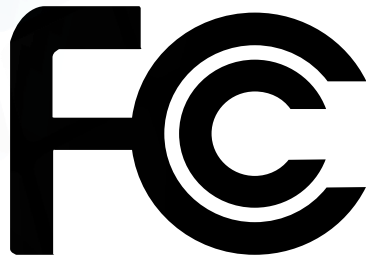




Broadband Engineering Basics



2021 INFORMATIONAL WEBINAR FOR
TRIBAL SPECTRUM LICENSEES

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Mobility Division, FCC

January 7, 2021

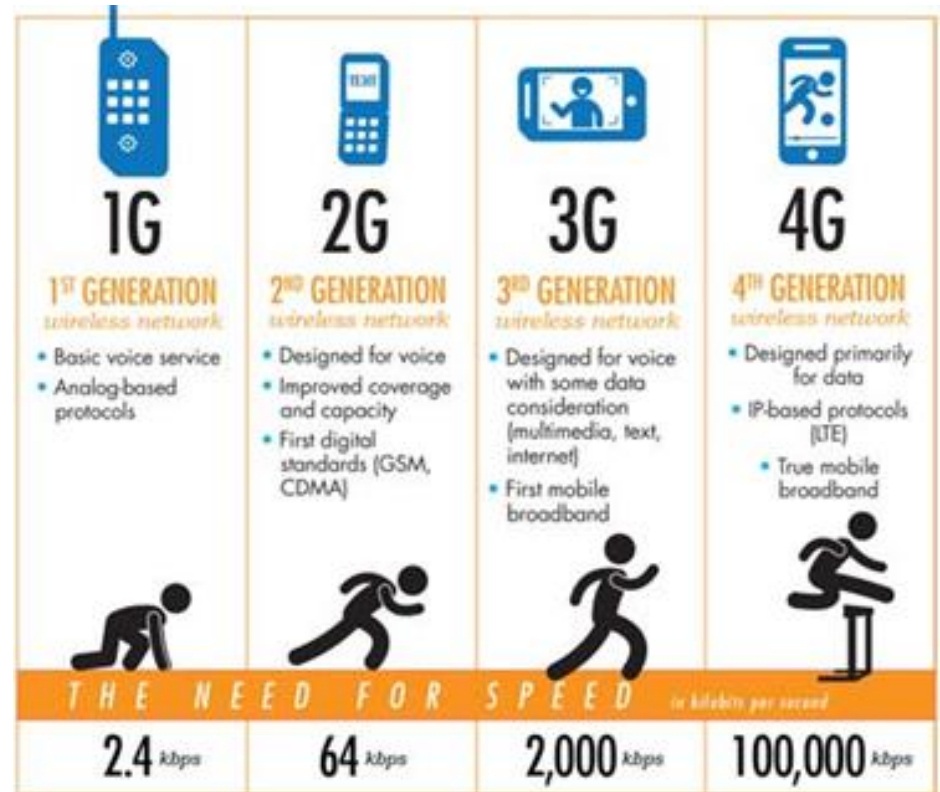
Note: The views expressed in this presentation are those of the author and may not necessarily represent the views of the Federal Communications Commission

Overview

- Basics and terminology
- Basic broadband system architecture
- Spectrum considerations
- Regulatory considerations
- Ongoing developments
- Questions

What's with GGGGG?

- ▶ 1st Generation - analog voice
- ▶ 2nd G - digital voice and text (still in use)
- ▶ 3rd G – data, web content (CDMA, GSM, UMTS)
- ▶ 4th G – high speed bi-directional data (LTE)
- ▶ 5G factors – higher order modulation, advanced antenna systems, increased cell density, use of higher frequencies for more bandwidth. Integrated machine to machine communication. Goal: faster, real time communications



What is 5G?

“New Radio” (NR): is the name developing 5G standards in 3GPP

1-10 Gbps connections to end points in the field (i.e. not theoretical maximum)

1 millisecond end-to-end round trip delay (latency)

