# EFFICIENT SON HANDOVER SCHEME FOR ENTERPRISE FEMTOCELL NETWORKS

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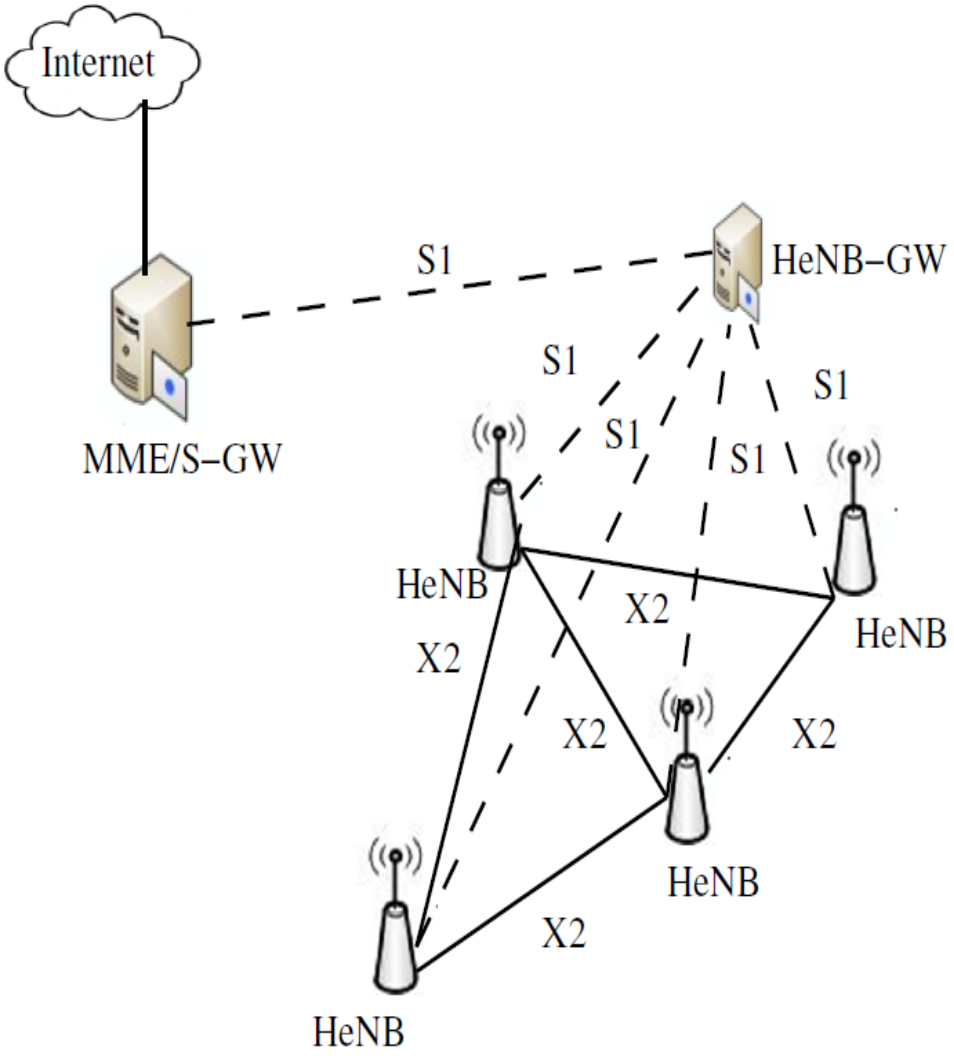
# Outline

- ✓ Introduction to LTE and Femtocells
- ✓ Handover Problems
- ✓ Existing solutions
- ✓ Proposed Solution: SON Handover algorithm
- ✓ Experimental Setup
- ✓ Performance Results
- ✓ Summary and Future Directions
- ✓ References

# Introduction to LTE and Femtocells

- 3GPP Long Term Evolution (LTE) is a standard for wireless communication of high speed data for mobile phones.
- LTE data rates: 100 Mbps downlink and 75 Mbps in uplink.
- WHAT IS A FEMTOCELL?
  - Small cellular base station
  - Limited transmission power
  - Limited user support (for home 8 users, for enterprise 16 to 32 users)
  - Plug and Play



