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December 5, 2007

Ex Parte via Electronic Filing

Marlene H. Dortch
Office of the Secretary
Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554

Re: Authorized Ex Parte Contact – Unlicensed Operation in the TV Broadcast Bands (ET Docket No. 04-186); Additional Spectrum for Unlicensed Devices Below 900 MHz and In the 3 GHz Band (ET Docket No. 02-380)

Dear Ms. Dortch:

Google Inc. ("Google"), by its attorney, respectfully submits this notification concerning an authorized ex parte contact in the above-referenced dockets. On December 4, 2007, Phil Gossett, Dan McCloskey, Paul Rodman, Michele Battelli, Guanfeng Li, and the undersigned from Google, along with consultant Paul Kolodzy, met with the following engineers from the Commission's Office of Engineering and Technology (OET) in Columbia, Maryland: Rashmi Doshi, Thomas Phillips, Steve Jones, Bill Hurst, and Steve Martin. Other OET staff from Washington, D.C. joined via videoconference, including Gerry Matise, Alan Stillwell, Bruce Romano, Harry Wong, Ron Chase, and Ira Keltz. The attached slide presentation was used during the course of the meeting.

The Google representatives presented a demonstration of preliminary test results, based on the initial phase of ongoing trials involving two forms of experimental technology utilizing repurposed equipment. In both instances, these test results demonstrate that digital televisions (DTVs) and wireless microphones can be amply protected from harmful interference by unlicensed personal/portable devices, using reasonable power levels and sensing thresholds.

First, the Google representatives demonstrated broadband spectrum sensing technologies that reliably detect DTV signals well below the noise floor. The broadband DTV sync signals gave reliable power level estimates, even when the pilot is deeply faded, removing the need for large margins. Preliminary figures from the initial phase of testing support an average sensitivity of -120 dBm. The Google representatives also showed preliminary indoor and outdoor testing data, explaining that anything with even a remote likelihood of being a licensed signal would be protected by turning off transmissions from the unlicensed device in those channels. They also indicated that some indoor tests showed better than outdoor tests, due to increased noise levels and a consequent decrease in gain. Notably, all channels plausibly receivable by a DTV tuner with a rooftop directional antenna were detected in all cases, some even outside the Grade B contours.

Second, the Google representatives demonstrated interference mitigation technologies utilizing short-burst transmissions. Those transmissions interact well with existing burst error correction in DTVs and FM modulation in wireless microphones. Specifically, these tests showed that short burst transmissions in the worst case scenario improved immunity by 15 dB for DTV, and 11 dB for wireless mics.

Should you have any questions, please do not hesitate to contact the undersigned.

Respectfully submitted,

Richard S. Whitt, Esq.
Washington Telecom and
Media Counsel
Google Inc.

Attachment: Google TV White Spaces Spectrum Sharing Technology Demonstration

TV White Spaces Spectrum Sharing Technology Demonstration

FCC OET

December 4, 2007

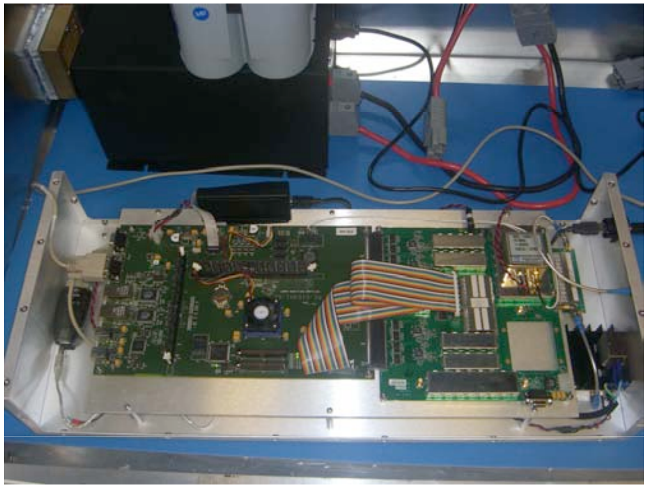
Outline

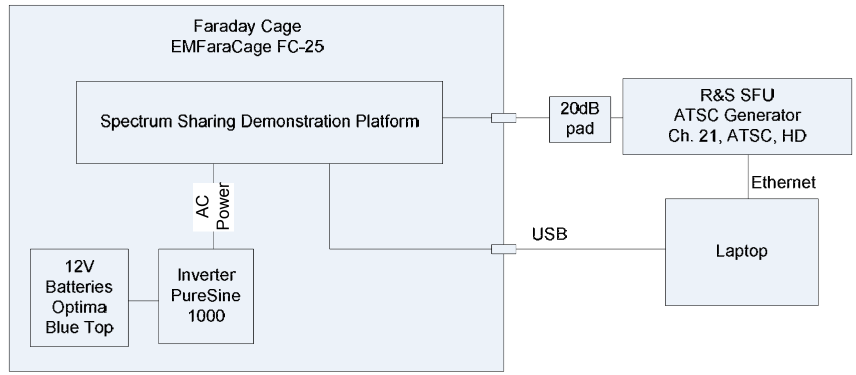
- This is a demonstration of spectrum sensing and interference mitigation technologies:
  1. Broadband spectrum sensing technologies can reliably detect DTV signals well below the noise floor
  2. Short burst transmissions interact well with existing burst error correction in DTVs and and FM modulation in wireless mics

