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# PERFORMANCE ANALYSIS OF HANDOVER INITIATION PARAMETERS IN LONG TERM EVALUATION – ADVANCED (LTE-A) NETWORK

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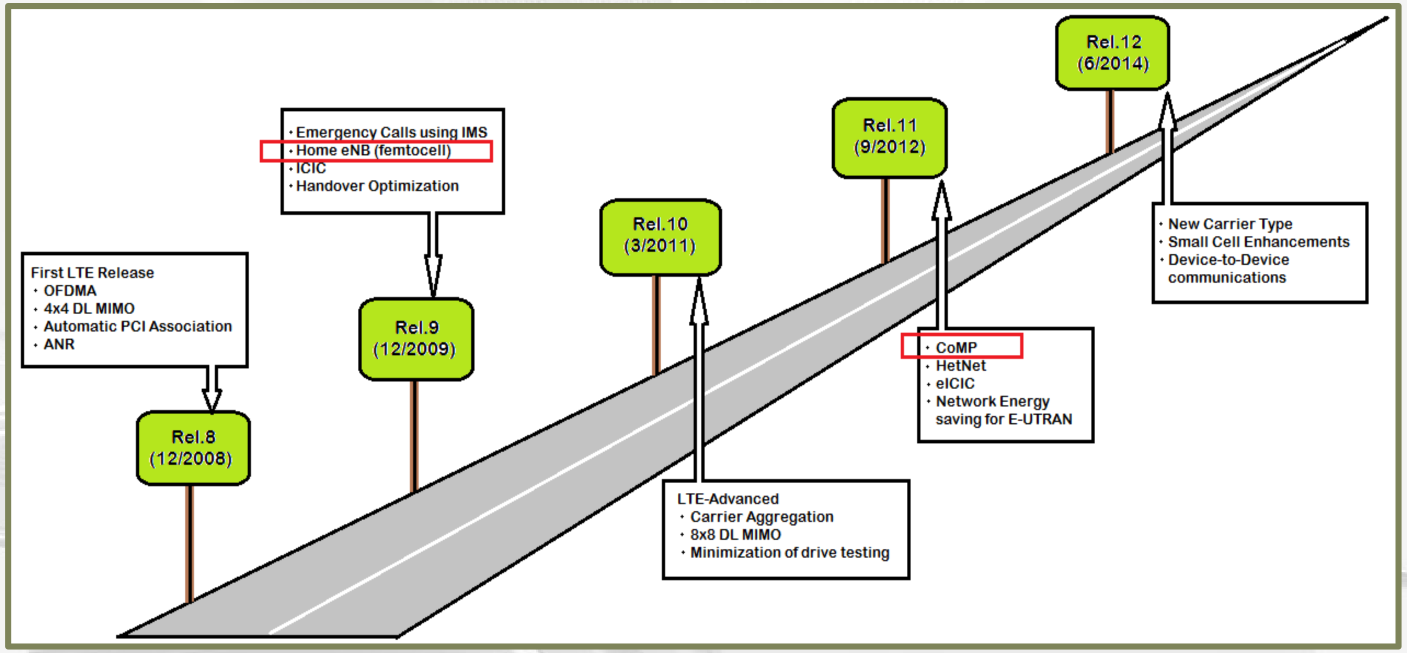
# PRESENTATION OUTLINES

1. Background of Study
2. Research Objective
3. Research Methodology
4. Result & Discussion
5. Conclusion & Future Recommendation
6. Reference

# LONG TERM EVOLUTION-ADVANCED (LTE-A)

**LTE-A** is a new generation of mobile wireless broadband technology with aims to provide a low latency and high throughput system. **3GPP** has been working on further evolution of the LTE, which is referred to as LTE-A release 10 and beyond to develop a true 4G standard. The LTE-A is targeted to fulfil or even surpass all the requirements of international mobile telecommunications-Advanced (IMT-Advanced).

The key features of the **LTE-A** as compared to **LTE**, is that it includes support for wider bandwidth, advanced multiantenna technology, improved uplink performance, advanced interference management, better energy efficiency and self-organizing network.




