Wireless Communications: Current and near-term V2X investments intentions

The Washington State Department of Transportation perspective and decision making considerations

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Session 4 : *"Wireless Communications Applied to Vehicle Safety, Services, and Transport Management - Current Status and Future Directions"*

Future Networked Car Symposium, Achieving connected, automated and safe mobility
March 16th, 2023: 13:00-16:00 CET: #ConnectedCar https://fnc.itu.int/

Wireless communication for public safety applications
(V2X, 5G, 4.9Ghz, 5.9Ghz, C-V2X, Cellular)

United States Wireless Carrier Spectrum Band Usage

Legend: in use | partially in use | not in use

https://en.wikipedia.org/wiki/Cellular_frequencies_in_the_United_States

2G / 3G

Carrier		AT&T	C Spire	Dish	T-Mobile	U.S. Cellular	Verizon
2G (MHz)	CLR (850)	—	Yes [A 1][B 1]	—	—	Yes [A 1][B 1]	Yes [A 1][B 1]
	PCS (1900)	—	No	—	Partial [A 2]	Partial [A 1][B 2]	Partial [A 1][B 2]
3G (MHz)	CLR (850)	— [A 3][C 1]	No	—	—	Partial [A 4][B 1]	Partial [A 4][B 1]
	AWS (1700 2100)	—	—	—	— [A 3][C 2]	—	—
	PCS (1900)	— [A 3][C 3]	Yes [A 4][B 2]	—	— [A 3][C 3]	Yes [A 4][B 2]	Yes [A 4][B 2]

4G LTE (MHz)

Carrier		AT&T	C Spire	Dish	T-Mobile	U.S. Cellular	Verizon
	DD (600) [D 1]	—	Partial	—	Yes	No	—
	SMH (700) [D 2][D 3][D 4][D 5][D 6]	Yes	Partial	—	Yes	Yes	Yes
	CLR (850) [D 7][D 8]	Partial	No	—	Partial	Partial	Partial
	AWS (1700 2100) [D 9][D 10][D 11]	Yes	—	—	Yes	Yes	Yes
	PCS (1900) [D 12][D 13]	Partial	Yes	—	Partial	Partial	Partial
	WCS (2300) [D 14]	Yes	—	—	—	—	—
	BRS (2500) [D 15]	—	Partial	—	Partial	—	—
	CBRS (3500) [D 16]	Partial	—	—	Partial	No	Partial
	U-NII (5200) [D 17]	Yes	No	—	Yes	No	Yes

5G NR (MHz)

Carrier		AT&T	C Spire	Dish	T-Mobile	U.S. Cellular	Verizon
	DD (600) [E 1]	—	Partial	No	Yes	Partial	—
	SMH (700) [E 2][E 3][E 4][E 5]	No	Yes	No	No	No	No
	CLR (850) [E 6][E 7]	Yes	No	No	No	No	Yes
	AWS (1700 2100) [E 8][E 9]	Partial	—	No	No	No	Yes
	PCS (1900) [E 10][E 11]	Partial	Yes	No	Partial	No	Yes
5G NR (MHz)	WCS (2300) [E 12]	No	—	—	—	—	—
	BRS / EBS (2500) [E 13]	—	No	—	Yes	—	—
	C-Band (3700) [E 14]	Yes	—	—	No	No	Yes
	K-Band (26000) [E 15]	No	No	No	Yes	No	No
	Ka-Band (28000) [E 16]	No	Yes	No	Yes	No	Yes
	Ka-Band (39000) [E 17]	Yes	No	No	Yes	No	Yes
	V-Band (47000) [E 18]	—	—	No	No	—	—

