Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	**)**	
	)	
Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion	**)**	WC Docket No. 19-285

COMMENTS OF DR. TIMOTHY J. TARDIFF

Introduction and Summary

The Federal Communications Commission's (FCC) Notice of Inquiry (NOI) in this proceeding seeks, among other things, data on deployment fixed broadband services for the period 2014-2018 for five speed metrics: (1) 10 Mbps downstream/1 Mbps upstream, (2) 25 Mbps downstream/3 Mbps upstream, (3) 50 Mbps downstream/5 Mbps upstream, (4) 100 Mbps downstream/10 Mbps upstream, and (5) 250 Mbps downstream/25 Mbps upstream.[1] These Comments, which update Reply Comments I submitted in the two previous broadband progress proceedings,[2] [3] present percentages of U.S. households living in census blocks with zero, one, two, or three or more suppliers.[4]

These Comments provide an analysis of the change in broadband services using a consistent set of measures over time,[5] based on availability measures that Advanced Analytical Consulting

[1] Federal Communications Commission, *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion*, GN Docket No. 19-285, Fifteenth Broadband Deployment Report and Notice of Inquiry, October 23, 2019 , ¶ 9, available at https://docs.fcc.gov/public/attachments/FCC-19-102A1.pdf.

[2] Reply Comments of Dr. Timothy J. Tardiff, *Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion*, WC Docket No. 17-199, October 6, 2017, available at https://ecfsapi.fcc.gov/file/10061571715086/Tardiff%20reply%20comments%202017%2010%2006.pdf.

[3] Reply Comments of Dr. Timothy J. Tardiff, *Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion*, WC Docket No. 18-238, October 1, 2018, available at https://ecfsapi.fcc.gov/file/100172553392/tardiff%20reply%20comments%202018%2010%2001.pdf.

[4] The FCC has observed that even two suppliers (especially if they are wireline suppliers) can competitively constrain one another. Federal Communications Commission, *Restoring Internet Freedom*, WC Docket No. 17-108, Declaratory Ruling, Report and Order, and Order, January 4, 2018, ¶ 126 , ("Internet Freedom Order") , available at https://docs.fcc.gov/public/attachments/FCC-17-166A1_Rcd.pdf.

[5] In previous proceedings evaluating the extent of broadband availability and competitive intensity, the FCC has not always used a consistent measurement of the change in broadband provision. For example, as I described in my 2017 Reply Comments, the FCC deemed competition to be insufficient in its 2010 Internet Order (Federal Communications Commission, *Preserving the Open Internet*, GN Docket No. 09-191, *Broadband Industry Practices*, GN Docket No. 09-191, Report and Order, December 23, 2010, ¶ 32, available at

Group, Inc. (AACG) has developed from the FCC's Form 477 data.[6] To the extent that stakeholders believe that the most appropriate measure of broadband is evolving over time, the consistent set of measures allows parties to see that evolution across time and geography. The consistent measures for broadband availability since 2013 reveal substantial growth in broadband availability at the 25 Mbps downstream/3 Mbps upstream speed level. Further, comparing the growth trends for the 25 Mbps downstream/3 Mbps upstream speed level with the trend for the 10 Mbps downstream/1 Mbps upstream speed level suggests that the strong growth in availability at the higher speed level was the combination of a modest increase in the number of providers and an upgrade in the offerings of existing providers from lower speed levels. With respect to the faster speed levels, the wireline growth patterns for the 50 Mbps downstream/5 Mbps upstream and 100 Mbps downstream/10 Mbps upstream speed levels are broadly similar to the corresponding pattern for the 25 Mbps downstream/3 Mbps upstream speed level. When fixed wireless and satellite are included, approximately three-quarters of U.S. households lived in census blocks with 2 or more alternatives at the 50 Mbps downstream/5 Mbps upstream speed level and approximately half of households at the 100 Mbps downstream/10 Mbps upstream speed level (compared to the virtual ubiquity of competitive alternatives at the 25 Mbps downstream/3 Mbps upstream speed level). Finally, there has been some growth since the middle of the 2014-2018 period for the 250 Mbps downstream/25 Mbps upstream speed level (over 1 in 5 households lived in census blocks with two or more alternatives) and the percentage of households with no suppliers had decreased to about 27 percent by the end of the period, with virtually none of this progress due to fixed wireless and satellite.

These Comments, consistent with the FCC's *Internet Freedom* Order (¶¶ 124-125),[7] provide results separately for all fixed broadband Internet Service Providers (ISPs), including fixed

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https://apps.fcc.gov/edocs_public/attachmatch/FCC-10-201A1_Rcd.pdf) and that progress in broadband deployment was insufficient in its 2016 Broadband Progress Report (Federal Communications Commission, *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act*, GN Docket No. 15-191, 2016 Broadband Progress Report, January 29, 2016, ¶ 4, available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-6A1.pdf), based on very different measures of broadband availability. In particular, in 2010, the FCC evaluated the adequacy of broadband availability by measuring the percentage of households living in census *tracts* in which 0, 1, 2, or three or more providers offered service at the 3 Mbps downstream/0.768 Mbps upstream speed level. In contrast, in 2016, the FCC evaluated broadband progress based on the percentage of the population living in census *blocks* (a much more granular scale) in which 0, 1, or 2 or more providers offered service at the 25 Mbps downstream/3 Mbps upstream speed level. Inconsistent measurement, as in any scientifically valid research, cannot produce valid conclusions on the *growth* in broadband availability.

[6] A description of these consistent measures and reports updating the measures after the FCC releases new Form 477 data can be found at http://aacg.com/litigation/telecommunications/net-neutrality/.

[7] While the FCC (¶ 125) appeared to question the strength of the competitive pressure exerted by fixed wireless and satellite, at least 75 percent of the locations of the top 10 winning bidders in the 2018 CAF II rural broadband auction will be served by fixed wireless or satellite. These locations account for about 60 percent of the 713,176 locations proposed by the winning bidders. Glass, V. and Tardiff, T., "The Federal Communications Commission's Rural Infrastructure Auction: What is Hidden in the Weeds?" Telecommunications Policy, Vol. 43, Issue 8, 2019, Tables 6 and 7.

wireless and satellite, and for wireline ISPs, e.g., cable television and telephone companies. In the tables below, data for the periods from December 2014 through June 2018 were calculated by Advanced Analytical Consulting Group, based on the FCC's biannual releases of Form 477 data[8] and the data for December 2013 was presented in former Chairman Tom Wheeler's 2014 speech.[9]

10 Mbps Downstream/1 Mbps Upstream

Table 1 presents broadband availability for the period from December 2014 through June 2017 when wireline, fixed wireless, and satellite ISPs are included.[10]

[8] Since the FCC changed how it measures broadband availability in its Internet Service Access Reports (available at https://www.fcc.gov/internet-access-services-reports), Advanced Analytical Consulting Group produces a series of consistent availability measures, including a series consistent with the FCC's December 2009 through December 2013 measures. A description of this analysis can be found at http://aacg.com/litigation/telecommunications/net-neutrality/.

[9] "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, p. 2, available at https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf.

[10] The corresponding availability for December 2016 from the *Internet Freedom* Order are 93.6 percent, 5.7 percent, 0.6 percent, and 0.1 percent for 3 or more, 2, 1, and no alternative providers, respectively. 2018 Order, ¶ 124. The small differences between the FCC's percentages and the corresponding percentages in Table 1 are due to small differences in households (Table 1) versus population (FCC) in each census block. Since the average number of persons per household varies across census blocks, such small differences are not surprising.

Table 1: Percentage of US households in census blocks in which wireline, fixed wireless, and satellite broadband ISPs reported deployment at speeds of at least 10 Mbps down/1 Mbps up

Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	NA	79.4%	81.9%	83.9%	92.7%	93.9%	93.9%	94.9%	97.2%
2	NA	17.1%	14.7%	13.3%	6.7%	5.7%	5.6%	4.7%	2.7%
1	NA	3.4%	3.3%	2.9%	0.5%	0.4%	0.5%	0.4%	0.0%
0	NA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

Primarily because fixed wireless and satellite ISPs offering service at this speed were widely available throughout the period,[11] Table 1 shows a modest increase in competitive alternatives. For example, as of December 2014, 79.4 percent lived in census blocks with three or more alternatives, while only 3.4 percent lived in census blocks with only one broadband provider at this speed. By June 2016, the percent of households in census blocks with three or more suppliers reached 92.7 percent, while the percent in census blocks with only one broadband provider at this speed had declined to 0.5 percent. By the end of the period (June 2018), 97.2 percent of households lived in census blocks with three or more alternatives, and every census block had at least two providers. The percent of households in census block with no providers of at least 10 Mbps down/1 Mbps up has remained at 0 percent since December 2014.

Table 2 displays the results for wireline ISPs only for the period from December 2013 through June 2018.[12]

Table 2: Percentage of US households in census blocks in which wireline broadband ISPs reported deployment at speeds of at least 10 Mbps down/1 Mbps up

Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	9.8%	7.5%	8.9%	9.3%	8.5%	9.3%	10.7%	14.3%	11.8%
2	51.5%	55.4%	58.2%	59.0%	56.5%	57.2%	59.5%	57.7%	60.6%
1	30.3%	28.8%	24.9%	24.6%	27.9%	27.2%	24.0%	22.8%	22.5%
0	8.4%	8.2%	8.0%	7.2%	7.1%	6.3%	5.8%	5.2%	5.1%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

[11] The FCC reported that as of December 2014, satellite broadband service at speeds of at least 10 Mbps downstream and 1 Mbps upstream was available in 99.4 percent of developed census blocks. Federal Communications Commission, "Internet Access Services: Status as of December 31, 2014," Industry Analysis and Technology Division, Wireline Competition Bureau, March 2016, Figure 5, available at https://www.fcc.gov/internet-access-services-reports.

