July 6, 2009

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Marlene H. Dortch, Secretary
Federal Communications Commission
Washington, DC.

Informal Comment 99
In Re: MM Docket No. ~~00-325~~

To: Ms. Dortch:

The following preliminary results are being submitted to the Federal Communications Commission in re: the Further Request for Comment, MM Docket No. 00-325, as an informal Comment, in response to the four issues for which comment is sought.

Respectfully Submitted,

Sid Shumate
President, Givens & Bell, Inc.
1897 Ridge Rd.
Haymarket, VA 20169

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Submitted to the Federal Communications Commission
In re: MM Docket 00-325
Further Request for Comment on Four Issues
Comment due July 6, 2009

Preliminary Results

FM COMPREHENSIVE MARKET RECEPTION REPORT
for the
WASHINGTON D.C. METRO MARKET #9

CUSTOMIZED TO INCLUDE
Both 1% and 10% IBOC POWER LEVELS

SUBMITTED BY:
Sid Shumate
Givens & Bell, Inc.
1897 Ridge Rd
Haymarket, VA

July 6, 2009

Marlene H. Dortch, Secretary
Federal Communications Commission
Washington, DC.

Informal Comment
In Re: MM Docket No. 00-325

To: The Commissioners and Staff:

The following preliminary results are being submitted to the Federal Communications Commission in re: the Further Request for Comment, MM Docket No. 00-325, as an informal Comment, in response to the four issues for which comment is sought.

This comment primarily addresses the first issue, as to whether the proceeding should wait until the NPR further studies are complete. To this we say Yes. The previous work by NPR Labs in gathering field measurements, and their traditional, empirical approach utilizing TIREM to analyze the results, is well worthy of consideration.

However, in delaying the consideration until this additional information is available, we also informally ask that the Commission leave open the door to alternate sources of data for discussion. Givens & Bell, Inc. has been pursuing, for more than a decade, a different, deterministic approach to measuring wireless broadcast reception, using the power of modern computers to better answer questions previously addressed in crude, approximate ways. This work is the first released results of this long awaited new approach, and is being submitted to the Commission in order to provide a second source, utilizing a far more sophisticated and detailed prediction of coverage that that possible using either the NTIA's outdated Longley-Rice ITM software core, or TIREM. This preliminary analysis includes a consideration of both 1% and 10% IBOC insertion levels, to provide raw, scientifically predicted coverage data to consider in addressing all four issues for which comment is being sought.

The full report, originally and still intended to be a demonstrator model for a product to be represented by BIA Advisory Services' Dataworld division, to be made available at this fall's NAB Radio Show, will be complete in approximately the same time frame as the NPR report. We are today including only the report for one station, a station much-measured with regard to HD Radio ™ development, and the Summary Results for the 32 full power FM stations considered by this report, in the Washington, DC Metro (#9) market.

This preliminary report consists only of:

1. Example prediction of coverage for FM station WETA-FM.
2. Market Summary Average Results of 32 Stations in the Washington, DC Market.
3. Revised version of most recent progress report White Paper presented at 2009 NAB Broadcast Engineering Conference, providing background and interpretation information.
4. Study area maps.

Sections 1 and 2 present results determined at the pixel (3-arc-second, approximately 1.6 acre size) level, utilizing 2000 Census tract-level data, to provide predicted actual coverage areas stated in square miles, and detailed population and demographic data. The various cases presented include theoretical what-if stages to provide a new understanding of the extent of the effect of the various restrictions on coverage area, including Galactic noise only, Full Noise (FN) interference, and Co-channel and adjacent channel interference, for Urban, Suburban, Rural and Very Rural Galactic Noise limited areas, for what-if cases of all stations transmitting first 1%, and then, 10% IBOC insertion power. The later scenarios consider only current (as of Dec. 2008) IBOC stations, providing current reception predictions for Exterior Parked or Low Speed, Mobile at Speed, Indoor, and Portable reception scenarios, for Prime and Acceptable reception areas.

Respectfully Submitted,

Sid Shumate
President, Givens & Bell, Inc.
1897 Ridge Rd.
Haymarket, VA 20169

SECTION 1:

WETA-FM Coverage Prediction Analysis:

COMPREHENSIVE MARKET REPORT
FOR FM STATION: app. id:
"WETA" 1184693
Study area boundaries: West: 80 East: 74 North: 41 South: 37 degrees
THEORETICAL 'WHAT IF' AND
'IF ALL STATION' SCENARIOS:

PRIME ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog very rural noise limited only	35622	13304367	5086439	1791648	926936	526953	1234028	1934348	2230388	1861067	2798998
Analog vs full noise (FN) limiting only	22195	8829319	3364658	1196842	608783	345801	815059	1321234	1510327	1254051	1777224
Analog vs FN and Analog (A) interference.	8517	5545080	2102968	758837	375509	213302	520933	863240	958886	792831	1061542
Analog vs FN A and 1 pct IBOC interf.	7421	5420729	2055233	742468	366865	208244	508116	846991	939170	775467	1033408
Analog vs FN A and 10 pct IBOC interf.	7221	5723388	2169870	784380	388851	220262	535472	889836	991045	816858	1096685

PRIME HYBRID Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	9743	5559387	2114054	756782	378672	215190	516317	852785	958348	797540	1083752
10 pct. IBOC vs FN A and 10 pct IBOC interf.	16423	7567903	2871669	1032180	522058	296284	697930	1136270	1299713	1079519	1503948

PRIME MULTICAST Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	5181	4143362	1585082	559526	276153	156824	392096	654121	715766	594358	794517
10 pct. IBOC vs FN A and 10 pct IBOC interf.	11079	5991960	2275520	816660	409518	232642	555821	913749	1032126	858408	1173037

ACCEPTABLE ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog very rural noise limited only	12378	4554512	1752948	606848	327892	185697	424446	618364	726749	610973	1053544
Analog vs full noise (FN) limiting only	14501	3701711	1422325	486946	262803	151077	336305	499624	604658	513430	846868
Analog vs FN and Analog (A) interference.	281	50231	19527	6792	3488	1999	5286	7053	7941	6668	11004
Analog vs FN A and 1 pct IBOC intf.	144	30588	11908	4146	2112	1208	3224	4378	4860	4060	6599
Analog vs FN A and 10 pct IBOC intf.	371	147752	56304	20363	10401	5859	13979	21950	25049	20015	30136

DIGITAL EDGE of HYBRID Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	6679	2008516	757615	275398	143386	81093	181613	283485	341364	281980	420196
10 pct. IBOC vs FN A and 10 pct IBOC intf.	4734	1118379	432223	149844	78115	44221	105937	162417	184961	151518	241366

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	11242	3424541	1286587	472654	245905	139460	305834	482149	583947	485161	709431
10 pct. IBOC vs FN A and 10 pct IBOC intf.	10078	2694322	1028371	365365	190656	107863	248047	384938	452548	372629	572276

CURRENT RECEPTION PREDICTIONS
EXTERIOR PARKED to LOW SPEED:

PRIME ANALOG RECEPTION	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC intf.	12670	6228877	2381467	841930	417739	238492	588944	972117	1071225	887278	1211152
Analog vs FN A and 10 pct IBOC intf.	12279	6412151	2430852	875727	437585	248891	598141	981460	1105499	915894	1248955

