Data Processing Methods

Overview

In Round 10, the California Public Utilities Commission identified 225 potential broadband providers, 131 of whom did not submit data, and 94 who did. This represents an increase of 5 providers over the prior Round. Together, these 94 providers comprise over 99.9% of the total broadband connections in California, according to the June 2013 FCC Form 477 data.

As with prior Rounds, we have eliminated zones from our submission areas where we could not validate the existence of broadband service availability prior to submitting data to the NTIA, as well as the California state broadband availability map. This resulted in a 5% reduction in available census blocks for wireline providers and a 17% reduction in land area as measured in square miles for wireless providers...

Data Collection

The California Public Utilities Commission (CPUC) sent out a Data Request to broadband providers to initiate the Round 10 data collection. Potential providers were strongly encouraged to submit broadband availability data. Providers who previously submitted data were also sent maps displaying their Round 9 coverage and validation results to guide their Round 10 submissions. Data submission instructions were posted online to assist providers along with template files, sample shapefiles and record formats on the CPUC Broadband Mapping Website at:

http://www.cpuc.ca.gov/PUC/Telco/Information+for+providing+service/BroadBand+Mapping.htm

The data submission instructions point each provider to the wireless and/or wireline datasets, which are separated into sections for those with GIS data (shapefiles or filegeodatabases) and those without GIS data (text or Excel files). For providers with GIS capabilities, statewide census block and TIGER/Line shapefiles were provided on the CPUC website. The square mileage of each block was calculated in advance in the sample census block shapefile. Using the shapefiles, providers were able to determine which blocks in their footprint were less than two square miles and which were two square miles or greater and therefore needed to be represented using the road segment shapefile. For providers without GIS capabilities, Excel spreadsheets were provided incorporating record field formats adhering to the NOFA data submission requirements.

Community Anchor Institutions (CAI)

CAI data is composed of the names and locations of schools, colleges, libraries, healthcare institutions and other community institutions, and the broadband technology and capacity of these institutions.

For each of these institutional categories, the facility data was sourced from the following locations:

- K-12 school data: http://www.cde.ca.gov/ds/si/ and http://nces.ed.gov/ccd/elsi/
- College data: http://nces.ed.gov/ipeds/datacenter/login.aspx
- California health facility data: http://oshpd.ca.gov/General_Info/Healthcare_Atlas.html and http://www.caltelehealth.org/
- Library data: https://harvester.census.gov/imls/data/pls/index.asp

Broadband technology and capacity for these facilities was captured using the following data sources:

- CPUC data from the California Teleconnect Fund (CTF) program with additional provider data from AT&T and TelPacific. The CTF program provides 50% discounts on telecommunications bills for qualifying schools, libraries, government-owned and operated hospitals and health clinics, and other community based organizations.
- Corporation for Education Networking Initiatives in California (CENIC) data. CENIC operates the K-12 High Speed Network (K12HSN) program which is funded by California Department of Education. K12HSN enables educators, students and staff across the state to have access to reliable high speed network to deliver high quality online resources to support teaching and learning and promote academic achievement. The crosswalk is included in Appendix 1 at the end of this paper.
- The State Librarian provided broadband access data from its recent survey as part of its "Needs Assessment and Spending Plan." The cross walk is included in Appendix 1 at the end of this paper.

Additionally, other non-government community organizations not listed above were sourced from the CTF data.

Finally, the CAI addresses were geo-coded to point locations and geo-matched to the Census Blocks 2010 shapefile to obtain the corresponding FULLFIPSID. Technology data was then associated with broadband technology and speed information.

Below is a summary by institution type of the broadband subscription data we have been able to collect for this round.

	All	Schools	Libraries	Medical	Colleges	CBOs
Total Count	27,031	14,069	1,150	5,403	510	5,899
With Tech	13,600	10,884	1,057	216	0	1,443
Unknown	13,431	3,185	93	5,187	510	4,456
% with Tech	50.31%	77.36%	91.91%	4.00%	0.00%	24.46%

CPUC Initial Data Verification

Each data set submitted by broadband providers was reviewed against the GIS data model posted on the SBDD Network website and checked if mandatory fields were filled in, and if each field contained the appropriate range of values. Where possible, we made certain that appropriate field headers were used and that each field contained the correct data type. When data was found to be missing or incorrect, the provider was contacted and the issue was documented in the Changes and Corrections document.

Geo-processing

After the initial CPUC review, data was transferred to the Geographical Information Center (GIC) at CSU Chico for geo-coding, geo-matching, propagation of wireless service by antenna, and validation of geographic data. In those cases where the CPUC received street address level data from broadband providers, such addresses were assigned a point location, (geo-coded) and then geo-matched to census blocks and street segments.

Wireless providers who were unable to submit a shapefile or geographic representation of their service area were asked for tower, antenna, and radio settings information. We used these and other parameters in EDX's Signal software, version 11.0.1, to model the service area, and from that we created a shapefile. In cases where a fixed wireless provider offers service at different speed tier combinations, a separate propagation was run and a separate shapefile was created for each. All shapefiles were then overlaid and dissolved so that only the maximum advertised speed available for each area appeared. The EDX propagation used the Anderson-2D propagation model. Individual unit specifications were used to predict coverage based on frequency, transmit power, receiver sensitivity, antenna gain, and height. The propagation model took into account terrain based on two datasets, EDX universal .201, and SRTM 3-second .HGT format. The model also took into account land use/clutter using USGS 2006 30m data (.151 files).

Validation Methods

Please refer to the Appendix for an explanation of the validation process employed for this data submission.

CPUC Final Data Verification

The resulting datasets were delivered from Chico to the CPUC in the SBDD transfer model geodatabase for final review and verification. Data sets were checked again and reviewed for unexpected changes resulting from the geo-coding/geo-matching process. Geo-processed data was visually reviewed using ArcGIS to verify service area footprints, and the SBDD check submission Python script was run on each dataset to identify unexpected values.

