BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554

In the Matter of: Implementation of Section 6002(b) of the Omnibus Annual Report and Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services.	WT Docket No. 16-137

COMMENTS OF THE CALIFORNIA PUBLIC UTILITIES COMMISSION

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The California Public Utilities Commission (CPUC or California) submits these comments in response to the Nineteenth Annual Report on the State of Competition in Mobile Wireless, including Commercial Mobile Radio Services (Nineteenth Report), released by the Federal Communications Commission (FCC or Commission) on April 29, 2016. The FCC seeks comment in connection with the mandate that the Commission submit annually to Congress a report analyzing competitive conditions with respect to commercial mobile services.[1]

The CPUC comments here on many, but not all, of the issues raised in the *FNPRM*. Silence on any issue should not be construed either as support or opposition to the FCC's proposal(s).

I. INTRODUCTION

For several years, the staff of the CPUC's Communications Division (CD) has been studying broadband measurement techniques, particularly with regard to mobile broadband service. Specifically, CD has undertaken and reported to the FCC on the following CPUC actions: 1) creation and implementation of CalSPEED, a project to measure mobile broadband throughput, quality and reliability data for the four national wireless carriers; 2) publishing of a mobile crowd-sourcing application; and 3) performance of semi-annual field testing of mobile broadband service quality in urban, rural and tribal areas throughout the state of California. Since 2012, every six months, CD has collected approximately 2,000,000 test results at the same 1,986 locations throughout California.[2] Prior to the most recent field test to capture backhaul and middle-mile information, CD enhanced its testing protocol in order to compare urban, rural, and tribal service characteristics and impacts. Analysis of the latest data collection is currently under way.[3] In addition, CD has developed an on-line tool, **CalSPEED.org**, to collect fixed broadband service speed, quality, and reliability information using the same testing protocol as used with our mobile app.

[1] 47 U.S.C. § 332(c)(1)(C).

[2] Test locations increased from 1,200 to 1986 as of Fall 2013.

[3] CalSPEED code and testing results are all open source. Data sets are available at http://www.cpuc.ca.gov/PUC/Telco/bb_drivetest.htm.

Because of the CalSPEED program, the CPUC is in a unique position to provide California data-driven recommendations to the FCC. Our data provides empirical evidence in response to the FCC's questions relating to the extent of broadband deployment in rural and tribal areas. These comments rely on the analysis of CalSPEED data performed by CPUC Staff, CPUC consultant Ken Biba at Novarum, Inc., and CPUC consultants at California State University (CSU) at Monterey Bay as well as by the Geographic Information Center at CSU Chico. Mr. Biba's preliminary analysis of the Spring 2015 field test results is referenced in these comments, and his analysis of Spring 2015 results is appended here as Attachment 1.[4]

II. DISCUSSION

For the Nineteenth Report, the FCC requested that parties propose alternative sources of quantitative data to help analyze competition in the mobile wireless marketplace. The Commission also sought comment on the extent of mobile broadband network deployment in rural and tribal areas, as well as whether any noteworthy trends are to be found in rural and tribal areas.

A. Minimum Advertised Speeds in 477 Are Unreliable

Over the years that California has been conducting performance speed testing, the CPUC's method of determining and displaying mobile broadband deployment has evolved. In conformance with a State Broadband Initiative grant from the National Telecommunications and Information Administration (NTIA), the CPUC initially received data on maximum advertised speeds from mobile providers. That information was displayed on both the on-line California Interactive Broadband Map and the NTIA's National Broadband Map to represent mobile broadband availability. While the provider-submitted mobile data on service areas and speeds was subject to both CPUC and FCC validation, public feedback indicated that even the validated data still overstated consumers' own experience with both mobile availability and speeds.

[4] Wireless Streaming Video in California – Spring 2015, Ken Biba, Managing Director and CTO Novarum, Inc.

After the 5-year federal grant expired, data collection transitioned from the NTIA (and the states) to the FCC. The FCC's bi-annual Form 477 became the reporting method for providers. Further, to better align the providers' data with consumer experience, the FCC changed the reporting standard for mobile broadband from *maximum* to *minimum* advertised speeds.[5] The issue becomes whether the reporting of minimum advertised speeds reflects actual customer experience.