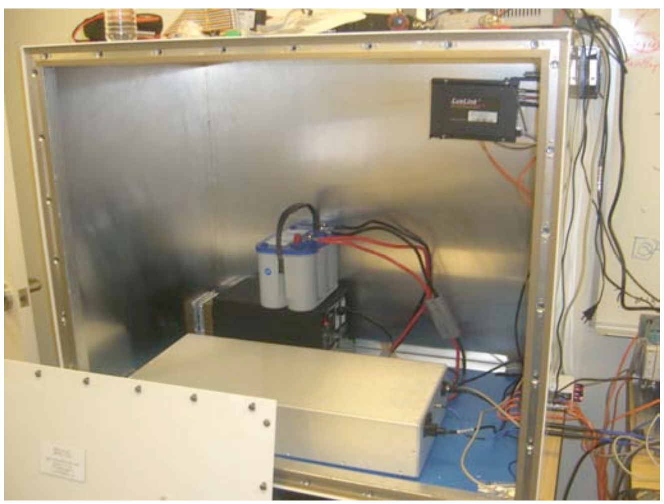
1. Broadband sensing technology

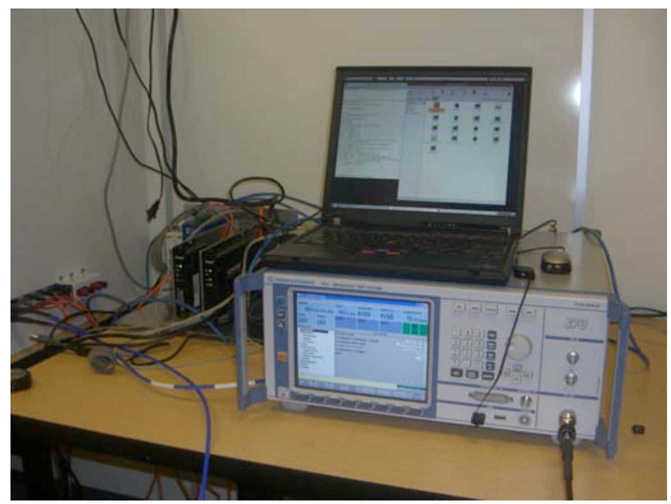
- Problem: Narrowband pilot-based schemes are subject to “deep fades”, making power estimation unreliable, requiring large margins
- Solution: Broadband DTV sync signals give reliable power level estimates, even when the pilot is deeply faded, removing the need for large margins

