



TV White Spaces: A Geolocation Database Platform to Govern Shared Use Spectrum

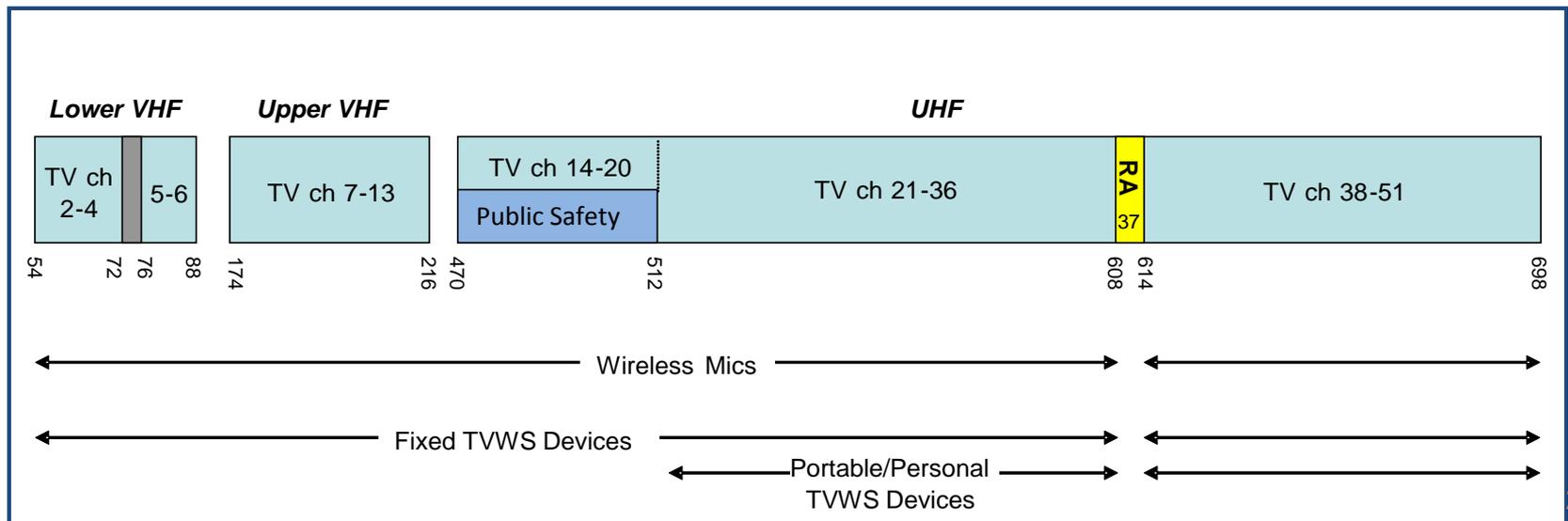
ISART

Boulder, CO – July 25, 2012

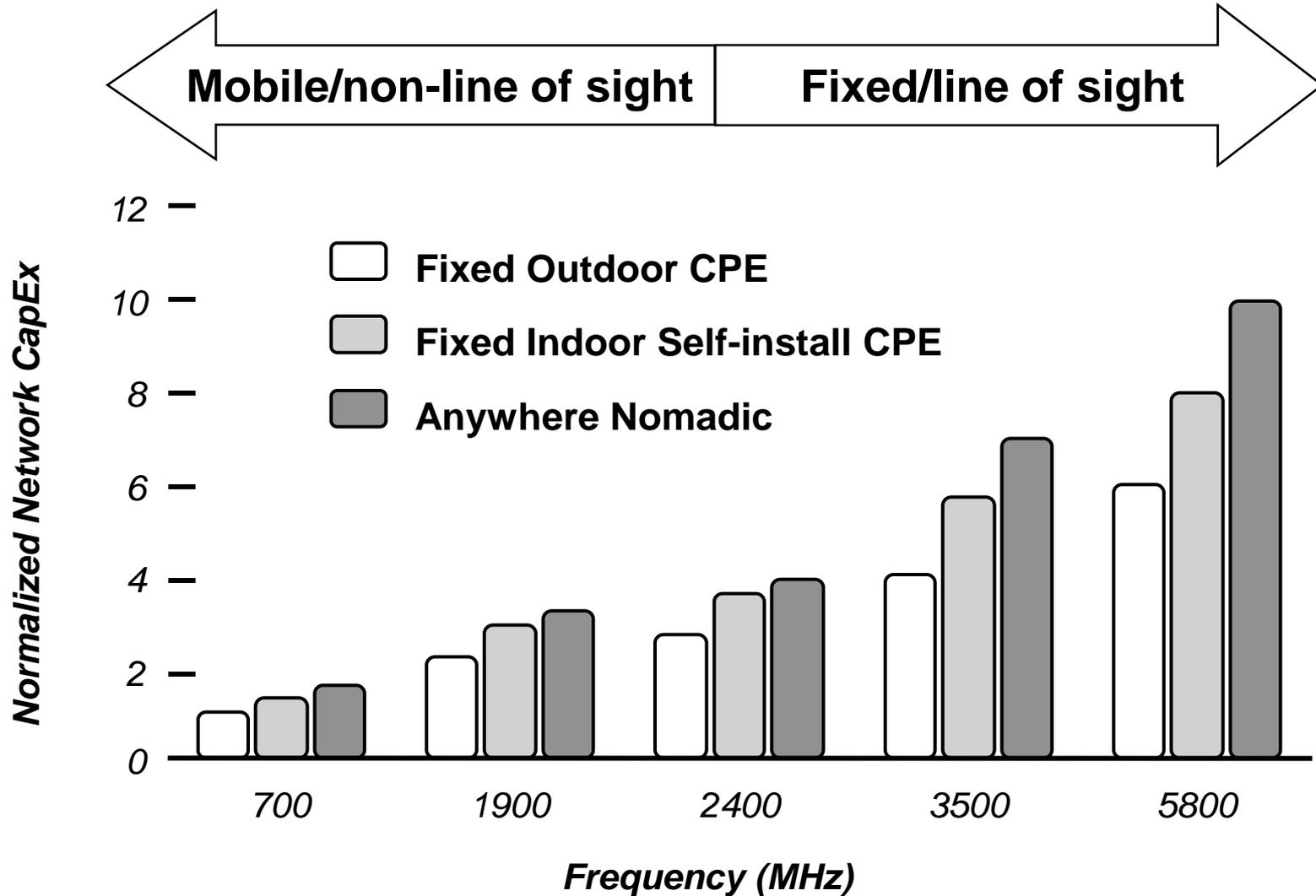
Michael Calabrese
Director, Wireless Future Project
Open Technology Institute
New America Foundation
calabrese@newamerica.net

What are TV White Spaces?

- Unassigned TV Channels – they are unoccupied channels in a given area.
- Many freed as a result of the Digital TV Transition (e.g., in US, UK)
- Channels vary widely by market – few in largest metros, more in small towns/rural areas
- Useable on an unlicensed basis for broadband applications (e.g., WiFi and as wireless backhaul), narrowband M2M, etc. Both Fixed and Portable.
- Much lower frequency than current WiFi (below 700 MHz)
- Signals cover far larger areas than WiFi and penetrate or bend around obstacles (trees, hills, deeper indoors) relative to higher frequencies



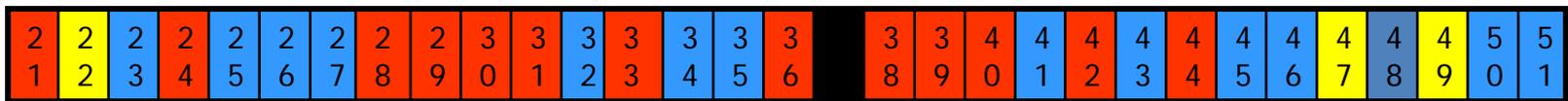
Location, Location, Location: Lower Capex, Better Coverage < 1 GHz