PRIME Reception; HYBRID SIMULCAST	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	9838	5562837	2115413	757189	378911	215333	516562	853185	958896	798076	1084885
IF 10 pct. IBOC vs FN A and 10 pct IBOC intf.	17211	7662967	2909096	1043865	528692	300293	705190	1149035	1316369	1093671	1525852

PRIME MULTICAST Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	5182	4143416	1585102	559533	276157	156827	392100	654128	715776	594367	794528
IF 10 pct. IBOC vs FN A and 10 pct IBOC intf.	11239	5998169	2277963	817398	409948	232897	556253	914471	1033123	859391	1174686

ACCEPTABLE ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC intf.	4876	730925	297295	89680	46265	27641	70689	109122	115366	103018	169143
Analog vs FN A and IF 10 pct IBOC intf.	4735	958527	391895	119715	59370	34789	93899	157120	157362	132070	204203

DIGITAL EDGE of HYBRID Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	7372	2100130	793684	286676	149781	84960	188628	295850	357473	295595	441167
10 pct. IBOC vs FN A and IF 10 pct IBOC intf.	7270	1569033	620626	204047	105159	60361	148381	237193	258463	215218	340211

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	12029	3519551	1323994	484331	252535	143466	313090	494907	600593	499304	731324
10 pct. IBOC vs FN A and IF 10 pct IBOC intf.	13242	3233831	1251760	430514	223903	127756	297318	471757	541709	449498	691377

CURRENT RECEPTION PREDICTIONS
FOR MOBILE AT SPEED:

ANALOG PRIME Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC intf.	15098	6595369	2530934	887662	440887	252280	623881	1028769	1129927	939153	1292810
Analog vs FN A and 10 pct IBOC intf.	14415	6970703	2660573	945149	471426	268536	654011	1077139	1198572	991552	1364317

PRIME Reception; HYBRID SIMULCAST	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	14277	6863379	2601699	936429	472768	268494	632353	1033785	1181427	981928	1356195
IF 10 pct. IBOC vs FN A and 10 pct IBOC intf.	17211	7662967	2909096	1043865	528692	300293	705190	1149035	1316369	1093671	1525852

PRIME MULTICAST Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	8528	5137343	1955509	698534	348480	198107	478225	793219	886858	737846	996074
IF 10 pct. IBOC vs FN A and 10 pct IBOC intf.	11239	5998169	2277963	817398	409948	232897	556253	914471	1033123	859391	1174686

ACCEPTABLE ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC intf.	4247	712754	288493	85316	44688	26699	73783	103067	110204	98741	170256
Analog vs FN A and IF 10 pct IBOC intf.	5162	781980	316949	96495	49818	29660	75821	116455	123636	109814	180280

DIGITAL EDGE of HYBRID Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	7173	1841426	720031	242876	125458	71552	171922	274813	307536	254208	393061
10 pct. IBOC vs FN A and IF 10 pct IBOC intf.	7270	1569033	620626	204047	105159	60361	148381	237193	258463	215218	340211

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	12922	3567462	1366221	480772	249746	141939	326050	515379	602105	498289	753182
10 pct. IBOC vs FN A and IF 10 pct IBOC intf.	13242	3233831	1251760	430514	223903	127756	297318	471757	541709	449498	691377

CURRENT RECEPTION PREDICTIONS
FOR INDOOR RECEPTION

PRIME ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC intf.	9500	5440829	2063718	742529	368035	209495	511996	844537	939363	778696	1046178
Analog vs FN A and 10 pct IBOC intf.	7770	5058143	1924306	688945	341555	194129	474828	787905	873408	724336	973037

PRIME Reception; HYBRID SIMULCAST	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	4315	3747455	1434700	505542	247915	140724	356480	598029	648616	538046	712104
IF 10 pct. IBOC vs FN A and 10 pct IBOC intf.	17211	7662967	2909096	1043865	528692	300293	705190	1149035	1316369	1093671	1525852

PRIME MULTICAST Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	1740	1851609	724153	239849	114615	65435	189726	315999	318865	266013	341107
IF 10 pct. IBOC vs FN A and 10 pct IBOC intf.	11239	5998169	2277963	817398	409948	232897	556253	914471	1033123	859391	1174686

ACCEPTABLE ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC intf.	3869	916027	370064	115283	57758	33818	89137	147292	152281	126844	193613
Analog vs FN A and IF 10 pct IBOC intf.	5244	1561543	591784	212522	108440	61973	143880	230145	267255	219503	317825

DIGITAL EDGE of HYBRID Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	5523	1815382	680713	251647	130996	74609	160082	255157	310280	260030	372581
10 pct. IBOC vs FN A and IF 10 pct IBOC intf.	7270	1569033	620626	204047	105159	60361	148381	237193	258463	215218	340211

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	8097	3711228	1391260	517340	264295	149898	326836	537186	640031	532063	743578
10 pct. IBOC vs FN A and IF 10 pct IBOC intf.	13242	3233831	1251760	430514	223903	127756	297318	471757	541709	449498	691377

CURRENT RECEPTION PREDICTIONS
FOR PORTABLE RECEPTION:

PRIME Reception; ANALOG	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC intf.	7536	4913658	1867932	669459	330692	188101	462342	769244	849263	704227	940330
Analog vs FN A and 10 pct IBOC intf.	5561	4338327	1657280	587299	289737	164615	409912	684041	749684	621623	831417

PRIME Reception; HYBRID SIMULCAST	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	2585	2575219	991649	343165	165519	94279	250898	427102	448220	371506	474532
IF 10 pct. IBOC vs FN A and 10 pct IBOC intf.	17211	7662967	2909096	1043865	528692	300293	705190	1149035	1316369	1093671	1525852

PRIME MULTICAST Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	580	776101	323754	87952	40268	23650	91740	147958	128369	108540	147625
IF 10 pct. IBOC vs FN A and 10 pct IBOC intf.	11239	5998169	2277963	817398	409948	232897	556253	914471	1033123	859391	1174686

ACCEPTABLE ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC intf.	4249	1096831	422609	145615	73949	42735	104787	166030	186317	153044	224354
Analog vs FN A and IF 10 pct IBOC intf.	5492	1746001	648504	244194	124935	71081	158642	250466	299882	247875	348926

DIGITAL EDGE of HYBRID Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	4153	2034001	766833	281101	144469	81958	180579	291763	348248	290848	415036
10 pct. IBOC vs FN A and IF 10 pct IBOC intf.	7270	1569033	620626	204047	105159	60361	148381	237193	258463	215218	340211

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC intf.	6159	3833119	1434728	536314	269720	152587	339737	570907	668098	553814	741943
10 pct. IBOC vs FN A and IF 10 pct IBOC intf.	13242	3233831	1251760	430514	223903	127756	297318	471757	541709	449498	691377

SECTION 2:

WASHINGTON, DC FM Radio Market #9
Coverage Prediction Analysis

Summary of Average Station Results:

COMPREHENSIVE FM MARKET ANALYSIS
SUMMARY REPORT for WASHINGTON, DC MKT#9

Study area boundaries: West: 80 East: 74 North: 41 South: 37 degrees
THEORETICAL 'WHAT IF'
AND 'IF ALL STATION; AVERAGES'
EXTERIOR PARKED to LOW SPEED:

