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### Femtocell : Is It the Future

Deepali Jhanji, Priya Garg

Student (B.Tech), Department of Computer Science Engineering, BPIT, Rohini, Delhi India

#### Abstract

The femtocell concept aims to combine fixed-line broadband access with cellular telephony using the deployment of ultra-low-cost, low-power third generation (3G) base stations in the subscribers' homes or premises. Femtocells are small cellular base stations that may be deployed in residential, enterprise, or outdoor areas. They utilize the available broadband connections of the users (e.g., cable or DSL) and typically have a coverage radius on the order of ten meters or more. Femtocell networks are considered to be a viable option that can fulfill the demands of high speed voice and data traffic for the indoor users. The cellular network operators need to modify the existing single tier macrocell network in order to provide the services of femtocells to its users. Femtocells are small cellular base stations that may be deployed in residential, enterprise, or outdoor areas. They utilize the available broadband connections of the users (e.g., cable or DSL) and typically have a coverage radius on the order of ten meters or more. Due to very short communication distances, femtocell networks offer significantly better signal qualities compared to the current cellular networks. This makes high-quality voice communications and high data rate multimedia type of applications possible in indoor environments.

**Keywords:** Femtocell, macrocell, broadband.

#### Introduction

Femtocells, despite their name, pose a potentially large disruption to the carefully planned cellular networks that now connect a majority of the planet's citizens to the Internet and with each other. Femtocells - which by the end of 2010 already outnumbered traditional base stations and at the time of publication are being deployed at a rate of about five million a year - both enhance and interfere with this network in ways that are not yet well understood. Will femtocells be crucial for offloading data and video from the creaking traditional network? Or will femtocells prove more trouble than they are worth, undermining decades of careful base station deployment with unpredictable interference while delivering only limited gains? Or possibly neither: are femtocells just a "flash in the pan"; an exciting but short-lived stage of network evolution that will be rendered obsolete by improved WiFi offloading, new backhaul regulations and/or pricing, or other unforeseen technological developments? This article overviews the history of femtocells, demystifies their key aspects, and provides a preview of the next few years, which

the authors believe will see a rapid acceleration towards small cell technology. In the course of the article.

#### Features

- High speed mobile communication (seamless handover)
- Licensed band
- Deployed by operator or customer MWNL Multimedia & Wireless Networking Lab.
- Closed Subscriber Group (CSG)/Open Subscriber Group(OSG)

#### Cognitive femtocell networks : An opportunistic spectrum access for future indoor network coverages

Femtocells have emerged as a promising solution to provide wireless broadband access coverage in cellular dead zones and indoor environments. Compared with other techniques for indoor coverage, femtocells achieve better user experience with less capital expenditure and maintenance cost. However, co-channel deployments of closed subscriber group femtocells cause coverage holes in macrocells due to co-channel interference. To address this problem, cognitive radio technology has been integrated with femtocells. CR-enabled femtocells can actively sense their environment and

exploit the network side information obtained from sensing to adaptively mitigate interference. We investigate three CR-enabled interference mitigation techniques, including opportunistic interference avoidance, interference cancellation, and interference alignment. Macrocell activities can be obtained without significant overhead in femtocells. In this article, we present a joint opportunistic interference avoidance scheme with Gale-Shapley spectrum sharing (GSOIA) based on the interweave paradigm to mitigate both tier interferences in macro/femto heterogeneous networks. In this scheme, cognitive femtocells opportunistically communicate over available spectrum with minimal interference to macrocells; different femtocells are assigned orthogonal spectrum resources with a one-to-one matching policy to avoid intratier interference. Our simulations show considerable performance improvement of the GSOIA scheme and validate the potential benefits of CR-enabled femtocells for in-home coverage.

The surest way to increase the system capacity of a wireless link is by getting the transmitter and receiver closer to each other, which creates the dual benefits of higher-quality links and more spatial reuse. In a network with nomadic users, this inevitably involves deploying more infrastructure, typically in the form of microcells, hot spots, distributed antennas, or relays. A less expensive alternative is the recent concept of femtocells - also called home base stations - which are data access points installed by home users to get better indoor voice and data coverage .

There are a few controversies around the deployment of femtocells. One of them was pointed out by an erstwhile colleague when he was trying to sort out his home phone issues. He got somewhat irate when the company suggested a femtocell. His gripe was that the Telco company was making him fix their black spots.

Of course, there are advantages to having a femtocell. One of these is that the coverage is likely to remain consistent wherever you are located in the office/home, due to the femtocell. This has the flow-on effect that your mobile terminal/phone won't use as much power, hence giving more battery time. A further advantage is that a mobile phone can be used as the main phone(s). Femtocells have the capacity to limit how many people are permitted to log on. This is a mechanism to restrict coverage. It makes using a femtocell in a small office attractive.

