



# Overview of Broadband Technology Platforms

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**Broadband Workshop**

**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

- The FCC's Broadband Initiative
- Digital Subscriber Line (DSL)
- Cable Broadband Service
- Fiber
- Satellite
- Fixed Wireless Service - Licensed
- Mobile Wireless Service - Licensed
- Wireless Internet Service Providers (WISPs) - Unlicensed



# FCC's Mobile Broadband Agenda

- Removing obstacles to 4G deployment
- Providing fair rules of the road for an open Internet
- Empowering consumers in a vibrant, transparent and competitive marketplace
- Unleashing spectrum for 4G mobile broadband



# [www.broadband.gov](http://www.broadband.gov)

- FCC will release the National Broadband Plan in March
- Staff is exploring ways to remove obstacles to broadband
  - *E.g.*, “Shot Clock” Order adopted in December to address tower siting delays.
- Exploring ways to optimize spectrum use and find more spectrum for broadband



# Comments to the Broadband NOI

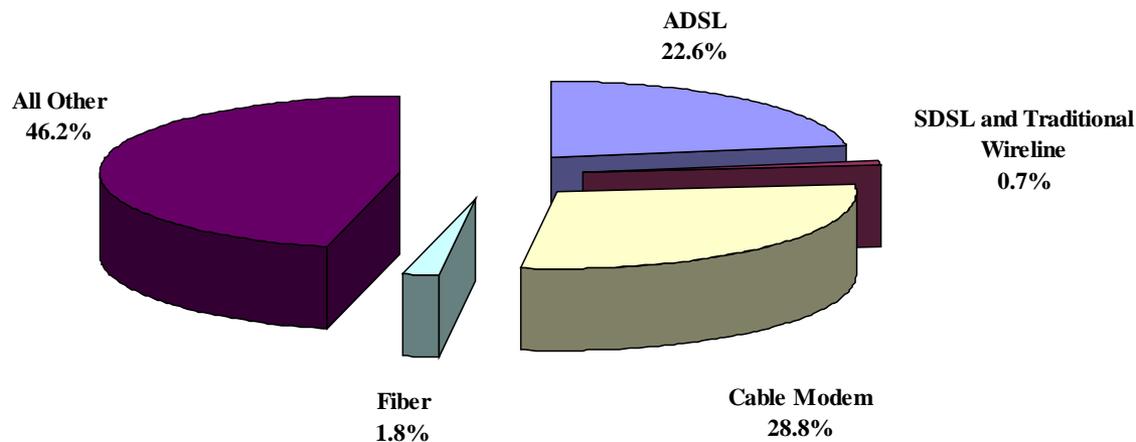
<b>Party</b>	<b>Record</b>
<i>AT&amp;T</i>	Data usage has increased 5000% in the past 3 years
<i>Clearwire</i>	120 megahertz of contiguous spectrum is needed
<i>Fibertower</i>	100 MHz or more will be needed for wireless backhaul
<i>NGMN Alliance</i>	Need more than 120 MHz of harmonized spectrum
<i>T-Mobile</i>	40 MHz is minimum needed for 4G deployment
<i>Verizon Wireless</i>	Will need more spectrum
<i>WiMAX Forum</i>	200+ MHz of globally harmonized spectrum
<i>WCAI</i>	Providers will require 150+ MHz



# Residential Advanced Services Lines by Technology as of June 30, 2008

High Speed Services for Internet Access Reports:

