NATIONAL TRIBAL BROADBAND SUMMIT

BROADBAND ENGINEERING FUNDAMENTALS

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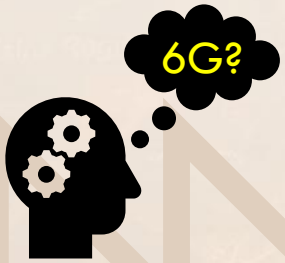
Note: The views expressed in this presentation are those of the author and may not necessarily represent the views of the Federal Communications Commission

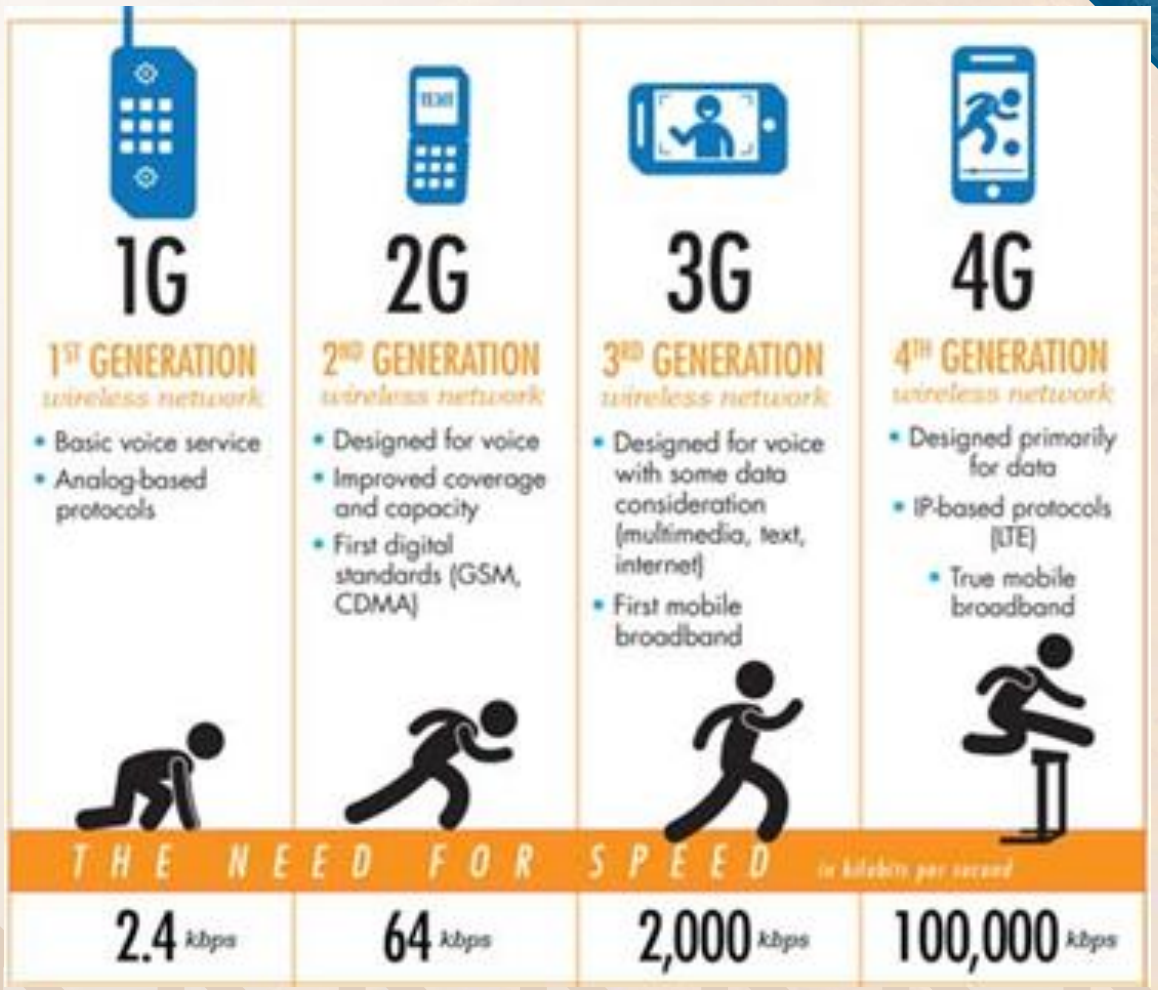
OVERVIEW

- Radio Frequency (RF) basics and terminology
  - Spectrum
- Basic Broadband system architecture
- Spectrum Consideration
- Regulatory Considerations
- Citizens Broadband Radio Service
- Questions

WHAT'S WITH GGGGG?