# Self Organizing Network (SON)

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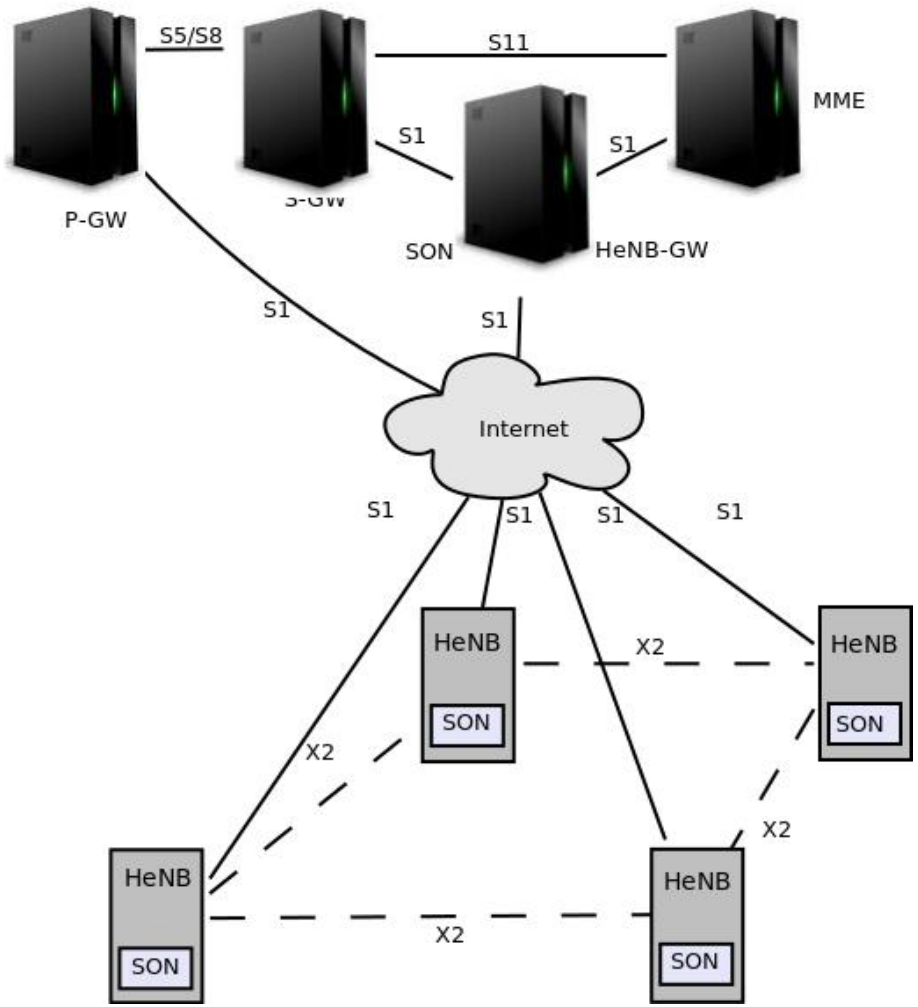
- SON Features
  - Self Configuring
  - Self Optimizing
  - Self Healing

- SON functionalities are executed as
  - Localized : based on local information at HeNB and UE
  - Distributed : based on information exchanged with neighbor HeNB (e.g.: via X2 interface)
  - Centralized : based on information available at HeNB-GW.
  - Hybrid : any combination of above

# LTE Femto Cell Architecture With SON




- Femto-GW (a.k.a HeNB-GW) with SON resides at operator. Femtocell (a.k.a HeNB) with SON resides at end user.

# Issue and Challenges

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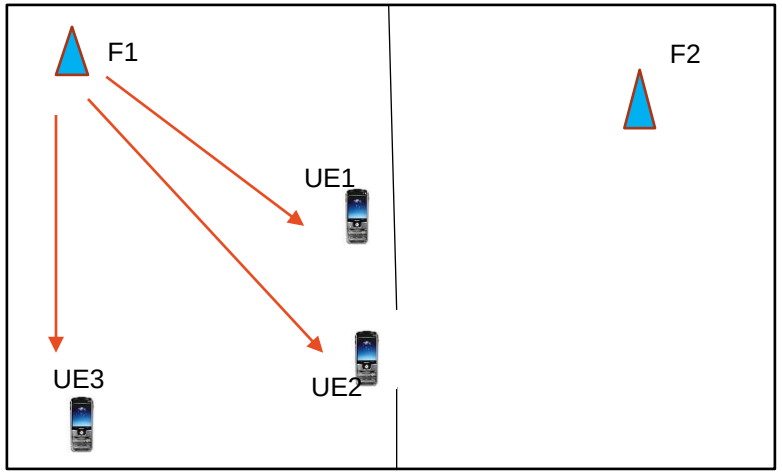
We face the following challenges inside a commercial building

- Interference from Macro and among Femtos.
- Unnecessary handovers inside the building.
- Battery consumption from UE side.
- Optimal Placement of Femtos inside building.
- Security issues

# Handover Problems

- Open (or hybrid) access mode of Femtos lead to frequent handovers.
- Handovers are unnecessary at regions, where user mobility is constrained.
- Unnecessary handovers can lead to loss of throughput, packet drop, high signaling etc.,



# Existing Solutions (Related Work)

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- Existing techniques for handovers deal with LTE Macro – Femtocell Network.
- Solutions using autonomic system[1][2], a self decision making system in Femto cell are proposed.
- Using autonomic systems needs additional computational capabilities.

