OET Briefing

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Outline

- What's at Risk (Background TV Info)
- Review of Technical Information
- "Acceptable" Interference Models
- 15.209 Out-of-Band Limits
- Adjacent Channel Interference
- Sensing (Co-Channel Interference)
- Future Testing

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What's At Risk

- About 70 Million TV sets NOT Connected to Cable or Satellite
  - NTIA Converter Box Program
- Future Over-the-Air Reception More Important to Broadcasters and Viewers
  - Lack of Cable Full HD and Multicast Carriage
  - Newsweek Article on Re-birth of TV Antenna
  - Law Suit Over HDTV Claims
- New Over-the-Air Applications

New Over-the-Air Applications/Developments

- USB ATSC Tuners
  - Tens of Models /Manufacturers
    - Pinnacle, Artec, SnapStream
- New Media PCs
  - Sony Vaio LS Series
  - HP Pavilion Media Center Series
  - HP Digital Entertainment Center PCs
- NAB's Technical Advocacy Program
  - Promote New Technology and Services
- Smart Antenna Development

New Over-the-Air Applications/Developments

- **CableLabs® Announces Initiative to Create Specifications for Receiving Off-Air Digital Broadcasts**

  Louisville, Colorado, March 1, 2007—CableLabs®, the cable television industry's technology development consortium, announced that it is working on an initiative to develop cable interface specifications for receipt of off-air digital broadcast signals.

  The interface specifications would enable devices to receive digital off-air television signals and would deliver these digital signals seamlessly through a cable set-top box. This technology would allow consumers to receive broadcast television signals as an integrated viewing experience. The concept combines over-the-air digital television transmission with television programming carried by the cable provider.

  Founded in 1988 by members of the cable television industry, Cable Television Laboratories is a non-profit research and development consortium that is dedicated to pursuing new cable telecommunications technologies and to helping its cable operator members integrate those advancements into their business objectives. Cable operators from around the world are members. CableLabs maintains web sites at www.cablelabs.com; www.packetcable.com; www.cablemodem.com; www.cablenet.org; and www.opencable.com.

New Mobile TV

- Samsung/R&S A-VSB System
  - Enhancement for Mobile and Pedestrian TV applications
  - Improves Fixed Reception
  - Simplifies Deployment of Distributed Transmission Systems

- Harris/LG Project Eagle
  - New Mobile TV Application
  - Claims twice the payload of A-VSB and more robust operation

Review of Technical Information

- Other than NAB/MSTV and NAF very little technical information and data submitted
- All of the technical information and data submitted confirms and supports MSTV/NAB positions
  - CRC Tests
  - UK Receiver Tests
  - MSTV Field Strength Measurement Data
  - NAF Working Paper Indoor Field Strength Measurements
- FCC Receiver Tests???

NAF Technical Comments

- NAF proposes protection be at “the grade B contour (perhaps with a few kilometers of exempt space added to ensure that harmful interference is even more unlikely), but is open to reasonable alternatives from the broadcasting community.” p. 13
- NAF, on emission limits, states that broadcasters are alarmists but “the above requirements (15.209) in the proposed §15.707 are inadequate.” p. 23
- NAF states that KU data indicates that 100 mW TV band device does not cause interference to DTV receivers tested, “if the channel used is avoided, and ***if the adjacent channel is also avoided.”*** (Emphasis added.) p. 27

"Acceptable" Interference Models

- Docket 20780
  - 15.209 limits for PCs
  - Established 10 meter interference distance
- Cellular/PCS
  - 1 meter distance
- H-Block
  - 2 meter distance discussed
- DTV to TV Band Device
  - New mobile applications
  - 2 to 3 meters appropriate
  - Less than 10 meters

15.209 Limits

- General agreement in the record that 15.209 limits are inadequate
  - NAB/MSTV
    - Two CRC Studies
  - IEEE 802
  - Motorola
  - NAF
  - Dell, et. al., state 15.209 OK but suggest transmitter mask

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15.209 Limits

- Established 1979 in Docket 20780
  - Used Grade A of 74 dBu (UHF)
  - S/I of 45 dB “used to represent TV receiver noise tolerance in the narrowband EMI model.”
    - Ensured a “tolerable interfering signal at the TV receiver”
  - Computers use indoors only

What's Changed

Late 1970's

- Operations removed from TV spectrum - No operations in TV band
- Narrowband interfering signal
- TV signal assumed is relatively strong at 74 dBu level
- Interference results in graceful degradation as signal gets noisy but still viewable for considerable increase in interference

