

FCC CAF Testing

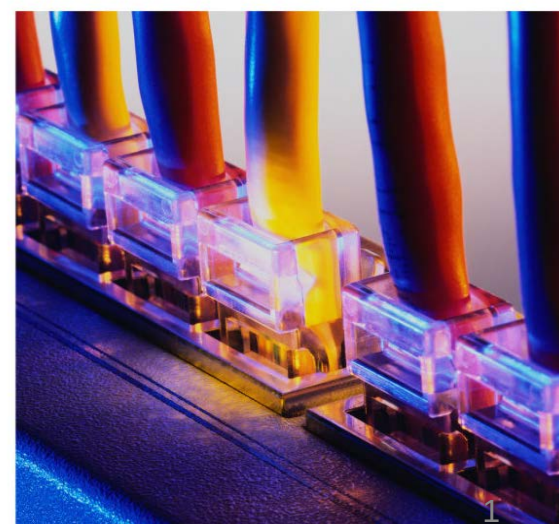
Monte R. Lee
& Company

Welcomes You

September 6, 2018

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Topics Covered Today



- Who is required to test
- Testing Requirements
- Methods to Test
- Required Test locations
- Standards for full compliance
- Detail testing methodology
- Next steps
- More information
- Questions

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

In the Matter of

Connect America Fund

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)
)

WC Docket No. 10-90

ORDER

Adopted: July 6, 2018

Released: July 6, 2018

By the Chiefs, Wireline Competition Bureau, Wireless Telecommunications Bureau, and Office of Engineering and Technology:

The FCC released the Order on July 6, 2018. Many items require further clarification, which may change some of the items discussed in this presentation.

Before implementing testing procedures a provider should study and understand all the rules for its unique services and follow future guidance provided by the FCC.

Who is Required to Test

In this Order, the Wireline Competition Bureau (WCB), the Wireless Telecommunications Bureau (WTB) (jointly referred to herein as the Bureaus), and the Office of Engineering and Technology (OET) adopt requirements promoting greater accountability for certain recipients of **Connect America Fund (CAF) high-cost universal service support,**

including price cap carriers,

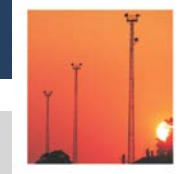
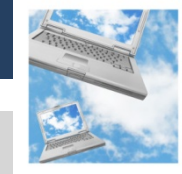
rate-of-return carriers,

rural broadband experiment (RBE) support recipients,

Alaska Plan carriers,

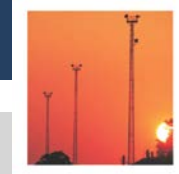
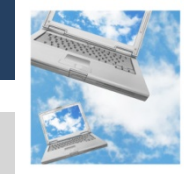
and CAF Phase II auction winners.

How to Test - Latency



- Latency
60 tests per hour, one per minute,
each test recorded separately
- Exception if consumer load
exceeds 64 Kbps downstream,
retry in next minute

How to Test - Speed



- Speed
one download test and
one upload test per hour
- Exception if consumer load
exceeds 64 Kbps downstream or
32 Kbps upstream,
retry in one minute

