



What's Next for White Space?

A 'Use it or Share it' Approach to Opening Unused Federal Spectrum Capacity

SDR-WInnComm

January 8, 2013

Michael Calabrese
Director, Wireless Future Project
Open Technology Institute
New America Foundation
calabrese@newamerica.net

The Great Disconnect: **Scarcity Amidst Abundance**

- FCC: “Looming spectrum crisis”
 - “Mobile data demand to grow 25-50 X within 5 years”
 - “The broadband spectrum deficit is likely to approach 300 MHz by 2014”
- Yet NSF studies of actual spectrum use show < 20% beachfront spectrum used in even the most congested cities (NY, DC, Chicago).
- Challenge: Seamless, high-capacity mobile connectivity at affordable prices will require an enormous increase in **overall capacity**

Conventional Wisdom: Spectrum is Scarce

UNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

 AEROMOBILE MOBILE	 WIRE SATELLITE	 RADIO AERONAUTIC
 AEROMOBILE MOBILE SATELLITE	 LAND MOBILE	 RADIO DETERMINATION SATELLITE
 AEROMOBILE RADIOBROADCAST	 LAND MOBILE SATELLITE	 RADIO DETERMINATION
 MARITIME	 MARITIME MOBILE SATELLITE	 RADIO DETERMINATION SATELLITE
 MARITIME SATELLITE	 MARITIME MOBILE SATELLITE	 RADIO DETERMINATION SATELLITE
 BROADCASTING	 MARITIME RADIOBROADCAST	 RADIO DETERMINATION SATELLITE
 BROADCASTING SATELLITE	 METEOROLOGICAL	 SPACE OPERATION
 BROADCASTING SATELLITE	 METEOROLOGICAL SATELLITE	 SPACE OPERATION
 FIXED	 MOBILE	 STORAGE FREQUENCY NOT THE SIGNAL
 FIXED SATELLITE	 MOBILE SATELLITE	 STORAGE FREQUENCY NOT THE SIGNAL SATELLITE

ACTIVITY CODE

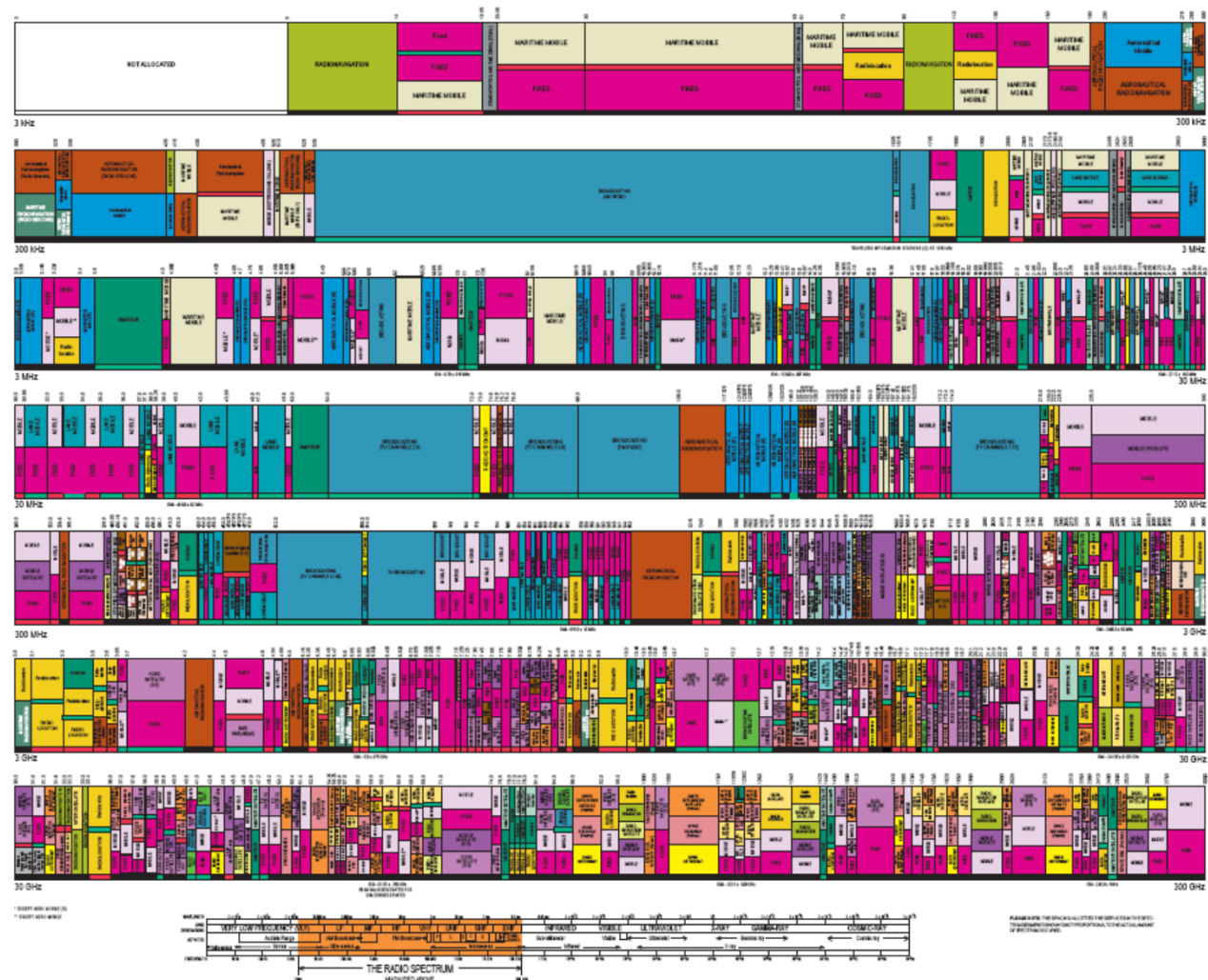
 GOVERNMENT EXCLUSIVE	 GOVERNMENT NON-EXCLUSIVE SHARED
 NON-GOVERNMENT EXCLUSIVE	

ALLOCATION USAGE DESIGNATION

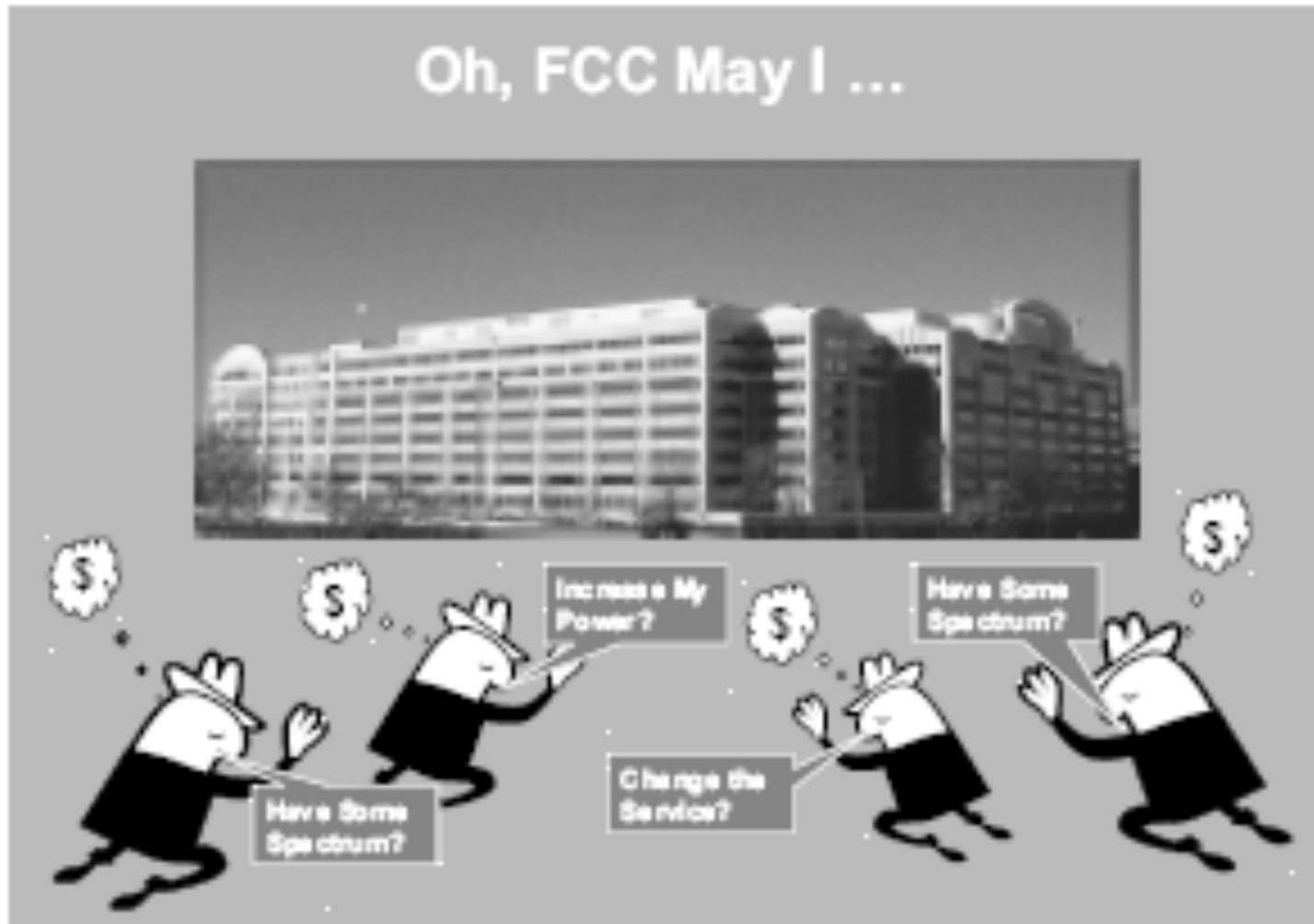
SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Fixed Station
Secondary	MARITIME	Maritime Station