There are drawbacks. Femtocells utilise the broadband connection, which may also be used for other applications such as video streaming. There can be problems when the provider of the broadband service differs from the mobile network provider. These relate to Quality of Service guarantees. A further issue relates to interference. Although the deployment of femtocells suggests that interference with other femtocells is not a huge issue, there is still some controversy over whether this will continue to be the case.

The use of femtocells is part of a more general trend in mobile communications toward smaller cell sizes. Whilst there are some drawbacks to femtocells, the advantages of using them could be seen in homes and in small offices or home offices.

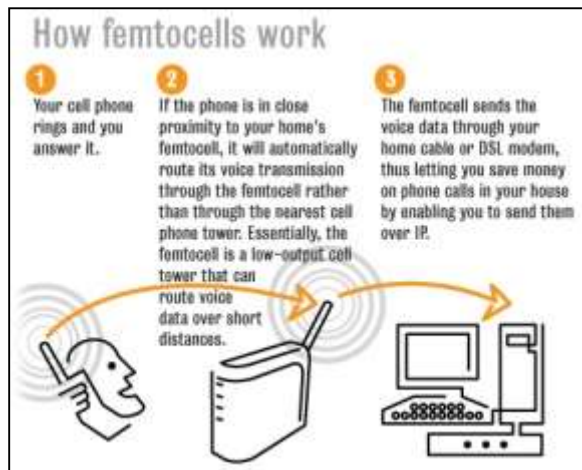


Figure1: Working of Femtocell



Figure2 :A Femtocell

**Advantages and disadvantages**

**Applications of femtocells**

- Connected Home • Remote control of home appliances • Home Security • Multi-media • Video Door Bell • Peer to Peer • Gaming Femto Aware Applications (Presence) • Camera phone to digital picture frame / home media server • Fridge Notes • Child monitor Many, many, many more ....
- Femto Services – Home Security • Femto detects presence of unknown mobile. • Turns on high def. security camera. • Alerts owner via SMS • {Sends alert to Police} • Delivers video to Internet • Creates log of mobile
- Video Doorbell • Waiting all day for a Service call • Worker arrives when you are away • Use femto based video server to see worker and authorize access from mobile device
- Connected Home Media • Femto detects arrival of user • Automatically downloads multimedia content from mobile to Home Server and from HS to Mobile. • Music • Pictures / Videos • RSS / Podcasts • DVR Programs • Digital Life...etc
- ‘Greater’ Femtocells • Not only for the home! • Femtocell economies of scale can deliver cost-effective deployments in offices and in high-traffic or low coverage locations • Femto in the enterprise and metrozone
- Scope for cost-effective access to rural and developing markets via appropriate backhaul solutions Macrocells – wide area coverage and mobility Enterprise femtocells Domestic femtocells Outdoor femtocells
- On the mobile handset . Cloud Connected Network Service Platform Home Services • Internet Femtozone Services Carrier Services.
- Femto Forum Services SIG Deliverables

### Future of femtocell

**Now lets imagine,** As you walk into your house, you press a button on your phone to turn on the living room lights. You aim your handset at your stereo system and play some Broken Social Scene. While sitting on your couch, you remember you need to bake a pot roast. No problem — you aim your phone at the oven and set it to 400 degrees. In the coming years we’ll be able to do this with femtocells, predicts David Nowicki, vice president of femtocell developer Airvana. The technology is currently being used to amplify cell-phone reception and

Wi-Fi signals, but Nowicki said the next logical step for femtocells is to get your household devices to interact with one another. "Your phone will be the coordinator of all your home devices," Nowicki said. Since a femtocell hub is primarily used in a home — and utilizing an internet bridge — it makes sense to eventually use it with other home appliances as well. Of course, Nowicki is thinking far ahead into the future, at which point virtually all devices will have an IP address.

The potential of femtocells will doubtlessly raise some concerns among users — the number-one worry being security. It would be a hacker’s dream come true to be able to transcend cyber-space sabotage by controlling a victim’s physical appliances. The imagined possibilities of femtocells are as frightening as they are exciting. But new technology always introduces new fears, and if this foretelling becomes a reality, we’ll likely have adequate security measures in place by then



Figure3 :Femtocell enabled home devices

### Conclusion

Femtocells have a key role in wireless services. They speed up launch of new services. Femtocell delivers significant performance improvements. It is reliable & has consistent coverage versus macro. It enables new services (Home Zone, Cloud, LBS, Mobile Advertising). Femtocell opens new markets for mobile operators: Enterprise PBX. It is a key launch pad for new services, building demand beyond the home and supports a business case for wider roll-out. Enabling factors defined via industry standards and the Femto Forum Femtocells

used in harmony with macrocell networks represent the best that mobile networks can be!

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	<b>Deepali Jhanji</b> Student (B.Tech), Department of Computer Science Engineering, BPIT, Rohini, Delhi India, E-mail: deepali.jhanji2931@gmail.com
	<b>Priya Garg</b> Student (B.Tech), Department of Computer Science Engineering, BPIT, Rohini, Delhi India E-mail : priya.901garg@gmail.com