



700 MHz Spectrum Transition & Interference Issues

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Sean Haynberg
Director of RF Technologies

OVERVIEW

- 700 MHz Spectrum – Band Plan
 - New Licensees – CMRS & Public Safety
- Incumbents – Transition & Interference Issues
 - Full-Power Broadcast TV
 - Transition date (June 12th)
 - U.S. market areas near Canada & Mexico
 - CH51 DTV issues
 - Low-Power TV (LPTV)
 - Impacts CMRS & Public Safety in 700 MHz
 - LPAS (Wireless MIC)
 - Impacts CMRS & Public Safety in 700 MHz
- Conclusions

700 MHz Spectrum – Band Plan

Lower 700 MHz Spectrum Bands								Upper 700 MHz Spectrum Bands										
CH 52	CH 53	CH 54	CH 55	CH 56	CH 57	CH 58	CH 59	CH 60	CH 61	CH 62	CH 63	CH 64	CH 65	CH 66	CH 67	CH 68	CH 69	
698	704	710	716	722	728	734	740	746	752	758	764	770	776	782	788	794	800	806
A	B	C	D	E	A	B	C	C	A	D	Public Safety	E	C	A	D	Public Safety	B	
UL	UL	UL	DL	DL	DL	DL	DL	DL	DL	DL	DL	DL	UL	UL	UL	UL		
CMRS			CMRS (Mobile TV)		CMRS			CMRS	TBD	Broadband (BB)	Narrowband (NB)	CMRS	TBD	Broadband (BB)	Narrowband (NB)			

- Previously Allocated to Broadcast TV (Upper UHF)
- New Licensees are Commercial (CMRS) & Public Safety (PS)
 - Primary Services in CH52 to CH69, per FCC Part 27 & 90 rules
 - Downlink (DL) & Uplink (UL) bands for Base to User & User to Base links
 - Public Safety includes narrowband voice and broadband data services
 - CMRS includes 4th generation broadband data, mobile TV, multimedia, messaging, machine-to-machine, and voice services
 - Licensed by various market areas: CMA, EA, EAG, REAG, MEA & Nationwide

Full-Power Broadcast TV

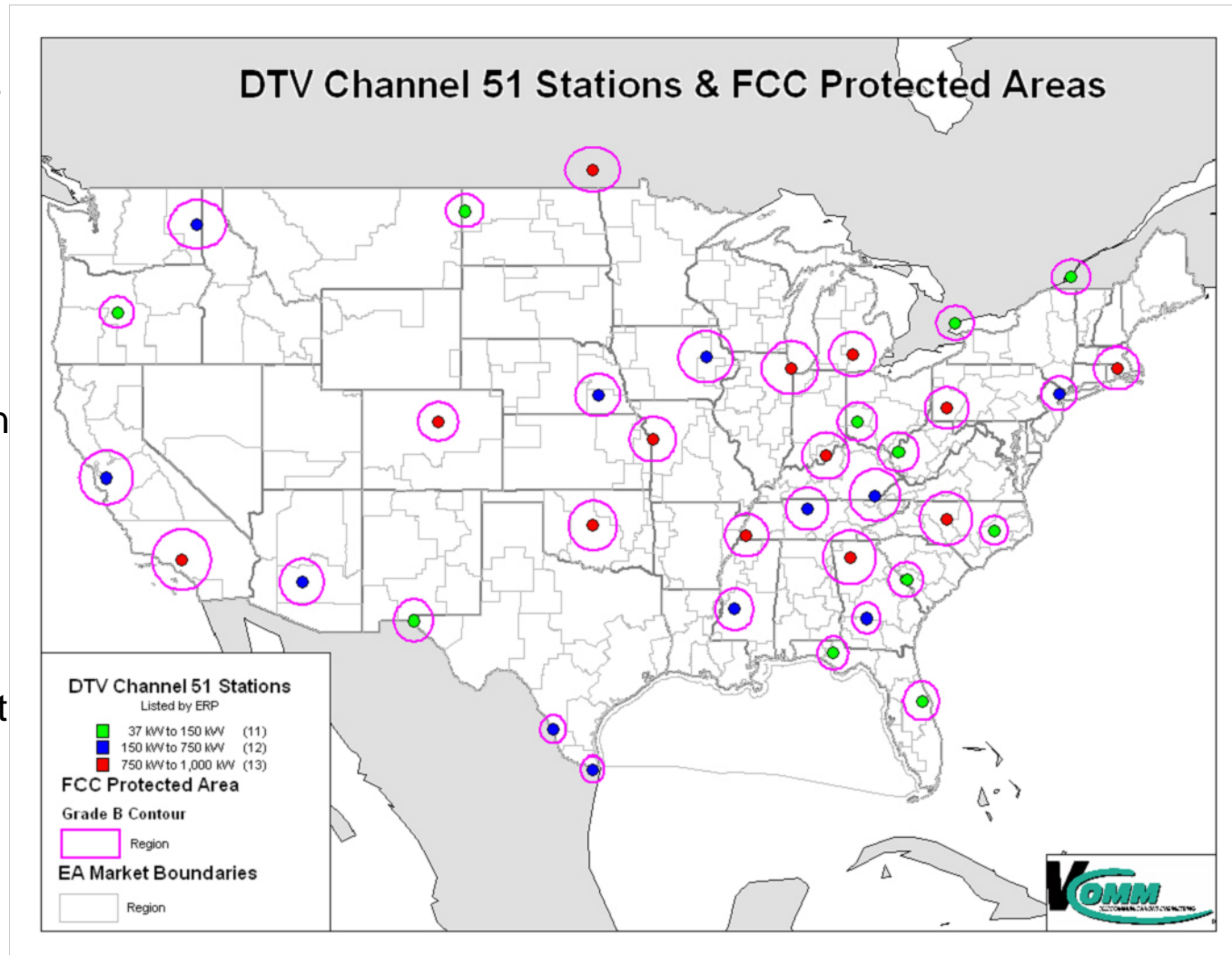
- U.S. TV Transition date is June 12th, 2009
 - All full-power stations must transition out of 700 MHz spectrum
 - Clears full-power TV stations from 700 MHz spectrum for new CMRS and Public Safety services
- Canada & Mexico TV stations
 - Continue to operate in 700 MHz – impacts utilization of spectrum near U.S. border areas
- Channel 51 digital TV stations
 - Adjacent to 700 MHz spectrum – represents adjacent channel interference issue to 700 MHz Lower A Block (channel 52)