When to Test



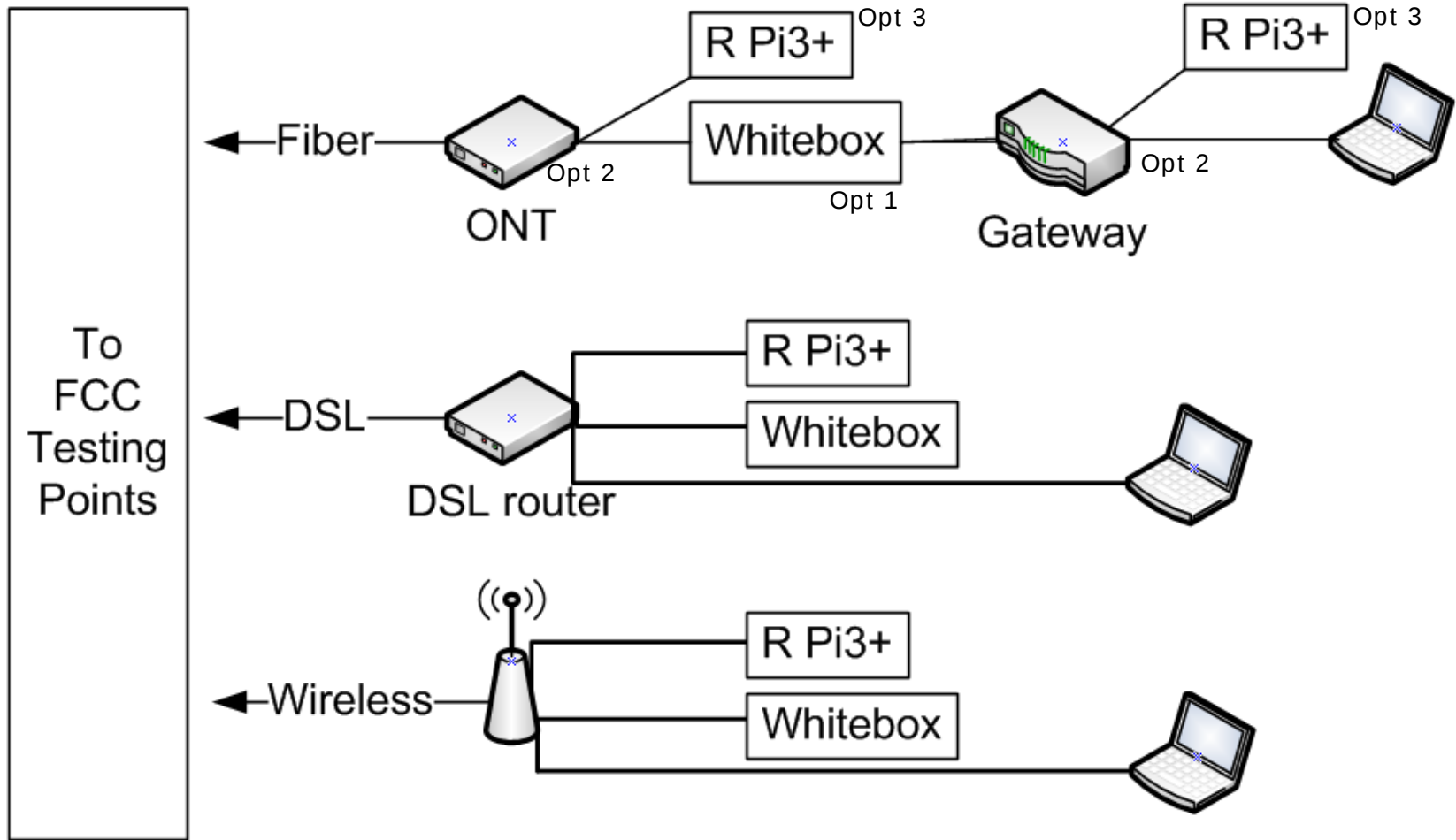
Certification Date	Quarters
7/1/2020	3Q2019 and 4Q2019
7/1/2021	1Q, 2Q, 3Q and 4Q 2020
7/1/2022	1Q, 2Q, 3Q and 4Q 2021
...	...
*Must continue while funds are received	

Choice of Testing Method

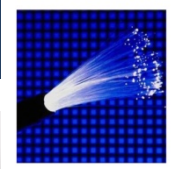
- 1) Use the MBA testing infrastructure (Measuring Broadband America) SamKnows whiteboxes
- 2) Existing network management systems and tools (off-the-shelf testing)
- 3) Provider-developed self-testing (described in detail in last section of presentation)