The 3GPP's Roadmap Evolution from Release 8 to Release 12

# HANDOVER

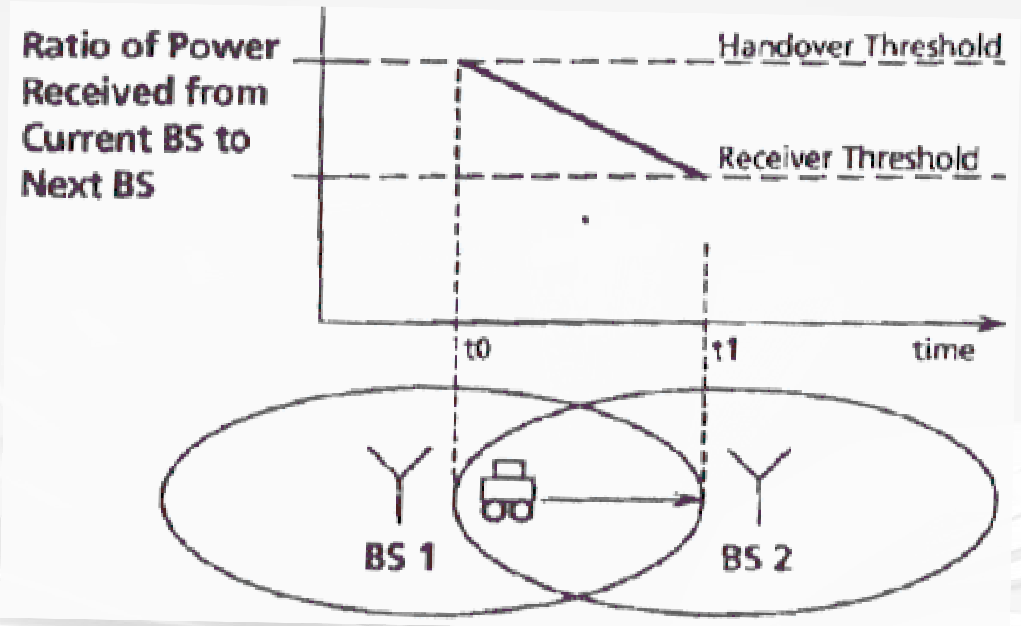
**Handover** is a process when a mobile phone switches between different call sites during a phone call. It is transferred from one channel to another within a cellular network. In addition, handover is the main process required to enable function for mobility and service continuity among a variety of wireless access technologies.

There are two types of basic handover and it can be defined as soft handover; makes new link before break and hard handover; breaks the link before make.

**<u>Handover Failure</u>**

1. Too early handover
   - Radio link failure may be caused by a low value of time-to trigger
2. Too late handover
   - Radio link failure may be caused by a high value of time-to trigger
3. Handover to wrong cell
   - the signal overlapping is existed when UE is located on the edge of eNBs, and UE may chosen a wrong Target eNB to result in radio link failure
4. Ping Pong handover
   - the UE moves on the edge of eNBs and caused unnecessary handover in a short time

# HANDOVER




- In mobile wireless communication system, the handover happens in the overlapped areas.
- A poorly designed handover process tends to make more cases of data loss or radio link failure

# RESEARCH OBJECTIVES

1. To identify parameters for handover initiation process in order to reduce handover fa ilure rate in LTE-A network.

2. To develop an analytical handover framework to ensure the determination of the right handover initiation time in LTE-A network.

3. To derive mathematical equations from the developed framework by incorporatin g the value of user's speed and handover signaling delay parameters.

