

Proposal for Graduate Project Adoption of Femtocells in Wireless Communications

Cellular network



Node B
public antenna



Picocell
local commercial repeater



Femtocell
home base station

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Purpose

The purpose of this project is to explore the use of femtocells in assisting wireless service providers as they expand network coverage and capacity. The project will focus on four key elements regarding femtocell adoption. The first part will investigate the capacity issue for wireless service providers and how this can be potentially solved. The second aspect will provide a technical analysis to determine what issues femtocells solve and what problems they create. This section will also compare competing technologies such as Wi-Fi which could provide similar services to femtocells, but at a fraction of the cost. The third part will explore the economic and business aspects, as these are the core drivers of femtocell adoption and a key to determine whether this technology will succeed. The fourth part will investigate the issues of open access introduced by femtocells as unrestricted wireless access is set to play a major role in the future. Overall, this project will investigate whether femtocells are the future for wireless communications and whether they will unite both wireless and wired services.

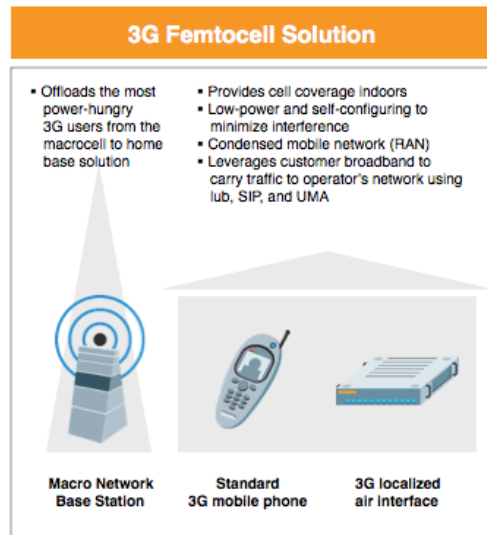
Background

The two major limitations of wireless communication are range and capacity. Currently when a wireless service provider wants to improve their coverage and capacity they either install a cell site that covers a wide geographical area or one that targets an extremely dense population such as a football stadium. The motivation to install these new cell sites is driven by economics. A wireless carrier would rather install a new site that will improve the coverage and performance for a large number of customers compared to a remote site which would only help few clients. This is the exact reason why cellular service is far superior in areas of high population density compared to areas of low density. The variable nature of wireless communications makes it impossible to offer a high level of service and reliability to every customer. This is where femtocells become an attractive solution.

Femtocells in their most basic form are miniature cell sites. Instead of providing service over miles like traditional cell sites, femtocells provide service just over a couple hundred feet. The goals of femtocells are to provide a household with reliable wireless communication using the household's existing broadband Internet connection. The femtocell fixes the issue of

unreliable RF coverage while also freeing up capacity on the wireless carrier's network.

Wireless carriers can now greatly improve the satisfaction of customers in areas of poor coverage with minimal capital investment.



Femtocell offloads usage indoors



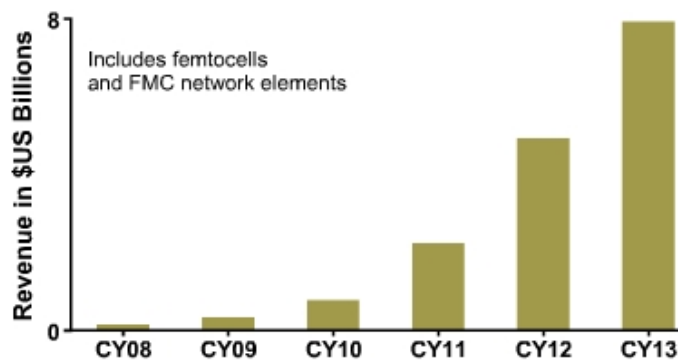
Similar in size to Wi-Fi Router

Currently, wireless service providers are either testing or have already marketed femtocells to their customers. The largest wireless carriers in the United States such as Verizon Wireless, At&t, Sprint, and T-Mobile all have femtocells on the market. All of these products are targeted towards customers in poor RF areas looking to improve their coverage. Currently customers have to pay a premium to use the femtocell service and this usually includes an equipment purchase and a monthly service charge. To entice customers, service providers have added unlimited calling plans when customers call from the areas served by their femtocells. Overall, femtocells haven't seen high growth and are considered a niche item for customers living in challenging RF coverage areas.

