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North American Broadcasters Association (NABA)

PLANNING CRITERIA FOR SPECTRUM SHARING AND INTERFERENCE MANAGEMENT IN THE BROADCAST BANDS BY LICENSED AND UNLICENSED DEVICES

The North American Broadcasters Association (NABA, www.nabanet.com) is an association of broadcasters in Canada, Mexico, and the United States, and the NABA Technical Committee is its standing technical body. NABA is, thus, in a position to present the technical viewpoints of the most authoritative association of professional North American Broadcasters in television and sound programme production, post-production, and distribution for terrestrial, satellite, and cable broadcasting.

NABA is a Sector Member of ITU-R and a long-time participant in ITU-R Study Groups, Working Parties, Task Groups, Rapporteur groups, etc. NABA numbers among its members Chairmen, Vice-Chairmen and members of the above groups. NABA also participates widely in the ITU work on radio, television and multimedia services and has a strong interest in ITU-R studies on spectrum management and engineering and, in particular, the technical aspects of spectrum sharing and interference management.

In this context NABA considers that ITU-R studies on spectrum sharing and interference management should be of highest priority in this 2008-2011 ITU-R Study Period. These studies should result in internationally approved approaches to share existing spectrum among both new services and existing services. Furthermore, the inter-service interference levels must permit a quality of service no lower than the one currently afforded by the Radio Regulations.

NABA notes that there is an interest in permitting the use of devices which would operate within the spectrum allocated in the ITU Radio Regulations to the Broadcasting Service. In particular, unlicensed devices, without an allocation in the RR, are proposed which would use frequencies within the TV bands that are temporally and/or geographically underutilized. These frequencies are being referred to as “white spaces”.

Consequently, NABA reminds Working Party 6D of the Recommendation ITU-R BT.1786 entitled “Criterion to assess the impact of interference to the terrestrial broadcasting service (BS)”. NABA considers this Recommendation of primary importance to protect broadcasting world-wide from interferences that could seriously jeopardize the broadcasting service. This Recommendation establishes the criterion to assess the impact of interference to the broadcasting service that may result from devices that produce emissions in the frequency bands allocated to the terrestrial broadcasting services. The acceptable limit for the total interference to the terrestrial broadcasting services that may result from the aggregate emissions of those radio devices “should at no time

exceed one percent of the total receiving system noise power". The referred radio devices include unlicensed white space devices (WSDs) as well as ultra-wideband (UWB), power line telecommunications (PLT), short range FM-modulators, software defined radios (SDR), cognitive radio systems (CRS), short range devices (SRD), etc.

Recent studies have addressed the issue of spectrum sharing between the Broadcasting Service and WSDs. Annex 1 below provides a summary of several studies which demonstrate the limitations of WSDs as cognitive radio systems and the potential for interference to the Broadcasting Service. NABA further offers the proposal for a Preliminary Draft New Recommendation in Annex 2 that provides a guideline for an acceptable limit for total interference to the terrestrial broadcasting services that may result from the emissions of radiocommunication devices that share a frequency allocation with the broadcasting service.

Annex 1

Interference to the Broadcasting Service from Devices operating in the TV bands

1 Introduction

The planning involved in the location of television broadcast transmitters and the allotment of frequencies includes constraints on the levels of interference that can be tolerated from co-channel and adjacent channel emissions (see Recommendation ITU-R BT.1368-6[1]). These constraints are used successfully to plan and implement the broadcasting service for television. There are, however, proposals to allow devices, such as wireless networks, to operate in those TV broadcast channels not occupied by a licensed television operator. The unoccupied channels are referred to as "white spaces". The wireless network devices would consequently have emissions in the "white spaces" of the TV broadcasting bands but without a corresponding frequency allocation in the Radio Regulations.

There is concern that consumer TV receivers may not be adequate to avoid interference from co-channel and adjacent channel emissions of wireless network devices. A study by the Federal Communications Commission (FCC) in the United States demonstrated the limited performance of DTV receivers from over-the-air interference in both co-channel and adjacent channel situations. The study report can be found in Attachment 1. The study demonstrated that wireless network devices should not be operated on co-channel and adjacent channels occupied by TV broadcasting services.

2 Evaluation of Direct-Pickup Interference to Television Receivers

A more recent study by the FCC investigated a concern that TV receivers with a direct connection to a cable TV system may also be susceptible to interference from wireless network devices operating within the TV broadcast spectrum on locally unused broadcast channels (TV white spaces). A cable TV system is likely to have fewer unused TV channels (if any) since the planning constraints are not as severe as over-the-air TV systems. The FCC study investigated the potential

[1] Recommendation ITU-R BT.1368-6, "Planning criteria for digital terrestrial television services in the VHF/UHF bands", 2006.

for ingress into the cable TV system at the TV receiver. The study report can be found in Attachment 2.