PRIME ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog very rural noise limited only	25400	9861856	3768049	1331124	681914	388045	913990	1456665	1666542	1388953	2034514
Analog vs full noise (FN) limiting only	16166	6659348	2528344	905417	459892	261466	612070	995750	1141933	949722	1332999
Analog vs FN and Analog (A) interference.	7763	4149523	1577318	564242	281880	160300	387845	637528	714117	592432	811068
Analog vs FN A and 1 pct IBOC interf.	5428	3488972	1326164	475112	235586	133916	328023	542788	601851	498272	673319
Analog vs FN A and 10 pct IBOC interf.	3976	3017815	1147595	410428	202401	115029	285304	473925	521248	431206	578170

PRIME HYBRID SIMULCAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	5271	3388647	1286637	460842	229712	130574	314690	522652	585525	487057	657486
10 pct. IBOC vs FN A and 10 pct IBOC interf.	9056	4766765	1807254	650327	326317	185335	440608	725750	821505	681900	934919

PRIME MULTICAST Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	2695	2177276	829401	293764	144880	82462	205222	342829	376806	314029	417184
10 pct. IBOC vs FN A and 10 pct IBOC interf.	6010	3675111	1394435	500318	249754	141977	340625	565009	634774	527905	714645

ACCEPTABLE ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog very rural noise limited only	12030	4388557	1686055	585974	314219	178031	407258	601470	708173	594456	998863
Analog vs full noise (FN) limiting only	10746	2836530	1093870	375200	197474	113345	259455	401750	470596	396168	622430
Analog vs FN and Analog (A) interference.	1482	399579	154943	53515	27236	15557	37720	59986	66793	55267	811068
Analog vs FN A and 1 pct IBOC interf.	521	139857	54222	18728	9458	5405	13358	21189	23406	19276	28928
Analog vs FN A and 10 pct IBOC interf.	496	165262	63098	22696	11396	6469	15491	24976	28138	22938	33046

DIGITAL EDGE of HYBRID Simulcast Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	3770	1378106	520600	189470	96587	54746	125905	203085	235960	194828	277418
10 pct. IBOC vs FN A and 10 pct IBOC interf.	2835	909556	349060	122984	62752	35709	84973	135374	153350	126531	187773

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	6345	2589476	977835	356549	181418	102860	235371	382907	444682	367855	517720
10 pct. IBOC vs FN A and 10 pct IBOC interf.	5876	2001215	761881	272998	139313	79064	184952	296118	340076	280528	408051

PREDICTED CURRENT AVERAGES ALL MARKET STATIONS:
EXTERIOR PARKED to LOW SPEED

PRIME ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC interf.	11854	5106095	1940979	694167	349139	198712	474909	775364	876012	727713	1010076
Analog vs FN A and 10 pct IBOC interf.	8352	4118713	1564022	560789	280430	159517	383792	631032	708906	588346	805896

PRIME HYBRID Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	194956	6315783	2397225	858729	429444	244244	584424	969156	1091051	908570	1230162
10 pct. IBOC vs FN A and 10 pct IBOC interf.	21378	9566394	3626738	1303343	657990	374033	880068	1442109	1645627	1368819	1894402

PRIME MULTICAST Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	91988	3932927	1497786	530814	262146	149232	369816	618126	680877	567629	754284
10 pct. IBOC vs FN A and 10 pct IBOC interf.	12676	6933798	2629909	943618	472829	268952	640203	1059509	1197011	996768	1354905

ACCEPTABLE ANALOG Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC interf.	4990	1073846	419786	140211	72769	41955	101313	155951	176508	148533	236602
Analog vs FN A and 10 pct IBOC interf.	4362	992619	384717	131947	67818	38900	93380	146179	165648	137842	210902

DIGITAL EDGE of HYBRID Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	10546	3250610	1229513	444614	228546	129788	295643	472952	554576	460249	664239
10 pct. IBOC vs FN A and 10 pct IBOC interf.	11314	2990696	1153394	399179	205832	117616	279722	440705	501038	416112	630489

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	16267	5633467	2128952	772529	395843	224801	510252	823982	964750	801189	1140118
10 pct. IBOC vs FN A and 10 pct IBOC interf.	20016	5623293	2150223	758905	390993	222697	519587	823305	949654	788163	1169986

PREDICTED CURRENT AVERAGES ALL MARKET STATIONS:
for MOBILE AT SPEED

PRIME ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC interf.	14281	5664682	2159149	767853	387002	220470	527384	858183	968744	804985	1130057
Analog vs FN A and 10 pct IBOC interf.	10668	4677150	1778418	635799	318961	181550	436046	712975	802852	666354	922608

PRIME HYBRID Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	303816	8267774	3134672	1126181	566382	322041	761384	1255281	1425026	1185551	1625925
10 pct. IBOC vs FN A and 10 pct IBOC interf.	21378	9566394	3626738	1303343	657990	374033	880068	1442109	1645627	1368819	1894402

PRIME MULTICAST Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	164949	5728892	2176593	777794	388053	220731	531468	883337	990176	824590	1112738
10 pct. IBOC vs FN A and 10 pct IBOC interf.	12676	6933798	2629909	943618	472829	268952	640203	1059509	1197011	996768	1354905

ACCEPTABLE ANALOG Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC interf.	4861	1056656	412365	136901	72274	41611	100791	147873	170451	144913	241838
Analog vs FN A and 10 pct IBOC interf.	4117	817170	321040	105833	55021	31807	77792	118418	133439	112630	182226

DIGITAL EDGE of HYBRID Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	11249	3176896	1214325	428489	220934	125772	294866	464599	536637	445097	660500
10 pct. IBOC vs FN A and 10 pct IBOC interf.	11314	2990696	1153394	399179	205832	117616	279722	440705	501038	416112	630489

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	18964	5715779	2172405	776876	399263	227081	524782	836543	971486	806057	1173687
10 pct. IBOC vs FN A and 10 pct IBOC interf.	20016	5623293	2150223	758905	390993	222697	519587	823305	949654	788163	1169986

PREDICTED CURRENT AVERAGES ALL MARKET STATIONS:
for INDOOR RECEPTION

PRIME ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC interf.	7369	3929574	1492365	534797	267233	152033	365449	603360	677150	562774	766774
Analog vs FN A and 10 pct IBOC interf.	4539	3005505	1143583	407838	202328	115118	281810	467837	518819	431024	580728

PRIME HYBRID Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	73558	3319099	1266332	445256	219156	124922	315159	525053	574013	479809	635727
10 pct. IBOC vs FN A and 10 pct IBOC interf.	21378	9566394	3626738	1303343	657990	374033	880068	1442109	1645627	1368819	1894402

PRIME MULTICAST Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	21993	1259819	495761	158312	77082	44367	130027	206673	212235	181998	249123
10 pct. IBOC vs FN A and 10 pct IBOC interf.	12676	6933798	2629909	943618	472829	268952	640203	1059509	1197011	996768	1354905

ACCEPTABLE ANALOG Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC interf.	5296	1382401	529078	186650	95796	54633	129095	203155	233164	193258	286647
Analog vs FN A and 10 pct IBOC interf.	4622	1310976	495949	179673	91842	52231	120459	192014	223489	185017	266248