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# PROPOSED SOLUTION

# Proposed Work: SON Handover Algo

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- SON located in HeNB-GW takes building information as input from operator
- SON of HeNB-GW communicate with SON at HeNB and passes building information.
- SON of HeNB extracts the room dimensions from building information.
- HeNB uses position reference signal to estimate UE position and calibrates the measurement with least square positioning algorithm [3][4].
- Estimated UE position after calibration, has an accuracy of + or – 0.2 meters.

# SON Handover Algo

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- SON gets estimated UE position from HeNB.
- SON verifies for handover happening regions based on the sub-regions in the room and UE position.
- After verifying for handover, SON allows Femto cell for handover decision
- Handover decision is performed using the equation,

$$\text{RSRP(t)} > RSRP(s) + HHMpingpong + HHMenergy$$

# SON Algorithm

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- Input 1: bInfo -> Building Information
- Input 2: uePos -> UE Poistion

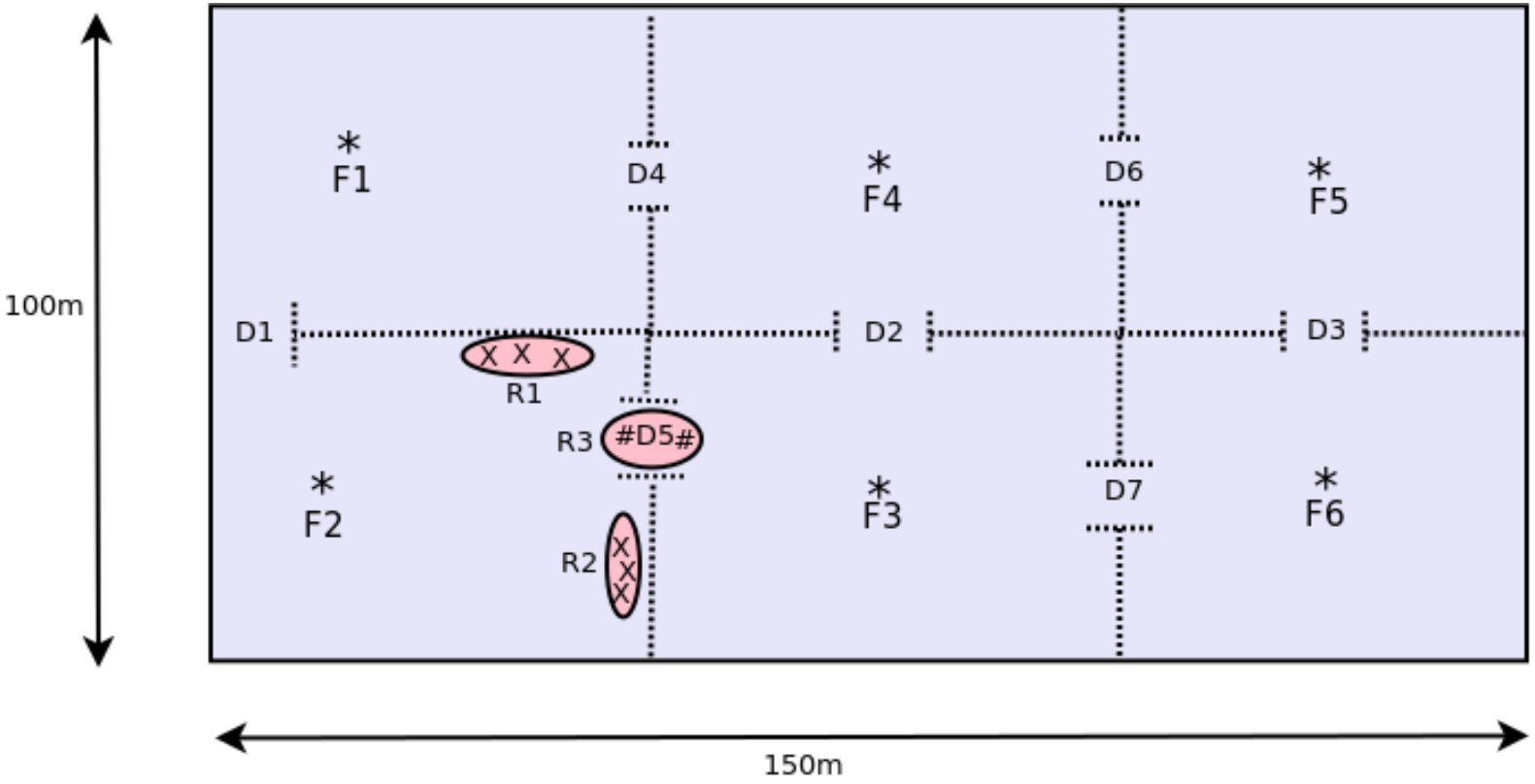
Step 1: Extract room dimensions along with entry and exit regions information

```
roomDim = GetroomCoords(uePos, bInfo);
entryorExit = GetEntryorExitInfo(roomDim, bInfo);
windows = GetWindowsInfo(roomDim, bInfo);
```