Broadband sensitivity test setup

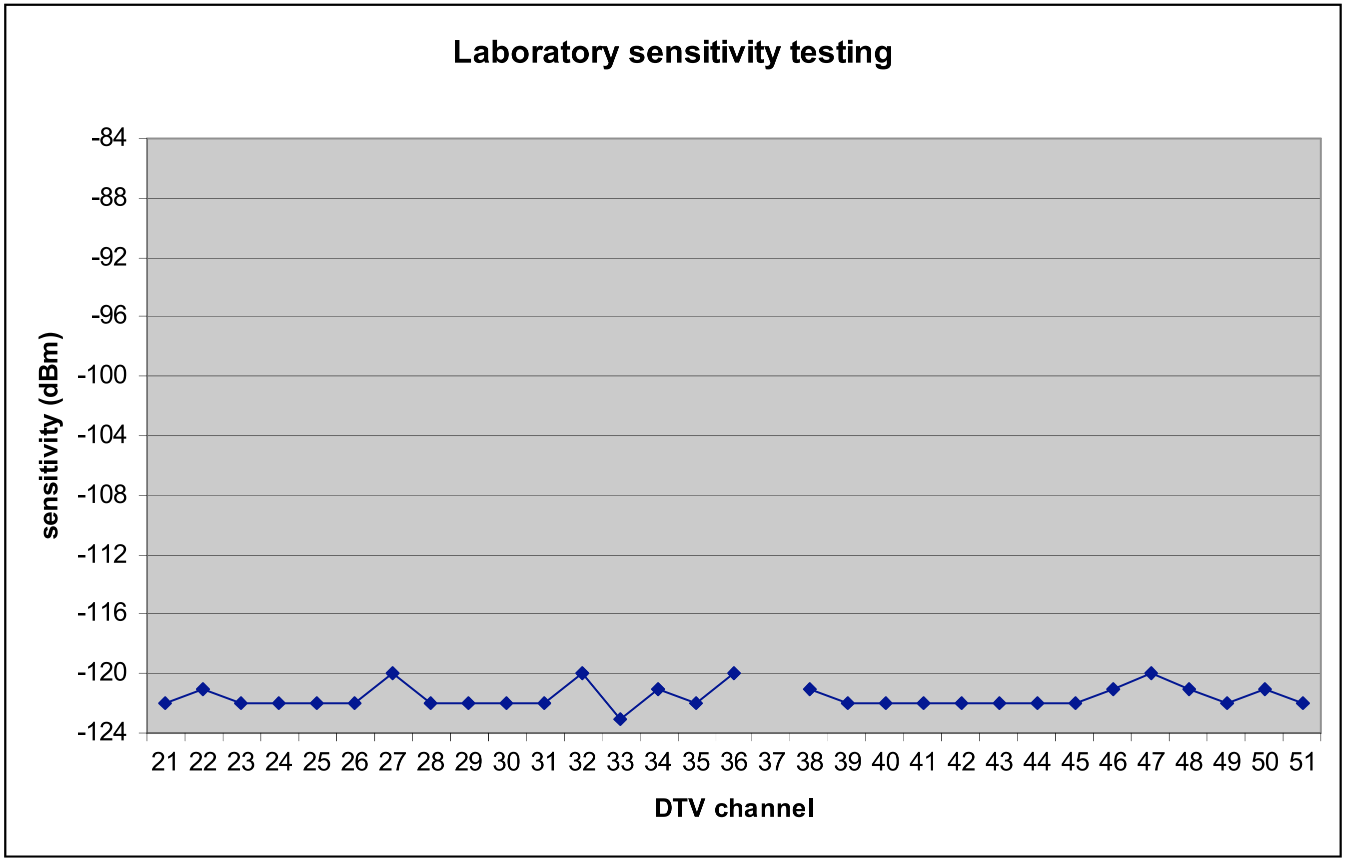








Results of sensitivity tests



Preliminary

DTV stations near Mtn. View, CA

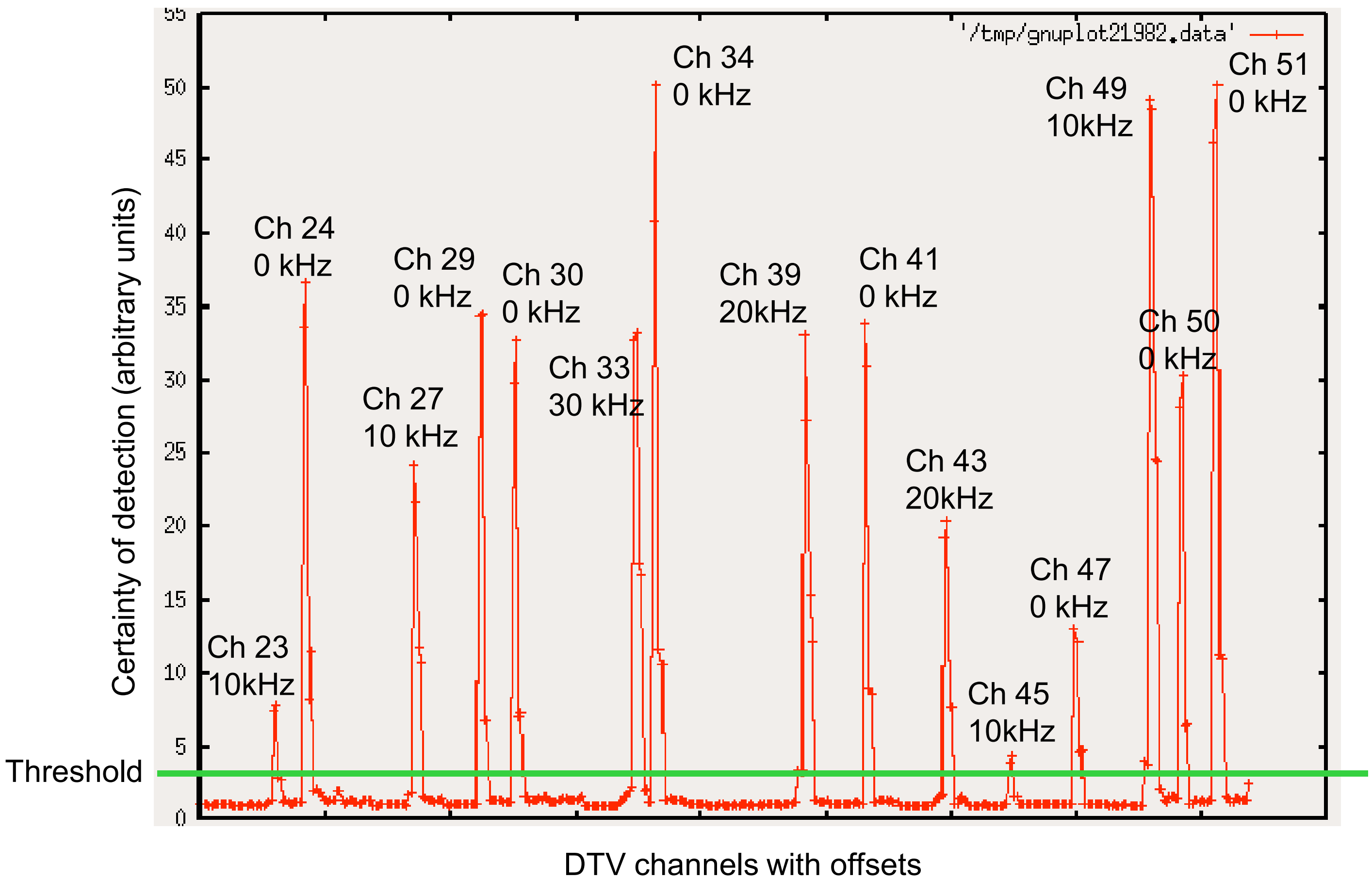
All licensed (or CP) DTV stations within 200 km of N 37° 25' 12.26", W 122° 4' 59.40" (Mountain View, CA):

Call	Ch		Status	City	ERP	HAAT	Latitude				Longitude				Distance	Det
KMAX-TV	21	ND	LIC	SACRAMENTO	850. kW	581.2	N	38	15	54.00	W	121	29	24.00	107.33 km	
KRCB	23	DA	CP MOD	COTATI	105. kW	630.4	N	38	20	54.70	W	122	34	37.50	111.84 km	*
KGO-TV	24	DA	LIC	SAN FRANCISCO	561. kW	437.0	N	37	45	19.00	W	122	27	6.00	49.43 km	*
KOVR	25	ND	LIC	STOCKTON	760. kW	591.0	N	38	14	24.00	W	121	30	3.00	104.45 km	
KTSF	27	DA	LIC	SAN FRANCISCO	500. kW	403.4	N	37	41	12.00	W	122	26	3.00	42.87 km	*
KPIX-TV	29	DA	LIC	SAN FRANCISCO	1000. kW	401.0	N	37	45	20.00	W	122	27	5.00	49.44 km	*
KQED	30	DA	LIC	SAN FRANCISCO	777. kW	437.0	N	37	45	19.00	W	122	27	6.00	49.43 km	*
KSMS-TV	31	DA	CP	MONTEREY	50. kW	700.6	N	36	45	23.00	W	121	30	5.00	90.00 km	
KION-TV	32	DA	LIC	MONTEREY	46. kW	758.0	N	36	32	5.00	W	121	37	14.00	106.54 km	
KMTP-TV	33	ND	CP	SAN FRANCISCO	500. kW	496.0	N	37	45	19.00	W	122	27	6.00	49.43 km	*
KFSF-TV	34	DA	LIC	VALLEJO	150. kW	419.0	N	37	45	19.00	W	122	27	6.00	49.43 km	*
KCRA-TV	35	ND	LIC	SACRAMENTO	1000. kW	462.0	N	38	14	50.00	W	121	30	3.00	105.15 km	
KCNS	39	DA	LIC	SAN FRANCISCO	1000. kW	428.0	N	37	45	19.00	W	122	27	6.00	49.43 km	*
KKPX	41	DA	LIC	SAN JOSE	1000. kW	418.0	N	37	41	15.00	W	122	26	1.00	42.89 km	*
KCSM-TV	43	DA	LIC	SAN MATEO	536. kW	428.0	N	37	45	19.00	W	122	27	6.00	49.43 km	*
KBCW	45	DA	LIC	SAN FRANCISCO	400. kW	446.0	N	37	45	19.00	W	122	27	6.00	49.43 km	*
KQCA	46	ND	LIC	STOCKTON	600. kW	580.0	N	38	15	54.00	W	121	29	24.00	107.33 km	
KTLN-TV	47	DA	CP	NOVATO	1000. kW	402.0	N	38	9	0.00	W	122	35	31.00	92.59 km	*
KSPX	48	DA	LIC	SACRAMENTO	1000. kW	489.0	N	38	15	54.00	W	121	29	24.00	107.33 km	
KSTS	49	DA	LIC	SAN JOSE	257. kW	688.0	N	37	29	57.00	W	121	52	16.00	20.71 km	*
KTEH	50	DA	LIC	SAN JOSE	290. kW	662.0	N	37	29	17.00	W	121	51	59.00	20.61 km	*
KDTV	51	DA	LIC	SAN FRANCISCO	476.3 kW	701.0	N	37	29	57.00	W	121	52	16.00	20.71 km	*

