Dynamic Interference Management in Femtocells

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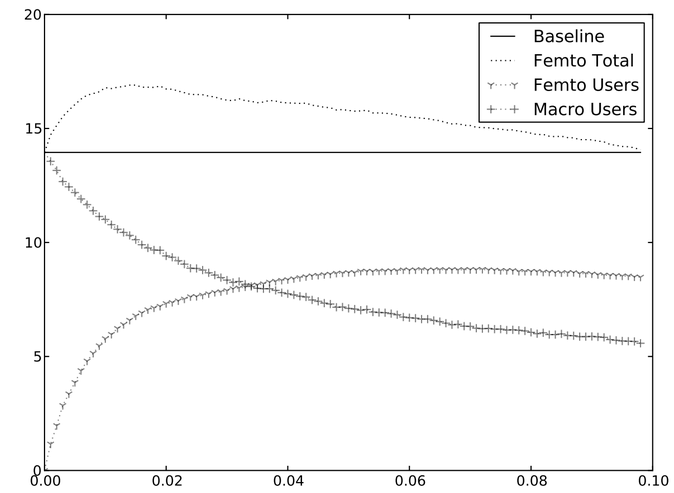
Introduction

- Femtocells are low power, low cost, user-deployed base stations
- They improve network coverage without costly macrocell upgrades
- Pilot signal strength determines femtocell coverage radius
- Interference from pilot signals reduces signal quality
- Tradeoff between coverage and interference from femtocell pilots
- We introduce dynamic algorithms to tune pilot signal strengths in dense femtocell deployments



Distributed Interference Management

- Femtocells measure the local radio environment:
  - $c =$ number of nearby femtocells (static measurement)
  - $d =$ user activity (dynamic measurement)
- When user activity is detected at a femtocell, it reduces its' pilot by:

$$\alpha = \frac{1}{2^{1+f(c,d)}}$$

- At the end of user activity, reset pilots

Distance-based Algorithm

- Femtocell pilots set based on target radius R_f
- Target radius set as $R_f = \frac{1}{2}\min\ distance(c)$
- Dynamic adjustment as in distributed algorithm
- Cooperative activity notification for in-use femtocells

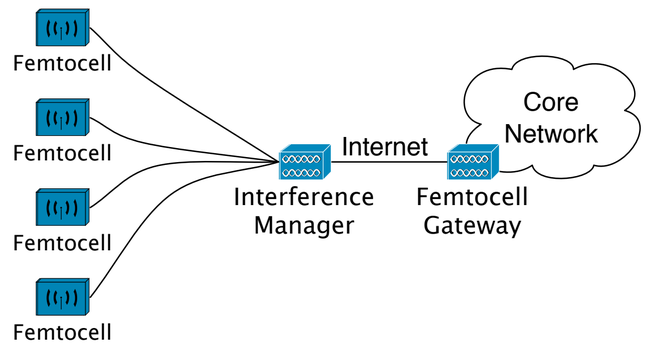
Measurement-based Algorithm

- Each femtocell requests that its neighbors adjust their pilots upwards or downwards by 3 dB if total measured interference at that femtocell is above or below a threshold
- Femtocells do not change their pilots in response to their own measurements
- Dynamic adjustments are made as in the distance-based algorithm

System Model

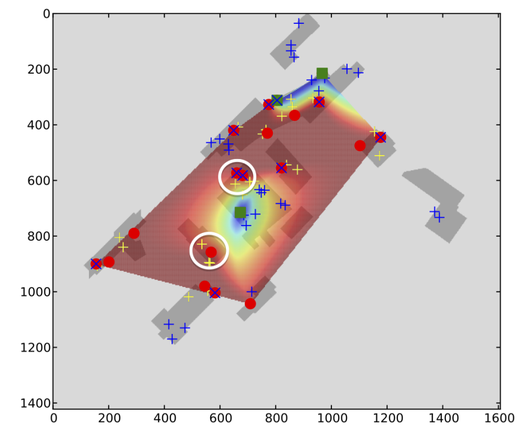
- WCDMA system in suburban and urban environments
- Random or hexagonal femtocell deployments on building interiors

Cooperative Interference Management

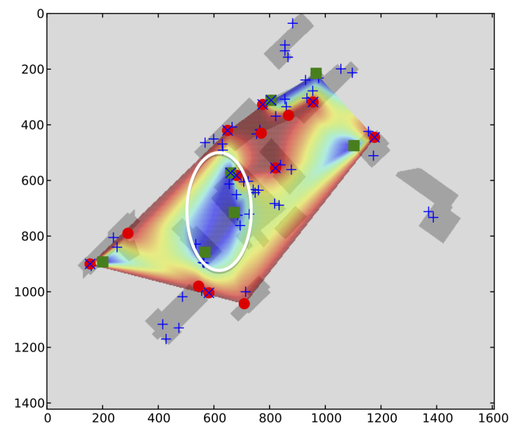


- Uses local interference management server to coordinate pilot strengths amongst femtocells
- Two *cooperative* interference management algorithms
- Set initial pilots and dynamically adjust them in response to user activity

Results



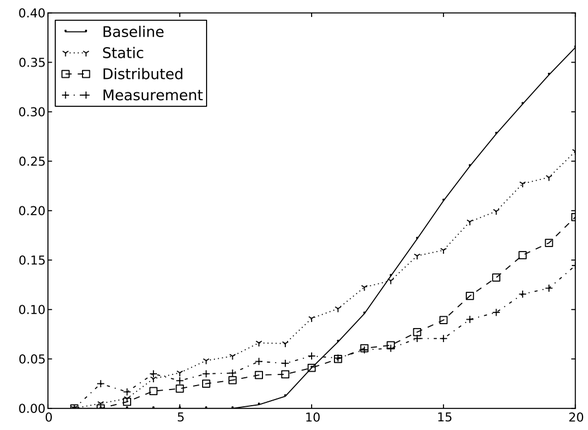
No interference management



Measurement-based algorithm

Environment	Suburban		
Distribution	Random		
Data Rate	64	144	384
Baseline	0.119	0.365	0.726
Static	0.093	0.26	0.566
Distributed	0.032	0.194	0.532
Distance	0.019	0.187	0.519
Measurement	**0.014**	**0.145**	**0.483**

Outage probabilities



Outage probability at 144 kbps

- Up to 85% reduction in outage probabilities
- Measurement-based algorithm is most effective overall

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