1000x bandwidth per unit area

10-100x number of connected devices

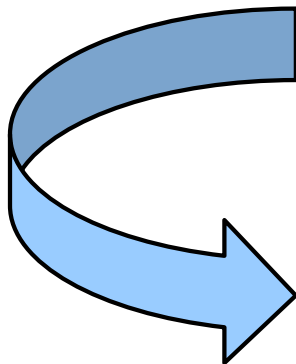
(Perception of) 99.999% availability

(Perception of) 100% coverage

90% reduction in network energy usage

Up to 10 year battery life for low power, machine-type devices

The Specifications



User perception of limitless bandwidth

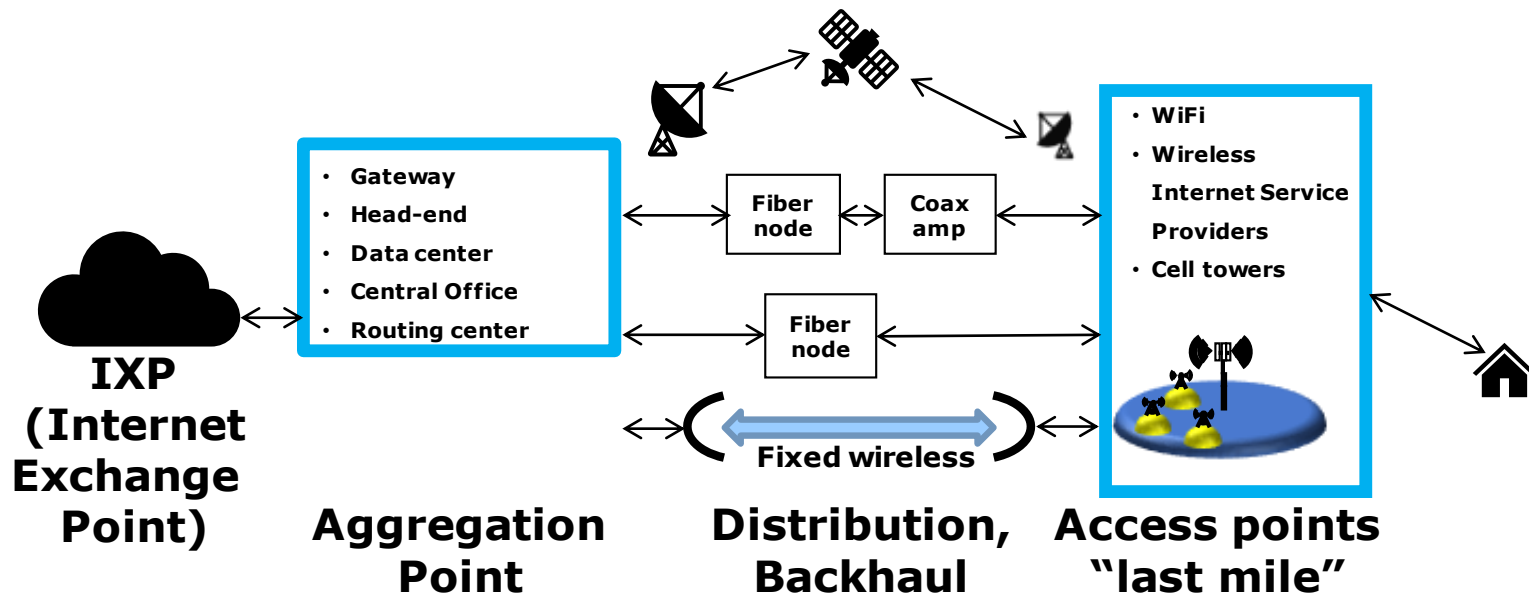
IoT, M2M: Enable connection of billions of devices