TVWS Spectrum Availability

- Available spectrum varies by location
- In rural areas many channels are available
- In big cities only a few channels may be available – and often none at all for fixed wireless able to operate at full Part 15 power
- Examples of availability in UHF channels 21 – 51 (Illustrative) :

New York



Washington, DC



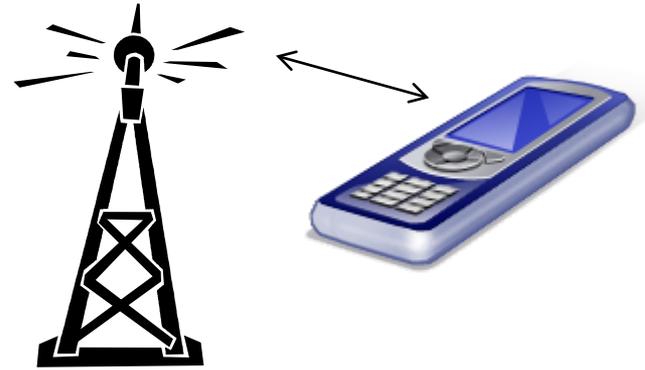
In less dense areas many channels are available.

For example: Wilmington, NC: 25 total WS channels = 150 MHz

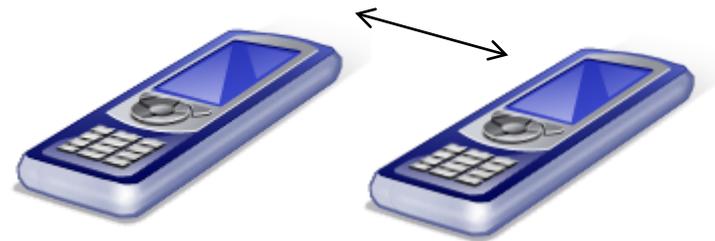