Can see every station not occluded by mountains, including several not receivable by DTV tuners.

Broadband sensing outdoor over-air test setup

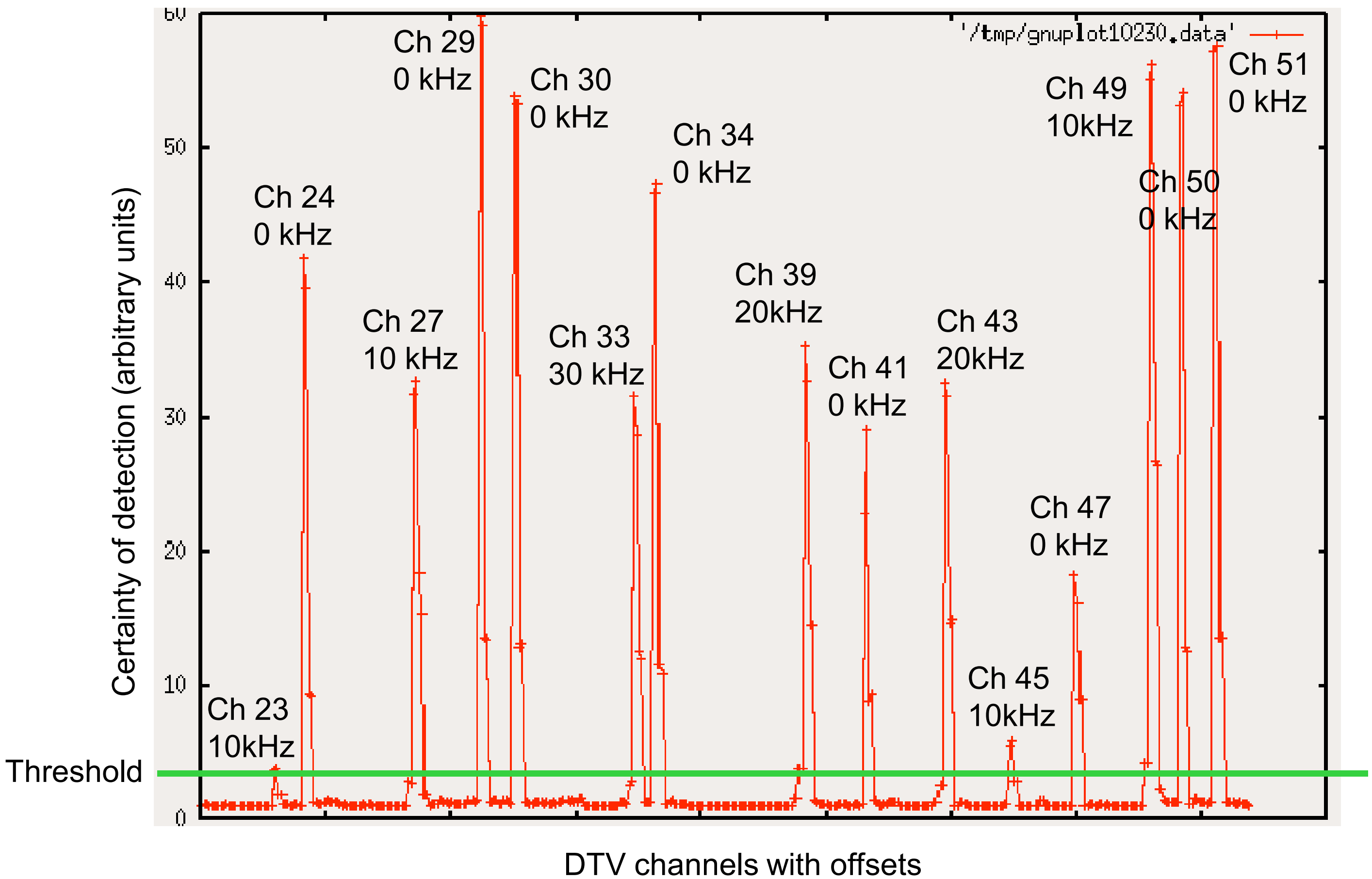
Results of outdoor over-air tests



Preliminary

Broadband sensing indoor over-air test setup

Results of indoor over-air tests



Preliminary

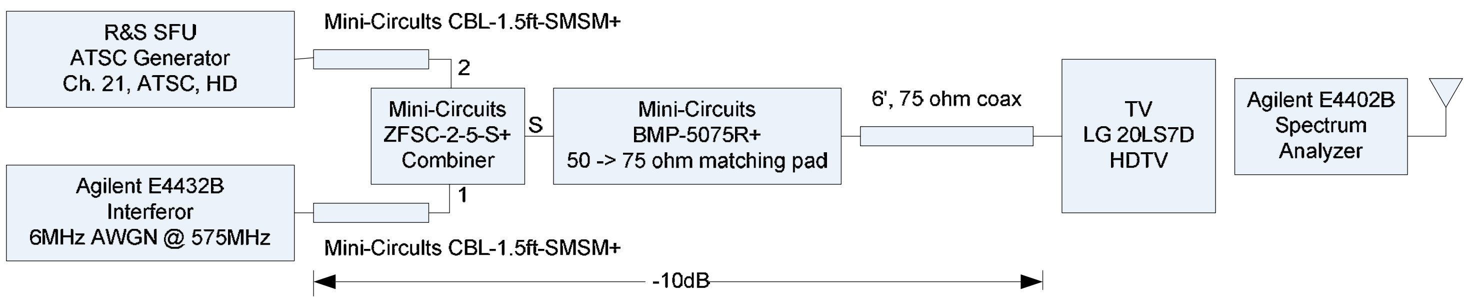
Wireless mics can also be detected and protected