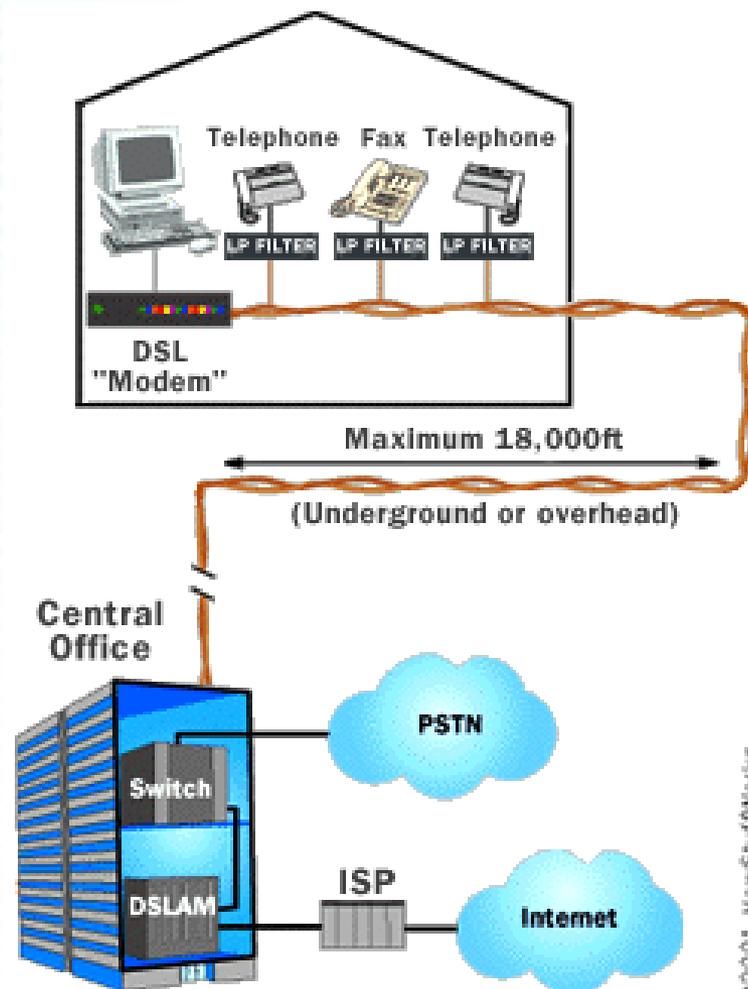
<http://www.fcc.gov/wcb/iatd/comp.html>





# Digital Subscriber Line (DSL)

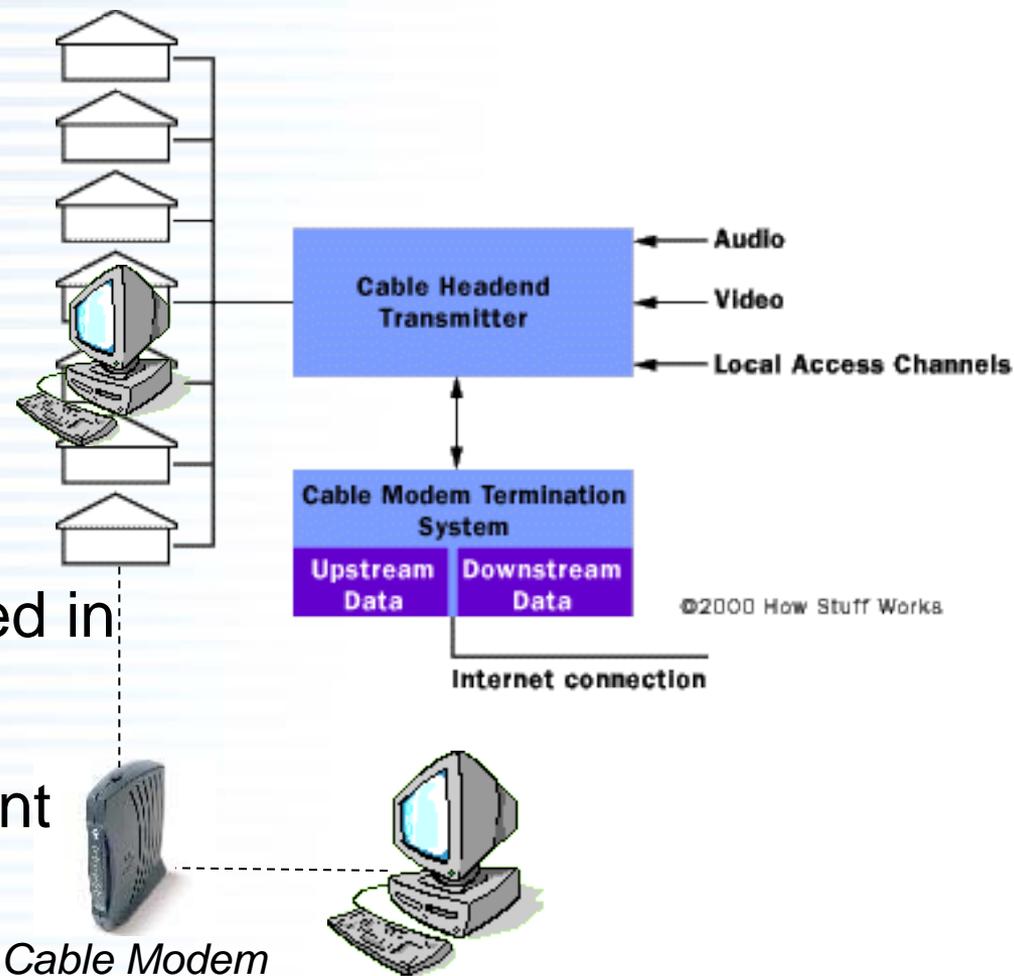
- Most commonly used by local telephone carriers
- Variations: ADSL, VDSL
- Up to 7 Mbs download; 1 Mbs upload
- Distance dependent





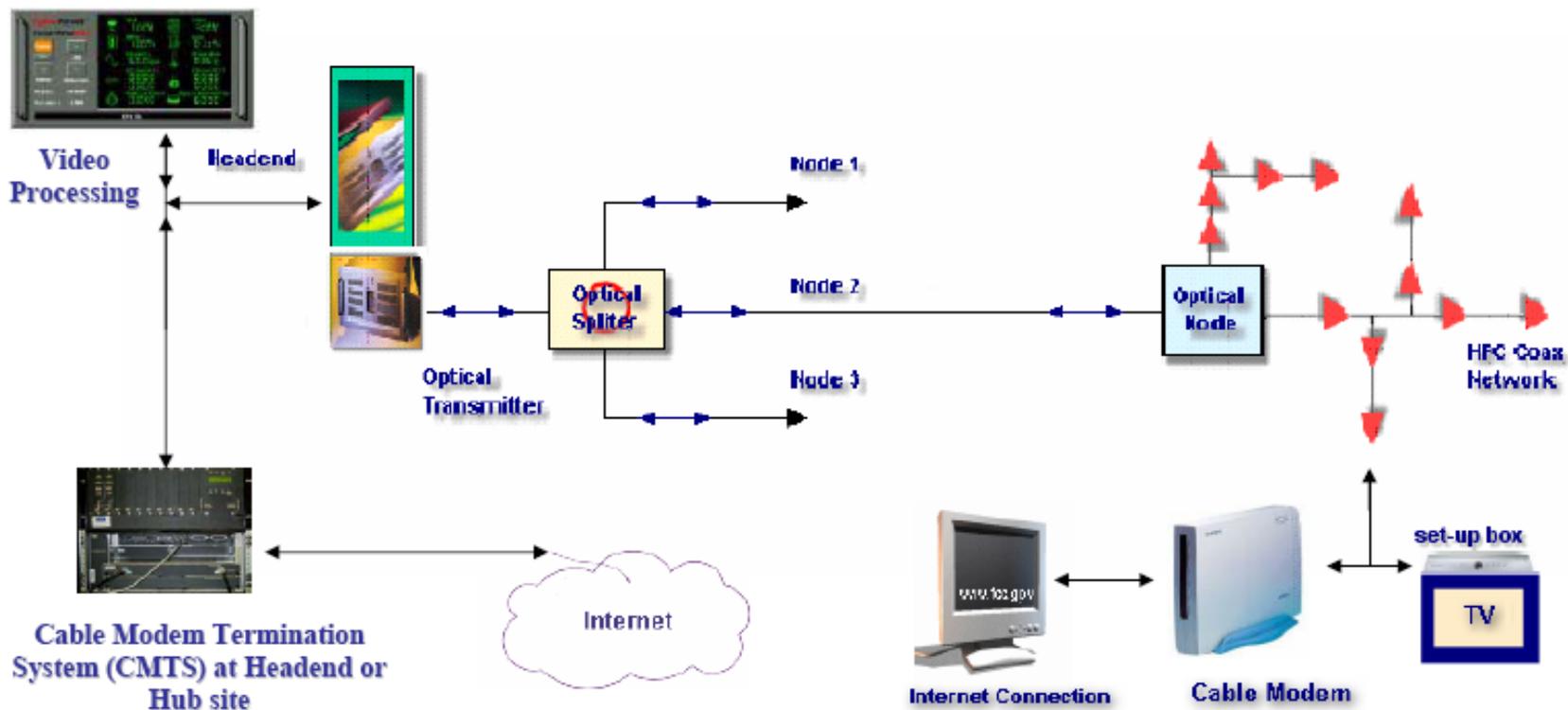
# Cable Broadband Service

- Developed for TV distribution
- Evolved to provide TV/Data/Voice
- Up to 15 Mbs download;  
2 Mbs upload
- DOCSIS 3.0 released in 2006
- Distance independent
- Register w/ FCC