Deliverable Data

The final dataset is delivered to the NTIA/FCC in filegeodatabase format containing the following feature classes:

- BB_ConnectionPoint_MiddleMile – Point between the local "last mile" network and the middle mile network which goes on to connect to the internet backbone. This is a confidential dataset.
- BB_Service_CAInstitutions – Community Anchor Institutions: points geo-coded from address lists
- BB_Service_CensusBlock – Broadband availability polygons for areas less than 2 square miles
- BB_Service_Overview – Service overview by County including Subscriber Weighted Nominal Speed
- BB_Service_RoadSegment – Broadband availability line segments for areas 2 square miles and greater
- BB_Service_Wireless – Wireless service area polygons.

Changes and Corrections Reporting

In reporting changes and corrections for this round of data collection, we included the following, where applicable:

1) Submitted new data, or no changes from previous Round 9

2) New provider

3) Changes through company merger/acquisition

4) Changes to FRN number

5) Changes in speeds, middle mile, and/or spectrum

6) Changes in number of blocks and road segments for wireline

7) Changes in coverage area for mobile and fixed wireless

Appendix 1: CAI Data Crosswalk

The crosswalk for the K-12 schools data is shown below.

NTIA Tech Type		K12hsn other conn type
All Other	0	ATM IMA - 3M
All Other	0	Frame Relay
All Other	0	Frame-Relay
All Other	0	Frame-Relay T-1
All Other	0	ISDN
Asymmetric xDSL	10	Business DSL
Asymmetric xDSL	10	DSL
Other Copper Wireline	30	AVPN 3M
Other Copper Wireline	30	AVPN 4.5M
Other Copper Wireline	30	Cat5 Copper
Other Copper Wireline	30	Dial Up
Other Copper Wireline	30	DS3
Other Copper Wireline	30	Lan
Other Copper Wireline	30	Local Area Network
Other Copper Wireline	30	Mix of Cable, DSL, Frame Relay
Other Copper Wireline	30	Private Copper
Cable Modem - Other	41	Cable
Optical Carrier / Fiber to the End User	50	CSME
Optical Carrier / Fiber to the End User	50	CSME + SDSL
Optical Carrier / Fiber to the End User	50	Primarily DSL, Cable, FiOS

Appendix 2: Validation Process

Overview

One of the requirements of our NTIA Mapping Grant is that we validate the data submitted to us by broadband providers. This document explains the validation methodology we used. The following data sources were used to validate each provider's data submission. <u>Areas we were unable to validate do not mean there is no service there, or that service at a particular speed is not available, it simply means that we were unable to confirm the presence of service based on the data sources available to us.</u>

Data Sources

The table below summarizes the validation method, data type, and to which type of broadband connection the validation method applies.

Data Source	Data Type	Fixed: Wireline	Fixed: Wireless	Mobile Wireless
FCC Form 477	Number of subscribers by upstream and downstream speeds by census tract used to validate availability and speed at census tract	YES	YES (speed only)	NO
Broadband Scout	Online purchases sorted by provider and census block or street segment used to validate availability and speed at census block	YES	YES (speed only)	YES
TeleAtlas Wire Center	Serving wire center locations of telephone companies used to validate DSL coverage	YES	NO	NO
CPUC Mobile Field Test Upstream and Downstream Interpolation	Interpolated coverage based on mean minus 1 standard deviation used to validate availability at census block	NO	NO	YES (availability only)
CPUC Mobile Field Test Results Point Data - "No Effective Service"	Provider-specific, "In coverage" location results showing "No Effective Service" (point data) from 5th Round mobile field testing used to validate availability at census block	NO	NO	YES (for both NTIA and for CA BB Map)
CalSPEED results	Speed test results from LTE-capable devices and "No Effective Service" results from ANY device used to	NO	NO	YES

	validate availability at census block			
Customer address service and speed information	Provider-supplied list of customers showing their address and subscribed speeds – used to validate at census tract and speeds	YES	YES	NO
Public Survey	Reports of "no service" for a specific provider used to validate availability at census block ("no service" = block becomes unavailable for that provider)	YES	YES	YES
Tower data and/or EDX propagation image	Coverage propagation of fixed wireless provider based on tower, radio, and antenna data submitted by the provider used as a baseline for availability footprint	NO	YES (footprint only)	NO

Explanation of Data Sources

- **FCC Form 477** For fixed services, the FCC collects data from each broadband provider twice a year, including the number of broadband connections by technology type and speed tier combination for each census tract where the provider has customers. Mobile broadband service data only includes state-wide totals and is not useful for geographic validation. If a provider indicates it has broadband service in a particular census block but has not reported customers to the FCC for the census tract where that block resides, the Form 477 data cannot validate the actual presence of service. In the case of speed validation, if a provider has not reported any subscribers receiving the speeds which they advertise for any of the census blocks within the applicable census tract, then Form 477 cannot validate the speed for the entire census tract. However the existence of coverage in the entire census tract is still validated. As with any validation technique, there are inherent errors. For example, if Form 477 data shows that a particular provider has customers in a census tract and at the maximum advertised speeds submitted to us, we consider all blocks within that census tract validated for speed and/or availability for that provider. Because Form 477 data is only available at the census tract level, this validation tool tends to yield false positives and overstate the number of validated areas. Conversely, the most recent Form 477 data available to the CPUC is usually six months old or more. This time lag between when faster service is made available and when customers are shown for that service may yield false negatives and understate the number of areas where speed is validated.