As another State Broadband Initiative grant-funded project, the CPUC developed mobile speedtest apps and conducted semi-annual drive tests throughout the state. Analysis of drive test results showed that this approach, which takes into account Broadband Internet Access Service (BIAS) providers' peering strategies and indices of quality and reliability in addition to speed, better represents the consumer experience.[6] For this reason, to identify the availability, speeds, and quality of mobile broadband network deployment, rather than relying on 477 reported minimum speeds, CD staff now uses mobile broadband data only from field testing.

Figures 1 and 2, below, show the difference in downstream speed for Verizon Wireless using minimum advertised speeds submitted via Form 477, compared with the CPUC's mobile analysis.[7] The minimum advertised values shown in Figure 1 suggest near ubiquity of downstream speeds between 6 Mbps and 10 Mbps (green) in California's populated areas. In contrast, availability using the CPUC's mean minus two standard deviation method shows consumers will often experience much slower speeds, as shown

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[5] By contrast, the FCC retained the "highest advertised speed" for fixed broadband services, which, through its SamKnows testing program, the FCC has found to generally reflect the actual speeds delivered." FCC's 2015 Measuring Broadband America Fixed Report: "We find that the actual speeds experienced by most ISPs' subscribers are close to or exceed the advertised speeds."

[6] Eleventh Broadband Progress Notice of Inquiry, paragraph 66

[7] In comments in response to the FCC's Eleventh Broadband Progress Notice of Inquiry (NOI) Concerning Deployment of Advanced Telecommunications Capability Pursuant to Section 706 of the Telecommunications Act of 1996 (GN Docket No. 15-191), the CPUC provided an explanation of how it determines mobile broadband coverage using mean minus two standard deviations. Assuming a normal distribution of data, the CPUC now reduces its CalSPEED test results by two standard deviations below the tested mean to better match the expected reliability of service. Lowering the tested mean allows consumers to see whether the available speed can actually be experienced either 84 or 98% of the time. By way of comparison, initial FirstNet specifications require service to first responders to have at least 95% reliability (FirstNet Solicitation No. D15PS00295 – Section J, Attachment J-1, Coverage and Capacity Definitions, Page J-1 – 2).

in Figure 2. The CPUC's analysis shows most of California's populated areas actually receiving service at speeds *below* 6 Mbps (brown, orange, and yellow), rather than *above* 6 Mbps, as providers' submitted data indicates.

For example, upon review of Verizon Wireless' most recent Form 477 filing for December 2015, CD staff estimates **99.6%** of California households[8] would have mobile broadband service available at mean speeds of at least 6 Mbps downstream and 1.5 Mbps upstream.[9] By contrast, relying on field testing data from Fall 2015, staff lowered the mean by 2 standard deviations to estimate speeds with 98% reliability. With this adjustment, CD staff found that only 9% of California households[10] have access to a combined 6 Mbps down and 1.5 Mbps up or faster service. For all four major mobile providers (AT&T, Sprint, T-Mobile, and Verizon), only **16%** of California households can expect access to mobile broadband at those levels (about 98% of the time). Moreover, while the FCC has established a mobile standard for "advanced telecommunications capability" of 25 Mbps down and 3 Mbps up, the CPUC's analysis, taking variability and other indices of quality into account, shows no California households with access to that service.[11]

[8] CPUC household projections, by census block, based on data from California Department of Finance, January 2015. Out of 12,830,035 households, Verizon Wireless served (≥6/1.5) households were 12,784,370; underserved (≥768 Kbps/200 Kbps<6/1.5 Mbps), 16,773; unserved (<768 Kbps/200 Kbps), 28,892 based on December 2015 Form 477 data.

[9] The CPUC uses data from Verizon Wireless in these comments for illustrative purposes because Verizon Wireless has the largest footprint in California.

[10] Using the same service level definitions in footnote 8, Verizon Wireless served households were 1,178,789; underserved, 10,992,545; unserved, 658,70 based on Fall 2015 field test results using mean minus two standard deviations.

[11] *See supra*, footnote 4.