Step 2: Based on ue position allow for handover.

Step 3: If handover is allowed, Femtocell will take the handover decision.

# Example




- Handovers happening at regions R1 and R2 are unnecessary.
- At Region R3, handovers need to be allow.

# Experimental Setup

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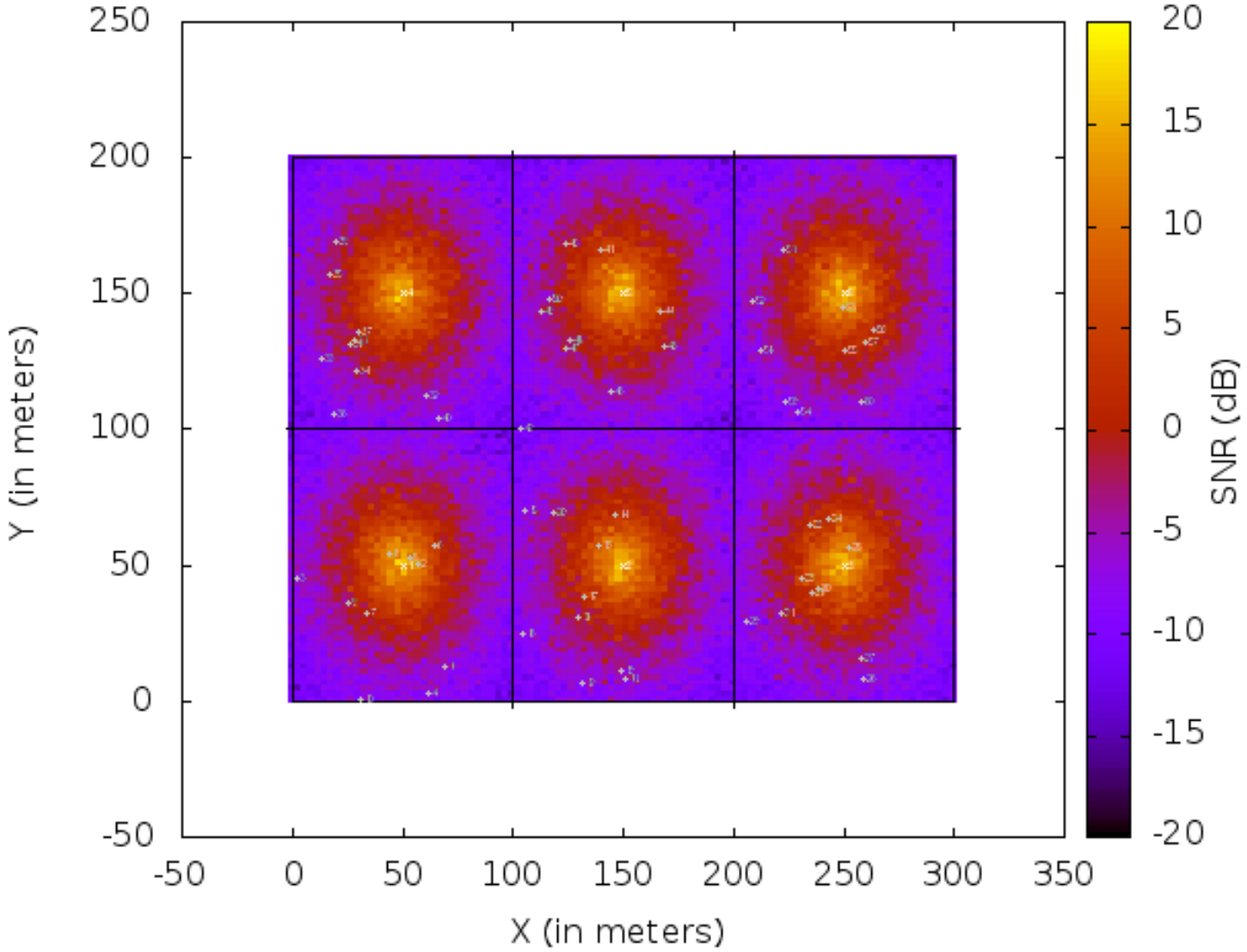
- The NS-3 simulator is used
  - ✓ Six rooms of an Enterprise buildings, each containing a Femto BS deployed randomly.
- UE speed is set to 1- 3 kmph
- As we are studying handovers, UEs move from one room to other room through exit regions.