- **BroadBand Scout** is a third party, comprehensive dataset designed specifically to show the providers, connectivity, speed, and usage details of the national broadband landscape. ID Insight's process analyzes hundreds of millions of Internet transactions that link a consumer's physical address to their Internet provider. BroadBand Scout data comes to us aggregated at the census block level. The presence of an on-line purchase over a particular provider's network validates service availability for that census block or street segment. The upstream and downstream throughput for an online purchase may be used to validate a provider's advertised speed.
- **TeleAtlas Wire Center data** lists every Local Exchange Carrier (LEC) landline wire center in the United States. The term "wire center" refers to the location where the telephone company terminates its local lines; this is usually the same location as a central office, although a wire center might house multiple central offices. Buffers were created at 12,000 feet and 18,000 feet from provided Wire Center point datasets to cross reference ISP data submissions to the CPUC. The wire center boundary is a representation of the area served by all of the switching equipment housed at that physical location. When a provider indicates broadband availability in a particular census block, and that location is within the distance from the wire center to support a given speed, that census block is considered validated. If the location is farther from the central office than what can support the maximum advertised speed, we are unable to validate the service.
- **CPUC Mobile Field Test Upstream and Downstream Interpolation** - Shapefiles were created from the 5th Round field test results (Spring 2014) of 1,990 locations based on a geographic modeling technique called Kriging. Kriging models were created from the data collected from the 1,990 locations using mean throughput (in Kb/s) minus one standard deviation. The standard deviation used was unique to each location and provider but averaged for both data card and smart phone, as well as for both East and West servers. A mask was used so that the surface interpolation and points used for analysis are only within the provider's service area based on each provider's submitted Round 9 availability data. The Kriging model used a 1 kilometer resolution, and the interpolation is based on the default nearest 12 points. This produces a raster surface that only encompasses the provider's service area. Our analysis of each Kriging models showed that all were significant predictors of both upstream and downstream speeds (p-value < 0.05), and that differences between observed and predicted speeds were found to be statistically insignificant (p-value > 0.05).
- **CPUC Mobile Field Tests** are conducted twice a year at 1,990 randomly selected points across the state and measure broadband performance for the four major mobile wireless operators: Verizon, AT&T, Sprint, and T-Mobile USA. The point data results from the Spring 2014 tests were compared against each operator's advertised availability in the census block where the test was conducted. In census blocks where the test result for a particular operator was zero or "No Effective Service," but the operator advertised coverage there, the coverage for that census block was considered un-validated.
- **CalSPEED Results** are crowd-sourced mobile test results from the CPUC's Android mobile testing application. The CPUC launched CalSPEED on Google Play's app store on April 5, 2013. The point

data results through May 2014 were compared against each operator's advertised availability in the census block where the test was conducted. These results included operators beyond the four tested for the bi-annual mobile field testing. In census blocks where the test result for a particular operator was zero or "No Effective Service," but the operator advertised coverage there, the coverage for that census block was considered un-validated.

- **Customer Address Service and Speed Information**
  In limited cases where we were unable to validate any areas of a provider's availability (their entire footprint was a red zone), we requested customer address information to use as a validation data source. Census blocks where customers resided were considered validated.

- **Public Survey (new to this Round) -** As part of our effort to collect and incorporate information from the public, we created an online as well as downloadable paper survey that member of the public fill out to tell us which providers they have and at what speeds they subscribe. The survey also captures whether they have been denied service or do not have access to specific providers claiming to offer service to their area. There is also a section where they can tell us the results from speed tests. The survey and FAQ are available on the CPUC web site at: http://www.cpuc.ca.gov/PUC/Telco/bbpubfeedback.htm. Results through July 31, 2014 were used to validate Round 10 broadband availability.

- **Tower data and/or EDX propagation image -** For fixed wireless providers, we used tower location and system parameter information, where available, to propagate a fixed wireless provider's coverage area using EDX's Signal software, version 11.0.1. The wireless propagation model is based on the Anderson-2D propagation model. System parameters included frequency, transmit power, receiver sensitivity, antenna gain, and height. EDX produced coverage patterns for each tower/sector combination taking into account terrain and land use/clutter that may hinder signal dispersion. For terrain, we used two data sets, EDX universal .201 and SRTM 3-second .HGT format. For land use/clutter, we used USGS 2006 30-meter .151 files. A separate propagation shapefile was created for each downstream and upstream speed tier combination, and all shapefiles were later overlaid and dissolved to where only the fastest advertised speed available was visible. In cases where a provider submitted a shapefile or vector file of their coverage, the EDX propagation was used as one source for availability and speed validation.

Validation Procedures

Wireline
A spatial selection was performed on Census Block and Street Segment data, either submitted by the provider, or created from submitted address records through a geocoding/spatial selection process, to derive only those blocks or street segments which intersect polygons in a given validation layer. Counts are recorded as number of unique blocks or unique segments which share geographic area with any given validation layer, compared to the total number of unique blocks submitted by, or created for, a given provider. Percentages are recorded as percentage of the total number of unique blocks or street segments which share geographic area with any given validation layer, compared to the total number of unique blocks submitted by, or created for, a given provider.

Validation data sources: we used FCC Form 477 (June 2013), Broadband Scout's ID Insight, and TeleAtlas Wire Center data sets. In limited instances customer addresses were used to validate availability and/or speed.