The study used three digital TV receivers that were available in 2005 and were used in a previous FCC study. The cable TV signals, connected directly to the TV receiver, were typical 256-QAM signals set at a minimum signal level specified for the "input terminals of the first device located on the subscriber's premises." The interfering signal was an OFDM signal with a 4.8 MHz bandwidth located with the cable TV channel to which the victim TV receiver was tuned. The OFDM signal is typically used for wireless network systems especially in portable applications. In each test, the power of the interfering signal applied to an antenna was adjusted to determine the minimum power level that caused interference to the operation of the TV connected to the cable TV system. The tests evaluated the interferer separated from the victim receiver by distances of two and ten meters. These distances are typical for wireless networks operating in the same residence and adjacent residences, respectively. In most cases, the tests included separation of the interferer and the victim TV by a wall emulating multiple rooms or apartments.

It should be noted that the FCC used high quality "quad-shielded" coaxial cable for interconnections between the cable TV system and the victim receivers. That level of shielding is much more than is typically installed in the average home. It is not uncommon to find installed coaxial cable with only 50 to 80 percent shielding. The potential is thus greater for interference to occur at even lower power levels than reported in this study.

The FCC results clearly demonstrate that cable TV systems are adversely affected by wireless networks operating in the TV bands. Furthermore, the interference occurs at power levels significantly below the levels proposed by the United States. The proposal permits fixed devices to operate at EIRP levels up to 36 dBm and portable devices to operate at 26 dBm. For the case where the interferer was two meters from the victim TV receiver, the minimum EIRP interference level with and without a wall was measured at 6.3 dBm. This scenario is typical if a wireless network is operating in the same room as a TV receiver or on the other side of a wall. Thus the proposed power levels are nearly 1000 times higher for fixed wireless devices and 100 times higher for portable wireless devices than the level necessary to ensure protection of the cable TV system.

For the case where the interferer was ten meters from the victim TV receiver, the minimum EIRP interference level with a wall was measured at 15.3 dBm. This scenario is typical of a wireless network being operated in an apartment building or townhouse. For this situation the proposed power levels that are over 100 times higher for fixed wireless devices and over 10 times higher for portable devices than is necessary to ensure protection to the cable TV system.

3 Evaluation of the Performance of TV-Band White Space Devices

The FCC also undertook a measurement study of the spectrum sensing and transmitting functions of prototype unlicensed low power radio transmitting devices (i.e., "white space devices" or WSDs) that would operate on frequencies allocated to the broadcasting service. The study report can be found in Attachment 3.

The study considered two aspects for sharing spectrum. One consideration was whether a WSD is capable of the technique to "detect and avoid" or "listen before talk" in order to avoid causing interference. This cognitive approach would use "spectrum sensing" techniques that listen for the signals of TV stations, wireless microphones and other incumbent services licensed to utilized the spectrum. Since the Broadcasting Service is a noise-limited service, the study attempted to determine whether the spectrum sensing capability of the devices should be able to detect signals lower than -116 dBm over a 6 MHz bandwidth. The FCC study also evaluated the potential for WSDs to interfere with TV reception and wireless microphone operations.

3.1 Interference to TV reception

Two devices were evaluated in the study. Both devices had the capability of spectrum sensing. Only one device, however, was capable of transmitting and was used to evaluate potential interference. The FCC performed both laboratory and field testing of the devices. The conclusion reached by the FCC states:

"…the sample prototype White Space Devices submitted to the Commission for initial evaluation do not consistently sense or detect TV broadcast or wireless microphone signals. Our tests also found tests also found that the transmitter in the prototype device is capable of causing interference to TV broadcasting and wireless microphones…"

One WSD failed to meet even the WSD proponent's -116 dBm sensing threshold by about 20 dB. The second WSD could detect the presence of an occupied DTV channel at -114 dBm. However, two-signal tests showed that the detection reliability was degraded by the introduction of a second DTV signal on a nearby channel.

The FCC also evaluated the interference potential of a WSD to over-the-air TV reception. Their tests demonstrated "that interference can occur at significant distances from a victim DTV receiver, even though favorable DTV reception conditions. This was seen to be particularly true for co-channel interactions that may occur as a result of unreliable detection of occupied channels."