# Simulation Parameters

| Parameters | Values |
|---|---|
| Number of Femto Cells | 6 |
| Number of UEs Per Femto | 10 |
| UE Deployment | Random |
| Femto Coverage Range | 60 m |
| Simulated Traffic | Downlink (CBR Video) |
| Mobility of UEs | 1 – 3 kmph |
| Mobility Model | Random walk Mobility Model |
| Building dimensions | 300 x 200 m^2 |
| Room dimensions | 100 x 100 m^2 |
| Exit area | 4 x 7 m^2 |
| Application Data Rate | 8kbps |
| Simulation Duration | 50 sec |

# SINR Heat Maps of Six Femtos in Femto Net



# Metrics

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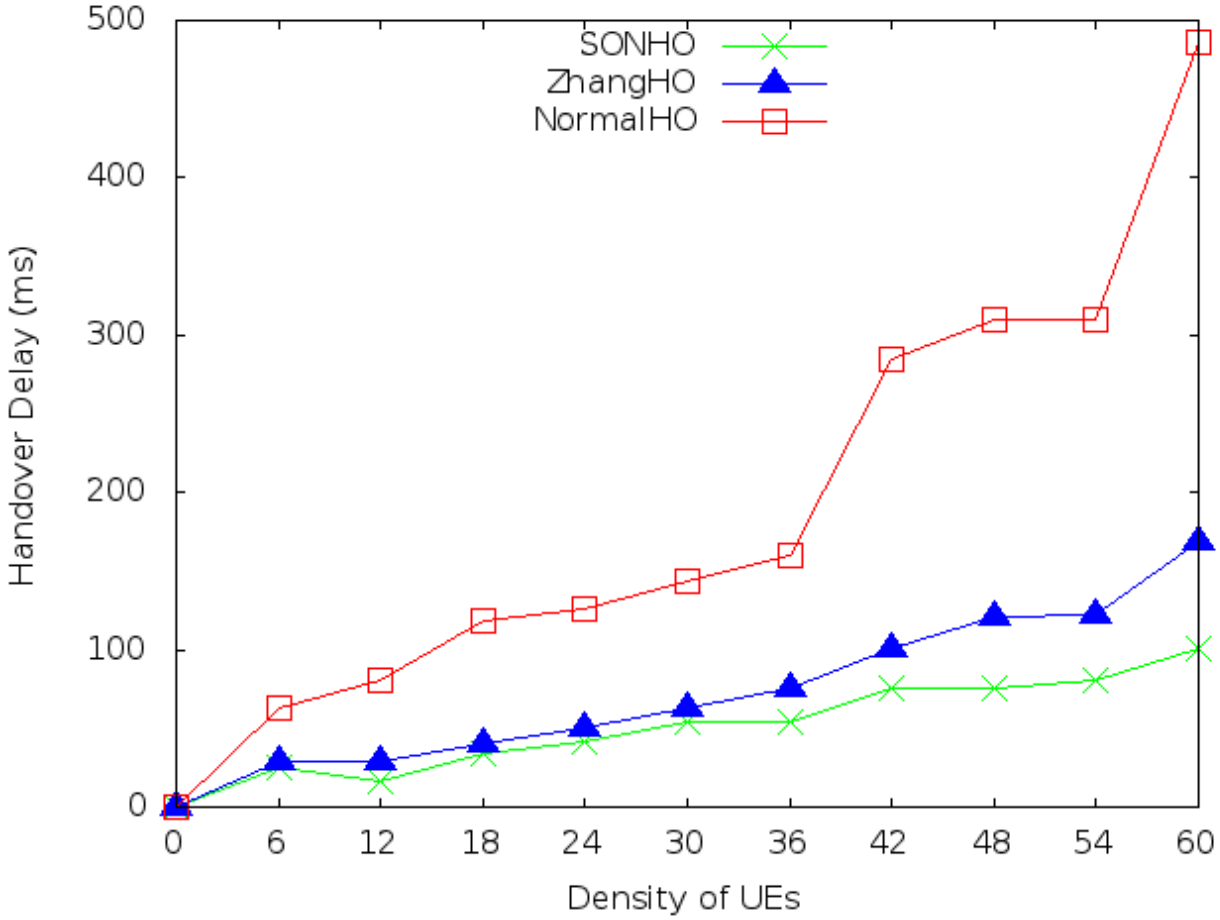
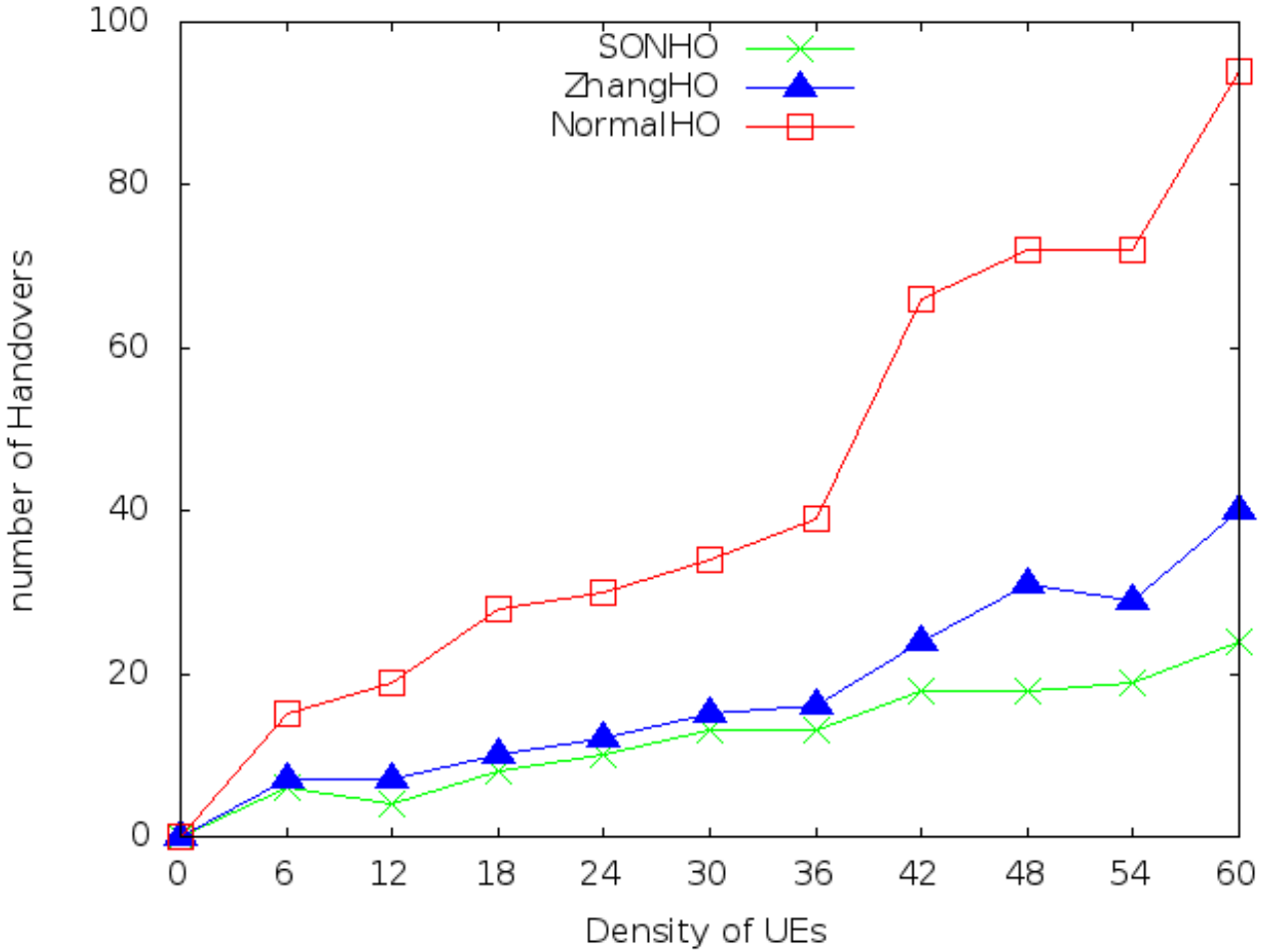
- Performance of proposed algorithm is measured with metrics
  - Number of Handovers (HO)
  - Handover Delay (HD)
  - Packet Drop Ratio (PDR)
  - Signaling Cost (SC)
- Algorithms used for comparison are
  - NormalHO
  - ZhangHO [5]