The image below is an example of how "red zones" were created for wireline providers. A red zone indicates a census block or census tract, depending on the third party data source, where we were unable to validate service availability based on subscriptions reported to the FCC or online transactions reported in Broadband Scout. In the example below, Integra, a provider of ADSL, DSL, and "other copper" broadband services, contains a number of red zones resulting from our validation. Conversely, areas shown in goldenrod were areas where we were able to validate service availability based on the presence of subscribers reported to the FCC or the presence of an online transaction from Broadband Scout. The goldenrod color represents Integra's maximum advertised downstream speed tier.
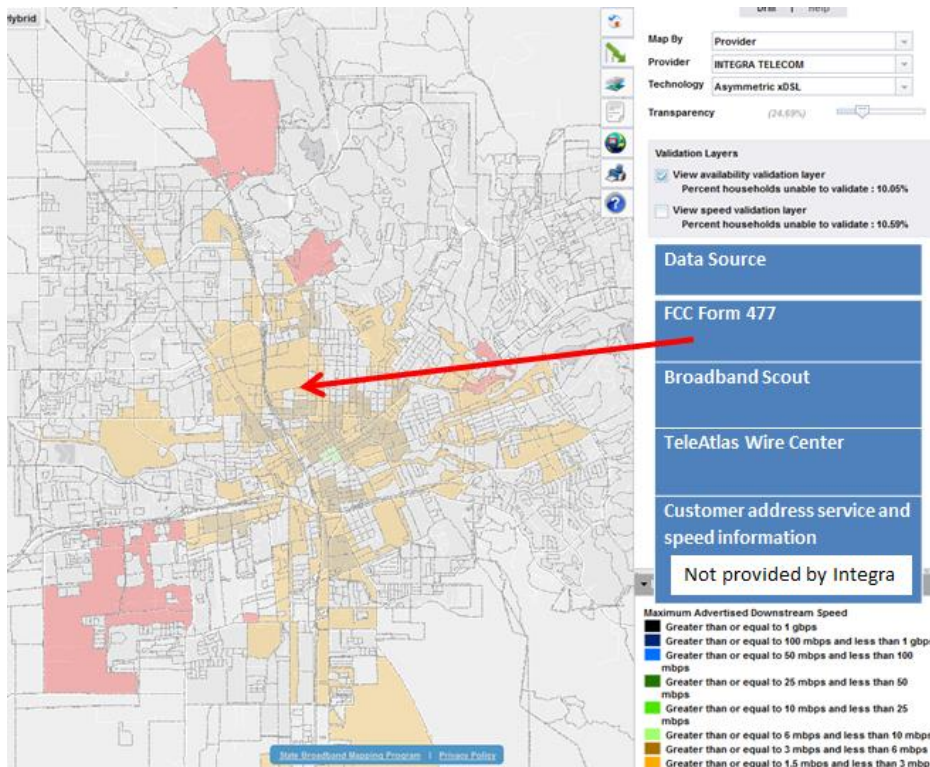
Following creation of the red zones from our validation process, the red zones were clipped from the provider's shapefile. The post-validation shapefile (goldenrod areas only in the example below) is what was submitted to the NTIA and shown on the California state broadband availability map for this round of data collection. In limited cases where a provider had a new fiber build in this Round's data submission, chances were that no validation data existed to validate availability. For new fiber builds, we considered the submission to be validated "as is." Additionally, in limited cases where we had both 477 and ID Insight data validating a census block and public feedback saying no service was available from a certain provider; we considered that census block to have availability.
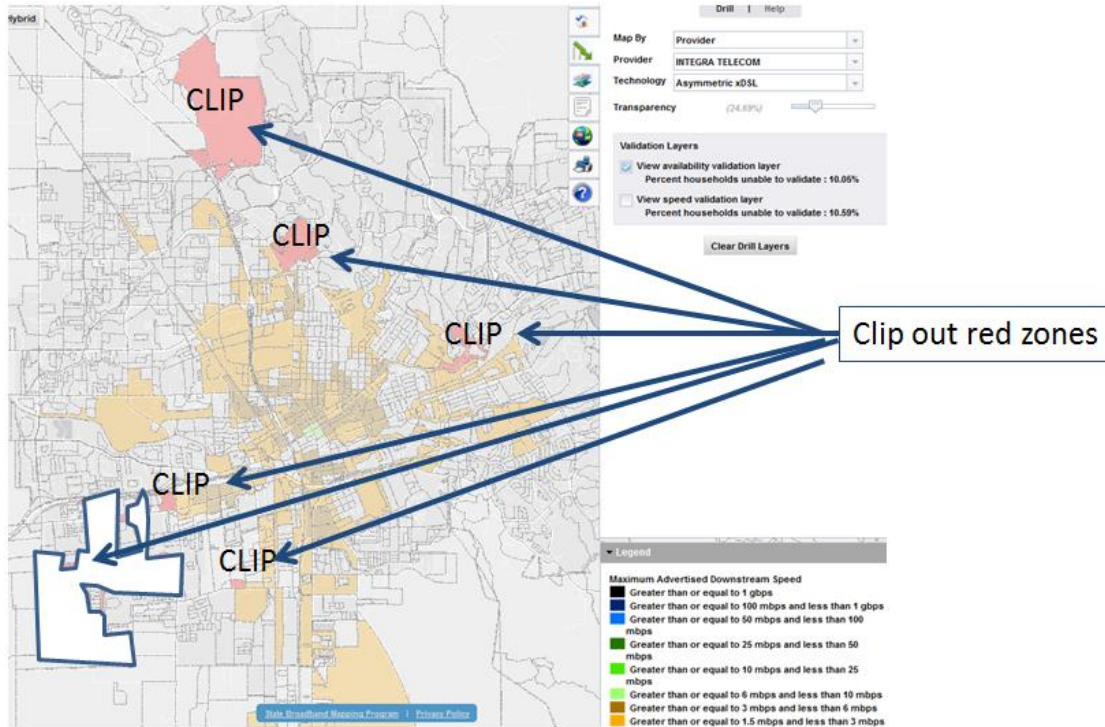
Fixed Wireless

A spatial overlay was performed on Wireless Availability data, either submitted by the provider, or created from tower and antenna location information, to select only those polygons which intersect a given validation layer. Results are recorded as a percentage of the total geographic area of wireless coverage sharing geographic area with any given validation layer compared to the total coverage area submitted by, or created for, a given provider.

