PROOF FOR LEMMA 1

→ P_n can be rewritten as follows

$$P_n = P(R_n T_m \geq N)$$

here,

$$T_i \triangleq \frac{N}{\log\left(1 + \frac{P_i^{ow}}{P_{N0}} |h_i|^2\right)},$$

$$R_n \leq \log\left(1 + \frac{P_n^{ow} |h_n|^2}{P_m^{ow} |h_m|^2 + P_N}\right)$$

So,

$$P_n = P\left(\log\left(1 + \frac{\rho_n |h_n|^2}{\rho_m |h_m|^2 + 1}\right) \geq \log(1 + \rho_m |h_m|^2)\right)$$

$$P_n = P\left(1 + \frac{\rho_n |h_n|^2}{\rho_m |h_m|^2 + 1} \geq 1 + \rho_m |h_m|^2\right)$$

$$P_n = P\left(\frac{\rho_n |h_n|^2}{\rho_m |h_m|^2 + 1} \geq \rho_m |h_m|^2\right)$$

$$P_n = P\left(|h_n|^2 \geq \frac{\rho_m}{\rho_n} |h_m|^2 + \frac{\rho_m^2}{\rho_n} |h_m|^4\right)$$

Date ___ / ___ / ___
Page ___

→ there is an implicit constraint,

$$|h_n|^2 \geq |h_m|^2;$$

So the event

$$\left\{|h_n|^2 \geq \frac{\rho_m}{\rho_n}|h_m|^2 + \frac{\rho_m^2}{\rho_n}|h_m|^4\right\}$$

can be divided into the following two events:

$$\left\{|h_n|^2 \geq \frac{\rho_m}{\rho_n}|h_m|^2 + \frac{\rho_m^2}{\rho_n}|h_m|^4\right\}$$

$$= \left\{|h_n|^2 \geq |h_m|^2, |h_m|^2 \geq \frac{\rho_m}{\rho_n}|h_m|^2 + \frac{\rho_m^2}{\rho_n}|h_m|^4\right\}$$

$$+ \left\{|h_n|^2 \geq \frac{\rho_m}{\rho_n}|h_m|^2 + \frac{\rho_m^2}{\rho_n}|h_m|^4, \frac{\rho_m}{\rho_n}|h_m|^2 + \frac{\rho_m^2}{\rho_n}|h_m|^4 \geq |h_m|^2\right\}.$$

the case with $\rho_n \geq \rho_m$, where the results for the case with $\rho_n < \rho_m$ can be obtained similarly.

$$P_n = \underbrace{P\left(|h_n|^2 > \frac{\rho_m}{\rho_n}|h_m|^2 + \frac{\rho_m^2}{\rho_n}|h_m|^4, |h_m|^2 > \frac{\rho_n - \rho_m}{\rho_m^2}\right)}_{T_1}$$

$$+ \underbrace{P\left(|h_n|^2 > |h_m|^2, |h_m|^2 \leq \frac{\rho_n - \rho_m}{\rho_m^2}\right)}_{T_2}$$

→ By using the order statistics, the joint pdf of $|h_m|^2$ and $|h_n|^2$ can be written as follows:

$$f_{|h_m|^2, |h_n|^2}(x,y)$$
$$= C_{mn}\, e^{-x}\, e^{-(M-n+1)y}\, (1-e^{-x})^{m-1}$$
$$\times\, (e^{-x} - e^{-y})^{n-1-m}$$

where C_{mn} is defined in the lemma

→ therefore, the probability T_1 can be expressed as follows.

$$T_1 = C_{mn} \sum_{p=0}^{n-1-m} c_p \int_{\frac{\rho_n - \rho_m}{\rho_m^2}}^{\infty} e^{-(p+1)x} (1-e^{-x})^{m-1}$$
$$\times\, \frac{1}{M-m-p}\, e^{-(M-m-p)\left(\frac{\rho_m}{\rho_n}x + \frac{\rho_m^2}{\rho_n}x^2\right)} dx.$$

→ by applying the binomial expansion,

$$T_1 = C_{mn} \sum_{p=0}^{n-1-m} \frac{c_p}{M-m-p} \sum_{l=0}^{m-1} \int_{\frac{\rho_n - \rho_m}{\rho_m^2}}^{\infty} c_l$$
$$\times\, e^{-\left(p+l+1+(M-m-p)\frac{\rho_m}{\rho_n}\right)x - (M-m-p)\frac{\rho_m^2}{\rho_n}x^2} dx.$$

→ To make the probabilities integral applicable, the Probability

$$T_1 = C_{mn} \sum_{p=0}^{n-1-m} \frac{C_p}{M-m-p}$$

$$\times \sum_{l=0}^{m-1} \int_{\frac{S_n - S_m}{S_m^2}}^{\alpha} C_l \, e^{-a\left(x+\frac{b}{2a}\right)^2 + \frac{b^2}{4a}} dx$$

$$T_2 = 1 - \frac{M!}{(m-1)!\,(M-m)!} \sum_{l=0}^{m-1} C_l \frac{e^{-(M-m+l+1)\frac{S_n - S_m}{S_m^2}}}{M-m+l+1}$$