3.2 Interference to Wireless Microphones

Low power wireless microphones are also licensed to use the TV bands and are commonly employed at sporting and theatrical venues as well as news events. As with the DTV sensing the first WSD "was generally unable to sense wireless microphones". The performance of the second WSD "was mixed when tested in a variety of situations and conditions. This device was found to be able to sense wireless microphone signals located in the center of a TV channel in all scans at a signal level as low as -120dBm. However, on some scans it also incorrectly indicated the presence of a microphone…"

3.3 Further sensing studies

Further studies are continuing with four additional WSDs submitted to the FCC. Initially the testing utilized ideal laboratory conditions where measurements were made with equipment directly connected by cable to the signal source and with the WSD tuned to a single channel. However, recent tests were conducted using the antenna supplied by the manufacturer. One device, when turned on, indicated in the laboratory that all channels were occupied including 608 to 614 MHz which is allocated in the Radio Regulations to radio astronomy in Region 2. This device also indicated that seven channels were occupied when the antenna was removed and the connection terminated. This same device, when operated outdoors, indicated that all channels were occupied with the antenna connected and that 16 channels were occupied with the antenna connection was terminated. Similar results have been observed for three additional WSDs including the false detection of occupied channels went the WSD was isolated within an anechoic chamber.

4 Assessment of spectrum for White Space Devices

A spectrum assessment study was performed to objectively determine the geographical range over which spectrum could be available within the broadcast TV bands for use by unlicensed devices in the United States[2]. The proposal allows fixed unlicensed transmitters to operate in "vacant" TV channels provided various desired-to-undesired (D/U) signal ratios are met at all points within the service area of the unlicensed transmitter. The desired signals are the broadcast TV stations either on co-channel or adjacent channels to the undesired unlicensed transmitter.

The study was conducted to determine the availability of vacant spectrum within the TV bands for use by these unlicensed devices. The study used the same propagation curves to compute the field strengths for both the desired and the undesired signals to identify the areas where these unlicensed transmitters could be placed.

The study modeled a grid of fixed unlicensed transmitters representing a network of unlicensed devices that was superimposed at different geographic regions within the United States to determine the number of vacant channels available at these locations. The study used a four watt Effective Radiated Power (ERP) for the unlicensed transmitter with an omnidirectional antenna placed at every intersection of a 30-second grid (latitude and longitude) across major populated regions of the United States. The unlicensed transmitter height was set at a modest height of 30 meters (HAAT) and the number of available channels was determined for each 30-second grid (i.e. approximately a one square mile area). The proposed protection ratios and service contours described in Recommendation ITU-R BT.1368-6 were used.

Figure 1 presents a map that shows the availability of TV channels for unlicensed devices for the North East region of the United States. The map is color-coded to identify the number of TV channels available for unlicensed device operation in a given location. The figure illustrates that, while some TV channels are available for unlicensed fixed operation in certain rural areas, little if any TV channels are available in congested areas, primarily along the Northeast corridor. The analysis indicates that approximately two-thirds of the population in the Northeast corridor will not have access to any spectrum. Another 14% will only have access to one TV channel. At 60 meters HAAT, the number of population without access to spectrum is significantly higher.

[2] "Interference from the Operation of Unlicensed Devices in the Broadcast TV Bands – Engineering Study (Exhibit A)", The Association for Maximum Service Television and the National Association of Broadcasters, 30 November 2004 http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6516883657

