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Femtocells: A Review

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Abstract: *Femtocell is nothing but a small cellular station meant that to enhance service quality and afford value added services within a home or a small business. Femtocells connect to service provider's network via broadband such as DSL or cable. Femtocell essentially routes mobile calls over internet. A Femtocell allows service providers to broaden service coverage indoors, specially where access would otherwise be restricted or occupied. This is true in many homes where wireless signal cannot reach inside or there is poor signal strength due to security or physical obstructions. For Fixed Mobile convergence (FMC) femtocells plays an important role. Traditional Fixed Mobile convergence requires make use of of dual mode (WiFi) handsets but with Femtocell, ordinary cellphones can be used for FMC. One of the most considerable advantages of Femtocell for the wireless operator is that by directing home mobile calls on the internet, operators can free of charge up the wireless network. In rising markets, wireless network congestion rates point to the idea that Femtocells would be a boon in such locations. On the reassurance of Femtocells, one can believe of them as fundamentally "mobile taking on WiFi". Femtocells High Speed Download Packet Access (HSPDA) inside or pack high-speed 3G technology, which can have 7Mbps downloading speed.*

Keywords: *Communication network, 3G, mobile core network, Broudband Router, HNB.*

I. INTRODUCTION

Femtocell is a small cellular base station installed in homes and offices that can combine mobile and internet technologies within the home[1]. As femtocells are even smaller than the nanocells, hence its output power is very low, even less than 0.1 watt. The objective of this paper is to provide a comprehensive overview of femtocell technique to be used in future mobile broadband networks to provide better mobile data experience. In this paper, we have discussed the need, concept and Benefits of femtocell. Also, we have discussed the advantages of femtocell over Wi-Fi and challenges in implementing femtocell service[2]. Femtocells are considered an important element of Fixed Mobile Convergence (FMC). Traditional Fixed Mobile convergence requires use of dual mode (WiFi) handsets but with Femtocell, for FMC ordinary cellphones can be used. One of the most major reward of Femtocell for the wireless operator[3] is that by directing home mobile calls on the internet, operators can free up the wireless network.

Necessity-

- Reduced in-home call charges.
- Excellent indoor coverage.
- Lower-cost voice voice and data services
- High-quality coverage
- Low-cost voice and data call

- Reduced churn
- Network cost reduction
- Low power

Femtocell is a very small, low cost base stations whose transmit power is very low. These devices are integrated to small plastic desktop and wall mounts cases that are powered from the customer's electricity sockets [4]. Femtocell backhaul connection is via customer's internet connection that can be DSL, or cable modem or any other [3] (see Figure 1 and Figure 2).

