COMPATIBILITY CHALLENGES FOR BROADCAST NETWORKS AND WHITE SPACE DEVICES

M. B. Waddell

BBC, United Kingdom

ABSTRACT

Digital Switch-Over plans have driven a thorough review of UHF spectrum and how it might be used. The deployment of low power white space devices (WSDs) has potential to deliver improved WiFi systems for mobile broadband and a new platform for multimedia streaming in the home. The FCC has recently approved plans for new fixed and mobile devices, based on a combination of spectrum sensing and geolocation. Devices are expected to appear in the market in the very near future, but will require significant modification to cope with the denser, higher-value network of transmitters in Europe. The spectrum sensing approach is at an early stage of development and in isolation is unlikely to provide the level of protection required to prevent interference to broadcast services and radio microphones. However when this technique is combined with Geolocation

INTRODUCTION

UHF terrestrial TV networks have historically been planned as Multi-Frequency Networks (MFNs) to support regional TV programming and to simplify international frequency co-ordination. This can be seen as a relatively inefficient use of the spectrum as a particular UHF channel carrying a TV multiplex for one region cannot be re-used until the signal strength has fallen to a level approaching the thermal noise floor. In the UK, 256MHz of spectrum is used to support 6 DTT licensed DTT signal to be detected will be received at a very low level. The WSD will be lower in height than a normal DTT antenna, it will have a lower antenna gain and will have an obstructed view of the transmitter. These effects combine to give a hidden node margin; this hidden node margin relates the rooftop antenna signal level for DTT reception to the WSD signal level available for detection. The components of the hidden node margin are shown in Figure 1.

Research by Randhawa et al [1], suggests that for outdoor suburban deployments of WSDs in the UK, the hidden node margin will be as high as 40dB. This figure is based on outdoor sensing at 1.5m with a 0dBi antenna. Assuming a planned field-strength of 50dBμ prototype devices have exploited the pilot tone in the ATSC DTV signal, which can be clearly seen on a spectrum analyser plot (Figure 2). For detection of DTV at -116dBm an overall signal to noise ratio of –13dB is available assuming a 3dB noise figure. However, by using a simple bandpass filter centred on the pilot tone, the signal to noise ratio improves significantly; for a 1kHz bandwidth filter, a signal to noise ratio of 13dB becomes available which is more than sufficient to rapidly detect the pilot.

Detection of COFDM systems like DVB-T and DVB-T2 will require far more sophisticated signal processing using correlation of the guard interval or detection of the OFDM pilot structure. This process is further complicated by the multiplicity of modes and has not yet been demonstrated on practical devices.

Geolocation

An alternative to sensing is to control access using an Internet-hosted, location-dependent database of available white space channels. A device would typically use GPS to locate itself and then request a table of available channels from a server. This avoids the difficulties associated with detection but clearly requires some additional hardware and infrastructure.

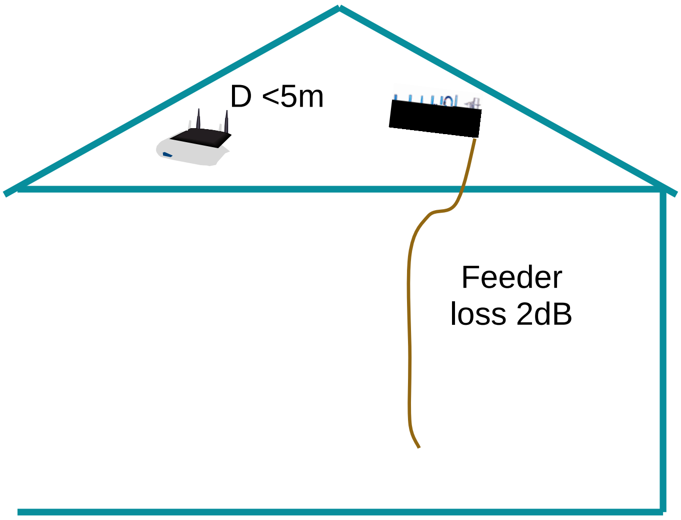
The technique is particularly appropriate for DTT protection, where channel assignments are essentially static but can readily be extended to protect PMSE use where access is licensed and logged by a band manager. This is particularly attractive in the UK where the existing PMSE band manager already makes extensive use of computer databases to license radio microphone users. In some countries PMSE is less well controlled and sensing techniques may still be necessary. PMSE sensing performance issues remain a concern and the FCC have chosen to adopt a “safe haven” approach reserving two location-dependent TV channels for exclusive PMSE use.

WSD EIRP LIMITS

Access to the white space channels using geolocation techniques should prevent co-channel interference, but careful control of the EIRP will be needed to prevent adjacent and non-adjacent channel interference. Ideally, devices will make use of power control to minimize interference and maximize opportunities for spectrum re-use. However sensible EIRP limits will be required to protect licensed incumbents and these must take account of typical antenna isolation values and the selectivity and overload characteristics of the existing receivers.

WSD to DTT Receiver Path Loss

The path loss between the WSD and the DTT receiver is clearly a crucial factor. Initial analysis by Ofcom [4] considered a WSD outdoors at 1.5m height, 45 degrees off axis to the DTT antenna as shown in Figure 3. The minimum distance between WSD and DTT antenna would be 10m, corresponding to a free space loss of 50dB at 800MHz. The WSD is off axis to the DTT antenna and was assumed to be 10dB down in gain from boresight, i.e. 2dBi, and the WSD antenna was assumed to be 2dB down from its peak value, i.e. –2dBi. For 800MHz .640026(T)-0 Td [(d)5.6


D <5m
Feeder
loss 2dB