[12] The corresponding availability for December 2016 from the *Internet Freedom* Order are 9.0 percent, 58.5 percent, 26.3 percent, and 6.2 percent for 3 or more, 2, 1, and no alternative providers, respectively. 2018 Order, ¶ 125.

Similar to Table 1, Table 2 shows a modest increase in competitive wireline alternatives.[13] For example, as of December 2013, 61.3 percent (9.8 percent + 51.5 percent) lived in census blocks with two or more alternatives, while 8.4 percent lived in census blocks with no wireline broadband providers at this speed. By June 2016, the percent of households in census blocks with two or more suppliers reached 65.0 percent (8.5 percent + 56.5 percent), while the percent in census blocks with no wireline broadband providers at this speed had declined to 7.1 percent. By the end of the period (June 2018), 72.4 percent (11.8 percent + 60.6 percent) of households lived in census blocks with two or more alternatives, while the percent in census blocks with no broadband providers at this speed had declined to 5.1 percent.

25 Mbps Downstream/3 Mbps Upstream

Table 3 presents broadband availability for the period from December 2014 through June 2018 when wireline, fixed wireless, and satellite ISPs are included.[14]

Table 3: Percentage of US households in census blocks in which wireline, fixed wireless, or satellite broadband ISPs reported deployment at speeds of at least 25 Mbps down/3 Mbps up

Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	NA	6.5%	6.0%	7.1%	21.9%	42.5%	71.7%	89.3%	93.7%
2	NA	30.4%	29.9%	30.8%	40.3%	33.4%	22.5%	9.6%	6.2%
1	NA	51.9%	52.8%	51.2%	30.4%	19.6%	5.8%	1.1%	0.1%
0	NA	11.1%	11.2%	10.8%	7.4%	4.5%	0.0%	0.0%	0.0%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

The data show a large increase in competitive alternatives. For example, as of December 2014, 36.9 percent (6.5 percent + 30.4 percent) lived in census blocks with two or more alternatives, while 11.1 percent lived in census blocks with no broadband providers at this speed. By June 2016, the percent of households in census blocks with two or more suppliers reached 62.2 percent (21.9 percent + 40.3 percent) while the percent of households in census blocks with no broadband providers at this speed had declined to 7.4 percent. Indeed, in the sixth month period from December 2015 to June 2016, the percentage of households in census blocks with two or more alternatives had increased from 37.9 percent (7.1 percent + 30.8 percent) to 62.2 percent, primarily due to an increase in satellite and fixed wireless providers offering service at this

[13] Former Chairman Wheeler's 2014 speech reported wireline ISP availability only, which provides an additional observation (December 2013) for this table (and Tables 4 and 6 below). That speech reported availability at 10 Mbps downstream and 0.768 Mbps upstream, a somewhat slower speed level with concomitant somewhat higher availability levels.

[14] The corresponding availability for December 2016 from the *Internet Freedom* Order are 43.9 percent, 32.6 percent, 19.1 percent, and 4.4 percent for 3 or more, 2, 1, and no alternative providers, respectively. 2018 Order, ¶ 124.

speed.[15] By the end of the period (June 2018), 99.9 percent (93.7 percent + 6.2 percent) of households lived in census blocks with two or more alternatives.

Table 4 displays the results for wireline ISPs only for the period from December 2013 through June 2018.[16]

Table 4: Percentage of US households in census blocks in which wireline broadband ISPs reported deployment at speeds of at least 25 Mbps down/3 Mbps up

Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	2.4%	2.2%	2.5%	2.5%	5.3%	6.0%	7.1%	10.5%	8.2%
2	22.9%	28.6%	28.5%	28.6%	42.6%	43.8%	47.7%	45.8%	50.7%
1	55.3%	57.3%	57.0%	57.0%	41.4%	40.6%	36.2%	35.5%	33.4%
0	19.4%	11.9%	12.0%	11.8%	10.7%	9.6%	8.9%	8.2%	7.8%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

Table 4 shows a steady increase in competitive wireline alternatives. For example, as of December 2013, 25.3 percent (2.4 percent + 22.9 percent) lived in census blocks with two or more wireline alternatives, while 19.4 percent lived in census blocks with no wireline broadband providers at this speed. By June 2016, the percent of households in census blocks with two or more wireline suppliers reached 47.9 percent (5.3 percent + 42.6 percent), while the percent in census blocks with no wireline broadband providers at this speed had declined to 10.7 percent. By the end of the period (June 2018), 58.9 percent (8.2 percent + 50.7 percent) of households lived in census blocks with two or more wireline alternatives, while the percent in census blocks with no wireline broadband providers at this speed had declined to 7.8 percent.

[15] In Table 4 below (where fixed wireless and satellite ISPs are not included), the trend from December 2014 through December 2015 is similar to the trend in Table 3, albeit at a somewhat higher level of availability. Subsequently, the respective trends diverge, suggesting that satellite and fixed wireless alternatives are generating much of the large increases in post 2015 availability shown in Table 3.

[16] The corresponding availability for December 2016 from the *Internet Freedom* Order are 5.9 percent, 45.2 percent, 39.6 percent, and 9.2 percent for 3 or more, 2, 1, and no alternative providers, respectively. 2018 Order, ¶ 125.

50 Mbps Downstream/5 Mbps Upstream

Tables 5 and 6 present the growth in broadband availability at the 50 Mbps downstream/5 Mbps upstream speed level. While the progress in wireline broadband availability is quite similar to the corresponding pattern for the 25 Mbps downstream/3 Mbps upstream speed level, broadband availability is relatively lower when fixed wireless and satellite are included, indicating that fixed wireless and satellite have had yet to provide ubiquitous service at the 50 Mbps downstream/5 Mbps upstream speed level as of June 2018.

Table 5 presents broadband availability for the period from December 2014 through June 2018 when wireline, fixed wireless, and satellite ISPs are included.

Table 5: Percentage of US households in census blocks in which wireline, fixed wireless, and satellite broadband ISPs reported deployment at speeds of at least 50 Mbps down/5 Mbps up

Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	NA	2.8%	3.3%	3.6%	6.4%	9.7%	9.1%	13.7%	35.3%
2	NA	26.4%	26.7%	28.2%	35.9%	37.3%	42.4%	42.9%	38.5%
1	NA	55.5%	57.4%	55.9%	46.4%	43.6%	39.2%	35.0%	21.7%
0	NA	15.2%	12.6%	12.3%	11.2%	9.4%	9.3%	8.4%	4.5%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

The data show a substantial increase in competitive alternatives. For example, as of December 2014, 29.2 percent (2.8 percent + 26.4 percent) lived in census blocks with two or more alternatives, while 15.2 percent lived in census blocks with no broadband providers at this speed. By June 2016, the percent of households in census blocks with two or more suppliers reached 42.3 percent (6.4 percent + 35.9 percent) while the percent of households in census blocks with no broadband providers at this speed had declined to 11.2 percent. By the end of the period (June 2018), 73.8 percent (35.3 percent + 38.5 percent) of households lived in census blocks with two or more alternatives, with at least one ISP offering service at this speed available in census blocks with 95.5 percent of US households.

Table 6 displays the results for wireline ISPs only for the period from December 2013 through June 2018.

Table 6: Percentage of US households in census blocks in which wireline broadband ISPs reported deployment at speeds of at least 50 Mbps down/5 Mbps up

Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	1.6%	1.6%	2.0%	2.1%	3.9%	4.4%	6.2%	10.1%	7.7%
2	16.0%	24.3%	25.7%	26.2%	35.5%	37.3%	43.5%	44.3%	48.6%
1	61.4%	58.4%	59.4%	59.0%	48.9%	47.9%	40.6%	36.7%	35.2%
0	21.0%	15.6%	12.9%	12.7%	11.7%	10.4%	9.7%	9.0%	8.5%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

Table 6 shows a steady increase in competitive wireline alternatives. For example, as of December 2013, 17.6 percent (1.6 percent + 16.0 percent) lived in census blocks with two or more wireline alternatives, while 21.0 percent lived in census blocks with no wireline broadband providers at this speed.[17] By June 2016, the percent of households in census blocks with two or more wireline suppliers reached 39.4 percent (3.9 percent + 35.5 percent), while the percent in census blocks with no wireline broadband providers at this speed had declined to 11.7 percent. By the end of the period (June 2018), 56.3 percent (7.7 percent + 48.6 percent) of households lived in census blocks with two or more wireline alternatives, while the percent in census blocks with no wireline broadband providers at this speed had declined to 8.5 percent.

100 Mbps Downstream/10 Mbps Upstream

Tables 7 and 8 present the growth in broadband availability at the 100 Mbps downstream/10 Mbps upstream speed level. Similar to the patterns for the 50 Mbps downstream/5 Mbps upstream speed level, while the progress in wireline broadband availability is somewhat similar to the corresponding pattern for the 25 Mbps downstream/3 Mbps upstream speed level, broadband availability is relatively lower when fixed wireless and satellite are included, indicating that fixed wireless and satellite have had yet to provide very much service at the 100 Mbps downstream/10 Mbps upstream speed level as of June 2018.

Table 7 presents broadband availability for the period from December 2014 through June 2018 when wireline, fixed wireless, and satellite ISPs are included.

Table 7: Percentage of US households in census blocks in which wireline, fixed wireless, and satellite broadband ISPs reported deployment at speeds of at least 100 Mbps down/10 Mbps up

Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	NA	1.7%	1.9%	2.1%	2.4%	3.2%	4.0%	10.8%	9.4%
2	NA	17.9%	18.0%	19.4%	18.5%	22.4%	26.4%	35.7%	39.8%
1	NA	42.7%	45.1%	44.4%	47.1%	48.9%	53.2%	41.8%	40.7%
0	NA	37.7%	35.0%	34.1%	31.9%	25.5%	16.4%	11.6%	10.1%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

The data show a substantial increase in competitive alternatives. For example, as of December 2014, 19.6 percent (1.7 percent + 17.9 percent) lived in census blocks with two or more alternatives, while 37.7 percent lived in census blocks with no broadband providers at this speed. By June 2016, the percent of households in census blocks with two or more suppliers reached 20.9 percent (2.4 percent + 18.5 percent) while the percent of households in census blocks with no broadband providers at this speed had declined to 31.9 percent. By the end of the period

[17] Former Chairman Wheeler's speech reported availability at 50 Mbps downstream and 3 upstream, a somewhat slower speed level with concomitant somewhat higher availability levels.