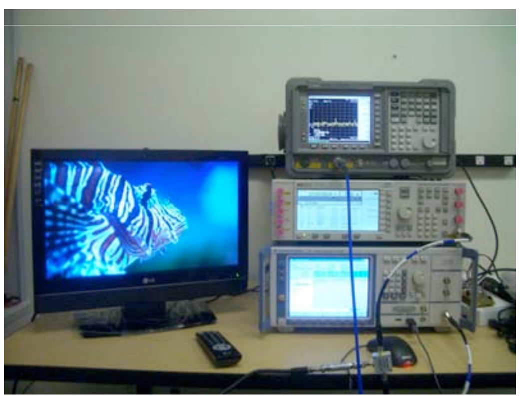
- Signals are simple, narrowband, and easy to detect with simple FFT-based schemes
- Due to their shorter range (100 m) and usage patterns (open areas, large halls) there is less opportunity for “hidden node” problems
- Wireless mic detection is not a subject of this demonstration

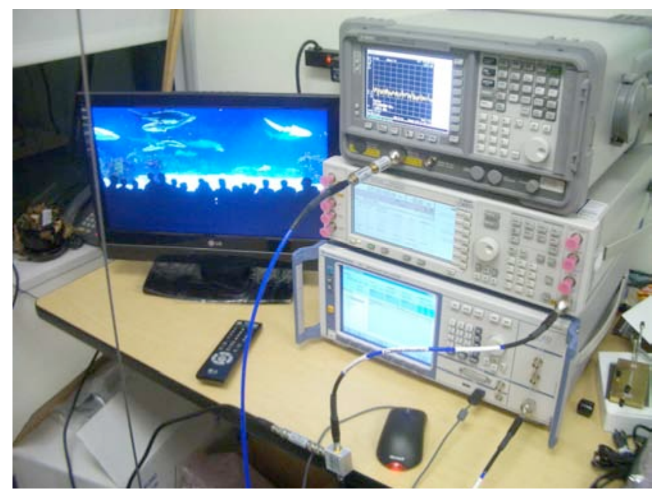
2. Burst transmission technology

- Observation: Burst error correction can be used to mitigate interference effects, since the ATSC standard specifies burst error correction up to 193 us
- Conclusion: Tests demonstrate that short burst transmission is both safe and practical