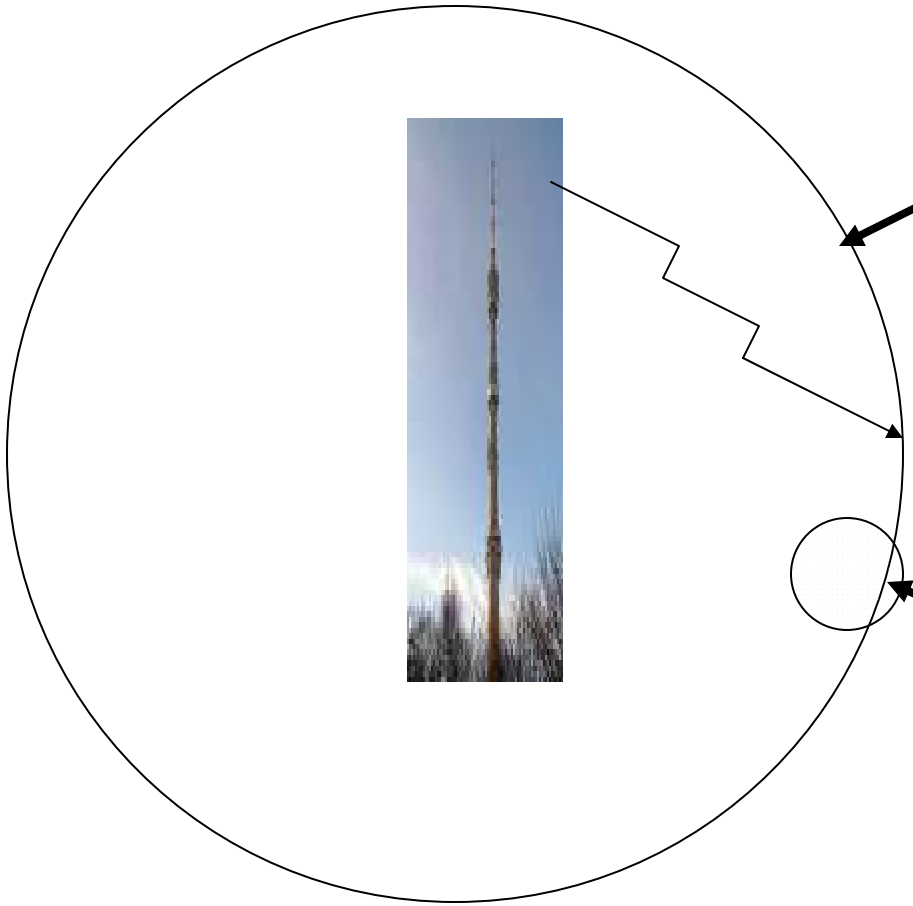
Now

- Possible operations in TV band
- Wideband interfering signals
- DTV signal relatively weak at 41 dBu level
- Even slight increase in interference results in abrupt loss of picture and sound

15.209 Limits

- 15.209 unwanted emissions are emissions that a device can produce on any channel including channels being used for TV operations

15.209 Limits



DTV Protected Contour is 41 dBu

15.209 level is 200 uV/m or
46 dBu at 3 m (This is 5 dB
higher than the desired DTV signal)

Example: DTV Station Transmitting on Channel 35
TV Band Device out-of-band emissions on Channel 35 at 15.209 level

Let's Do the Math

How do you protect a DTV receiver at the edge of the contour (or receiving a weak but acceptable 41 dBu signal)?

- 15.209 limit of 200 uV/m = 46 dBu
- This is "co-channel energy"
- Co-channel D/U ratio needed is about 23 dB
- Maximum energy for NO interference is:
  - 41 dBu signal – 23 dB = 18 dBu