(June 2018), 49.2 percent (9.4 percent + 39.8 percent) of households lived in census blocks with two or more alternatives, with at least one ISP offering service at this speed available in census blocks with 89.9 percent (9.4 percent + 39.8 percent + 40.7 percent) of US households.

Table 8 displays the results for wireline ISPs only for the period from December 2014 through June 2018.

Table 8: Percentage of US households in census blocks in which wireline broadband ISPs reported deployment at speeds of at least 100 Mbps down/10 Mbps up

Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	NA	1.2%	1.4%	1.5%	1.4%	1.7%	2.6%	8.4%	6.1%
2	NA	16.5%	17.8%	18.1%	17.3%	20.5%	25.3%	35.9%	40.9%
1	NA	44.3%	45.6%	46.1%	49.0%	51.6%	55.2%	43.7%	42.6%
0	NA	38.0%	35.2%	34.4%	32.3%	26.1%	16.9%	12.0%	10.4%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

Table 8 shows a steady increase in competitive wireline alternatives. For example, as of December 2014, 17.7 percent (1.2 percent + 16.5 percent) lived in census blocks with two or more wireline alternatives, while 38.0 percent lived in census blocks with no wireline broadband providers at this speed. By June 2016, the percent of households in census blocks with two or more wireline suppliers reached 18.7 percent (1.4 percent + 17.3 percent), while the percent in census blocks with no wireline broadband providers at this speed had declined to 32.3 percent. By the end of the period (June 2018), 47.0 percent (6.1 percent + 40.9 percent) of households lived in census blocks with two or more wireline alternatives, while the percent in census blocks with no wireline broadband providers at this speed had declined to 10.4 percent.

250 Mbps Downstream/25 Mbps Upstream

Finally, Tables 9 and 10 show that (1) while there is substantially less availability of broadband capability at the 250 Mbps downstream/25 Mbps upstream speed level than at the slower speed levels and (2) the results with and without fixed wireless and satellite differ very little (indicating that the non-wireline alternatives have yet to offer services at this speed level), there has nonetheless been some progress since the middle of the 2014-2018 period. For example, Table 9 shows that as of June 2016, only 1.5 percent (0.1 percent + 1.4 percent) of households lived in census blocks with 2 or more alternatives, and 77 percent of households were in census blocks with no offerings at this speed level. However, by the end of the period (June 2018), 23.0 percent (2.4 percent + 20.6 percent) of households lived in census blocks with two or more alternatives, while the percentage of households in census blocks with no broadband at this speed level had declined to 26.8 percent.

Table 9: Percentage of US households in census blocks in which wireline, fixed wireless, and satellite broadband ISPs reported deployment at speeds of at least 250 Mbps down/25 Mbps up

Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	NA	0.0%	0.1%	0.1%	0.1%	0.4%	0.7%	3.8%	2.4%
2	NA	0.1%	0.6%	1.2%	1.4%	5.9%	9.0%	14.6%	20.6%
1	NA	4.9%	11.4%	19.0%	21.6%	34.8%	38.8%	39.6%	50.2%
0	NA	95.0%	87.9%	79.6%	77.0%	58.9%	51.5%	42.0%	26.8%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

Table 10: Percentage of US households in census blocks in which wireline broadband ISPs reported deployment at speeds of at least 250 Mbps down/25 Mbps up

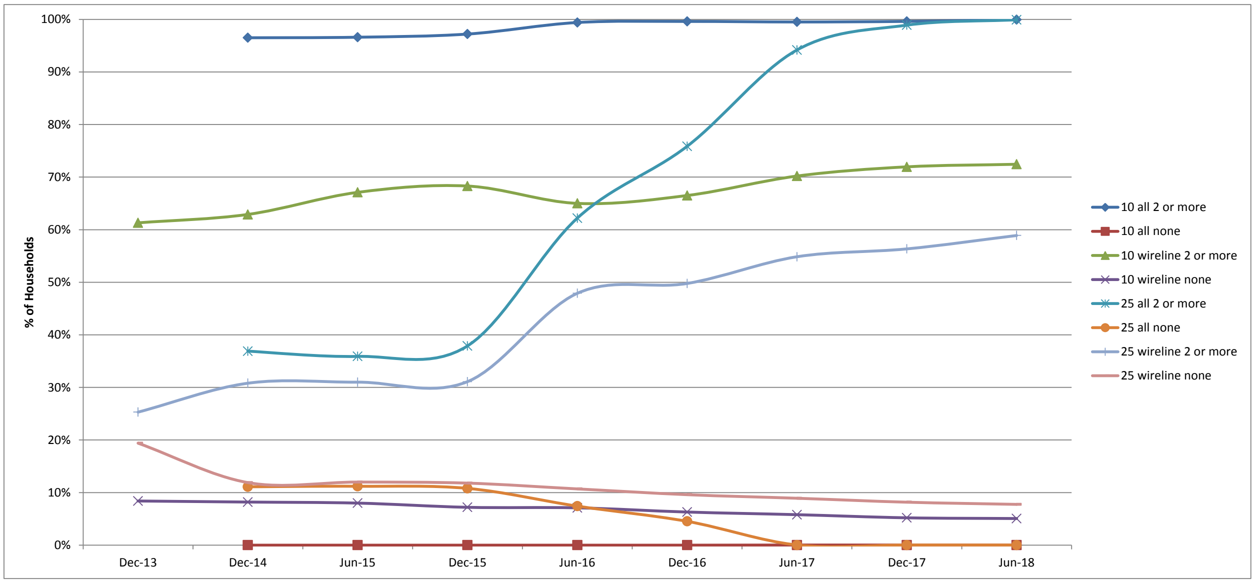
Alternatives	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16	Dec-16	Jun-17	Dec-17	Jun-18
3 or more	NA	0.0%	0.1%	0.1%	0.1%	0.2%	0.4%	3.7%	1.7%
2	NA	0.1%	0.6%	1.2%	1.3%	5.3%	8.5%	14.1%	20.7%
1	NA	3.9%	10.4%	18.0%	20.4%	35.4%	39.4%	39.8%	50.8%
0	NA	96.0%	89.0%	80.7%	78.1%	59.1%	51.8%	42.4%	26.9%

Sources: December 2013: "Prepared Remarks of Chairman Tom Wheeler: The Facts and Future of Broadband Competition," September 4, 2014, https://apps.fcc.gov/edocs_public/attachmatch/DOC-329161A1.pdf. December 2014, June 2015, December 2015, June 2016, December 2016, June 2017, December 2017, and June 2018: calculated from data available at https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477.

Summary

As shown in Figure 1 below, comparing the growth trends for the 10 Mbps downstream/1 Mbps upstream speed level with the trend for the 25 Mbps downstream/3 Mbps upstream speed level suggests that the strong growth in availability at the higher speed level was the combination of a modest increase in the number of providers and an upgrade in the offerings of existing providers from lower speed levels.

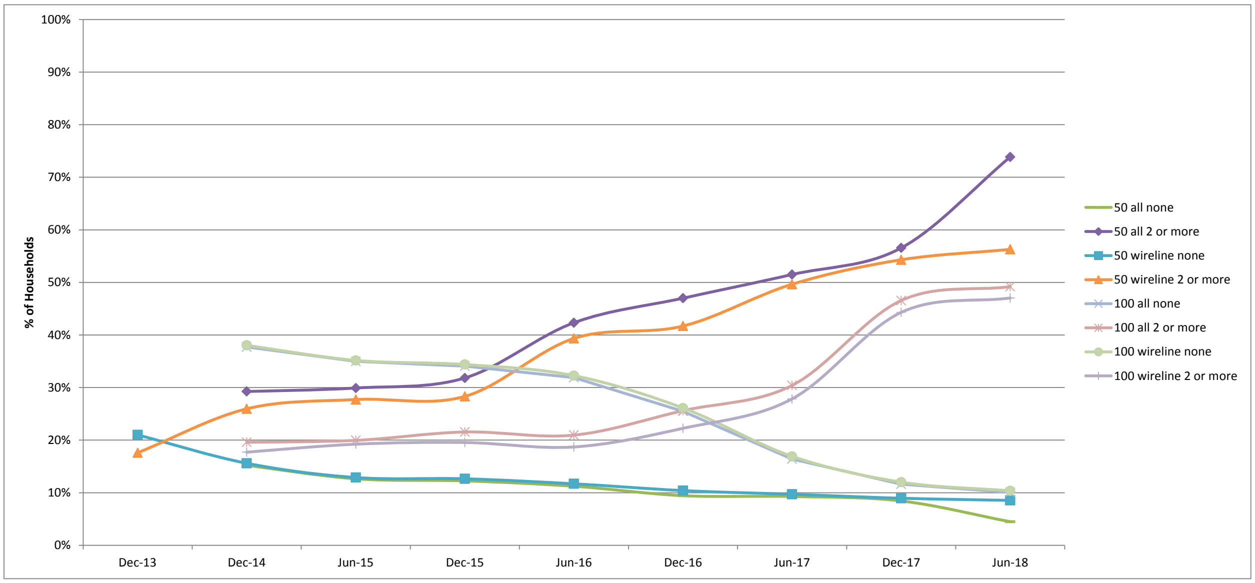
Figure 1: Broadband progress December 2013 through June 2018: 10 Mbps downstream/1 Mbps upstream and 25 Mbps downstream/3 Mbps upstream