Connection Methods

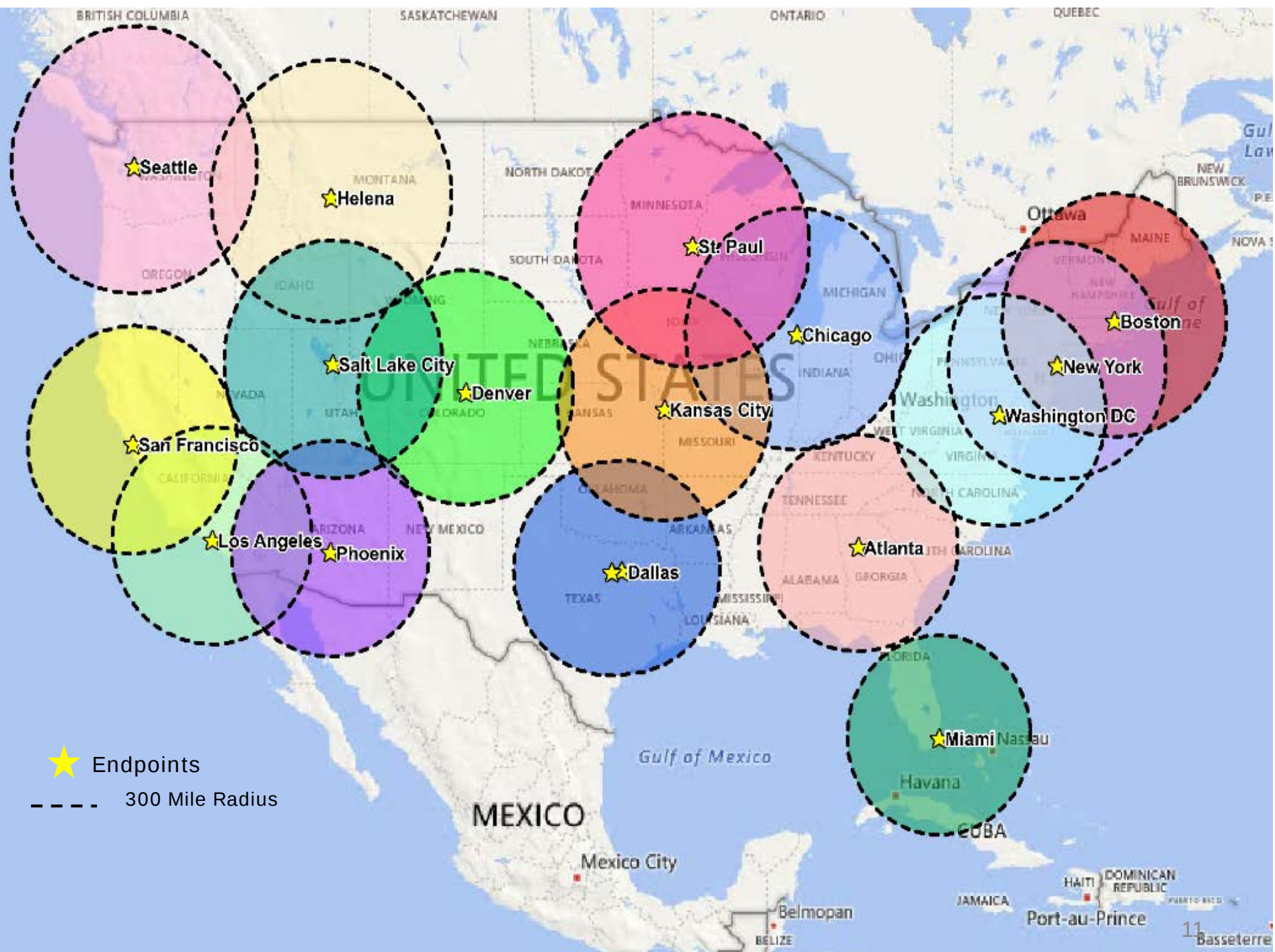


Required Testing Endpoints to or Through Points

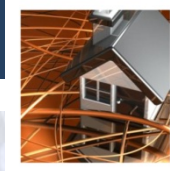


New York City, NY
Washington, DC
Atlanta, GA
Miami, FL
Chicago, IL
Dallas-Fort Worth, TX
Los Angeles, CA
San Francisco, CA

