SINR Calculation

First of all, our SINR calculation was completely wrong from the beginning. The reason it was wrong is that we forgot the case SNR is actually computed as $SNR = 20 \times \log\left(\frac{S}{N}\right)$ not $SNR = \frac{S}{N}$. If we call SNR caused by a primary node as INR and SNR caused by CR base station as SNR, according to our previous calculations we have found $SINR = \frac{SNR}{INR+1}$. It was convenient to us to say since

$$\frac{\frac{S}{N}}{\frac{I}{N}+1} = \frac{S}{I+N} \tag{1}$$

This miscalculation also caused miscalculation of max INR threshold which we earlier found as

$$INR \leq \frac{SNR - \tau}{\tau} \tag{2}$$

where τ is min SINR threshold to be able to communicate without any collision.

Therefore, If we call $x = \frac{S}{N}$ and $y = \frac{I}{N}$, SNR and INR can be computed as follows:

$$\begin{aligned} SNR &= 20 \times \log(x) \\ INR &= 20 \times \log(y) \end{aligned} \tag{3}$$

Also, by using Equation1 and Equation3 SINR can be computed as

$$\begin{aligned} SINR &= 20 \times \log\left(\frac{x}{y+1}\right) \\ SINR &= 20 \times \log(x) - 20 \times \log(y+1) \\ SINR &= SNR - 20 \times \log(y+1) \end{aligned} \tag{4}$$

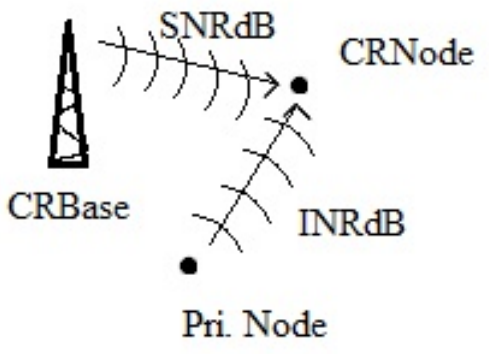

Figure 1: General Collision Case

Finally, if we think about the case in the Figure1 what we need to find to understand whether a frequency can be used or not is when a threshold for SINR, $SINR \geq \tau$, is given to find another threshold for INR. So, we can find a threshold for INR when a threshold for SINR is given as follows:

$$\begin{array}{lcl} SINR & \geq & \tau \ \Rightarrow \ No\ Collision \\ SNR - 20 \times \log(y+1) & \geq & \tau \\ 20 \times \log(y+1) & \leq & SNR - \tau \\ y & \leq & 10^{(SNR-\tau)/20} - 1 \\ 20 \times \log(y) & \leq & 20 \times \log\left(10^{(SNR-\tau)/20} - 1\right) \\ INR & \leq & 20 \times \log\left(10^{(SNR-\tau)/20} - 1\right) \end{array} \tag{5}$$

In our program's source code we can compute this threshold equation by using methods of WirelessChannel class. These methods are *magTodb* and *dbToMag*. Therefore the code that will compute the maximum threshold for INR value to be able to communicate CR users without any collision is:

WirelessChannel.magTodb(WirelessChannel.dbToMag(snr_from_base - SimulationRunner.wc.sinrThreshold)-1)

Notice that INR threshold computed in Equation5 can be negative. In this case even the unused frequencies will not be assigned to any user to communicate. Negative threshold case must be taken into account and in that case threshold must be rearranged as zero.

Also note that, since logarithm is not defined in negative real numbers, in Equation5 $10^{(SNR-\tau)/20}$ − 1 must be grater than zero. This will lead us to the conclusion that SNR must be grater than τ as follows:

$$\begin{array}{lcl} 10^{(SNR-\tau)/20} - 1 & > & 0 \\ 10^{(SNR-\tau)/20} & > & 1 \\ \dfrac{SNR-\tau}{20} & > & \log(1) \\ \dfrac{SNR-\tau}{20} & > & 0 \\ SNR - \tau & > & 0 \\ SNR & > & \tau \end{array} \tag{6}$$