TV Stations in Canada & Mexico

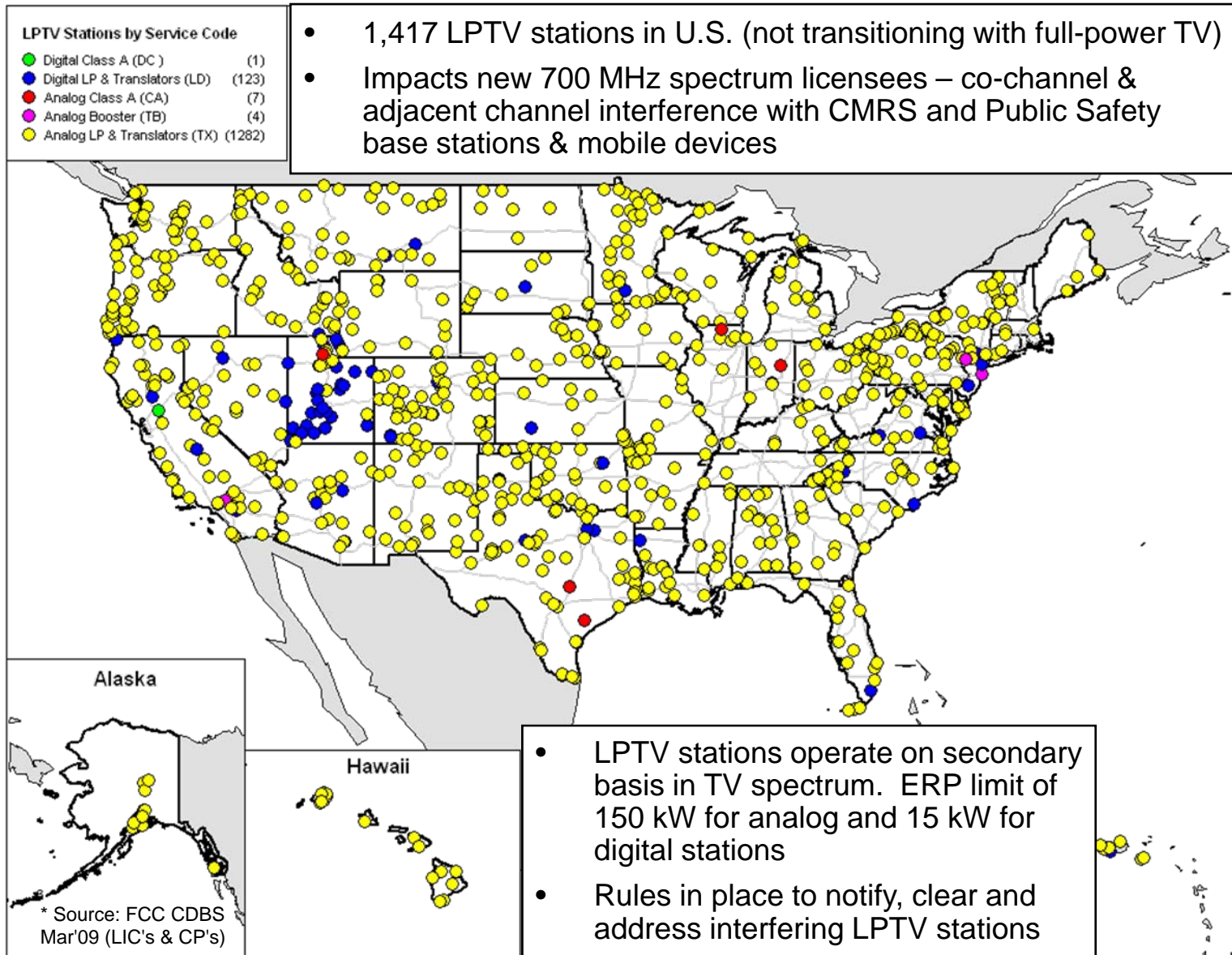
- TV transition dates (to clear TV service from 700 MHz)
 - Canada is Aug 2011 (~2 yrs after U.S.)
 - Mexico is 2021 (~12 yrs after U.S.)
 - Prior to these dates, new 700 MHz operations in some U.S. border areas likely to be problematic due to late transition
 - Represent potential interference from TV stations in border areas and requirement to protect TV receivers
- Subject to U.S. treaties & agreements
 - Primarily provides interference protection for TV stations operating in border areas
 - Does not protect new 'non-broadcast' services in U.S.
 - Potential interference in border areas for co-channels and adjacent channels in 700 MHz spectrum