Seattle, WA
Denver, CO
Salt Lake City, UT
St. Paul, MN
Helena, MT
Kansas City, MO
Phoenix, AZ
Boston, MA



Testing Details:



Per Quarter

- One complete week
- From 6:00 pm to 12:00 am including weekends
- All test results (pass and fail) must be submitted
- 60 Latency per hour
- 1 Upload and 1 Download per hour

Required Test Locations

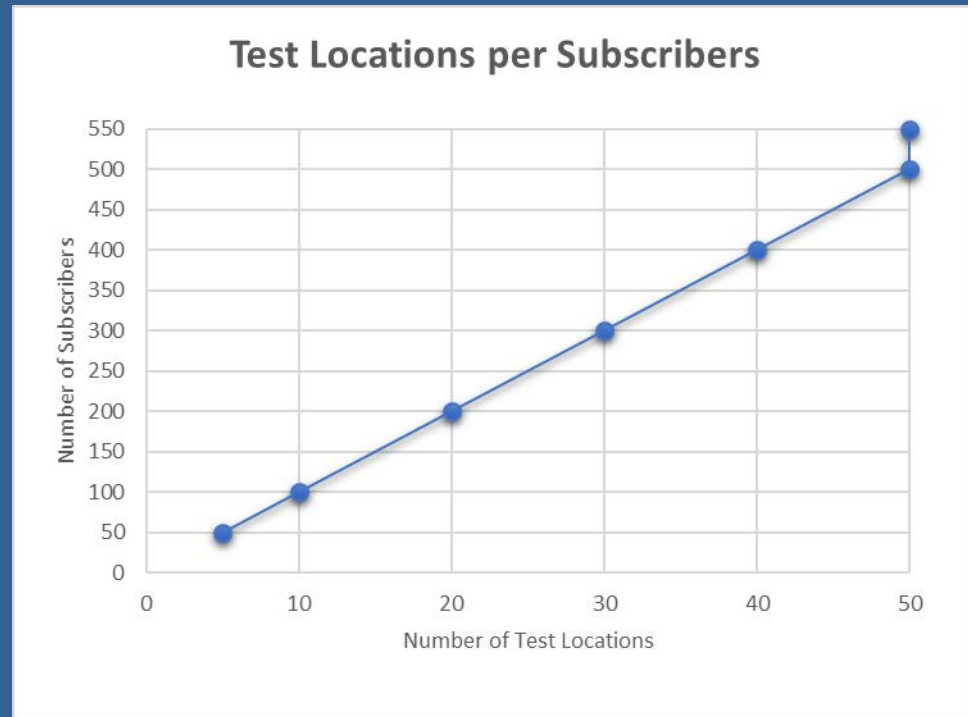


Number of Subscribers at CAF-Supported Locations <u>per State and Service Tier</u> Combination	Number of Test Locations
50 or fewer	5
51–500	10% of total subscribers
Over 500	50

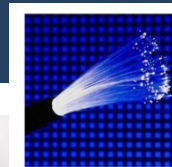
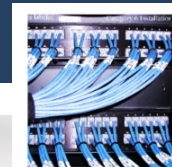
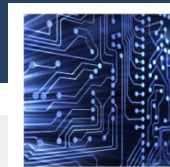
Required Test Locations per Service Tier Per State



Providers numbers of tests required
will increase with increased
subscribers!