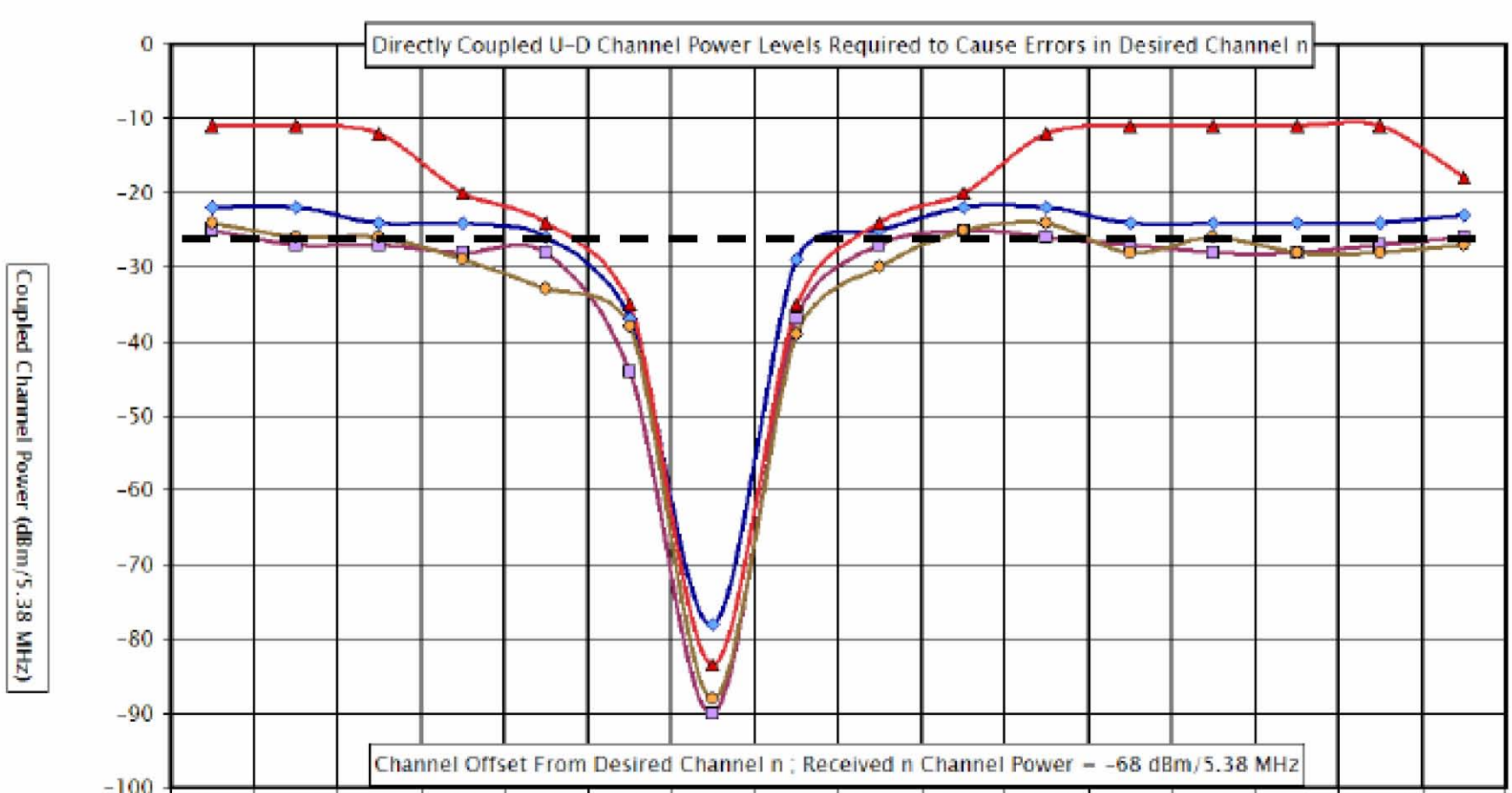
- BOTTOM LINE: 15.209 level needs to be significantly reduced to prevent interference to DTV reception

Adjacent Channel Interference

- NAF states that KU data indicates that 100 mW TV band device does not cause interference to DTV receivers tested, “if the channel used is avoided, and ***if the adjacent channel is also avoided.”*** (Emphasis added.) p. 27
- NAF computes signal level of a 100 mW device at 10 meters:

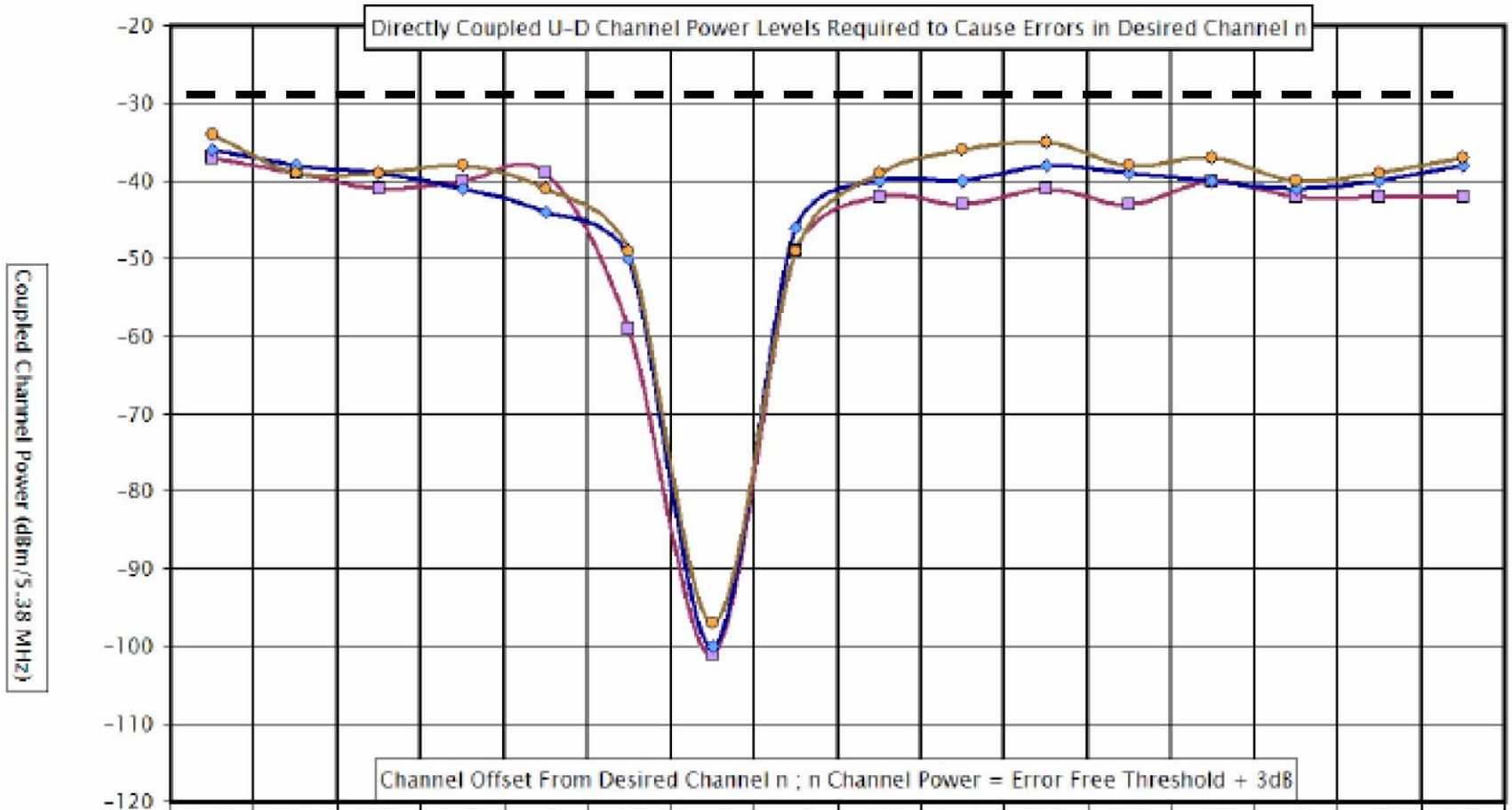
100mW	=	20 dBm
10 m Free Space Loss @ 600 MHz	=	- 48 dB
Signal Strength at 10 m	=	- 28 dBm

A.10. Receivers #1, #2, and #3 ATSC A/74 "Weak Desired" -68 dBm/5.38 MHz Test



	n-10	n-8	n-5	n-3	n-2	n-1	n=0	n+1	n+2	n+3	n+4	n+6	n+8	n+9	n+10	n+15
Receiver #1	-25	-27	-27	-28	-28	-44	-90	-37	-27	-25	-26	-27	-28	-28	-27	-26
Receiver #2	-22	-22	-24	-24	-26	-37	-78	-29	-25	-22	-22	-24	-24	-24	-24	-23
Receiver #3	-24	-26	-26	-29	-33	-38	-88	-39	-30	-25	-24	-28	-26	-28	-28	-27
ATSC A/74	-11	-11	-12	-20	-24	-35	-83.5	-35	-24	-20	-12	-11	-11	-11	-11	-18

A.11. Threshold Test: Desired Signal +3dB above "Error Free Threshold" of Receivers #1, #2, #3



	n-10	n-8	n-5	n-3	n-2	n-1	n=0	n+1	n+2	n+3	n+4	n+6	n+8	n+9	n+10	n+15
Receiver #1	-37	-39	-41	-40	-39	-59	-101	-49	-42	-43	-41	-43	-40	-42	-42	-42
Receiver #2	-36	-38	-39	-41	-44	-50	-100	-46	-40	-40	-38	-39	-40	-41	-40	-38
Receiver #3	-34	-39	-39	-38	-41	-49	-97	-49	-39	-36	-35	-38	-37	-40	-39	-37

Receiver # 1: Desired Channel Power = -80 dBm/5.38 MHz (-83 dBm/5.38 MHz EFT)
Receiver # 2: Desired Channel Power = -81 dBm/5.38 MHz (-84 dBm/5.38 MHz EFT)
Receiver # 3: Desired Channel Power = -78 dBm/5.38 MHz (-81 dBm/5.38 MHz EFT)