DIGITAL EDGE of HYBRID Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	6743	2996684	1130893	413473	210287	119322	269264	444103	517037	428760	594435
10 pct. IBOC vs FN A and 10 pct IBOC interf.	11314	2990696	1153394	399179	205832	117616	279722	440705	501038	416112	630489

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	9608	5055964	1901464	700417	352361	199877	454397	762483	878816	726571	981038
10 pct. IBOC vs FN A and 10 pct IBOC interf.	20016	5623293	2150223	758905	390993	222697	519587	823305	949654	788163	1169986

PREDICTED CURRENT AVERAGES ALL MARKET STATIONS:
for PORTABLE RECEPTION

PRIME ANALOG Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC interf.	5242	3266275	1241604	443717	220815	125642	304775	505652	563922	469000	632748
Analog vs FN A and 10 pct IBOC interf.	3049	2382313	907978	321942	158921	90462	224648	374452	411659	342455	457769

PRIME HYBRID Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	37284	1927371	745737	250035	122309	70095	191966	310736	328864	278688	374675
10 pct. IBOC vs FN A and 10 pct IBOC interf.	21378	9566394	3626738	1303343	657990	374033	880068	1442109	1645627	1368819	1894402

PRIME MULTICAST Digital Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	8046	589378	240889	68631	32956	19175	66702	101190	96277	83753	120691
10 pct. IBOC vs FN A and 10 pct IBOC interf.	12676	6933798	2629909	943618	472829	268952	640203	1059509	1197011	996768	1354905

ACCEPTABLE ANALOG Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
Analog vs FN A and 1 pct IBOC interf.	5332	1510372	572451	206421	105752	60151	139259	220799	256740	212737	308510
Analog vs FN A and 10 pct IBOC interf.	4078	1421657	536782	195912	99471	56509	130221	210840	243779	201571	283350

DIGITAL EDGE of HYBRID Reception	Area:sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	4882	2924077	1100574	406451	203936	115576	260649	443605	509979	420543	563334
10 pct. IBOC vs FN A and 10 pct IBOC interf.	11314	2990696	1153394	399179	205832	117616	279722	440705	501038	416112	630489

DIGITAL EDGE of MULTICAST Reception	Area: sq.mi.	Population	Households	Under 9	10 to 14	15 to 17	18 to 24	25 to 34	35 to 44	45 to 54	55 and over
1 pct. IBOC vs FN A and 1 pct IBOC interf.	6506	4262069	1605422	587854	293289	166497	385913	653152	742566	615477	817318
10 pct. IBOC vs FN A and 10 pct IBOC interf.	20016	5623293	2150223	758905	390993	222697	519587	823305	949654	788163	1169986

SECTION 3:

White Paper, updated to accompany this report: FM RADIO RECEPTION IN THE D. C. MARKET FOR VARIOUS IBOC POWER LEVELS

FM RADIO RECEPTION IN THE D.C. MARKET FOR VARIOUS IBOC POWER LEVELS

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BACKGROUND

Over the past few years, the HD Radio™ hybrid mode of In-Band-On-Channel (IBOC) combined analog and digital transmission in the FM band has been proposed, tested, accepted and regulated by the FCC. It has been implemented in many FM commercial and non-commercial radio stations, providing extensive nationwide coverage, in no small part due to the efforts of the HD Radio Alliance, consisting of most of the twenty largest group operators of commercial radio stations, and due to the financial and technical support of the Corporation for Public Broadcasting (CPB), National Public Radio, and NPR Labs.

In 2006, at the National Association of Broadcasters (NAB) Broadcast Engineering Conference (BEC), we proposed a new, advanced method of predicting and displaying FM radio (including HD Radio) reception, that would provide results that were as easily read and understood as today's FCC-defined contour maps. This 55 page report, "Determining FM Coverage Area For Car Radio Reception in the Hybrid Era", too long to publish in the BEC Proceedings, has been one of the most often downloaded white papers available on the www.bia.com website. Most of this report deals with establishing a new set of RF level and RF interference-based reference signal levels for predicting Prime and Acceptable levels of analog reception, and Digital Prime and Digital Edge levels of digital hybrid IBOC reception. These results were based on the results of the many test results submitted to the FCC during the IBOC acceptance proceedings. Significant additional testing has been performed by NPR Labs, among others. In addition, more recent man-made background noise information derived from ITU Recommendations have been integrated into the methodology. Analysis of the effects of these updates have served to render the 2006 determinations obsolete. In this paper, we update the methodology, and the relative contour levels utilized, in the accompanying preliminary report.

MORE POWER, WE NEED MORE POWER

The advent of multicasting in IBOC hybrid mode made the problem of indoor reception of the digital signals more acute. The additional digital channels are not backed up by falling back to simulcast analog reception in weak signal areas; they instead flicker on and off, or cannot be received. In 2008, Filings requesting a FM digital power increase were submitted under the pending digital audio proceeding, MM Docket No. 99-325. The FCC responded by issuing Public Notice DA 08-2340, a request for comment, later delaying the deadline to December 5, 2008 for comments and to January 12, 2009 for replies. It was proposed, and the FCC is considering, an increase in the allowable power in the digital sidebands. The maximum allowable hybrid mode analog-to-digital power ratio is currently 100 to 1. The increase being considered could be as much as 10 dB, up to an allowable maximum analog-to-digital power ratio of 10 to 1.

It is therefore necessary to revisit our earlier work, and the more recent work of Ibiquity, NPR Labs and the International Telecommunications Union (ITU), to determine the differences a digital sideband power increase of up to 10 dB would make.

In our previous work, we have compared signal levels referenced to the analog carrier's signal strength, as does the Federal Communications Commission (FCC). Therefore, we will continue to refer in these charts to the analog signal strength, not the combined analog and digital signal strength.

We note that in field measurements, when and if the digital sideband power increases to 10%, many analog field strength meters may now show a measurable increase in received strength when the digital sidebands are turned on. The increase noted will depend upon the bandwidth and shape of the input filter. At 1% power, this was insignificant.

POWER INCREASE VERSUS dB

When we talk about a change from 1% to 10% insertion level, it we also hear references to a 10 dB increase. It is convenient that a ten times (x 10) increase in power is also a 10 dB increase in power. Decibels, dB, are nonlinear, however, so for the purposes of the HD insertion level discussion, below is a conversion chart from insertion power increase to dB increase in power:

Insertion Level	Power factor	dB Increase (power dB)
1%	x 0	0 dB
2%	x 2	3.0 dB
3%	x 3	4.8 dB
4%	x 4	6.0 dB
5%	x 5	7.0 dB
6%	x 6	7.8 dB
7%	x 7	8.5 dB
8%	x 8	9.0 dB
9%	x 9	9.5 dB
10%	x 10	10.0 dB

Since reception field strength predictions and measurements are usually referenced to changes in dB, and to dBu (dB in voltage referenced to one microvolt per meter), we will use dB, not power factor, for this discussion. One of the conveniences of using dB is that a 1 dB change in power will result in a 1 dB change in field strength voltage.

REFERENCE CONTOUR LEVELS FOR A 10 dB (10X) INCREASE IN DIGITAL SIDEBAND POWER

In the 2006 report, in the section 'Part B: for Digital' on pages 43-50, signal strength 'budgets' were determined for various quality levels of digital reception with no co-channel or adjacent channel interference. For the minimum level of 'Digital Edge' reception, defined at the edge of the digital 'cliff' for various location-dependent background noise levels, the results in 2006 were as shown in Table 12.

