. For example, a software logic malfunction could cause a hardware card to stop processing and the service provider could view this as a hardware failure when, in reality, the root cause was a software error that caused the card to stop processing. Further analysis is required to differentiate the true nature of reported failures for categories of hardware versus software. The two-month period analysis suggests that software has a 98% reliability score while hardware has a 24% reliability score.

Key Finding: Service providers report a very high hardware failure rate and a very low software failure rate. Further investigation is required to determine if this is accurate, or whether carriers are incorrectly reporting hardware as the root cause of DS3 outages for software malfunctions or errors.

B. Wireline Voice Outages Impacting Residential Customers

1. Number of Customers Impacted by Wireline Outages

Wireline telephone service is a critical safety service for residential consumers in California. During January and February 2017, over 156,000 wireline voice subscribers experienced lengthy outages in California. The majority of California switched access (non-VoIP) wireline voice customers are serviced by two service providers. *** [REDACTED]

***¹⁵ The major service outage data shows that one of these service providers had a significantly higher percentage of reported wireline outages. *** [REDACTED]
*** of all reported wireline outages.

¹⁴ <http://call811.com/>.

¹⁵ According to Form 477 data as of June 2016, *** [REDACTED]

Key Finding: *** [REDACTED] *** has almost *** [REDACTED] *** of the subscribers but reported *** [REDACTED] *** of the wireline outages during the storm period.

The data shows a disproportionate number of outages related to the overall subscription numbers for *** [REDACTED] ***. Figure 4 shows that over a two-month period, *** [REDACTED] *** had 139,049 customers impacted by outages, which was the highest number of customers impacted. The *** [REDACTED] *** total was nearly *** [REDACTED] *** the combined total of all reported outages by the other service providers in California.

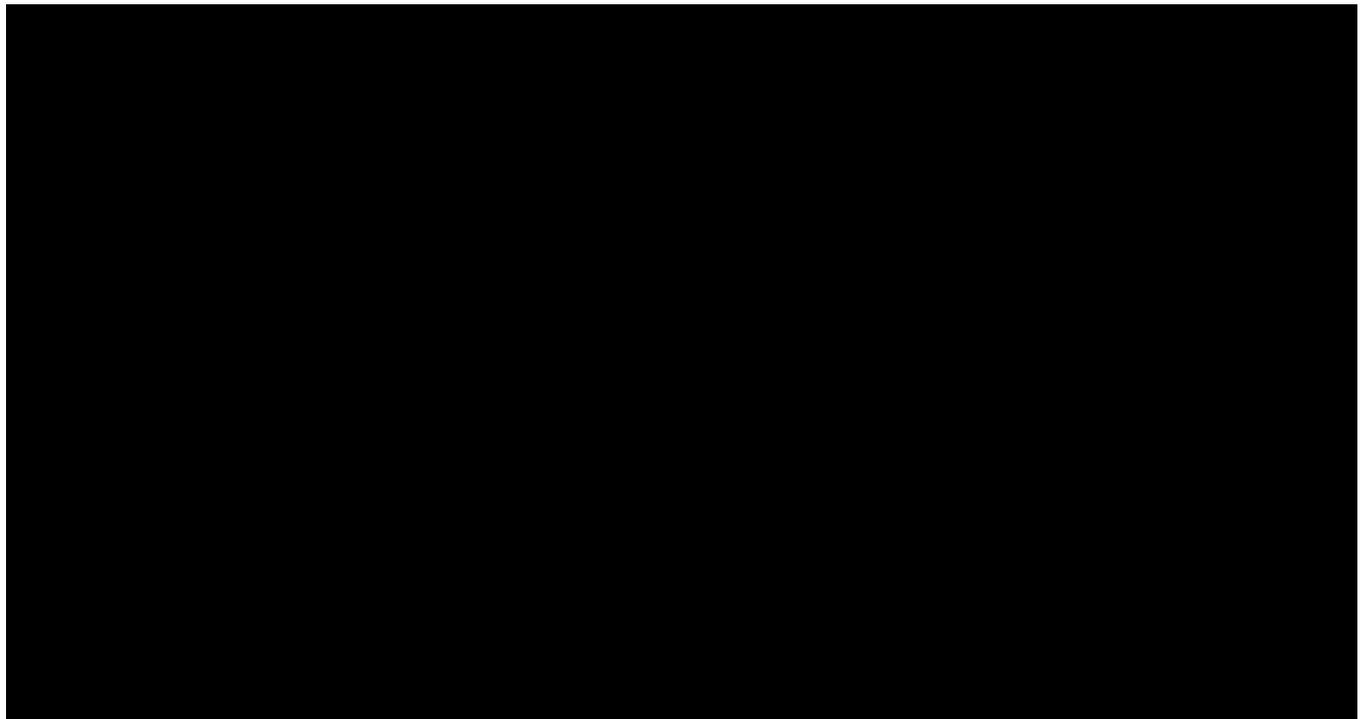


Figure 4. Total subscribers out of service.

2. Duration of Outages for Wireline Subscribers

The total duration of a wireline outage is a key factor in determining the user-minute common metric for wireline outages. Service providers must restore service in a reasonable time period to provide safe service for consumers. As of June 2016, there were approximately 15 million users relying on both switched access and VoIP wireline service throughout California.¹⁶ This means that 38% of the California population subscribes to wireline switched and VoIP service for their communication needs.¹⁷ This section of the report looks at both cable and traditional

¹⁶ FCC Form 477 data state level subscriptions, <https://www.fcc.gov/voice-telephone-services-report>.

¹⁷ Given the total estimated population of the state is around 39 million and the number of households is 12.5 million, the number of people dependent on wireline service is significant.

wireline switched access (or “plain old telephone service” (POTS) which is voice-grade telephone service employing analog signal transmission over copper loops¹⁸) providers to see how they performed during adverse weather conditions.

Figure 5 shows the number of minutes out of service reported by all carriers during January through February 2017. *** [REDACTED] *** had the most minutes out of service, meaning that it took *** [REDACTED] ** longer to restore service to customers.

*** [REDACTED] *** had the second most minutes out of service (*** [REDACTED] [REDACTED] [REDACTED] ***). *** [REDACTED] *** and *** [REDACTED] *** had approximately the same number of wireline customers impacted; however, *** [REDACTED] *** performed much better in restoring service faster by a factor of seven. ***

