Service Area Reliability Degradation Analysis:

Tile-Based Coverage and Interference Analysis

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MARTIN RAIS

Software Solutions in Radio Communications

Abstract

The Telecommunications Industry Association's (TIA) Technical Service Bulletin 88 (TSB-88) series of documents addresses the impact and effects of non-homogenous land mobile radio systems operating in the VHF and UHF bands following the Federal Communication Commission's (FCC) spectrum refarming and narrowbanding initiatives. The Service Area Reliability Degradation (SARD) analysis is a tile-based procedure outlined in the TIA's TSB-88 series that provides a more granular approach to area-based interference analysis than HAAT-based contour analysis. By calculating pre-interferer service levels and correlating with interfered levels, the SARD analysis offers a percentage of an existing emission's area that may be negatively affected when a proposed emission is brought online on a tile-by-tile basis. Though processor intensive, the SARD analysis allows for greater efficiency in frequency assignment in congested RF areas.

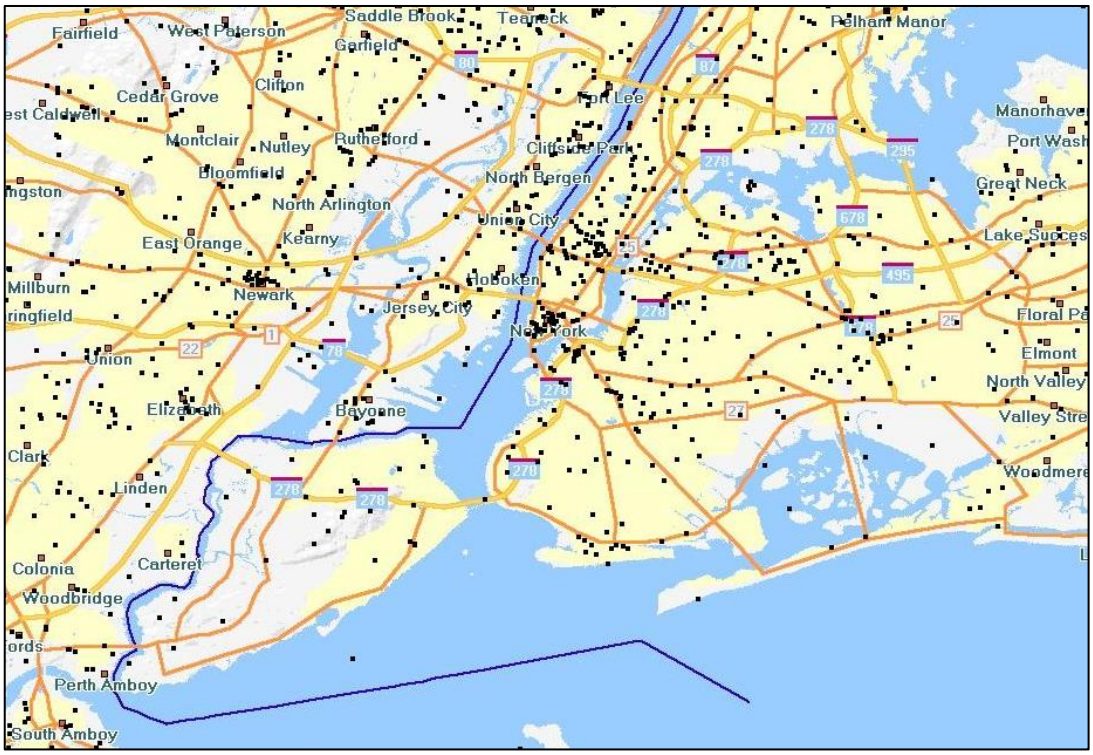

Figure 1: There are over 11,000 LMR emissions between 150 and 160 MHz within 50 kilometers of New York City

TIA Technical Service Bulletin 88

The Telecommunications Industry Association, or TIA, periodically releases Telecommunications Systems Bulletins that recommend methods and procedures for the coordination, deployment,

modeling, and analysis of various telecommunications systems. For wireless systems, the TSB-88 series of documents, entitled Wireless Communications Systems Performance in Noise and Interference Limited Situations, provides guidance for VHF and UHF wireless systems for bandwidth-efficient deployment.

Following such guidelines and recommended procedures is essential for efficient and effective spectrum management as the Federal Communications Commission (FCC) mandates spectrum refarming and narrowbanding initiatives. These initiatives introduce a greater amount and variety of land mobile radio systems into already congested bands and RF areas, posing the risk of introducing greater amounts of interference between the systems as well. The TSB-88 document aims to maintain low amounts of interference while allowing a wider variety and greater amount of emissions to operate in a given area.

Calculating Service Area Reliability Degradation

Service Area Reliability, as defined by the TSB-88 document, is the mean tile-based area reliability for all tiles within the service area. A service area is defined as a specific user's geographic bounded area of concern, usually consisting of political boundaries such as city lines or county limitations or an emission's R-6602 Carrey service contour.

