DETAILED DERIVATION OF PERFORMANCE METRIC-I

- The Sensing Signal $y_i(m)$ at the SU in subchannel i is given as follows:

$$y_i(t) = \begin{cases} g_i(t)\sqrt{q_i} s_i(t) + \sqrt{\sigma_i}\, \delta_i(t), & H_1 \\ \sqrt{\sigma_i}\, \delta_i(t), & H_0 \end{cases} \quad ; m = 1, 2, \ldots, M \tag{1}$$

$\Rightarrow$

$$y_i(t) = \begin{cases} \dfrac{g_i(t)}{\sqrt{1 + d_i^T}} \sqrt{q_i}\, s_i(t) + \sqrt{\sigma_i}\, \delta_i(t), & H_1 \\ \sqrt{\sigma_i}\, \delta_i(t), & H_0 \end{cases} \quad ; m = 1, 2 \ldots M \tag{2}$$

- energy statistic of the Sensing signal

$$\Phi(y_i) = \frac{\sum_{t=1}^{M} \| y_i(t) \|^2}{M} \tag{3}$$

Acc to central Limit theorem

$$\Phi(y_i) \sim \begin{cases} \mathcal{N}\left(\left(q_i \left(\frac{g_i^2}{1 + d_i^T} \right) + \sigma_i \right), \frac{\left(q_i \left(\frac{g_i^2}{1 + d_i^T} \right) + \sigma_i \right)^2}{M} \right), & H_1 \\ \mathcal{N}\left(\sigma_i, \frac{\sigma_i^2}{M} \right), & H_0 \end{cases} \tag{4}$$

- False Alarm Probability & Detection Probability are defined to measure the spectrum sensing performance.

Here the false Alarm Probability is given as follows:

$$P_f = P_r\left(\Phi(y_i) > \delta \mid H_0\right) = Q\left(\left(\frac{\delta}{\sigma_i} - 1\right)\sqrt{\tau f_s}\right) \quad (5)$$

Probability of detection is given as:-

$$P_d = P_r\left(\Phi(y_i) > \delta \mid H_1\right) = Q\left(\left(\frac{\delta}{q_i\left(\frac{g_i^2}{1+d_i^T}\right) + \sigma_i} - 1\right)\sqrt{\tau f_s}\right) \quad (6)$$

From eq^n (4) we can make δ the subject to find its value.

$$\delta = \sigma_i\left(\frac{Q^{-1}(P_f)}{\sqrt{\tau f_s}} + 1\right)$$

We can substitute the value of δ in eq (6) to find the value of P_d

$$P_d = Q\left(\left(\frac{\sigma_i\left(\frac{Q^{-1}(P_f)}{\sqrt{\tau f_s}} + 1\right)}{q_i\left(\frac{g_i^2}{1+d_i^T}\right) + \sigma_i} - 1\right)\sqrt{\tau f_s}\right)$$