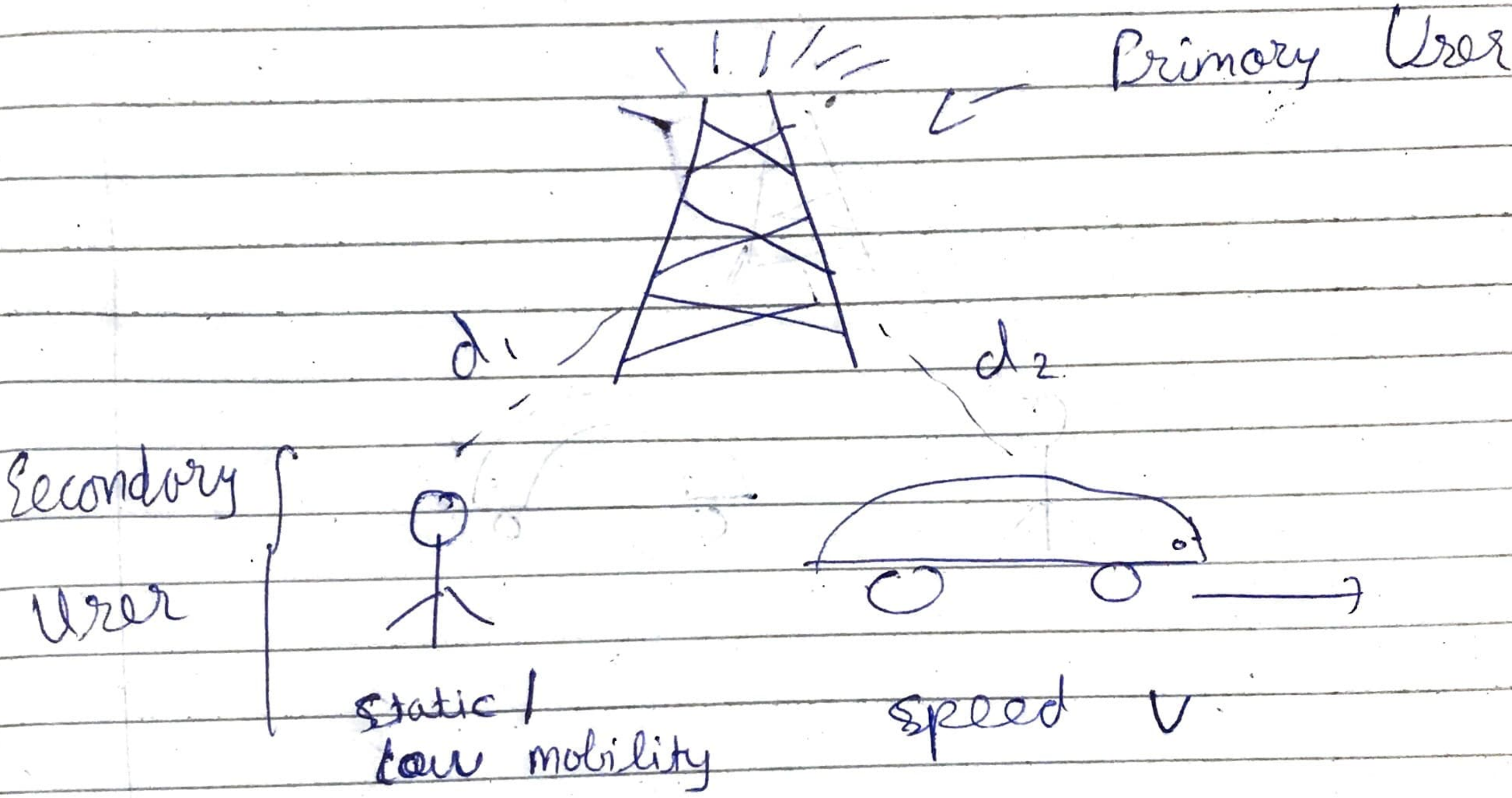
$$P_n = C_{mn} \sum_{p=0}^{n-1-m} \frac{C_p}{M-m-p} \sum_{l=0}^{m-1} C_l \, e^{b^2/4a}$$

$$\times \frac{\sqrt{\pi}}{2\sqrt{a}} \left(1 - \phi\left(\frac{\max\{0, S_n - S_m\}}{S_m^2} + \frac{b\sqrt{a}}{2a}\right)\right) + 1$$

$$- \frac{M!}{(m-1)!\,(M-m)!} \sum_{l=0}^{m-1} C_l \frac{e^{-(M-m+l+1)\frac{\max(0, S_n - S_m)}{S_m^2}}}{M-m+l+1}$$

INNOVATIVE IDEA

Considering Mobility



$d_1 \rightarrow$ constant / changing slowly

$d_2 \rightarrow \int_0^t v(t)\,dt$, where $v(t)$ follows log-normal distribution

→ For best pairing core of NOMA (strong & weak user), we consider one user near to PU & other far from PU.

→ From article, the PDF of SNR distribution of arbitraily correlated Nakagami-m (with mobility) for near user is:-

$$\boxed{P_{\gamma_1}(\gamma_1) = \frac{\left(\frac{\gamma_1 m}{\bar{\gamma}}\right)^{d(Lm-1)} e^{\left(\frac{-\gamma_1}{\bar{\gamma}_1 \times (1-\det(\Lambda))}\right) \times \alpha}}{(1-\det(\Lambda))^{d_1(L-1)}\ \Gamma(Lm)}}$$

→ For user who is far,

$$\boxed{P_{\gamma_2}(\gamma_2) = \frac{\left(\frac{\gamma_2 m}{\bar{\gamma}}\right)^{d(Lm-1)} e^{\left(\frac{1}{\bar{\gamma} \times (\det(\Lambda))}\right) \times \beta}}{(\det(\Lambda))^{d_2(L-1)}\ \Gamma(d'')}}$$

For best pairing, we can use these 2 PDFs,

Finding Joint Probability

$$\boxed{P_{\gamma_1,\gamma_2}(\gamma_1,\gamma_2) = P_{\gamma_1}(\gamma_1) \times P_{\gamma_2}(\gamma_2)}$$

Considering ~~i~~ independent among each other

→ ~~Fo~~ After double Intergration of above equation, we can find offloading probability for mobile users also.