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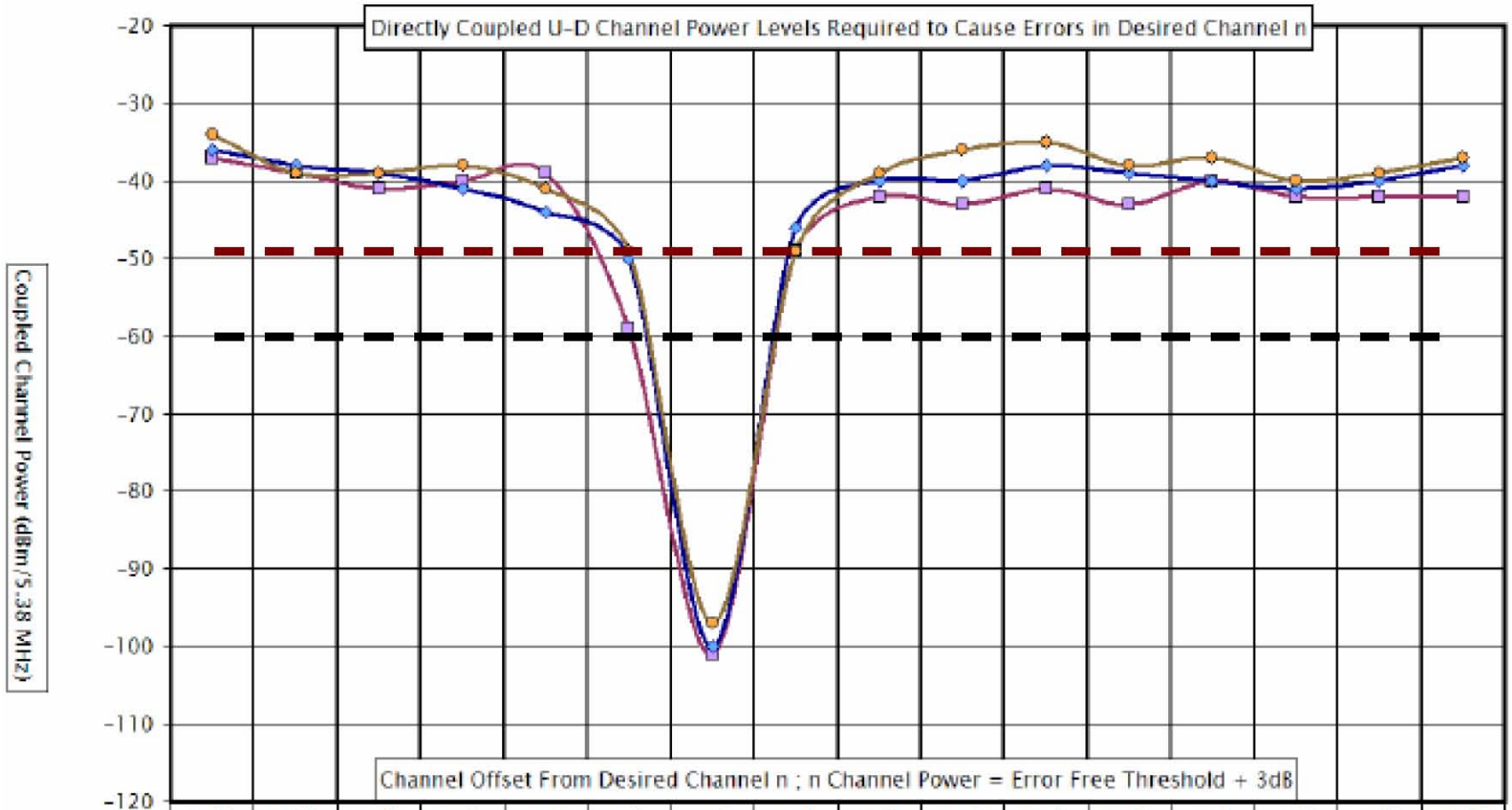

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Receiver #2	-36	-38	-39	-41	-44	-50	-100	-46	-40	-40	-38	-39	-40	-41	-40	-38
Receiver #3	-34	-39	-39	-38	-41	-49	-97	-49	-39	-36	-35	-38	-37	-40	-39	-37

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Adjacent Channel

- So how much further would interference be caused to permit adjacent channel operations?

- NAF's data suggests -50 dBm is needed to protect most receivers and -60 dBm to protect all receivers
  - -50 dBm yields an interference distance of 126 meters for a 100 mW device
  - -60 dBm yields an interference distance of 398 meters for a 100 mW device

Adjacent Channel

- Receiver studies indicate operation on other channels may also be problematic
  - 2nd Adjacent Channel Operation (UK & CRC receiver studies)
  - N+7, N+14 and N+15 (CRC receiver study)
- Impact of multiple interfering signals needs to be taken into account
  - N +x and N + 2x

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Sensing

- Detection threshold level must ensure that TV band device is far enough away from any TV receiver to not cause interference
- Para. 36 – “In the U-NII case, we set the sensing level at a value where the distance … is far enough from the radar site that the radar receiver will not receive interference from an unlicensed device operating at its maximum allowed power.”