New use cases for telemedicine & other high data, low latency apps

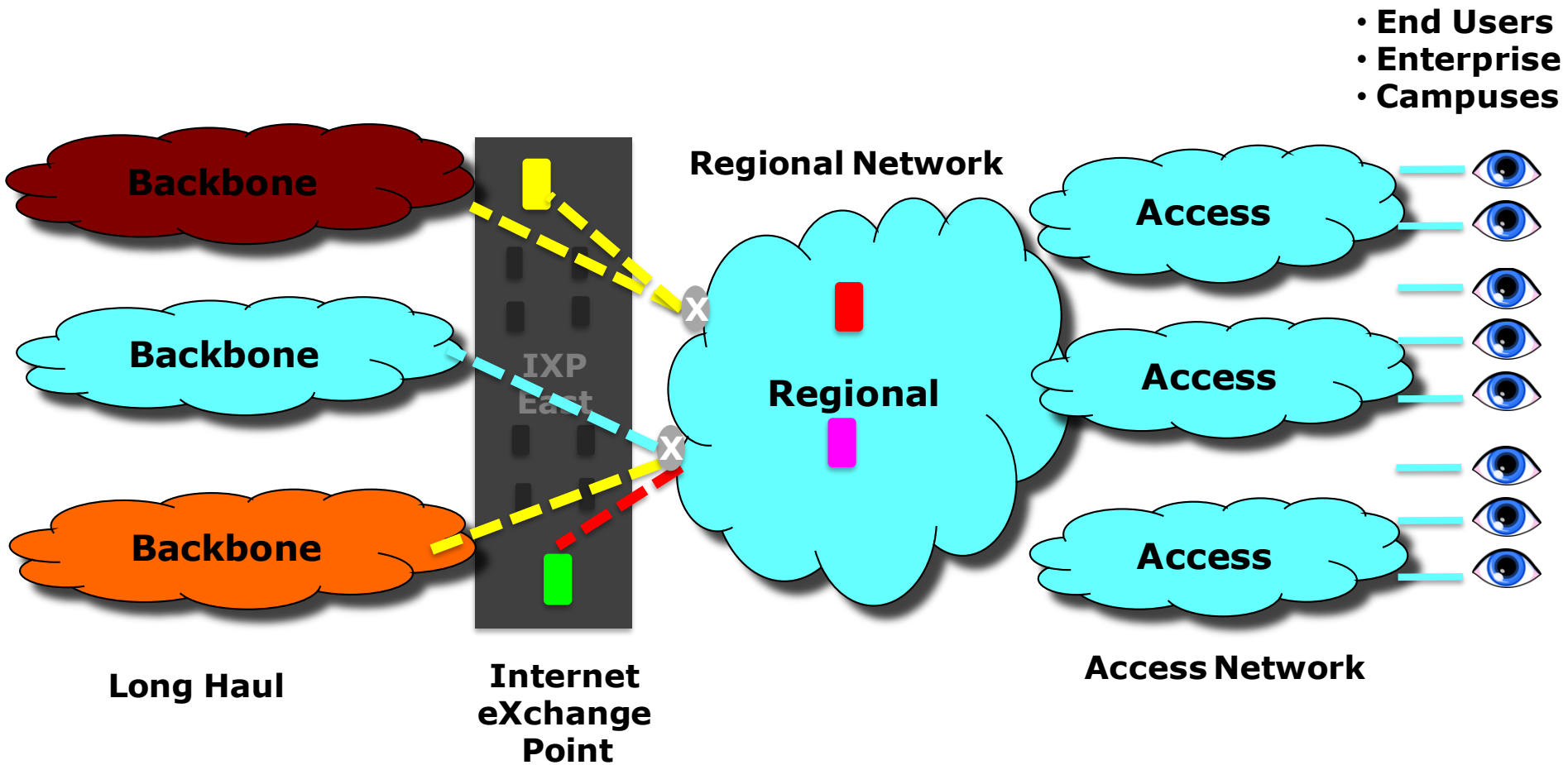
The Goals

Broadband Architecture Basics

- A broadband network needs to connect with the Internet, thus an Internet Exchange Point is critical
- Potential components and architectures across various platforms for the local broadband network are shown below



Interconnection Topology



Spectrum Considerations

The FCC manages and regulates spectrum for commercial (non-federal) uses – later we will explore related policy considerations

Below are some of the factors to consider when planning the wireless portions of a broadband deployment:

- Lower frequencies travel further, but higher frequencies provide more bandwidth
- Are you looking for mobile broadband or service to a fixed location?
- Spectrum availability and cost; varies between urban and rural deployments
- Equipment availability and cost, established bands have more equipment options
- Scope of deployment and whether you need exclusivity

Allocations vs. Assignment

- Allocation Categories: Mobile, Fixed, Broadcast, Fixed Satellite Service Uplink...etc.
- Allocation Status: Primary (protected), Co-primary (coordinated), Secondary, and Must Accept Interference (unlicensed)
- Assignment is obtaining authorization to use a frequency band at a location (aka obtain a license)
- The license and rules typically dictate what frequencies are assigned for what purpose, geographic scope, and maximum technical parameters (power, antenna height, spurious emission limits)

Spectrum Access

- Licensed service
 - *Geographic area licensing*
 - Exclusive assignment of a block of spectrum over a defined geographic area
 - Generally assigned by auction, but secondary market process is very flexible
 - *Coordinated site-based licensing*
 - Fixed backhaul (aka microwave or links), some satellite and narrowband land mobile
 - Can be shared or exclusive, but coordination is used to prevent interference

Spectrum Access

- License by Rule
 - Shared, but with some status
 - Citizens Broadband Radio Service (CBRS) General Authorized Access (GAA) and Part 95 (CB, FRS, Medradio)
- Unlicensed
 - Free access, flexible rules, low power, but no protection or rights
 - UNII, Wifi

Licensed Mobile Spectrum Considerations

- True mobility typically requires licensed spectrum, which can be expensive to obtain through auction or the secondary market
 - Customers expect wide area coverage
 - Spectrum is often more readily available in rural areas
 - Easier to cover large areas with wireless and can call 911 on the road
 - More power, interference protection, certainty compared to unlicensed
- License term typically 10-15 years, with the potential for renewal
- Regulatory requirements:
 - Meet construction requirements, renewal requirements, 911 and others
 - Update ULS to keep your records up to date

Obtaining Spectrum Through the Secondary Market

- Commission has provided for flexible secondary market options
- Contact us – we are here to help you navigate ULS, applications, processes...
- Transfer of Licenses
- Spectrum leasing
 - Other licensee still owns the license, but you get access under negotiated terms
 - Licensee must keep the license in good standing

Obtaining Secondary Market Spectrum

- Partitioning (breaking off a geographic area)
 - You get your own license and will have your own regulatory requirements
 - We do not usually aggregate licenses back together
 - Be mindful of the size of the area due to construction requirements and emission limits at the license boundary
- Disaggregation (breaking off bandwidth)
 - Be mindful of how much bandwidth you need with evolving broadband demands and technologies
 - Can disaggregate and partition in one application

Licensed Fixed Spectrum Considerations

- 47 CFR Part 101 point-to-point for backhaul:
 - Relatively low coordination and filing fees \$300 application fee, \$500-600 coordination fee per link
 - Can achieve line of sight distances of 20-30 miles
 - Scalable spectrum blocks to meet demand (e.g., 30 MHz channels)
 - Explore leasing capacity on existing paths
- Fixed point-to-multipoint services
 - Spectrum Frontier bands above 24 GHz
 - High bandwidth for the last mile, but short range; evolving uses for fixed mobile
 - Past attempts failed due to equipment challenges and competition, but renewed interest thanks to 5G and greater bandwidth demands
 - 2.5 GHz band is used for last mile fixed or mobile with better propagation