NOISE LEVELS FROM THE 2006 REPORT

In the 2006 report, we utilized reference ambient noise levels for IBOC reception, of:

Urban	34.4 dBu
Suburban	18.4 dBu
Quiet Rural	0.4 dBu

These levels were derived from *Radio Propagation Fundamentals, Bell System Technical Journal, vol. 36 #3, Fig. 4.* K. Bullington, 1957, a respected, but very old, reference.

Table 12, from 2006 report:

Noise Limited Signal Budget for the "Digital Edge" of FM HD Radio™ Reception (referenced to FCC (50,50) curve levels)

	Required Field Strength, dBu				
Location:	***Dense Urban***	***Sub-Urban***		***Very Quiet Rural***	
Component	**Budget in Field Strength**				**Units**
Digital Lock D/U ratio:	22	22	22	22	dBu
Antenna Gain dB(V)	-1.76	-1.76	-1.76	-1.76	dB
Ambient Noise	40.4	34.4	18.4	0.4	dB
Height Corrections	9	8	6	6	dB
Rayleigh Fading	7	7	7	7	dBu
Long Term Fading	2	2	2	2	dB
(Location Reliability for 50% of the time)	0	0	0	0	dB
Required Field Strength	79	72	54	36	dBu

UPDATING THE NOISE LEVELS

To bring this two decades closer to being up to date, in response to comments received after presenting this paper at the 2009 NAB Broadcast Engineering Conference, and to be compatible with with the ITU Recommendations, the noise levels have been updated with values from *Fig. 10, ITU Recommendation P.372-8*, based on 1970's measurements, adjusted as per the calculations on p. 41 and 45 of the 2006 report for the relevant IF bandwidths. These noise penalties compute to be:

Business (Urban):	15.0	dB
Residential (Suburban):	11.0	dB
Rural	6	dB

With reference to Galactic Noise (as Quiet Rural).

In ITU-R P.372-8 Fig. 10, in the FM band, Quiet Rural is less than, therefore superceded by, Galactic noise.

These are useful for cross-referencing against U.S. Census data, which denotes each census tract as being Urban, Mixed, Rural or Island. For determining areas of man-made noise, we therefore reference these locations as being:

U.S.Census Tract	Radio Reception Area
Urban	Business (Urban)
Mixed	Residential (Suburban)
Rural	Rural
Island, or very low \population density:	Very Quiet Rural, i.e. \Galactic Noise

Note that one category, Dense Urban, has been removed from the original report's charts, while Rural has been added. Revising the 2006 Figures to reflect the change in the reference source for the ambient noise levels, we obtain:

Contours for FM Analog Fig. 1R
Exterior, Parked or Slow:

@0 to 2.5% digital	Required Field Strength, dBu			
Analog	Urban	Sub Urban	Rural	Galactic
"Acceptable" (defaulted to mono)	**28**	**24**	**18**	**13**
"Prime" (stable stereo)	**34**	**30**	**24**	**19**

And for IBOC, i.e. HD Radio™, in Hybrid mode:

Contours for HD Radio™ Fig. 2R
Exterior, Parked or Slow Speed:

@ 1% digital	Required Field Strength, dBu			
HD Radio™ Digital IBOC	Urban	Sub Urban	Rural	Galactic
"Prime", Digital Main Simulcast	**55**	**51**	**45**	**44**
"Prime" Digital Multicast	**63**	**59**	**53**	**52**
"Digital Edge" (to cliff)	**45**	**41**	**35**	**34**

These new-metric contour levels may seem quite low when compared to the FCC's traditional City Grade and Class B levels. The differences are caused by:

1. The levels reference tests of modern FM receiver qualities, not those of 1947 receivers.
2. These contour levels are applied *after* the coverage losses due to co-channel and adjacent channel interference have been determined. Later penalties considered, including building penetration and tiny portable antennas, reduce both the desired and undesired signals received, and are therefore best considered after coherent noise (co-channel and adjacent channel interference) penalties have been determined and applied.

Contours for HD Radio™ Fig. 3R
Exterior, Parked or Slow Speed:

@10% digital	Required Field Strength, dBu			
HD Radio™ Digital IBOC	Urban	Sub Urban	Rural	Galactic
"Prime", Digital Main Simulcast	**45**	**41**	**35**	**34**
"Prime" Digital Multicast	**53**	**49**	**43**	**42**
"Digital Edge" (to cliff)	**35**	**31**	**25**	**24**

Note the small difference between Rural and Galactic noise contours for IBOC. At a transmitted reference to actual digital power of 10%, the digital receiver sensitivity becomes the limiting factor for reception levels slightly below the Rural level. At 1% insertion, this limiting factor occurs in the middle of the Rural field strength range.

However, as we will see in the Market Analysis, this lower man-made noise floor level will not provide much of an improvement in the final results for area, population, and demographics, when applied after the co-channel and adjacent channel interference loss determination.

For receivers with an essentially linear input power response, as indicted by previous analog and digital testing of vehicle receivers, for a 10 dB increase in

digital sideband power, when the signal levels are above the receiver sensitivity minimum, the only change in the budget occurs in the Digital Lock D/U ratio. With reference to the analog power level, a 10 dB increase in digital sideband power results in a 10 dB increase in the Digital Lock D/U ratio required for digital (not blended to analog) reception, from 22 to 12 dB. Please note that these signal levels are with regard to the overall, and still primarily analog, signal strength.

The Required Field Strength for the reception of audio from the digital sidebands of a hybrid digital IBOC transmission, as referenced to the analog audio signal power, for "Digital Edge" reception, decreases by 10 dB with reference to Fig. 2. This .also applies to "Prime" quality reception for digital simulcast and digital multicast, so for 10% digital power, we get the levels in Fig. 3, each 10 dB lower than in Fig. 2, and can interpolate for various levels of digital power, dB for dB, or by using the Power Increase versus dB chart above.

STATION-TO-STATION INTERFERENCE

As to co-channel interference, the 2dB D/U interference criteria stated in the 2006 report remains valid if both the main and interfering station increases digital power to 10%. If only the desired station increases power, the D/U ratio changes to a –8 D/U ratio; if the undesired interferer is the one that increases digital power to 10 dB, the D/U ratio becomes 12 dB.

For analog audio, the reconsideration will be more complex, and will require a step-by-step analysis expanding on the 2006 report analysis and adding in new information.

We start with the interference of the transmitted digital signal to the received analog signal. In the 2001 Advanced Television Test Center (ATTC) tests, switching on the desired signal transmitter's HD Radio™ signal had a barely measurable (0.1 dB) effect on the SNR of the two car receivers tested. This would initially suggest that minimal interference from a station's own digital sidebands will be observed on most car receivers. The automotive receivers tested have, in general, proven to have the most interference-resistant front end filtering systems of all FM reeeivers.

By comparison, switching on the digital signal on the transmitter caused the SNR of the portable analog FM receiver tested, to drop from 59 dB to 35 dB, only 5 dB above the 30 dB tune-out SNR. The analog "tune-out SNR" as determined by Ibiquity tests, is defined as the point where the average listener would "tune out" to a different station due to objectionable interference. It is stated in terms of Weighted Quasi-Peak Signal-to-Noise Ratio (WQPSNR). This is not the desired-to-undesired (D/U) ratio at which the signal would be completely lost. Therefore, a 10 dB increase would put the quality of the FM reception well below the "tune-out SNR" of the portable receiver.

