OPTIMAL FEMTO PLACEMENT IN ENTERPRISE BUILDING

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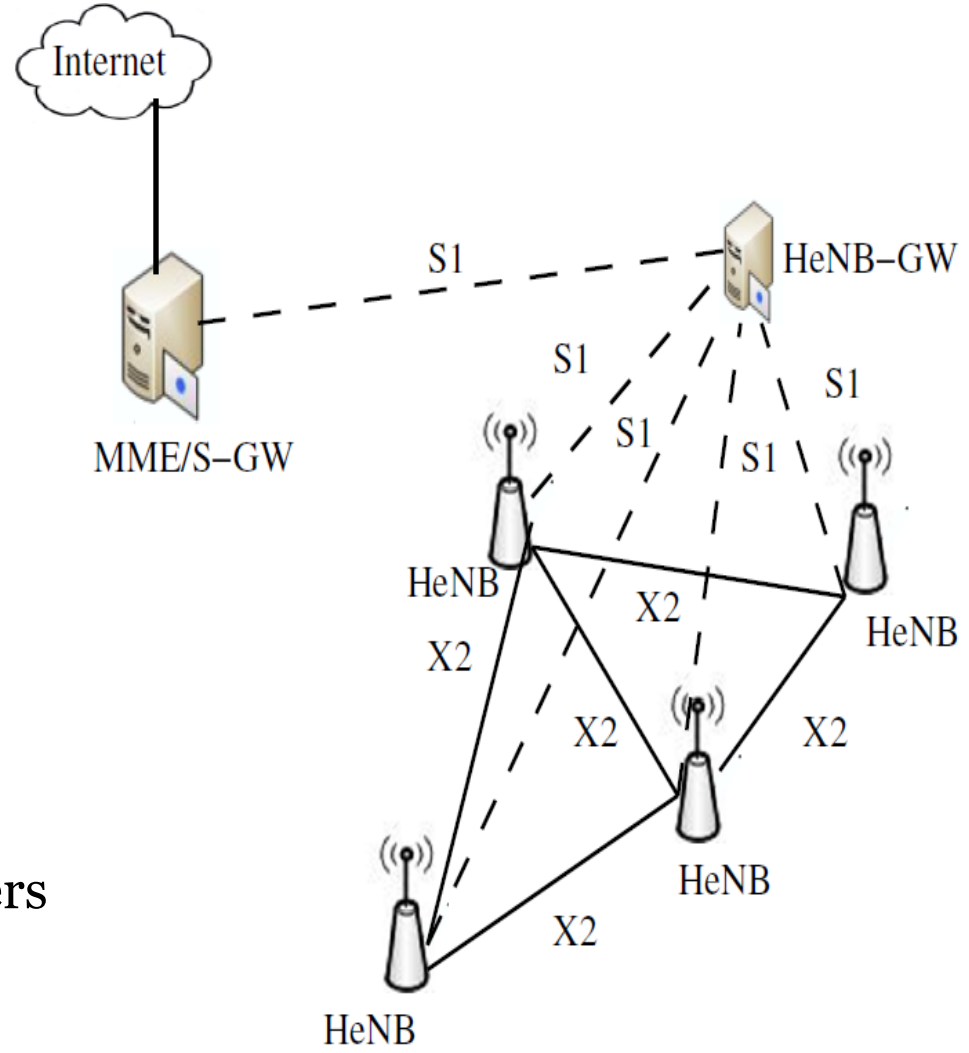
Background

- LTE data rates: 100 Mbps downlink and 75 Mbps in uplink
- In future video traffic will contribute to 70% of total cellular traffic
- 80% of traffic from Indoors
- Small cells can address growing Indoor traffic demands
- End-users install small cell base stations (a.k.a. Femto cell nodes) inside their homes/offices
- A home Femto can serve up to 7 end-users whereas enterprise Femto can serve up to 40 end-users
- A win-win situation for both telecom operator and end-users!