The image below is an example of how "red zones" were created for fixed wireless providers. A red zone indicates a provider's coverage area polygon where we were unable to validate service availability based on subscriptions reported the FCC, online transactions reported in Broadband Scout, and in limited instances, customer addresses or propagated tower data. In the example below, Digital Path provided both a shapefile of their service area and speeds as well as tower data. In comparing the two, we noticed large discrepancies between their claimed coverage versus their tower locations. We also noticed a large difference between areas we were able to validate, shown in green, versus areas we were unable to validate based on the third party data sources mentioned above.

9th Round – Digital Path

Fixed Wireless Service
Maximum Advertised Downstream Speed

Data Source

Tower data and/or EDX propagation image

Customer address service and speed information
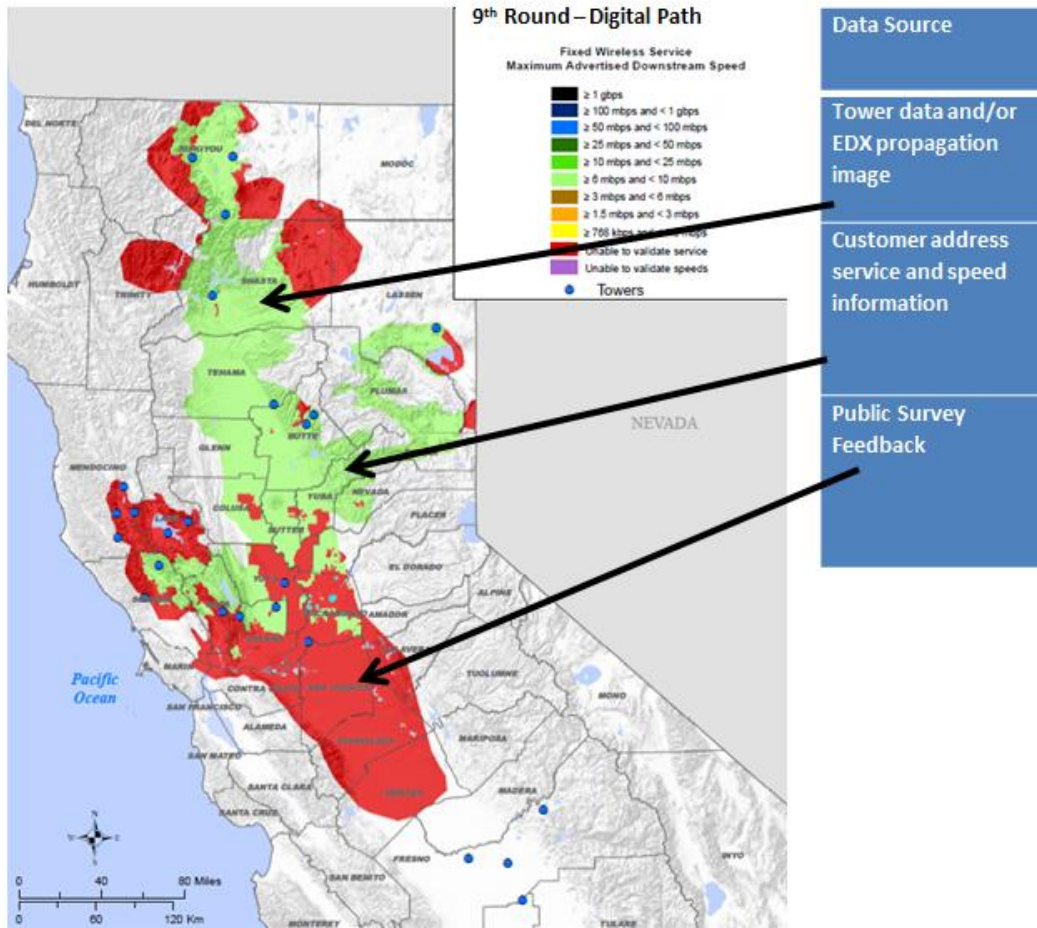
Public Survey Feedback

Following creation of the red zones from our validation process, the red zones were clipped from the provider's shapefile. The post-validation shapefile (green areas only in the example below) is what was submitted to the NTIA and shown on the California state broadband availability map for this round of data collection.

Mobile

A spatial selection was performed on Wireless Availability data, submitted by the provider, to select only those polygons which intersect a given validation layer. Results are recorded as a percentage of the total geographic area of wireless coverage sharing geographic area with any given validation layer compared to the total coverage area submitted by, or created for, a given provider.

Validation data sources: For this Round, we relied on interpolated upstream and downstream shapefiles to the validation data sources for the four major mobile providers. As stated in "Explanation of Data Sources," we using the interpolation of mean minus one standard deviation shapefiles as a baseline, we clipped provider advertised coverage areas falling outside of the interpolated coverage areas. This resulted in small changes for the two largest providers (4% reduction in square miles for Verizon Wireless and 6% for AT&T Mobility), and larger changes for T-Mobile (22% reduction), and Sprint (76% reduction) due mainly to their lack of high speed service in rural and tribal areas. For all mobile providers, we used Broadband Scout's ID Insight and CalSPEED results through May 31, 2014. As stated earlier, FCC Form 477 for mobile broadband providers is aggregated the state level rather than census tract and is not useful for geographic validation. Specific census blocks where a test result (mobile field test or CalSPEED) showed either "No Effective Service" or a zero value but was within in a provider's advertised coverage area were clipped.

Validation using interpolation (AT&T Mobility, Sprint, T-Mobile, and Verizon Wireless only)
The two images shown below are of the December 2013 (Round 9) maximum advertised downstream coverage and speeds for AT&T Mobility (left) and the interpolated coverage and speeds based on field test results. Notice that while there are significant color differences in speeds, the coverage pattern is very similar. Where there were gaps, we clipped coverage, as shown in the red zone image below these.