This chart is a simplified representation of the United States Frequency Allocation Table. It is not a legal document and should not be used for legal purposes. For more information, please refer to the Federal Communications Commission (FCC) website.

U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Office of Spectrum Management
October 2023



Reality: Spectrum Licenses are Scarce



Reality: Spectrum Bandwidth is Abundant (90% not in use)

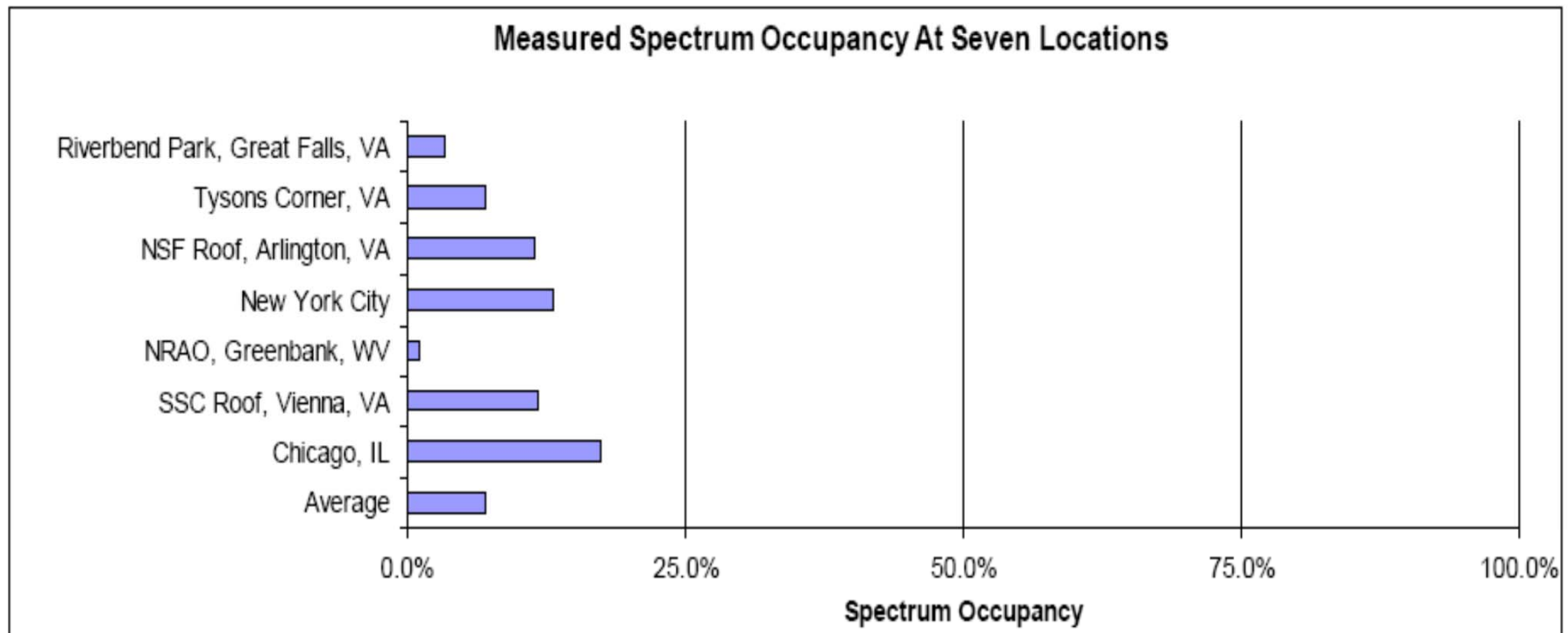
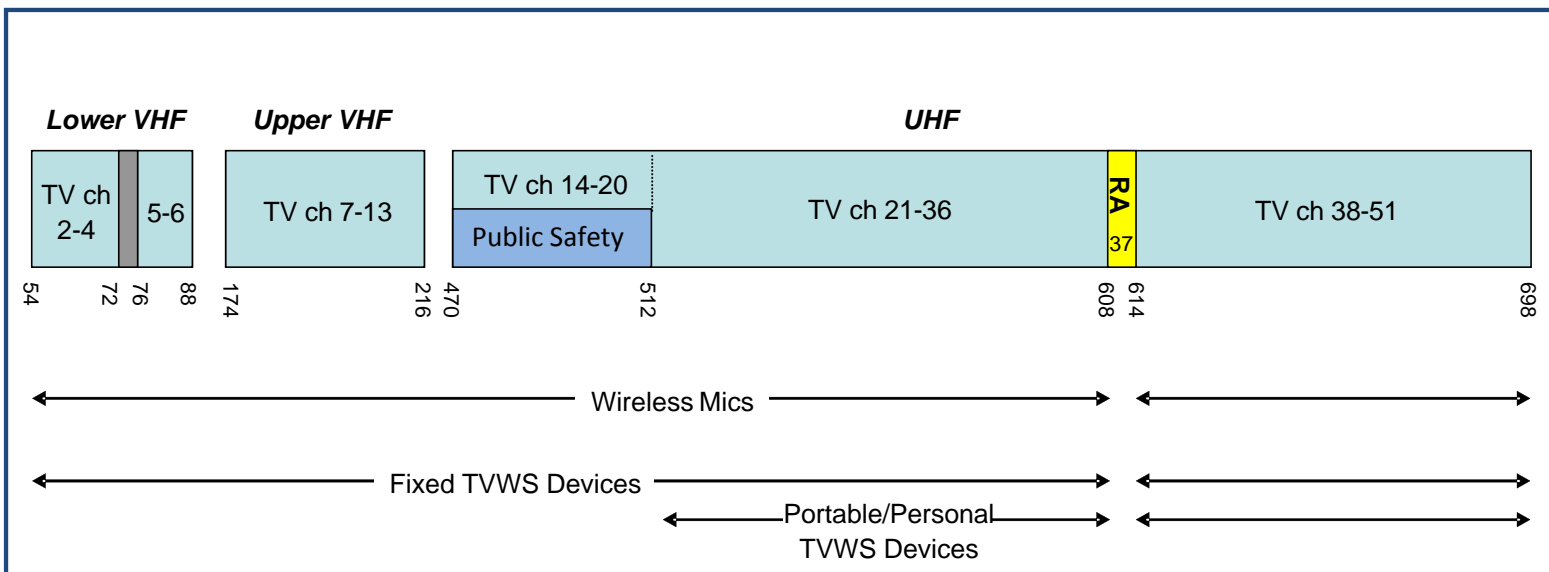


Figure 75 Overall Spectrum Occupancy Measured at Seven Locations

What are TV White Spaces?