In particular, Figure 1 shows that the percentage of households with two or more wireline, fixed wireless, and satellite suppliers at the 10 Mbps downstream/1 Mbps upstream speed level (10 all 2 or more) has been consistently above 90 percent. The corresponding growth in wireline suppliers at this speed level (10 wireline 2 or more) saw the percentage of households living in census blocks with two or more alternatives change from about 60 percent to about 70 percent. For the 25 Mbps downstream/3 Mbps upstream speed level, wireline-only broadband progress (25 wireline 2 or more) tracked the corresponding progress when all broadband suppliers are included (10 all 2 or more) through December 2015. Subsequently, the convergence in the percentage of households living in census blocks with two or more wireline providers at the 25 Mbps downstream/3 Mbps upstream speed level (25 wireline 2 or more) towards the corresponding percentage at the 10 downstream/1 Mbps upstream speed level (10 wireline 2 or more) suggests that wireline suppliers have been upgrading their offerings (and/or customers are opting for the higher level). Similarly, the convergence in the percentage of households living in census blocks with two or more wireline, fixed wireless, and satellite providers at the 25 Mbps downstream/3 Mbps upstream speed level (25 all 2 or more) towards the corresponding percentage at the 10 downstream/1 Mbps upstream speed level (10 all 2 or more) additionally reflects the effect of satellite broadband becoming ubiquitously available by the end of the period. Finally, the four lower curves (25 wireline none, 25 all none, 10 wireline none, 10 all none) show that the percentage of households in census blocks without wireline providers has dropped to less than 10 percent, even at the 25 Mbps downstream/3 Mbps upstream speed level, while at the same time when satellite and fixed wireless providers are added to the mix, broadband service has been ubiquitously available at 10 Mbps downstream/1 Mbps upstream throughout the period and at the higher speed level by the end of the period.

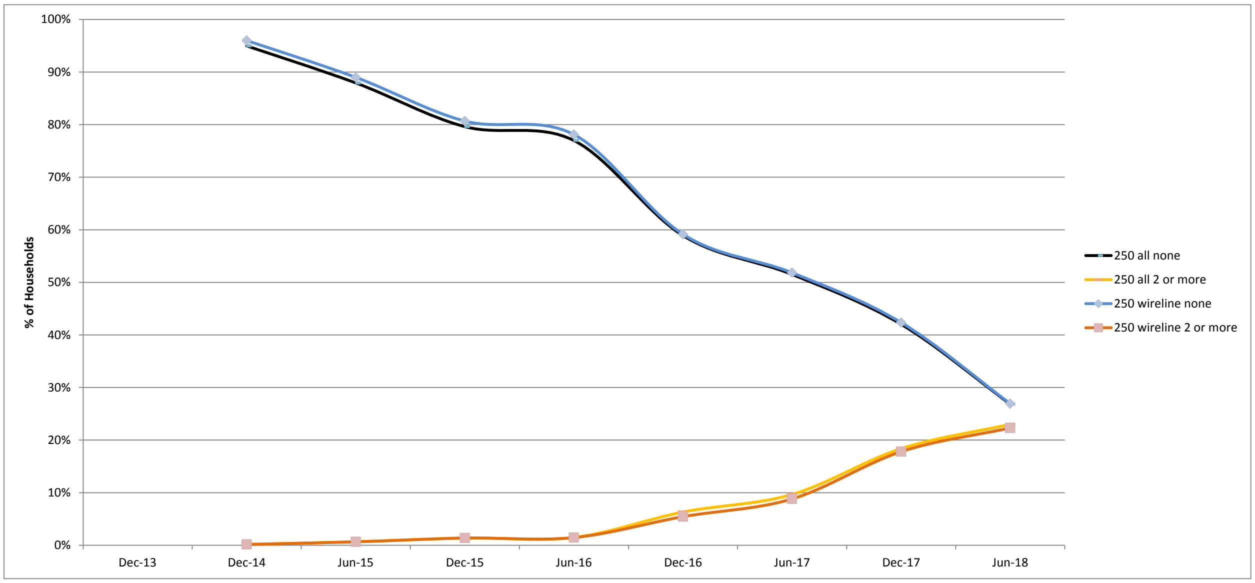
Figure 2 depicts the growth in broadband availability at the 50 Mbps downstream/5 Mbps upstream and 100 Mbps downstream/10 Mbps upstream speed levels. As discussed earlier, the growth patterns for two or more wireline suppliers (50 wireline 2 or more and 100 wireline 2 or more) are broadly similar to the corresponding pattern for the 25 Mbps downstream/3 Mbps upstream speed level depicted in Figure 1. However, when fixed wireless and satellite are included (50 all 2 or more and 100 all 2 or more), there are fewer available suppliers. While virtually all U.S. households lived in census blocks with two or more wireline alternatives at the 25 Mbps downstream/3 Mbps upstream speed level as of June 2018, the corresponding percentages were 73.8 percent for the 50 Mbps downstream/5 Mbps upstream speed level and 49.2 percent for the 100 Mbps downstream/10 Mbps upstream speed level.

Figure 2: Broadband progress through June 2018: 50 Mbps downstream/5 Mbps upstream and 100 Mbps downstream/10 Mbps upstream



Finally, Figure 3 shows that (1) there has been some growth since the middle of the 2014-2018 period for the 250 Mbps downstream/25 Mbps upstream speed level (over 1 in 5 households lived in census blocks with two or more alternatives and the percentage of households with no suppliers had decreased to about 27 percent by the end of the period and (2) virtually none of this progress has been due to fixed wireless and satellite, as indicated by the coincidence of the "wireline" and "all curves".

Figure 3: Broadband progress through June 2018: 250 Mbps downstream/25 Mbps upstream



Timothy J. Tardiff
November 22, 2019

Attachment A

ADVANCED ANALYTICAL
CONSULTING GROUP

Timothy J. Tardiff, Ph.D.

Principal
Advanced Analytical Consulting Group, Inc.
Office: (617) 338-2224
Direct: (617) 340-7872
Email: TimTardiff@AACG.com

Professional Summary

Dr. Timothy J. Tardiff has more than 30 years of academic and consulting experience. He has participated in numerous legal and regulatory proceedings regarding telecommunications, economics, intellectual property antitrust, and regulation issues. His research consulting, and expert witness experience in telecommunications has addressed pricing and costing issues involving increasingly competitive services, such as wireless and traditional wireline services. This experience has also included extensive examination and economic evaluation of all facets of the costing methodologies used to establish prices in rate-regulated industries—including expert reports and testimonies in a U.S. Department of Transportation proceeding on the reasonableness from an economic perspective of the rates international carriers at Los Angeles International Airport pay for use of terminal space. His work has included the telecommunications, software, transportation, energy, and public utility industries, and he has published extensively in economics, telecommunications, and transportation journals.

Dr. Tardiff is an economic consultant with clients in the telecommunications and regulated utilities industries. From 2006 to 2009, he was a Managing Director at Huron Consulting Group. Prior to joining Huron, Dr. Tardiff served as a vice president in the telecommunication practice at NERA Economic Consulting. During his career, he has served as the director of Marketing Research and senior member of the transportation practice at Charles River Associates, Inc. and assistant professor in the Department of Civil Engineering and Division of Environmental Studies at the University of California, Davis.

Dr. Tardiff's research has addressed the demand, cost, and competitive aspects of converging technologies, including wireless and broadband. He has evaluated pricing policies for increasingly competitive telecommunications markets, including appropriate mechanisms for pricing access services to competitors and studied actual and potential competition for services provided by incumbent telephone operating companies. Most recently, he has analyzed the effects of convergence and growing intermodal competition on whether incumbent firms

should be considered dominant in the provision of certain services and the regulatory and antitrust implication of such determinations.

Since the passage of the United States Telecommunications Act, Dr. Tardiff has participated in interconnection arbitrations, unbundled element proceedings, universal service investigation, applications by incumbent local exchange carriers for authorization to provide interLATA long-distance, and implementation of the Triennial Review Order rules for unbundling network elements in over 25 states and before the United States Federal Communications Commission. His international research and consulting experience includes studies and expert reports on telecommunication competition issues in Canada, Japan, New Zealand, Peru, Australia, and Trinidad and Tobago, where he was an economic expert in an interconnection arbitration between two wireless carriers.

Education

- Ph.D., Social Sciences, University of California, Irvine, CA
- B.S., Mathematics, California Institute of Technology, Pasadena, CA

Testimony experience

- Affidavit of Timothy J. Tardiff on presumptive just and reasonable rates for pole attachments, prepared for filing with the Federal Communications Commission on behalf of Verizon Maryland LLC, Complainant v. The Potomac Edison Company, Defendant, November 21, 2019.
- Affidavit of Timothy J. Tardiff on presumptive just and reasonable rates for pole attachments, prepared for filing with the Federal Communications Commission on behalf of Verizon Pennsylvania LLC and Verizon North, Complainants v. Metropolitan Edison Company, Pennsylvania Electric Company, and Pennsylvania Power Company, Defendants, November 20, 2019.
- Reply Witness Statement of Dr. Timothy J. Tardiff on international interconnection rates, prepared for filing with the Telecommunications Authority of Trinidad and Tobago on behalf of Telecommunications Services of Trinidad and Tobago Limited, Reference Nos: 4/07/07/5 and 4/07/06/6, April 17, 2019.
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- Deposition Testimony, Susan Mojica and Thomas Mojica, Individually and on behalf of others similarly situated v. Securus Technologies, Inc., Civil Action No. 5:14-cv-5258-TLB, U.S. District Court for the Western District of Arkansas, May 31, 2017.
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- Expert Rebuttal Report, Susan Mojica, Individually and on behalf of others similarly situated v. Securus Technologies, Inc., Civil Action No. 5:14-cv-5258-TLB, U.S. District Court for the Western District of Arkansas, October 7, 2016.
- Deposition Testimony, Global Tel*Link Corporation ICS Litigation, Civil Action No. 5:14-cv-5275-TLB, U.S. District Court for the Western District of Arkansas, August 9, 2016.
- Deposition Testimony, Susan Mojica, Individually and on behalf of others similarly situated v. Securus Technologies, Inc., Civil Action No. 5:14-cv-5258-TLB, U.S. District Court for the Western District of Arkansas, July 12, 2016 and August 30, 2016.
- Expert Report, Susan Mojica, Individually and on behalf of others similarly situated v. Securus Technologies, Inc., Civil Action No. 5:14-cv-5258-TLB, U.S. District Court for the Western District of Arkansas, June 10, 2016.
- Expert Report, Global Tel*Link Corporation ICS Litigation, Civil Action No. 5:14-cv-5275-TLB, U.S. District Court for the Western District of Arkansas, June 9, 2016.
- Reply Affidavit of Timothy J. Tardiff on the economic evaluation of the monetary value of possible joint use agreement advantages, prepared for filing with the Federal Communications Commission on behalf of Verizon Virginia and Verizon South, Verizon Virginia LLC and Verizon South, Inc., Complainant v. Virginia Electric and Power and Light