Figure 1: Verizon Wireless Minimum Advertised Downstream Speed (Form 477)

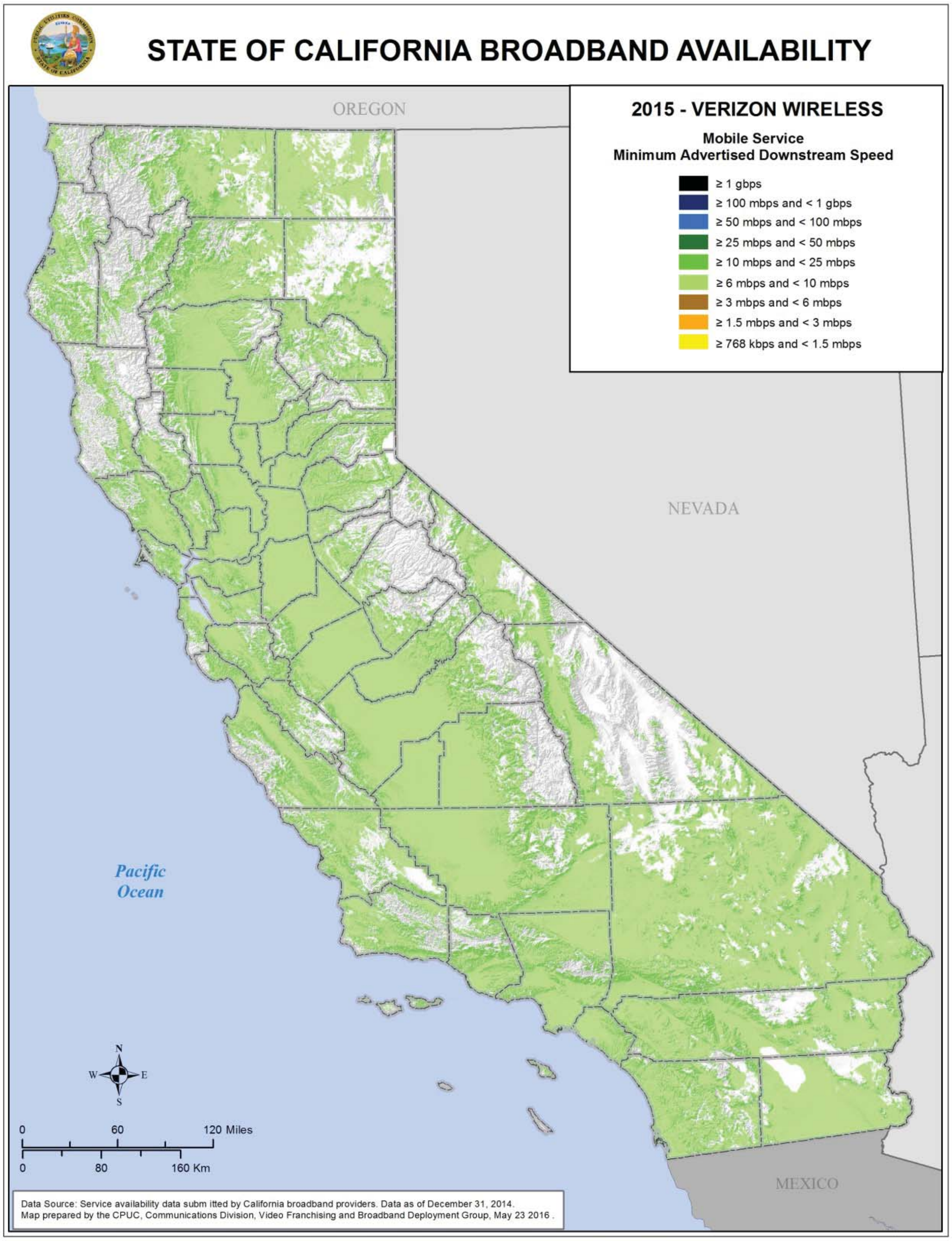
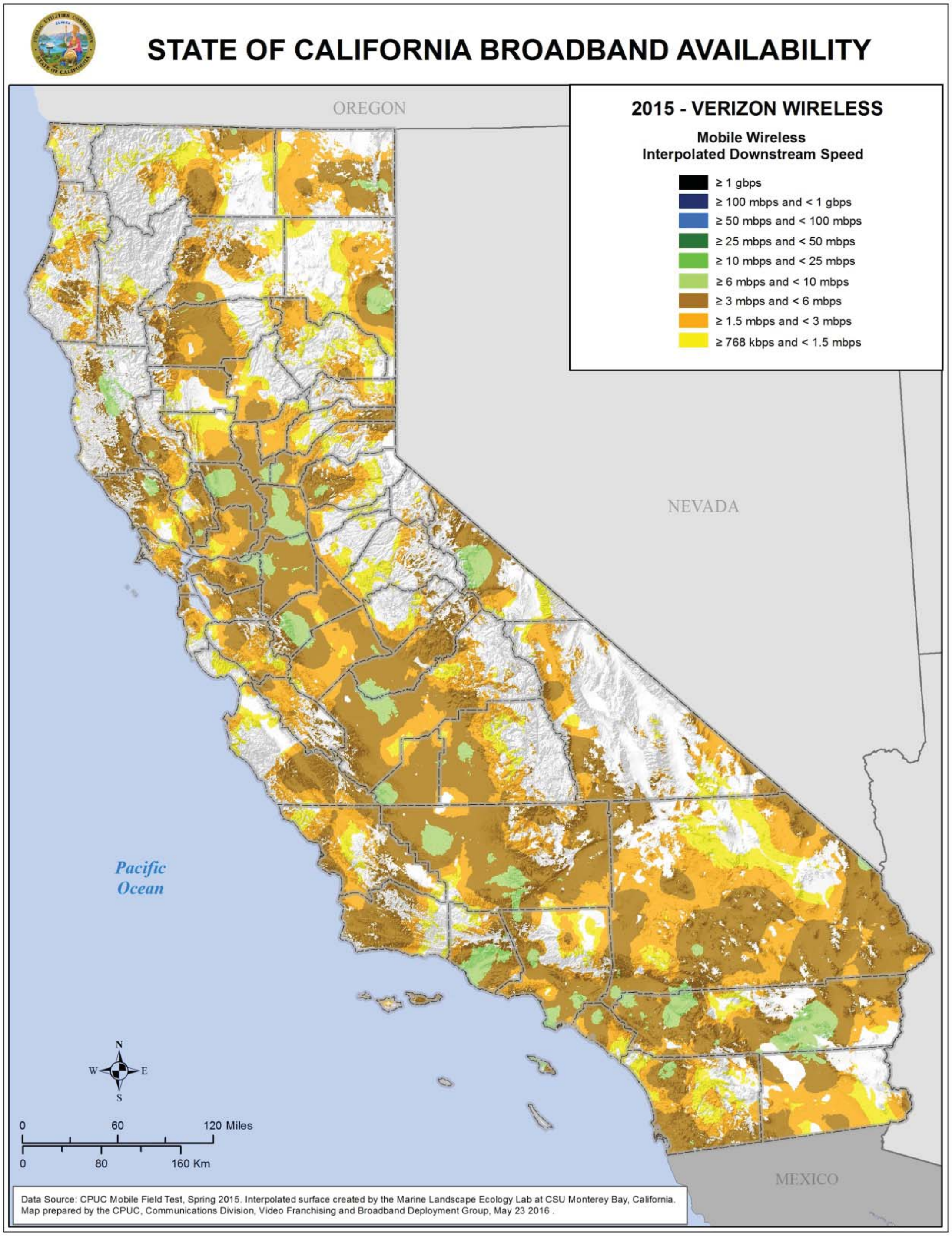