# RESEARCH METHODOLOGY

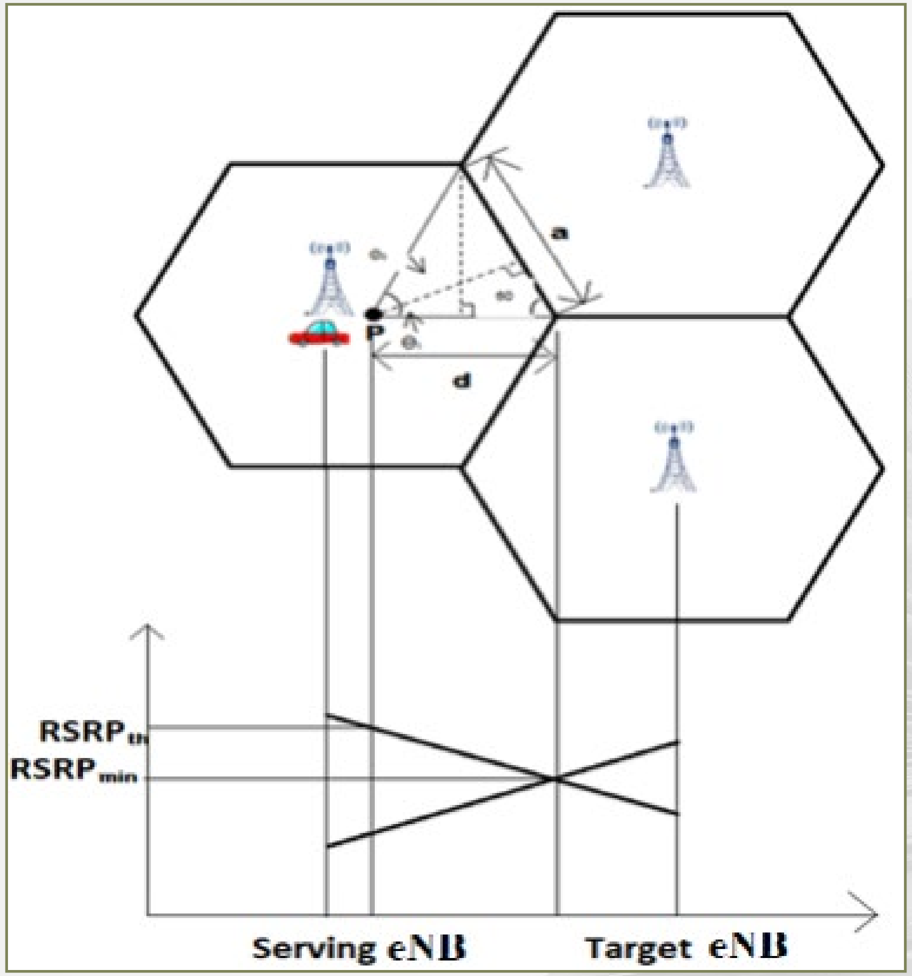



**Figure 1**: An Analytical of Handover Framework

ANALYTICAL HANDOVER FRAMEWORK

Consists of macrocell and UE's movement

Figure 1 shows three macrocells with eNB on each cell which are situated at the center of the hexagon where a is the radius of the cell, d the distance between UE and cell boundary, and RSRPth is the threshold value of the RSRP to initiate the handover process. This implies that when the RSRPmin of UE goes below the threshold, the UE will start to initiate handover process to the new target eNB. θ1 and θ2 is the angle which is later divided by two in between the path way for the UE moves from point P to the boundary cell.

The mathematical equations have been derived showing the movement of UE from the serving eNB to another which is called the target base station.

# MATHEMATICAL DERIVATION

On this framework , the UE is considered connected to the current base station. The UE is moving with a speed v and it is assume to be uniformly distributed in [Vmin,Vmax]. Thus, the probability density function (pdf) of v is given by

$$f_v(V) = \frac{1}{Vmax - Vmin} \qquad Vmin < V < Vmax \qquad (3.1)$$

When the UE location reached the point P as in Figure 1, the UE is assume to move in any direction with equal probability. Thus the probability density function (pdf) of UE direction of motion, θ is

$$f_\theta(\theta) = \frac{1}{\pi} \qquad 0 < \theta < \pi \qquad (3.2)$$

# MATHEMATICAL DERIVATION

Since the angle of direction θT is the total of angle θ1 and θ2, thus the time of UE to move out from the coverage area also have to be calculated into two equation depend on which direction the UE want to move.

From the mathematical equation derivation, thus the pdf of β is

$$f_\beta = \begin{cases} \frac{1}{\theta_1} & 0 < \beta < \theta_1 \\ \frac{1}{\theta_2} & \theta_1 < \beta < \theta_2 \\ 0 & otherwise, \end{cases}$$

# MATHEMATICAL DERIVATION

Therefore, the probability of false handover initiation, Pa is

$$P_a = 1 - \int_0^{\theta_T} f_\theta(\theta) d\theta \qquad (3.26)$$

$$= \frac{5}{6} - \frac{1}{\pi} tan^{-1} \frac{a_2}{d\prime} \qquad (3.27)$$

Where a is a radius of the cell.

The derivative probability of handover failure is given by

$$p_f = \begin{cases} 1 & \tau > \frac{\sqrt{{a_2}^2 + d'^2}}{v} \\ p(t < \tau) & \frac{d'}{v} < \tau < \frac{\sqrt{a^2 + d'^2}}{v} \\ 0 & \tau \leq \frac{d\prime}{v} \end{cases} \qquad (3.44)$$

# MATHEMATICAL DERIVATION

From the probability handover failure, τ is the summation of Radio Link failure(RLF) timer and handover signalling and p(t < τ) is the probability when t < τ.