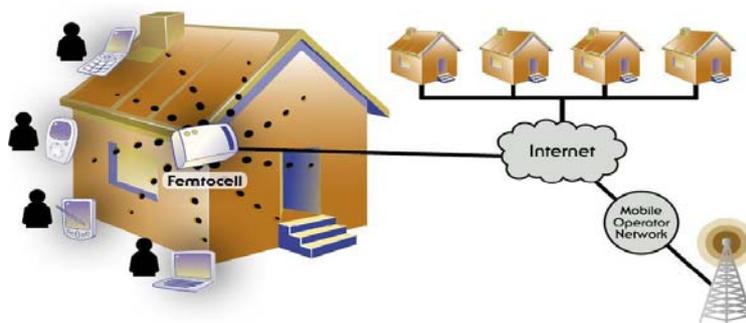


Fig. 1. Femtocell Diagram

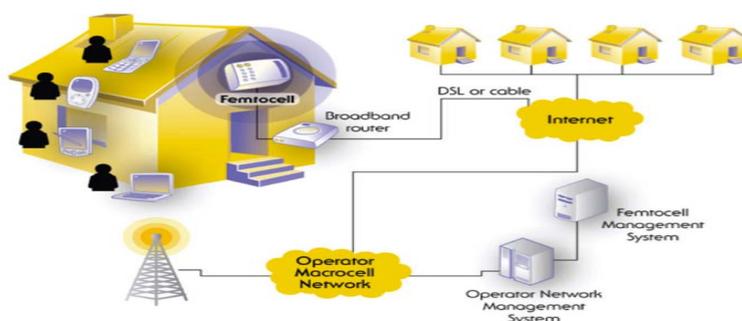
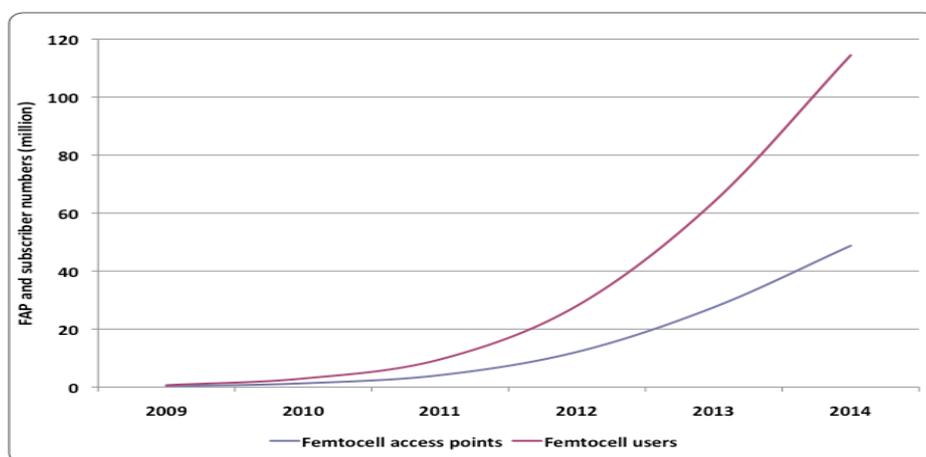


Fig. 2. Femtocell Architecture

Operator licensed spectrum works with the help of 3G femtocell. It connects mobile device to 3G network that phone uses outdoors. But for this 3G femtocell access point must be connected to a broadband internet connection. Hence it completes voice call or data session by connecting to operator's network through the broadband connection [5]. Hence there is no need to make any modifications or change any settings in a standard 3G handsets. When users are indoors, cell phone connects to femtocell instead of searching for an external base station and calls are smoothly handed off between inside and outside cells as the users move. It also increases battery life of user's handset as mobile phone is latched with minimum 6 BTS's (Base Transceiver Station) at a time and out of which 1 is selected which has maximum RX Level (Range) and this latching process will be done by Femtocell device [6,7].



Graph 1. Femtocell access point and user forecasts [8] Source: Informa Telecoms & Media

Femtocell technology is extending within the home environment and several operators are launching dual femtocell access points for enterprise environments and consumer. The sales of fixed-mobile convergence (FMC) network elements as well as femtocells are expected to record a compound annual growth rate (CAGR) according to Infonetics Research of 86 percent from 2009 to 2014. The similar is supported by the Informa Telecom and Media (See Graph 1) [3,8].

II. SYSTEM DEVELOPMENT

2.1 Femtocell Network Architecture -

US : Kineto Wireless announced today its full support for the 3GPP agreement reached last week on the Home NodeB (HNB) architecture[9] for femtocell-to-core network connectivity. Recognizing that a criterion is essential for the mass-market success of femtocells, Kineto took a lead role in developing consensus among the causal companies. Having an agreed architecture grades a major milestone towards the achievement of a global 3G femtocell standard.

Developing an industry-wide standard requires a tremendous amount of cooperation between operators and vendors, with all parties causal their information and experience to build up the best possible solution. The femtocell consistency attempt within 3GPP provides a great example of such collaboration, with the approved architecture merging key attributes of the 3GPP UMA/GAN-based approach proposed by Kineto with other companies' proposals to create an optimized architecture capable of supporting mass-market femtocell deployments. The agreed 3GPP HNB architecture[9] follows an access network-based approach, leveraging the alive Iu-cs and Iu-ps interfaces into the core service network. The architecture defines two new network elements, the HNB Gateway (a.k.a. Femto Gateway) and the HNB (a.k.a. Femtocell). Between these elements is the new Iu-h interface.