The image below shows the red zones where we were unable to validate coverage and the purple zones where we were unable to validate speeds. Only the red zones affected the NTIA submission in terms of shapefile polygon geometry because the red zones were clipped, whereas the purple zones, which indicate coverage validation but not speed validation, were retained.

Mobile Availability Validation using Interpolation

10TH ROUND - AT&T MOBILITY
Mobile Service
Maximum Advertised Downstream Speed

- ≥ 1 gbps
- ≥ 100 mbps and < 1 gbps
- ≥ 50 mbps and < 100 mbps
- ≥ 25 mbps and < 50 mbps
- ≥ 10 mbps and < 25 mbps
- ≥ 6 mbps and < 10 mbps
- ≥ 3 mbps and < 6 mbps
- ≥ 1.5 mbps and < 3 mbps
- ≥ 768 kbps and < 1.5 mbps
- Unable to validate service
- Unable to validate speeds

Unable to validate availability (shown in red)
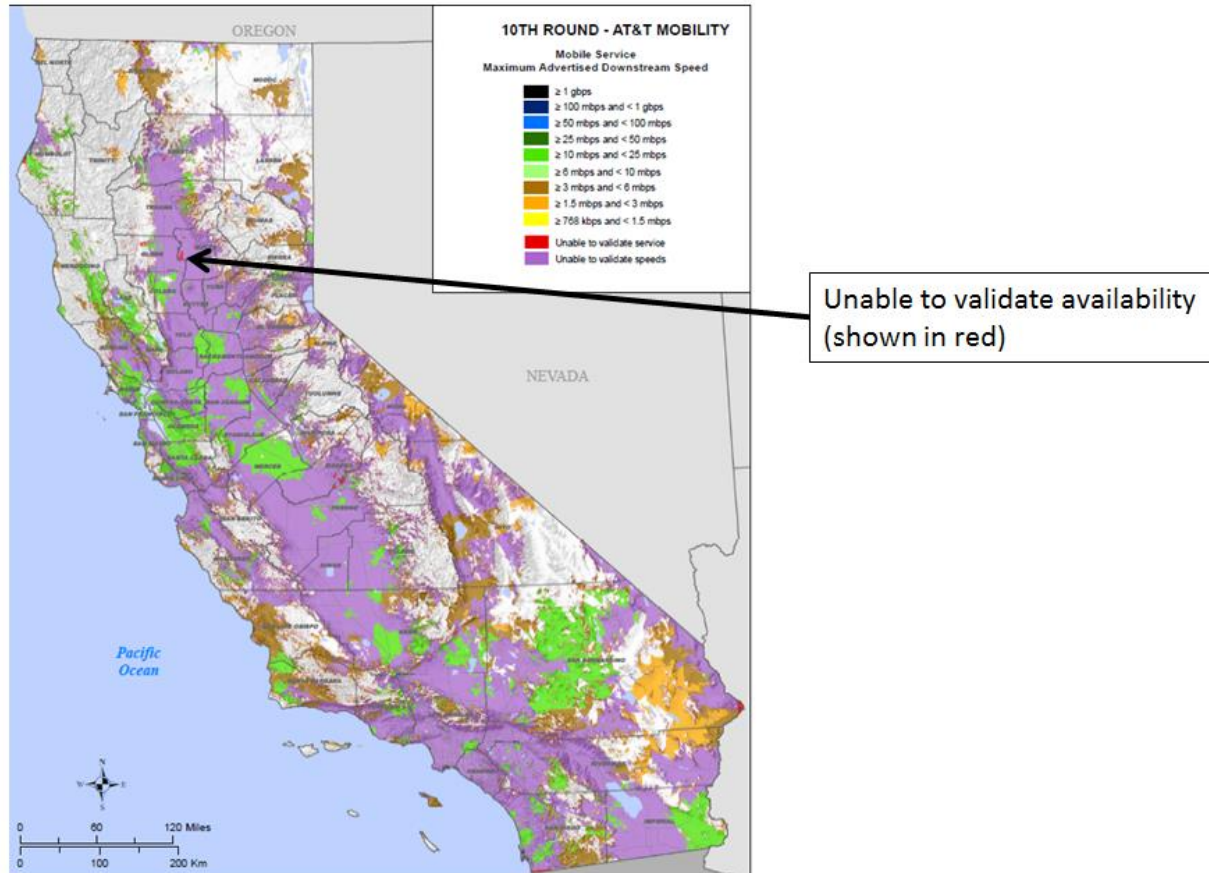
Validation using CalSPEED (all mobile providers)

The example below shows a mobile field test result of zero kilobits per second for AT&T Mobile at location #1720, which is within AT&T Mobile's advertised coverage area. In this example, the census block where the test location falls becomes a red zone.