Lexington, KY: 28 non-adjacent channels = 168 MHz (10 + 15 contiguous)

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

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

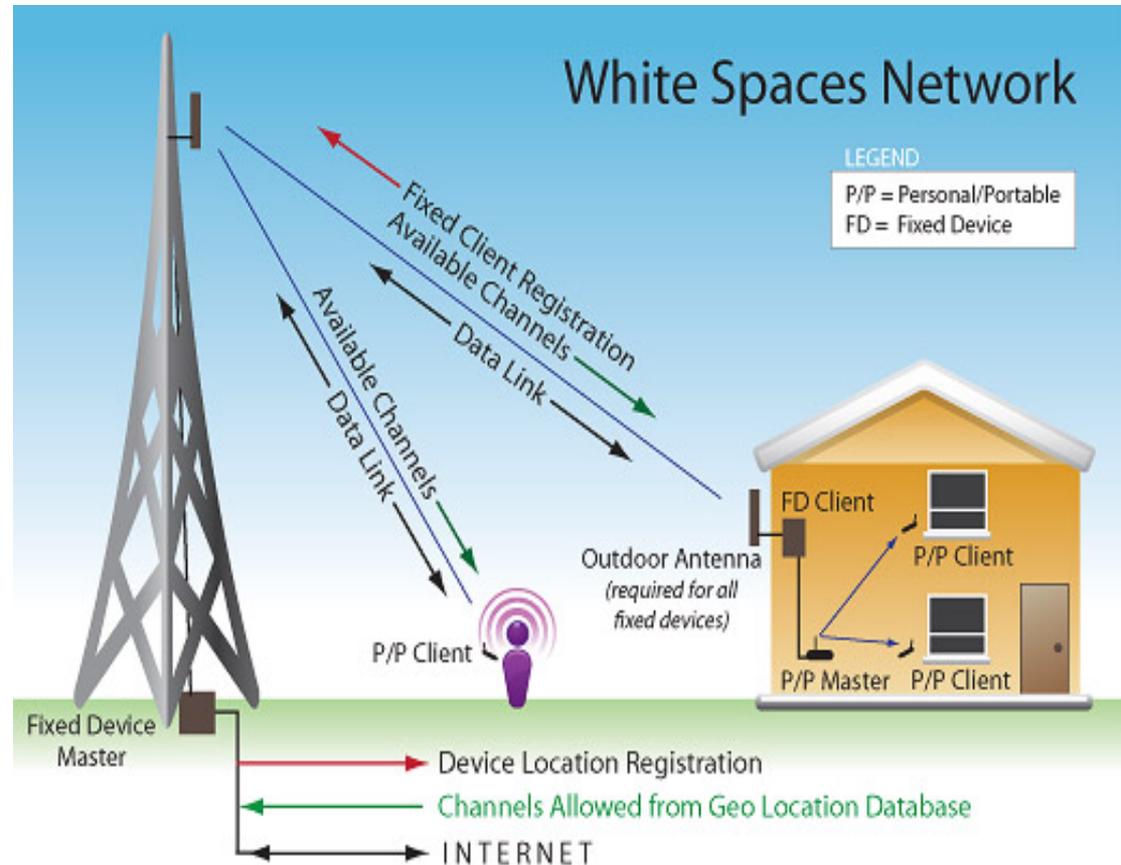
- **Must avoid** use co-channels and **first-adjacent channels**
- Can use Chs 5 – 51 (except 37) at **max. 4 Watts EIRP**
- **Must access database at least once a day** to verify channel availability
- 250 meter HAAT max. for tower site & 30 m AGL max. for base stations – but **overall height cannot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