Channel 51 Digital TV Stations

- Operate on channels adjacent to 700 MHz spectrum – continue to operate after TV transition
- No guard band between channel 51 and Lower A block on channel 52
- Adjacent channel interference issues – potentially impacts CMRS base stations receiving on adjacent channel 52



LPTV Stations in 700 MHz Spectrum



LPAS (Wireless Microphones)

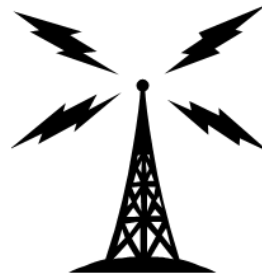
- Low Power Auxiliary Stations (LPAS) Operations
 - Operate pursuant to FCC Part 74 rules for broadcast operations
 - Secondary licensed operation in TV spectrum including the 700 MHz spectrum -- Must not interfere with primary licensed services
 - Power levels up to 250 mW (50 mW typical), bandwidths up to 200 kHz (FM)
 - Include handheld microphones, belt pack transmitters with lapel microphones, and wireless monitoring units
- Venues include a variety of locations i.e. shows, concerts, theatres, sporting events, convention centers, hotels, mega-churches, etc.
 - However, vast majority not authorized or eligible for use per Part 74 rules
 - Large venues can use hundreds of wireless microphones
- Impacts new CMRS & Public Safety Licensees in 700 MHz
 - Co-channel interference to CMRS & Public Safety
 - Impacts base stations & mobile devices on uplink & downlink bands

LPAS, CMRS, and PS 700 MHz Operations

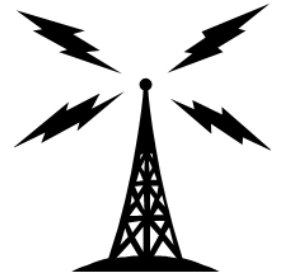
LPAS



CMRS



Public Safety



Example at NFL Sporting Event

User Group	Number of Units
Local Broadcast	142
Coaches	64
Network TV	33
Network Radio	33
NFL	27
Local Team	17
Stadium Operations	14
Visiting Radio	12
Visiting TV	10
Stadium Audio/Visual	10
Food Service	10
Security	9
Film Crews	8
CQB	4
Cleanup	3
Total Devices	396