- Unassigned TV Channels: 6 Mhz (174-698 MHz range)
- Channels vary by market: large amounts of spectrum outside major metros
- Available on an unlicensed basis (like WiFi)
- “Super WiFi”: Much lower frequency (than current WiFi) provides for:
 - Signal coverage over far larger areas (up to 5 km vs. 100 meters for WiFi)
 - Non-Line of Sight: Signals penetrate or bend around obstacles (trees, buildings, hills) far better than higher frequencies
- An inexpensive ‘last mile’ solution to add coverage and capacity where fiber is not close by.



Fixed Wireless Devices: Base Stations at Part 15 Power Using Second Adjacent Channels (per TVDB)

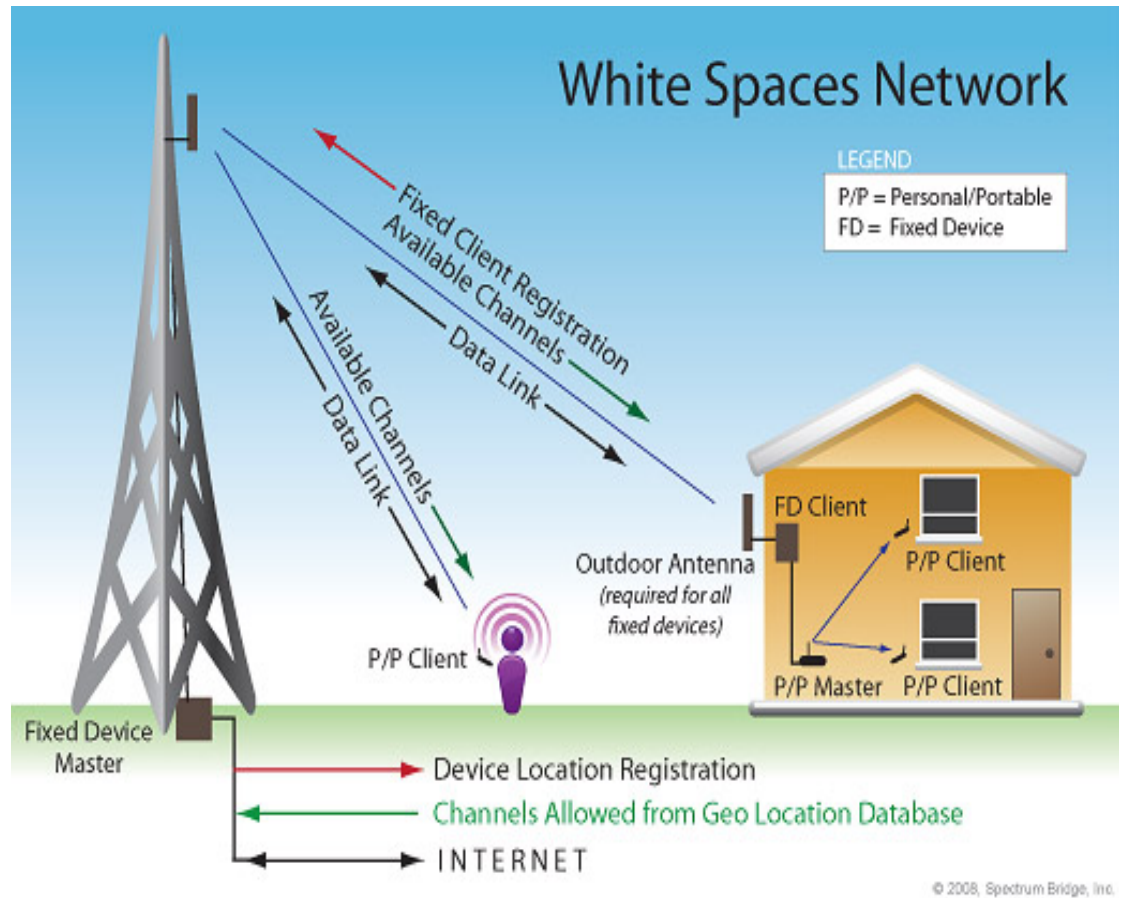
- **Must avoid** co-channels and first-adjacent channels
- Can use Chs 5 – 51 (except 37) at **max. 4 Watts EIRP**
- **Must access database at least once a day** to verify channel availability
- 250 meter HAAT max. for tower site & 30 m AGL max. for base stations – but **overall height cannot exceed 250 m HAAT**

Wireless Broadband (WISPs)

- Higher Power Fixed(Last Mile)
- Wireless Backhaul

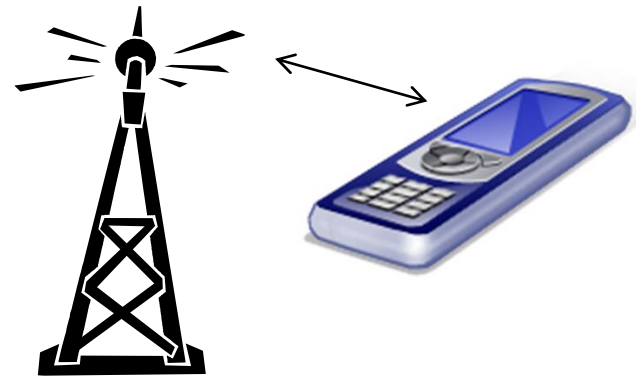
Machine-to-Machine

- Smartgrid AMIs
- Remote Sensing /Monitoring/ video surveillance

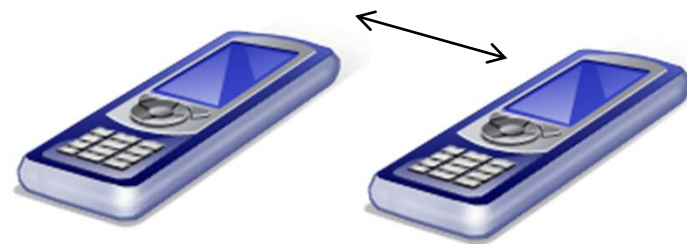


Personal/Portable Devices: Must Check Geolocation Database for Available Channels in Area

- **Power limit: 100 mW except only 40 mW on channels adjacent to TV**
- May operate on TV channels 21-51, except channel 37
- Mode 1 device obtains channels from a base station or device w/ Internet access
- Mode 2 device obtains channels direct from database
- Mode 2 devices re-check daily
- Mode 1 devices must contact, or receive a contact signal from, their fixed or Mode 2 device at least once per minute



Mode 1: Portable device obtains location/channels from fixed device



Mode 2: Portable device uses its own geolocation/data base access capability

TV White Space Trial Deployments

Currently operational TVWS trial deployments supported by Spectrum Bridge, Microsoft, Google and other companies.



Rural Broadband: Nation's first TVWS network – Claudville, VA



“Smart Grid” Network Deployment – Plumas-Sierra Rural Electric Co-Op, CA



“Smart City” Network Deployment– Wilmington, NC

Partnership with city and Public Safety entities



Telemedicine Applications – hospital campus – Logan, OH



Tribal and Public Safety Remote Area Deployment – Yurok Reservation, Arcata, CA



Super WiFi Network Deployment – Cambridge, England – In UK, 1-year trial: variety of use cases by consortium 14 companies (Microsoft, BT, BBC), Adaptrum, Neul, Nokia, etc) and 2 networks in Finland by Spectrum Bridge



AIR.U



Consortium of Higher Education Groups, New America, Microsoft and Google Launch Program to Deploy Bandwidth to College Communities (6/26/12)



NEW AMERICA
FOUNDATION

Rural and small city colleges/universities are well suited for Super Wi-Fi innovation

- Higher than average Bandwidth Requirements (Increasing)
- Lower than average Bandwidth Alternatives (Static)
- Fewer than average Broadcasters results in far more White Space



Declaration
Networks
Group, LLC

Pilot Phase Objectives

- ✓ **Aggregate Demand**
- ✓ **Energize the Eco-System**
- ✓ **Establish Sustainable Business Models**



The University Community Next Generation Innovation Project



The Winding Road to White Space Spectrum

‘What a Long, Strange Trip It’s Been ...’