Wireless Broadband (WISPs)

- Higher Power Fixed (Last Mile)
- Wireless Backhaul

Machine-to-Machine

- Remote Sensing and Monitoring
- Smartgrid AMIs
- Mobile Video Surveillance



How We Got Here

‘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**

2012 Spectrum Bill: Cliff Notes

➤ Incentive Auctions

- Voluntary participation by TV stations determines how many MHz/Channels can be cleared for auction
- Broadcasters not participating compensated for channel relocation

➤ FCC Repacking Authority

- FCC determines how to reorganize the TV Band
- Negative provisions on unlicensed dropped
- Vacant TV Channels remain unlicensed – market-by-market
- Will there be “triples” (high power fixed channels) left for WISPs?

➤ Auction Band Plan: Contiguous Unlicensed

- FCC discretion to designate LTE gap/guard bands for unlicensed nationwide
- Duplex gap/guard bands must be “technically reasonable”

➤ 3550-3650 MHz not mandated for auction

➤ Potential 195 megahertz of unlicensed spectrum in 5 GHz

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
– Claudeville, VA



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



“Smart City” Network Deployment –
Wilmington, NC
Partnership with city and Public Safety



Telemedicine Applications –
hospital campus – Logan, OH



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



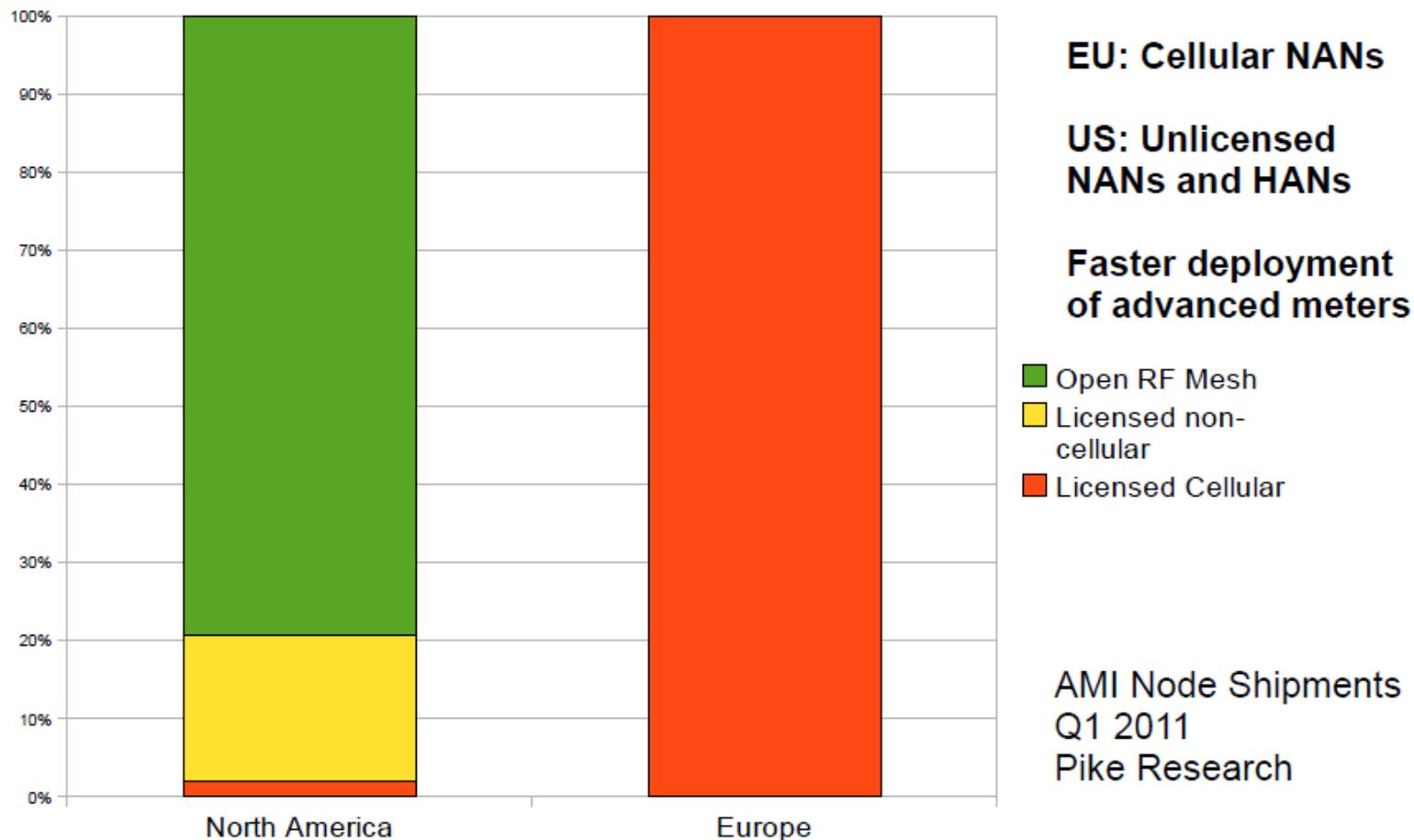
Super WiFi Network Deployment – Cambridge, England –
and 2 Spectrum Bridge networks in Finland

In UK, 1-year trial: package of use cases by consortium 14 companies
(Microsoft, BT, BBC, Neul, Nokia, Adaptrum)