Issues and Challenges

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Femto cell deployments face the following issues and challenges in commercial buildings:

- Cross-tier and Co-tier Interference among Macros and Femtos
- Unnecessary handovers inside the building
- Energy efficiency from UE point of view
- Optimal Placement of Femtos inside building

Related Work

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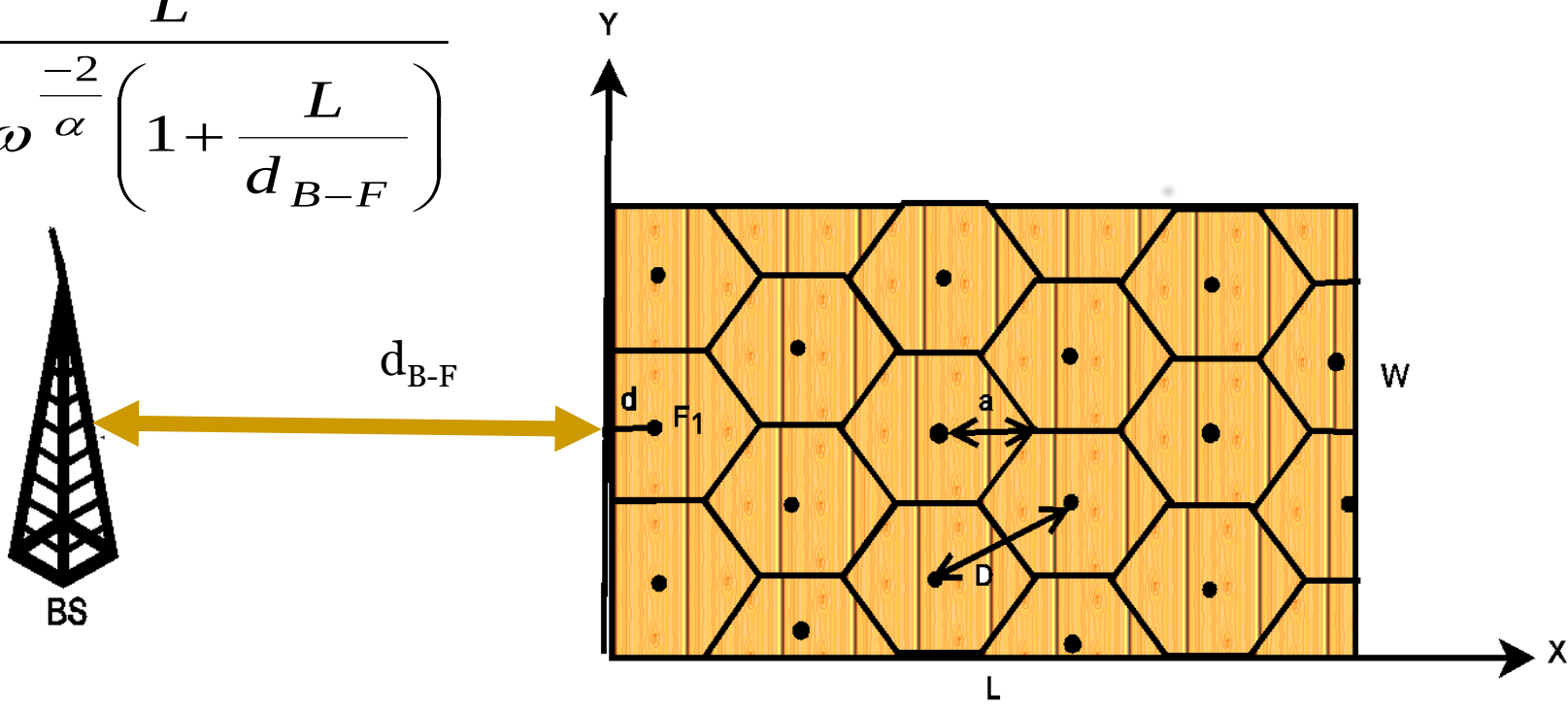
- Optimal Femto placement in an enterprise building does not consider the effect of macro base station interference on Femtos
- Proposed an automatic prediction technique for Femtos in heterogeneous network
- Queries like how many Femtos required and where exactly to place these Femtos are not addressed

Assumptions

- We assume that every Femto can service a Hexagonal Coverage Area (HCA). Within a given HCA of a Femto, SINR decreases along the distance r. At some particular distance (r = a), SINR reaches its threshold min (γ_{min}), where a is the maximum distance that can be covered by a Femto.