- *Home NodeB (HNB)* : Connected to an existing residential broadband service, an HNB gives radio coverage for pattern 3G handsets[4] within a home. HNBs integrate the capabilities of a standard NodeB as well as the radio resource management functions of a standard Radio Network Controller (RNC).
- *HNB Gateway (HNB-GW)*: Installed within an operator's network, the HNB Gateway aggregates traffic from a large number of HNBs back into an existing core service network through the standard Iu-cs and Iu-ps interfaces.
- *Iu-h Interface*: The Iu-h interface because of residing between an HNB and an HNB-GW. Iu-h interface includes a new HNB application protocol (HNBAP) for enabling highly-scalable, ad-hoc HNB deployment. The interface also introduces an well-organized, scalable method for transporting Iu manage signaling over the Internet.

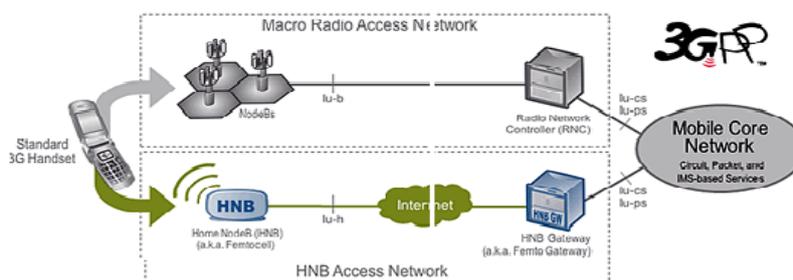


Fig. 3. System Architecture

2.2 Femtocell synchronization-

- Need to learn the summary of the fundamentals the femtocell synchronization i.e. why femtocell synchronisation is needed and how it can be easily achieved. Femtocell synchronization is an important aspect of their design. Reasonable levels of femtocell synchronisation required by many aspects of their operation.
- Reasons for femtocell synchronization-

- Synchronisation occurs in a number of areas of femtocell operation and frequency accuracy if they are to be able to operate satisfactorily.
- Supply frequency information to handsets: It is not possible for the handsets or user equipments to archive the level of frequency accuracy that can be achieved by base station. As a result, the handsets synchronization to base station.
- Ensure reliable handover: If the femtocell is not synchronized to the network, and the adjacent base-station, then a variety of offsets may exist that would make any handovers fail or become disrupted.
- Interference reduction: By having all base stations synchronized the levels of interference can be reduced. Higher levels of interference can reduce call quality and reduce the network capacity.
- Ensures femtocell to be attentive of adjacent cell sites: If the femtocell is accurately synchronized to the rest of the network it can detect other cells more quickly and thereby improve the operation of the femtocell.

2.3 Addressing Technology Challenge-

- The successful deployment of femtocell technology can bring great rewards, but require that broadband operators overcome diverse technology challenges.
- Operators face significant challenge with the deployment of new technology, new applications and the ever-increasing usage demands placed upon mobile networks. At the forefront of these challenges is marking 3G coverage [4] as “near ubiquitous” as practically possible, both outdoors and indoors.
- The traditional 3GPP 3G network architecture, complete up of abundant macro base-stations, with its centralized RNC function and ATM backhaul was designed to provide wide-area coverage. It was not however designed to scale, physically or economically, to provide effective coverage for individual indoor/residential situations.