Burst transmission test setup for DTV





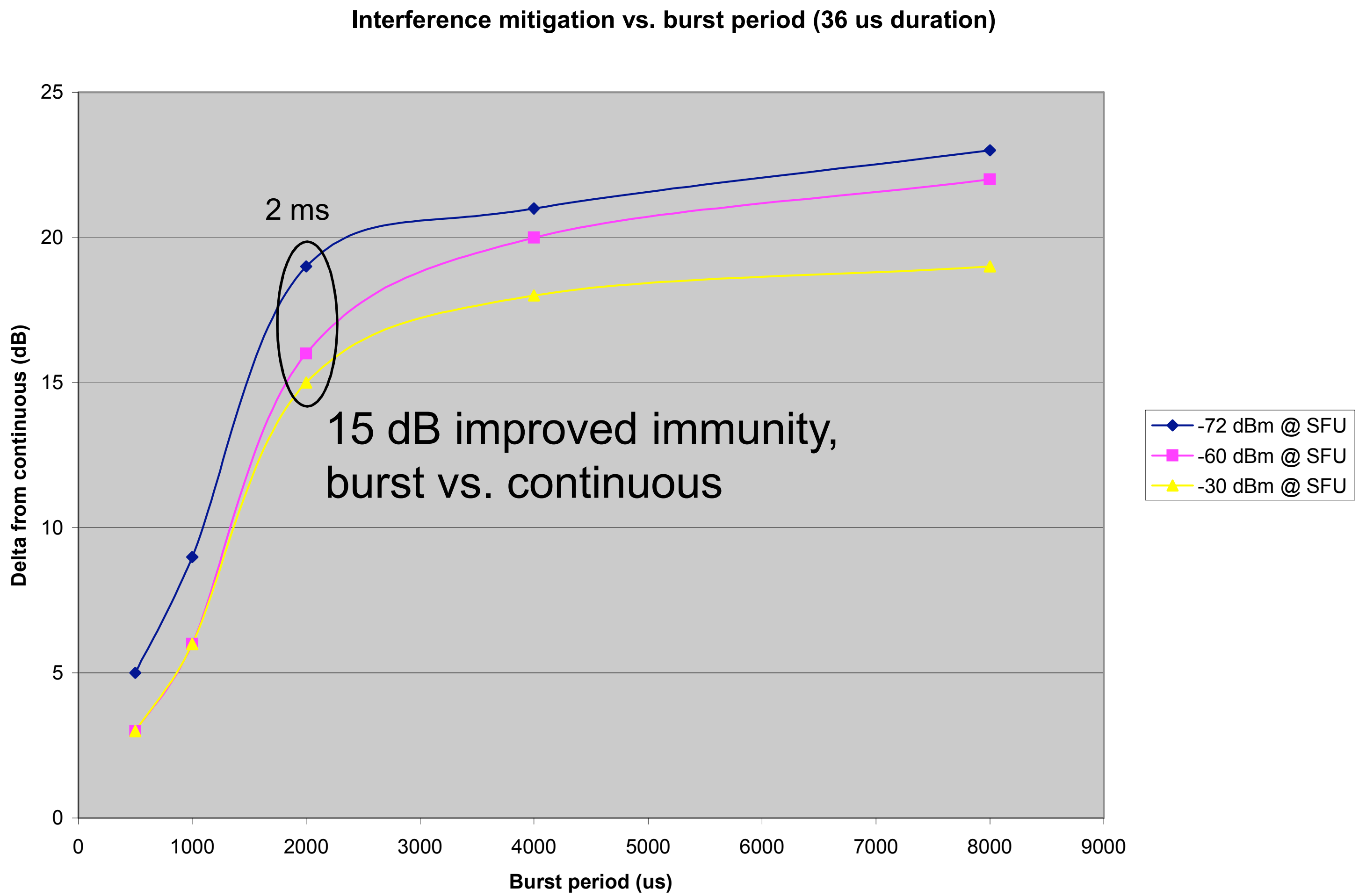


Results of burst transmission tests for DTV

ATSC Signal Power @ SFU (dBm)			-72	-60	-30	-72	-60	-30	-72	-60	-30
Pulse Dur. (us)	Pulse Per. (us)	DC (%)	Interferer (dBm)			Burst S/N (dB)			Delta from cont.		
1000	1000	100	-89	-74	-44	17	14	14	0	0	0
200	2000	10	-85	-72	-42	13	12	12	4	2	2
100	2000	5	-83	-70	-40	11	10	10	6	4	4
52	2000	2.6	-75	-63	-32	3	3	2	14	11	12
36	2000	1.8	-70	-58	-29	-2	-2	-1	19	16	15
20	2000	1	-67	-52	-24	-5	-8	-6	22	22	20
36	500	7.2	-84	-71	-41	12	11	11	5	3	3
36	1000	3.6	-80	-68	-38	8	8	8	9	6	6
36	2000	1.8	-70	-58	-29	-2	-2	-1	19	16	15
36	4000	0.9	-68	-54	-26	-4	-6	-4	21	20	18
36	8000	0.45	-66	-52	-25	-6	-8	-5	23	22	19