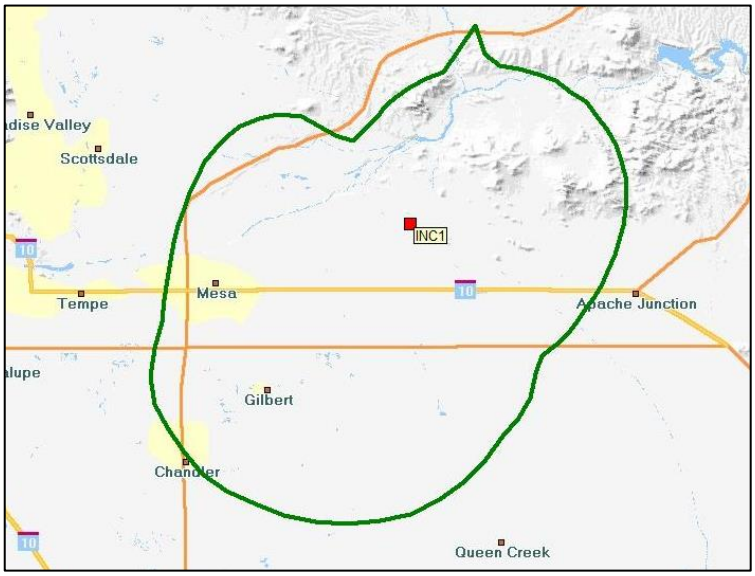

Figure 2: Service contour of an incumbent station

When an analysis is tile-based, the area under investigation is broken down into a uniform grid of a given resolution, typically denoted in arcseconds. The grid resolution is usually a factor of the terrain

resolution available for the propagation analysis. With typical terrain resolutions of 1-, 2-, or 3-arcseconds, the corresponding tile sizes are 30-meter, 60-meter, and 90-meter resolution. The grid resolution is determined by the quality of data available to the engineer but must be weighed against calculation duration since the process can be quite computer- and time-intensive. Stepping down from 3-arcsecond resolution data to 2-arcsecond resolution data more than doubles the amount of calculations required; switching from 3-arcsecond data to 1-arcsecond data increases the number of calculations nine-fold.

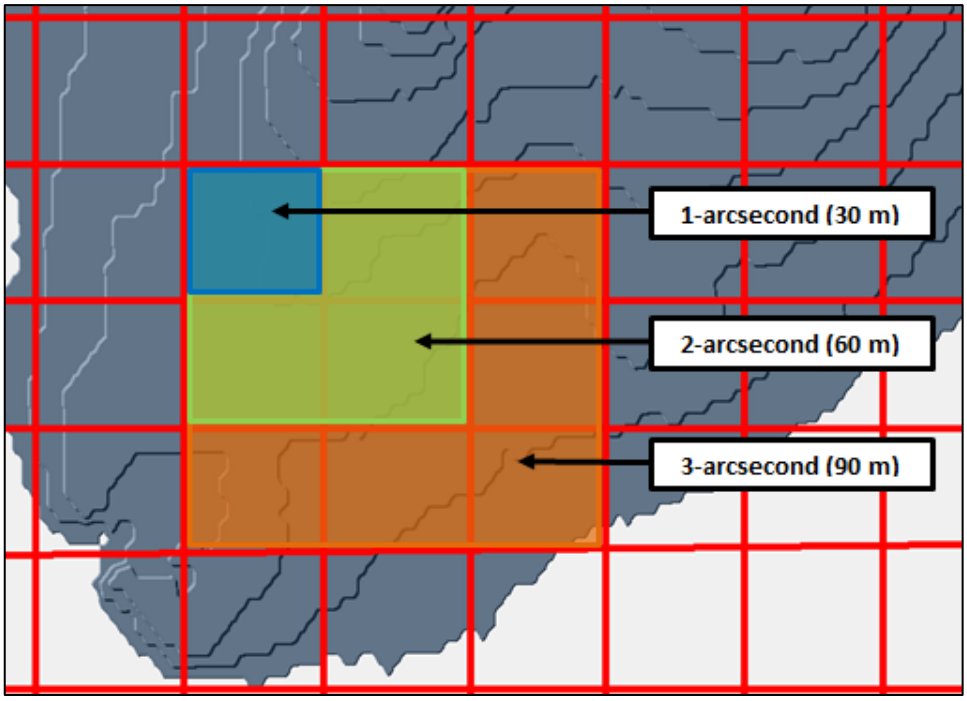

Figure 3: 1-arcsecond resolution tiles on high-resolution terrain layer

Whether a tile in a Service Area Reliability analysis is deemed reliable is based on the CPC, or the Channel Performance Criterion, which varies based on the type of modulation that is employed by the radio system. It is a performance margin required above the sum of interference and noise power for a carrier signal to be deemed reliable and can be represented by Delivered Audio Quality, or DAQ. The higher the required DAQ, the easier it is to understand speech through the RF system being tested.

DAQ is based on a five-point scale, with the quality more stringent as the number increases from level 1, where speech is present but unusable, to level 5, where the speech is easily understood. For DAQ level 1, the static signal plus noise plus distortion-to-noise plus distortion ratio is typically less than 8 dB. For DAQ level 5, the static signal plus noise plus distortion-to-noise plus distortion ratio is typically greater than 33 dB.