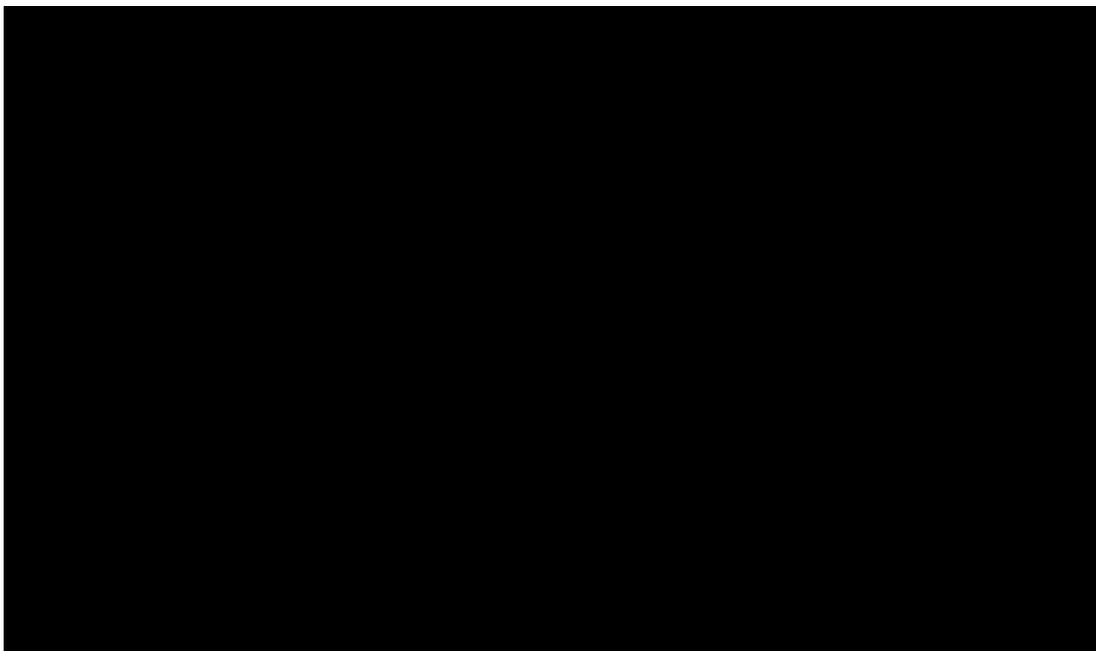


Figure 5. Total wireline minutes out of service. ***

Key Finding: *** [REDACTED] *** *had the longest restoration times for wireline outages.*

Staff categorized the reasons for failure into two categories for wireline services: cable and hardware. A cable failure refers to damage to the copper or fiber cable used to provide the voice service. Hardware failure refers to any of the network components in a provider’s wireline network that failed. As the copper networks continue to age, the expectation would be that cable outages would make up the majority of outages and the data shows that 78% of

¹⁸ <http://www.gpo.gov/fdsys/pkg/FR-1994-09-19/html/94-23033.htm>.

residential outages are cable-related. During the observed time period of January through February, there were a total of 73 cable and hardware outages reported.

Key Finding: *The reliability of aerial or underground copper lines for wireline carriers was a major issue during the January through February 2017 storms.*

Figure 6 shows that ** [REDACTED] ** had the most cable and hardware outages reported. Cable failures, which include aerial, underground, fiber, and copper cable, made up 78% of total outages and hardware or network component failures accounted for 22%. In comparison, for DS3 lines, the outage results had an inverse relationship to cable failures in that the percentage of hardware failures for wireline users was 22%. The data suggests that for high capacity transport, the majority of the failures were due to hardware and for residential wireline service, cable had a higher percentage of failures.

The majority of cable failures reported by *** [REDACTED] ** were due to wet cable caused by excessive water intrusion into manholes or moisture penetration into copper cable. The storms that hit California either flooded manholes or damaged copper cables. In some cases, falling trees struck telephone poles or vehicles damaged poles causing damage to the cable.

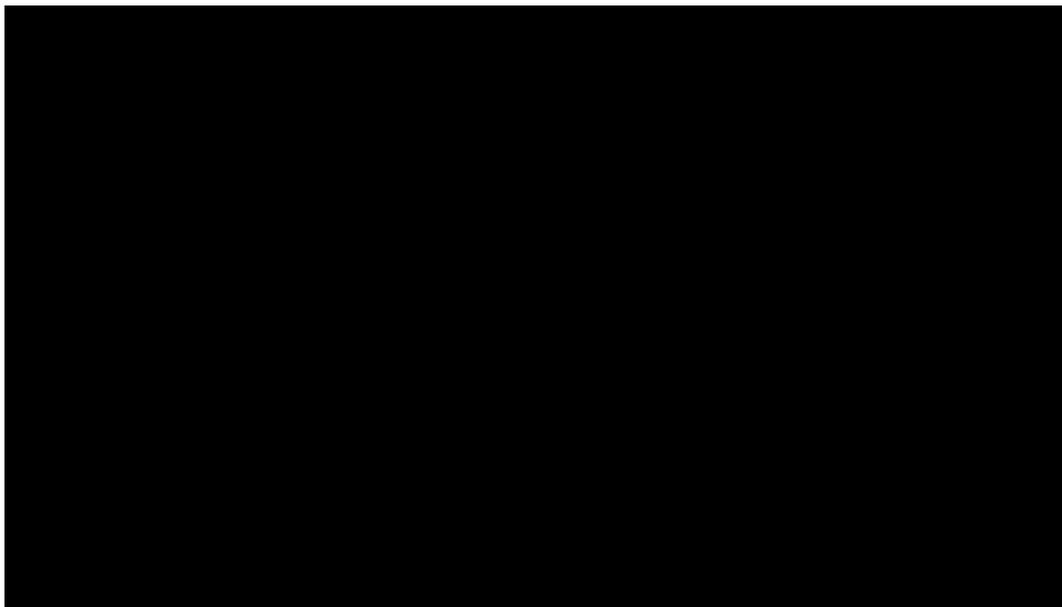


Figure 6. Cause of wireline outage.

This report categorizes wireline hardware outages into either “loss of power” or “network equipment failure.” Figure 7 shows that a failed network element caused 59% of all hardware wireline outages and loss of commercial power caused 41% of all hardware outages for all carriers. Back-up power is a critical safeguard to ensure communications remain operational during emergencies and this two-month snapshot shows how service providers performed in a real-time emergency event.

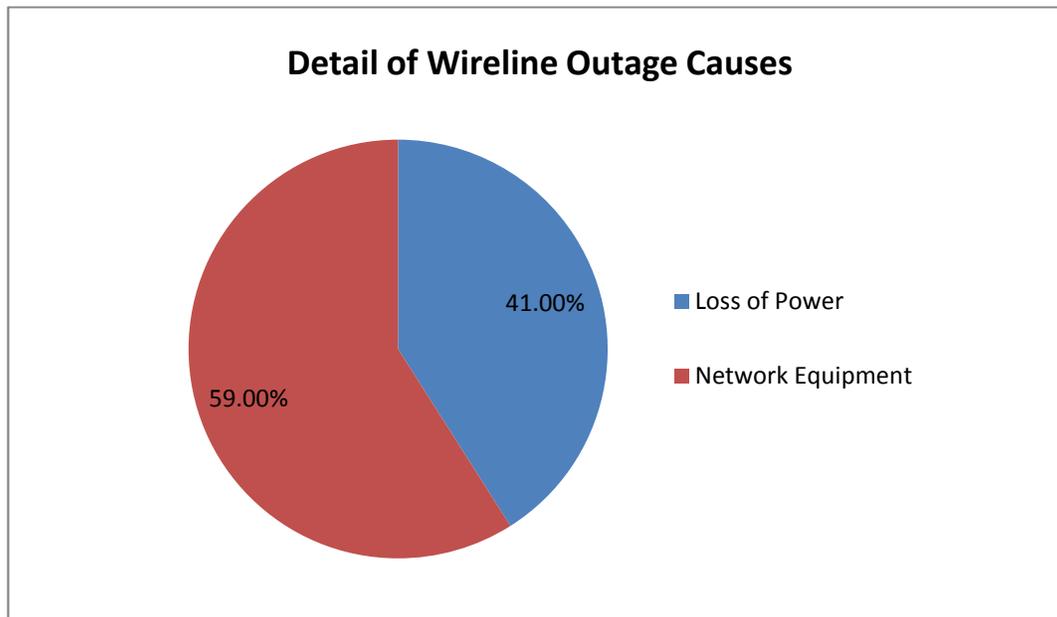


Figure 7. Hardware outage detail.