License-Free Spectrum Considerations

- Shared bands
 - Must share with services like radars and baby monitors
 - No protection rights, power limits, but flexible rules and few regulatory obstacles
- 47 CFR Part 15, Unlicensed
 - Fixed links at 902, 2400 and 5725 MHz
 - Can reach several miles depending on factors
 - 1 watt and varying antenna gain depending on the band
- White spaces in TV bands

License-Free Spectrum Considerations

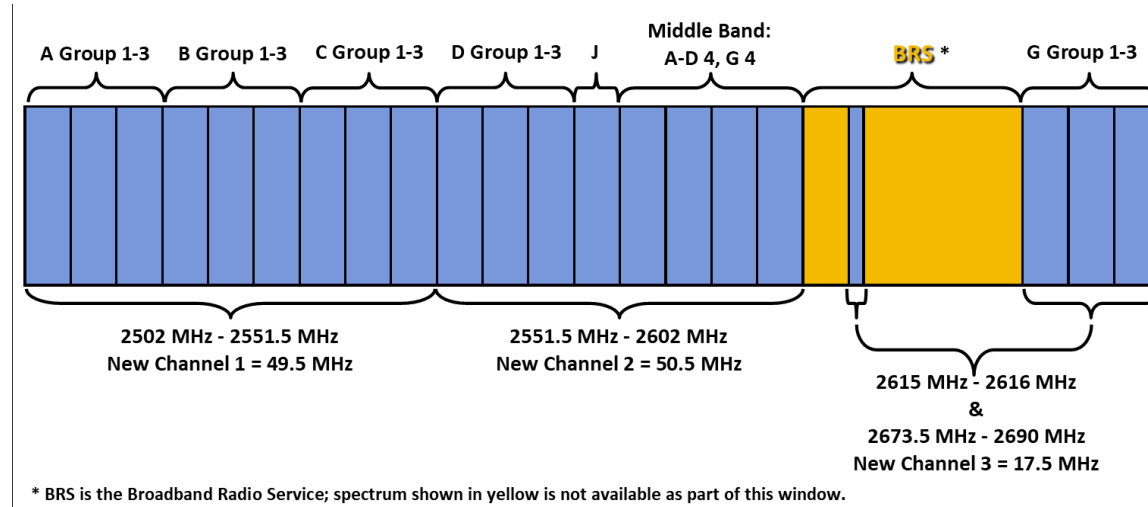
- Unlicensed WiFi and Wireless Internet Service Providers (WISPs)
 - Affordable equipment, good for small cluster of homes, but limited range
- 3550-3700 MHz CBRS
 - Mid-band spectrum has licensed and unlicensed options for 5G local access in 10 MHz channels
 - Access controlled by a dynamic spectrum access system to protect incumbents and priority entities that paid for the spectrum
- Unlicensed Spectrum Frontier bands good for very short hops with wide bandwidths

TV White Space Changes (Part 15)

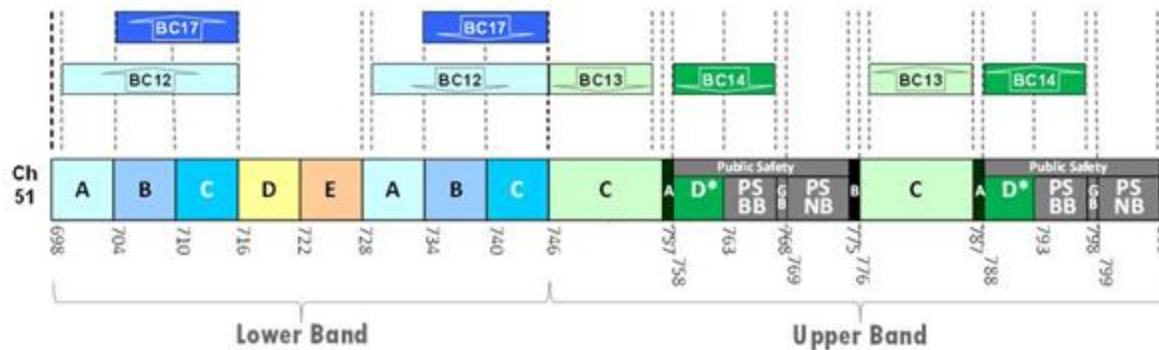
- Order adopted in October 2020 (FCC 20-156) expands ability of white space devices to deliver wireless broadband services
 - In “less congested”, e.g., rural areas: higher fixed and mobile power - up to 16 watts and higher antenna height above average terrain
 - In all areas: eliminated antenna height above ground limit and rule changes to allow narrowband IoT devices
- Considerations:
 - PROS: excellent VHF/UHF propagation, license free, TV channels generally lightly used in rural areas
 - CONS: still have to work around TV and wireless microphone operations, lack of a license means no exclusive rights to the spectrum