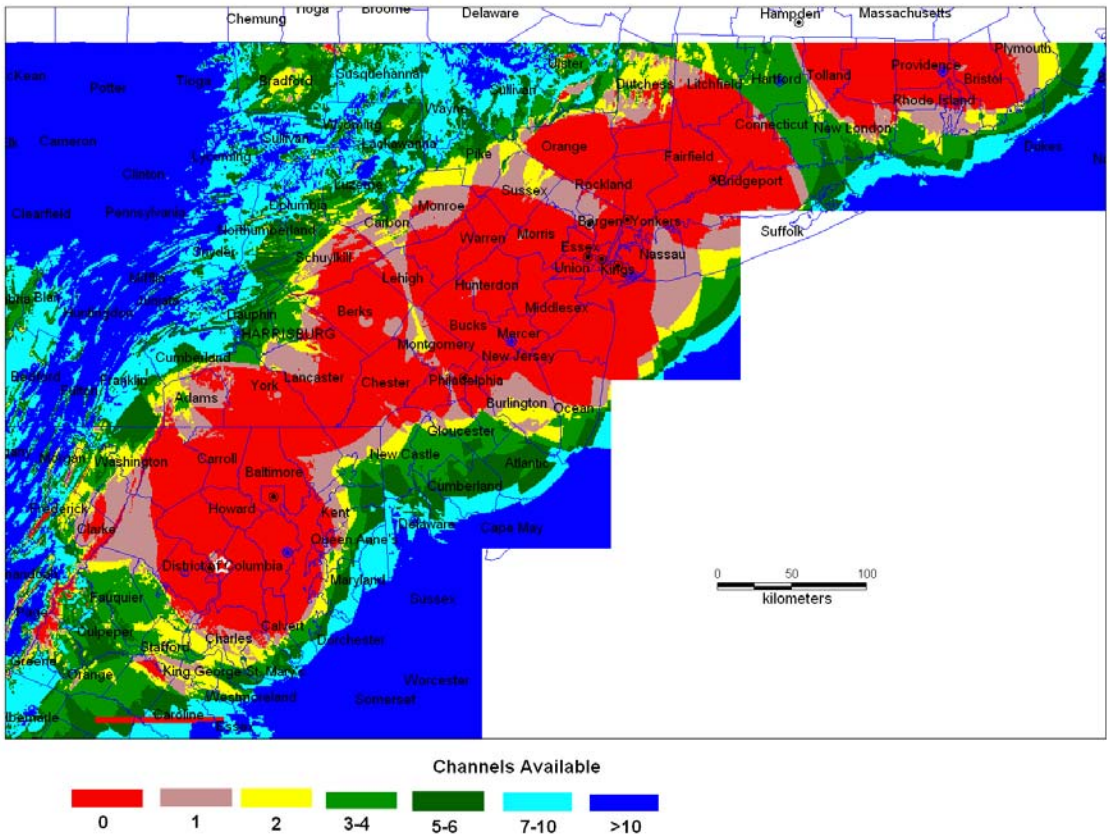

FIGURE 1

Availability of Unlicensed Devices Channels in the North East Region of the United States

Moreover, the spectrum availability in these states and urban areas varies significantly from one geographical grid to another. As shown in the North East region map, it is nearly impossible to establish large enough areas with sufficient channels to permit operation of unlicensed device networks in the television broadcast spectrum. Furthermore, identifying these white spaces require complex engineering evaluation and analysis to determine where these devices will be allowed to be located. It will also require the proper design and careful installation of these fixed transmitters. These requirements make it extremely difficult, if not impossible, for untrained unlicensed device operators to conduct these analyses and/or install these transmitters without proper guidance and/or oversight by responsible entities. Similar findings were observed in other regions of the United States. For example, the analysis further indicates that approximately three-quarters of the population in the state of California will not have access to any spectrum. An additional 7% will only have access to one TV channel.

The analysis generally concluded that, using the proposed parameters for protecting TV reception, little if any TV channels are available for unlicensed device operation within the broadcast TV band in the major metropolitan areas of the United States. Television channels are only available in the less populated and rural areas of the country.

Annex 2

PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R BT.[SHARE]

Criterion to assess the impact of spectrum sharing and interference management for the terrestrial broadcasting service (BS)

(Question ITU-R 4-2/6)

Scope

This Recommendation provides a guideline for an acceptable limit for total interference to the terrestrial broadcasting services that may result from the emissions of radiocommunication devices that share a frequency allocation with the broadcasting service.

The ITU Radiocommunication Assembly,

considering

a) that the terrestrial broadcasting services are protected services;

b) that the terrestrial broadcasting service is a noise-limited service;

c) that radiocommunication devices may exist with emissions from applications having a corresponding frequency allocation in the RR, that may occur in the frequency bands allocated to the broadcasting services;

d) that there is an established protection requirement in Recommendation ITU-R BT.1368 for BS-to-BS intraservice interference;

e) that there is an established protection criterion in Report ITU-R BT.2075 for terrestrial broadcasting services restricting interference caused by emissions from broadcasting-satellite systems and networks;

f) that there is an established protection criterion in Recommendation ITU-R BT.1786 for non-broadcasting radiocommunication devices not having a corresponding frequency allocation in the RR;

g) that limits must be established for emissions of devices so that the established interference protection criteria for terrestrial broadcasting services will not be violated,

recommends

1 that beyond the BS-to-BS intraservice protection requirement as prescribed in the Recommendation mentioned in *considering* d) above, the total interference contribution arising from interservice spectrum sharing should be 10 dB lower to ensure that the degradation in the C/N margin is no more than 0.5 dB of the available margin.

Attachment 1

"Tests of ATSC 8-VSB Reception Performance of Consumer Digital Television Receivers available in 2005", Office of Engineering and Technology, Federal Communications Commission (USA), OET Report FCC/OET 05-TR-1017, 2 November 2005

FCC OET
05-TR-1017.pdf

Attachment 2

"Direct-pickup Interference Test of Three Consumer Digital Cable Television Receivers", Office of Engineering and Technology, Federal Communications Commission (USA), OET Report FCC/OET 07-TR-1005, 31 July 2007.

FCC OET
07-TR-1005.pdf

Attachment 3

"Initial Evaluation of the Performance of Prototype TV-Band White Space Devices", Office of Engineering and Technology, Federal Communications Commission (USA), OET Report FCC/OET 07-TR-1006, 31 July 2007.

FCC OET
07-TR-1006.pdf