Figure 2: Verizon Wireless Interpolated Mean Minus 2 Standard Deviation Downstream Speed



B. Mobile Real-Time Services in Rural Areas Are Significantly Worse

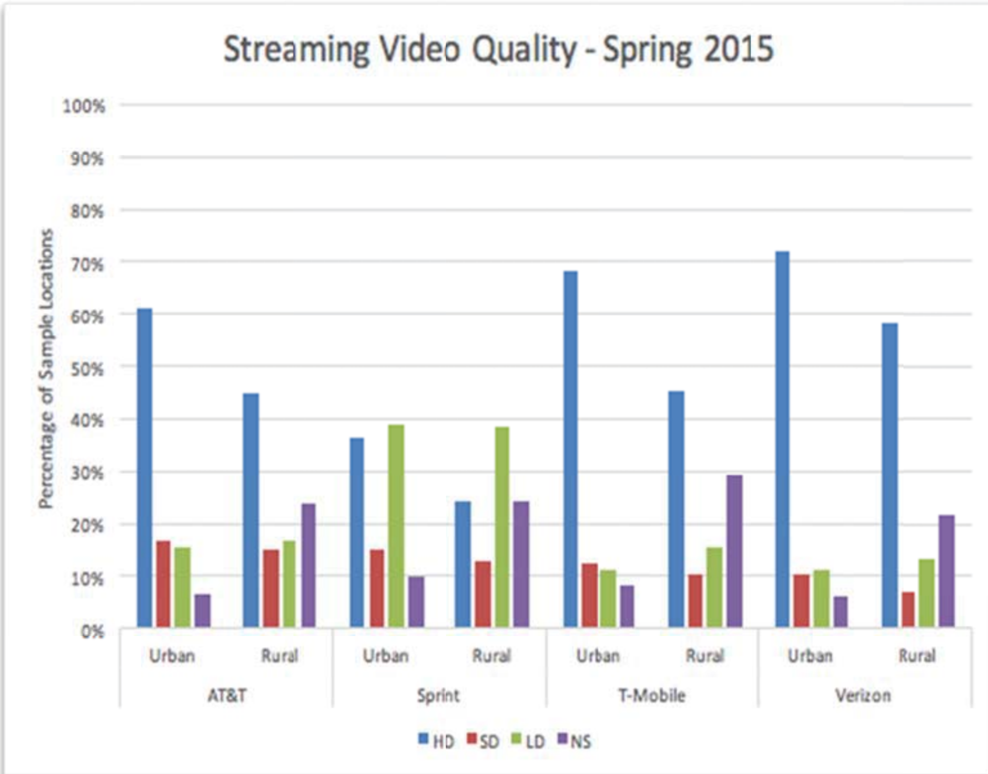
For the CPUC's Spring 2015 field test, we evaluated the ability of the mobile device to support one-way streaming video (such as YouTube) and two-way video conferencing. First responders increasingly rely on advanced services like streaming and interactive video when responding to emergencies, including natural disasters, yet mobile providers are much less likely able to deliver those services in rural areas and tribal lands.

Using a modified measurement algorithm originated by Google to assess YouTube video quality[12], we evaluate network performance for two types of service – a streaming video service, such as YouTube, which is often delivered from a cache server located close to the user, and interactive video – a live two-way, video conference such as Skype, FaceTime, as well as applications such as telemedicine and distance learning. Each tested location is assigned a video capability category based on Google's performance algorithm: high definition video (HD), standard definition video (SD), low definition video (LD), or no service (NS).

As shown in Chart 1, one-way streaming video service substantially degrades when the user moves from urban to rural areas. This degradation is characterized not only by a decrease in video quality, but also by a dramatic increase in locations with no video capability at all. For AT&T, the number of locations with no video service more than quadruples from 5% in urban areas to 23% in rural areas; for Sprint the numbers change from 10% to 23%; for T-Mobile, 7% to 29%; and for Verizon, 4% to 22%.

[12] Please refer to Attachment 1 for an explanation of the measurement method.

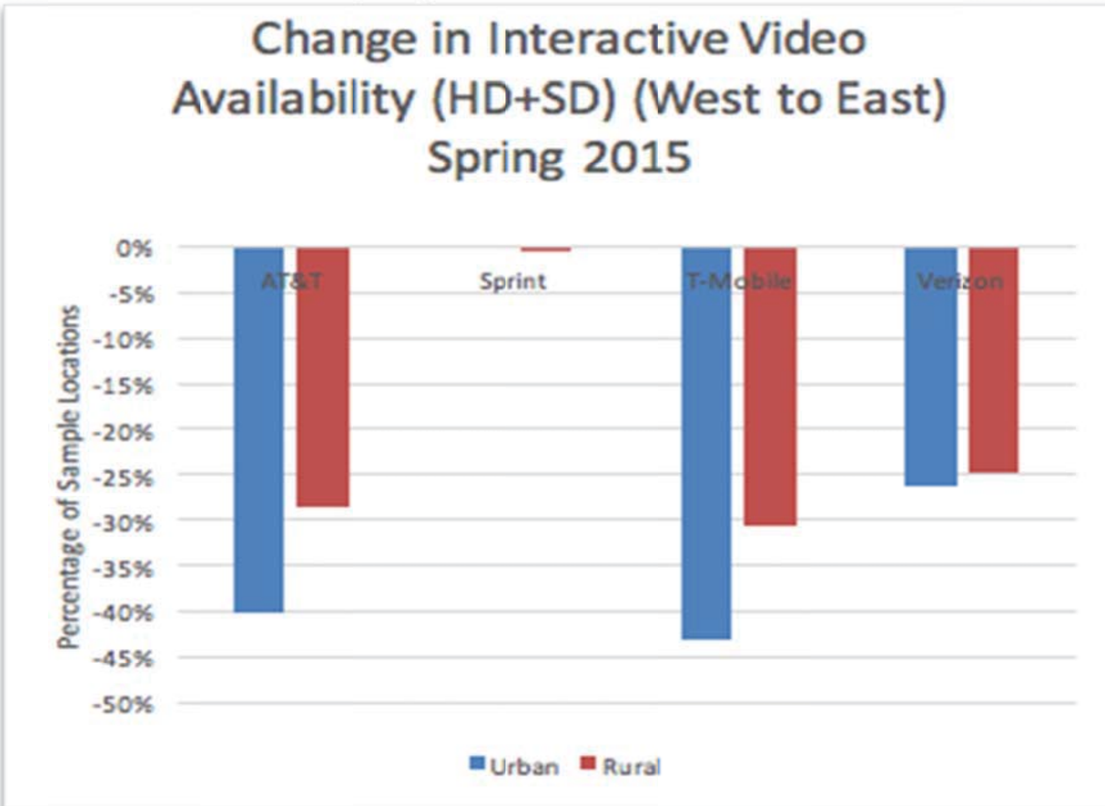
Chart 1: Streaming Video Quality – Spring 2015 Field Test Results