Inside the radio wave spectrum
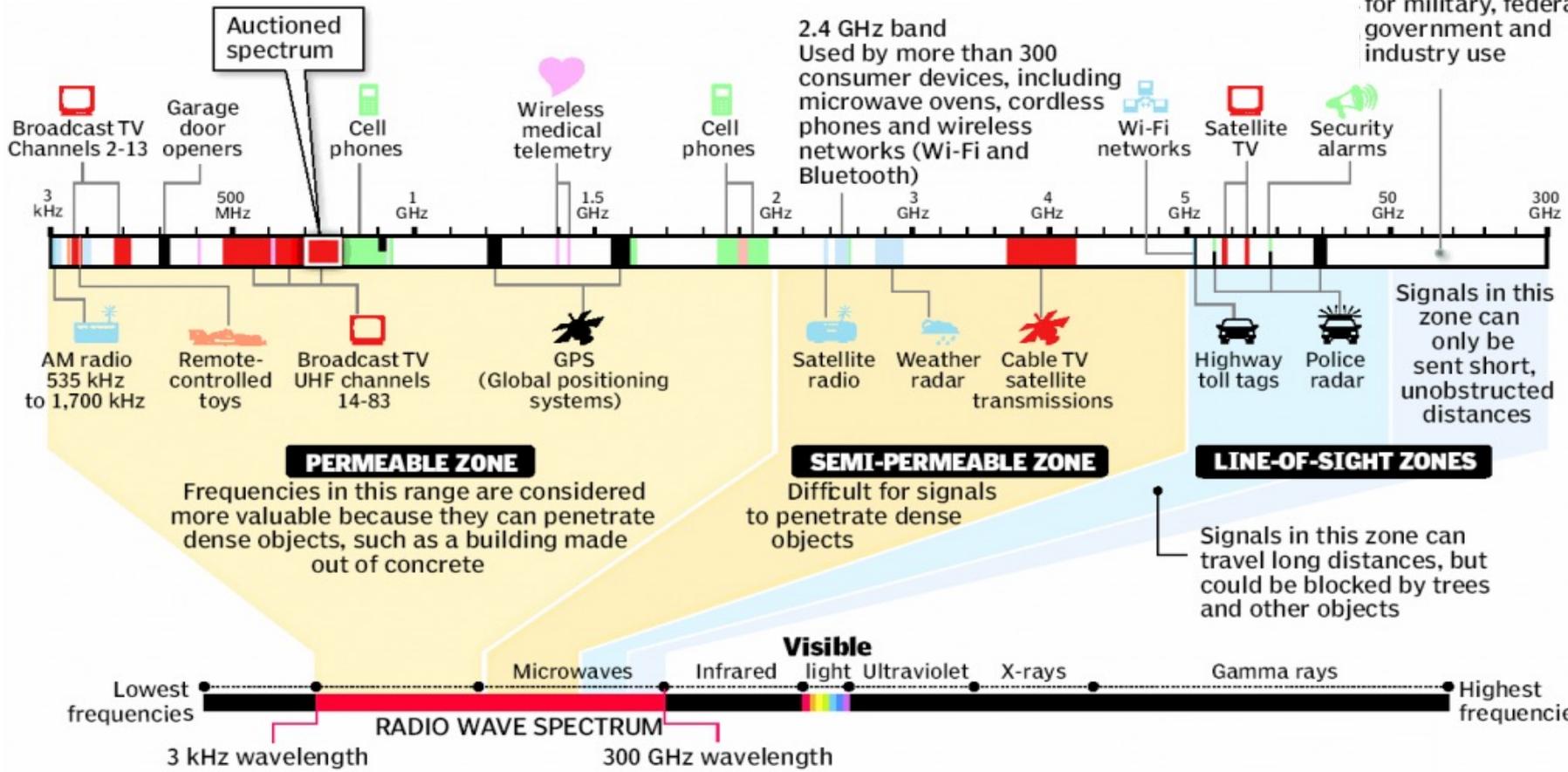
4.9Ghz vs 5.9Ghz vs 5G

4.9Ghz is WSDOTs primary spectrum for ITS and other V2X applications that are not using the cellular network

4.9Ghz

5.9Ghz

39Ghz 5G proposed

6GHz   24GHz   100GHz

5G mmWave

4G
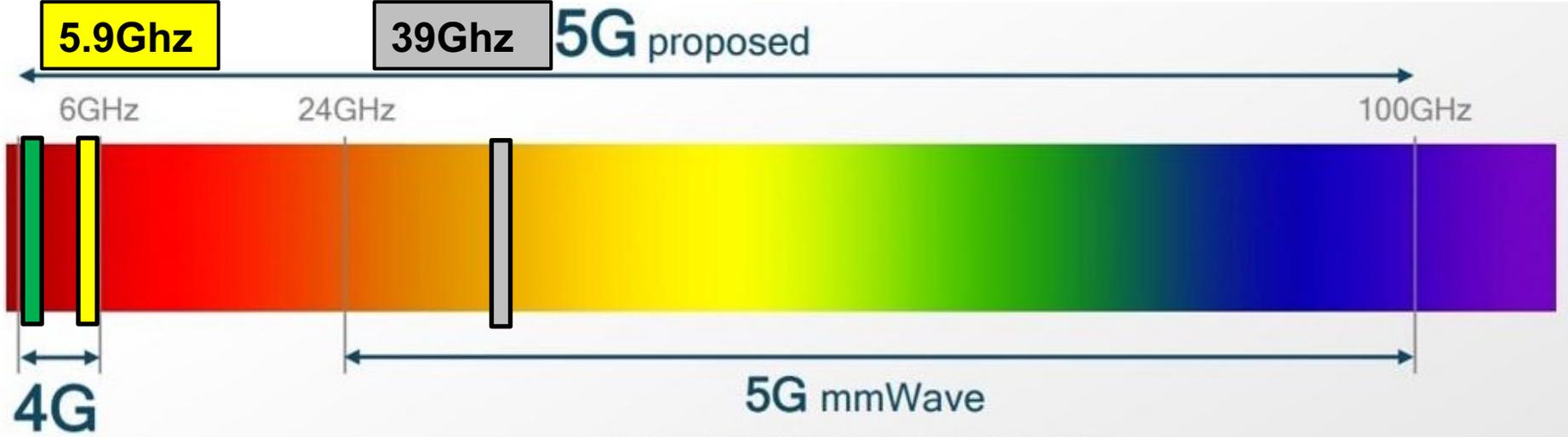
850Mhz to 39Ghz (Potential Spectrum range for C-V2X Applications based on current United States Wireless Carrier Spectrum Band Usage)