- Generations of wireless evolution:
  - 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





Source: https://www.blog.aquadsoft.com/evolution-of-generations-of-internet-1g-to-5g/

WHAT IS 5G?

"New Radio" (NR): developing NR 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

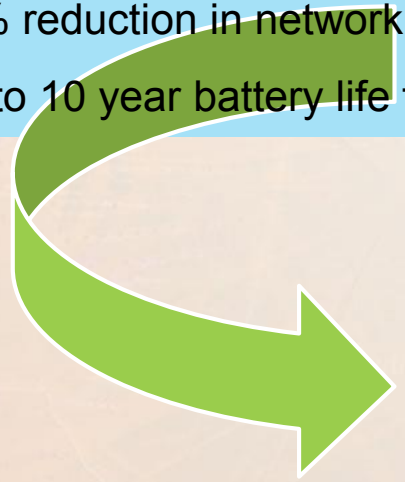
(Perception of) 99.999% availability

(Perception of) 100% coverage

90% reduction in network energy usage

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

The Specifications



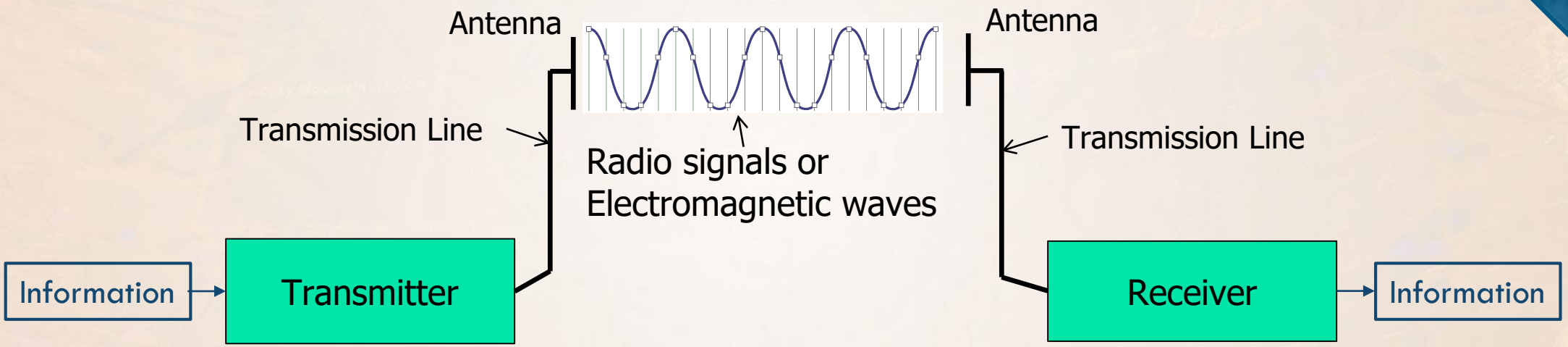
User perception of limitless bandwidth

IoT, M2M: Enable connection of billions of devices

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

The Goals

WIRELESS BASICS



The transmitter generates a wireless signal based on the information and feeds it to an antenna by a transmission line

The receiver detects the signal and recovers the information.

Frequency = number of cycles per second:

- Hertz = 1 cycle per second
- Kilohertz = Thousand cycles per second
- Megahertz = Million cycles per second
- Gigahertz = Billion cycles per second