Thus, the probability of handover failure by considering θ1 and θ2 is given by

$$p_f = \begin{cases} 1 & \tau > \frac{\sqrt{{a_2}^2 + d'^2}}{v} \\ \frac{1}{\theta_1} arccos \left| \frac{d}{v\tau} \right| & \frac{d'}{v} < \tau < \frac{\sqrt{{a_1}^2 + d'^2}}{v} \\ \frac{1}{\theta_2} arccos \left| \frac{d}{v\tau} \right| & \frac{d'}{v} < \tau < \frac{\sqrt{{a_2}^2 + d'^2}}{v} \\ 0 & \tau \leq \frac{d'}{v} \end{cases} \qquad (3.66)$$

# RESULTS

PLOT

**Performance Evaluation of False Handover Initiation Probability ($P_a$)**

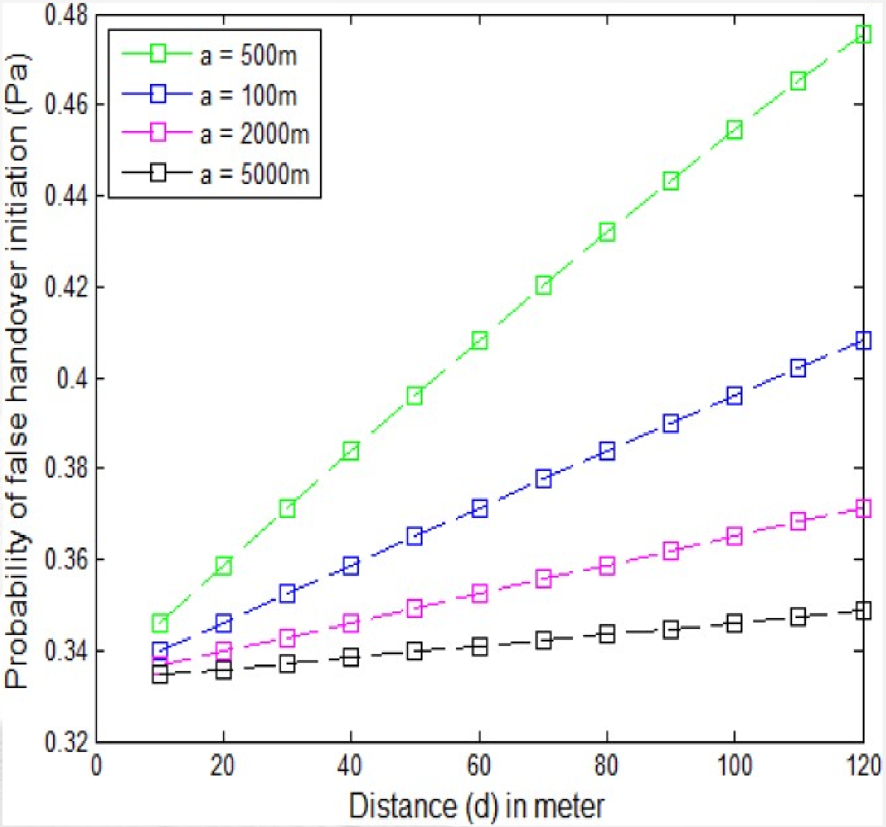