Both traditional and VOIP carriers reported wireline outages. Loss of power can be considered within a service provider’s control because power can be provided by stand-by diesel or propane generators, or fuel cells.

Key Finding: Redundant back up power systems for all wireline carriers would improve reliability of provider networks. Approximately 41% of outages could have been avoided with redundant back-up power.

C. Wireless Voice Outages Impacting Customers

The increasing dependence on wireless service for telephone service is a critical safety issue for California consumers. From 2010-2016, the data shows an increase in the number of wireless subscribers in California and a corresponding decrease in traditional wireline switched access subscribers.¹⁹ Since 2010, the number of wireline subscribers has decreased by more than 50%.²⁰ As of June 2016, wireline subscribers make up 26% of total subscriptions in California.²¹ With 74% of subscribers relying on wireless providers for service, the reliability of wireless networks is of utmost importance for public safety.

¹⁹ See Appendix E, Form 477 aggregated data 2011-2015.

²⁰ Form 477 data, June 2016, <https://www.fcc.gov/voice-telephone-services-report>.

²¹ *Ibid.*

During January-February 2017, there were a total of 634,777 wireless customers out of service as reported by the following carriers: *** [REDACTED] **, ** [REDACTED] ***, and *** [REDACTED] ***. This number is over 4 times more than the number of wireline customers that experienced service interruption during the same time period.

Figure 8 below shows that *** [REDACTED] *** had the largest number of subscribers impacted, followed by *** [REDACTED] *** and *** [REDACTED] ***, respectively.²² The number of “user-minutes” potentially affected is the outage’s duration expressed in minutes and the number of users potentially affected by the outage. Figure 8 shows that while *** [REDACTED] *** had a lower number of subscribers impacted, it had a higher user minute total due to its longer restoration times. The bar graph shows *** [REDACTED] *** had approximately 102,000 customers impacted but it took significantly longer to restore service and thus its user minutes show the highest of the three wireless providers.

Key Finding: * [REDACTED] ** had longer duration outages during January-February 2017.**

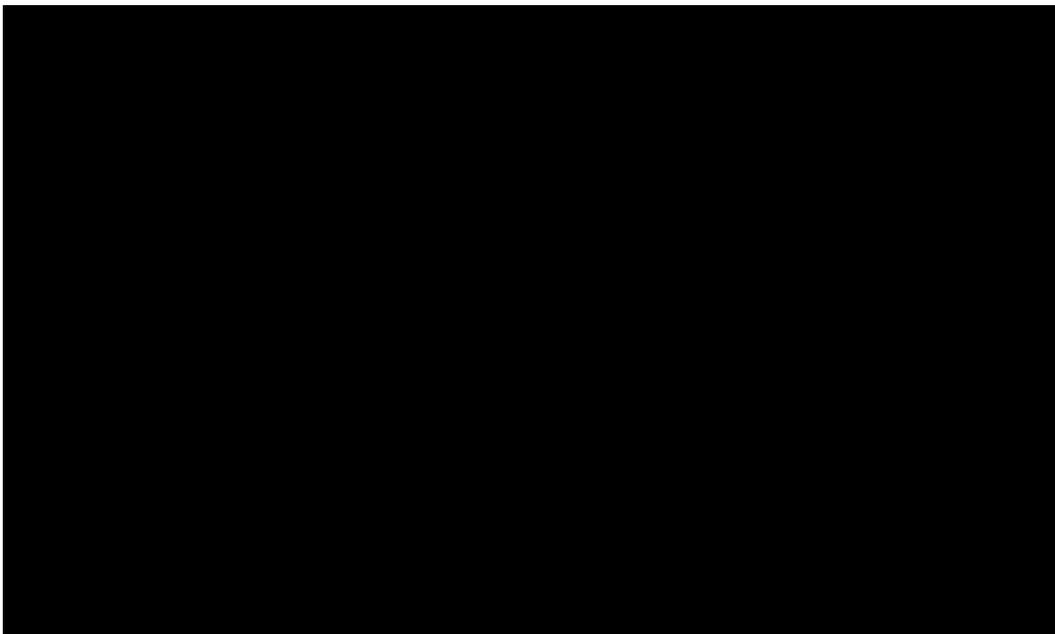


Figure 8. Total wireless subscribers out of service.

²² *** [REDACTED] *** did not report any wireless outages that met the 900,000 user minute threshold for wireless users during this period; however, the company did report 9-1-1 outages. The company’s lack of reported outages is problematic because the CPUC’s independent measurement of wireless coverage and connection quality for this provider’s network indicates that there should be reported outages.

There are five sub-categories of reasons for outages for wireless network providers:

1. Hardware – Physical network equipment failed.
2. Cable – Failure in facilities interconnecting equipment, i.e. copper or fiber.
3. Power – Loss of commercial power.
4. Planned – Planned maintenance by service provider.
5. Engineering – Failure to follow established policy from vendor or provider.

Figure 9 below shows that from the reported wireless outages for January and February 2017, 39% of outages were due to loss of commercial power, which was indirectly a result of storms in the state. Adding the 7% of planned outages to the power totals and the fact that backup power solutions are within a carrier's control, staff concludes that approximately half of all the wireless outages could have been prevented.

Key Finding: *About half of carrier wireless outages could have been prevented with more backup power.*

Most wireless service providers have a limited amount of back-up power at each cell site.²³ In 2007 the FCC ordered Commercial Mobile Radio Service providers to provide a minimum of eight (8) hours of battery backup at each cell site;²⁴ however, the D.C. Circuit Court issued an order of abeyance in 2008 which vacated the FCC order.²⁵ When there is a widespread loss of commercial power, customers lose service because the back-up system batteries drain down and cell sites go off air. A key issue for carriers is the cost of maintaining back-up systems which includes a stand-by generator for each cell site in the event of a commercial power outage.

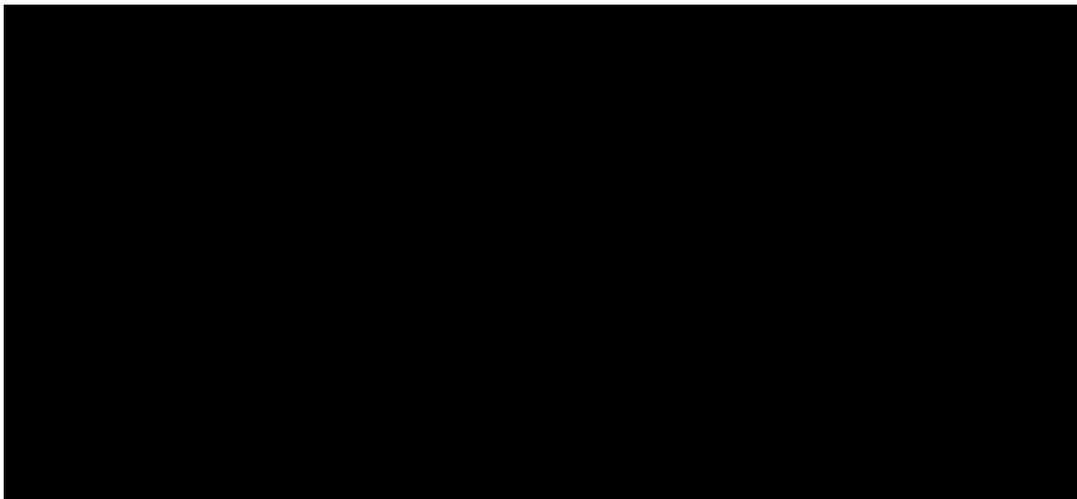


Figure 9. Root cause of wireless outage.