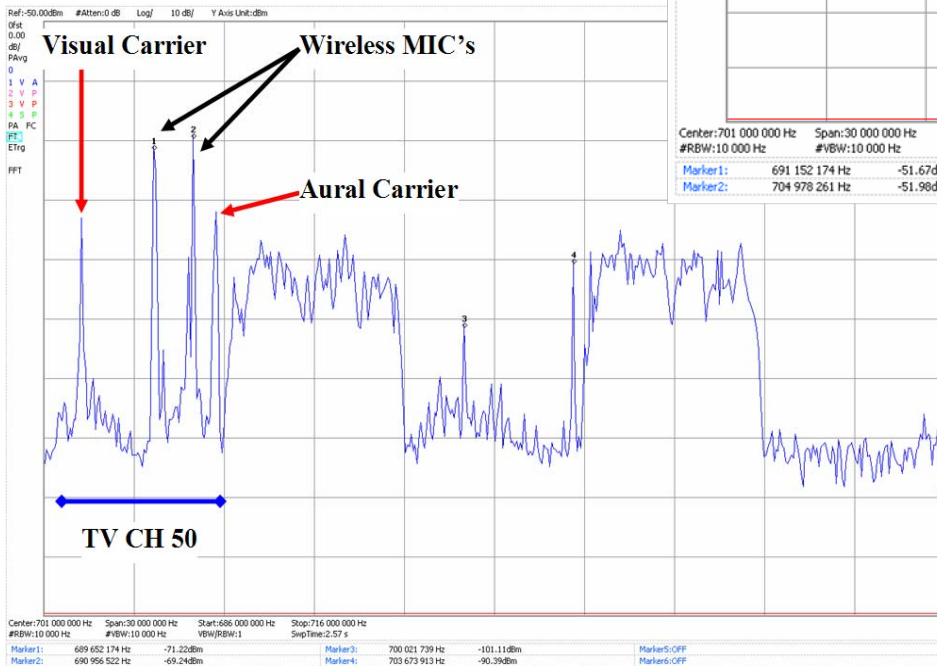
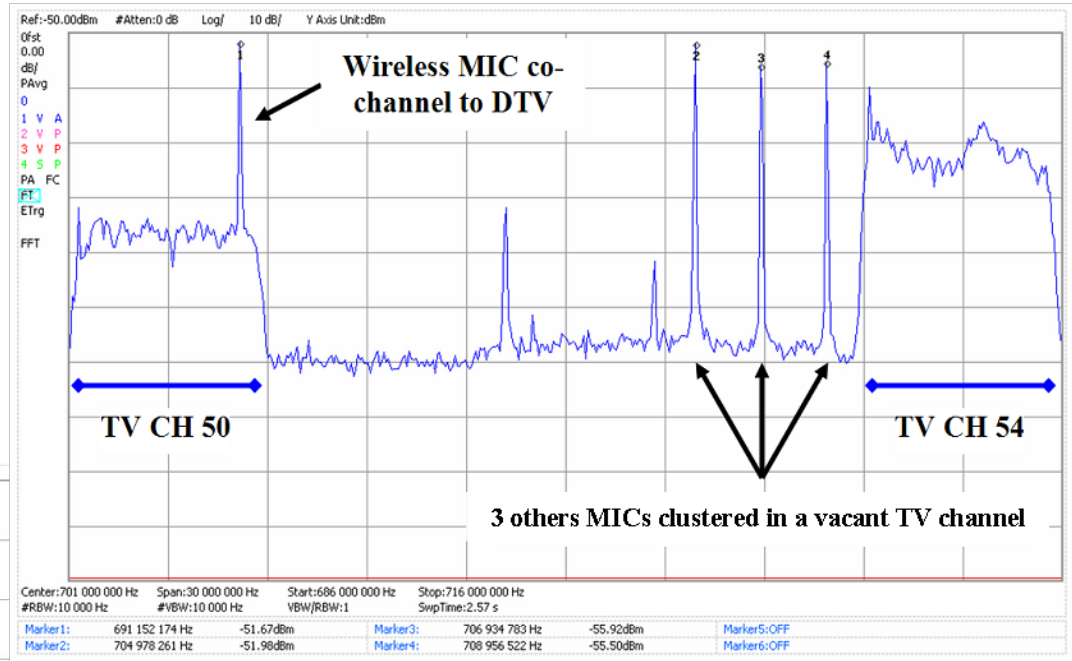
RF environment at NFL sporting events is congested with about 400 wireless devices (from SBE frequency coordinator)



V-COMM surveyed ~80 wireless microphones in 700 MHz spectrum at the NFL Superbowl 2009