$$d = \frac{L}{1+\omega^{\frac{-2}{\alpha}}\left(1+\frac{L}{d_{B-F}}\right)}$$



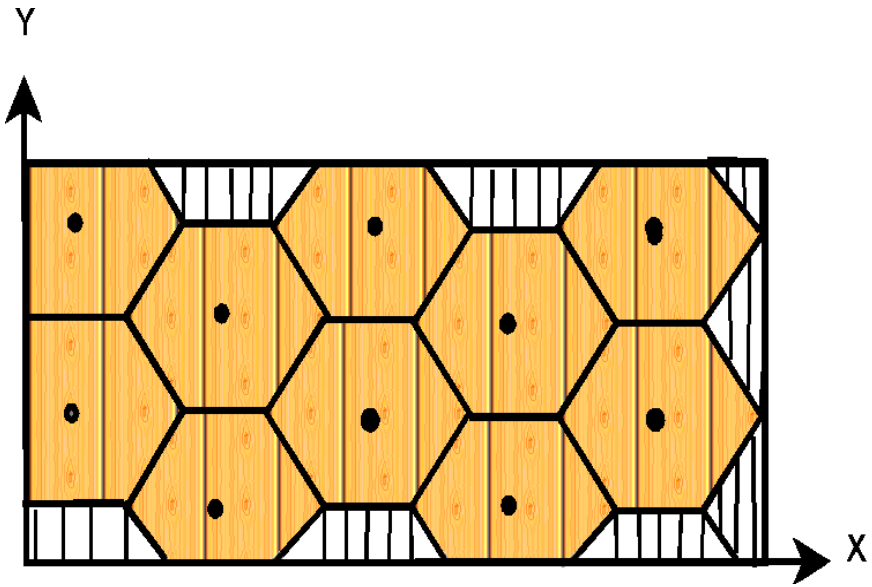
Assumptions

- Inter-distance relationship between femtos:

  $\sqrt{3}a \leq D \leq 2a$ where a is hexagonal radius for a given SINR threshold. D can be relaxed to 2a to assure min SINR value for all UEs.

- The area of the building is L X W and area of each HCA is $2.6a^2$ The minimum number of Femtos required is the lower bound of the relation given below.

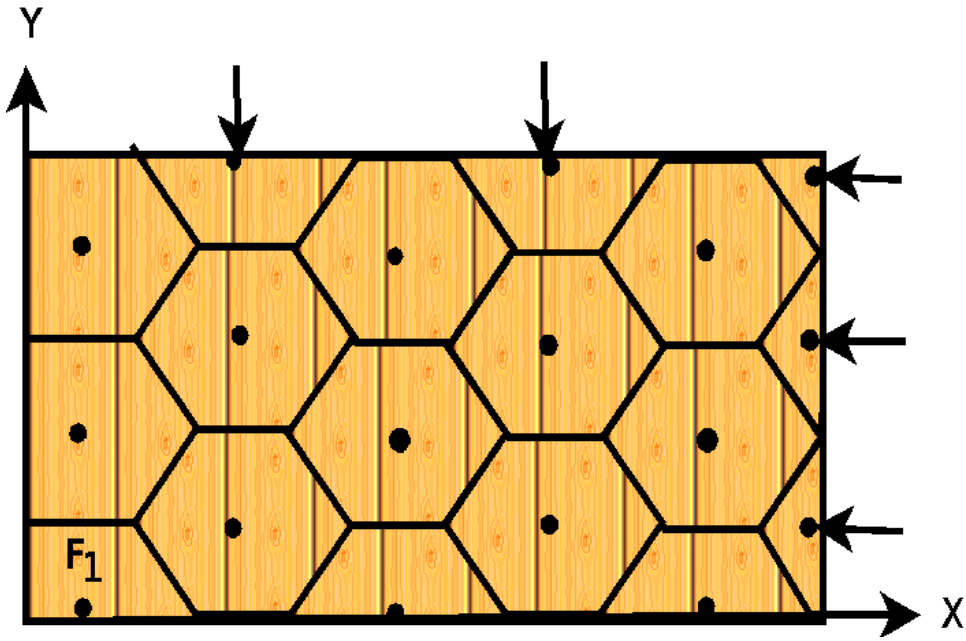
$$\left\lceil \frac{LW}{2.6a^2} \right\rceil$$