- **2002: Spectrum Policy Task Force → Notice of Inquiry**
- **2004: First Notice of Proposed Rulemaking (NPRM)**
- **2006: Bipartisan Legislation → WS Testing Timeline Set**
- **2008: FCC Adopts Report & Order (5-0 vote)**
- **2010: FCC Adopts Final (Recon) Order (5-0)**
- **2011: First WS Database and Deployment Authorized (Wilmington, NC – launched Jan. 2012)**
- **2012: Spectrum Bill Enacted (“Incentive Auctions”)**
- **2012: Final Recons Resolved – Devices/DBs Certified**

And it's not over yet . . .

Proposed Incentive Auction Band Plan:

Two Unlicensed Guard Bands Separating LTE and TV (plus Ch 37)

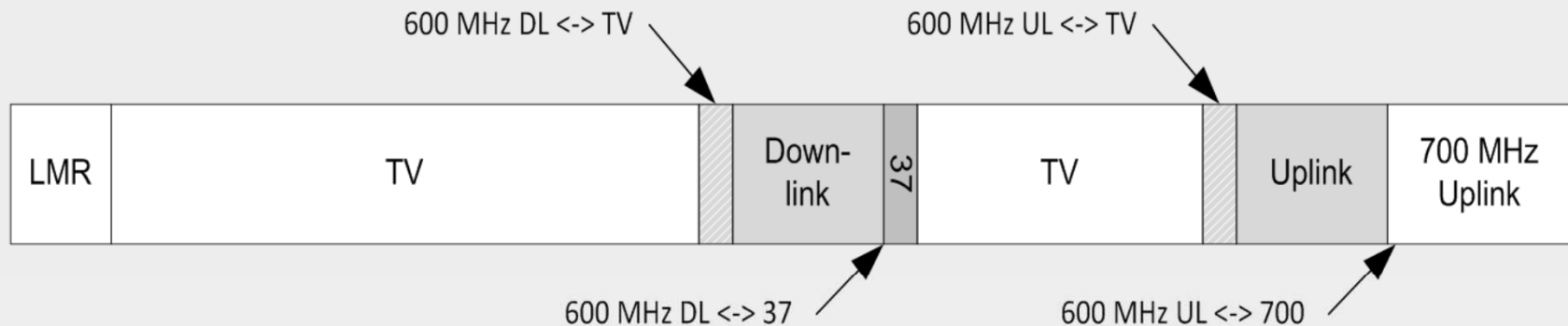


Figure 10. Guard band locations in the proposed band plan

Opportunities and Uncertainties

On the Plus Side . . .

FCC proposes 5 channels (30+ MHz) Unlicensed in every market, some contiguous nationwide:

- Two one-channel guard bands (min. 6 + 6)
- Each could be 0-to-4 MHz wider (remainders from rebanding LTE in 5 Mhz channels)
- Unlicensed access to Ch 37 nationwide (subject to exclusion zones: radio astronomy)
- Allow access to two reserve mic channels (relying on Database reservations instead)

Opportunities and Uncertainties

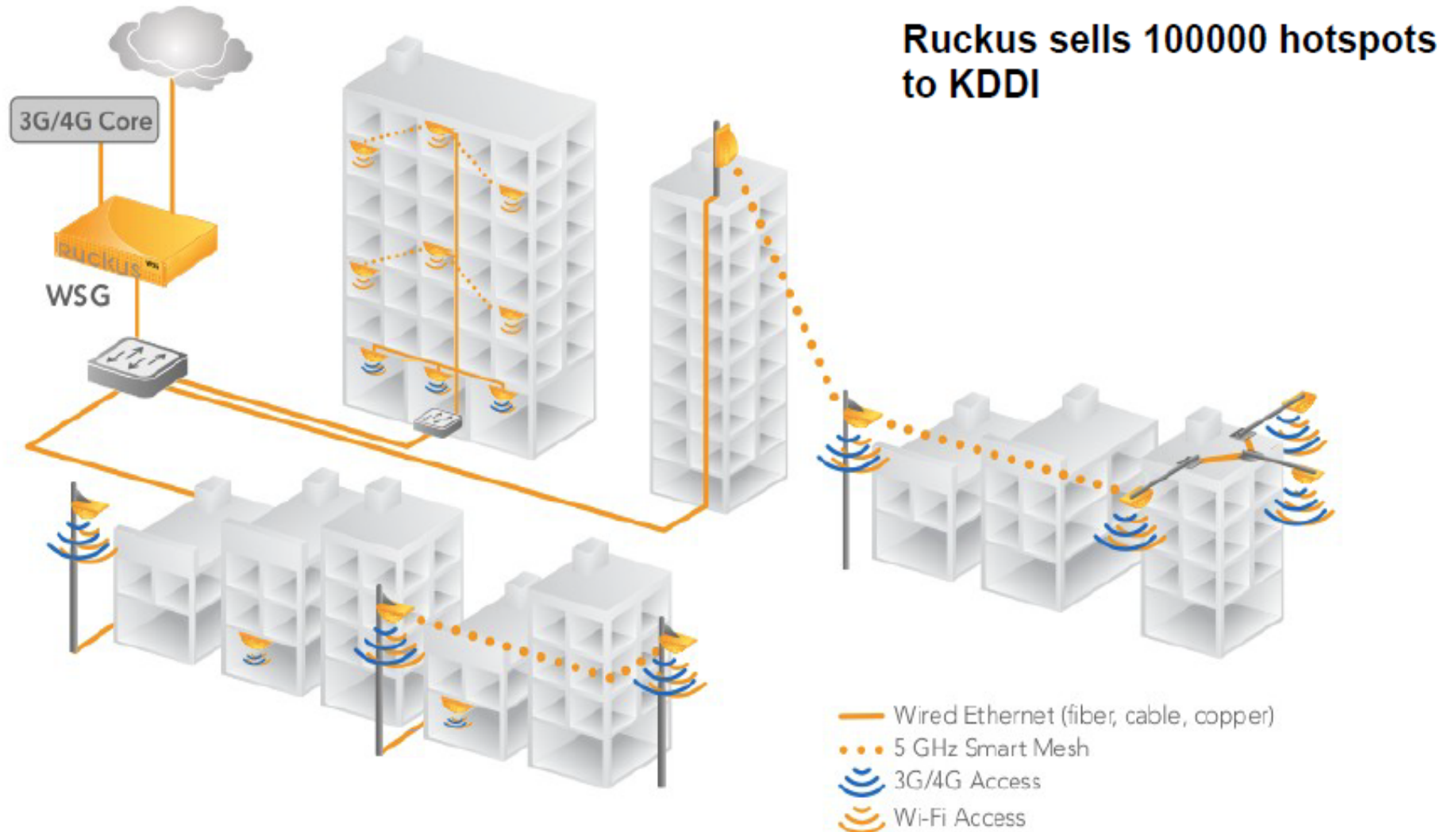
On the Down Side . . .