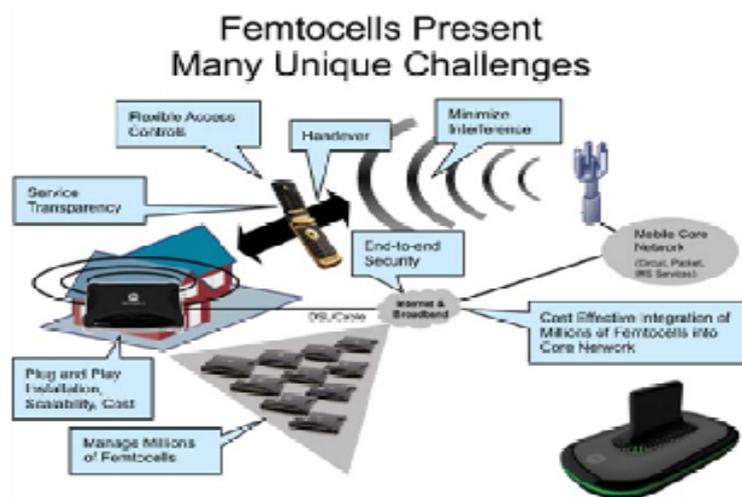


Fig. 4. Femtocells Present Many Unique Challenges

When subscribers at home connect to the wireless operator’s mobile network over existing network infrastructure, it allows operators to make mobile communications truly pervasive, creating long-term bonds with subscribers that minimize churn and enabling new revenue opportunities from bundle mobile and broadband service packages.

Broadband operators can make a compelling value proposition for partnering with mobile operators. A coverage and economic perspective familiar within the mobile telecommunications industry that the draw on of outdoor macro-cells to provide indoor/residential coverage quite simply does not provide an effective solution. It also impacts practical matters, such as site acquisition, which is becoming increasingly problematic.

Not only is site acquisition costly, forming a most significant fraction of network build-out costs, it is also very time consuming because many local authorities closely regulate the sale and usage of potential call-sites. Considering suitable sites can be acquired, increasing cell-site density through the use of smaller cells may not overcome all coverage issues but will lead to increased backhaul costs and other practicality issues[10].

People are becoming increasingly reliant on their handset device to the coverage that it forms part of their uniqueness. Similarly, more people would favour one device to handle all their communication requirements, be it in the home or somewhere else. Many end-users prefer to use their mobile phone indeed take for granted, the convenience that the mobile phone provides: primarily in terms of mobility, but also through the convenience of having a single device that includes their contacts and even takes and store their messages in a variety of formats[11].

3G signals, operating at very high frequencies and high bandwidths, penetrate through structures poorly. This often leads to service quality and service experiences that do not meet end-user expectations and can lead to disappointment, condensed minutes of use, increased customer churn and ultimately, lost revenues.

Coverage provided by macro base station settled by most end-users of 3G services[4] serving their location at that place and time where stationary out in the world, in a building or while on the move. 3G and building, or to be precise their fabric, are inherently not a good mix because of the issues associated with providing coverage for indoor situations from macro base-stations are well known. Since late 2006, interest in femtocell solutions[12] has increased to the extent that most industry analysts suggest femtocell deployment will become widespread in the coming years.

III. DESIGN OF FEMTOCELL

Having considered the major drivers for femtocell deployment, here looks at some of their practical aspects. Femtocells overcome the issue of providing effective indoor coverage from the 3G-macro layer by their placement in the end-users' homes. Once installed in the home, a femtocell will enable the cable operator to provide higher-quality and higher-performance wireless voice and 3G data services in and around the immediate vicinity of the home environment[13].

Femtocell products are in many ways similar to Wi-Fi access points in that they enable access through an unobtrusive device; however femtocells enable full 3G service delivery in the home. Similar in size to a cable modem, a femtocell is a low-capacity base-station which radiate only sufficient power to cover the area of a home surroundings. Open 3GPP-based standards through the end-user's household broadband internet connection rather traditional cellular backhaul methods with the help of operator's core network of femtocell.

The key features that are considered as the characteristics of femtocell in the design of femtocell.

Low-impact – Many times there is a limitation for some households. So that results obtained by femtocells must be physically minute, preferably aesthetically pleasing and simple to place. Furthermore, they should also be still in operation, create low levels of heat production and reasonably priced to run in terms of on-going [electricity] cost.

Low RF power – The transmit RF power output of femtocells is low as it is in between 10 and 100 milli-watts. In perception, this is a lesser power level than many Wi-Fi access points, which can be particular up to 1 Watt of production power. Moreover, by being close up to the femtocell the 3G handset is itself able to transmit at lower power levels than it might otherwise have to when on the macro network.