Wavelength=(Speed of Light)/Frequency

Amplitude= Signal Strength or Power

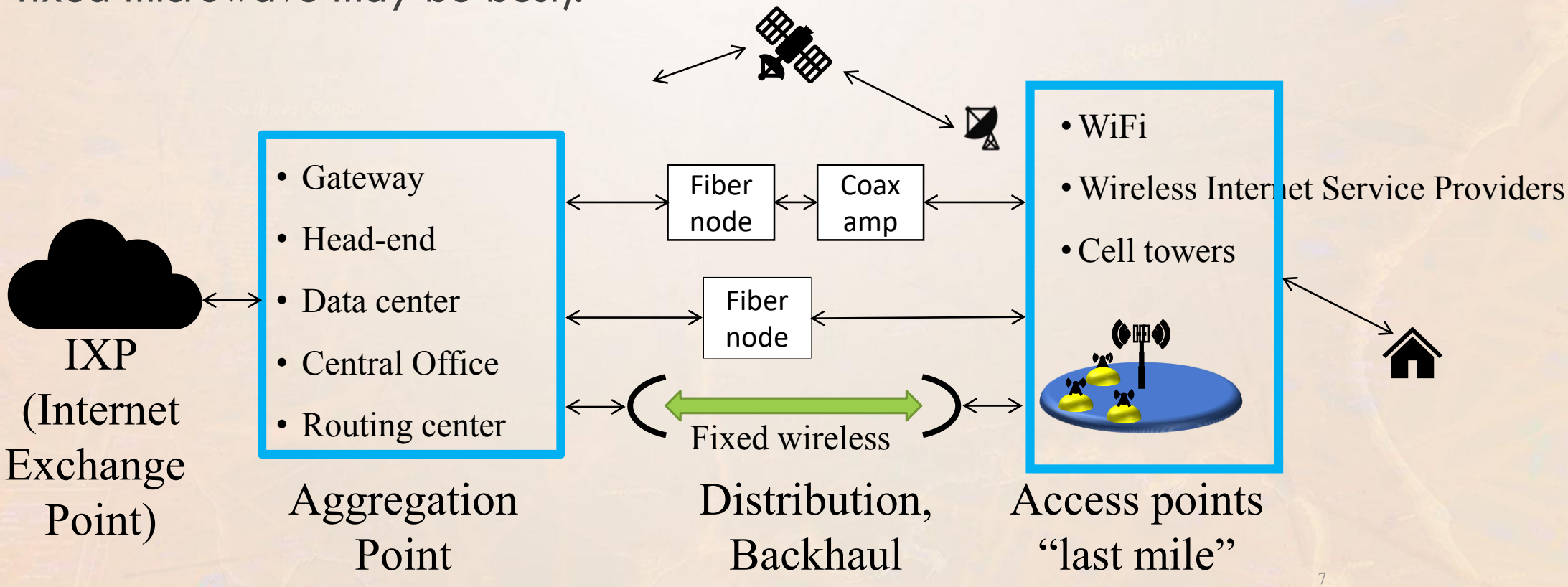
BANDWIDTH (BW)

$$BW = f_{high} - f_{low}$$

- Bandwidth is the amount of RF spectrum occupied by an RF signal.
- Wider bandwidth channels can carry more information.
- Spectrum is a renewable resource that requires management to prevent interference and to enable renewal
- FCC manages non-Federal spectrum use
  - NTIA manages Federal spectrum use.
- Spectrum in the US is either exclusive Federal, exclusive non-Federal, or shared Federal/non-Federal.

BROADBAND ARCHITECTURE BASICS

- Common options and architecture across various platforms below
- Best option depends on the requirements and budget
- i.e., fiber has lots of capacity, but expensive to deploy in rural areas where fixed microwave may be best).



SPECTRUM CONSIDERATIONS

- Lower frequencies travel farther, but higher frequencies have more bandwidth.
- Lower frequencies tend to penetrate buildings better than higher frequencies
- 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.

SPECTRUM ACCESS

- **Licensed service, License-by-rule, Unlicensed**
  - 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 used to prevent interference.
  - License-by-Rule – shared, but with some status: Citizens Broadband Radio Service and Part 95 (CB, FRS, Medradio)
  - Unlicensed – UNII, WiFi
    - Free access, flexible rules, low power, but no protection or rights

DEVELOPMENTS TO WATCH FOR

- 3.5 GHz is rolling out
  - We present information on 3.5 GHz opportunities here!
- 2.5 GHz BRS/EBS Report and Order includes a Tribal priority filing window for unassigned 2.5 GHz spectrum
- Check out FCC Session on 2.5 GHz Spectrum Opportunities
  - Spectrum Opportunities – Federal Communications Commission 2.5 GHz Rural Tribal Priority Window
  - *Catherine Schroeder, Attorney-Advisor, FCC Wireless Bureau, Broadband Division*
- Mid-Band is under going changes
  - Docket 18-122 - exploring 5G options at 3.7-4.2 GHz.
  - Docket 18-295 – exploring new unlicensed options at 6 GHz.
- Auction 103: new flexible use licenses in the Upper 37 GHz, 39 GHz, and 47 GHz bands