Table 4 of the Digital Radio Coverage & Interference Analysis (DRCIA) Research Project Final Report, prepared by NPR Labs for the CPB, indicates that the co-channel interferer D/U ratios for mobile receivers are the same for Analog and for IBOC at 1% digital power, which agrees with the conclusion in our 2006 report that self-interference into analog is insignificant for car radios at the 1% digital power level. Table 4 does show a 5 dB penalty in D/U ratio at 10% digital power and a –60 dBm reeeived signal power level, and a 6 dB penalty at 10% digital power –70 dBm received signal level. If this effect is also linear, the break point where self-interference becomes a problem would be a digital power level increase of 4 dB, or a digital power ratio of 2.5%. Therefore, since we are primarily focused on mobile reception and defining the edge of reception, for analog reception where the desired station is transmitting with 10 dB more digital power, we will need to increase the minimum signal requirements by 6 dB. The contours worksheet for analog reception would be the same as Fig. 2 up to a digital/audio power ratio of 4 dB (2.5%); after that, the change equally matches the increase in digital power. The analog levels for automotive reception of a station transmitting with 10% digital power would then be as shown in Fig.4:

Contours for FM Analog Fig. 4R

Vehicle Reception:

Revised 2009

@10% digital Required Field Strength, dBu

Analog	Urban	Sub Urban	Rural	Galactic
"Acceptable" (defaulted to mono)	**34**	**30**	**24**	**19**
"Prime" (stable stereo)	**46**	**42**	**36**	**31**

As derived in the 2006 report, these values consider only the reception capability of modern average automobile receivers, self-interferenee from the digital sidebands of the transmitting station, and man-made and galactic background noise. Interference from 1st, 2nd and 3rd adjaeent stations, both single and symmetrical duals, are considered first before these contours are applied.

EFFECT ON ANALOG RECEPTION FROM 1ST AND 2ND DIGITAL HYBRID ADJACENTS

In the 2006 report, we stated that 1st adjacent interference from a digital station would result in a 20 dB loss in fringe and near-fringe reception SNR (in the overlap area between the stations), as the SNR would be unlistenable when the D/U ratio drops below 3 dB D/U, vs. a SNR listenable down to –16 dB D/U against an analog 1st adjacent. As for 2nd adjacent interference, there would be an 18 dB loss in the fringe and near-fringe reception SNR, as the SNR would be unlistenable when the D/U ratio drops below –45 dB D/U vs. a SNR listenable down to –64 dB D/U against an analog 2nd adjacent signal.

The –64 dB D/U ratio was a reasonable projection, based on the previous published tests of receivers, as the original test beds could not test down to this level. Since that time, NPR Labs has obtained test results indicating a –62 dB D/U ratio is the actual measured value. We therefore must adjust our values, as we did for the presentation at the NAB BEC, to reflect this 2 dB difference, in order for all our interference benchmark values to be based on actual, existing, published tests. As a result we now say that for 2nd adjacent interferenee, there would be a 17 dB loss in the fringe and near-fringe reception SNR, as the SNR would be unlistenable when the D/U ratio drops below –45 dB D/U vs. a SNR listenable down to –62 dB D/U against an analog 2nd adjacent signal.

By revisiting the analysis in the 2006 report, we see that increasing the digital sideband by 10 dB will further reduce the loss in fringe and near-fringe reeeption by an additional 10 dB for a 1st adjacent analog FM station. One of the digital sideband signals of the 1st adjacent will be within the analog RF envelope of the analog station. Therefore, the SNR would be unlistenable when the D/U ration drops below 13 dB D/U. As for 2nd adjacent interference, there would be a 27 dB loss in the fringe and near-fringe reception SNR, as the SNR would be unlistenable when the D/U ratio drops below –35 dB D/U vs. a SNR listenable down to –62 dB D/U against an analog 2nd adjacent signal. This is because the digital sideband signal of a 2nd adjacent is within the far side of the frequency bandwidth of a 1st adjacent station. A base level having already been established, a 10 dB increase in power simply results in a 10 dB increase in analog interference over that of a 1% digital 2nd adjacent.

EFFECT ON DIGITAL HYBRID RECEPTION FROM SINGLE 1ST, 2ND AND 3RD DIGITAL HYBRID ADJACENT INTERFERERS

For a 1% (1 to 100) digital-to-analog power ratio, we previously established that 1st adjacent interference from a single digital station would result in robust reception to –29 dB D/U (vs. to –16 dB D/U for analog). Today, we say that for a single 2nd adjacent interferer, we would still have robust reception to a -62 dB D/U if the signal strength allows.

This is due to the redundant duplication of the upper and lower sidebands, such that interference to only one sideband, where the other sideband is operating with little interference, has a reduced effect. Therefore, the ratios change with the desired station's digital power level. A 10 dB increase in the desired station's digital power should result in a 10 dB improvement, to –39 dB, for the receivable D/U ratio, until the undesired interfering station(s) also increases power, returning the receivable D/U ratio back to –29 dB.

EFFECT ON DIGITAL HYBRID RECEPTION FROM SYMMETRICAL DUAL 1ST, 2ND AND 3RD DIGITAL HYBRID ADJACENT INTERFERERS

A symmetrical dual interference situation consists of two adjacent channel interferers with overlapping interference areas, where one is above the frequency of the desired station, and one is equally below (a 1st above and a 1st below, for example). We previously established that for (symmetrical) dual 1st adjacent interference at 1% IBOC insertion power, the simulcast signal blends to analog and the multicast signal drops out where the undesired signals overlap and the D/U ratio with respect to both interfering signals is below 21 dB D/U.

If all three stations increase digital power, the ratio remains the same, but the triple overlap area of

interference increases. The ratio remains the same if only one of the interfering stations increases power. If both interfering stations increase power and the desired station does not, the D/U ratio suffers by the smallest amount of dB increase in the two interfering stations. If the desired station increases digital power and one of the digital interfering stations does not, the desired station has an advantage by the amount of power increase in dB with respect to the triple overlap interference area, and the dual overlap interference area with the 1% digital station.

For 2nd and 3rd, single and symmetrical dual adjacent digital-to-digital interference, the 2006 report's conclusion that for 1% digital power, robust digital reception continues until the signal strength runs out, is mirrored in the results of Table 4 of the NPR Labs DRCIA Final Report. The ATTC tests did not study the 3rd adjacent signals, but the prediction in the 2006 report, that signals with 3rd adjacent interfering signals would have equal or slightly better reception D/U ratios than those determined for 2nd adjacent situations, has been verified by the equal results in Table 4 of the DRCIA Final Report.

The NPR Labs tests at 10% digital power, however, indicate that a 5 dB reduction in D/U ratio occurs at weak (-70 dBm) desired signal reception levels, for both single 2nd and 3rd adjacent digital-to-digital interference to mobile (automotive) receivers. Since iBiquity's reception tests found that 2nd adjacent interference at 1% digital power can only be found very near, (in fact, driving by) the undesired transmitter site, at a D/U ratio of approximately 47 dB, and the DRCIA report indicates D/U ratios above 50 dB, we will essentially continue, as a practical matter, to ignore 2nd and 3rd adjacent interference at 10 dB digital power ratios, as it appears that the interference will primarily occur within a kilometer of the interfering transmitter site, where results from Longley-Rice and ITU-R P1546 prediction computations are already considered unreliable.