WSDOT wireless spectrum use

700Mhz – Voice LMR

800Mhz – Voice LMR

2.4Ghz – No longer using due to interference issues (unlicensed frequency)

4.9Ghz – Data: Video, VOIP, VMS, VSL, RWIS, HAR, ITD Network to remote locations. Also used as last mile connections from devices to microwave or fiber transport.

5.9Ghz – ATC Controllers (technically 5.9Ghz ready), but not installing radios anywhere (Traffic Signals, Ramp Meters, Data Station Applications in the future, no V2X use to date or planned use)

6Ghz – Microwave transport (10meg to 300Meg) We can do Higher capacities by "stacking" links, but that requires more spectrum. We are spectrum saturated in the Pacific Northwest so this would be limited.

11Ghz – Microwave Transport (10Meg to 300Meg) same as above.

18GhZ – Microwave transport, we migrating off our longer links due to weather interference. Good for short links (10 to 200Meg)

23Ghz – Microwave Transport, Same as 18Ghz, but even more impacted by weather, needs to be even shorter than 18Ghz to be reliable in the Pacific Northwest.

WSDOT "V2X" Use Cases
Type of Communication (4.9Ghz, 5.9Ghz, Cellular)

1. **ATC Controller (Traffic Signals, Ramp Meters, Data Stations),** 4.9Ghz, 5.9Hhz, Cellular
2. **Transit and Emergency Vehicle Priority/Preemption** (Cellular)
3. **Smart/Connected Work Zones** (Cellular)
   - Real-time work zone location communication (Google, Waze, INRIX, other)
   - HAAS Alert
   - Pi-Lit
   - iCone
   - Vermac (wearable technology)
4. **Truck Parking (Space availability by location prediction algorithm)** (Cellular)
5. **Weigh in Motion / Truck Bypass** (Cellular, RFID Tags)
   - DriveWyze (Evaluating and Piloting)
6. **Automated Speed Safety Camera Systems** (Cellular, other??) Pending Legislative Approval
7. **Static to Dynamic Flashing Beacons** (Cellular) Potential Future application
8. **Traveler Information** (Application Program Interface (API))

Traveler Information (API)

The Traveler Information Application Programming Interface is designed to provide third parties with a single gateway to WSDOT's traveler information data. Information is available for 3rd parties to process and share, "V2X" to multimodal travelers through various communication mechanisms (most likely cellular)

https://www.wsdot.wa.gov/traffic/api/

Data Type	Docs	WSDL	REST	RSS	KML
Border Crossings	Doc	WSDL	REST	RSS	KML
Bridge Clearances See Disclaimer	Doc	WSDL	REST		
Commercial Vehicle Restrictions	Doc	WSDL	REST	RSS	KML
Highway Alerts	Doc	WSDL	REST	RSS	KML
Highway Cameras	Doc	WSDL	REST	RSS	KML
Mountain Pass Conditions	Doc	WSDL	REST	RSS	KML
Toll Rates	Doc	WSDL	REST	RSS	KML
Traffic Flow	Doc	WSDL	REST	RSS	KML
Travel Times	Doc	WSDL	REST	RSS	KML
Weather Information	Doc	WSDL	REST	RSS	KML
Weather Stations	Doc	WSDL	REST	RSS	
More Weather Information	Doc		REST		
WSF Fares	Doc	WSDL	REST		
WSF Schedule	Doc	WSDL	REST		
WSF Terminals	Doc	WSDL	REST		
WSF Vessels	Doc	WSDL	REST		

For More Information

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https://www.wsdot.wa.gov/travel/automated-connected/home