Band Plan Examples: Licensed Spectrum

2.5 GHz Band Plan



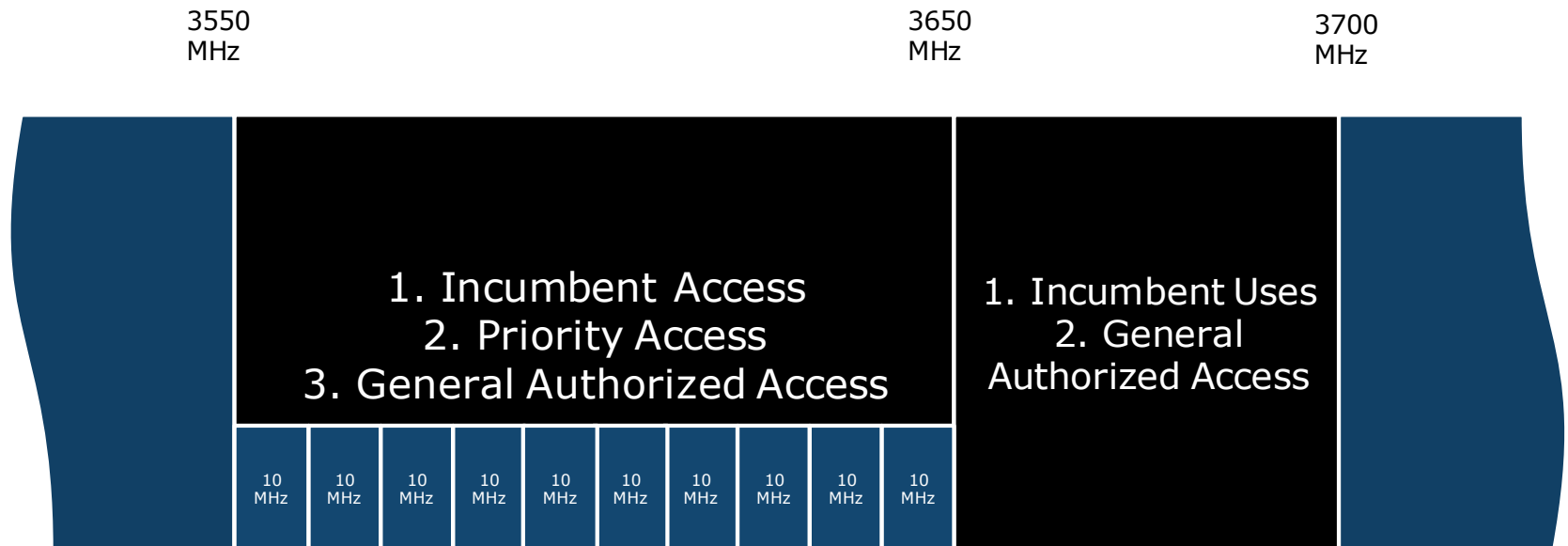
700 MHz Band Plan & 3GPP Band Classes



"BCxx" indicates Band Classes proposed as part of the international 3GPP industry LTE technical standards processes.

*The D Block will be reallocated for use by public safety entities as directed by recent Congressional mandate.

CBRS Band Plan



- Each license is a 10 MHz channel in the 3550-3650 MHz band
- No more than seven licenses will be issued in any county

Spectrum Available for Broadband

Licensed

- Existing commercial wireless bands allow flexible use (600 MHz, 700 MHz, Cellular (800 MHz), PCS (2 GHz), AWS 1.7-2.1 GHz, 2.5 GHz...)
- Expansion of spectrum:
 - Rulemaking on 3.45-3.55 GHz
 - CBRS – 3.55-3.7 GHz Priority Access Licenses and General Access
 - 3.7 GHz Service (280 megahertz)
 - New flexible-use licensed bands within millimeter wave spectrum at: 24 GHz, 28 GHz, 37 GHz, 39 GHz, and 47 GHz

Unlicensed

- Existing unlicensed bands allow flexible use:
 - 915 MHz (902 – 928 MHz)
 - 2.4 GHz (2400 – 2483 MHz)
 - 5 GHz (Total of 600 MHz)
 - 5.7 – 6.4 GHz (6 GHz)
 - Overlay in many other bands
- Expansion of unlicensed:
 - TV “White Spaces”
 - 3.5 GHz – advanced sharing (General Authorized Access or GAA)
 - Relaxed existing 5 GHz rules
 - Repurposed 5.9 GHz band
 - Expanded 6 GHz band
 - New band at 64 – 71 GHz

Developments to Watch For

- CBRS 3.5 GHz roll out
 - 70 MHz of Priority Access county-based licenses just auctioned
 - License free GAA equipment that simply needs to pay spectrum manager fees
 - Could be used for last mile fixed, mobile or private LTE networks
- New TV White Space options
- Mid-band initiatives
 - Docket 18-122 - 5G options at 3.7-3.98 GHz auction ongoing
 - Docket 18-295 – new unlicensed options at 6 GHz
 - Docket 19-348 – 3.45-3.55 GHz for flexible use

Finding Licenses in ULS

License Search - Advanced License Search - Google Chrome

Federal Communications Commission [US] | https://wireless2.fcc.gov/UlsApp/UlsSearch/searchAdvanced.jsp;JSESSIONID_ULSSEARCH=PHKTckdfqYLkYXs6GKQqG...