# Handover Delay



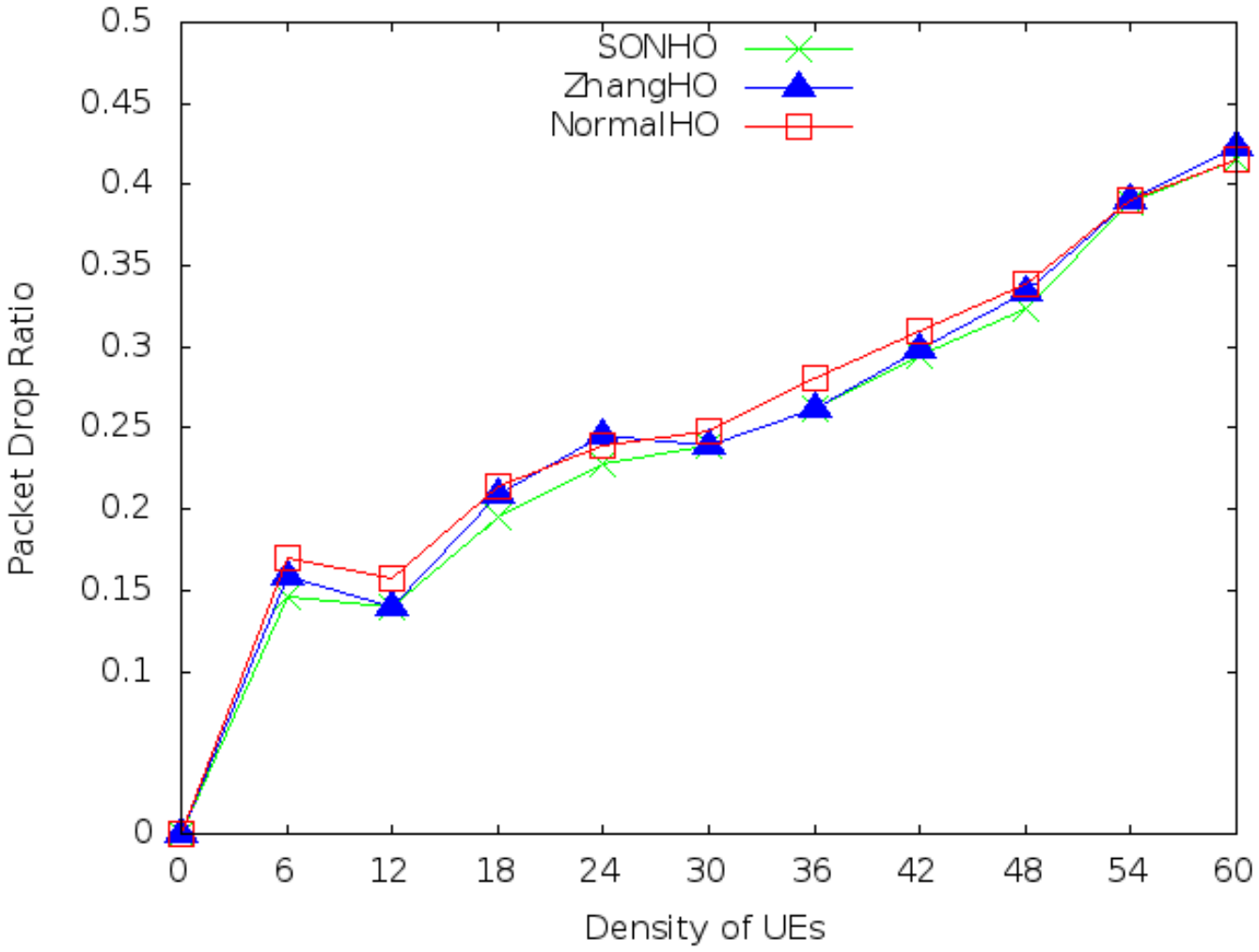

- Average Handover delay for indoor users is decreased by 31 % when SON algorithm is employed.