IMPORTANCE OF 3.5 GHZ BAND

- Desirable combination of coverage and capacity
- Low-cost entry points to mid-band spectrum
- Attractive propagation and channel width for rural areas
- Key opportunity for deployment of advanced wireless services to Tribal areas

POSSIBLE USE CASES FOR 3.5 GHZ BAND

- Flexible operating rules allow for a wide variety of potential use cases, including:
  - Wireless broadband access
  - 5G services
  - Internet of Things
  - Intelligent manufacturing
  - Power generation and sensor technologies
  - Wireless backhaul

ACCESS TO 3.5 GHZ BAND

- Hybrid sharing regime managed by a Spectrum Access System
- Priority Access Licenses
- General Authorized Access

DIFFERENCES BETWEEN PALS AND GAA

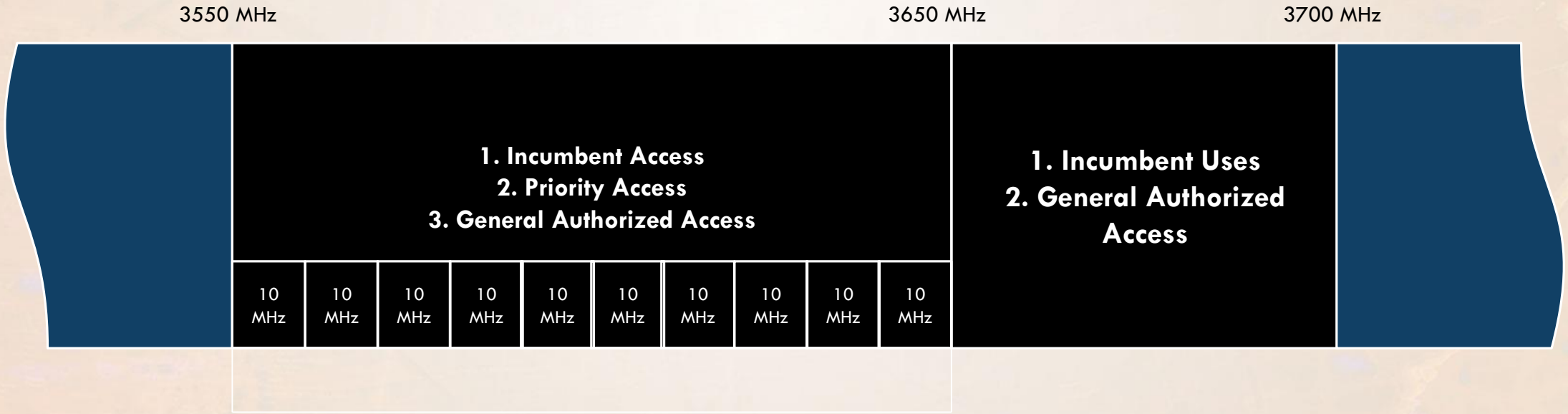
PRIORITY ACCESS LICENSES (PALS)

- 10 megahertz unpaired channels within the 3550-3650 MHz band
- Licensed by auction for a ten-year renewable term on a county-by-county basis
- No more than seven licenses will be issued in any county
- Substantial service requirement at the end of the license term
- Tribal lands bidding credit

GENERAL AUTHORIZED ACCESS

- Operations in the 3550-3700 MHz band
- Licensed by rule
- At least 80 megahertz in any given county available to GAA users
- Can operate on any “unused” Priority Access License channels
- Use spectrum at risk of interference from others in the band