A-CAM Subscribers and Tiers



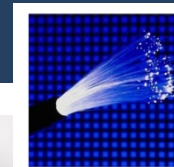
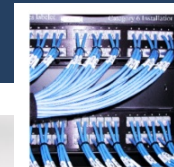
Service Tier	25/3	10/1	4/1*	Total
Locations Passed (not used)	76	124	38	238
Subscribers (used)	48	82	10	140
CPE Tests Units Required	5	9	5	19



A-CAM Years four (40%) through ten (100%) your subscriber numbers will increase as your buildout requirements are met.

* FCC did not include a discussion of 4/1 in the initial rules.

CAF-BLS Subscribers *



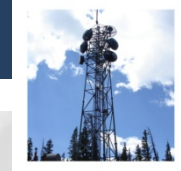
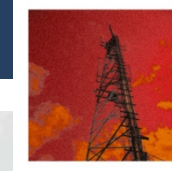
*** Not currently defined in the Rules**

Service Tier	10/1
Locations Passed	356
Subscribers	217
CPE Tests Units Required	22



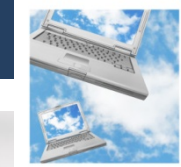
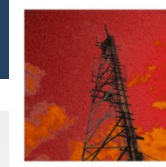
CAF-BLS less than 80% has buildout requirements. Providers testing numbers will increase as subscriber count increases.

CAF-BLS Testing (PENDING)



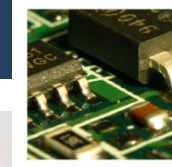
- Look for clarification to comments made via ECFS
- Above 80% - Not yet defined.
- Below 80% - Yes
new buildout requirements include testing (areas not defined)

Required CPE Locations



- Carriers must identify the set of testing locations at the beginning of the testing and cannot exclude some locations during or after the testing
- Test subjects must be randomly selected every two years from active subscribers.
- Subscribers for latency testing may be selected from those being tested for speed.
- Random selection must be used to replace subscribers that are no longer active.
- Carriers may use inducements to encourage subscribers to participate in testing.
- WCB will provide further guidance regarding random selection by public notice.

Defining “Test”



- Must test speed and latency from active subscriber premises to a remote test server located at or reached by passing through a FCC-designated IXP.
- A speed test is a single measurement of download or upload speed of 10 to 15 seconds duration between a customer location and a specific remote server location.
- A latency test is a single measurement of latency, often done using a single UDP packet or a group of three ICMP or UDP packets sent at essentially the same time, as is common with ping tests.

Timing of Tests - Latency

- Latency - one discrete test per minute, i.e. 60 tests per hour
- "If the consumer load exceeds 64 Kbps downstream, the test can be retried in the next minute."
- Provider must include all test results from all tests performed during test periods.
- $6 \text{ hours} * 60 \text{ tests} * 7 \text{ days} = 2,520 \text{ tests per location}$



Timing of Tests - Speed

- Speed - one download test and one upload test per testing hour at each subscriber testing location.
- "If the consumer load exceeds 64 Kbps downstream or 32 Kbps upstream, the test can be deferred for one minute."
- The load check-and-retry must continue at one minute intervals until the test can be run or the hourly test window ends.
- Also, as with latency, providers who elect to do more than the minimum required number of tests must include results from all tests performed during testing periods.
- To capture seasonal effects, carriers subject to latency and speed testing must conduct one week of testing in each calendar quarter.
- "Expanded test period requires testing between 6:00 pm and 12:00 am, including weekends."
- Testing for all locations in a single speed tier in a single state must be done during the same week.
- $6 \text{ hours} * 1 \text{ test per hour} * 7 \text{ days} = 42 \text{ tests per location download}$
- $6 \text{ hours} * 1 \text{ test per hour} * 7 \text{ days} = 42 \text{ tests per location upload}$



High-Latency Voice Performance Testing

- High-latency providers subject to testing must demonstrate a MOS of four or higher.
- High-latency providers required to conduct ITU-T P.800 conversational-opinion test.