²³ Based on staff experience, typical battery backup is 4-8 hours.

²⁴ *Recommendations of the Independent Panel Reviewing the Impact of Hurricane Katrina on Communications Networks*, FCC WC Docket No. 06-63.

²⁵ CTIA – The Wireless Association v. FCC, No. 07-1475 (D.C. Cir. filed July 31, 2009).

For wireless service providers, hardware outages made up 29% of their total outages which is similar to the 22% for wireline, but still significantly less than the 76% for DS3 lines. However, in both cases, this number is significantly less than the 76% of outages that were caused by hardware failures resulting in DS3 outages (see Section IV, A, *supra*).

V. Analysis: 9-1-1 Impact for Residential and Business Customers

The reliability of systems to support 9-1-1 and emergency calls is a paramount safety concern to the CPUC. First responders, consumers, and businesses rely upon this 9-1-1 network to function, as maintaining communication is critical to saving lives and property put at risk from accidents, personal emergencies, or disasters. California experienced 6,986 major fires in 2016 and the storms which are the subject of this report resulted in nearly 1 million customers unable to reach the 9-1-1 network. Accordingly, these outages placed consumers in danger.

Section 4.5 (e) of the FCC Part 4 rules, which G.O. 133-D incorporates, specifies the reporting requirements for outages related to 9-1-1 facilities.²⁶ These outages must be reported when there is loss of communications to PSAPs,²⁷ selective routers²⁸ or mobile switches, and/or loss of location/number information to a PSAP. 9-1-1 service should be available at all times to ensure public safety; thus, in this section, we examine the performance of wireline, wireless, and VOIP service providers for 9-1-1 services.

During January through February 2017, there were a total of fifteen 9-1-1 outages reported. Figure 10 below shows that a total of 964,003 subscribers, or 2.5% of Californians, could not dial 9-1-1 for some period of time. According to the reporting rules, these 964,003 subscribers are independent from the other potentially affected subscribers.

Key Finding: *Almost 1 million customers could not dial 9-1-1 for some period of time during the January and February storms of 2017.*

²⁶ Section 4.5 (e) states:

(e) An outage that potentially affects a 9-1-1 special facility occurs whenever:

- (1) There is a loss of communications to PSAP(s) potentially affecting at least 900,000 user-minutes and the failure is neither at the PSAP(s) nor on the premises of the PSAP(s); no re-route for all end users was available; and, the outage lasts 30 minutes or more; or
- (2) There is a loss of 9-1-1 call processing capabilities in one or more E9-1-1 tandems/selective routers for at least 30 minutes duration; or
- (3) One or more end-office (e.g., landline) or Mobile Switching Center (MSC) switches or host/remote clusters is isolated from 9-1-1 service for at least 30 minutes and potentially affects at least 900,000 user-minutes; or
- (4) There is a loss of ANI/ALI (associated name and location information) and/or a failure of location determination equipment, including Phase II equipment, for at least 30 minutes and potentially affecting at least 900,000 user-minutes (provided that the ANI/ALI or location determination equipment was then currently deployed and in use, and the failure is neither at the PSAP(s) or on the premises of the PSAP(s)).

²⁷ A public service answering point is a call center responsible for answering calls to an emergency telephone number for police, firefighting, and ambulance services.

²⁸ A selective router uses the originating telephone number as a search key to match the origination of the call to the network location or Emergency Service Number (ESN) of the appropriate PSAP.

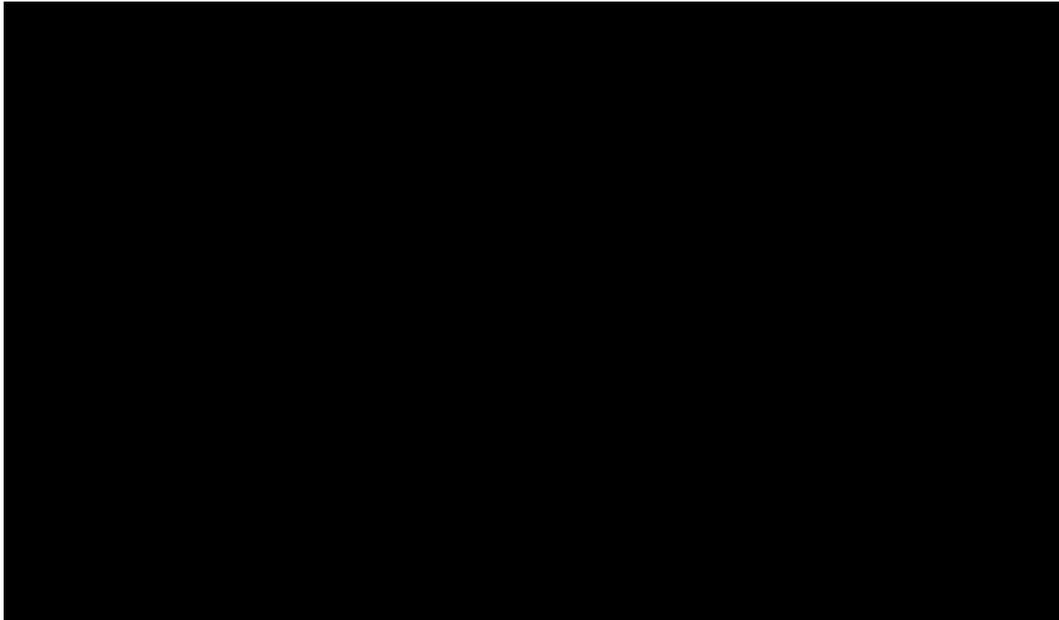


Figure 10. Number of subscribers impacted by 9-1-1 outage.

Figure 10 above shows that the wireless carriers accounted for 74% of all customers impacted by 9-1-1 services, with *** [REDACTED] ** having the most subscribers impacted by 9-1-1 outages. The other 26% of outages were distributed among other landline providers such as *** [REDACTED] ***, *** [REDACTED] ***, *** [REDACTED] ***, and *** [REDACTED] ***. The data in this two-month period seems to indicate that the wireless networks are not as resilient as the landline networks in providing 9-1-1 services.

Key Finding: *Wireless service provider outages impacted significantly more 9-1-1 facilities and customers than landline and VOIP service providers combined during the January and February 2017 storm period.*

While numbers of people affected by outages provide one data point about the volume of customers impacted, the duration of the outage is also an important factor. Figure 11 below shows which carriers had the longest outage times and deduces the restoration times for each service provider. The following chart puts the outage minutes into a more meaningful context:

Minutes	Equivalent
60	1 hour
1,440	1 day
7,200	5 days

Of the wireless providers that reported outages in this category, *** [REDACTED] *** performed the best in having the least amount of outage minutes, followed by

*** [REDACTED] ** and *** [REDACTED] **. *** [REDACTED] *** did not report any 9-1-1 outages. For the wireline providers, Figure 11 shows that *** [REDACTED] *** and *** [REDACTED] *** had the worst performance with most minutes out of service followed by *** [REDACTED] ***.

