March 27, 2015

VIA ECFS

Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, SW
Washington, DC 20554

Re: WC Docket No. 10-90, Connect America Fund; Ex Parte of Hughes Network Systems, LLC

Dear Ms. Dortch:

Based on discussions with FCC staff on methodologies for testing latency in connection with the Connect America Fund (CAF), Hughes Network Systems, LLC (Hughes) submits this ex parte presentation to elaborate on its proposal for an alternative approach to latency -- the web page "loading time" test and, for Voice over Internet Protocol (VoIP), the R-Factor test.[1] Adoption of these methodologies will fulfill the Commission's mandate for CAF Phase II public interest obligations and avoid arbitrarily excluding certain broadband providers from the program based solely on technology.

In the *USF/ICC Transformation Order*, the Commission concluded that all recipients of CAF support would be required to meet certain public interest obligations, including "to offer sufficiently low latency to enable use of real-time applications, such as VoIP."[2] The Commission has not yet established specific criteria for how providers will be required to meet this standard in the CAF Phase II competitive bidding process.[3] Hughes opposes the

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[1] Comments of Hughes Network Systems, LLC, WC Dkt No. 10-90 (filed Dec. 22, 2014) ("Hughes Comments").

[2] *Connect America Fund, et al.*, Report and Order and Further Notice of Proposed Rulemaking, 26 FCC Rcd 17663, 17698 ¶ 96 (2011), *aff'd sub nom. In re: FCC 11-161*, 753 F.3d 1015 (10th Cir. 2014) ("*USF/ICC Transformation Order*").

[3] *Connect America Fund*, Report and Order, Declaratory Ruling, Order, Memorandum Opinion and Order, Seventh Order on Reconsideration, and Further Notice of Proposed Rulemaking 29 FCC Rcd 7051, 7103 ¶ 149 (2014), *Connect America Fund*, Report and Order, 29 FCC Rcd 15644 (2014) (not applying 100 ms latency requirement on competitive bidders).

Commission's proposal to require such providers to meet a simple 100 ms latency standard because such a rigid requirement would arbitrarily exclude satellite broadband providers based purely on their technology and is unnecessary to ensure that consumers can use real-time broadband applications such as VoIP.[4] Instead, Hughes proposes a pair of tests that, together, will provide an appropriate and effective measure of whether broadband services offer sufficiently low latency to enable real-time applications including VoIP.

Web Page Loading Time Methodology

In its comments, Hughes demonstrated that a web page loading time test would be an appropriate component of a latency test for purposes of the CAF public interest standards. FCC staff has requested that Hughes demonstrate how web page loading time correlates to customer satisfaction or customer-perceived quality of the connection. Studies have found that web page loading time is the most important factor in determining customer experience for Internet web browsing.[5] This is because web page loading time is directly related to the ability of the Internet service provider to handle customer web traffic.

Web page loading time is driven principally by latency. Other factors include packet loss and the sufficiency of the provider's deployment of Domain Name System (DNS) and Hypertext Transfer Protocol (HTTP) proxy technology. A web page loading test takes into account all of these factors and would serve the public interest because it is a recognized way to measure customer satisfaction. In addition, unlike a latency time (ms) standard, a web page loading time methodology is technology neutral, which would ultimately allow for more competitive broadband choices within the CAF.

The web page loading time methodology can be implemented today by utilizing SamKnows whiteboxes, which the FCC has deployed for its Measuring Broadband America project. The current SamKnows whiteboxes measure end-to-end delay by performing a simulated visit to a list of well-known and common web Uniform Resource Locators (URLs). This test leverages all relevant aspects of the provider's network and measures the time to fetch all of the objects required by the page. Furthermore, SamKnows whiteboxes are able to measure

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[4] *See, e.g.*, Comments of Hughes Network Systems, WC Dkt No. 10-90 (filed Aug. 11, 2014).

[5] A 2012 Institute of Electrical and Electronic Engineers study explored the "Quality of Experience" for web browsing and determined that waiting time was the prime determinant of a user's satisfaction. *See* S. Egger, T. Hossfeld, R. Schatz, and M. Fiedler, Waiting Times in Quality of Experience for Web Based Services (2012), *available at* http://www.bth.se/fou/forskinfo.nsf/0/349bbe221ba80e52c1257a60005503fc/$file/Waiting%20times.pdf. Sandvine, a leading provider of network management and measurement services, published a similar analysis that came to the same conclusion -- web page loading time is the most important factor in determining customer experience. *See* An Industry White Paper, Measuring Web Browsing Quality of Experience: Requirements for Gaining Meaningful Insight, *available at* https://www.sandvine.com/downloads/general/whitepapers/measuring-web-browsing-qoe.pdf.

performance empirically using a consistent set of web resources, which is updated over time to ensure representative coverage of the types of services accessed by users.[6]