FCC Home | Search | Updates | E-Filing | Initiatives | For Consumers | Find People

FCC Federal Communications Commission

Universal Licensing System

FCC > WTB > ULS > Online Systems > License Search [FCC Site Map](#)

License Search
Advanced License Search
[License Search Home](#) [HELP](#)

RESET **GEOSEARCH** **SEARCH**

*Please be aware that some combinations of search criteria may result in a longer wait.

Exact Matches Only

Exclude Leases

Call Sign & Radio Services

Call Sign

Service Group

Match all radio services within this group

Match only the following radio service(s):

- GX - SMR, 806-821/851-866 MHz, Conventional
- YC - SMR, 806-821/851-866 MHz, Auctioned
- YD - SMR, 896-901/935-940 MHz, Auctioned
- YS - SMR, 896-901/935-940 MHz, Trunked
- YX - SMR, 806-821/851-866 MHz, Trunked

Licensee

Name

FRN

City†

State†

ZIP Code†

†: Matches licensee mailing address, not transmit locations.

License Detail

Status All Active Expired
 Canceled Terminated Termination Pending

Authorization Type All Regular STA
 Developmental Demonstration

Date Information

Date Type

ULS Geosearch

License Search - Geographic Search - Google Chrome
Federal Communications Commission [US] | https://wireless2.fcc.gov/UlsApp/UlsSearch/searchGeographic.jsp

[License Search Home](#)

RESET **SEARCH**

Specified Search
The following search criteria will be applied in addition to any information specified below.

Radio Service CL, CW, CY, GR, GX, YC, YD, YS, YX
Authorization Type Regular
Status Active
[Modify Search Criteria](#)

Geographic Search Criteria

Include Nationwide Area of Operations
 Include Continental Area of Operations
 Include Licenses with a Mobile Area of Operations
 Exclude Leases

State/County
You may search on state, county, or both. Use the state list to filter the list of counties. Please be aware that searching on multiple states or counties may result in slower search results.

State(s)
Nevada
New Hampshire
New Jersey
New Mexico

County(s)
NM - Harding
NM - Hidalgo
NM - Lea
NM - Lincoln

Address

Street
City
State All
ZIP Code
Radius Kilometers

Coordinates
This search is based on NAD 83 coordinates ([convert from NAD 27](#)).

Latitude ° ' " N (+)
Longitude ° ' " W (+)
Radius Kilometers

Frequencies

All Frequencies
Frequency Exact MHz

[Show all](#) X

ULS Results, Contact Info, Frequencies

License Search - Search Results - Google Chrome
 Federal Communications Commission [US] | https://wireless2.fcc.gov/UlsApp/UlsSearch/results.jsp

FCC Home | Search | Updates | E-Filing | Initiatives | For Consumers | Find People

Universal Licensing System

FCC > WTB > ULS > Online Systems > License Search [FCC Site Map](#)

License Search [HELP](#)

Search Results

[New Search](#) [Refine Search](#) [Printable Page](#) [Query Download](#) [Map Licenses](#)

Specified Search

State = New Mexico
 County = LINCOLN
 Radio Service = CL, CW, CY, GR, GX, YC, YD, YS, YX
 Authorization Type = Regular
 Status = Active

Matches 1- 10 (of 71)

Page 1 [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [NEXT](#)

	Call Sign/Lease ID	Name	FRN	Radio Service	Status	Expiration Date
1	PA KNHY474	NEXTEL WEST CORP.	0001608363	YX	Active	03/16/2022
2	KNKN217	AT&T Mobility Spectrum LLC	0014980726	CL	Active	10/01/2019
3	KNKN265	NEW MEXICO RSA 6-I PARTNERSHIP	0001838655	CL	Active	10/01/2020
4	KNKN412	CommNet Cellular Inc.	0017329715	CL	Active	10/01/2020
5	PA KNKN598	New Cingular Wireless PCS, LLC	0003291192	CL	Active	10/01/2019
6	KNKQ336	Cellco Partnership	0003290673	CL	Active	10/01/2020
7	PA KNLF277 L	T-Mobile License LLC	0001565449	CW	Active	06/23/2025
8	PA KNLF278 L	New Cingular Wireless PCS, LLC	0003291192	CW	Active	06/23/2025
9	KNLF775	Cellco Partnership	0003290673	CW	Active	09/17/2026
10	PA KNLH597	SPRINTCOM, INC.	0002315950	CW	Active	04/28/2027

Page 1 [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [NEXT](#)

* Please note search results do not return licenses that contain geometry data issues.