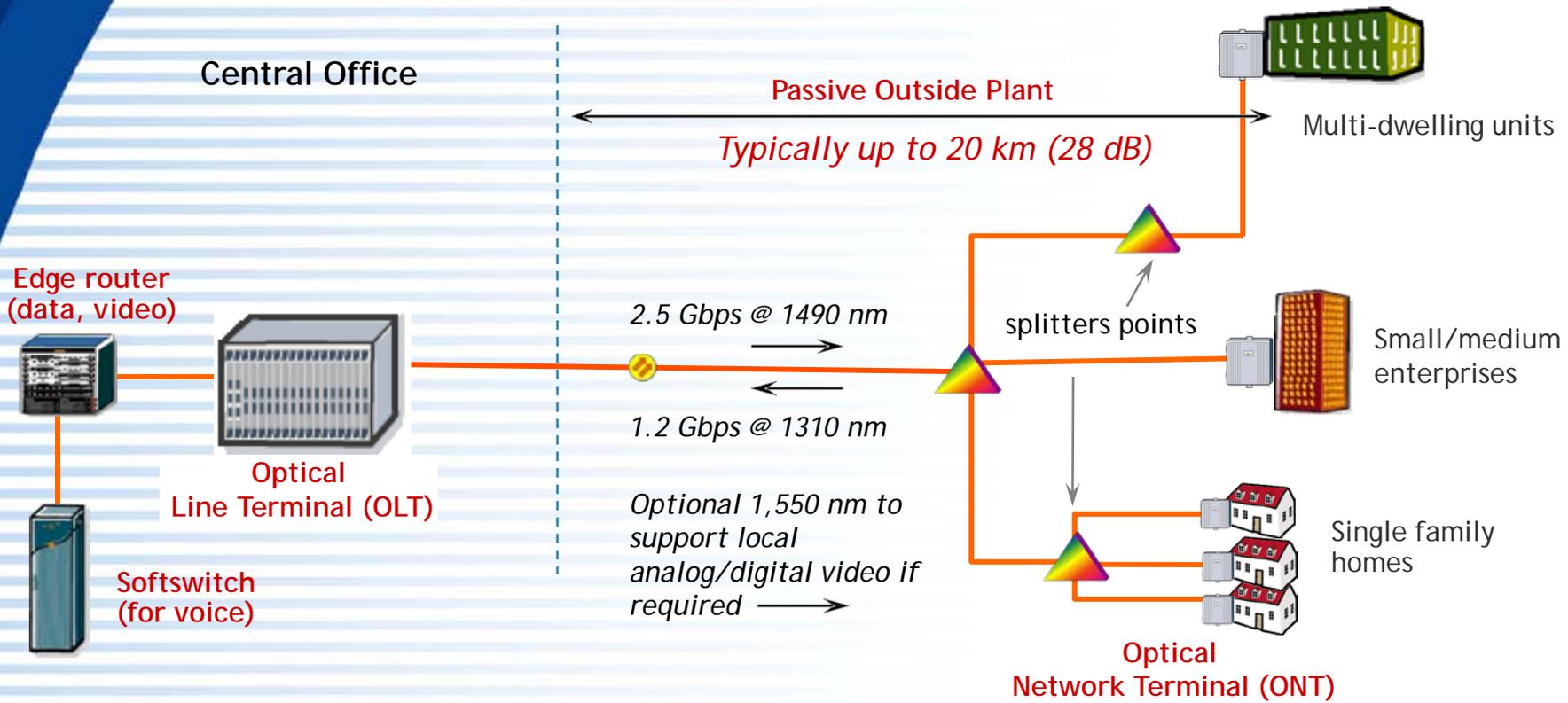


# Hybrid Fiber/Coax (HFC) CATV Network





# Gigabit Passive Optical Network (GPON) Fiber to the Home Architecture



Source: Fiber to the Home Council



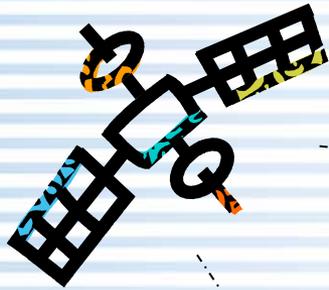
# Satellite

- Geos; Non-Geos; Leos
- Fixed:
  - C-band – 4 & 6 GHz
  - V-Sats – 11 & 14 GHz
- Mobile Satellite Service
- Satellite advantage:  
Ubiquitous coverage
- Limitation: Foliage, rain,  
etc. can affect availability



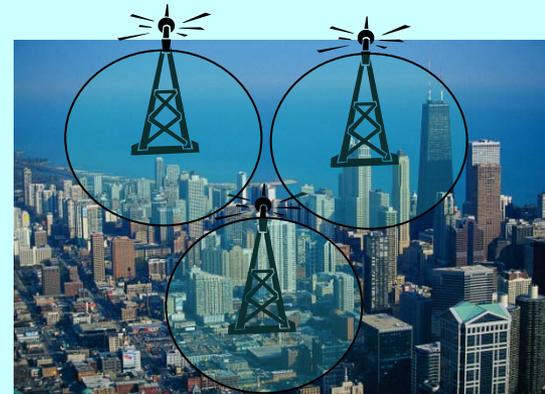


# Mobile Satellite Service Ancillary Terrestrial Component



*Satellite provides ubiquitous coverage, including rural areas*

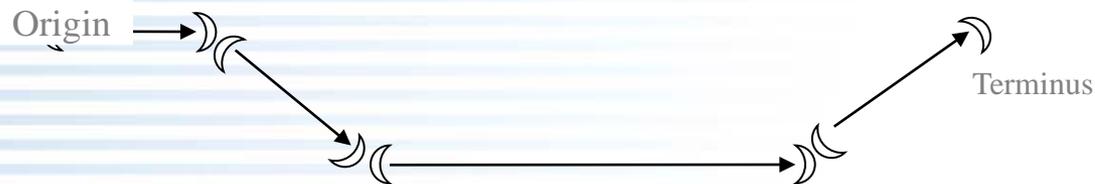
*Terrestrial base Stations provide coverage in areas where satellite signals may be weak*





# Fixed Wireless Services - Licensed

- Traditional fixed point-to-point service: Microwave signals are aimed along a narrow path using high-gain antennas.
- Requires line-of-sight
- Applications: Communications backbones; studio-transmitter links; cable relay



Signals can be carried over great distances by relaying them over multiple “hops”.