For two-way video conferencing, the CPUC examines three components: downstream video quality, upstream video quality, and voice quality, as determined by an imputed Mean Opinion Score for over-the-top Voice over Internet Protocol (VoIP). Two-way conferencing is is harder to provision, as it requires the **upstream** signal to support both video and audio -- with one-way video streaming, we only need to apply our video and audio quality algorithms to the downstream signal. Two-way video conferencing quality is affected significantly by the distance between calling parties, as well as by whether one or both of the parties is in a rural area.

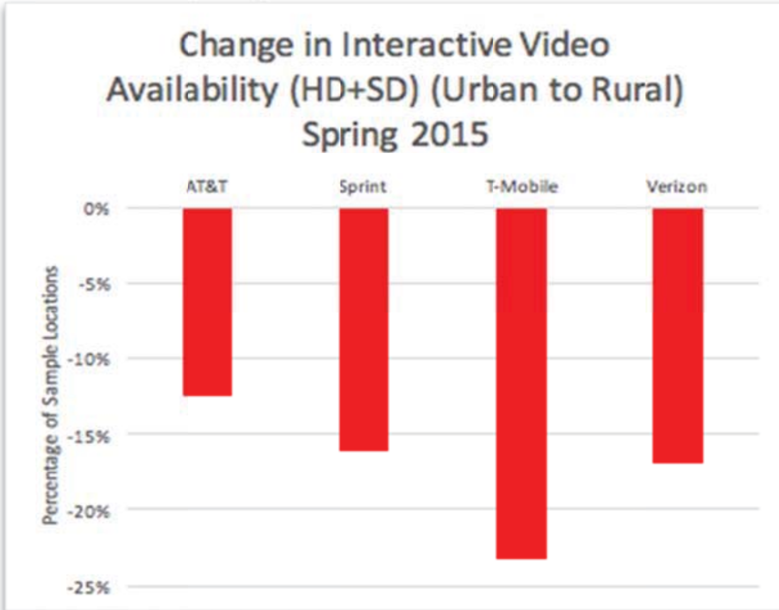
Chart 2 below shows a dramatic difference in interactive video quality for AT&T, T-Mobile, Sprint, and Verizon depending on whether one of the parties is in a location distant from the others' locations. This is true for both urban and rural users. The difference suggests that carrier Internet backhaul design for these three carriers substantially reduces interactive video quality. The number of locations supporting either HD or SD quality decreases as distance to the server increases, while the number of locations with LD quality dramatically increases. Users would likely experience this not only as an increase in session failure, but also as an increase in "successful" sessions of unusable quality. As shown in Chart 2, Sprint shows very little difference in video quality between the two server locations.