Thus, the factors that are considered in a Service Area Reliability Degradation analysis are the service area of an existing licensed station, the noise (interference) power introduced by a proposed station (interferer), the wanted signal power received, and the channel performance criterion. Once all parameters have been determined at each map tile, the SARD can be determined.

Interpreting the Results

The Service Area Reliability Degradation process is based on two criteria at each tile of the map: Does an existing licensed station offer reliable coverage on that tile? If a proposed station is approved for operation, does interference from that new station reduce the reliability of the existing licensed station on that tile?

The figures below show an example of SARD analysis for a hypothetical proposed station and three incumbent stations operating on the same frequency. The data is presented both as a map and as a table.

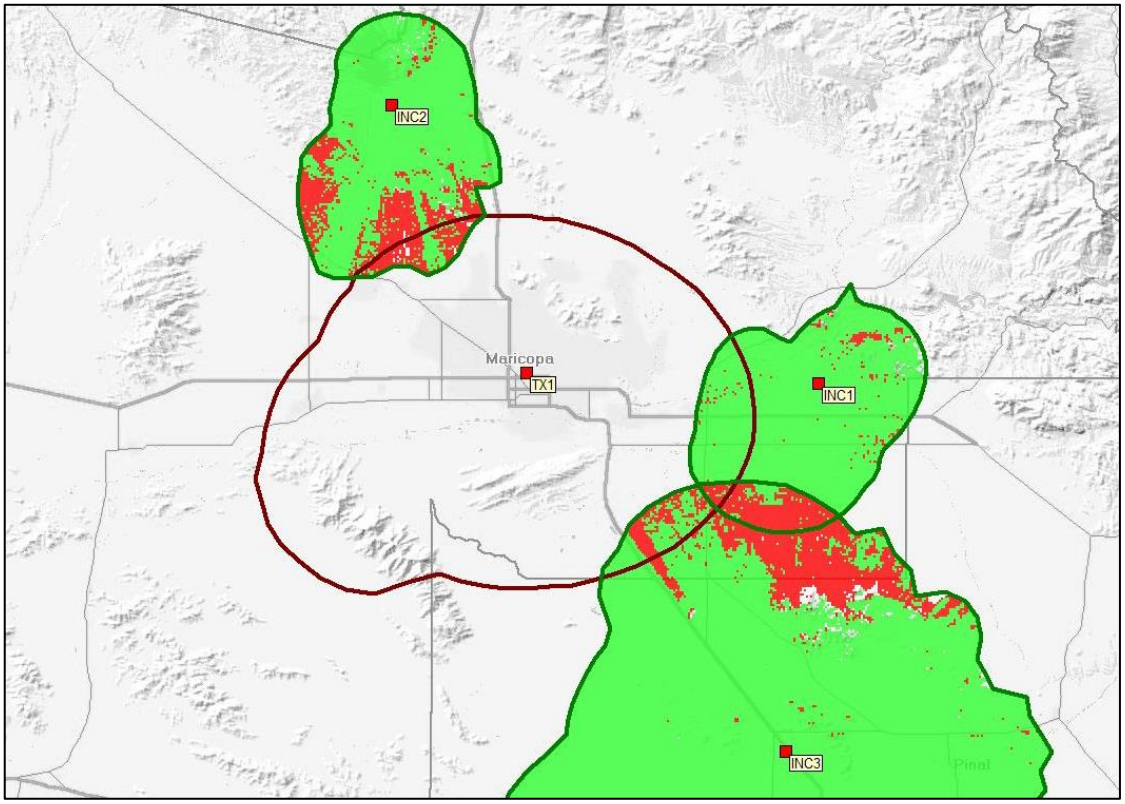

Figure 4: TSB-88 Service Area Reliability Degradation Results

overlap_pc	sard
0	
18.7	3.7% (From 98.4% To 94.8%)
6.2	19.5% (From 96.3% To 76.8%)
1.9	7.0% (From 96.8% To 89.8%)

Figure 5: TSB-88 Service Area Reliability Degradation Values

The map overlay displays the interference contour of the proposed station, the service contours of the incumbent stations, and the results of the SARD analysis for the area within the service contours of the incumbent stations. When a pixel within the service contour of an incumbent station is not shaded, the incumbent station does not offer reliable service at that pixel even before the proposed station is considered. Any point within an incumbent's service area that appears in green represents an area where reliable service is maintained even after the proposed station is considered for interference. Pixels shaded in red represent areas where previously reliable service is rendered unreliable due to the addition of the proposed station.

The table displays the amount of each incumbent station's service area that is overlapped by the interference contour of the proposed station along with the SARD results. A percentage reduction is shown along with the initial and potentially degraded reliability figures.

Ultimately, a regulatory commission must decide upon acceptable levels of Service Area Reliability Degradation. A percentage figure that is low may make it artificially difficult to establish a new station or emission. Conversely, a percentage figure that is high may introduce an excessive amount of interference into an already crowded RF area. A common acceptable value for Service Area Reliability Degradation is 5 dB.