Examples of Wireless Microphones on Active TV Channels

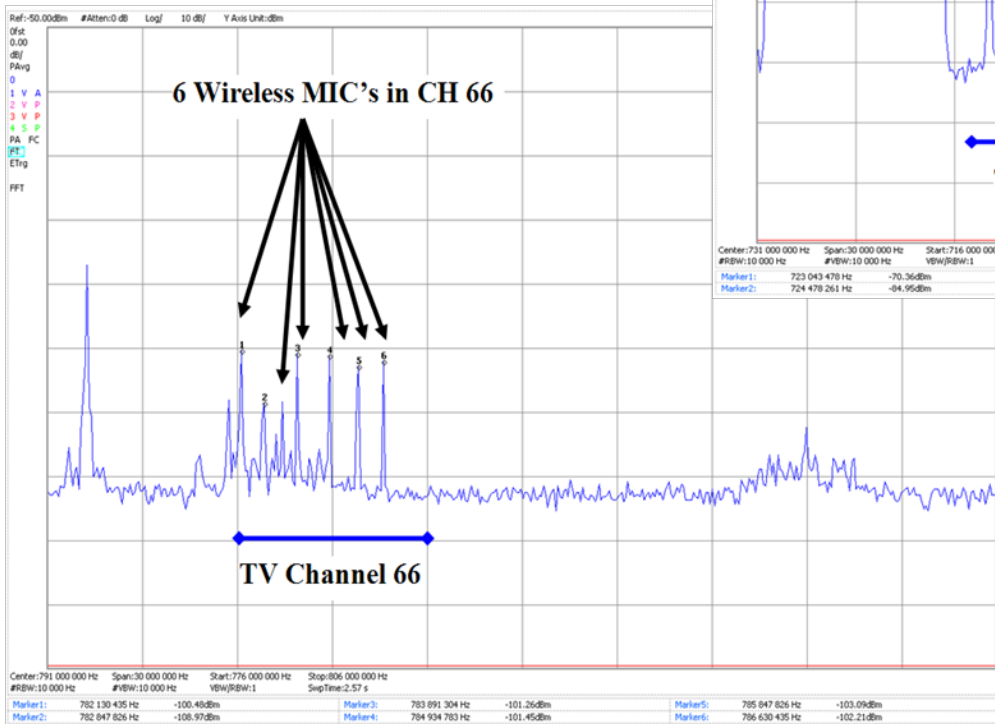
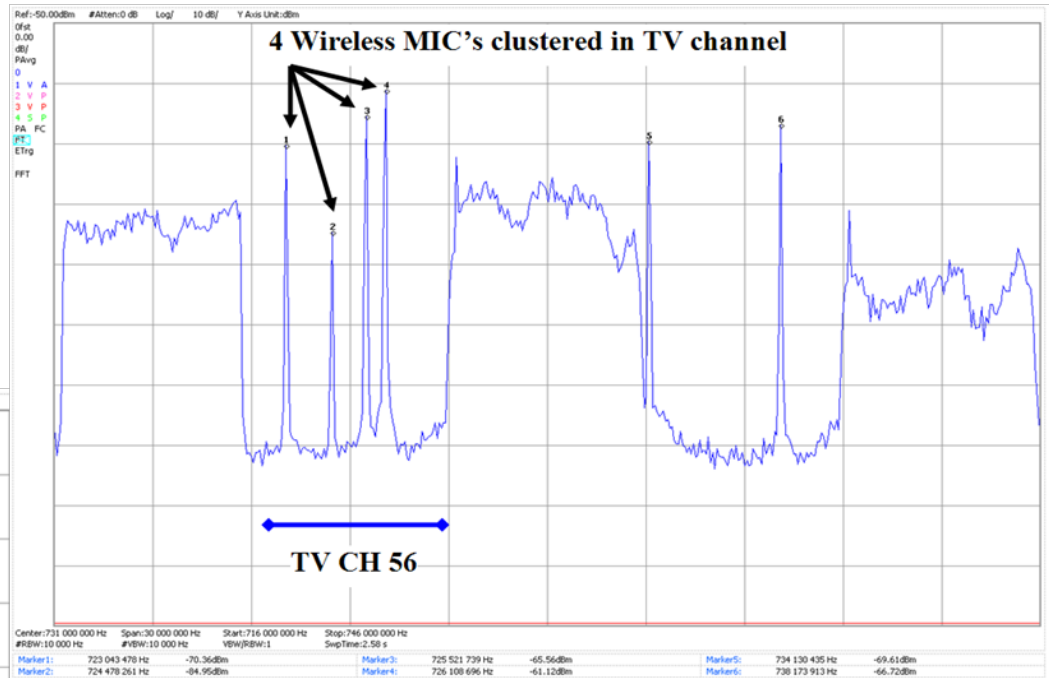
Wireless Microphones can operate on active co-channels of DTV & analog TV signals in market



Wireless Microphones could operate on active CMRS and PS channels in 700 MHz spectrum

Examples of Wireless Microphones Clustered in a Channel

Wireless Microphones tend to cluster signals within specific TV channels



This practice can increase interference impact to CMRS and PS in 700 MHz bands

Range of Interference to CMRS & Public Safety

MIC Transmit Power (mW)	BTS with 10 dB Clutter Loss (km)	BTS with No Clutter Loss (km)	Devices with 10 dB Clutter Loss (m)	Devices with No Clutter Loss (m)
250	1.8	3.3	220	400
100	1.4	2.6	175	318
50	1.2	2.2	147	267
10	0.8	1.5	98	179

- Range of co-channel interference from Wireless Microphones to CMRS & Public Safety base stations and devices operating in 700 MHz are provided above, with clutter loss of 10 dB (i.e. typical loss of 1 wall partition) and without clutter losses (i.e. for outdoor venues)
- For additional information see V-COMM's report filed in FCC's LPAS Docket (08-166 and 08-167) on October 1, 2008
 - V-COMM studied the interference from wireless microphones to CMRS & Public Safety systems operating in 700 MHz. Typical operating parameters for CMRS & Public Safety systems and wireless microphone systems were utilized in the interference study

