EFFICIENT SON HANDOVER SCHEME FOR ENTERPRISE FEMTOCELL NETWORKS

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Outline

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✓ Handover Problems
✓ Existing solutions
✓ Proposed Solution: SON Handover algorithm
✓ Experimental Setup
✓ Performance Results
✓ Summary and Future Directions
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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)

- **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

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)

- 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.
PROPOSED SOLUTION
Proposed Work: SON Handover Algo

- 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 $\pm 0.2$ meters.
SON Handover Algo

- 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,
  \[ RSRP(t) > RSRP(s) + HHM\text{pingpong} + HHM\text{energy} \]
**SON Algorithm**

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

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

\[
\text{roomDim} = \text{GetroomCoords}(\text{uePos}, \text{bInfo});
\]

\[
\text{entryorExit} = \text{GetEntryorExitInfo}(\text{roomDim}, \text{bInfo});
\]

\[
\text{windows} = \text{GetWindowsInfo}(\text{roomDim}, \text{bInfo});
\]

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

- 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

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Femto Cells</td>
<td>6</td>
</tr>
<tr>
<td>Number of UEs Per Femto</td>
<td>10</td>
</tr>
<tr>
<td>UE Deployment</td>
<td>Random</td>
</tr>
<tr>
<td>Femto Coverage Range</td>
<td>60 m</td>
</tr>
<tr>
<td>Simulated Traffic</td>
<td>Downlink (CBR Video)</td>
</tr>
<tr>
<td>Mobility of UEs</td>
<td>1 – 3 kmph</td>
</tr>
<tr>
<td>Mobility Model</td>
<td>Random walk Mobility Model</td>
</tr>
<tr>
<td>Building dimensions</td>
<td>300 x 200 m^2</td>
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<tr>
<td>Room dimensions</td>
<td>100 x 100 m^2</td>
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<tr>
<td>Exit area</td>
<td>4 x 7 m^2</td>
</tr>
<tr>
<td>Application Data Rate</td>
<td>8kbps</td>
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<tr>
<td>Simulation Duration</td>
<td>50 sec</td>
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</tbody>
</table>
SINR Heat Maps of Six Femtos in Femto Net
Metrics

- 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]
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

- 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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