- Repacking the Broadcasters will mean less TVWS overall – and fewer full power channels (“triples”) for fixed wireless broadband (WISPs)
- LPTV and other 2ndary broadcast licensees will continue to needlessly occupy 6 MHz channels
- Some companies may advocate auctioning the guard bands
- Congress may pressure to maximize revenue (and spectrum auctioned) above all

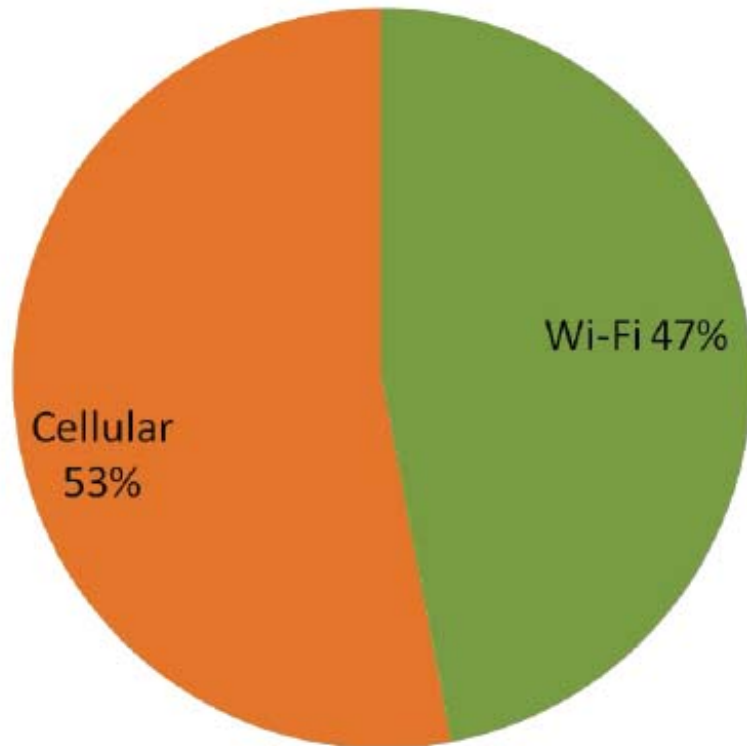
What's Next for White Space?

HetNets: Mobile Carrier Offload

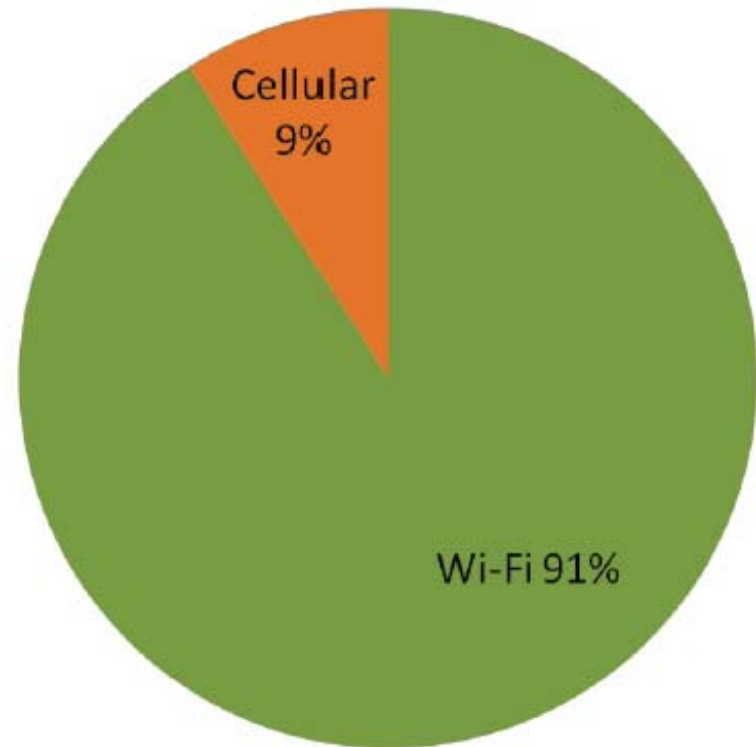
The Ruckus solution for a Wi-Fi and LTE small cell integrated network supported by Smart Mesh backhaul



Wi-Fi is Already Offloading ~ 30% Mobile Data Traffic *and*
Improving User Experience