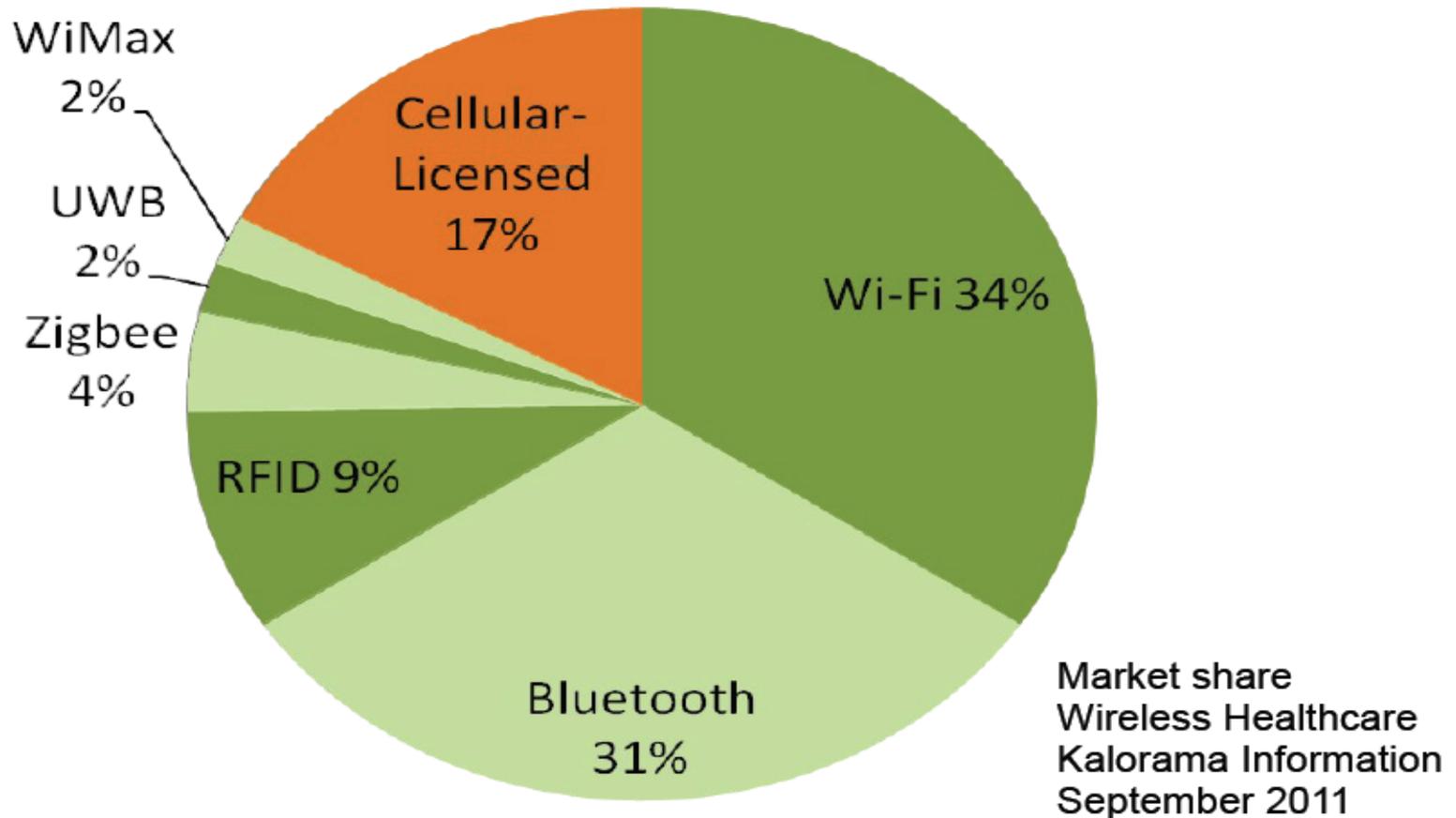
What's Next for White Space?

Smart grid communications: Wireless Meters



What's Next for White Space?