ULS Help [ULS Glossary](#) - [FAQ](#) - [Online Help](#) - [Technical Support](#) - [Licensing Support](#)

ULS Online Systems [CORES](#) - [ULS Online Filing](#) - [License Search](#) - [Application Search](#) - [Archive License Search](#)

About ULS [Privacy Statement](#) - [About ULS](#) - [ULS Home](#)

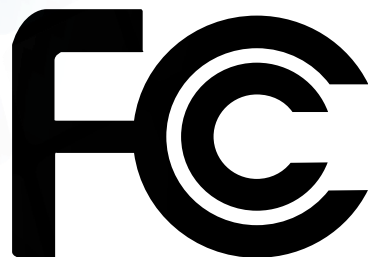
Basic Search By Call Sign = [SEARCH](#)

License Search -html [Show all](#)

Thank You for Your Time

- Questions?
- Reach out if you need us
 - www.fcc.gov
 - 1-888-CALL-FCC (225-5322)
 - thomas.derenge@fcc.gov

Spectrum License Requirements



2021 INFORMATIONAL WEBINAR FOR
TRIBAL SPECTRUM LICENSEES

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January 7, 2021

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Overview

- Introduction
- Buildout Requirements
- License Conditions
- Technical and Operational Rules
- Administrative Updates
- Renewal Application Requirements
- Leasing Requirements
- Discontinuance of Service
- Questions

Introduction

- FCC licensees must comply both with FCC regulations and the conditions on their licenses
 - These rules and conditions includes operational, technical and administrative requirements
 - Licensees are responsible for knowing the applicable rules and staying on top of rule changes
 - “I didn’t know” is not an excuse
- For 2.5 GHz licenses, the relevant FCC rules are in Title 47, Parts 1 and 27 of the Code of Federal Regulations, available at www.ecfr.gov

Buildout Requirements

- Most FCC spectrum licenses have buildout requirements
 - Licensees must construct and operate a system using their licensed spectrum at the specified minimum level within a specified period in order to retain and renew their licenses
 - The buildout requirements vary by band and service
- Under 47 CFR Sec. 27.14(u), Tribal licenses in the 2.5 GHz band have two buildout requirements:
 - An interim deadline 2 years after license grant, and
 - A final deadline 5 years after license grant

Buildout Requirements

- 2-year interim requirement:
 - 50% population coverage, OR
 - 1 link per 50,000 population in the license area (fixed point-to-point service)
- 5-year final requirement:
 - 80% population coverage, OR
 - 1 link per 25,000 in the license area (fixed point-to-point service)
- If the interim requirement is not met, the final deadline accelerates to 4 years after license grant
- Licensees must file a construction notification on Form 601 within 15 days of the relevant deadline

License Conditions

- License conditions are restrictions placed on specific licenses
 - These are in addition to the regulations that apply to all licenses in a band or service
 - Specific license conditions are available in ULS under the Admin tab
- Three types of conditions for 2.5 GHz Tribal licenses
 - Prohibition on operating in areas and on frequencies subject to an incumbent license (all licenses)
 - International coordination with Canada (licenses within either 120 km or 120-160 km of the Canadian border)
 - International coordination with Mexico (licenses within 80 km of the Mexican border)

License Conditions - Incumbents

- 2.5 GHz Tribal “overlay” licenses may overlap with incumbents
 - Incumbent retains the right to operate under the terms of its license
 - New Tribal licensees may not operate on any channel(s) in any area where those channels are **licensed** to the incumbent
 - If the incumbent license is cancelled, terminated, or expires, the new Tribal “overlay” licensee automatically acquires the right to operate in overlap areas
- New licensees can negotiate with incumbents to operate in overlap areas
 - Incumbent contact information is in the Universal Licensing System
 - The Commission does not mediate, arbitrate, or assist in negotiations

License Conditions – Canadian Coordination

- 2.5 GHz Canadian coordination requirements:
 - Within 120 km of the border, 2.5 GHz licensees must comply with current US/Canada coordination requirements before operating
 - Between 120 and 160 km from the border, 2.5 GHz licensees also have certain coordination requirements
- New 2.5 GHz licensees in the affected areas should receive a letter describing their coordination obligations
 - These obligations apply regardless of whether a licensee receives such a letter
 - License as granted contains a specific coordination condition

License Conditions – Canadian Coordination

- Current agreement:
 - *Interim Arrangement Concerning the Use of the Frequency Bands 2150 - 2162 MHz and 2500 - 2690 MHz by MCS and MDS Stations near the Canada/United States of America Border*
 - https://transition.fcc.gov/ib/sand/agree/files/can-nb/Arrangement_M.pdf
- 2.5 GHz licensees are bound by any future US/Canada agreements concerning this band
- 47 CFR Sec. 1.928 further describes affected areas and frequencies

License Conditions – Mexican Coordination

- Within 80 km of the Mexican border, 2.5 GHz licensees must comply with current US/Mexico coordination requirements before operating
- New 2.5 GHz licensees in the affected area should receive a letter describing their coordination obligations
 - These obligations apply regardless of whether a licensee receives such a letter
 - License as granted contains a specific coordination condition