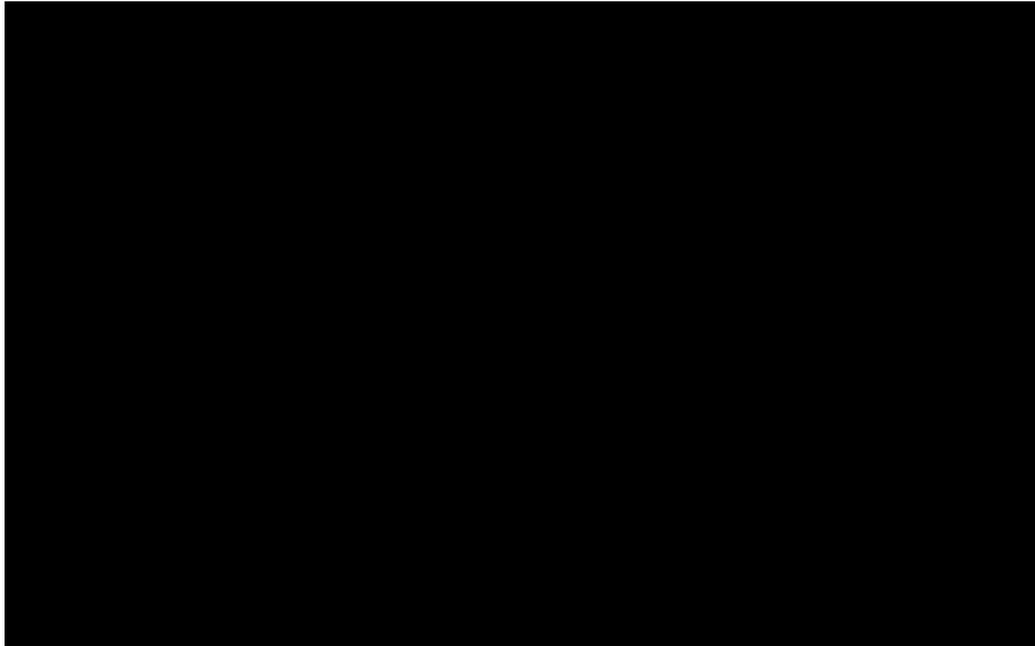


Figure 11. Total outage minutes for 9-1-1 services.

Figure 12 below shows *** [REDACTED] *** and *** [REDACTED] *** had the most user minutes out of service for 9-1-1 outages.



Figure 12. Total user minutes outage for E9-1-1 services

Key Finding: *Of all the reporting service providers, *** [REDACTED] ***, *** [REDACTED] ***, *** [REDACTED] ***, and *** [REDACTED] ** had longer restoration times for 9-1-1 outages.*

Staff analyzed the root causes for 9-1-1 service outages and placed them into three major categories. Figure 13 shows hardware failure of physical network equipment caused 67% of the outages. Cable outages caused 27% of 9-1-1 outages and 7% were categorized as “unknown” root cause. The reliability of 9-1-1 systems is important for public safety and the results show that a failed network component caused two-thirds of the outages.

Redundant network components that can detect primary fault and switch over to a working secondary system are critical for public safety networks. Staff concludes that some 9-1-1 systems do not have sufficient redundant components in place to provide a backup for service continuity when a primary network component fails. Additional discussion with carriers is warranted to better understand the level of reliability that is engineered into the 9-1-1 system.

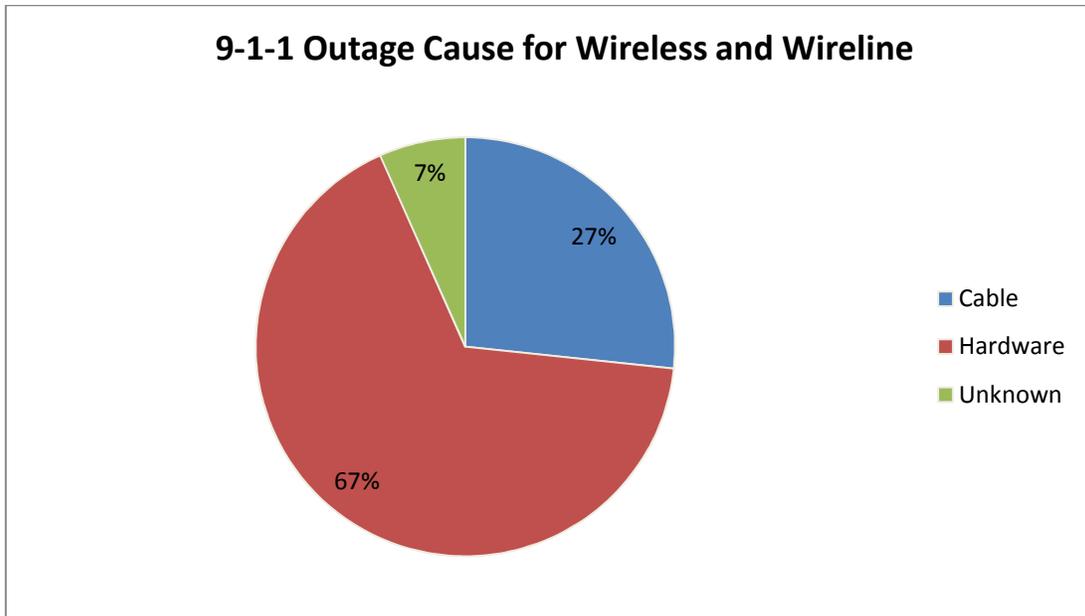


Figure 13. Root cause of outage for 9-1-1 services.

Key Finding: *9-1-1 network outages reported show that hardware failures compromised reliability, and having redundant systems may mitigate these failures.*

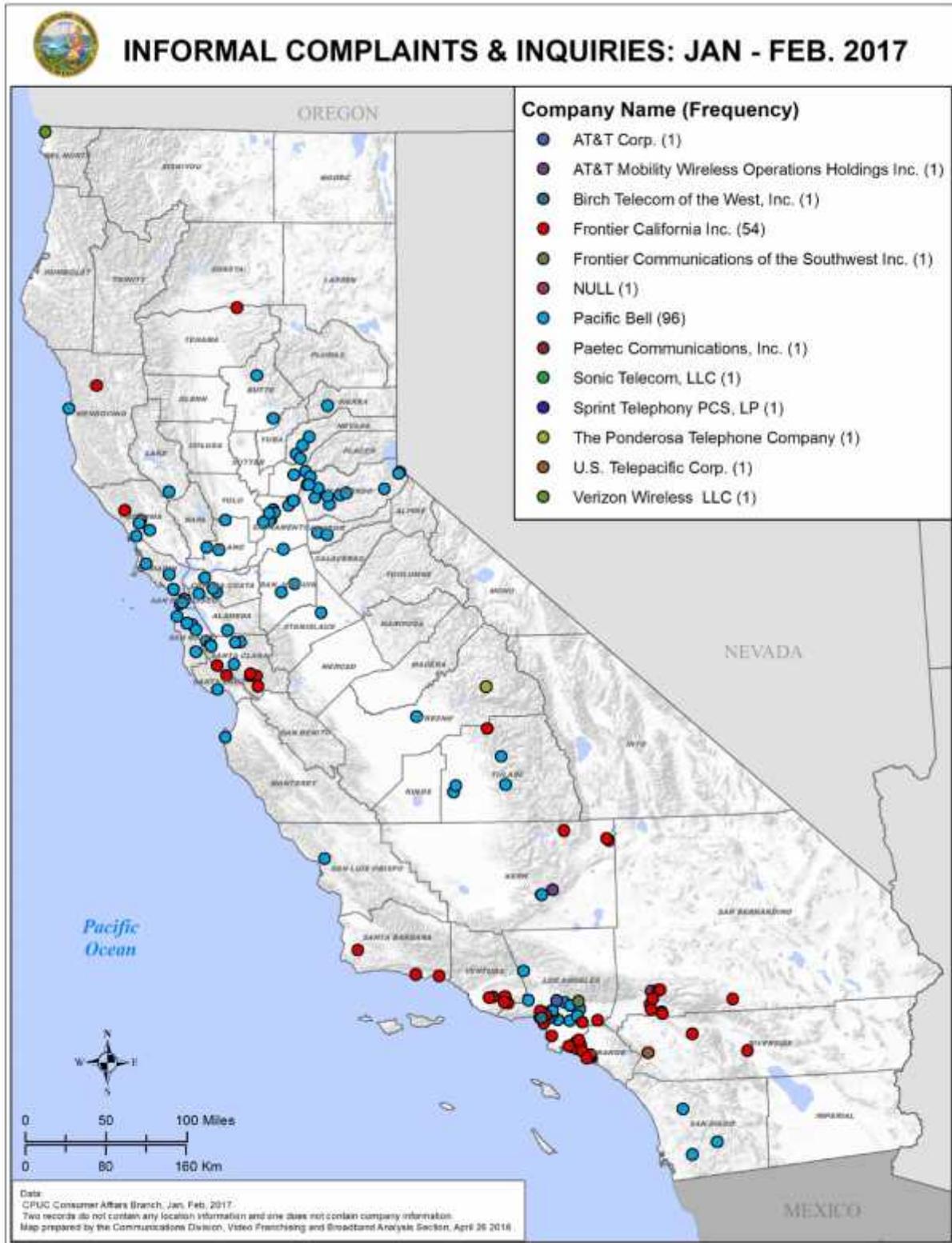
VI. Complaints Analysis: Consumer Affairs Branch Complaints