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- Affidavit of Timothy J. Tardiff on the economic evaluation of the monetary value of possible joint use agreement advantages, prepared for filing with the Federal Communications Commission on behalf of Verizon Virginia and Verizon South, Verizon Virginia LLC and Verizon South, Inc., Complainant v. Virginia Electric and Power and Light Company dba Virginia Dominion Power, Respondent, Docket No. 15-190, File No. EB-15-MD-006, August 3, 2015.
- Affidavit of Timothy J. Tardiff on the economic evaluation of the monetary value of possible joint use agreement advantages, prepared for filing with the Federal Communications Commission on behalf of Verizon Florida, Verizon Florida LLC, Complainant v. Florida Power and Light Company, Respondent, Docket No. 15-73, File No. EB-15-MD-002, March 13, 2015.
- Reply Affidavit of Timothy J. Tardiff on presumptive just and reasonable rates for pole attachments, prepared for filing with the Federal Communications Commission on behalf of Frontier Communications, Commonwealth Telephone Company d/b/a Frontier Communications Commonwealth Telephone Company and CTSI, LLC d/b/a Frontier Communications CTSI Company, LLC, Complainants v. UGI Utilities – Electric Division, Respondent, File No. EB-14-MD-007, September 15, 2014.
- Reply Affidavit of Timothy J. Tardiff on presumptive just and reasonable rates for pole attachments, prepared for filing with the Federal Communications Commission on behalf of Frontier Communications, Commonwealth Telephone Company LLC d/b/a Frontier Communications Commonwealth Telephone Company, Frontier Communications of Breezewood, LLC, Citizens Telecommunications Company of West Virginia d/b/a Frontier Communications Company of West Virginia, and Frontier West Virginia Inc., Complainants, v. Metropolitan Edison Company, Pennsylvania Electric Company, West Penn Power Company d/b/a Allegheny Power , Monongahela Power Company, and the Potomac Edison Company, Respondents, File No. EB-14-MD-008, July 31, 2014.
- Supplemental Expert Report, Duke Energy Carolinas, LLC, Plaintiff v. Frontier Communications of the Carolinas LLC, Defendant, 2:13-cv-00040-MR-DLH, U.S. District Court for the Western District of North Carolina, June 27, 2014.
- Deposition Testimony, Florida Power & Light Company, Plaintiff v. Verizon Florida LLC, Defendant, Case No. 13-014808-CA-01, Circuit Court of the Eleventh Judicial District in and for Miami-Dade County, Florida, June 24, 2014.

- Affidavit of Timothy J. Tardiff on presumptive just and reasonable rates for pole attachments, prepared for filing with the Federal Communications Commission on behalf of Frontier Communications, Commonwealth Telephone Company LLC d/b/a Frontier Communications Commonwealth Telephone Company, Frontier Communications of Breezewood, LLC, Citizens Telecommunications Company of West Virginia d/b/a Frontier Communications Company of West Virginia, and Frontier West Virginia Inc., Complainants, v. Metropolitan Edison Company, Pennsylvania Electric Company, West Penn Power Company d/b/a Allegheny Power , Monongahela Power Company, and the Potomac Edison Company, Respondents, File No. EB-14-MD-008, June 11, 2014.
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- Affidavit of Timothy J. Tardiff on presumptive just and reasonable rates for pole attachments, prepared for filing with the Federal Communications Commission on behalf of Frontier Communications, Commonwealth Telephone Company d/b/a Frontier Communications Commonwealth Telephone Company and CTSI, LLC d/b/a Frontier Communications CTSI Company, LLC, Complainants v. UGI Utilities – Electric Division, Respondent, File No. EB-14-MD-007, May 14, 2014.
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- Rebuttal Testimony of Timothy J. Tardiff on the rate for wholesale services provided to competitive local exchange carriers, prepared for filing with the Texas Public Utility Commission on behalf of AT&T Texas, Docket No. 38389, May 11, 2012.

- Affidavit of Timothy J. Tardiff on statistical sampling issues, on behalf of Albert Pecherek, M.D., Medicare Appeal Number: 1-691874218, ALJ Appeal No. 1-750870135, September 16, 2011.
- Expert Report, Qwest Communications Corporation, Complainant v. Farmers and Merchants Telephone Company, Defendant, File No. EB-07-MD-001, Federal Communications Commission, November 30, 2010.
- Affidavit of Timothy J. Tardiff on the reasonableness of dominant carrier regulation for fixed line services, Telecommunications Services of Trinidad and Tobago, Claimant and Telecommunications Authority of Trinidad and Tobago, Defendant, Claim No. CV2010-02389, High Court of Justice, Republic of Trinidad and Tobago, September 29, 2010.
- "The Economics of Access Stimulation: Economic Evaluation of the 'Fact Report' by Drs. Alan Pearce and W. Brian Barrett," ex parte filing with the Federal Communications Commission on behalf of Qwest Communications International, WC Docket No. 07-135, August 5, 2010.
- Statement of Timothy Tardiff on the regulation of retail local telephone services, prepared for filing with the Commonwealth Public Utilities Commission, Commonwealth of the Northern Mariana Islands on behalf of the Micronesian Telecommunications Corporation, CPUC Docket No.09-3, July 30, 2010.
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- Counterstatement of Timothy Tardiff and Harold Ware on deregulation of single line retail telephone services, prepared for filing with the Iowa Utilities Board on behalf of Iowa Telecom, Docket No. INU-08-1, April 28, 2008.
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- Reply Expert Report of Dr. Timothy J. Tardiff on interconnection costs and rates, prepared for filing with the Telecommunications Authority of Trinidad and Tobago on behalf of Telecommunications Services of Trinidad and Tobago Limited, Reference No: 4/7/06/4, September 25, 2007.
- Expert Report of Dr. Timothy J. Tardiff on interconnection costs and rates, prepared for filing with the Telecommunications Authority of Trinidad and Tobago on behalf of Telecommunications Services of Trinidad and Tobago Limited, Reference No: 4/7/06/4, August 24, 2007.
- Expert Report of Daniel P. Wikel and Timothy J. Tardiff on airport terminal rental rates, prepared for filing with the Office of the Secretary, United States Department of

Transportation on behalf of Tom Bradley International Terminal Airlines, Docket No. OST-2007-28118, April 30, 2007.

- Joint Expert Supplemental Report of Daniel P. Wikel and Timothy J. Tardiff on airport terminal rental rates, prepared for filing with the Office of the Secretary, United States Department of Transportation on behalf of Tom Bradley International Terminal Airlines, Docket No. OST-2007-27331, April 6, 2007.
- Joint Expert Reply Report of Daniel P. Wikel and Timothy J. Tardiff on airport terminal rental rates, prepared for filing with the Office of the Secretary, United States Department of Transportation on behalf of Tom Bradley International Terminal Airlines, Docket No. OST-2007-27331, March 5, 2007.
- Expert Report of Daniel P. Wikel and Timothy J. Tardiff on airport terminal rental rates, prepared for filing with the Office of the Secretary, United States Department of Transportation on behalf of Tom Bradley International Terminal Airlines, Docket No. OST-2007-27331, February 23, 2007.
- Rebuttal Testimony of Timothy Tardiff and Harold Ware on predatory pricing and price discrimination allegations, prepared for filing with the Iowa Utilities Board on behalf of Iowa Telecom, Docket No. FCU 06-48, December 1, 2006.
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- "Report on Interconnection Costs in Trinidad and Tobago," prepared for filing with the Telecommunications Authority of Trinidad and Tobago on behalf of Telecommunications Services of Trinidad and Tobago Limited, Reference No: 4/7/06/1 (with Agustin J. Ros), May 4, 2006.
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- Reply Testimony of Timothy J. Tardiff concerning geographic market definition, prepared for filing with the Indiana Utility Regulatory Commission on behalf of SBC Indiana, Cause No. 42500, February 13, 2004.