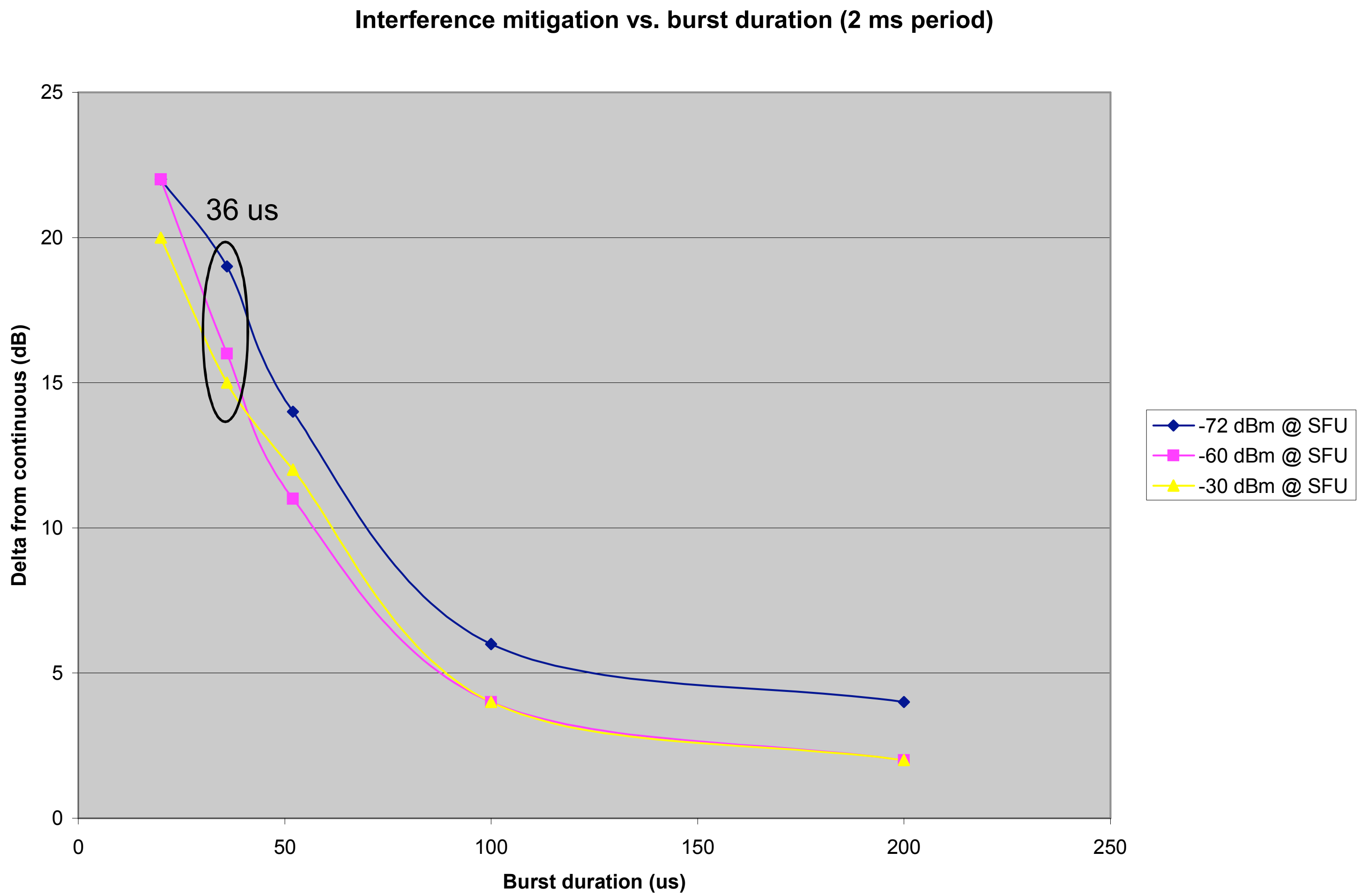
Preliminary

Results of burst transmission tests for DTV



Preliminary

Results of burst transmission tests for DTV

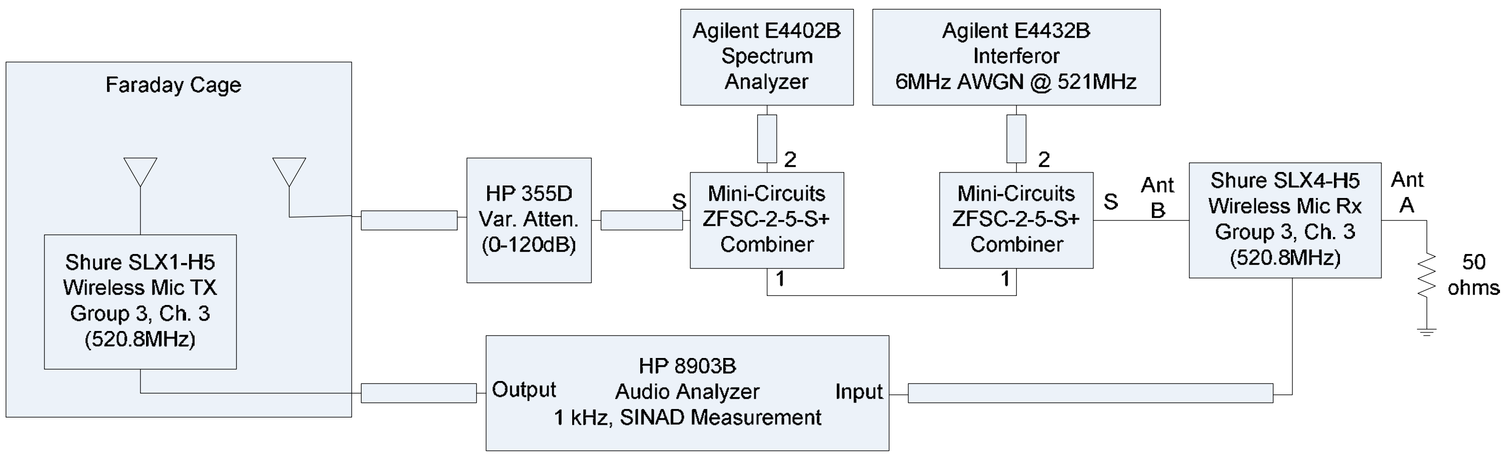


Preliminary

The same burst transmission scheme works for wireless mics

- FM is inherently burst noise tolerant
- Tests confirm the same burst transmission scheme is also effective for wireless mics