**Figure 2:** Relationship between false handover initiation probability and distance

# RESULTS

PLOT

**Performance Evaluation of Handover Failure Probability (Pf)**

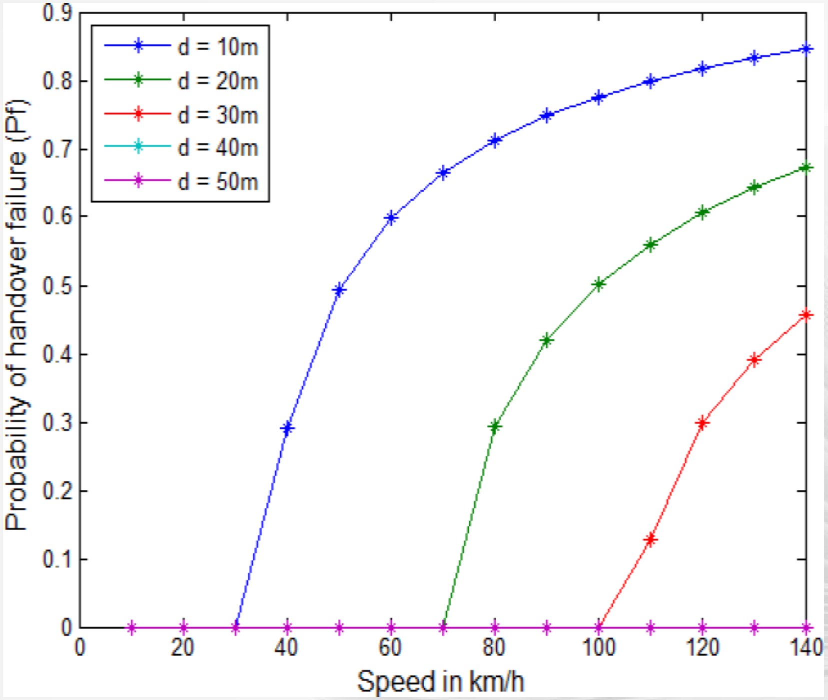



**Figure 3**: Relationship between probability of handover failure and speed for angle θ1 (less than 30 degree) with handover signaling delay of 1 s

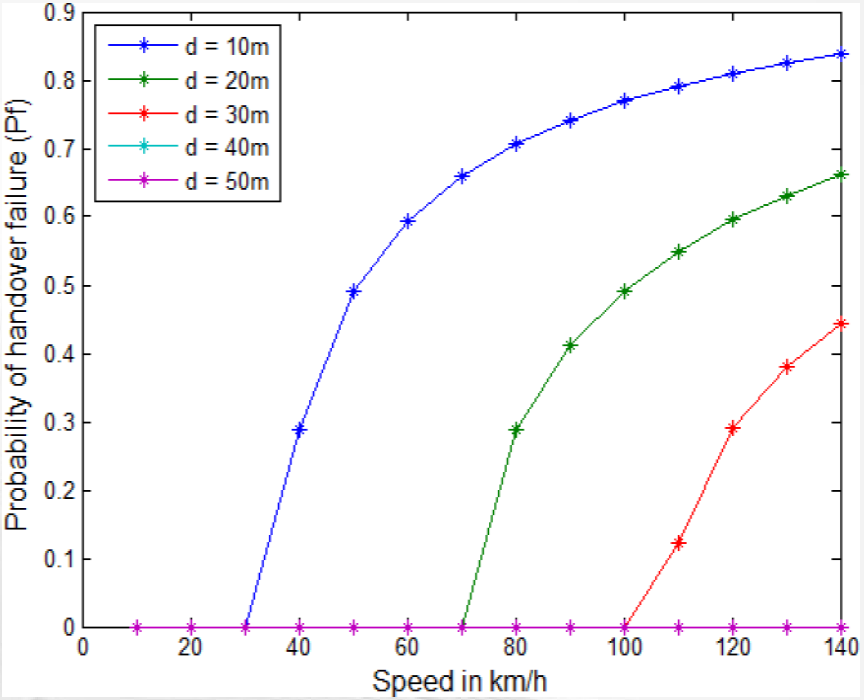



**Figure 4**: Relationship between probability of handover failure and speed for angle θ1 (more than 30 degree) and with handover signaling delay of 1 s