Mobile – for 4 major providers only

Location 1720 - 9201-9289 Brookdale Rd, Millville, CA 96062 4.0 ft S

Census block boundaries

5th Round Average Downstream Speed

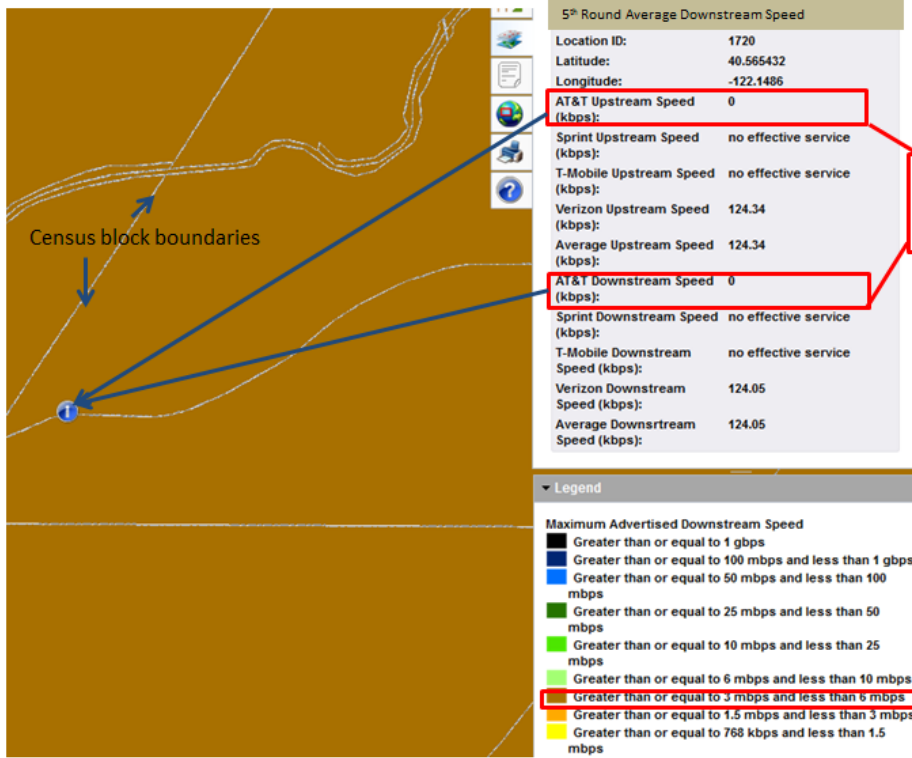|	
Location ID:	1720
Latitude:	40.565432
Longitude:	-122.1486
AT&T Upstream Speed (kbps):	0
Sprint Upstream Speed (kbps):	no effective service
T-Mobile Upstream Speed (kbps):	no effective service
Verizon Upstream Speed (kbps):	124.34
Average Upstream Speed (kbps):	124.34
AT&T Downstream Speed (kbps):	0
Sprint Downstream Speed (kbps):	no effective service
T-Mobile Downstream Speed (kbps):	no effective service
Verizon Downstream Speed (kbps):	124.05
Average Downsrtream Speed (kbps):	124.05

Data sources:
5th Round field tests and CalSPEED
Results for "in" coverage locations
- "No Effective service" or
- Zero value

5th Round field test results show up and down results as zero

▾ Legend

Maximum Advertised Downstream Speed
- ■ Greater than or equal to 1 gbps
- ■ Greater than or equal to 100 mbps and less than 1 gbps
- ■ Greater than or equal to 50 mbps and less than 100 mbps
- ■ Greater than or equal to 25 mbps and less than 50 mbps
- ■ Greater than or equal to 10 mbps and less than 25 mbps
- ■ Greater than or equal to 6 mbps and less than 10 mbps
- ■ Greater than or equal to 3 mbps and less than 6 mbps
- ■ Greater than or equal to 1.5 mbps and less than 3 mbps
- ■ Greater than or equal to 768 kbps and less than 1.5 mbps

But AT&T claims to provide 3-6 Mb/s down in the census block

The census block where test result was zero becomes a red zone

Mobile – Red zone creation

Location 1720 - 9201-9289 Brookdale Rd, Millville, CA 96062 4.0 ft S
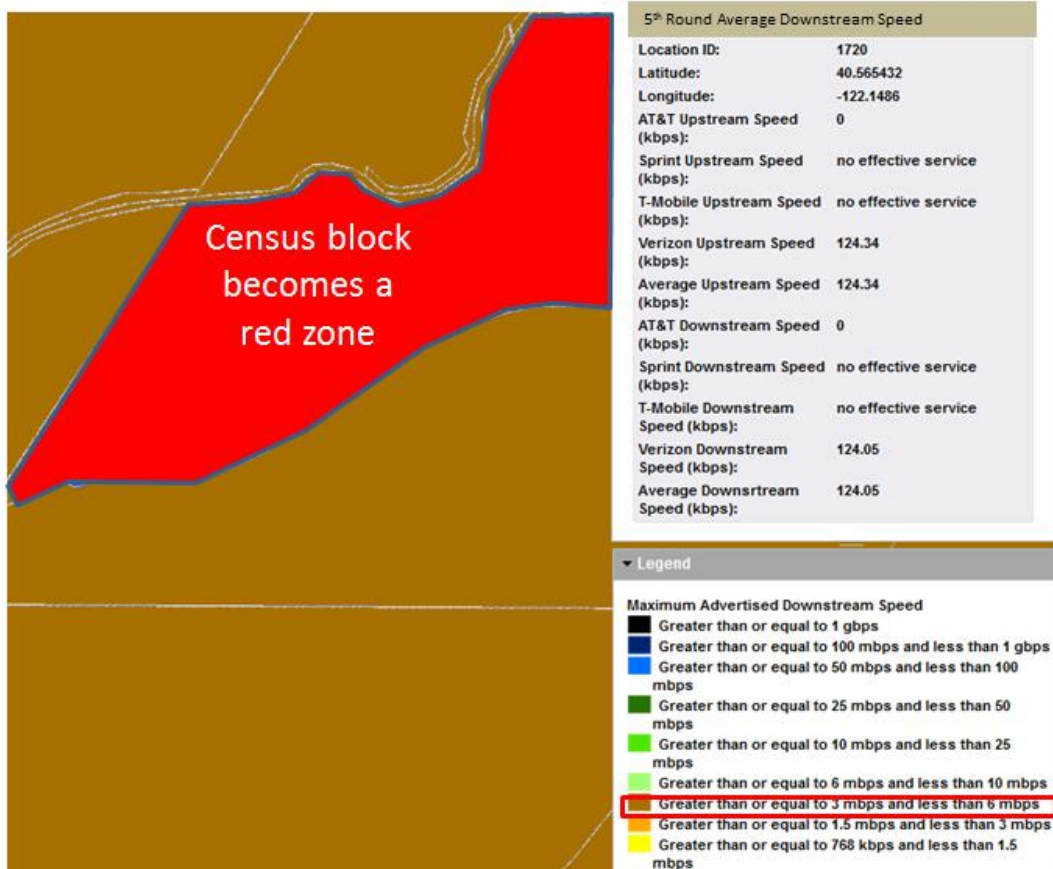
Following creation of the red zones from our validation process, the red zones were clipped from the provider's shapefile. The post-validation shapefile (brown areas only in the example below) is what was submitted to the NTIA and shown on the California state broadband availability map for this round of data collection.