Required Test Locations for MOS Testing

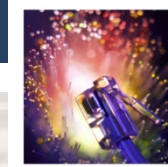
Number of Subscribers at CAF-Supported	Number of MOS Test Locations
3500 or fewer	100
Over 3500	370

Standards for Full Compliance



- Latency - 95% or more of all testing hours measurements of round-trip latency are at or below 100 ms.
- Speed - 80% of download and upload measurements must be at or above 80 percent of the CAF-required speed tier.
- To ensure that outlying observations do not impact results, results with values greater than 150% of the advertised speed will be considered invalid.
- The speed for which the provider should be testing is the speed required by the relevant CAF rules, not the advertised speed. If a provider must deploy 10/1 but advertises and sells 12/2, the compliance will be calculated on 10/1 not 12/2.

How Percentage for Compliance is Calculated



If 95% of a providers latency measurements are at or below 100ms, the score is 100%

If 80% of a providers speed measurements are passing, the score is 100%

Latency		
ATR*	95%	Score
100	/95	105.3
97.5	/95	102.6
95	/95	100.0
92.5	/95	97.4
80.8	/95	85.0

Speed test		
ATR*	80%	Score
100	/80	125.0
95	/80	118.8
90	/80	112.5
85	/80	106.3
80	/80	100.0
75	/80	93.8
68	/80	85.0

* Average Test Results

Non-Compliance and Verification Measures

Compliance Levels and Support Reductions

	Qualifying Compliance Percentage x	Required Quarterly Reporting	Monthly support Withheld
Full Compliance	$x \geq 100\%$	No	N/A
Level 1	$85\% \leq x < 100\%$	Yes	5%
Level 2	$70\% \leq x < 85\%$	Yes	10%
Level 3	$55\% \leq x < 70\%$	Yes	15%
Level 4	$x < 55\%$	Yes	25%

From page 24 of the Rules

All carriers not fully compliant in a particular state must submit quarterly reports providing one week of testing hours test results, subject to the same requirements we establish in this Order, and describing steps taken to resolve the compliance gap, and USAC will withhold a percentage of a non-compliant carrier's monthly support.

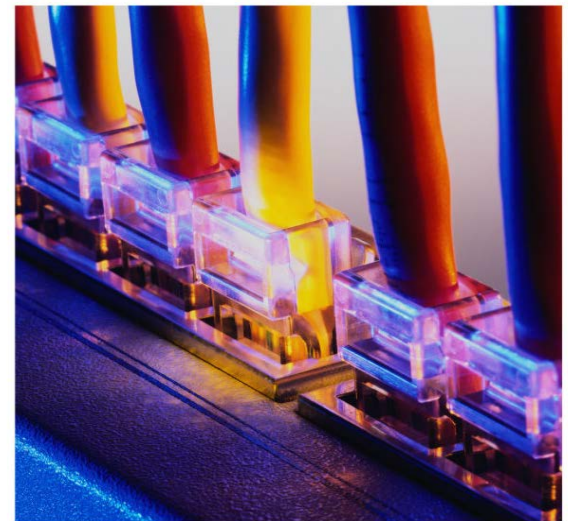
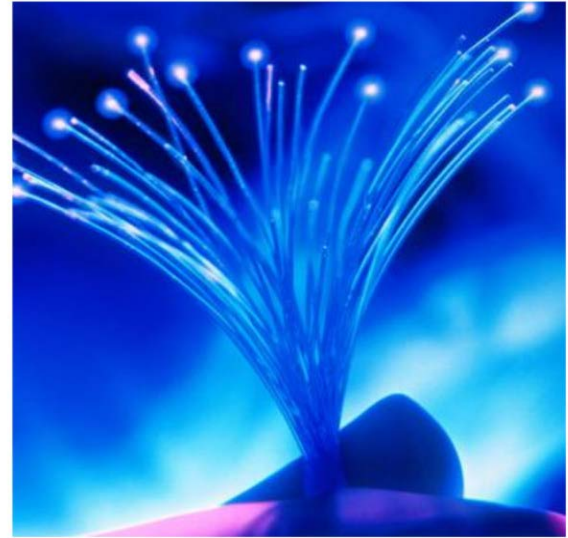