- Direct Testimony of Timothy J. Tardiff concerning geographic market definition, prepared for filing with the Oklahoma State Corporation Commission on behalf of SBC Oklahoma, Cause No. 200300646, February 11, 2004.
- Rebuttal Testimony of Timothy J. Tardiff concerning geographic market definition, prepared for filing with the Indiana Utility Regulatory Commission on behalf of SBC Indiana, Cause No. 42500, January 30, 2004.
- Reply Declaration of Howard Shelanski and Timothy Tardiff on the review of rules for pricing unbundled network elements, prepared for filing with the Federal Communications Commission on behalf of Verizon, WC Docket No. 03-173, January 30, 2004.
- Direct Testimony of Timothy J. Tardiff concerning geographic market definition, prepared for filing with the Indiana Utility Regulatory Commission on behalf of SBC Indiana, Cause No. 42500, January 16, 2004.
- Rebuttal Testimony of Timothy J. Tardiff concerning geographic market definition, prepared for filing with the Missouri Public Service Commission on behalf of SBC Missouri, Case No. TO-2004-0207 Phase I, January 16, 2004.
- Reply Testimony of Timothy J. Tardiff concerning geographic market definition, prepared for filing with the California Public Utilities Commission on behalf of SBC California, Rulemaking 95-04-043, Investigation 95-04-044, January 16, 2004.
- Direct Testimony of Timothy J. Tardiff concerning geographic market definition, prepared for filing with the Missouri Public Service Commission on behalf of SBC Missouri, Case No. TO-2004-0207 Phase I, December 18, 2003.
- Declaration of Alfred E. Kahn and Timothy Tardiff on the review of rules for pricing unbundled network elements, prepared for filing with the Federal Communications Commission on behalf of Verizon, WC Docket No. 03-173, December 16, 2003.
- Direct Testimony of Timothy J. Tardiff concerning geographic market definition, prepared for filing with the California Public Utilities Commission on behalf of SBC California, Rulemaking 95-04-043, Investigation 95-04-044, December 12, 2003.
- Direct Testimony of Timothy J. Tardiff concerning geographic market definition, prepared for filing with the Public Utilities Commission of Ohio on behalf of SBC Ohio, Case No. 03-2040-TP-COI, November 12, 2003.
- Statement of Timothy J. Tardiff on the Commission's Telecommunications Service Obligation (TSO) Model, prepared for filing with the New Zealand Commerce Commission on behalf of Telecom Corporation of New Zealand, May 20, 2003.
- Rebuttal Declaration of Timothy J. Tardiff on the use of the HAI, Release 5.3 Model for unbundled network elements costs, prepared for filing with the California Public Utilities Commission on behalf of SBC California, Application Nos. 01-02-024, 01-02-035, 02-02-031, 02-02-032, and 02-03-002, March 12, 2003.

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- Affidavit of Timothy J. Tardiff on the use of the FCC's Synthesis Model to calculate unbundled network switching and transport prices, prepared for filing with the Regulatory Commission of Alaska, on behalf of Alaska Communications Systems, Docket No. U-96-89, December 20, 2002.
- Declaration of Timothy J. Tardiff in support of the Petition of Verizon for Forbearance From The Prohibition Of Sharing Operating, Installation, and Maintenance Functions Under Section 53.203(a)(2) Of The Commission's Rules, CC Docket No. 96-149, September 24, 2002.
- Affidavit of Timothy J. Tardiff on unbundled network element pricing, prepared for filing with the Federal Communications Commission on behalf of ACS, WC Docket No. 02-201, July 24, 2002.
- Reply Declaration of Alfred E. Kahn and Timothy J. Tardiff in the triennial review of unbundled network elements, prepared for filing with the Federal Communications Commission on behalf of Verizon, CC Docket Nos. 01-338, 96-98, and 98-147, July 17, 2002.
- Statement of Alfred E. Kahn and Timothy J. Tardiff on funding the telecommunications service (universal service) obligation, prepared for filing with the New Zealand Commerce Commission on behalf of Telecom Corporation of New Zealand, June 10, 2002.
- Supplemental Surrebuttal Testimony of Timothy Tardiff and Francis Murphy on the use of the FCC's Synthesis Model for evaluating the costs of unbundled network elements, prepared for filing with the Florida Public Service Commission on behalf of Verizon-Florida, Docket No. 990649B-TP, April 22, 2002.
- Surrebuttal Testimony of Timothy Tardiff and Francis Murphy on the use of the FCC's Synthesis Model for evaluating the costs of unbundled network elements, prepared for filing with the Florida Public Service Commission on behalf of Verizon-Florida, Docket No. 990649B-TP, March 18, 2002.
- Surrebuttal Testimony of Howard Shelanski and Timothy Tardiff on economic principles for determining the costs of unbundled network elements, prepared for filing with the Pennsylvania Public Utility Commission on behalf of Verizon-Pennsylvania, Docket No. R-00016683, February 8, 2002.
- Surrebuttal Testimony of Timothy J. Tardiff and Joseph A. Gansert on the application of the Modified Synthesis Model for the costs of unbundled network elements, prepared for filing with the Pennsylvania Public Utility Commission on behalf of Verizon-Pennsylvania, Docket No. R-00016683, February 8, 2002.
- Rebuttal Testimony of Howard Shelanski and Timothy Tardiff on economic principles for determining the costs of unbundled network elements, prepared for filing with the

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- Rebuttal Testimony of Timothy J. Tardiff on the application of the Modified Synthesis Model for the costs of unbundled network elements, prepared for filing with the Pennsylvania Public Utility Commission on behalf of Verizon-Pennsylvania, Docket No. R-00016683, January 11, 2002.
- Declaration of Alfred E. Kahn and Timothy J. Tardiff submitted to the U.S. Federal Communications Commission on behalf of Verizon regarding broadband regulation, December 18, 2001.
- Supplemental Rebuttal Testimony of Timothy J. Tardiff on the application of the Modified Synthesis Model for the costs of unbundled network elements, prepared for filing with the Federal Communications Commission on behalf of Verizon-Virginia, CC Docket Nos. 00-218, 00-249, and 00-251, November 16, 2001.
- Declaration of Timothy J. Tardiff on the use of the HAI, Release 5.2a for deriving an unbundled switch cost reduction, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, October 30, 2001.
- Declaration of Timothy J. Tardiff on the use of the HAI, Release 5.2a for deriving an unbundled loop cost reduction, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, October 19, 2001.
- Surrebuttal Testimony of Howard Shelanski and Timothy J. Tardiff on economic principles for determining the costs of unbundled network elements, prepared for filing with the Federal Communications Commission on behalf of Verizon-Virginia, CC Docket Nos. 00-218, 00-249, and 00-251, September 21, 2001.
- Rebuttal Testimony of Timothy J. Tardiff on the application of the Modified Synthesis Model for the costs of unbundled network elements, prepared for filing with the Maryland Public Service Commission on behalf of Verizon-Maryland, Case No. 8879, September 5, 2001.
- Declaration of Timothy J. Tardiff on the use of the HAI, Release 5.2a and Modified Synthesis Models for unbundled loop and switch costs, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, September 4, 2001.
- Rebuttal Testimony of Timothy J. Tardiff on the application of the Modified Synthesis Model for the costs of unbundled network elements, prepared for filing with the Federal Communications Commission on behalf of Verizon-Virginia, CC Docket Nos. 00-218, 00-249, and 00-251, August 27, 2001.
- Affidavit of Timothy J. Tardiff on the use of proxy costs models for unbundled network elements, prepared for filing with the Regulatory Commission of Alaska, on behalf of Alaska Communications Systems, Docket No. U-96-89, July 27, 2001.
- Rebuttal Testimony of Timothy J. Tardiff on the application of the Hatfield Model for the costs of unbundled network elements, prepared for filing with the Massachusetts

Department of Telecommunications and Energy on behalf of Verizon-Massachusetts, Docket No. D.T.E. 01-20, July 18, 2001.

- Rebuttal Testimony of Timothy J. Tardiff on the application of the Hatfield Model for the costs of unbundled network elements, prepared for filing with the New Jersey Board of Public Utilities on behalf of Verizon-New Jersey, Docket No. TO00060356, October 12, 2000.
- Supplemental Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the State of Maine Public Utilities Commission on behalf of Bell Atlantic-Maine, Case No. 97-505, October 10, 2000.
- Public Interest Affidavit before the Federal Communications Commission in the matter of Application of SBC Communications Inc. Nevada Bell Telephone Company and Southwestern Bell Communications Services, Inc. d/b/a Nevada Bell Long Distance for Provision of In-Region InterLATA Services in Nevada (with Alfred E. Kahn), July 24, 2000.
- Responsive Testimony on the HAI Model of unbundled network elements, prepared for filing with the New York Public Service Commission on behalf of Bell Atlantic-New York, Case 98-C-1357 (filed as part of panel testimony), June 26, 2000.
- Affidavit of Timothy J. Tardiff on avoided cost discounts for wholesale services, prepared for filing with the Regulatory Commission of Alaska, on behalf of Alaska Communications Systems, Docket Nos. U-99-141, U-99-142 and U-99-143, April 17, 2000.
- Third Affidavit of Timothy J. Tardiff on costs models for unbundled network elements, prepared for filing with the Regulatory Commission of Alaska, on behalf of Alaska Communications Systems, Docket Nos. U-99-141, U-99-142 and U-99-143, March 24, 2000.
- Second Affidavit of Timothy J. Tardiff on costs models for unbundled network elements, prepared for filing with the Regulatory Commission of Alaska, on behalf of Alaska Communications Systems, Docket Nos. U-99-141, U-99-142 and U-99-143, February 25, 2000.
- Rebuttal Testimony of Timothy J. Tardiff on collocation costs models, prepared for filing with the Delaware Public Service Commission on behalf of Bell Atlantic-Delaware, Docket No. 99-251, February 24, 2000.
- Affidavit of Timothy J. Tardiff on costs models for unbundled network elements, prepared for filing with the Regulatory Commission of Alaska, on behalf of Alaska Communications Systems, Docket Nos. U-99-141, U-99-142 and U-99-143, February 11, 2000.
- Public Interest Affidavit before the Federal Communications Commission in the matter of Application of SBC Communications Inc. Southwestern Bell Telephone Company and Southwestern Bell Communications Services, Inc. d/b/a Southwestern Bell Long Distance for Provision of In-Region InterLATA Services in Texas (with Alfred E. Kahn), January 10, 2000.
- Rebuttal Testimony of Timothy J. Tardiff on collocation costs models, prepared for filing with the Pennsylvania Public Utility Commission on behalf of Bell Atlantic-Pennsylvania, Docket Nos. R-00994697 and R-00994697C0001, December 21, 1999.