Mobile – to NTIA

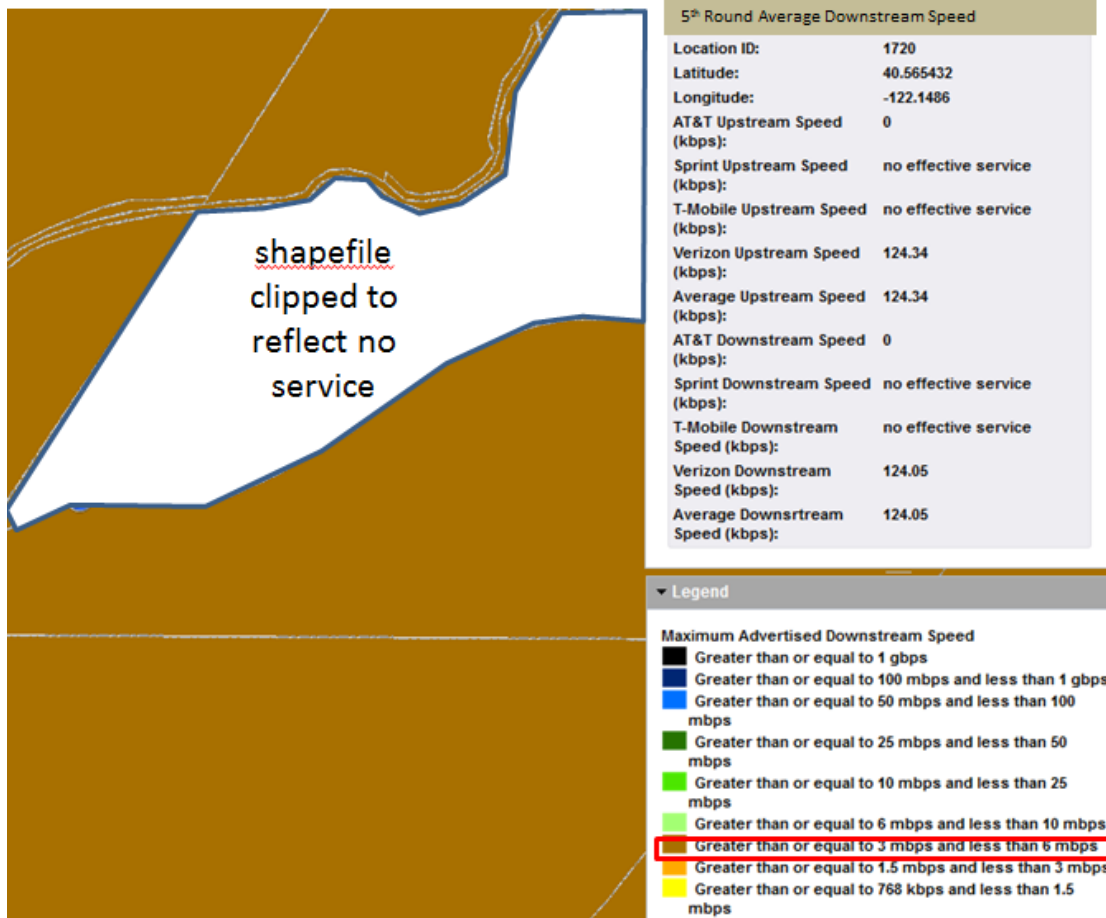Location 1720 - 9201-9289 Brookdale Rd, Millville, CA 96062 4.0 ft S

5th Round Average Downstream Speed	
Location ID:	1720
Latitude:	40.565432
Longitude:	-122.1486
AT&T Upstream Speed (kbps):	0
Sprint Upstream Speed (kbps):	no effective service
T-Mobile Upstream Speed (kbps):	no effective service
Verizon Upstream Speed (kbps):	124.34
Average Upstream Speed (kbps):	124.34
AT&T Downstream Speed (kbps):	0
Sprint Downstream Speed (kbps):	no effective service
T-Mobile Downstream Speed (kbps):	no effective service
Verizon Downstream Speed (kbps):	124.05
Average Downsrtream Speed (kbps):	124.05

shapefile clipped to reflect no service

Legend

Maximum Advertised Downstream Speed
- Greater than or equal to 1 gbps
- Greater than or equal to 100 mbps and less than 1 gbps
- Greater than or equal to 50 mbps and less than 100 mbps
- Greater than or equal to 25 mbps and less than 50 mbps
- Greater than or equal to 10 mbps and less than 25 mbps
- Greater than or equal to 6 mbps and less than 10 mbps
- Greater than or equal to 3 mbps and less than 6 mbps
- Greater than or equal to 1.5 mbps and less than 3 mbps
- Greater than or equal to 768 kbps and less than 1.5 mbps

Process Evolution

As we gather more validation data and add to our list of available third party data sources, we plan to improve the accuracy of validation. With the previous round of data collection, we sent a copy of the red zones to each provider and solicited feedback. Those that provided feedback often provided additional data such as customer addresses to help us better validate service availability and speeds. Many, however, did not provide feedback. It is our hope that this round of data collection will spur further engagement with the providers and help us improve validation for the next round.