# Fixed Wireless Services - Licensed

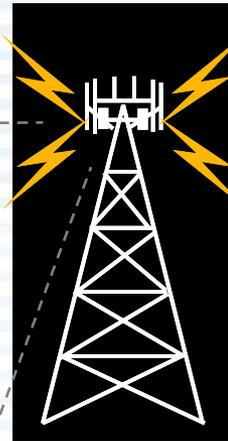
*Examples:*

*Broadband Radio Service/  
Educational Broadband Service*

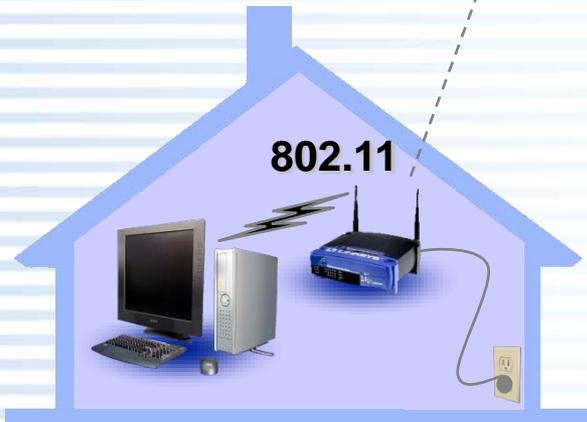
*Local Multipoint  
Distribution Service*



Business  
Access &  
Backhaul



W-Fi



Directly to  
Indoor Modem



Wi-Fi  
Hotspot  
Backhaul



# Mobile Wireless Broadband Service

- The FCC has created multiple mobile radio services suitable for broadband:
  - Cellular Service
  - Specialized Mobile Radio Service (SMRs)
  - Personal Communications Service (PCS)
  - Advanced Wireless Service (AWS)
  - 700 MHz (Recently Auctioned)
- Technologies: GSM family; CDMA family; planned WiMAX
- Various types of service, with data speeds of up to 2 Mbs
- Actual speed depends on several factors
- All of the major technologies have developed evolutionary paths to faster data rates





# Wireless Internet Service Providers (WISPs) - Unlicensed

- Part 15 of the FCC rules provides for operation of unlicensed devices
- Many kinds of devices operate under these low power rules - Wi-Fi
- Various techniques are used to enable broadband service in rural areas
- Data speeds vary
- There are thousands of WISPs operating on an unlicensed basis around the U.S.



**Metropolitan, Rural & Community Networks**



# Wireless Broadband: Licensed and License-Exempt Spectrum Access



# Spectrum Management

- One of the key roles of the FCC in facilitating the deployment of broadband wireless technologies is to make additional spectrum available for these services and technologies
- Mechanisms to make spectrum available
  - Allocate Spectrum to various radio services
  - Develop Service Rules concerning administrative requirements, technical standards, and other operational requirements for shared intra- and inter-service use of the spectrum
  - Assign Frequencies to individual systems or authorize specific equipment use



# Frequency Allocations

- Frequency allocations determine the type of use allowed in the block or band of frequencies
  - Services: Satellite (FSS, MSS...), Fixed, Mobile, Broadcast, Radiolocation, etc.
  - License Exempt: permitted in non-restricted frequency bands (Part 15 devices)
  - Status: Primary, Secondary, Non-Interference Basis
- Spectrum Use Models
  - Exclusive Use
  - Shared Use
  - Commons



# Choosing Spectrum

- Many factors considered when deploying wireless broadband systems
  - Type of service
  - Range of operation
  - End users
  - Interference protection
  - Spectrum availability
  - Equipment availability, reliability, affordability



# Choosing Spectrum

- Broadband systems may consist of a combination of different technologies in different frequency bands and regulatory structures
  - Backhaul may be provided by wireline, satellite, licensed fixed point-to-point, or license-exempt devices
  - Local access may use licensed or license-exempt spectrum depending on the range that is needed, spectrum and equipment availability



# Frequency Assignments, Authorizations

- First-come, First-served (coordinated site based services)
- Market oriented approach to licensing
  - Exclusive licensees receive specific geographic and spectrum blocks
  - Equipment must meet basic technical requirements
  - Have flexibility to offer new applications
- Licensed-exempt use
  - No protection from interference
  - Low cost barrier to entry
- Hybrid licenses
  - Capitalize on benefits non-exclusive, nationwide licenses
  - Licensees register sites to help avoid mutual interference



# Auction of Licenses

- The FCC auction homepage has information on spectrum that has been made available, geographic license areas, spectrum block sizes and other information



- One can then search for specific licensee information using the Universal Licensing System (ULS) and equipment information using the Equipment Authorization System (EAS)