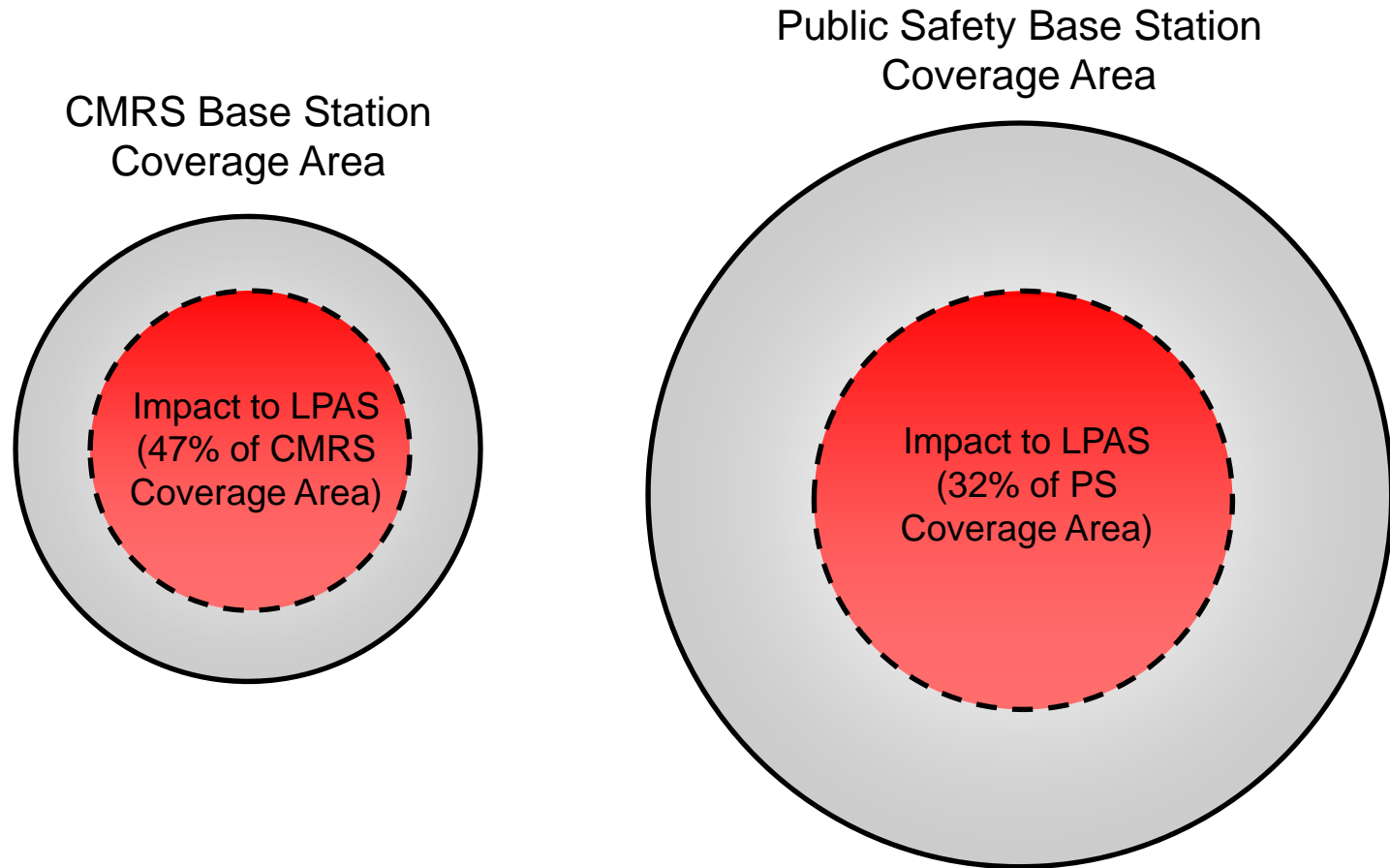
Range of Interference to Wireless Microphones

CMRS Interference	Suburban BTS (100 ft AGL)	Urban BTS (50 ft AGL)	CMRS MS
Range of Impact to LPAS MIC	1.8 km (1.1 mi)	1.3 km (0.8 mi)	79 m (260 ft)

Public Safety (PS) Interference	Suburban BTS (100 ft AGL)	Urban BTS (50 ft AGL)	PS MS (Portable)	PS MS (Vehicular)
Range of Impact to LPAS MIC	2.4 km (1.5 mi)	1.7 km (1.1 mi)	144 m (471 ft)	303 m (995 ft)

- Range of co-channel interference from CMRS & Public Safety base stations (BTS) and mobile stations (MS) to wireless microphone systems is given above
- For additional information see V-COMM's report filed in FCC's LPAS Docket 08-166 on April 17, 2009

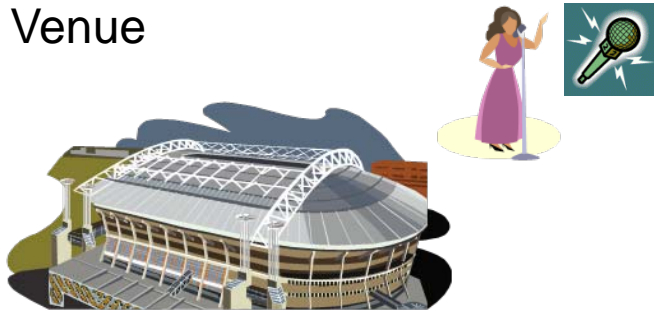
Interference to Wireless Microphones on Downlink Bands



- Area of interference to wireless microphones is 47% and 32% of the base station coverage areas for CMRS and Public Safety, respectively, when operating in the base station **downlink** spectrum bands