MAKING THE NEW ANALYSIS SYSTEM A REALITY

When this new system was proposed, it was expected that we could bring the product to market within the year. We knew that, while deceptively simple in final appearance, the automated calculation and analysis underlying the new mapping system required a highly detailed, terrain-point-by-terrain-point accurate prediction system to analyze potential co-and adjacent channel interference for all stations in a market. This analysis includes the interference situations most critical to HD Radio, the various co-channel and single and dual 1st and 2nd adjacent signal interference scenarios. To make the interference predictions accurate by incorporating terrain shielding effects, we found that we needed to have a Longley-Rice prediction analysis that accurately computed results to the individual terrain area of 3 arc-seconds by 3 arc-seconds, the terrain "pixel" on an output display.

Developing this, as it turned out, non-extant, new Longley-Rice system took an additional two years. To achieve this as a viable, reliable product, we found it necessary to create our own, customized Longley-Rice predictive software system. We started by upgraded an already sophisticated, all-points considering, open-source Linux wrap-around software package to operate with the FCC-accepted standard NTIA-issue Longley-Rice core subroutine set, the Irregular Terrain Model (ITM), which had remained essentially unchanged since 1982. But we were disappointed with the results; the wrap-around software worked as advertised; but the old core subroutines did not. The unexpected, but necessary next step was to dig into the core.

OVERHAULING THE ITM

We found it necessary to analyze the ITM itself. We found that we had to make corrections to the ITM algorithms and source code, and then expand and update the ITM into a new implementation, the Irregular Terrain with Obstructions Model (ITWOM), which was presented at the 2008 NAB Broadcast Engineering Conference. These new algorithms, derived from the data in ITU-R P1546-2, et al, were added to the Longley-Rice methodology in order to provide a prediction methodology that worked near obstructions, and for single obstructions (cases in which the ITM actually uses a discredited averaging approximation system for the line-of- sight and early diffraction range), were presented before a joint conference of the NTIA and of the Working Group 3 of the International Telecommunications Union (ITU), which is responsible for the ITU-R Recommendations. This occurred in June of 2009 at the International Symposium for Advanced Radio Technologies (ISART) in Boulder, CO. This new set of core subroutines, the ITWOM, has

been integrated with our wrap-around software, and is first being used to prepare these FM Comprehensive Market Reception Reports (FMCMRR). The methodology and creation of the Washington D.C. FMCMRR is discussed in this paper. The results are being presented before the FCC and will be made available for free distribution by BIA Advisory Services (www.bia.com) and at (www.givensandbell.com).

MAPPING THE ANALOG VEHICULAR RECEPTION AREAS

In the 2006 report, we proposed: "The updated contour levels above are compatible with the current FCC contour levels in that they predict the contour level at the TASO measurement height, so for comparison, either FCC contour maps or Longley-Rice analyses can use or mix together the updated levels with the old 70, 60, and protection level contours."

The new ITWOM Longley-Riee-Shumate core subroutines, utilized with the new LORIS wrap-around input-output software, now computes the signal levels at two meters above ground level, eliminating the requirement to adjust the signal strength to the old standard FCC TASO height.

For the Washington DC test/demonstrator market report, Longley-Rice-Shumate analyses at a 3-arc-second pixel size (approximately 1.6 acres per pixel) for a total of 1171 full power authorizations flagged as "Current" in a December, 2008 download of the FCC CDBS database, were run and the resulting approximately 400 Gigabytes of maps and signal strength data files were storcd on a one-terabyte hard drive to allow adequate room for further processing. Each analysis has a study radius of 65 to 170 miles depending upon the Class and peak ERP of the station. For directional stations, FM Antenna azimuth patterns were taken from the FCC CDBS database; elevation patterns were standard Dielectric FM antenna patterns selected based on the number of bays specified in the FCC database or, if not stated, a formula based on ERP.

Shadow maps and data files of the seven interferers (Co-channel, lower and upper 1st., 2nd, and 3rd adjacent stations for analog) were then generated and compared to the market stations to eliminate areas of coverage lost due to a lack of adequate desired-to-undesired (D/U) signal ratio compared to the interferers, for the drop-out point (digital) or tune-out point (analog) for each pixel.

The new "Acceptable" Analog Reception and "Prime" Analog Reception contour levels can then be utilized with the remaining reception area to determine coverage for the External Parked at low speed, Mobile at Speed, Indoor, and Portable reception scenarios. Reception areas, population, households and demographics are then determined at the individual pixel detail level, using 2000 Census tract data.
The IBOC Prime Hybrid Simulcast and the Prime Multicast Reception Areas, areas that meet the FCC-defined reliability requirements for reliable digital reception, and Digital Edge Reception areas, between Prime and the Digital cliff, are also similarly determined for each reception scenario.

The 10 dB and 15 dB penalties for Indoor and Portable reception, as established and utilized by the NPR Labs DRCIA report, have been maintained in order to allow comparison with the DRCIA report results.

Some of the "Acceptable" reception area results may seem odd, in that they increase for Analog Acceptable reeeption with a change from 1% to 10% IBOC insertion. Interpretation is necessary: upon studying the maps, we see that what is happening is that both part of the Analog Prime reception area, and the existing Acceptable Analog reception area are being lost; some of the former Prime Reception area is being converted to Acceptable Reception area. Therefore, please remember to consider the combination of Prime and Aceeptable as the total reception area.

We continue to utilize the Analog reeeived audio signal-to-noise ratio (SNR) 'tune out point' established by Ibiquity's tests, as the lower limit of the Acceptable Analog reception contour.

MAN-MADE BACKGROUND NOISE LEVEL LOCATION DETERMINATION

The original paper proposed the use of population level mapping and Longley-Rice or similar point-by-point analysis to allow the combined mapping of Acceptable or Prime reception using chosen levels of population density as an indication of whether the area is quiet rural, rural, suburban, or urban, in order to select the appropriate field intensity level to use for each location. We have utilized data from the U.S. Census bureau, whose

2000 Census tracts are each identified as being Urban, Mixed, Rural or Island areas, and a separate flagging, by the Census, of very low population density areas utilized as "very Rural/Galactic noise", for assigning background noise penalties in the contour levels shown.

MAPPING THE DIGITAL VEHICULAR RECEPTION AREA

The original 2006 proposal concluded with: "The process for digital is similar to that for analog; prepare a 'Digital Edge' contour map base layer in the coverage mapping program using the appropriate 'Digital Edge' signal levels.

For digital reception, the interference of interest is, in descending priority:

1. Areas where dual (one above, one below) 1st adjaeent station coverage areas overlap with the desired station.
2. Areas where single 1st adjacent station coverage areas overlap with the desired station.
3. Co-channel interference.

Areas of digital interference, especially 1st adjacent interference, should be analyzed for multipath and terrain interference losses, as the presence of 1st adjacent interferers increases the desired station's susceptibility to multipath and other digital interferers.

The 2nd and higher adjacent channels pose no significant threat to digital reception. They can be ignored.

