Application of Space Object Conjunction Method in the Radio Channel Modeling and Interference Analysis

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Radio interference or multipath propagation is one of main reasons that have great affection on overall performance of wireless telecommunication systems which is shown in Fig1. Spectrum management mechanism has been adopted for decades to solve it in some extent. Many standards and specifications which include lots of curves or tables are proposed to allocate most applicable frequency spectrum from short wave to millimeter wave. But they didn't tell the whole story for two main reasons. One is that the mode or feature of wireless interference is usually dynamic while they are static. The other is the domain of interference is obviously high dimension such as location, time, and frequency while they are commonly in one dimension of frequency. So, the present description of radio interference need to be updated to a more generalized version.

The space object conjunction is one of the key concepts in the theory of space surveillance which is the first line of defense of all objects in space. The necessary condition for a conjunction is that there are at least two objects that have an intersection on orbits of them respectively. If all orbits are known, then the conjunction can be predicted. Similarly, if all information of radiation source is given, its interference orbit can be gotten. And when all orbits of interference sources are known, it is not so hard to predict the conjunction of two radio system, set up the radio channel model, and improve the effectiveness of telecommunication devices.

There are a few concepts that are proposed to describe the interference conjunction for radio systems, such as rate of radio conjunction, probability of radio conjunction, power spectrum density of radio transmitter, distribution of power spectrum updating, etc. There are also a few equations that are presented to describe the radio channel characteristics, such as

Function $T_r(x,y,z,t)$ denotes the orbit of a carrier, where (x,y,z) is the three-dimensional coordinate. If there are two carriers, e.g. A and B, the distance between them is $Dis\ \ (t)$ which is defined as

$$Dis\ \ (t) = \sqrt{(x_A - x_B)^2 + (y_A - y_B)^2 + (z_A - z_B)^2}$$

where $t = t_A = t_B$.

Power spectrum density of A is defined as

$$PSD_A(f, t_A) = P_A / \left(4\pi Dis(t_A)\right)^2$$

where P_A is the power of transmitter A.

If $PSD_A(f, t_A)$ is larger than $Thre_B$ which is the sensitivity threshold of B, then the conjunction of A and B occurs. Similarly, if power spectrum density of B $PSD_B(f, t_B)$ is larger than $Thre_A$ which is the sensitivity threshold of A, then the conjunction of A and B occurs too.

So, when space object conjunction method could be adopted, we will have another powerful tool to setup channel model and analyze the performance of radio systems.