Detail Testing Methodology

**Measuring Broadband
America (MBA)
SamKnows
Testing Option**

Pricing: What SamKnows will Share

- Subscription Component
NDA needed
- Hardware Component
NDA needed
- Test Server Component
(depending on test server
could be free if used for
research purposes)



Deep Dive MBA (SamKnows)



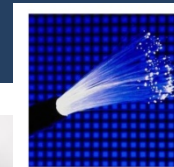
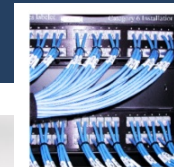
- Can use UPnP (Universal Plug and Play) to query load on CPE prior to testing
- Preventing cross-talk (FCC term) or excessive load on CPE from influencing tests

SamKnows Whiteboxes



- 8 different versions available
- Manufactured by Netgear, TP-Link and MediaTek
- They use a customized version of DD-WRT (OpenWrt)
- Requires truck roll if customer has issues installing.

Whitebox Models



Model	Platform reference	Release date	Maximum measurable speed	Wireless capabilities
Whitebox 8.0	skwb8	2016	1Gbps down, 1Gbps up	802.11a/b/g/n/ac, 2.4Ghz and 5Ghz
Whitebox 6.0	ac1750v2	2015	650Mbps down, 650Mbps up	802.11a/b/g/n/ac, 2.4Ghz and 5Ghz
Whitebox 5.0	wdr4900	2014	800Mbps down, 800Mbps up	802.11a/b/g/n, 2.4Ghz and 5Ghz
Whitebox 3.0	wdr3600	2013	550Mbps down, 300Mbps up	802.11a/b/g/n, 2.4Ghz and 5Ghz
Whitebox 2.0	wr1043nd	2011	200Mbps down, 200Mbps up	802.11b/g/n, 2.4Ghz
Whitebox 1.0	wr741ndv4	2011	100Mbps down, 100Mbps up	802.11b/g/n, 2.4Ghz
Whitebox 0.5	wnr3500l	2010	150Mbps down, 100Mbps up	802.11b/g/n, 2.4Ghz

Existing Network Management Systems and Tools

Off the Shelf Testing



Broadband Forum:

- TR-069 and TR-143
- Used with existing hardware (Gateways in the field)
- Requires a test of Gateways to verify compliance with TR's
- Requires purchase of management server to control testing
- Requires use of third party test location to terminate tests beyond FCC Designated IXP's

Broadband Forum - The TR's

TR-069 is the application layer protocol between CPE and ACS (Auto Configuration Servers)



TR-143 is the diagnostic layer allowing per-CPE diagnostics of network quality and throughput monitoring.



TR-069 and TR-143 have Evolved!

TR-143 (Currently versioned as amendment 1) describes the methodology for performing remotely executed network performance tests.

TR-069, and its successor, the User Services Platform (TR-369) (<http://usp.technology>) are protocols for remotely managing CPE and other connected devices. Both make use of the "Device:2 Data Model for CWMP Endpoints and USP Agents" (commonly referred to as TR-181 Issue 2), which can be found online at <http://cwmp-data-models.broadband-forum.org> and <http://usp-data-models.broadband-forum.org>, respectively. There are some minor differences between the way TR-069 and USP use the data models, but the base is the same.

Within Device:2 are a set of diagnostic operations that correspond to the methodology defined in TR-143. For TR-069 they can be found here:

<https://cwmp-data-models.broadband-forum.org/tr-181-2-12-0-cwmp.html#D.Device:2.Device.IP.Diagnostics>.

There are SOME diagnostics defined in an older data model that was only used for TR-069 early on. That is the IntergetGatewayDevice:1 data model, defined in TR-098, which is deprecated, but many deployments are still using it. It's certainly not recommended for new deployments of the system. It is also not supported by USP.