Interference to Wireless Microphones on Uplink Bands

Public Venue



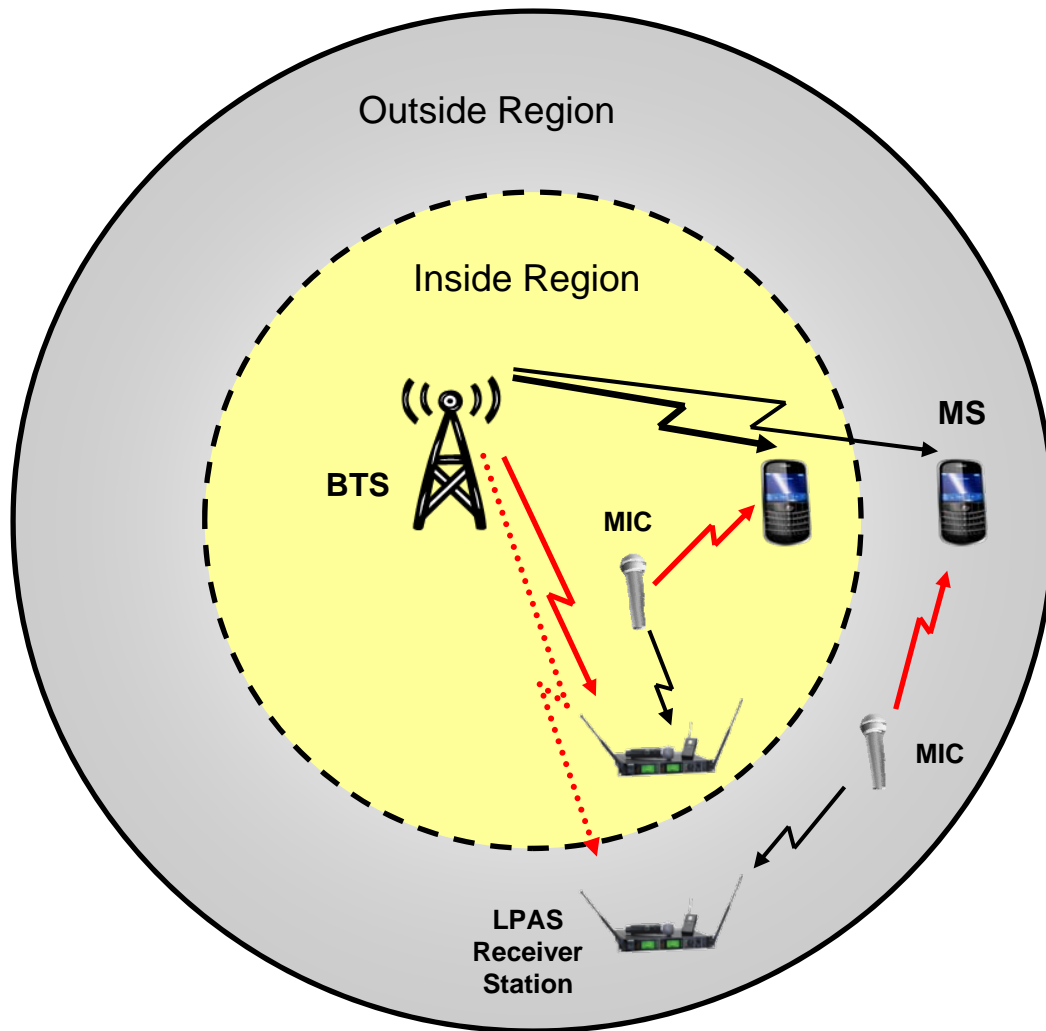
Operating in same area



- Occurs with CMRS and PS devices transmissions inside or nearby the venues
- Exception is when CMRS devices are close to their serving base stations and transmitting at low power (i.e. -20 dBm, 10 microwatts)

Interference Between CMRS & Public Safety vs. Wireless Microphones

Downlink Spectrum -- LPAS Operating on CMRS/PS *Downlink* Band



Outside Region (Away from BTS)