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Sensing

- Sensing is a co-channel issue
- General agreement on co-channel protection
  - Protected contour of TV station
  - Level of -84 dBm
  - Positive D/U required (23 dB proposed in NPRM)
- Interference potential of TV band devices not really discussed
  - TV Band device proponents assume interference confined to same dwelling or very close by

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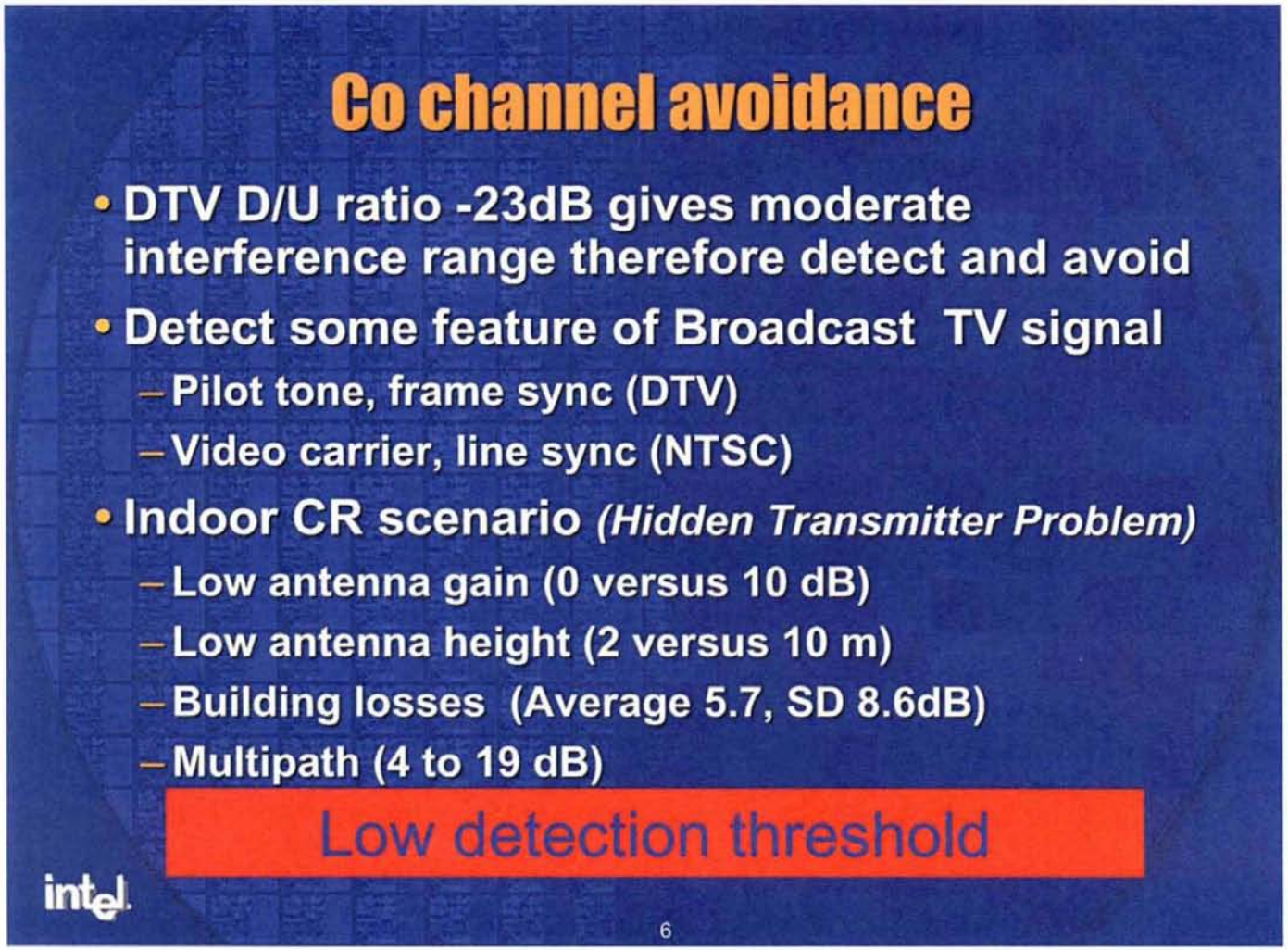

Intel Presentation to FCC 11/1/2004

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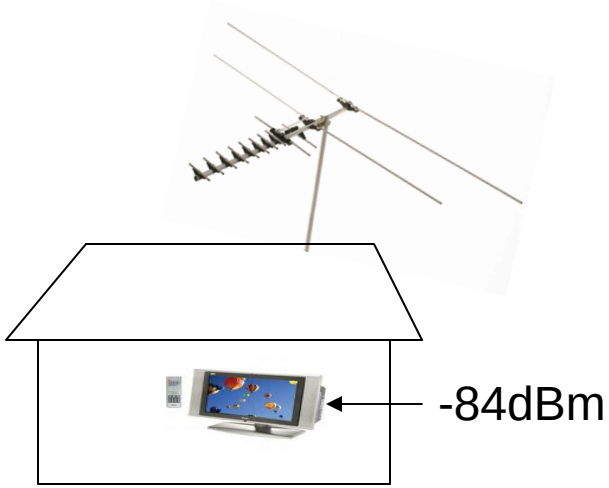
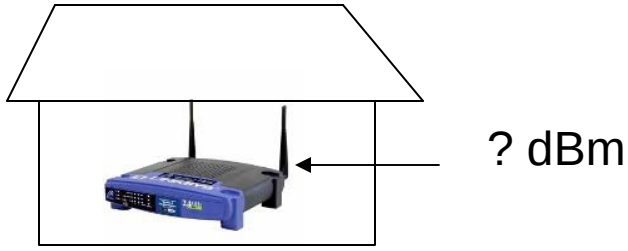
Sensing