Share of iPhone data traffic

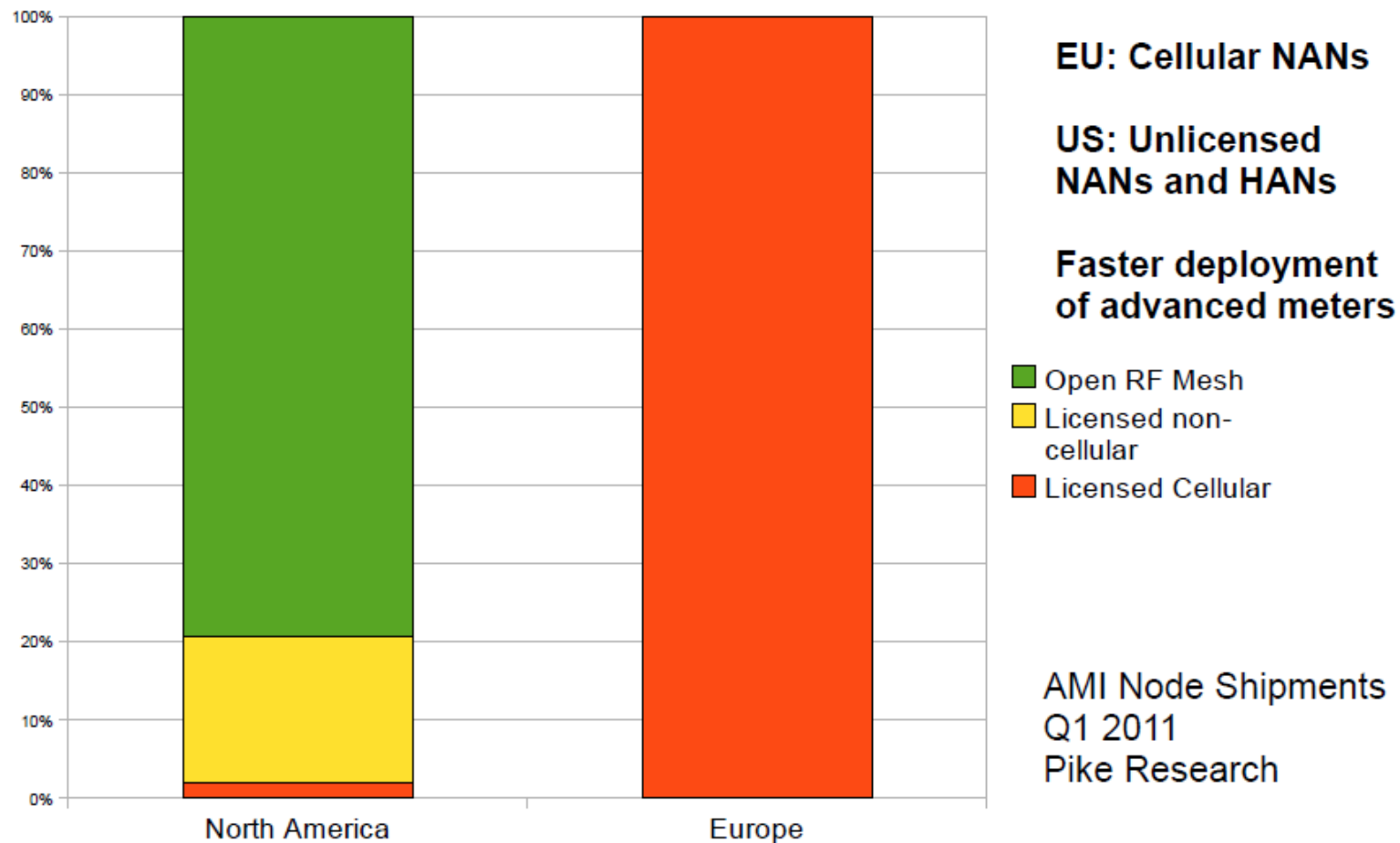


Share of iPad data traffic

Source: ComScore Digital Omnivores, Oct. 2011

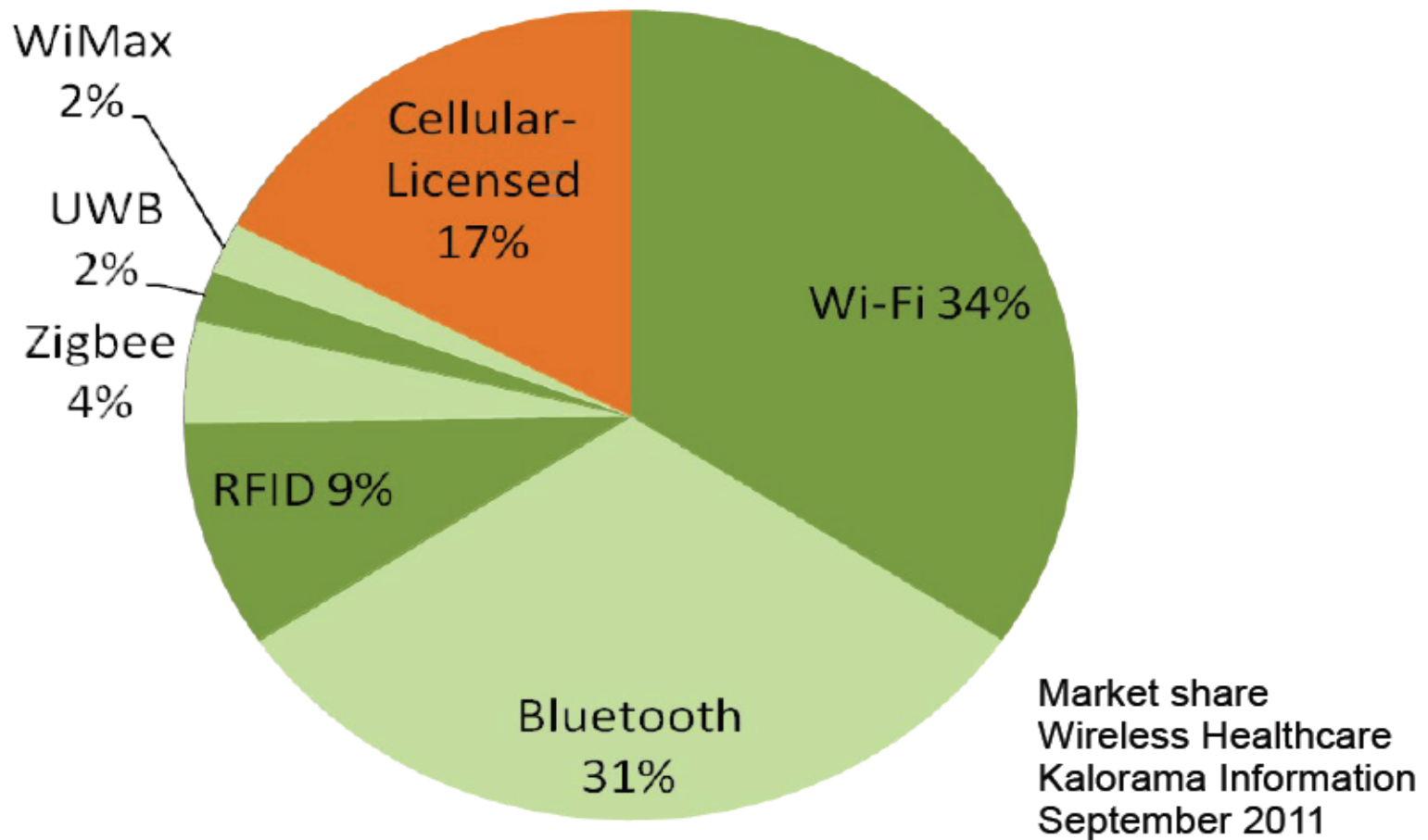
What's Next for White Space?

Smart grid communications: Wireless Meters



What's Next for White Space?

Mission Critical: Wireless Healthcare



M2M: Sensor Networks: Smart Home, Mobile Payments



General Approach:

Use it or Share it

➤ National Broadband Plan:

“The FCC should spur further development and deployment of opportunistic uses across more radio spectrum.” (p. 95)

➤ PCAST: Licenses are for exclusive ***use ... not non-use.***

➤ Under Communications Act, unused capacity remains available to the public.

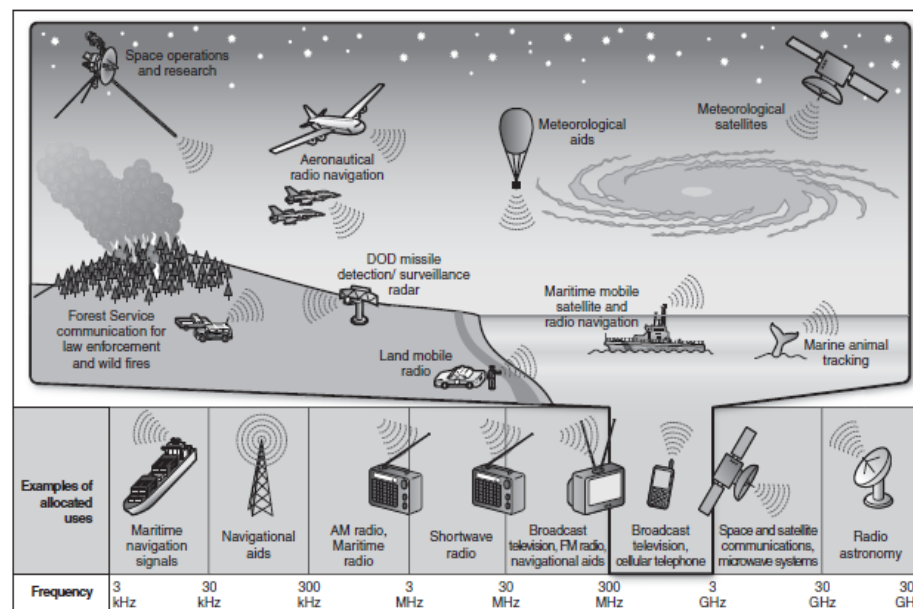
➤ **Proposal:** Identify and open the most underutilized and useful bands for opportunistic sharing on a secondary basis

➤ . . . Subject to band-by-band conditions protecting incumbent uses from interference:

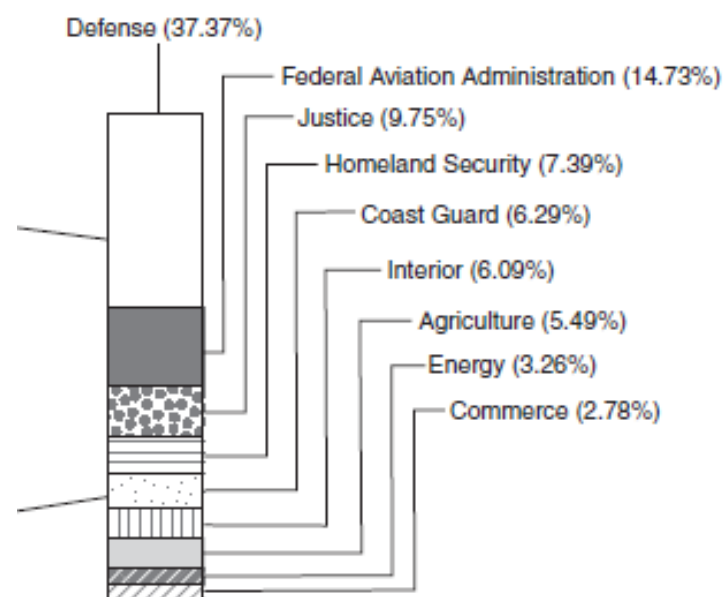
- Transmit power limits
- Geographic exclusion zones
- Coordination with geolocation database (“connected devices”)
- Sensing/DFS
- Remote preemption/updating/disabling (“policy radios”)

PCAST Study Focused on Federal Spectrum

- Clearing and reallocation of Federal Spectrum for *exclusive* use is not sustainable
 - Few bands can be cleared any time soon
 - > 1700 MHz is radar, radio air navigation and air telemetry (bands low or intermittent use, but no commercial substitutes)
 - NTIA Study : Clearing one band (1755-1850) will take 10 years, **cost \$18 billion**, and cause significant disruption.
 - Domino Effect: Where to move Federal systems?
- More Efficient and Immediate Use of Federal Spectrum will be Obtained through Sharing



Source: GAO analysis of NTIA, federal agencies, and industry information.