- "Relaxed Regulation of High Capacity Services in Phoenix and Seattle: The Time is Now," prepared for filing with the Federal Communications Commission on behalf of US WEST Communications, Petitions of US WEST Communications for Forbearance from Regulation as a Dominant Carrier in the Phoenix and Seattle MSAs (with Alfred E. Kahn), July 21, 1999.
- Rebuttal Testimony of Timothy J. Tardiff on the HAI Model of unbundled network elements, prepared for filing with the Pennsylvania Public Utility Commission on behalf of Bell Atlantic-Pennsylvania, Docket Nos. P-00991648 and P-00991649, June 15, 1999.
- "High Capacity Competition in Seattle: Reply to Comments of Intervening Parties," prepared for filing with the Federal Communications Commission on behalf of US WEST Communications, Petition of US WEST Communications for Forbearance from Regulation as a Dominant Carrier in the Seattle, Washington MSA (with Alfred E. Kahn), March 10, 1999.
- Rebuttal Testimony of Timothy J. Tardiff on collocation costs models, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, February 8, 1999.
- Surrebuttal Testimony of Alfred E. Kahn and Timothy J. Tardiff filed with the Missouri Public Service Commission, in support of the Applications of SBC Communications, Inc., Southwestern Bell Telephone Company, and Southwestern Bell Communications Services, Inc., for Provision of In-Region InterLATA Services in Missouri, Docket No. TO 99-227, February 4, 1999.
- Rebuttal Testimony of Timothy J. Tardiff on the HAI Model of unbundled network elements, prepared for filing with the Rhode Island Public Utilities Commission on behalf of Bell Atlantic-Rhode Island, Docket No. 2681, January 15, 1999.
- Reply Testimony of Timothy J. Tardiff on collocation costs models, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, January 11, 1999.
- "Economic Evaluation of High Capacity Competition in Seattle," prepared for filing with the Federal Communications Commission on behalf of US WEST Communications, Petition of US WEST Communications for Forbearance from Regulation as a Dominant Carrier in the Seattle, Washington MSA (with Alfred E. Kahn), December 22, 1998.
- Testimony of Timothy J. Tardiff on collocation costs models, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, December 18, 1998.
- "Measuring and Recovering the Costs of Long-Term Number Portability: Implications of Price Cap Regulation," Prepared for Southwestern Bell for presentation to the Federal Communications Commission, December 10, 1998.
- Direct Testimony of Alfred E. Kahn and Timothy J. Tardiff, filed with the Missouri Public Service Commission, in support of the Applications of SBC Communications, Inc., Southwestern Bell Telephone Company, and Southwestern Bell Communications Services, Inc., for Provision of In-Region InterLATA Services in Missouri, Docket No. TO 99-227, November 20, 1998.
- "High Capacity Competition in Phoenix: Reply to Comments of Intervening Parties," prepared for filing with the Federal Communications Commission on behalf of US WEST

Communications, Petition of US WEST Communications for Forbearance from Regulation as a Dominant Carrier in the Phoenix, Arizona MSA (with Alfred E. Kahn), October 28, 1998.

- "Measuring and Recovering the Costs of Long-Term Number Portability," Prepared for Southwestern Bell for presentation to the Federal Communications Commission, October 28, 1998 (with Alfred E. Kahn).
- Declaration of Timothy J. Tardiff on the economic impacts of separate subsidiary requirements for the offer of advanced services by incumbent local exchange carriers, prepared for filing with the Federal Communications Commission on behalf of Bell Atlantic, in the matter of Deployment of Wireline Services Offering Advanced Telecommunications Capability, October 15, 1998.
- "An Analysis of the HAI Model Release 5.0a," Rebuttal Testimony filed with the Florida Public Service Commission, Docket No. 980696-TP, on behalf of GTE Florida, September 2, 1998 (with Gregory M. Duncan, Karyn E. Model, Christian M. Dippon, Jino W. Kim, Francis J. Murphy, Robert P. Cellupica, and Thomas F. Guarino).
- "Economic Evaluation of High Capacity Competition in Phoenix," prepared for filing with the Federal Communications Commission on behalf of US WEST Communications, Petition of US WEST Communications for Forbearance from Regulation as a Dominant Carrier in the Phoenix, Arizona MSA (with Alfred E. Kahn), August 14, 1998.
- Rebuttal Testimony of Timothy J. Tardiff on the HAI Model of unbundled network elements, prepared for filing with the New Hampshire Public Utilities Commission on behalf of Bell Atlantic-New Hampshire, Docket No. DE-97-1171, June 22, 1998.
- Rebuttal Affidavit before the Arkansas Public Service Commission in the matter of the Application of Southwestern Bell Telephone Company Seeking Verification that It Has Fully Complied with and Satisfied the Requirements of Section 271 (c) of the Telecommunications Act of 1996 (with Alfred E. Kahn), June 11, 1998.
- Rebuttal Testimony before the State Corporation Commission of the State of Kansas in the matter of Southwestern Bell Telephone Company – Kansas' Compliance With Section 271 of the Federal Telecommunications Act of 1996, Docket No. 97-SWBT- 411-GIT (with Alfred E. Kahn), May 27, 1998.
- Rebuttal Affidavit Before the Public Utilities Commission of the State of California in support of Pacific Bell's Draft Application for Authority to Provide InterLATA Services in California (with Alfred E. Kahn), May 20, 1998.
- "An Analysis of the Hatfield Model Release 4.0," prepared for filing with the California Public Utilities Commission on behalf of GTE California, May 1, 1998 (with Gregory M. Duncan, Karyn E. Model, Christian M. Dippon, Jino W. Kim, Francis J. Murphy, Robert P. Cellupica, and Thomas F. Guarino).
- Reply Testimony of Timothy J. Tardiff on unbundled network element prices and retail service price floors, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, April 27, 1998.

- Rebuttal Testimony of Alfred E. Kahn and Timothy J. Tardiff filed with the Oklahoma Public Service Commission, in support of the Applications of SBC Communications, Inc., Southwestern Bell Telephone Company, and Southwestern Bell Communications Services, Inc., for Provision of In-Region InterLATA Services in Oklahoma, Case No. PUD 970000560, April 21, 1998.
- Reply Affidavit before the Federal Communications Commission in the matter of Application of SBC Communications Inc. Southwestern Bell Telephone Company and Southwestern Bell Communications Services, Inc. d/b/a Southwestern Bell Long Distance for Provision of In-Region InterLATA Services in Texas (with Alfred E. Kahn), April 17, 1998.
- Testimony of Timothy J. Tardiff on unbundled network element prices and retail service price floors, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, April 8, 1998.
- Affidavit before the Federal Communications Commission in the matter of Application of SBC Communications Inc., Pacific Bell, and Pacific Bell Communications for Provision of In-Region InterLATA Services in California (with Alfred E. Kahn), March 31, 1998.
- "Economic Principles Governing Measurement of Nonrecurring/OSS Costs: An Analysis of the AT&T/MCI Recommendations," prepared for filing with the California Public Utilities Commission on behalf of GTE California and Pacific Bell, March 4, 1998 (with Gregory M. Duncan).
- "Analysis of the Hatfield Model Release 5.0a," Rebuttal Testimony filed with the North Carolina Utilities Commission, Docket No. P-100, Sub 133d, on behalf of GTE South, March 2, 1998 (with Gregory M. Duncan, Rafi A. Mohammed, Christian M. Dippon, Aniruddha Banerjee, Karyn E. Model, Francis J. Murphy, Robert P. Cellupica, and Thomas F. Guarino).
- "Analysis of the Hatfield Model Release 5.0a," Rebuttal Testimony filed with the South Carolina Public Service Commission, on behalf of GTE South, March 2, 1998 (with Gregory M. Duncan, Rafi A. Mohammed, Christian M. Dippon, Aniruddha Banerjee, Karyn E. Model, Francis J. Murphy, Robert P. Cellupica, and Thomas F. Guarino).
- Affidavit before the Federal Communications Commission in the matter of Application of SBC Communications Inc. Southwestern Bell Telephone Company and Southwestern Bell Communications Services, Inc. d/b/a Southwestern Bell Long Distance for Provision of In-Region InterLATA Services in Texas (with Alfred E. Kahn), March 2, 1998.
- "Analysis of the Hatfield Model Release 5.0a," Rebuttal Testimony filed with the Kentucky Public Service Commission, on behalf of GTE South, February 26, 1998 (with Gregory M. Duncan, Rafi A. Mohammed, Christian M. Dippon, Aniruddha Banerjee, Karyn E. Model, Francis J. Murphy, Robert P. Cellupica, and Thomas F. Guarino).
- Affidavit before the Federal Communications Commission in the matter of Application of SBC Communications Inc. Southwestern Bell Telephone Company and Southwestern Bell Communications Services, Inc. d/b/a Southwestern Bell Long Distance for Provision of In-Region InterLATA Services in Arkansas (with Alfred E. Kahn), February 24, 1998.