The advantage of USP over TR-069 for initiating TR-143 style tests is that a separate ACS could be used to initiate the tests since USP supports multiple controllers.

Service Provider Developed Testing

Hardware:

- Raspberry Pi
- Whitebox
- Other single board computers

Software: Beginning with code from existing programs

- perfSONAR (CentOS, Debian, Ubuntu) doesn't pre-test load of CPE
http://docs.perfsonar.net/intro_about.html
- M-lab Network Diagnostic Tool (NDT)
<http://software.internet2.edu/ndt/>

Will require truck roll



Next Steps to Determine Testing Method

Where are your vendors:

- Some have implemented basic TR-069, but have not implemented TR-143
- Most say they will be ready to 3Q2019, it is in development
- Some are potentially licensing SamKnows
- Some fixed wireless say they are level 2 only - won't support any TR testing – they require a gateway after the wireless terminal



Next Steps - Continued

- Further definitions and rule updates will be provided by the FCC.
- AT&T, Verizon and other USTelecom members are using units similar to Raspberry Pi since they only test 10/1; it will also be good for 25/3.



Next Steps - Continued

Issues to be defined:

- Process on how to annually certify and the data format to be provided to USAC, has only defined that every test result is to be kept.
- Rules for random selection of CPE test locations?
- Will the number of test locations be determined annually or by quarter?
- Will 4/1 service have requirements?
- Timing of Gig tests, can they be staggered in a hour
- Many carriers enable “burst” mode, should they be penalized by 150% rule



Summary of Testing Requirements

- This framework applies to all providers with CAF Phase II, A-CAM, rate-of-return mandatory buildout, RBE, and Alaska Plan obligations. (CAF-BLS is coming)
- Three testing options will be permitted: use of MBA testing; off-the-shelf testing; and provider-developed self-testing or self-testing.
- A test is defined to be a single, discrete observation or measurement of speed or latency conducted from the customer premises of an active subscriber at a CAF-supported location to a remote test server located at, or reached by, passing through an FCC-designated IXP.
- Testing must be conducted for one week during each quarter of the year. In those weeks, testing must be performed between the hours of 6:00 pm to 12:00 am local time each day, including weekends (testing hours).
- For latency testing, a provider must conduct a minimum of one test per minute—sixty tests per hour—for each testing hour.
- For speed testing, a provider must conduct a minimum of one test per testing hour in each direction (download and upload) and start at the beginning of each test hour.

More Information

See Appendix A it is a short-form of the new rules.

<https://docs.fcc.gov/public/attachments/DA-18-710A1.pdf>

Research Test Servers:

<http://www.measurementlab.net/> also used by SamKnows

Certification Testing:

<https://www.qacafe.com/cdrouter/>

Questions?

Two Important Footnotes from DA 18-710

¹⁴⁵ To ensure that outlying observations do not unreasonably affect results, we will exclude from certification calculations any speed measurements with values greater than 150% of the advertised speed, because such values are likely invalid. Thus, for a carrier that offers 20/3 Mbps service to satisfy its CAF obligation to provide 10/1 Mbps service, we will exclude a download test result showing a value of greater than 30 Mbps (i.e., 150% of the advertised 20 Mbps download speed). We will not automatically exclude test results that are “too slow,” because those results likely reflect poor performance or network congestion, rather than fundamental problems with the testing infrastructure. However, if a carrier knows or suspects that the testing infrastructure has failed or has negatively impacted test results, the carrier may submit evidence of the test infrastructure failure with sufficiently detailed information for the Commission to understand its cause and determine the extent to which any test results should be discarded or adjusted when calculating compliance.

¹⁴⁶ The speed for which the provider should be testing is the speed required by the relevant CAF rules, not the advertised speed. Thus, for example, if a provider must deploy broadband with a speed of 10/1 Mbps but advertises and sells services of 12/2 Mbps, the provider should calculate compliance based on a requirement of 10/1 Mbps, not 12/2 Mbps.

Thank You for Attending

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