The CPUC's Consumer Affairs Branch (CAB) answers consumer questions and resolves informal complaints submitted by consumers against utility providers that are subject to CPUC authority. During the January-February 2017 period, CAB received 163 complaints from consumers regarding the outages experienced by the storms. Of the 163 complaints, three were wireless complaints and 160 were wireline complaints (or 98% of the total complaints).²⁹

There was significant disparity in number of complaints filed from wireline versus wireless customers. Even with a 74% wireless subscriber base in California, 98% of the CAB complaints came from wireline subscribers.

Staff geocoded the 163 CAB complaints on the map below by service provider and by type (e.g., wireline or wireless). As seen on the map, the CAB complaints were concentrated in the Sacramento area, San Francisco Bay Area, and Southern California area. The majority of complaints filed were from urban areas.

²⁹ The number of wireline complaints filed is disproportionate to the overall wireline subscriber base in California. Wireline subscribers represent 26% of the total wireless and wireline subscriber base; however, 98% of the total CAB complaints were wireline complaints.



VII. Conclusions and Recommendations

A. Summary of Findings

During the January-February 2017 period, service providers experienced lengthy outages for both wireline and wireless services in California that impacted business and residential customers. Service providers filed a total of 303 major service outage reports:

- 288 reports for wireline, wireless, and DS3 outages and
- 15 reports for 9-1-1 outages.

During this two-month period, the total number of customers impacted included:

- 964,003 9-1-1 customers;
- 634,777 wireless customers;
- 156,864 wireline customers; and
- 52,296 DS3s out of service.

Rainy weather was reported as a key cause of the outages and was indirectly responsible for communications outages throughout the state. Staff categorized the causes into two main categories for wireline outages:

- Network equipment (59%)
- Loss of power (41%)

For wireline service, the worst performing service provider reported 78% of its network outages were due to cable failure, as well as its network being especially susceptible to water intrusion. In addition, the lack of backup power for the wireline networks for all service providers caused all carrier networks to experience loss of service when commercial power failed.

For wireless service, the three major outage categories were as follows:

- Loss of commercial power (39%),
- Hardware issues (29%), and
- Cable issues (23%).

The worst performing wireless provider had a restoration time with a total of 166 days of outage time for wireless customers, with commercial power failures contributing to 30% of wireless outages. This report shows that it is likely these commercial power failures would not have resulted in customer outages if providers had more robust battery backup systems in place (which might include both equipment and/or refueling).

During the January-February 2017 period, there were a total of:

- 52,296 DS3s out of service.

DS3 lines are vital to the operation of businesses in California and there was a total of 416 days of lost connectivity time from all service providers combined during this two-month period. Hardware component failures accounted for 76% of outages for this type of service, and this report reveals that the availability of secondary systems could have prevented these outages. Consumer complaints for January-February 2017 were mostly attributed to wireline carriers, with 83% of all complaints filed for AT&T California and Frontier Communications. The number of complaints for the two largest wireline carriers is consistent with the wireline subscriber base in California.

B. Impact on California

California's economy requires a communication infrastructure that is safe and reliable. Consumers, first responders, businesses, and government organizations rely on this critical infrastructure to run their daily operations. DS3s are high capacity transport circuits usually leased by corporations and government organizations to run their operations. Having disruptions in DS3 service has a direct impact on California's economy.

Unavailable, non-functioning communications services compromise public safety because people cannot access emergency services, institutions cannot perform their key functions, and businesses cannot process transactions. As discussed in this report, customers impacted by the January and February 2017 outages included:

- Nearly 1 million Californians who were unable to call 9-1-1 during the January-February 2017 storms.
- 791,641 customers who experienced a loss of wireline and wireless communication service.

Extreme weather events are becoming more commonplace; therefore, service providers should be better prepared to prevent outages by developing redundant power capability when commercial power fails.

The 163 CAB complaints demonstrate why a reliable communications network is crucial to ensure public safety. Some customers were without service for over a week or more. As one customer complained, "I have to contact them every time it rains, they say sorry but they can only get someone to look at problem when they can, so I have no phone for over a week and they can only give me credit when the phone is back up. They don't care much about the customer." See Appendix A, CAB complaint excerpt 2. Another customer explained her dire need for a working phone because she is "a senior with a disability who cares for her husband who has Alzheimers." See *id.*, CAB complaint excerpt 3.

C. Recommendations

Many factors contribute to maintaining a reliable robust interconnected communications network. Following are staff recommendations to improve communication network reliability based on the root cause analysis from this report.

- Meet with major service providers to conduct reviews of network performance and understand specific drivers that may contribute to sub-par performance.
- Understand network improvement plans of carriers for counties with population density of fewer than 10 persons per square mile.
- Review infrastructure program investments to assess the quality of service and redundancy of network facilities in those areas.
- Compare major service outage data to other service quality data to pinpoint vulnerable locations in California.
- Evaluate this report's recommendations together with the network examination,³⁰ the results of which will provide insights and suggested corrective action plans on the condition of carrier network infrastructure and facilities.
- Meet with poor performing wireless service providers to discuss what factors contributed to the lower restoration time for cell sites.
- Confer with service providers who did not submit reports during the January-February 2017 period to confirm whether they had reportable outages.
- Work to provide public information on communications outages while addressing carrier confidentiality concerns.

VIII. Appendices

³⁰See D.13-02-023 and D.15-08-041 regarding the network evaluation study of AT&T California and Frontier Communications' (formerly Verizon California, Inc.) provisioning of wireline telecommunications services in California, completion due in 2nd Quarter 2019.

Appendix A: Overview of Outages

The CPUC receives major service interruption reports from service providers pursuant to GO 133-D. The CPUC receives these reports the same time service providers submit them to the FCC.