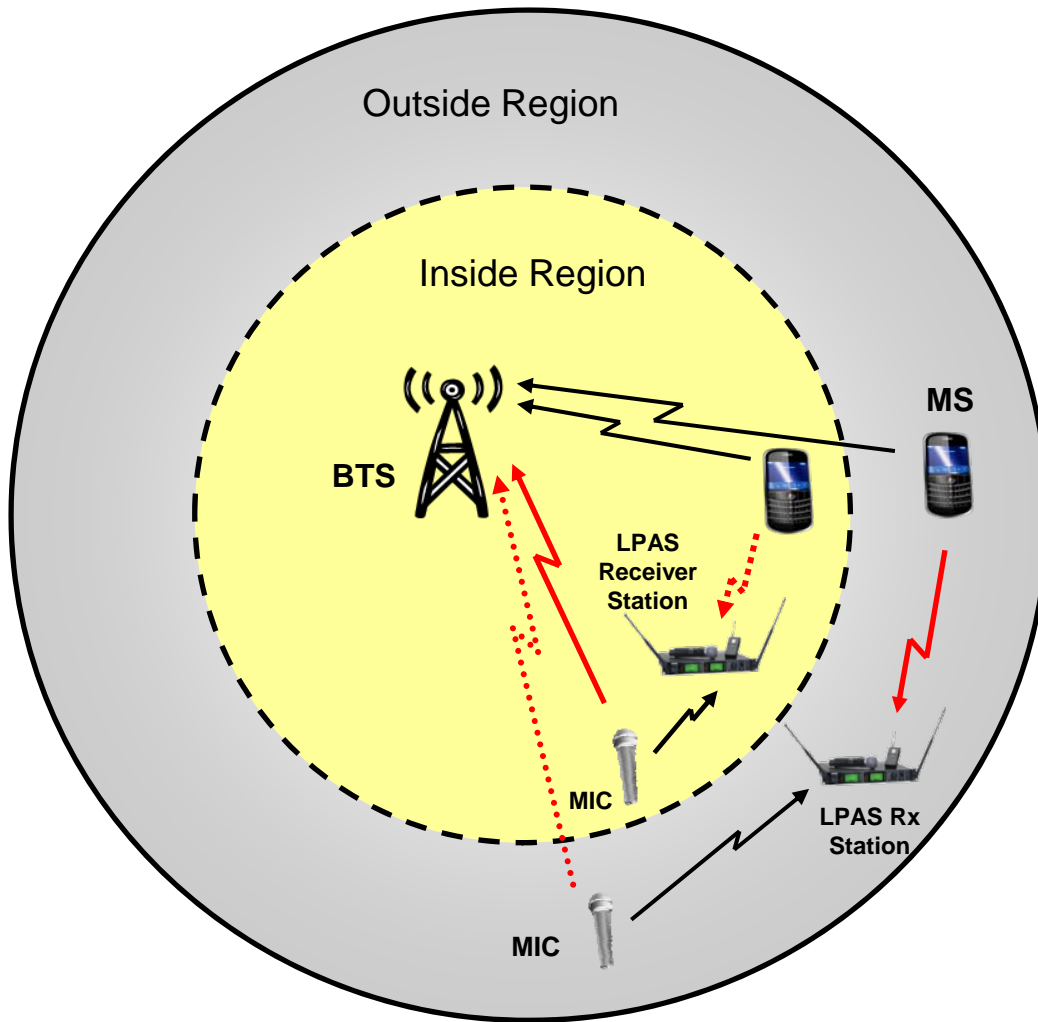
- CMRS & PS devices receive lower *desired* signals from serving BTS, and are most vulnerable to LPAS interference in these regions
- Results in significant interference to CMRS & PS devices
- LPAS users receive weakest interference from CMRS & PS BTS. Thus, in these regions LPAS users can operate without any interference

Inside Region (Near BTS)

- LPAS users experience strongest interference from CMRS & PS BTS
 - Some LPAS users can tune to other channels to avoid the interference
- CMRS & PS devices receive stronger desired signals, which can mitigate LPAS interference in some cases

Interference Between CMRS & Public Safety vs. Wireless Microphones

Uplink Spectrum -- LPAS Operating on CMRS/PS *Uplink* Band



Outside Region (Away from BTS)

- LPAS users receive strong interference from nearby CMRS & PS devices
 - Some LPAS users can tune to other channels to avoid the interference
- CMRS & PS BTS receive less interference from LPAS users that are farther away from BTS

Inside Region (Near BTS)

- CMRS & PS BTS experience strongest interference from LPAS users that are closer to BTS
- Results in **significant interference to CMRS & PS BTS**
- LPAS users receive weakest interference from CMRS devices, which are powered back when they are near their serving BTS
- Thus, in these regions **LPAS users can operate without interference from CMRS devices**

Conclusions

- Clear spectrum is needed in 700 MHz for CMRS & Public Safety networks to operate efficiently and without harmful interference
- Existing users in 700 MHz need to carefully consider prior to network deployments
 - LPTV stations – there are existing rules & methods in place to address them. Eventually, these will transition from 700 MHz
 - TV stations along Canada's & Mexico's border – require updated international treaties to fully utilize spectrum along border
 - Wireless Microphones – vast number of unauthorized users represents a difficult situation. No method to clear them from 700 MHz. Open issue, needs to be addressed



V-COMM is a leading provider of quality engineering and engineering consulting services to the worldwide wireless telecommunications industry with offices in Cranbury, NJ and Blue Bell, PA. V-COMM's engineering staff is experienced in Cellular, Personal Communications Services (PCS), Enhanced Specialized Mobile Radio (ESMR), Paging, Wireless Broadband Data, 2-Way radio, Microwave and Broadcast Mobile TV networks. We have provided our expertise to wireless operators in engineering, system design, implementation, performance, optimization, and evaluation of new wireless technologies.

We have extensive experience in analyzing interference in various spectrum bands including Cellular, SMR, PCS, AWS, Air-to-ground, Public Safety, and 700 MHz spectrum. We have engineering experience in all commercial wireless technologies, including HSPA, UMTS, EVDO, CDMA, GSM, MediaFLO, DVB-H and Analog technologies, and Public Safety wireless technologies including analog and digital Project 25, EDACS & Opensky, and many trunking and conventional radio networks. Further, V-COMM was selected by the FCC & Department of Justice to provide expert analysis and testimony in the Nextwave and Pocket Communications Bankruptcy cases.

For additional information, visit V-COMM's web site at www.vcomm-eng.com.