# RESULTS

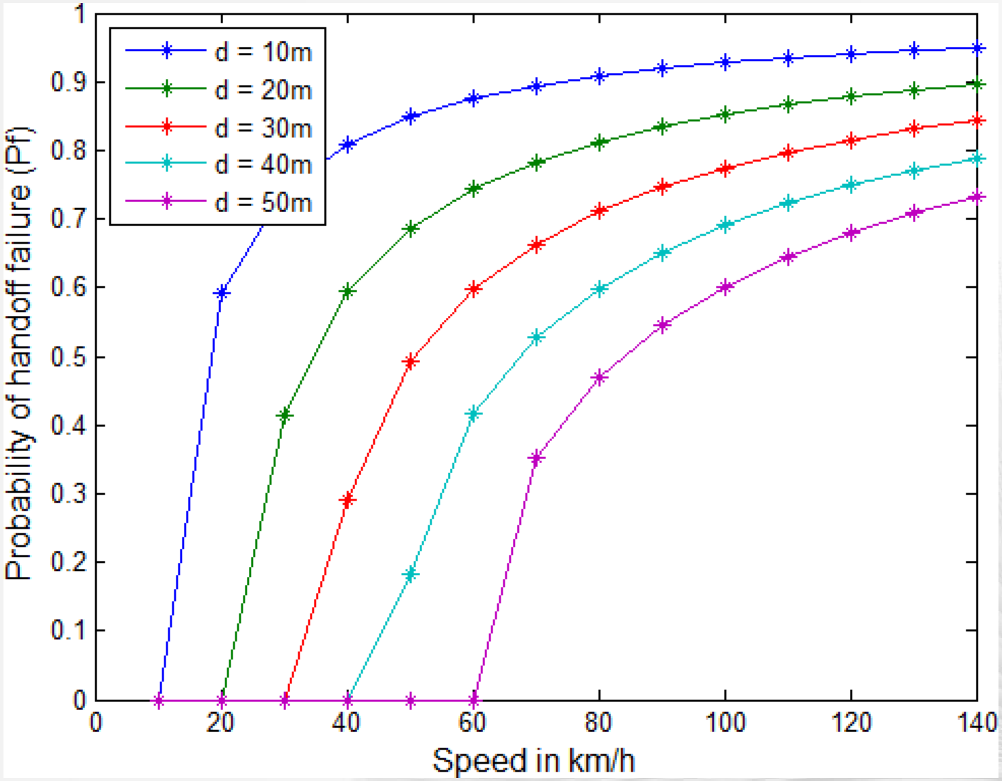



**Figure 5**: Relationship between probability of handover failure and speed for angle θ1 (less than 30 degree) and with handover signaling delay of 3 s

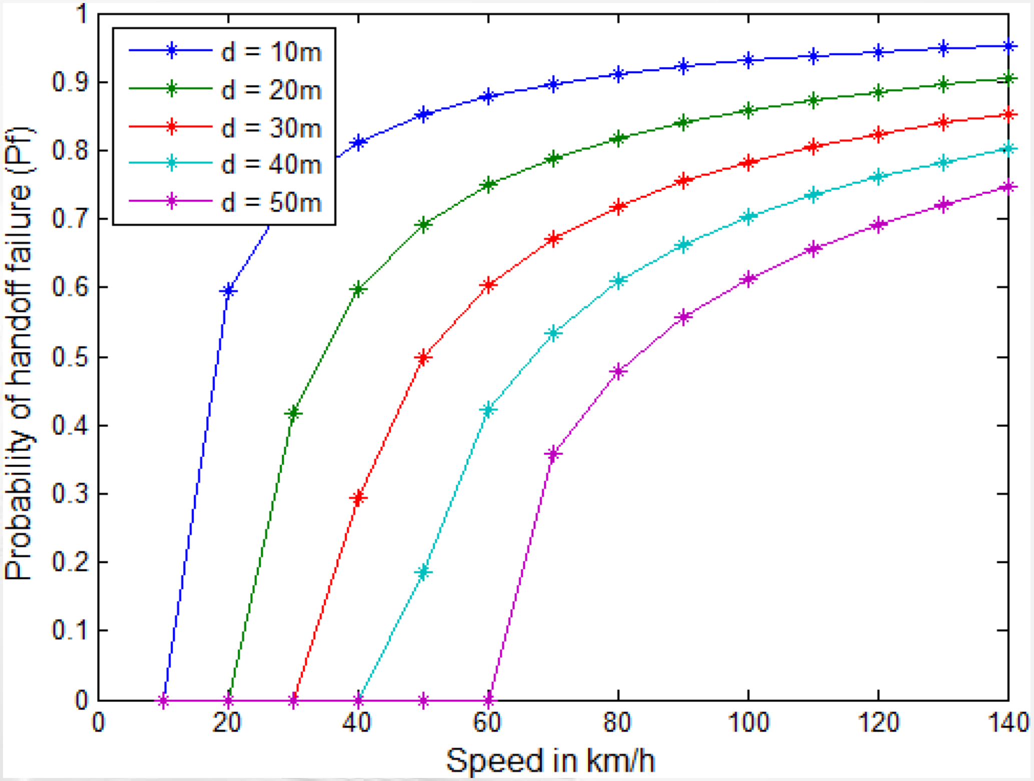
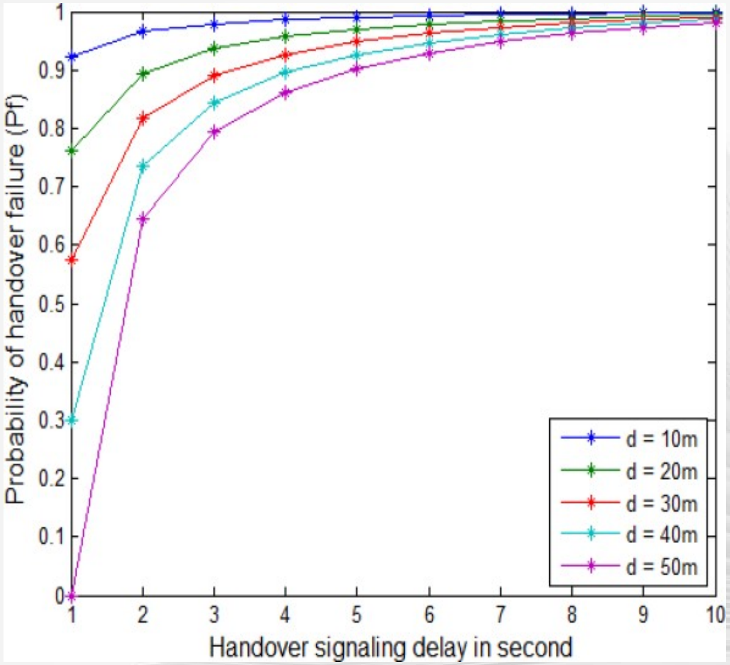