There are three types of reports a service provider must file:

- Notification - Report is due within two (2) hours; contains minimal info on outage.
- Initial - Report is due within 72 hours; contains more detail on outage.
- Final - Report is due within 30 days; contains full detail on cause of outage and mitigation practices for the future.

A fourth report is filed when a service provider determines an outage was filed in error.

- Withdrawn - Report may be submitted anytime provider determines the outage did not meet outage thresholds.

The FCC requires wireless, wireline, cable, and satellite communications providers of switched voice and paging communications to electronically report information about significant disruptions or outages to their communications systems that meet specified thresholds set forth in Part 4 of the FCC's rules (47 C.F.R. Part 4). Providers must also report disruptions affecting E9-1-1 facilities and airports.

The CPUC adopted the FCC Part 4 thresholds in D.09-07-019 and requires the following service providers to report outages:

- Wireline, wireless, cable, and VOIP service providers.

Definitions of the reporting thresholds for major service interruptions reporting:

- a) **900,000 user minutes** - The number of “user-minutes” potentially affected is the outage’s duration expressed in minutes and the number of users potentially affected by the outage.

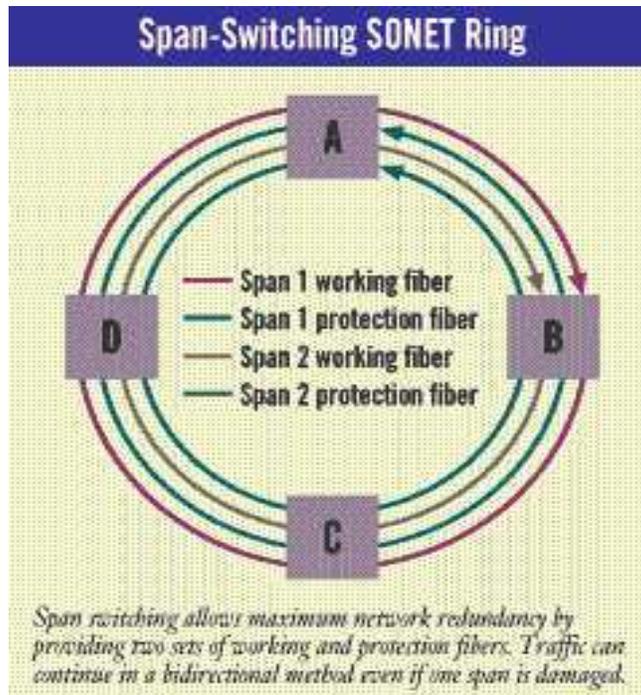
For example: (30 minutes X 30,000 users = 900,000 user-minutes). An outage must be reported if its duration is at least 30 minutes and it potentially affects at least 900,000 user-minutes. The user minutes metric is any combination of length of outage and number of users impacted.

- b) **1,350 DS3 minutes** – For DS3s, the number of minutes is also a function of how many DS3s are out of service and length of outage. The metric is calculated as follows: 1 DS3 = 672 DS0 circuits. 30,000 customers / 672 DSO’s = 44.6 ~ 45 DS3s. 45 DS3s X 30 minutes = 1,350 DS3 minutes.

- c) **DS3 Simplex** - A simplex event occurs when a DS3 circuit, designed with multiple paths to provide circuit resiliency, experiences a failure on one working path for greater than five days.
- d) **90,000 Block calls** – Service providers must report Interexchange Carrier (IXC) and Local Exchange Carrier (LEC) tandem outages of at least 30 minutes duration in which at least 90,000 calls are blocked. Carriers may use historical data to estimate blocked calls when required real-time blocked call counts are not possible.

Appendix B: Simplex Definition

A simplex event occurs when circuits that are configured with built-in path protection, as when arranged in a protection scheme such as a Synchronous Optical Network (SONET) ring, lose one of the paths. Under such configurations, when one of the circuits fails, traffic is diverted to a back-up circuit, or “protect path,” and a “simplex event” has occurred. The diagram below illustrates a simplex event.



Appendix C: Aggregated Form 477 Data 2010-2015

California Communications Subscriptions by Technology 2011 - 2015					
	Voice			Broadband	
	Wireline	Wireless	VOIP	Mobile	Fixed
June 2011	14,551,472	34,299,299	3,727,426	15,834,419	10,194,271
Dec 2011	13,717,628	34,892,416	4,161,764	18,369,318	10,368,579
June 2012	13,002,175	35,162,925	4,525,637	20,228,052	10,545,305
Dec 2012	12,270,687	35,616,196	4,912,881	22,019,584	10,725,231
June 2013	11,478,055	35,790,558	5,358,402	23,182,641	10,900,718
Dec 2013	10,708,200	36,446,240	5,738,552	27,655,604	11,086,821
June 2014	9,838,000	37,299,000	5,722,000	28,505,802	11,262,411
Dec 2014	9,174,000	38,746,000	6,309,000	29,356,000	11,438,000
June 2015	8,436,476	40,687,526	6,704,784	31,876,237	11,610,866
Dec 2015	7,887,926	41,632,504	7,092,862	32,254,803	11,775,417

Source: FCC Form 477 carrier data submissions

Appendix D: Consumer Complaints Excerpts

There were 163 informal complaints submitted to the Consumer Affairs Branch for the January-February 2017 communications outages. Below are a few samples of the issues customers called in about that provide a sample of the overall issues with reliability from AT&T California and Frontier Communications.

1. "Complaint / Concern: We decided to have our landline reconnected, partly for call clarity and partly to have the security that 9-1-1 emergency locating provides. Our first premise visit was scheduled for 12/23/2016 (wow, it just hit me that we started this process last year). 12/23 came and went, and no show/no call. I called AT&T, and after 40 minutes of a seemingly endless ride on the call tree, our premise visit appointment was pushed out to 12/27. 12/27 came and went, no show/no call. I called AT&T, call tree runaround, apology, apology, apology, appointment now pushed out to 1/6, and now our appointment is labeled "Priority". An hour after I hung up with AT&T, we get a automated message informing us that a technician would not be able to make the appointment, and our appointment was now being pushed out to 1/9. I just don't have the stomach to go back on the call tree merry go round yet again. Utility Comment: "I'm sorry you are having this problem". That's their catch phrase for anything Request of CPUC: Back in the days when I worked for "the phone company" (Pacific Telephone/Pacific Bell/SBC), we went from the only game in town, to a company that had to compete for a share of the telecommunications market. In those days, a complaint generated through the CPUC was a huge deal, and handled as such. But now that AT&T is again the only game in town, their service reflects as such. Utility Name: AT&T"
2. "Complaint / Concern: For over a year our home phone goes out of service when it rains. The last rain again left us without phone service I caller 611 (repair) and was told they could not fix until Jan. 21st, once it dries out service comes back which it did Sunday Jan. 15th, once it starts raining again we will be out of service again, that will be tomorrow. We had a death in the family and they had to send someone to our house to inform us. We need someone to take this seriously, my husband who was on *** [REDACTED] *** City Council cannot get calls from the City, he does not use a cell phone. I have been a customer with AT&T for over 45 years and have been treated unfairly. We need to have our phone service up and working not have to wait over a year for this problem to be repaired. Utility Comment: I have to contact them every time it rains, they say sorry but they can only get someone to look at problem when they can, so I have no phone for over a week and they can only give me credit when the phone is back up. They don't care much about the customer Request

of CPUC: I want a complaint issued and phone repaired in a timely manner. I need it repaired so I don't lose service every time it rains. Utility Name: AT&T"