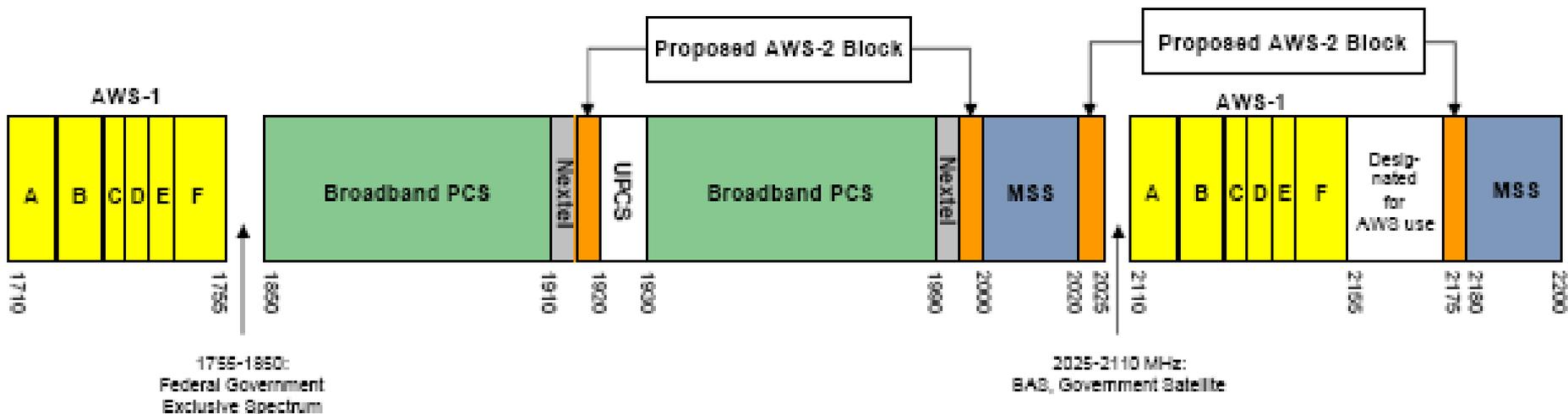
# Rules that Assist Rural Deployment

- Diverse spectrum offerings.
  - Spectrum auctions offer various spectrum block sizes and geographic block sizes
- Secondary Markets
- Construction requirements (Substantial Service filings)
- Tribal Lands bidding Credits
- Small Business Bidding Credits

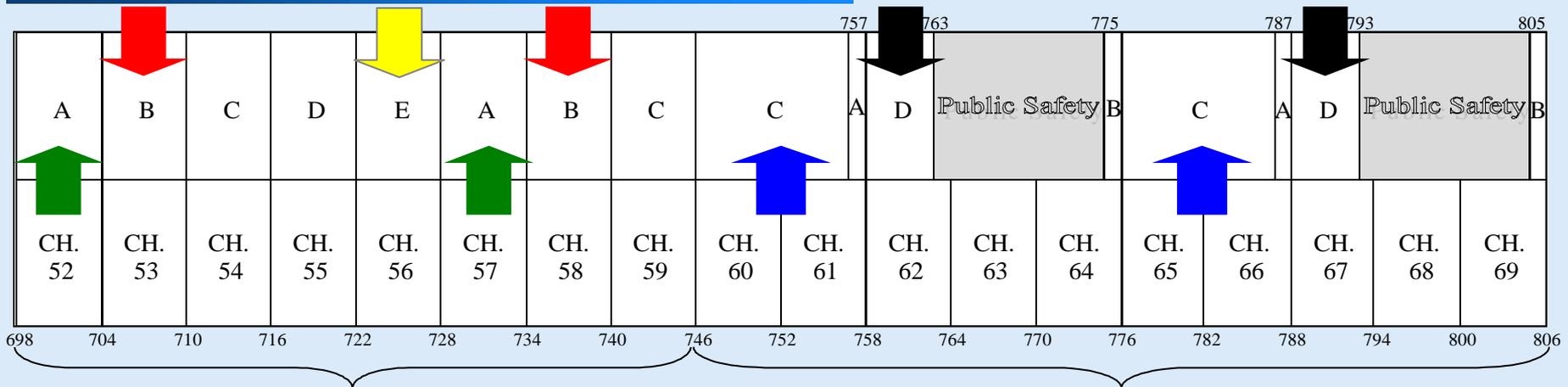


# AWS -1

## Advanced Wireless Services (AWS) Band Plan



# Revised 700 MHz Band Plan



LOWER 700 MHz BAND (CH. 52-59)

UPPER 700 MHz BAND (CH. 60-69)

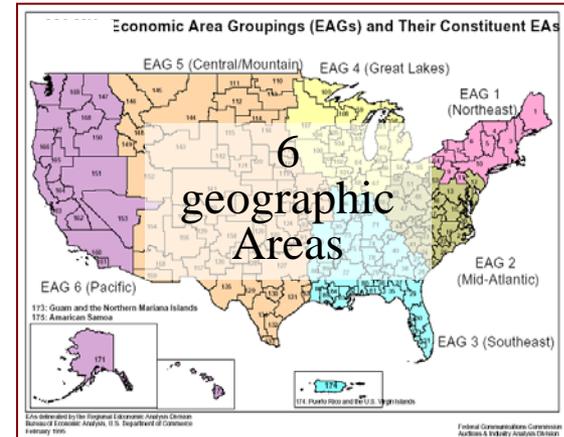
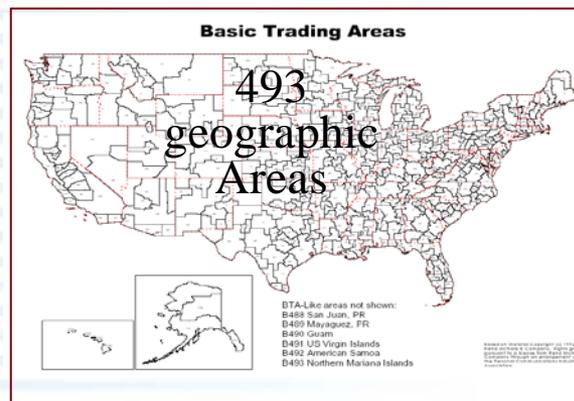
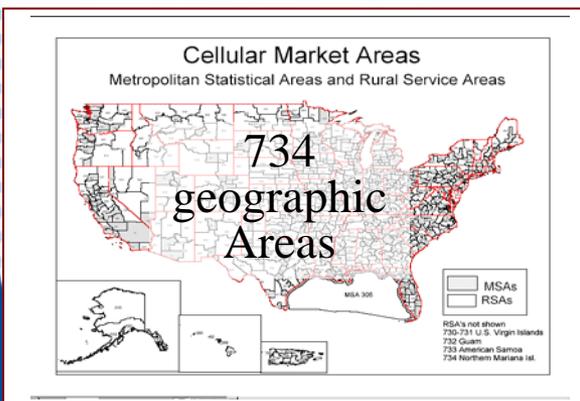
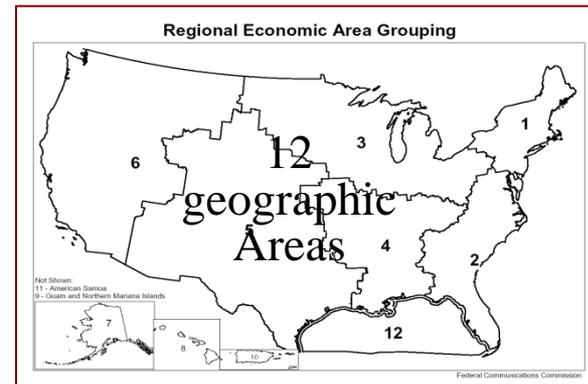
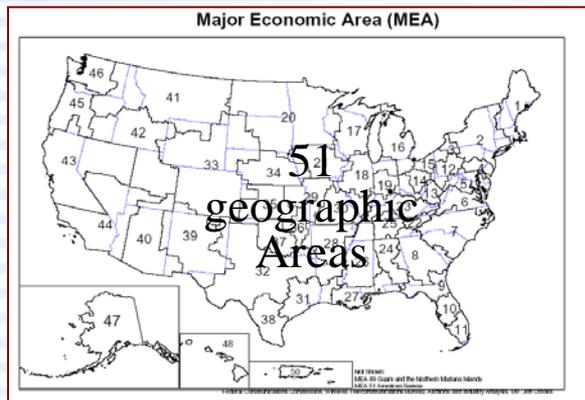
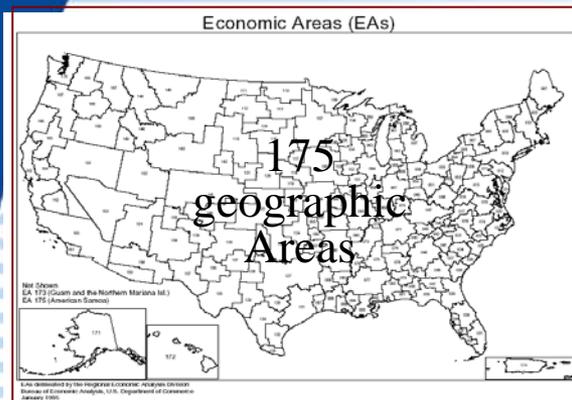
Block	Frequencies	Bandwidth	Pairing	Area Type	Licenses
A	698-704, 728-734	12 MHz	2 x 6 MHz	EA	176
B	704-710, 734-740	12 MHz	2 x 6 MHz	CMA	734
C	710-716, 740-746	12 MHz	2 x 6 MHz	CMA	734
D	716-722	6 MHz	unpaired	EAG	6
E	722-728	6 MHz	unpaired	EA	176
C	746-757, 776-787	22 MHz	2 x 11 MHz	REAG	12
D	758-763, 788-793	10 MHz	2 x 5 MHz	Nationwide	1
A	757-758, 787-788	2 MHz	2 x 1 MHz	MEA	52**
B	775-776, 805-806	2 MHz	2 x 1 MHz	MEA	52**