- Step 1 – Determine interference distance of TV Band device to TV receiver

- Co-channel Operation (D/U of +23 dB)
  - Interference contour is -84 dBm – 23 dB = -107 dBm
- Can't operate anywhere within the TV protected contour
  - NAF agrees protection be at "the grade B contour (perhaps with a few kilometers of exempt space added to ensure that harmful interference is even more unlikely)" p. 13
  - Intel analysis suggested 100 mW device had to be 5 km beyond protected contour
  - Bob Eckert suggests beyond the radio horizon (10 to 15 km)
- Interference NOT just a same dwelling or nearby issue

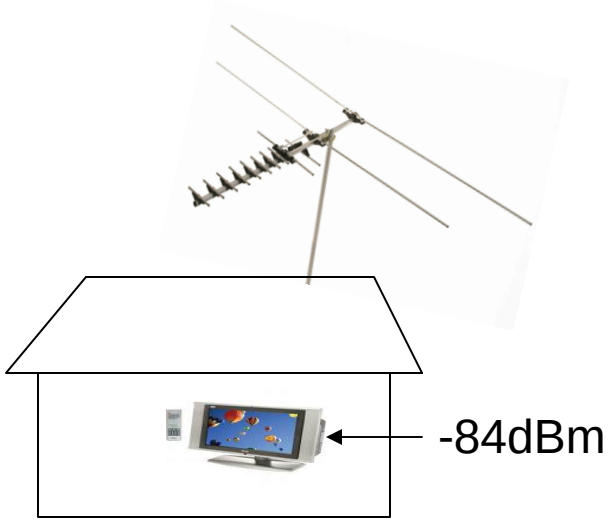
Differences in Reception

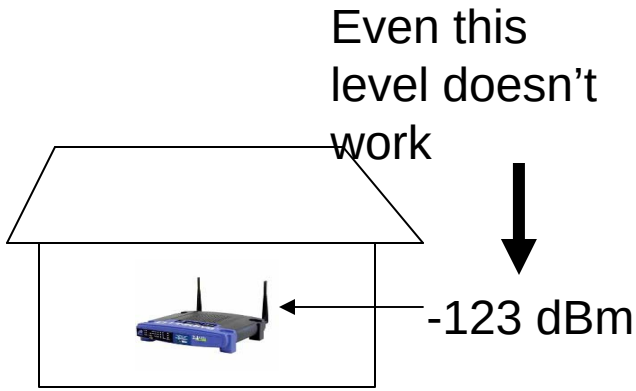




Lower signal beyond contour	3 – 7 dB
Difference in Antenna Gain	10 dB
Difference in Antenna Height (30’ vs. 6’)	7 dB
Outdoor vs. Indoor	15 dB
Total	35 -39 dB

Differences in Reception





- Values chosen conservative
- F(50/90) 3-7 dB doesn't really guarantee device beyond contour
- No terrain or building attenuation (other than home) taken into account
- No multipath considerations
- Even -123 dBm doesn't provide required no interference Part 15 protection

NAF's Indoor Measurements

CH.	Residence1				Residence 2				Residence3			
36	-64.3	BA3	-89.6	BA5	-61.5	BA2	-89.2	KIT	-84.8	FR	-95.6	BA1
53	-76.7	BR3	-98.4	DN	-71.9	BR3	-88.8	BA1	-90.6	KIT	-98.6	LR
60	-74.4	BR4	-101.2	UT	-69.6	LR	-81.0	FR	-87	BA1	-96.4	BR2
65	-71.2	BR1	-88.7	DN	-68.7	BR3	-75.3	BA3	-85.2	KIT	-96.2	BA1

- All three residences are located within one mile of each other and have clear line of sight to the TV transmitting antenna about 25 miles away
- 20 dB + differences on same channel within a house
- 30 dB difference between houses (L-R and Tirem predictions within 1 dB on any channel between all three residences)
- F(50,90) predicts about -34 dBm (-45 dBm for pilot) for ch. 36 all three homes – indoor measurements 15 to 55 dB different