3.5 GHZ BAND PLAN



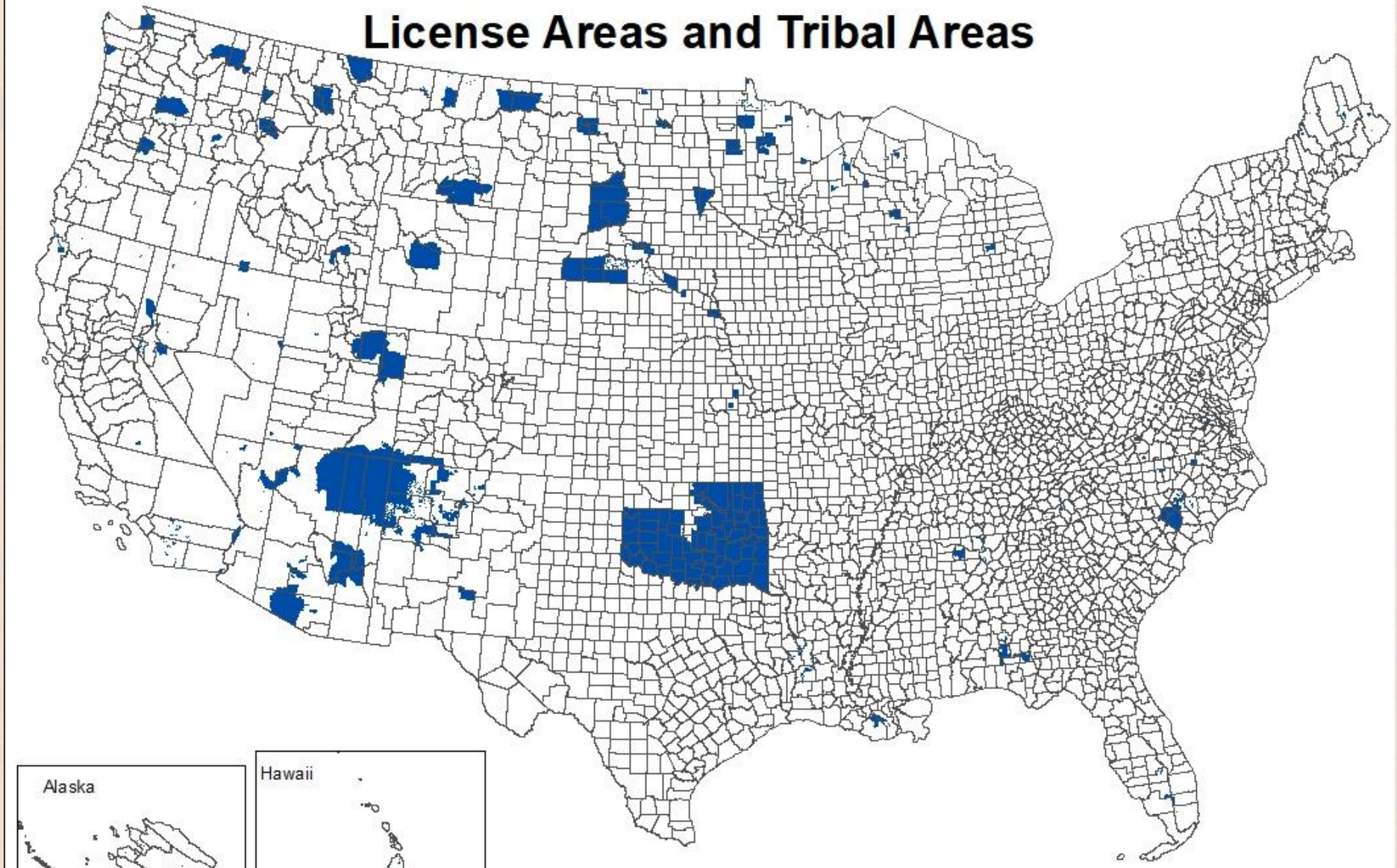
- Each license is a 10 MHz channel in the 3550-3650 MHz band
- No more than seven licenses will be issued in any county

TIMING

- Prior to Operations
  - Priority Access Licenses and General Authorized Access Users must register fixed stations or networks with the Spectrum Access System
  - The Spectrum Access System must authorize Priority Access Licenses and General Authorized Access Users to operated registered stations
- Initial Commercial Deployment of Spectrum Access Systems

For informational purpose only

License Areas and Tribal Areas



3.5 GHZ BAND RESOURCES

- For more information about the 3.5 GHz band, please visit https://www.fcc.gov/35-ghz-band-overview
- To review the history of the 3.5 GHz band, search EDOCs or ECFS for Docket Numbers 12-354, 17-258, 15-319, and 19-244

THANK YOU FOR YOUR TIME

- Questions?
- Reach out if you need us.
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