\*\* These Guard Band Blocks have been auctioned, but are being relocated.



# Service Rules

## Different Geographic Areas for Different Services and Blocks





# Service Rules

- Promote Intra-service and inter-service spectrum sharing and ensures use of the spectrum
  - Technical rules (power limits, frequency and emissions) to control interference
  - Coordination processes, coordination thresholds
  - Construction requirements
  - Discontinuance prohibitions



# Secondary Markets

- Generally refers to a means of accessing spectrum after it has been assigned to an entity.
- Spectrum lease (Sections 1.9020, 1.9030)
- License assignment (Section 1.948)
- Partitioning (breaking up the geographic area)
- Disaggregation (dividing the spectrum)
- **WARNING:** Note the regulatory requirements on a license before entering an agreement.



# Help with Secondary Markets

- FCC hotline can walk parties through the filing process
  - (877) 480-3201 (M – F 8:00 am – 6:00 pm ET)
- <http://wireless.fcc.gov/uls>
  1. License Assignment
    - File FCC Form 603
  2. Spectrum Lease/Sublease
    - File FCC Form 608



# Tower Information

- Towers over 200 feet or within the glide-slope of an airport must obtain FAA clearance and register with the FCC.
- Tower information URL:  
[http://wireless.fcc.gov/index.htm?job=towers\\_antennas](http://wireless.fcc.gov/index.htm?job=towers_antennas)
- This URL can be used to find a tower for your antenna or to learn of regulations.
  - National Environmental Policy Act
  - National Historic Preservation Act



# Licensed Exempt Devices

- Part 15 provides for operation of low power radio transmitters without a license
- Operating conditions:
  - **May not cause harmful interference**
  - **Must accept any interference received**
- Part 15 minimizes likelihood of interference by:
  - **Limiting operation to certain non-restricted frequency bands (Ref. Section 15.205)**
  - **Limiting power to relatively very low levels**
  - **Requiring equipment approval to ensure compliance**