License Conditions – Mexican Coordination

- Current agreement:
 - *Agreement Between the Government of the United States of America and the Government of the United Mexican States Regarding the Assignment of Frequencies and Usage of the 2500 to 2686 MHz Band Along the United States-Mexico Border, as amended in October 1998*
 - <https://transition.fcc.gov/ib/sand/agree/files/mex-nb/finall.pdf> (starting at page 70)
- 2.5 GHz licensees are bound by any future US/Mexico agreements concerning this band

2.5 GHz Technical and Operational Rules

- New 2.5 GHz Tribal licensees should review all relevant technical rules in Part 27 of the FCC's rules
- We will review:
 - Power strength limits at the border - 47 CFR Sec. 27.55(a)(4)
 - Interference Protection - 47 CFR Sec. 27.1221
- Licensees should also review:
 - Power limits - 47 CFR Sec. 27.50(h)
 - Emission limits - 47 CFR Sec. 27.53(m)

2.5 GHz Technical and Operational Rules – Power Strength Limits at the Border

- A 2.5 GHz licensee must meet certain power limits at the border of its license area - see 47 CFR Sec. 27.55(a)(4) for details
- A licensee can operate at a greater power in the absence of an adjacent market operator, but must comply with the limits should an adjacent market operator deploy
- Agreements with adjacent market operators for different power limits are possible
- Absent such an agreement, 2.5 GHz licensees must comply with the applicable limits and must not cause interference

2.5 GHz Technical and Operational Rules – Interference Protection

- Interference protection for 2.5 GHz band stations is based on both:
 - The height of the antenna, and
 - The distance from another operator's base station
- There is no limit on the antenna height, but that height in part determines whether a base station gets interference protection
 - Base stations within their applicable antenna height benchmarking limits are not required to reduce power even if they are causing interference
 - Base stations that exceed their applicable antenna height benchmarking limits must reduce power to come into compliance upon notice
- Technical specifications, process requirements, and applicable height benchmarking limits are located at 47 CFR Sec. 27.1221

Administrative Updates

- Contact Information

- The information in ULS is a licensee's or applicant's official contact information for FCC purposes
- Licensees and applicants should keep their names, addresses, phone numbers and email addresses current in ULS
- If any of its contact information changes, the licensee or applicant should file an administrative update as soon as possible in ULS - 47 CFR Sec. 1.5

- Ownership Information

- If the information contained in a licensee's or applicant's FCC Form 602 Ownership Disclosure changes, a new form should be filed as soon as possible in ULS - 47 CFR Sec. 1.919

Renewal Application Requirements

- All spectrum licenses have a specific term – 10 years for 2.5 GHz licenses
- A renewal application must be filed in ULS on or before the license expiration date and must include an attachment showing that over the license term, the licensee:
 - Provided and continues to provide service to the public, or
 - Operated and continues to operate the license to meet the licensee's private, internal communications needs per the final performance requirements
- The FCC's rules on license renewals contain safe harbors and specify the required information for filings
 - A licensee that does not make an adequate showing will have its renewal application denied and its license cancelled
 - See 47 CFR Sec. 1.949, 47 CFR Sec. 27.14(u), 47 CFR Sec. 27.1205

Renewal Application Requirements

- First renewal safe harbor: the licensee must demonstrate it met both its interim and final performance requirements
- Subsequent renewals safe harbor: the licensee must demonstrate it continues to provide service meeting or exceeding its final performance requirements
- If it cannot meet the safe harbor: a licensee can make an alternative showing of the service provided, to be evaluated on a case-by-case basis

Assignments

- 2.5 GHz Tribal licenses may not be assigned until the build-out requirements are met, and the construction notification is approved
- General assignment requirements:
 - Prior FCC approval is required before any license is assigned to a third party, and an assignment application must be filed in ULS by both parties (the assignor and assignee)
 - The parties also must notify the FCC in ULS after consummation - 47 CFR Sec. 1.948
- Pro forma assignment:
 - The form of ownership changes, but actual control is with the same entity

Leases

- 2.5 GHz Tribal licenses can be leased, in whole or in part, at any time
- FCC approval is required for all leases
 - What one must file and when depends on the type of lease involved; in some cases, prior FCC approval may be required
 - Key factors are who retains control over the license, manages the network, and is responsible for compliance with FCC rules
 - Approval process involves an application filed in ULS by both the lessor and lessee
 - See 47 CFR Sec. 1.9001 *et seq.* for more details

Discontinuance

- Permanent discontinuance of service or operations is defined as 180 consecutive days during which a licensee does not operate or provide service to at least one subscriber
- Starting from when the licensee is required to be providing service or operating, if a licensee permanently discontinues service or operations during the license term, the authorization will automatically terminate without specific Commission action - 47 CFR Sec. 1.953
- A licensee may file a request for a longer discontinuance period for good cause
 - An extension request must be filed at least 30 days before the end of the applicable discontinuance period
 - Filing an extension request will automatically extend the discontinuance period a minimum of an additional 30 days or the date upon which WTB acts on the request, whichever is later - 47 CFR Sec. 1.953

Thank You for Your Time

- Questions?
- Email: RuralTribalWindow@fcc.gov
- For the full text of rules applicable to 2.5 GHz licenses: see 47 CFR Parts 1 and 27 online at www.ecfr.gov