# Handovers



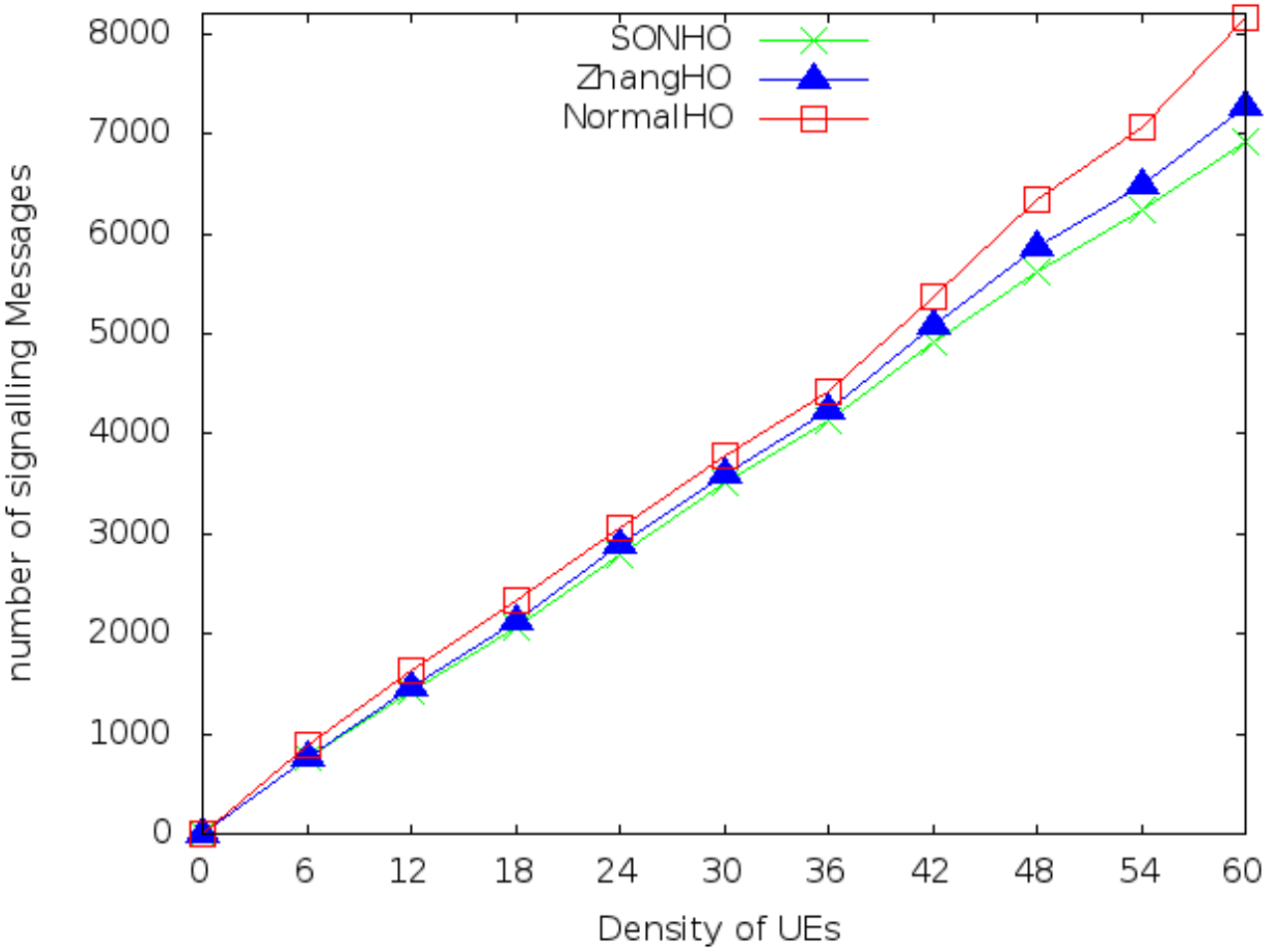

- Average number of handovers are decreased by 28% when SON algorithm is employed.

# Packet Drop Ratio




- Packet drop ratio during handovers is less when SON algorithm is employed

# Signals during handovers




- Signaling cost in the network is low when SON algorithm is used

# Summary and Future Directions

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- Proposed a SON handover scheme to improve the efficiency of handovers in enterprise Femtocell Network.
- Experimental results demonstrated superiority of proposed solution compared to existing solutions.
- Studying energy efficiency of UE with proposed solution.
- Studying load balancing factor while handover decision using SON.
- Applying and studying the performance of proposed solution in HetNets.

# References


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# THANK YOU!

## Feedback ?

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