Mission Critical: Wireless Healthcare

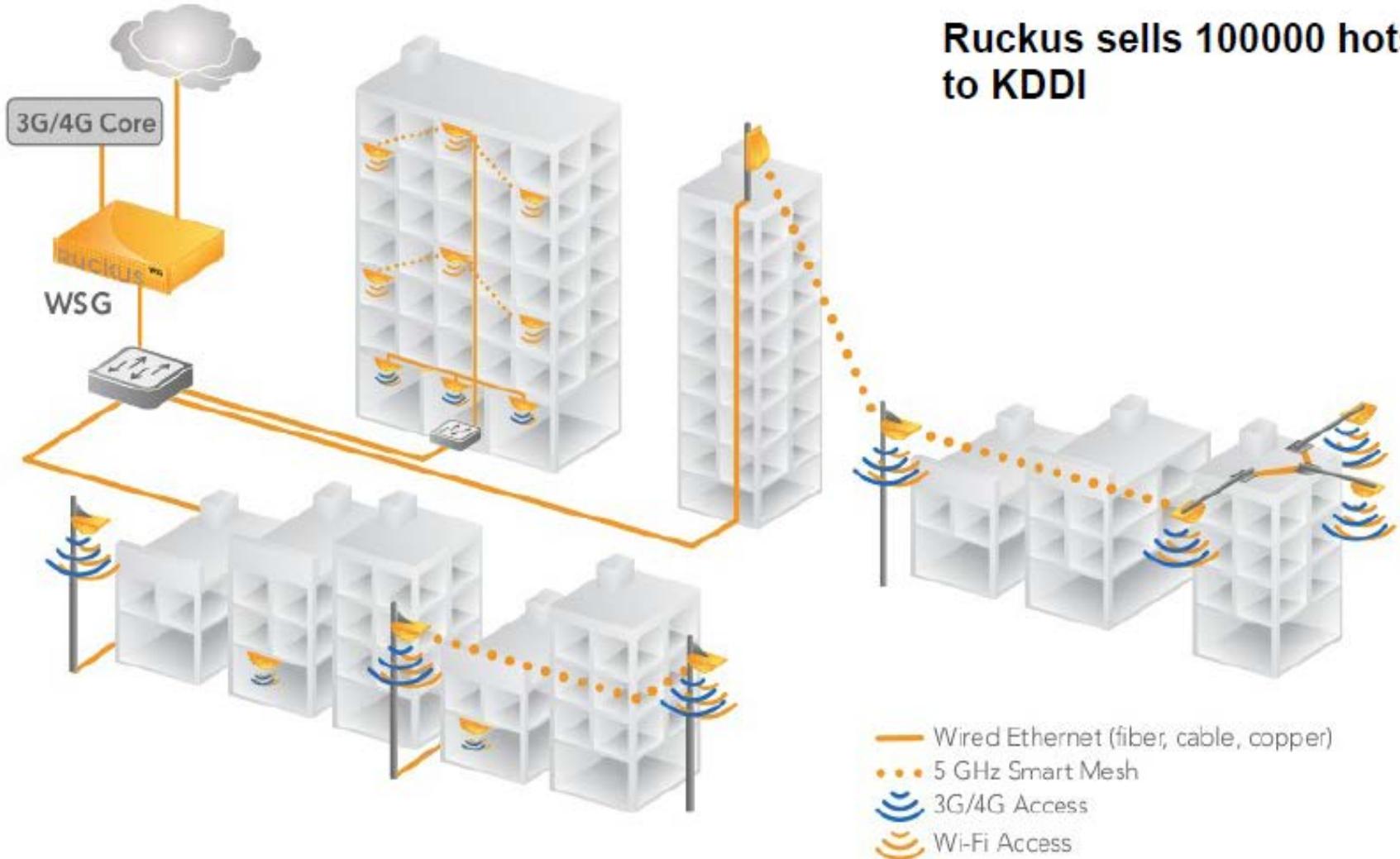


M2M Networks: Smart Home, Mobile Payments, Inventory



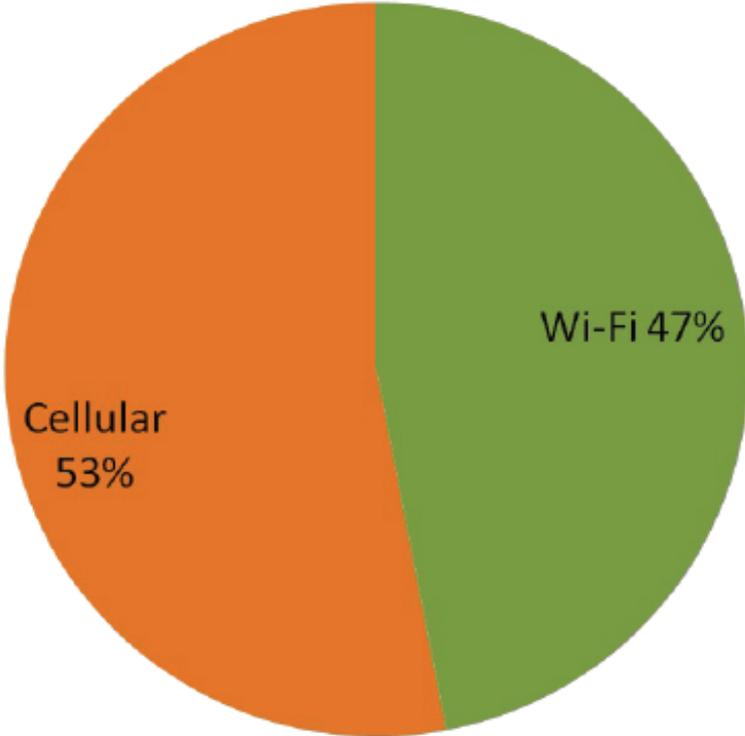
HetNets: Mobile Carrier Offload

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

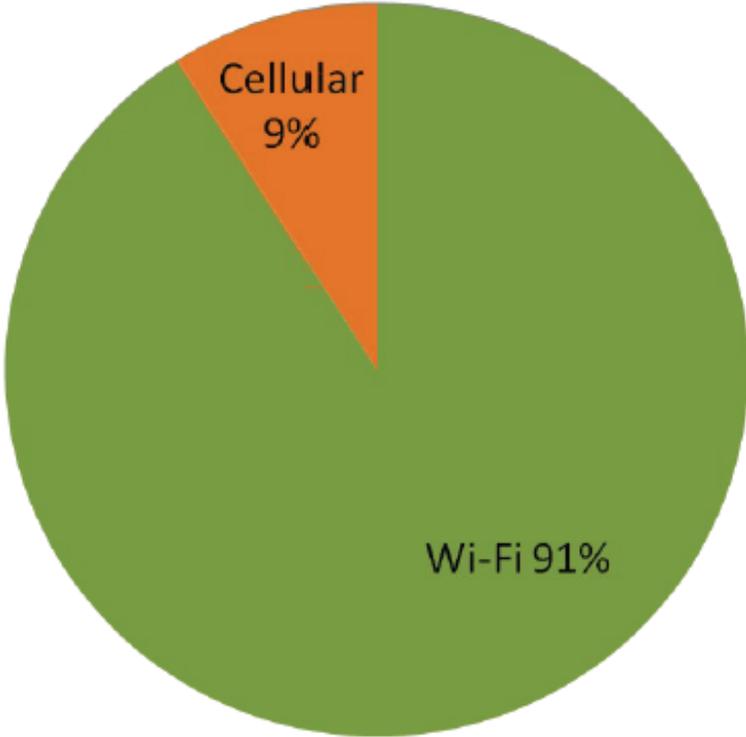


Ruckus sells 100000 hotspots to KDDI

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

The Great Disconnect: Scarcity Amidst Abundance

- FCC: “Looming spectrum crisis”
 - “Mobile data demand to grow 25 to 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**

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)

Other Benefits of Extending TVDB to Govern Shared Access to Other Bands

❑ A Platform to Enable Secondary Markets

- Geolocation database(s) can manage opportunistic access
- Transparency, automation and standards can be leveraged to lower transaction costs for small-area and as-needed 2ndary market transactions

❑ More capacity and efficient use spectrum

- Spectrum re-use and backhaul is most cost-effective at the edge of the network, closest to end user
- **Hybrid networks** relying on low-power access to shared spectrum, small cells and self-provisioned backhaul will be most cost-effective and spectrum-efficient way to meet high-capacity and peak use

❑ More Competition and Innovation

- Low barriers to entry
- Indicators: ~ 2,000 WISPs and proliferation unlicensed devices

❑ An alternative to toothless use-it-or-lose-it

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”)

Three Categories of Bands for Shared Access

1. Warehoused FCC Spectrum
2. Underutilized Federal Bands
 - ~ 1,000 MHz per PCAST
3. Fallow Licensed Bands (not built out)

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

12 bands identified and prioritized to consider for repurposing:

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