Continue…

- Required number of Femtos for a given length and width of the building depends on

$$\left\lceil \frac{LW}{2.6a^2} \right\rceil \leq M \leq \left\lceil \frac{LW}{2.6a^2} \right\rceil + \left\lceil \frac{L}{3a} \right\rceil + \left\lceil \frac{W}{\sqrt{3}a} \right\rceil$$



- Voids are created for every 3a distance along the length, and at every $\sqrt{3}a$ distance along the width. Hence, a maximum of $L/3a$ Femtos are required along length and $W/\sqrt{3}a$ Femtos are required along width.
- This value defines the upper bound of the relation.

Proposed Heuristic Placement Algorithm

- Input 1: $\gamma_{\min}$ (SINR-Threshold)
- Input 2: L,W (Building Dimensions)

Step 1: Obtain a (hexagonal radius) for given $\gamma_{\min}$ using

$$\gamma(r) = \log_{10} P_f - L_x - 10\alpha \log_{10} \frac{r}{x} - \log_{10} P_b$$

$$C = \min(\log_2(1+\gamma), 5.6)$$

Step 2: Obtain d to get X co-ordinates of the first femto by

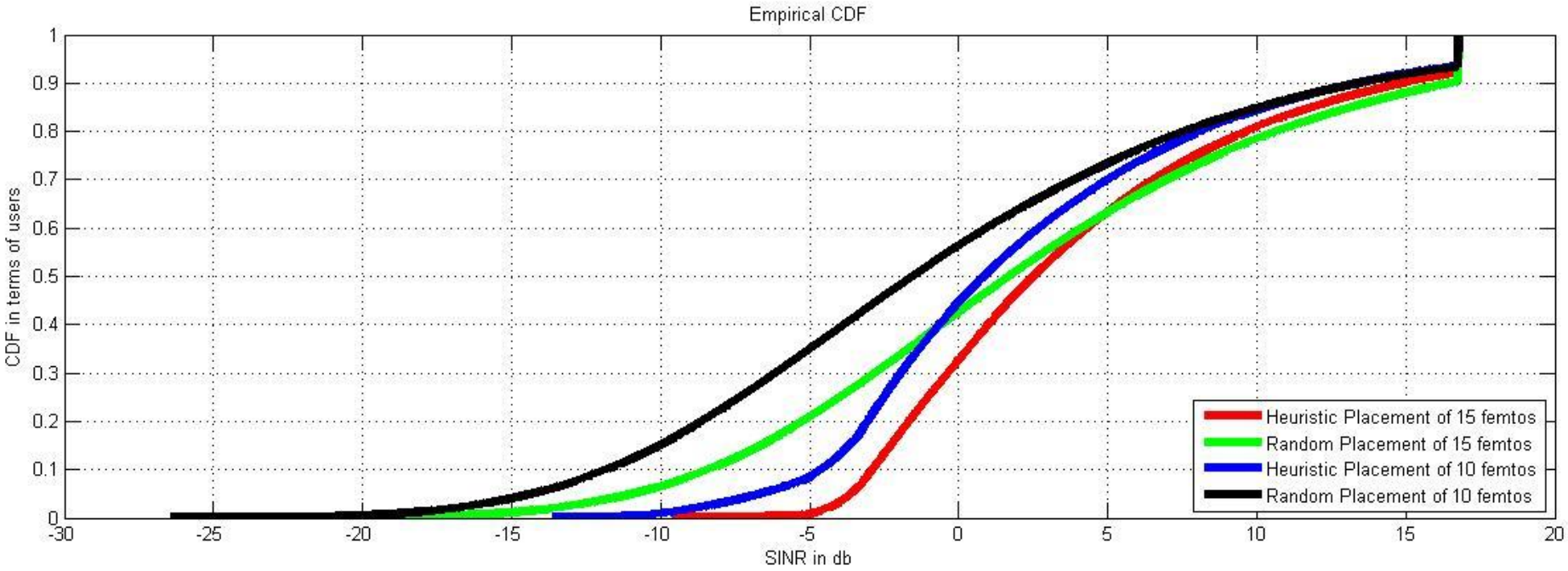
$$d = \frac{L}{1 + \omega^{\frac{-2}{\alpha}} \left(1 + \frac{L}{d_{B-F}}\right)}$$