While femtocell adoption hasn't exploded, estimates show that this will soon change. According to Infonetics Research, it is estimated that in just five years, femtocells will represent more than a \$5 billion market. Where will this growth come from if wireless carriers continue to expand their cellular footprints? The growth of femtocells are expected to be driven by the wireless carriers need for additional capacity. As high speed wireless communication continues

to become more mainstream, wireless carriers are running out of wireless spectrum to meet the growing consumer demand. Additionally, wireless spectrum is limited and is only offered in occasional government auctions as steep prices. Adding to the pain is technology is nearing the theoretical limits of what can be achieved given a certain bandwidth. Wireless carriers have a dilemma; either purchase more spectrums at extremely high prices or find ways to better utilize existing spectrum. The latter option is the one which most experts believe will drive femtocell growth. Instead of wireless carriers spending billions of dollars on purchasing additional spectrum, they could deploy femtocells to offload cellular capacity when users are indoors. As more consumers receive faster broadband services offered by fiber to the home and fiber to the neighborhood, the performance of mobile devices using femtocells will be far superior to that of the cellular network. The massive bandwidth that fiber optic based broadband provides makes it possible to support numerous cellular users over a single residential Internet connection. With studies showing that approximately 50% to 60% of all cellular traffic originates from indoors, femtocells have the potential to make a large impact in the future.

The FMC and Femtocell Equipment Market Is Growing Fast, Nearing \$8 Billion in 2013



© Infonetics Research, *FMC and Femtocell Equipment, Phones, and Subscribers Biannual Market Size, Share, and Forecasts*, March 2009

Potential for huge growth in the future

Approach

This project is examining four aspects related to femtocells which are crucial for their adoption:

- 1) **Is there enough RF spectrum to support the needs of the wireless industry?**

The CTIA, the Wireless Association representing companies in the US, recently stated that they need an additional 800MHz of spectrum to support future growth. The FCC chair, Julius Genachowski, told the CTIA that it was one of his top four priorities to free up additional spectrum for 4G cellular communications. Even if some spectrum is freed up, is this enough to support the future of growth of wireless communications? Additionally is it economically viable for companies to purchase additional spectrum? Shannon's law dictates the theoretical maximum bit rate given a limited bandwidth and signal to noise ratio, and experts in the industry claim that existing technology is coming close to reaching this limit. The answer to these questions will help determine whether femtocells become popular in expanding cellular capacity or if they remain just a tool to extend wireless coverage.

2) How do femtocells work and what are the technologies and issues associated with them?

This section will investigate the inner workings of femtocells and the many technologies and options that wireless carriers have in deploying these devices. The impact of femtocells on cellular network capacity will be extensively examined to see if these devices can actually prolong the use of existing spectrum resources. The issues pertaining to femtocells will also be investigated as they lack many capabilities of a fully fledged cell site, at the same time consumers expect them to provide similar service.

3) Does the deployment of femtocells make business and economic sense?

Femtocells are expected to have massive growth, but this will only occur if there is an economic benefit. Currently, femtocells are being deployed solely to improve coverage and consumers are paying a hefty price to purchase one. As spectrum becomes scarcer, will it make sense for wireless service providers to start providing these devices for free? Will femtocells become a household norm, just like Wi-Fi routers have for broadband access? Can femtocells provide additional revenue and value for wireless carriers? These crucial questions will be examined as they define whether femtocells will be successful.

4) What role will femtocells play in providing open access for wireless service providers?

As open access is seen as the future for the wireless industry, will femtocell play a part of this vision? Many wireless service providers use the same technology, but currently femtocells are locked to specific wireless carrier. Consumers would like the ability to use multiple wireless service providers with a femtocell and not be limited to a single provider. The key question is whether femtocells will be open access so they work with multiple service providers. Open access could spur the use of new wireless companies which would solely provide access using femtocells. These femtocell providers would be similar to today's VOIP providers except that they would utilize customers existing phones and would be available wherever femtocells are present.

Work Sited

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