- Testimony before the State Corporation Commission of the State of Kansas in the matter of Southwestern Bell Telephone Company – Kansas' Compliance With Section 271 of the Federal Telecommunications Act of 1996, Docket No. 97-SWBT- 411-GIT (with Alfred E. Kahn), February 17, 1998.
- "Analysis of the Hatfield Model Release 5.0," Rebuttal Testimony filed with the Alabama Public Utilities Commission, on behalf of GTE South, February 13, 1998 (with Gregory M. Duncan, Rafi A. Mohammed, Christian M. Dippon, Aniruddha Banerjee, Karyn E. Model, Francis J. Murphy, Robert P. Cellupica, and Thomas F. Guarino).
- Affidavit before the Federal Communications Commission in the matter of Application of SBC Communications. Inc. Southwestern Bell Telephone Company and Southwestern Bell Communications Services, Inc. d/b/a/ Southwestern Bell Long Distance for Provision of In-Region InterLATA Services in Oklahoma (with Alfred E. Kahn), February 13, 1998.
- "Analysis of the Hatfield Model Release 5.0," Rebuttal Testimony filed with the North Carolina Utilities Commission, Docket No. P-100, Sub 133b, on behalf of GTE South, January 30, 1998 (with Gregory M. Duncan, Rafi A. Mohammed, Christian M. Dippon, Aniruddha Banerjee, Karyn E. Model, Francis J. Murphy, Robert P. Cellupica, and Thomas F. Guarino).
- Supplemental Rebuttal Testimony of Timothy J. Tardiff on switching costs, prepared for filing with the State of Maine Public Utilities Commission on behalf of Bell Atlantic-Maine, Case No. 97-505, December 22, 1997.
- "Reply to AT&T Recommendations for Regulatory Treatment of OSS Costs," prepared for filing with the California Public Utilities Commission on behalf of GTE California and Pacific Bell, December 15, 1997 (with Gregory M. Duncan).
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the Vermont Public Service Board on behalf of Bell Atlantic-Vermont, Case No. 57-13, November 21, 1997.
- Reply Affidavit of Timothy J. Tardiff on the Hatfield Model, filed with the New York Public Service Commission on behalf of Bell Atlantic-New York, Case 94-C-0095 and Case 28425, November 17, 1997.
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the State of Maine Public Utilities Commission on behalf of Bell Atlantic-Maine, Case No. 97-505, October 21, 1997.
- Rebuttal Testimony of Timothy J. Tardiff on the application of the Hatfield Model to universal service funding requirements, prepared for filing with the New Jersey Board of Public Utilities on behalf of Bell Atlantic-New Jersey, Docket No. TX95120631, October 20, 1997.
- "Analysis of the Hatfield Model Release 4.0," filed with the Pennsylvania Public Utility Commission on behalf of GTE North, October 20, 1997 (with Gregory M. Duncan, Rafi A. Mohammed, Christian M. Dippon, Francis J. Murphy, Robert P. Cellupica, and Thomas F. Guarino).

- Supplemental Rebuttal Testimony of Timothy J. Tardiff on toll and carrier access demand elasticities and universal service rate rebalancing prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, October 10, 1997.
- Rebuttal Testimony of Timothy J. Tardiff on toll and carrier access demand elasticities and universal service rate rebalancing, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, September 30, 1997.
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the State Corporation Commission of Virginia on behalf of Bell Atlantic-Virginia, Case No. PUC970005, June 10, 1997.
- Reply Affidavit of Alfred E. Kahn and Timothy J. Tardiff, filed with the Federal Communications Commission, in support of the Applications of SBC Communications, Inc., Southwestern Bell Telephone Company, and Southwestern Bell Communications Services, Inc., for Provision of In-Region InterLATA Services in Oklahoma, May 26, 1997.
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- Declaration of Timothy J. Tardiff on OANAD Cost Studies, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, April 16, 1997.
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the Maryland Public Service Commission on behalf of Bell Atlantic-Maryland, Case No. 8731-II, April 4, 1997.
- "Economic Evaluation of the Hatfield Model, Release 3.1," filed with the Washington Utilities and Transportation Commission on behalf of GTE, March 28, 1997 (with Gregory M. Duncan and Rafi Mohammed).
- "Economic Evaluation of the Hatfield Model, Version 2.2, Release 2," prepared for filing with the California Public Utilities Commission on behalf of GTE California and Pacific Bell, March 18, 1997 (with Gregory M. Duncan).
- Statement of Alfred E. Kahn and Timothy J. Tardiff, "Funding and Distributing the Universal Service Subsidy," Prepared for US West for presentation to the Federal Communications Commission, March 13, 1997.
- Testimony of Timothy J. Tardiff on toll and carrier access demand elasticities, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, March 6, 1997.
- Surrebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the Pennsylvania Public Utility Commission on behalf of Bell Atlantic-Pennsylvania, Dockets A-310203F0002, A-310213F0002, A-310236F0002, A-310258F0002, February 21, 1997.
- Affidavit of Alfred E. Kahn and Timothy J. Tardiff, filed with the Oklahoma Public Service Commission, in support of the Applications of SBC Communications, Inc., Southwestern Bell

Telephone Company, and Southwestern Bell Communications Services, Inc., for Provision of In-Region InterLATA Services in Oklahoma, February 21, 1997.

- "Reply to Kravtin/Selwyn Analysis of the Gap Between Embedded and Forward-Looking Costs," affidavit filed with the Federal Communications Commission, In the Matter of Access Charge Reform, Price Cap Performance Review for Local Exchange Carriers, Transport Rate Structure and Pricing, on behalf of GTE, February 14, 1997.
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the Arkansas Public Service Commission on behalf of Southwestern Bell Telephone Company, Docket 96-395-U, January 9, 1997.
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the Kansas Corporation Commission on behalf of Southwestern Bell Telephone Company, Docket 97-AT&T-290-Arb, January 6, 1997.
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the Massachusetts Department of Public Utilities on behalf of New England Telephone and Telegraph Company, Docket 96-80/81, October 30, 1996.
- Statement of Alfred E. Kahn and Timothy J. Tardiff, "Joint Marketing, Personnel Separation and Efficient Competition Under the Telecommunications Act of 1996," Prepared for US West for presentation to the Federal Communications Commission, October 11, 1996.
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the Oklahoma Public Service Commission on behalf of Southwestern Bell Telephone Company, September 30, 1996.
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the Missouri Public Service Commission on behalf of Southwestern Bell Telephone Company, Case No. TO-97-040 & TO 97-40-67, September 30, 1996.
- "Economic Evaluation of Version 2.2 of the Hatfield Model," prepared for filing in interconnection arbitrations in Pennsylvania, California, Florida, Indiana, North Carolina, Oklahoma, Iowa, Texas, Virginia, Minnesota, Hawaii, Nebraska, Kentucky, Washington, and Missouri on behalf of GTE, September 1996 (with Gregory M. Duncan).
- Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the Texas Public Utility Commission on behalf of Southwestern Bell Telephone Company, Docket Nos. 16189, 16196, 16226, 16285, 16290, September 6, 1996.
- "Economic Analysis of MFS's Numerical Illustration," prepared for filing with the Federal Communications Commission, In the Matter of Implementation of the Non-Accounting Safeguards of Sections 271 and 272 of the Communications Act of 1934, as amended and Regulatory Treatment of LEC Provision of Interexchange Services Originating in the LEC's Local Exchange Area, on behalf of US West, August 30, 1996.

- Affidavit of Timothy J. Tardiff on proxy rates for unbundled local switching, prepared for filing with the Federal Communications Commission on behalf of GTE Corporation, petition for a stay of the First Report and Order in the Matter of Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, August 28, 1996.
- Rebuttal Testimony of Timothy J. Tardiff on the Hatfield Model of unbundled network elements, prepared for filing with the New York Public Service Commission on behalf of New York Telephone, July 15, 1996.
- Reply Testimony of Timothy J. Tardiff on local exchange service price floors, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, July 10, 1996.
- "Economic Evaluation of Version 2.2 of the Hatfield Model," attached to Reply Testimony of Timothy J. Tardiff, prepared for filing with the California Public Utilities Commission on behalf of GTE California, July 10, 1996. Also presented to the Federal Communications Commission as attachment to letter from Whitney Hatch of GTE to William F. Caton, In the Matter of Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, July 11, 1996.
- Testimony of Timothy J. Tardiff on local exchange service price floors, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, June 14, 1996.
- Declaration of Alfred E. Kahn and Timothy J. Tardiff, prepared for filing with the Federal Communications Commission, In the Matter of Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, on behalf of Bell Atlantic, May 30, 1996.
- Declaration of Timothy J. Tardiff on Round I and Round II OANAD Cost Studies, prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, May 24, 1996.
- "Economic Evaluation of Pacific Bell's Round I and Round II Cost Studies: Reply Comments," prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, April 17, 1996.
- "Incremental Cost Principles for Local and Wireless Network Interconnection," prepared for filing with the Federal Communications Commission on behalf of Pacific Telesis, March 4, 1996 (with Richard D. Emmerson).
- "Economic Evaluation of Selected Issues from the Fourth Further Notice of Proposed Rulemaking in the LEC Price Cap Performance Review: Reply Comments," Prepared for filing with the Federal Communications Commission on behalf of the United States Telephone Association, March 1, 1996 (with William E. Taylor and Charles J, Zarkadas).
- Declaration of Timothy J. Tardiff on the toll and carrier access demand stimulation caused by the January 1, 1995 price reductions (update), prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, January 19, 1996.
- "Universal Service Funding and Cost Modeling," prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, January 19, 1996.

- "Changes in Interstate Price Regulation: Reply Comments," prepared for filing with the Federal Communications Commission on behalf of Pacific Bell and Nevada Bell, January 10, 1996.
- "Economic Evaluation of Selected Issues from the Fourth Further Notice of Proposed Rulemaking in the LEC Price Cap Performance Review," Prepared for filing with the Federal Communications Commission on behalf of the United States Telephone Association, December 18, 1995 (with William E. Taylor and Charles J, Zarkadas).
- "Changes in Interstate Price Regulation: An Economic Evaluation of the Pacific Bell and Nevada Bell Proposal," prepared for filing with the Federal Communications Commission on behalf of Pacific Bell and Nevada Bell, December 11, 1995 (with Alfred E. Kahn).
- "Evaluation of the Benchmark Cost Model," prepared for filing with the California Public Utilities Commission on behalf of Pacific Bell, December 1, 1995.
- Affidavit of William E. Taylor and Timothy J. Tardiff on interconnection regulation, prepared for filing with the Mexican Secretariat of Communications and Transport on behalf of Southwestern Bell International Holdings Corporation, October 18, 1995.
- Participant, California Public Utilities Commission, Full Panel Hearing on Universal Telephone Service, September 29, 1995.
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Professional associations

- Member, American Economic Association
- Associate Member, American Bar Association
- Member, Federal Communications Bar Association

Fellowships, grants and awards

- First Place, Dissertation Contest of the Transportation Science Section of the Operations Research Society of America.
- National Science Foundation (NSF) Research Initiation Grant (Engineering Division), 1976-1978.
- NSF Grant for Improving Doctoral Dissertation Research in the Social Sciences, 1973-1974.
- NSF Predoctoral Fellowship, 1972-1974.
- Public Health Service Traineeship, 1971-1972.