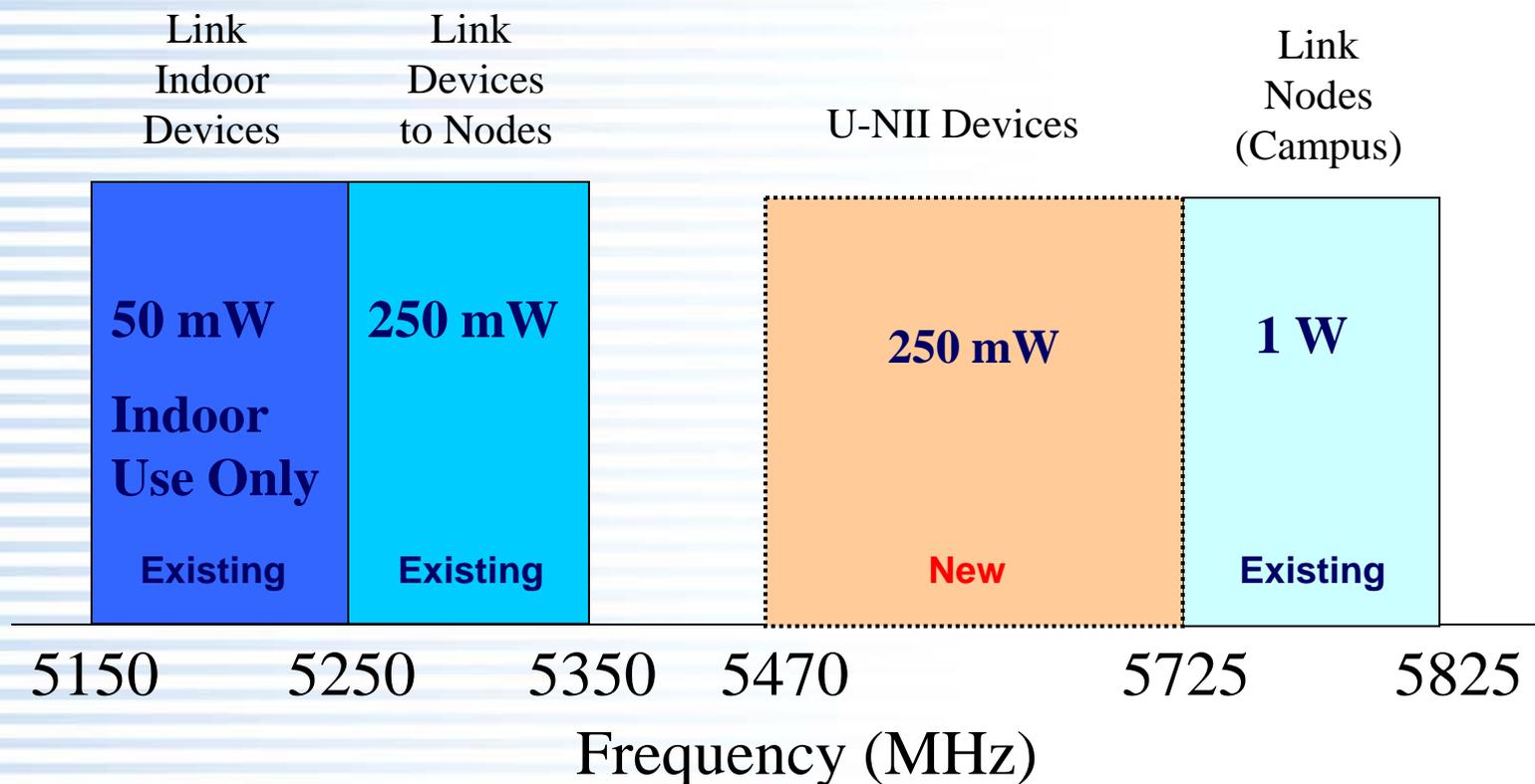
# Licensed Exempt Devices

- On most frequencies, operation is limited to  $< 100$  mW; duty cycle applies in some cases
- Three (ISM) bands allow 1 W transmitter power:
  - 902-928 MHz
  - 2400- 2483 MHz
  - 5725 – 5875 MHz
    - Power reduction for antenna gain  $> 6$  dB



# Licensed Exempt Devices

- **FCC has made available an additional 255 MHz of spectrum for anticipated Wi-Fi growth**
  - **Provides A Total of 555 MHz of Spectrum for unlicensed operations**





# Licensed Exempt Devices

- **IEEE Committee 802.11 developed a family of standards for unlicensed WiFi data networks within the framework of the Part 15 rules**

<b><u>Standard</u></b>	<b><u>Frequency Band</u></b>	<b><u>Modulation</u></b>	<b><u>Data Rate</u></b>
<b>802.11(b)</b>	<b>2.4 GHz</b>	<b>DSS</b>	<b>11 Mb/s</b>
<b>802.11(g)</b>	<b>2.4 GHz</b>	<b>OFDM</b>	<b>54 Mb/s</b>
<b>802.11(a)</b>	<b>5.8 GHz</b>	<b>OFDM</b>	<b>54 MB/s</b>



# TV “White Spaces”

- Spectrum below 900 MHz is particularly well suited for penetrating buildings
- Permits fixed and personal portable devices on certain TV channels
  - Power and out-of-band emission limitations
  - Geo-location and databases
  - Registration