Chart 2: Change in Interactive Video Availability (HD + SD) (West to East) Spring 2015 Field Test Results



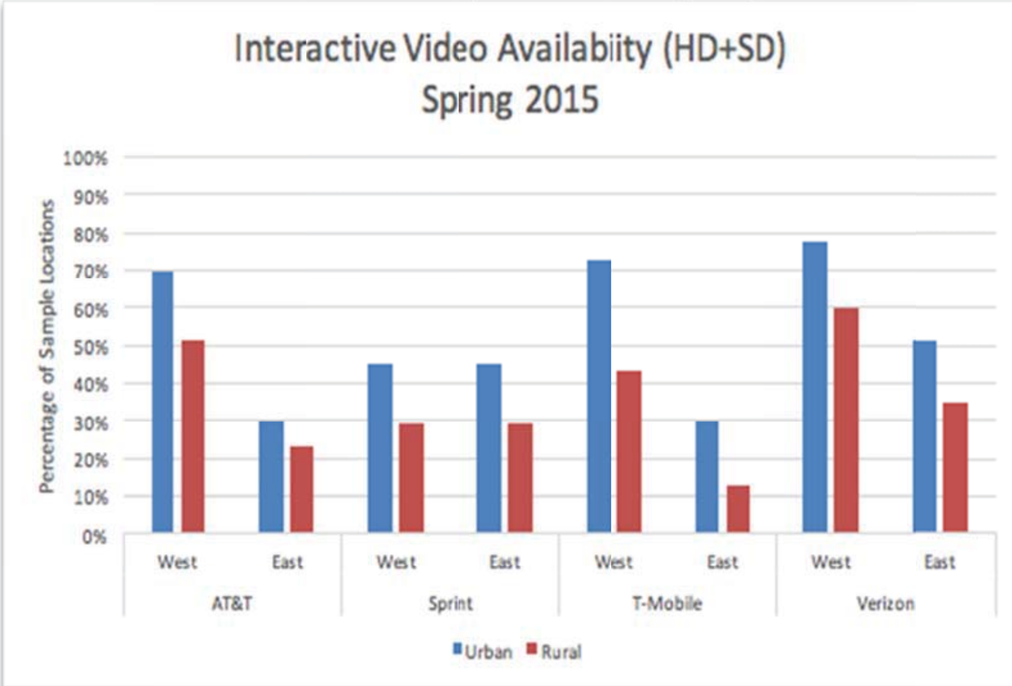
Furthermore, CalSPEED data suggests a substantial quality difference in two-way video conference quality between urban and rural users. Chart 3 below illustrates that the percentage of locations supporting either HD or SD interactive video session decreases by 10-20% for all carriers as the model user moves from urban to rural locations.

Chart 3: Change in Interactive Video Availability (HD+SD) (Urban to Rural), Spring 2015 Field Test Results



The effects of rural versus urban location, combined with the distance to the called party are additive, as shown in Chart 4 below. A rural user attempting a two-way video session would be less likely to have HD or SD quality, and even less likely if the distance to the called party were large. We can summarize this analysis on the chart below. It illustrates the total percentage of sample locations that can support either HD or SD quality interactive video sessions. We can see both the quality degrading effects of Internet distance (between west and east servers) and between urban and rural users.

Chart 4: Interactive Video Availability (HD+SD), Spring 2015 Field Test Results



Attachment 1 contains maps of both one-way video streaming and two-way video conferencing for each of the four major mobile providers.

II. CONCLUSION

The CPUC appreciates this opportunity to update the Commission regarding our testing methodologies and our analysis of mobile broadband service quality in California. The CPUC uses its mobile broadband analysis in determining eligible areas for California's infrastructure grant program, The California Advanced Service Fund (CASF).[13] The CalSPEED data presented here lead to the following conclusions:

- Relying on minimum advertised speeds, which the FCC requires from the wireless providers in their Form 477 submissions, does not yield an accurate evaluation of mobile broadband availability and quality, or of competition.
- As we measure advanced mobile services, such as two-way interactive video, service availability decreases significantly when users are in rural areas.

Finally, the CPUC's metrics are more accurate and reliable than are advertised minimum speeds. If the FCC were to consider using the CPUC's metrics and testing

[13] The CPUC also uses our new wireline tester CalSPEED.org to measure compliance with grant performance requirements.

methodologies, it could better measure the extent of the mobile divide among urban, rural and tribal areas, as well as monitor whether mobile services are robust enough to meet the speeds and deliver the services to meet consumer expectations.

Respectfully submitted,

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