3. "Complaint / Concern: I spent over one hour on the phone with repair due my calling a specific business number, my 24 Hr Pharmacy, which just rang for 3 minutes and then dropped. I was told to take the battery out of my hardware and or unplug it from inside the house to fix it. The plug is under my desk and I'm a senior with a disability who cares for her husband who has Alzheimers. This didn't work so they scheduled a tech to come out. This happened on 2/6 and tach came out on 2/11. The tech said it sounded like it was a problem with the pharmacy line and not mine. He called the number from his cell phone and it answered but he never asked them if they had a problem and his response was they wouldn't tell him if he asked? The number in question is [REDACTED] and the tech told me that was a Frontier Communications number but he only handles resident lines. I asked if he could contact the business side of the house and he told me NO he would get in trouble. Utility Comment: The tech, Gabriel employee # *** [REDACTED] ***, stated he was a lead and there was NOTHING he could do for me unless I wanted him to just go through the steps of unplugging the battery and resorting the router, but he stated that wouldn't help. I asked if he couldn't contact the business side of the house could his supervisor and he said NO. I also called Gabby today in the executive office of Frontier @877-433-3806 Ext *** [REDACTED] *** who also told me its up to the business to contact repair and she didn't have a contact on the business side of the company, Request of CPUC: I want the CPUC to make FRONTIER Communications UNDERSTAND their customers aren't being helps and they need to open communication with the business side of the house. I retired from a utility company and THE CUSTOMER SHOULD ALWAYS BE HELPED. FRONTIER Communications DOESNT HELP THE CUSTOMER AND IS ALWAYS MAKING IT HARDER FOR US. Utility Name: FRONTIER COMMUNICATIONS"

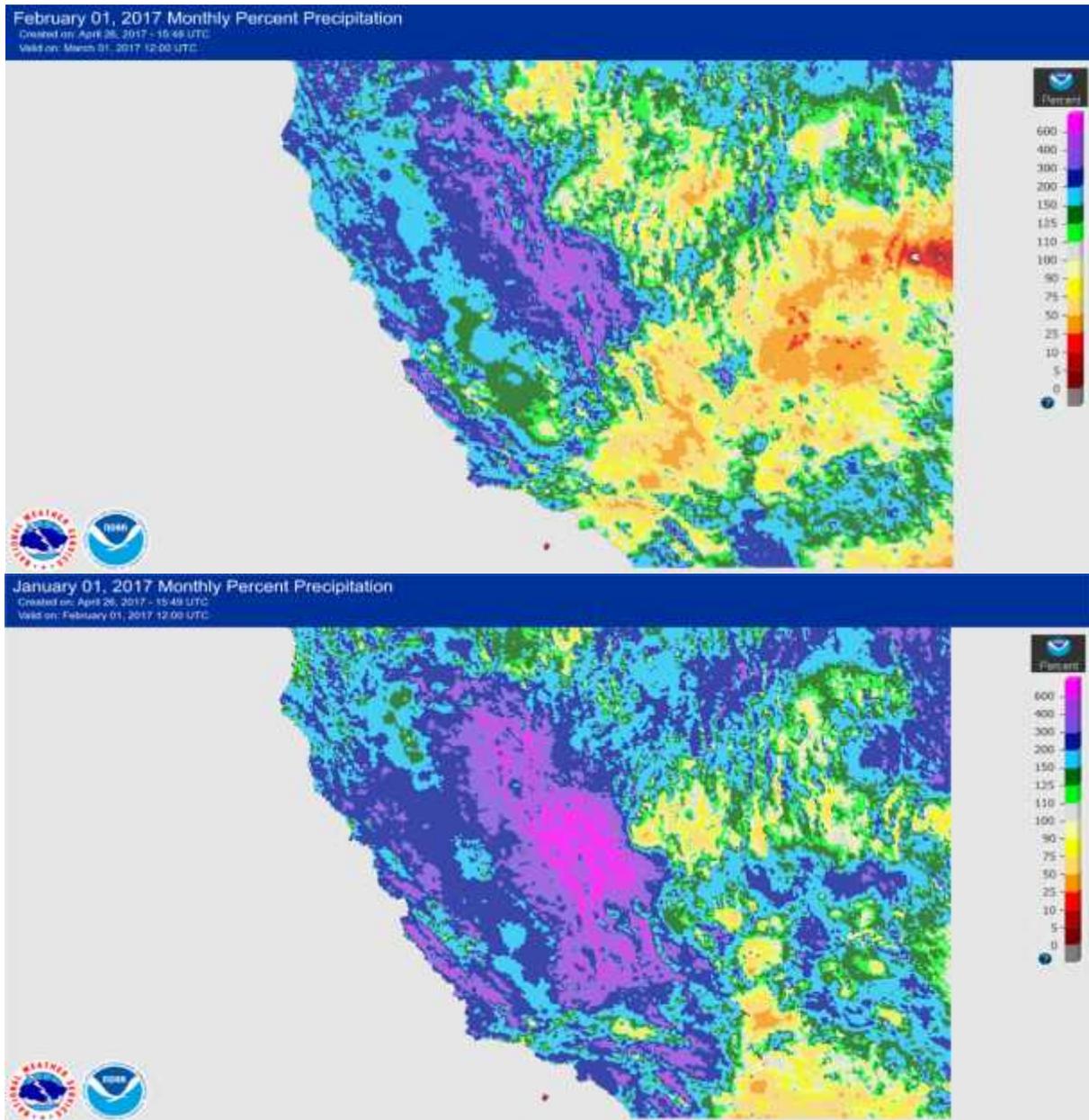
4. "Complaint / Concern: Frontier Communications has had inferior service since they acquired the Verizon FIOS accounts on April 1. I have many issues from major technical issues to on-going spotty internet, on-going static-y landline, and cable and other service features not being available. However, I am contacting you regarding the customer service issues that I have had with the company. Utility Comment: December 12, 2016 contacted support for an situation with my landlord voicemail. They were unable to help me at that time. They told me I would get a call back within 24 hours. I'm still waiting for the call back. Saturday, February 11, 2017 I receive a voicemail (cellular) that a service technician would be at my house in 15 minutes. I know nothing about a service call scheduled or even needed. After spending many hours on the phone with Frontier Communications on February 13, I learned that Frontier Communications had planned to change all the wiring in my house. Bewildered why they would arrange an appointment without working on a convenient time with me. Perturbed they would plan this type of service without consulting with me first.

Changing the telephone lines in my house would cause the home security system to stop working. Hopefully, the worse issues this would have caused for me is additional cost with the alarm company and inconvenience. Request of CPUC: In my area, we have Frontier Communications and Charter Spectrum available to us for cable/internet if we are not using satellite.

I switched from Charter Communications when Verizon FIOS became available in 2007 due to on-going billing problems. As listed above, I have problems with Frontier Communications. With my limited choices, I can return to a company that I previously had problems with. stay with the current provider that has been offering substandard service. PLEASE consider bring in more fiber optics cable/internet providers into my area. One with a proven track record for technical support and customer service.” Thank you. Utility Name: Frontier Communications”

Appendix E: Jan.-Feb. 2017 Rainfall

The rainfall in California exceeded yearly averages by several hundred percent according to the National Weather Service.³¹ The scale on the right hand side shows the percentage above normal. For example, the purple scale indicates there was a 600% increase in rainfall from normal years in the central part of California.



³¹ <http://water.weather.gov/precip/>.