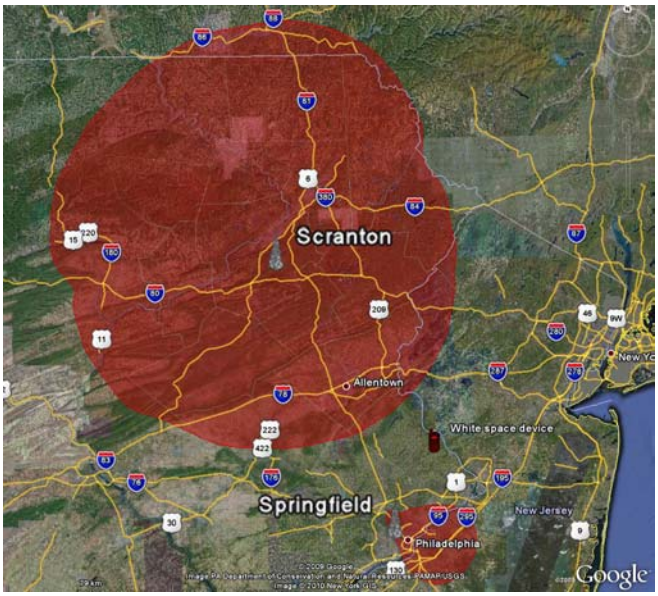
White Space White Paper

Abstract: This White Paper discusses the meaning and use of spectrum "white space", including methods to identify white space, types of devices, requirements on a geo-location database, and some of the key issues to consider including propagation models.

What is White Space?

The idea of white space can be demonstrated by the figure below which has been simplified to only show only two transmitters.



This picture shows the coverage in red of two US broadcast transmitters taken from the FCC database, namely a 200 kW ERP transmitter close to Scranton (fictional home of the US TV series *The Office*) and a 140 kW ERP transmitter at Springfield. Both are operating on channel 41 at 632 – 638 MHz.

It can be seen that there is a gap of about 40 km between the two coverage areas, some of which could in theory be available for other devices if they operate at sufficiently low power so that they will not cause interference into receivers of the licensed broadcaster.

The concept of white spaces is to identify these unused gaps and make them available to wireless communications devices.

Identifying White Spaces

A number of ways of identifying white space locations have been considered including:

1. Sensing: a white space device would listen to see if it could detect transmissions on each channel.
2. Beacons: any transmitter or receiver would transmit a signal that could be detected that would identify its requirement for protection
3. Geolocation databases: a white space device would identify its location and use that to query a database that would know which channels are available to it.

Initially the sensing method was preferred, but problems have been identified that question its reliability. The FCC undertook a series of test campaigns in which some devices failed to detect licensed transmissions, and the approach has significant difficulties with the so called "hidden transmitter" problem. Meanwhile the beacon method would require significant modifications to existing equipment and require additional spectrum.

Hence the prefered approach is for a white space device to identify its location and query a central database as to what channels are available.

The broadcasting bands are particularly suitable for this approach as the location of transmitters is well known and changes are infrequent. There are also significant gaps between coverage areas that could be utilised for other applications.

White Space Devices

Manufacturers are working on a number of possible set of white space devices, but two of the most likely categories are:

- Home wireless access networks: operating in UHF these should have greater ability to connect within buildings compared to heigher frequencies, and hence distribute multi-media content with an eirp of 100 mW
- Rural wireless coverage using base stations with eirp of 4W. Again the lower UHF frequency should provide greater coverage than Wi-Fi networks at 2.4 GHz

White Space Databases

The prefered approach to open up the UHF bands used for broadcasting applications for white space devices is therefore to develop one or more databases that can be queried over the internet.

This database would have to take account of the various constraints on use of the spectrum including:

- Broadcast networks as described above
- Program making and special events (PMSE) in particular radio microphones

- Exclusion zones around protected sites such as Radio Astronomy observatories, airports etc
- Exclusion zones around country borders

The size of the exclusion zones could vary by device type and height: for example the FCC Part 15 rules specify that the distance to a TV protected contour should be 6 km if the device antenna height is below 3 m but 14.4 km if between 10 and 30 m.

Architecture

The white space database would be web based and potentially have to be able to handle large numbers of requests within a short response time. This would have to be carefully designed to ensure sufficient resources are available without incuring excessive costs using, for example, load balancing technique and pre-caching of information on a pixel by pixel basis.

Issues to Consider

The white space database will need to take into account a number of key issues, including:

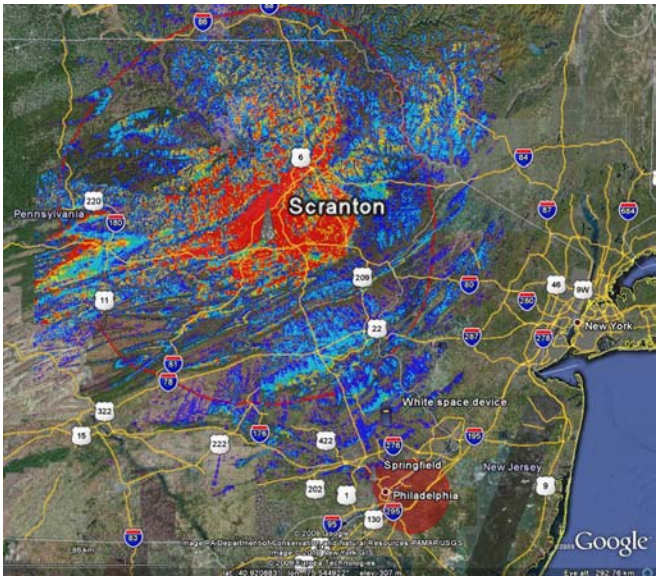
Keeping the database up to date

The broadcast transmitters will slowly change over time. For example the Scranton transmitter shown in the figure above was severely damaged by ice in 2007.

The methodology used to predict coverage

The figure below shows the coverage of the Scranton transmitter generated using two methodologies:

- The FCC service contour derived using the field strength curves propagation model in R-6602
- The coveraged predicted using the propagation model in Rec. ITU-R P.1812 that takes into account terrain data.



It can be seen that there can be a significant difference between the two. The P.1812 propagation model takes account of the hills and valleys and is likely to be more accurate. Therefore some areas inside the FCC generated contour will not receive a usable TV signal while some points outside will.

In particular if the FCC contour is used there is the danger of interference:

- Into TV receivers that are outside the FCC contour but have found that in practice they are able to receive at present a usable signal
- Into white space devices that have identified that this location could be used on channel 41 when in practice it couldn't

Database pixel size

Data would have to be pre-calculated and stored on a pixel by pixel basis to improve performance. A question then is the size of pixel, as in general smaller pixels bring increased accuracy.

Management of radio microphones

These can be issued at short notice for short periods of time and the system to include them in the calculations should be quick and efficient.

Pricing

There will be a cost that must be borne for management of the white space database. This could be recovered from a fee charged to manufacturers or ISPs when registering a device. This is likely to be a one off payment, but that must take into account the need to provide support over the life time of the device.

Privacy and transparency

The information collected could include data about individuals that they would want to ensure is controlled effectively and not used for additional purposes

Key Skills

We at Transfinite have the key skills need to provide a white space solution including understanding issues relating to:

- Developing online radio related applications such as our Visualyse SM web based licensing solution
- Web based databases including searches, map displays and manipulation of geo spatial data
- Radio communication systems including broadcasting, PMSE, and white space devices
- Propagation modelling and coverage predictions - in particular in our Visualyse Professional tool

We would be happy to talk to others interested in teaming to be a white space database manager or studying issues relating to white space devices.