The R-Factor Test Using the E-model for Voice

As Hughes explained in its comments, for VoIP the FCC should address latency by measuring quality of voice using the R-Factor test.[7] The R-Factor test is similar to the Mean Opinion Score (MOS) but measures customer satisfaction more precisely using a 100-point scale.[8] FCC staff has requested that Hughes provide more detail on the R-Factor test and explain how it is a measurement of customer satisfaction. As an initial matter, it is important to bear in mind that the R-Factor test is a metric of customer satisfaction in the same way that the MOS test (which the FCC used for this purpose in the Rural Broadband Experiments[9]) is a metric of satisfaction – the only difference is the precision of the measurement. The R-Factor can be calculated by using the E-model. A benefit of using the E-model to calculate the R-Factor is that it takes into account all attributes of a speech connection, from "mouth to ear." Therefore, it is a good measure of the customer experience. Moreover, using this test is in the public interest as it provides the Commission a technology-neutral way to measure VoIP call quality, which will benefit the public by allowing more providers to participate in the CAF.

The E-model is documented in International Telecommunications Union ("ITU") Recommendation ITU-G.107.[10] In conjunction with ITU-G.107, the ITU also recommends

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[6] The Commission should seek comment on what the "loading time" threshold should be.

[7] Hughes Comments at 3-4.

[8] *See* ITU-T, G.107: The E-model: a computational model for use in transmission planning, https://www.itu.int/rec/T-REC-G.107. While Hughes previously cited to a 0 to 120 scale, *see* Hughes Comments at 3, the FCC should consider adopting a more standard scale – that of 0 to 100. This is the scale that is utilized in the ITU standardized measurement process.

[9] In adopting criteria for rural broadband experiments, the FCC allowed providers proposing to serve extremely high-cost locations to satisfy "requirements for quality of voice service by demonstrating it can provide voice service that meets a Mean Opinion Score (MOS) of four or greater." *Connect America Fund*, Report and Order and Further Notice of Proposed Rulemaking, 29 FCC Rcd. 8769, 8780 ¶ 29 (2014). *See also* Reply Comments of the Satellite Broadcasting & Communications Association, WC Dkt No. 10-90 *et al.* at 3-4 (filed Sept. 8, 2014).

[10] *See* ITU-T, G.107: The E-model: a computational model for use in transmission planning, https://www.itu.int/rec/T-REC-G.107; *see also* E-model Tutorial, Background, https://www.itu.int/ITU-T/studygroups/com12/emodelv1/tut.htm (last visited Mar. 23, 2015) ("E- model is a transmission planning tool that provides a prediction of the expected voice quality, as perceived by a typical telephone user, for a complete end-to-end (i.e. mouth-to-ear) telephone connection under conversational conditions.")

certain categories for rating speech transmission quality in ITU Recommendation ITU-G.109.[11] After calculating the R-Factor score, the score can then be correlated to the MOS. The ITU specification provides the calculations on how to correlate the R-Factor score to the MOS.

The parameters that are measured in the E-model are a function of: 1) the telephone equipment provided by the end user, 2) the ambient noise in the user's location and 3) the coding algorithms used by the customer's VoIP service. In using the E-model to calculate the R-Factor, Hughes proposes fixing certain parameters with "typical" values, as suggested by the ITU, and then measuring those parameters that are under the control of the Internet Access Provider, which are 1) the Mean One-Way Delay (T) and 2) the Packet Loss Rate (Ppl) of the connection. These two characteristics can be measured by the SamKnows whiteboxes, via periodic User Datagram Protocol (UDP) probing of the network. The T should be calculated as the average latency of the UDP probes plus the average Jitter.[12] The Ppl can be directly measured.[13] The remaining parameters calculated under the E-model should be set to the default values suggested by the ITU's E-model calculator.[14]

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[11] ITU-T Recommendation G.109, Series G: Transmission Systems and Media, Digital Systems and Networks, Definition of Categories of Speech Transmission Quality.

[12] This is because modern VoIP Analog Telephone Adapters employ jitter buffers to hold packets for the duration of the average jitter in order to ensure packets are decoded without loss or gap, so this becomes a part of the one-way delay.

[13] The whitebox transmits a series of UDP packets, and the destination test server indicates which packets arrived. For example, if the whitebox sends 100 packets and the server only acknowledges 98, then 2 packets were lost, for a Ppl of 2 percent.

[14] *See* The E-model, https://www.itu.int/ITU-T/studygroups/com12/emodelv1/calcul.php (last visited Mar. 23, 2015). Hughes urges the Commission to seek comment to develop a record on what the appropriate threshold should be, but at this time, does not submit a proposed threshold for the calculated R-Factor.

The record in this proceeding supports adopting a latency standard that is technology neutral which will make the CAF Phase II auction more robustly competitive. As discussed herein, the web page "loading time" and R-Factor methodologies are appropriate measures of customer satisfaction as each evaluates a range of factors that determine the customer's web browsing and VoIP service experiences, respectively. Accordingly, the FCC should adopt these methodologies as a means of demonstrating, in CAF Phase II, that a provider offers broadband service with sufficiently low latency to use real-time applications such as VoIP. In order to adopt these tests, the Commission should seek comment on the appropriate thresholds without delay.

Sincerely,

/s/ Jennifer A. Manner

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