Burst transmission test setup for wireless mics

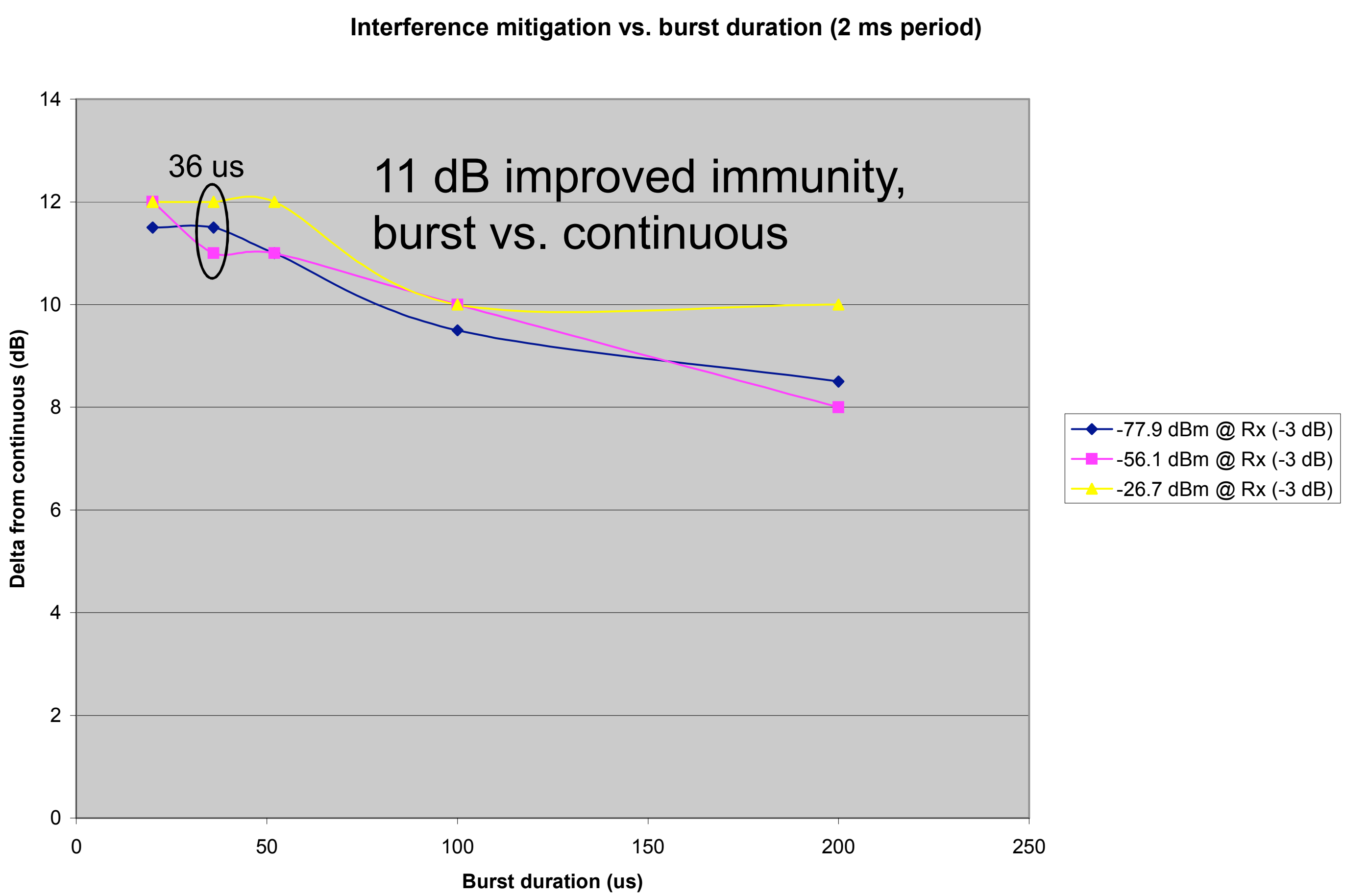


Results of burst transmission tests for wireless mics

Mic Signal at Rx (dBm, -3dB)			-77.9	-56.1	-26.7	-77.9	-56.1	-26.7	-77.9	-56.1	-26.7
Pulse Dur. (us)	Pulse Per. (us)	DC (%)	Interferer (dBm, -3dB)			Burst S/N (dB)			Delta from cont.		
1000	1000	100	-78.5	-57	-29	0.6	0.9	2.3	0	0	0
200	2000	10	-70	-49	-19	-7.9	-7.1	-7.7	8.5	8	10
100	2000	5	-69	-47	-19	-8.9	-9.1	-7.7	9.5	10	10
52	2000	2.6	-67.5	-46	-17	-10.4	-10.1	-9.7	11	11	12
36	2000	1.8	-67	-46	-17	-10.9	-10.1	-9.7	11.5	11	12
20	2000	1	-67	-45	-17	-10.9	-11.1	-9.7	11.5	12	12
36	1000	3.6	-68	-47	-18	-9.9	-9.1	-8.7	10.5	10	11
36	2000	1.8	-67	-46	-17	-10.9	-10.1	-9.7	11.5	11	12
36	4000	0.9	-66	-45	-16	-11.9	-11.1	-10.7	12.5	12	13

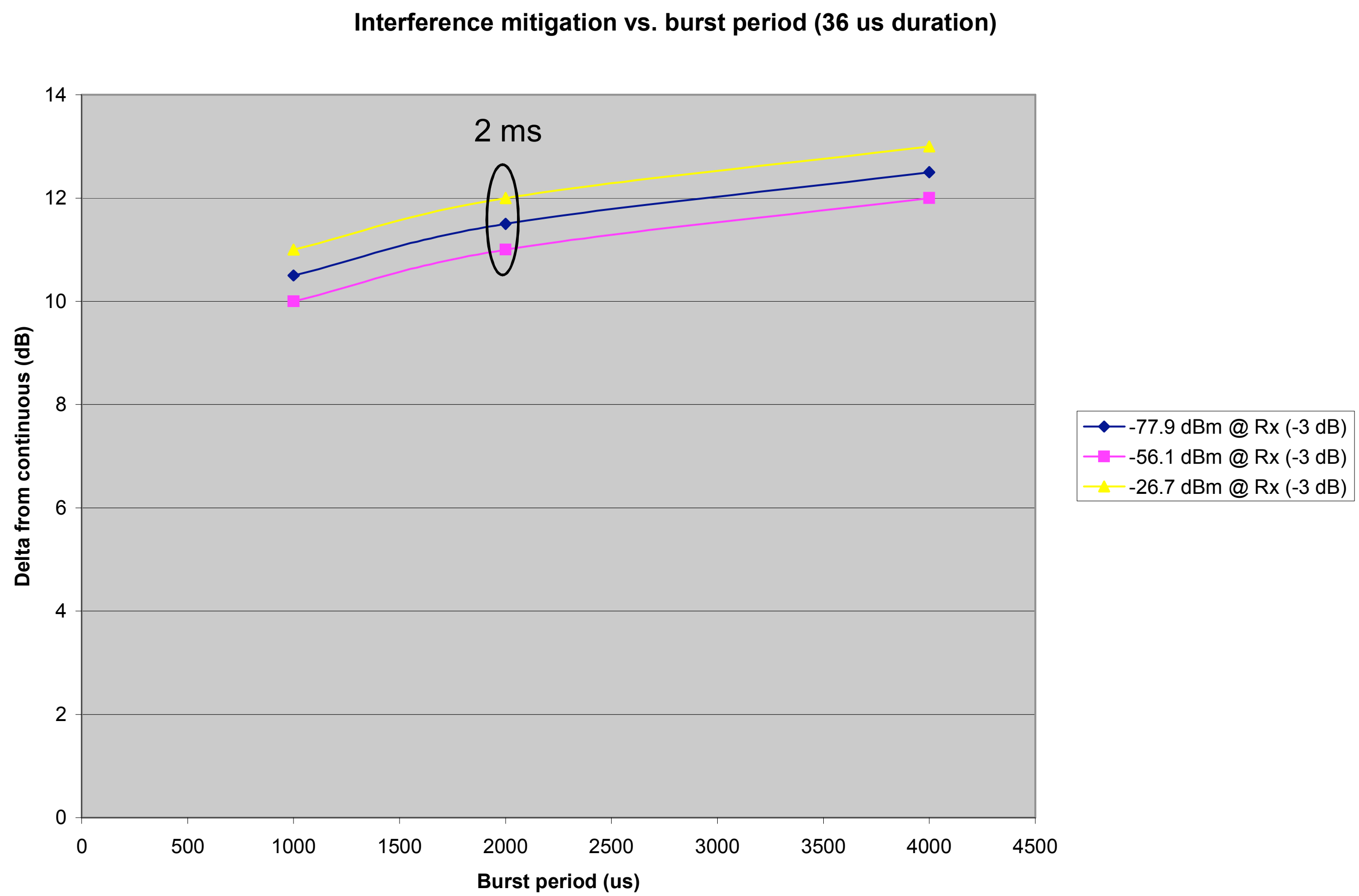
40dB SINAD

Results of burst transmission tests for wireless mics



Preliminary

Results of burst transmission tests for wireless mics



Preliminary

Conclusion

- Unlicensed devices can safely coexist with licensed devices, without fear of harmful interference
  1. Broadband sensing technologies can greatly improve the accuracy and reliability of spectrum sensing
  2. Burst transmissions inherently cause less harmful interference to existing licensed devices