Federal Spectrum: A History of Sharing

- Amateur Radio
- Lojack
- Unlicensed (900 MHz: 1st Gen)
- 5 GHz WiFi (2d Gen: Dynamic Freq Selection)
- 70-80-90 GHz (Database Registration)
- 3.65 GHz (“lightly licensed”/Registration)
- Medical Devices (share w/ radiosondes, telemetry, some radars)
- 1710-1755 (transitional / geog exclusions)

PCAST: Overarching Recommendations

PCAST recommends that the President:

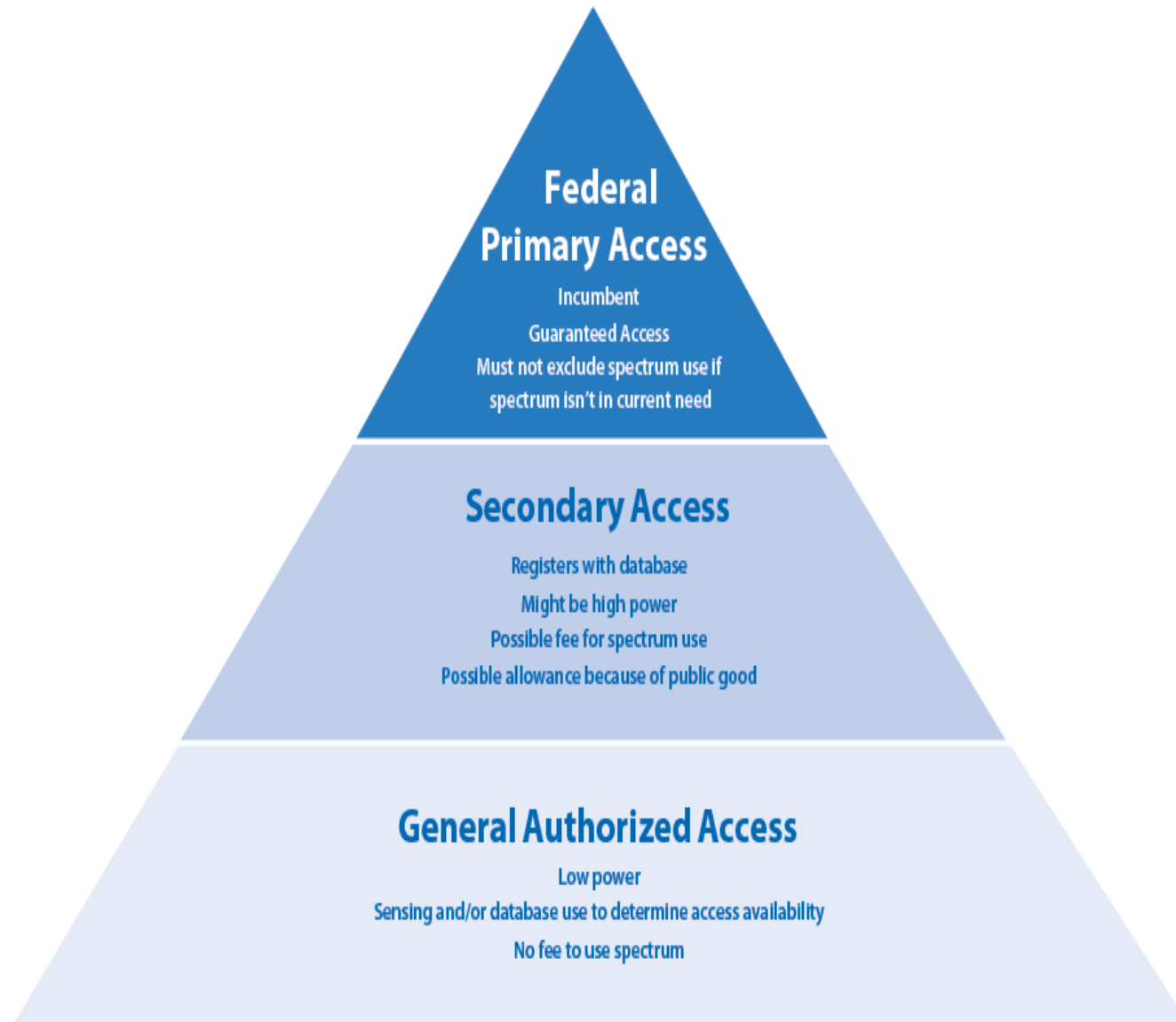
- Issue a new Executive Memorandum stating
- policy of the USG is to share *all* underutilized Federal spectrum; and
- **Identify immediately 1,000 MHz** of Federal spectrum for sharing with the private sector, **starting with the 3550-3700 MHz band**

Create shared-use spectrum superhighways:

- Make sharing by Federal with commercial the norm
- **Create 3 tiers of access to Federal Bands:**
 - Primary: Incumbent Federal Operation
 - Secondary: Licensed (priority/protected use)
 - Tertiary: General Authorized Access
- Develop a ***Spectrum Access System*** to enforce band-by-band “rules of the road” (interference protections)
- Emphasize small cell, low-power, spectrum re-use