By mapping against the noise maps or population density, the reception maps can be simplified into three (or four, if multicasting) easy to understand maps; one showing the FM reception prior to digital broadcasting, one showing analog reception after digital arrives nearby, and one for digital main audio channel Hybrid mode reception. If multicasting, an additional map showing only a single contour for multicast audio reception can also be drawn."

REALIZATION:

The accompanying preliminary results for a Washington DC Market FMCMRR for 1% and 10% IBOC digital–to-analog power ratios, submitted to the FCC, is the first completed example released of this new metric, and utilized the new Longley-Rice-Shumate ITWOM subroutines core to obtain positional prediction accuracy not available from use of either the obsolete ITM or its more fully developed fraternal twin, TIREM.

These preliminary results from the first FMCMRR provide multiple scenarios of prediction of the coverage of the FM radio stations in the DC Radio Market. The first section steps the reader through the various theoretical stages. From the best case where the station is the only station in the market study area within $\pm$ 3 channels and with only Galactic noise limitation, it stages through the effect of various levels of reception area reduction, showing the individual effects of full noise limitation (Galactic to Urban noise applied), co-channel and adjacent channel interference, and up to the worst case for Analog; full analog and IBOC interference with associated full noise limiting from all levels, with all existing stations within 200km transmitting 10% IBOC. These are all shown for the External Parked or Low Speed scenario.

The 'current' status, (from Dec. 2008 FCC CDBS database) with only the existing IBOC stations transmitting at 1% IBOC, and a final theoretical scenario of all current IBOC stations transmitting 10% IBOC, are then presented for all scenarios.

These results are preliminary, as the final product scheduled for release at the NAB 2009 Radio Show by BIA, for which the final version of this report will serve as the demonstrator, is intended to utilize a more recent FCC CDBS database download, including the recent elevation data additions, as well as adding expanded analysis of the Mobile, at Speed scenario, and full data and maps for all 32 commercial and non-commercial stations eonsidered in the Washington, DC Market analysis.

References:

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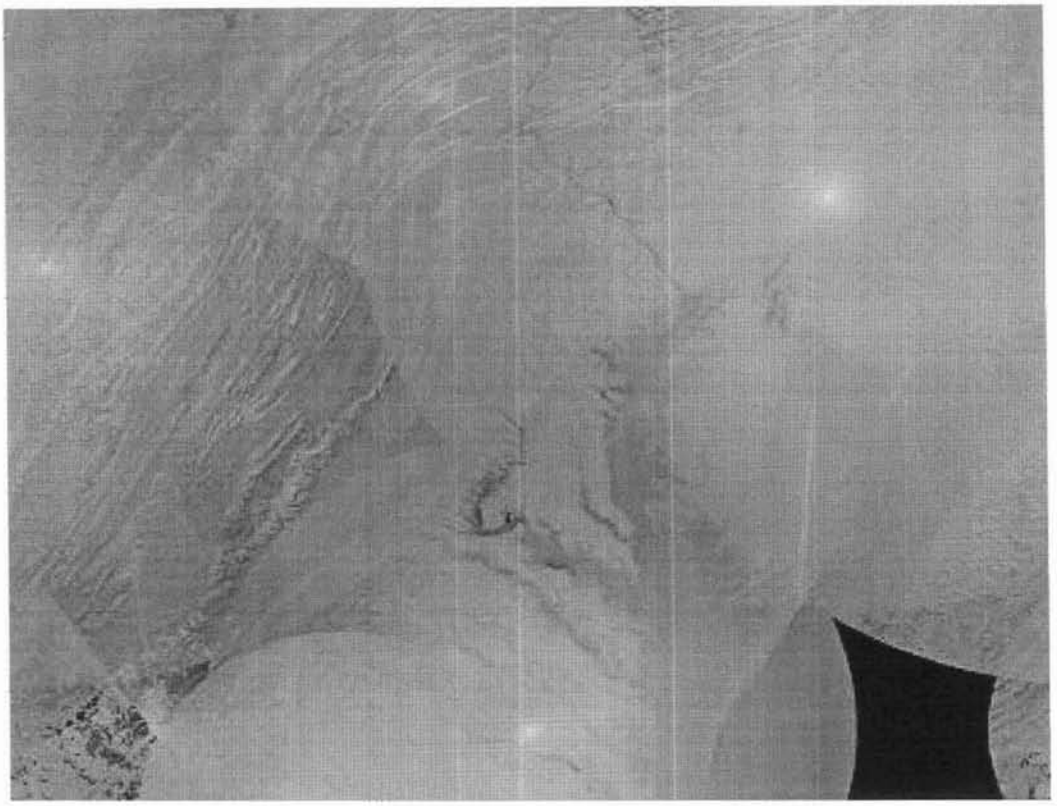
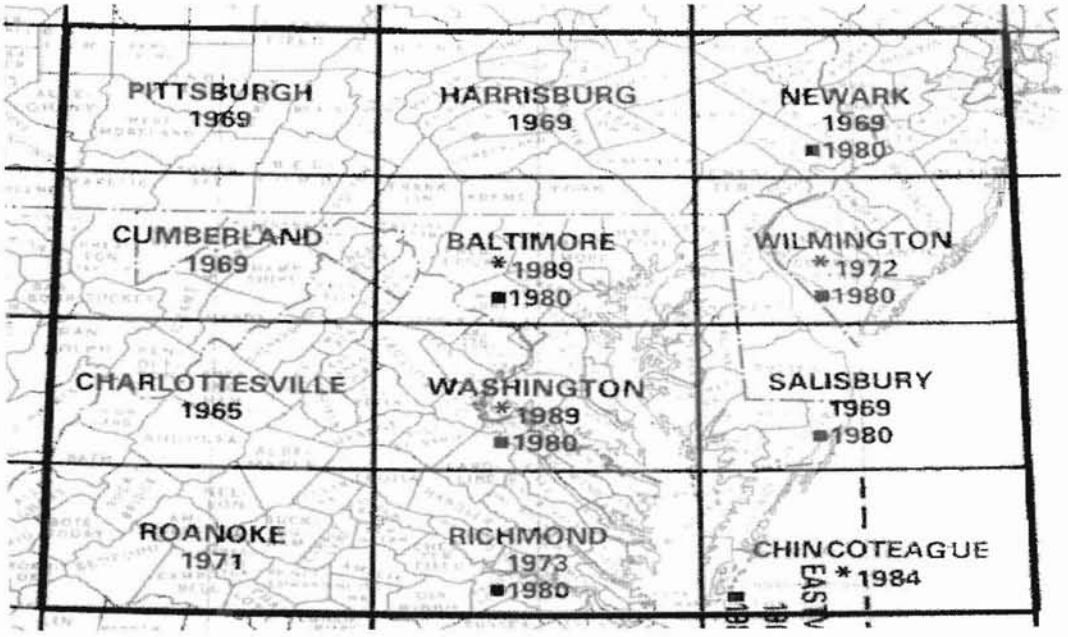
SECTION 4:

Washington Area Study Area Map

WETA-FM Co-Channel Shadow Map

WETA-FM Co-Channel Shadow Map: corners 80,74,41,37 deg.



Bright spots are interfering co-channel stations. Signal strength is in intensity. Market Study grid for above shown below.