Step 3: Fix Y co-ordinates of the first Femto and the total number of Femto (M) using equation

$$\left\lceil \frac{LW}{2.6a^2} \right\rceil \leq M \leq \left\lceil \frac{LW}{2.6a^2} \right\rceil + \left\lceil \frac{L}{3a} \right\rceil + \left\lceil \frac{W}{\sqrt{3}a} \right\rceil$$

Step 4: Plot HCA for all Femtos by extending first Fetmo HCA.

Performance Results



- Our proposed scheme offers 10% improvement in SINR when compare to random placement of Femtos.

Performance Results

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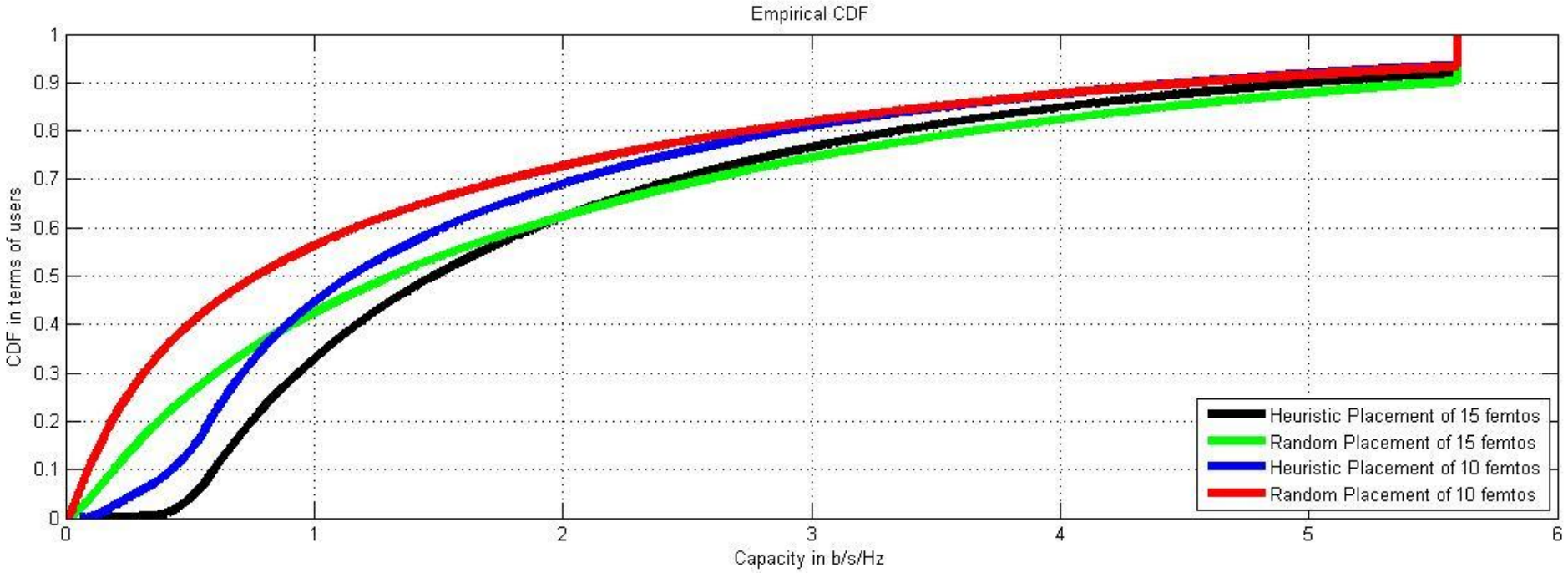

Conclusion and Future Directions

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- Our proposed algorithm ensures minimum number of Femtos and maintains a threshold SINR to all indoor UEs
- Considering interference between Femtos inside the building?
- Considering the placement of Femtos inside the building depending on UE occupant probability?
- The attenuation factor due to inner walls?

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THANK YOU!

Feedback ?

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