PCAST: 3-Tier Hierarchy of Access



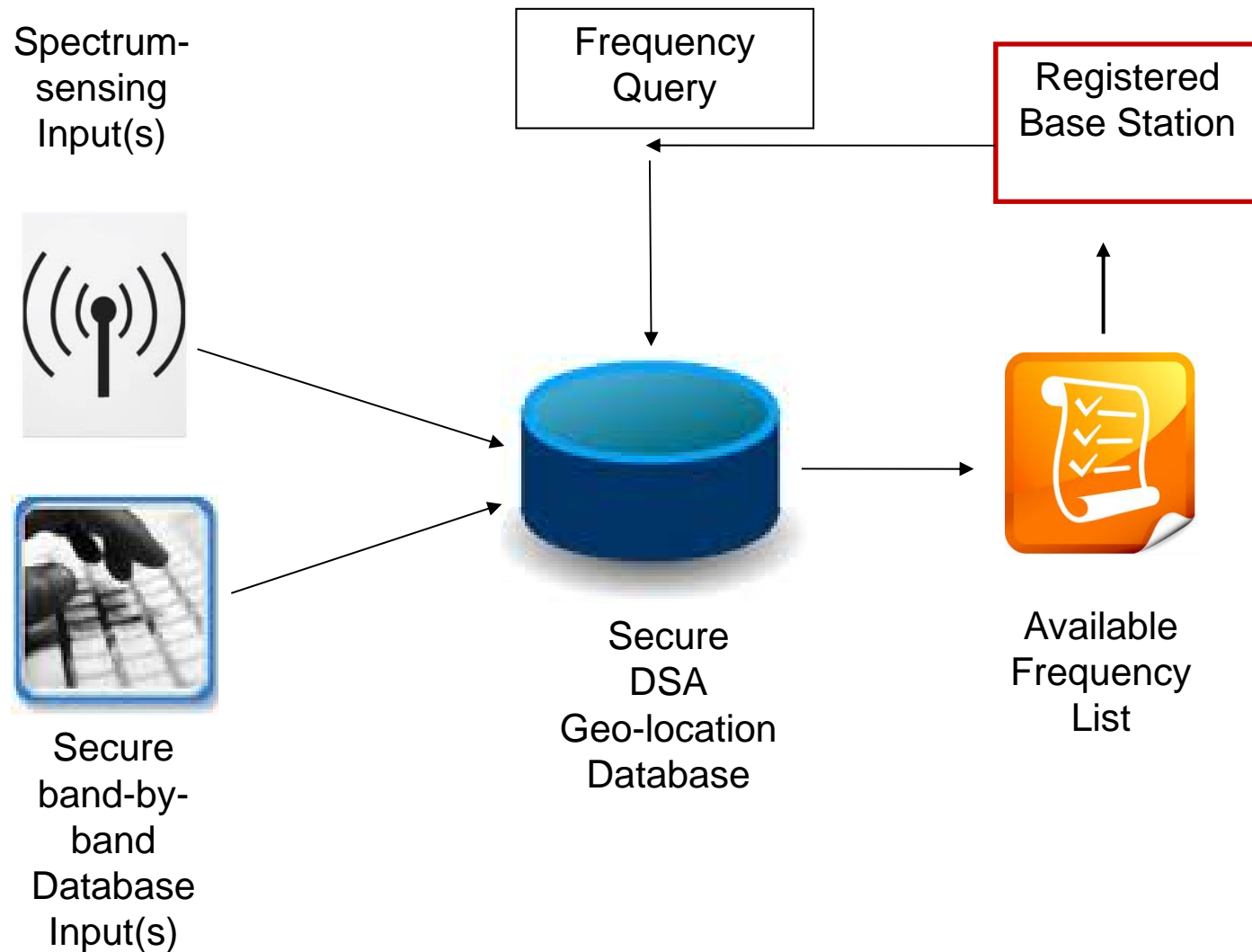
Spectrum Sharing Chasm

Sharing Technology & Systems Gap



Spectrum Access System

Dynamic Spectrum Access



Advantages of Building on TV Bands Database

- **No permanent assignments, no stranded users**
 - Any band can be listed – then de-listed
 - CSMAC: Prohibit single-frequency and unconnected ('dumb') devices on new shared and unlicensed bands
- Access to each band can be subject to unique access/operating conditions
- Preemption, shut down and priority access can protect primary operations
- Any 'Tragedy of the Commons' can be avoided
 - At any point, access can be limited or conditioned on micro-payments
- Enhanced features can be added (e.g., sensing)

PCAST: Shared Use Spectrum Superhighway

12 bands identified and prioritized to consider for repurposing, 950 MHz of which is contiguous (2700 to 3650 MHz)

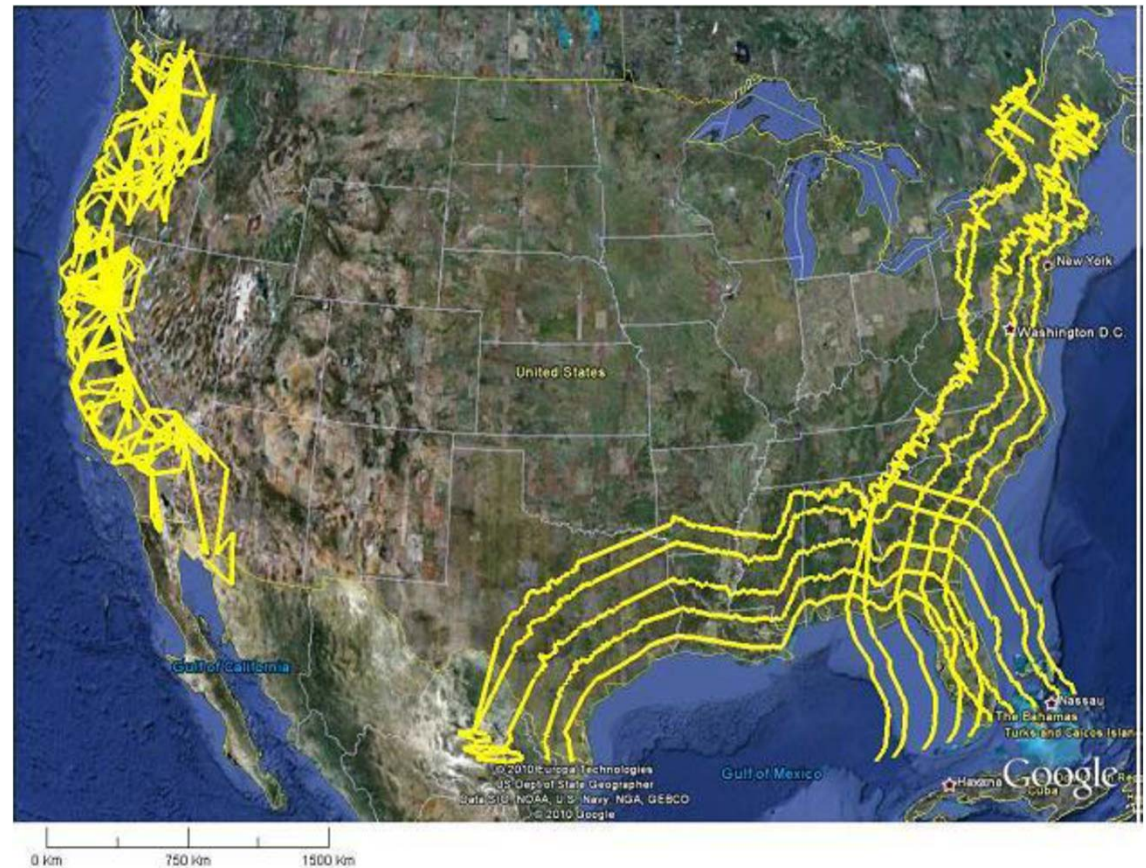
Source: NTIA, “Second Interim Progress Report on the Ten-Year Plan and Timetable,” October 17, 2011

Table 2-3 Prioritization Results for Repurposing Federal and Shared Spectrum Bands	
Licensed non-federal exclusive use bands	Non-federal/federal shared use bands
1. 1755-1850 MHz	1. 1300-1370 MHz
2. 1695-1710 MHz	2. 1675-1695 MHz
3. 406.1-420 MHz	3. 2700-2900 MHz
4. 1370-1390 MHz	4. 2900-3100 MHz
5. 4200-4400 MHz	5. 3100-3500 MHz
6. 3500-3650 MHz	6. 2200-2290 MHz

Short-Term Recommendation: 3550-3700 MHz

- **Modify Rules to Allow “General Authorized Access” to Operate in two bands** in the NTIA Fast Track List – specifically the 3550-3650 MHz (radar bands)
- **Extend the TV White Space Geolocation Database** system already in operation to enforce terms of use.
- Require opportunistic access devices to *register* and to be *frequency agile* (multi-band, DFS devices/systems)

3550-3650 MHz NTIA Exclusion Zones*



NTIA Fast-Track Report, Figure 5-3. Composite Depiction of Exclusion Zone Distances, Shipborne Radar Systems

What's Next for White Space

3.5 GHz NPRM:

“Citizens Broadband Service”

FCC's Notice of Proposed Rule Making:

- “The new service would be modeled on the spectrum access framework proposed in the PCAST Report.”
- “Three-tiered licensing/interference protection framework”:
 - Incumbent Access (Federal primaries)
 - Priority Access (50 mhz licensed by rule for “mission critical” indoor use)
 - General Authorized Access (opportunistic, but must register in SAS)
- “An SAS incorporating a dynamic database and, potentially, other mitigation techniques . . . Modeled after TVWS database”
- Priority Access and GAA would be low power, small cell
 - Exception: Higher GAA power in non-congested areas (akin to 3650)
- GAA permitted where could receive interference from radars

What's Next for White Space

Extending 5 GHz Unlicensed

- 5350-5470 MHz and 5850-5925 MHz Bands
 - Spectrum Act requires NTIA to issue reports on extent to which bands can be shared for unlicensed use
 - Reports expected soon
 - For 5350-5470 MHz band, FCC required to initiate rulemaking proceeding by February 2013
 - Some companies interested in wide channels for indoor use (video routing)
 - WISPs plans to advocate for unlicensed *outdoor* use of these bands

What's Next for White Space

Sharing 4.9 GHz Public Safety

- 4.9 GHz Band
 - FCC has initiated a rulemaking that may allow unlicensed or lightly licensed commercial use on a shared basis with public safety users in the 4940-4990 MHz band
 - FCC requested comment on variety of issues
 - Should sharing be permitted?
 - Could a geolocation database protect incumbents, help coordinate among public safety users and help coordinate among unlicensed users?
 - Should public safety have priority access to commercial networks during emergencies?

THANK YOU!

QUESTIONS?

Contact:

Michael Calabrese

Open Technology Institute

New America Foundation

calabrese@newamerica.net