Transmits in  
vacant channel

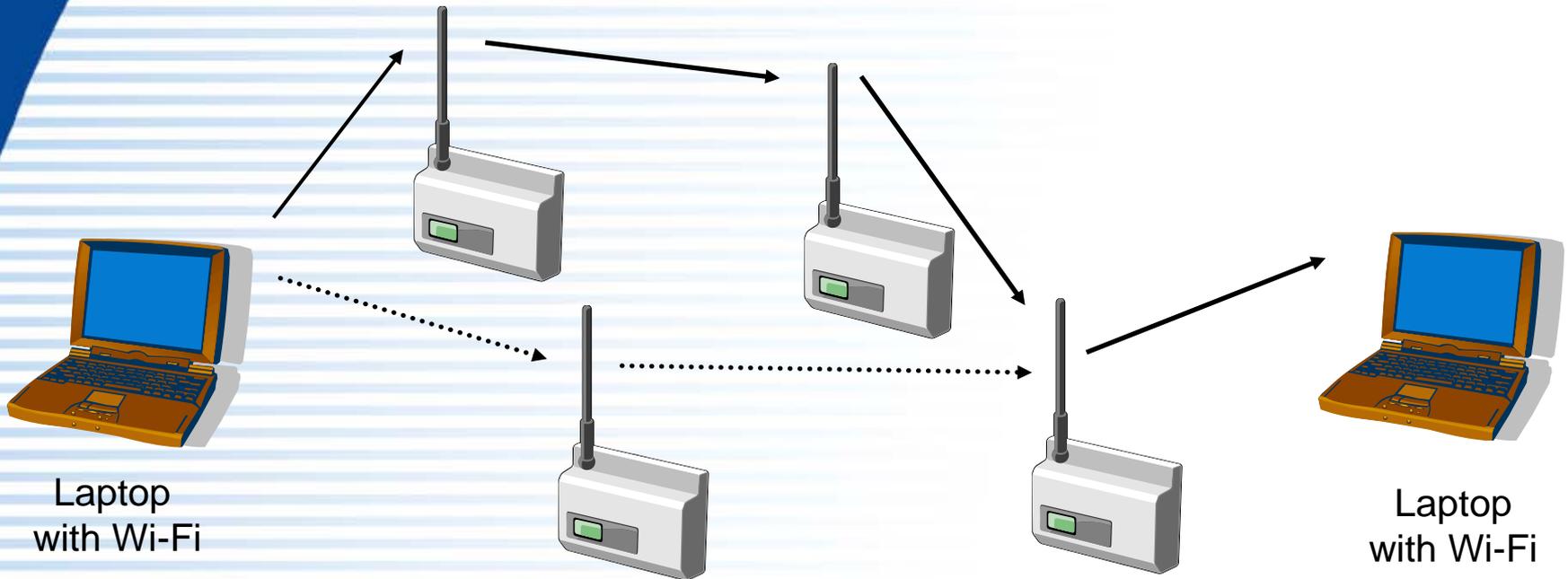
Device identifies  
vacant channels



“White Spaces”  
Are channels left  
vacant in each market



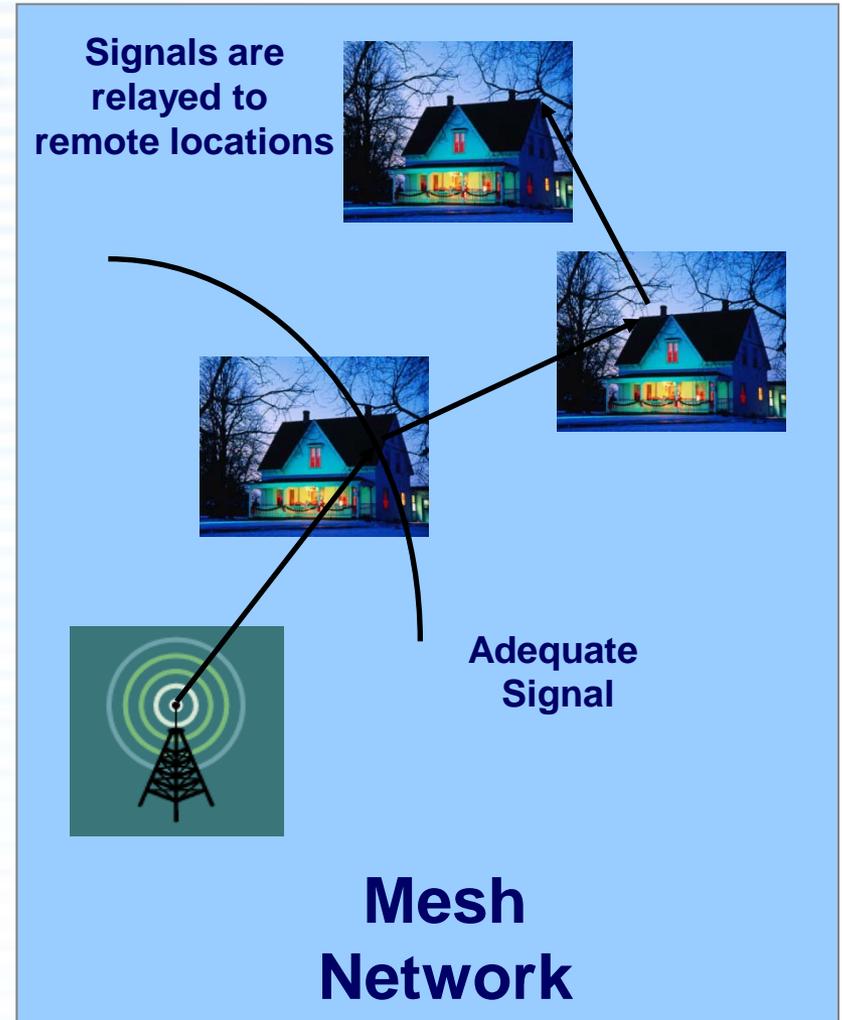
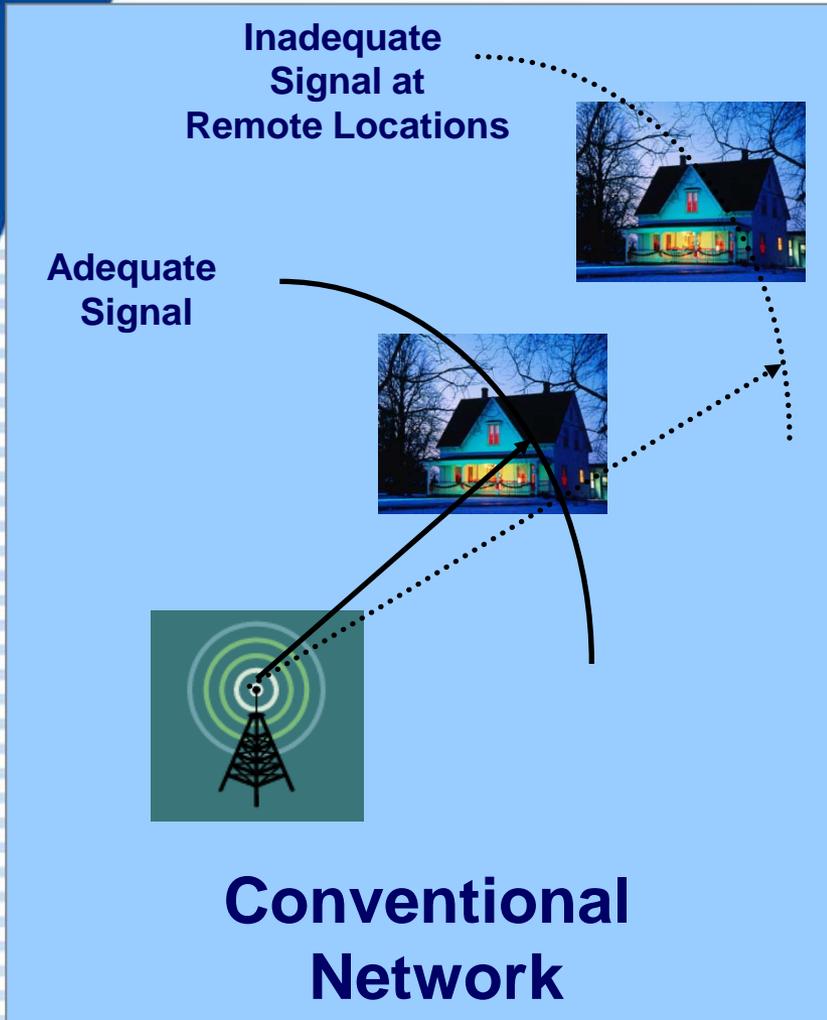
# Wi-Fi Mesh Networks



Mesh networks use each transmitter/receiver as a relay point to provide wide service areas. They are self-forming and provide numerous communication paths- - same principle as the Internet



# Mesh Network Coverage





# Conclusion

Thank you!

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