**Figure 6**: Relationship between probability of handover failure and speed for angle θ1 (more than 30 degree) and with handover signaling delay of 3 s

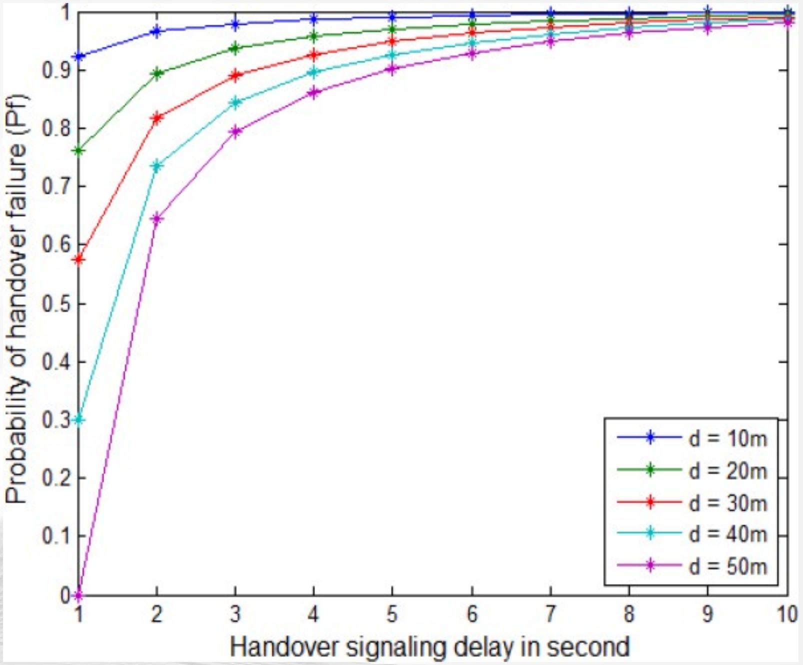
# RESULTS

PLOT

**Performance Evaluation of Handover Failure Probability for Different Handover Signaling Delay**




(a)




(b)

**Figure 7**: Relationship between handover failure probability and τ for (a) θ < 30° (b) θ >30°

# CONCLUSION

1. The study shows that when a fixed value of RSRPth is used, the likelihood of handover failure probability increases as the speed of the UE increase.
2. The failure of the handover increases with handover signaling delay increased for a fixed RSRPth value. Moreover, the analysis shows that an unnecessarily large value of RSRPth should not be used as it will later increases the probability of false handover initiation and hence, affected the performance of the system negatively.
3. For future research, we would propose to use an adaptive value of RSRPth for the initiation of the handover which will depend on the pace of the user and the handover signaling delay at a given time to minimize the failure while handover and at the same time to reduce the excessive load on the system which may occur due to false initiation of the handover.

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# THANK YOU