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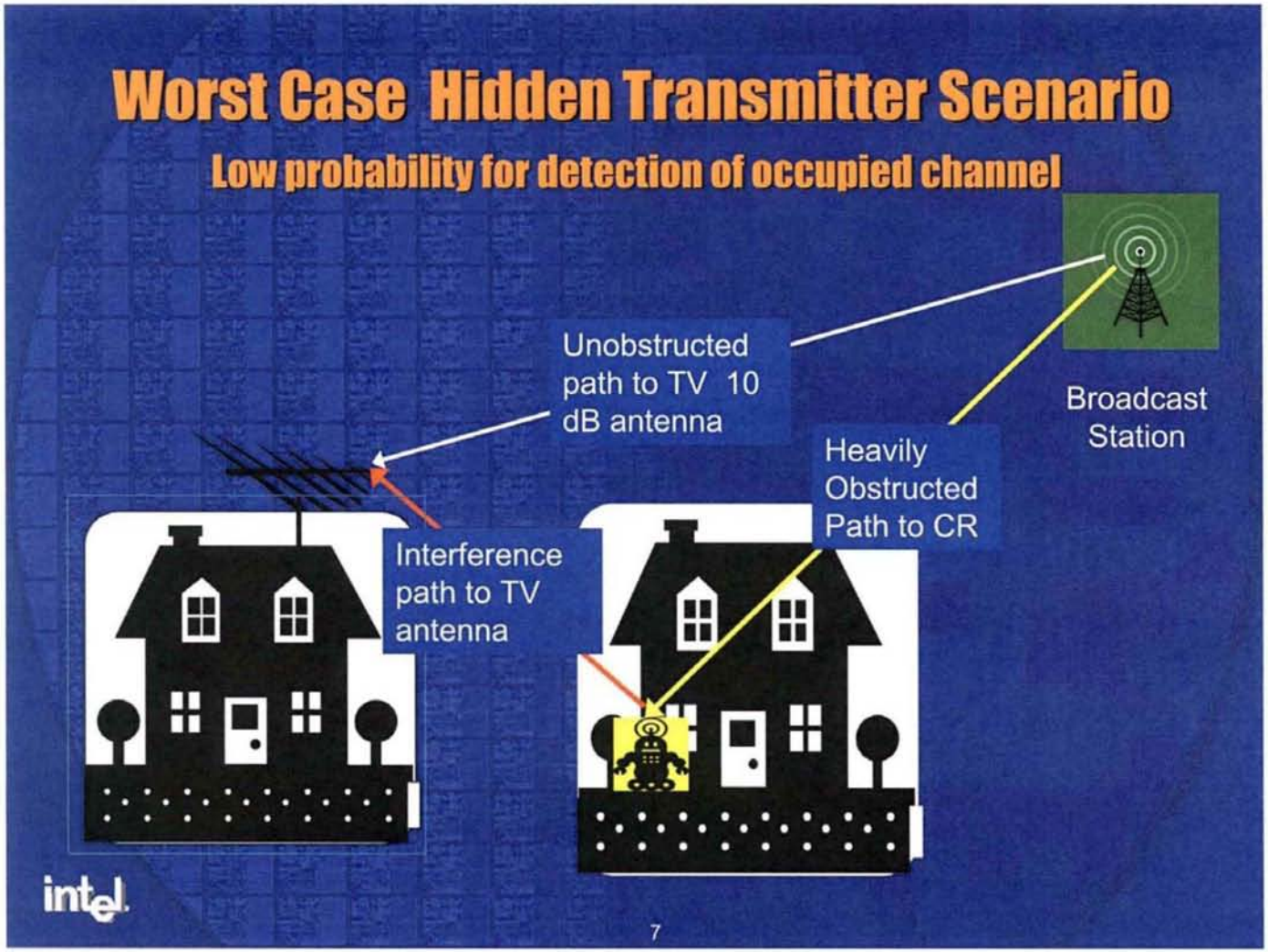

Intel Presentation to FCC 11/1/2004

NAF's Sensing Paper

- Claims sensing at -121 dBm (132 dBm pilot detection) possible
  - With 1 second observation time
- Claim 37 dB additional attenuation compared to rooftop antenna
  - Claim 27 dB margin for three measured homes

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NAF Sensing Paper

- Don’t dispute that sensing can detect at 37 dB lower than DTV receiver – It’s just that 37 dB is not enough to protect DTV viewers!
- Problem is difference in receive systems between DTV and TV band device
- Sensing must account for difference in propagation, building attenuation, and hidden node between device and DTV set
- Sensing must work over entire interference distance of the TV device

NAF's Sensing Paper

- Margin "fails" to take into account the fact that TV antenna is outside and sensing can be inside (i.e., building attenuation)
- Margin "fails" to take into account height difference of TV antenna and TV device (at least 7 dB)
- Margin "fails" to take into account that measurements made at 25 miles with clear line of sight
  - FCC (F50/90) curves predict DTV signal to be 40 dB lower at the edge of contour versus 25 miles
- Even at -121 dBm careful analysis of NAF's measurements show sensing fails

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Device Testing

- IEEE 802 test procedures
- Determining detection threshold
- Use of ATSC captures
- Testing in the presence of strong signals
- Field testing