Capacity – Femtocells are aimed at delivering dedicated 3G coverage to a household and in doing so can provide a very good end-user experience within the home environment. As a result, femtocells have a design "capacity" of up to 6 end-user.

Low-cost – There is major contest for access solutions in the home space. Wi-Fi is routine, simple to set up/arrange, supply a very high-quality yardstick in terms of presentation, and are extremely cost effective. Femtocells will be accessible for acquire via their Operators. This may be straight or through resellers.

Energy offset - Low-power conservation – obviously if the end-user is to base the bill for the electrical energy consumed by the femtocell base-station then this figure must be low enough not to raise concerns as to its crash on the fuel bill. Suppose that , from an Operator’s viewpoint, this OPEX is effectively offloaded, which makes the industry case for femtocells yet more gorgeous.

Easy end-user installation – Femtocells will be installed by consumers and activated through facility providers like DSL routers and cable modems. This resources that the Operator no longer has to utilize mechanism teams or have a truck-roll every time a new femtocell is “deployed”. From the end-user perspective the unit must be a simple “plug and play” installation with a minimal amount of intervention required.

Backhaul via broadband– Femtocells exploit Internet protocol (IP) and flat base-station architectures. Backhaul correlation to Operator networks will be through wired broadband Internet service existing in the home. Here are no connections mandatory to the wider cellular network other than through the IP core. This will advantage Operators by efficiently offloading traffic that would otherwise be on the macro-layer straight onto the internet from the femtocell; this not only reduces the load on the core network but also lowers the cost of delivering wireless traffic when compared to the macro network.

Interference - The utilize of femtocells in spectrum also currently used by the macro layer may, if not managed accurately, offer rise to issues with interference between cells; macro with femtocell and in the instance of close proximity of two or additional units, femtocell with femtocell. Operators will likely want to launch femtocells on the same channel as their macro cell network for capacity reasons.

Handovers - Current macro RF planning techniques are unfortunate for femtocells. Not slightest because of the sheer potential numbers of femtocells and managing the neighbor lists that would be necessary. Also the possible to “ping-pong” between layers, particularly as an end-user moves around the home and enters into areas where the signal potency from the macro-cell is superior than that of the femtocell, must be measured very carefully to ensure that the networks provide the best overall coverage without apprehension. To demonstrate, in macro based 3G networks the transparency related with soft-handovers accounts for a important amount of RNC processing capability. Justifiably then and in order not to worsen the issue, great care and complicated algorithms are necessary to overcome these potential issues and ensure that the over-all network quality is not impacted by inefficient handovers and wasted capacity.

Security - Given the requirements for low-cost and easy mechanism, the utilize of the broadband internet as the network boundary becomes very easy to appreciate. However this raises sanctuary risks in that broadband internet has release access. There are a variety of approaches to address this issue including the embedding of the Iub interface within the IP signalling itself while network security is managed by the IP security (IPSec) protocol.

Worldwide cellular network standards support – Understandably femtocell merchandise are likely to appeal to many end-users about the world. As a consequence differing models will be developed and accessible to suit the a variety of that needs from the dissimilar regions. The products will proffer maintain for their own and alive (3GPP) UMTS and (3GPP2) CDMA standards. WiMAX, LTE and UMB are the rising standards.

Support for existing 3G handsets and devices – Support for existing handsets and devices is a very important consideration for the end-user and Operator alike, not slightest since of the cost of changing devices if that were essential. In each expertise market, femtocells will support existing handsets and devices further helping to drive uptake of 3G services and femtocells in exacting.

Operation (transmit/receive) in Operator-owned spectrum – Femtocells operate in licensed spectrum owned by Operators and may share the same spectrum (currently the 2100MHz frequency band) with the macro network.

Operator controlled – Femtocells operate in licensed spectrum and as such Operators must make confident that they obey with the conditions of that license and any other controls enforced by a controller. To these ends femtocells attribute client software that enables remote configuration and monitoring through an Operation, Maintenance and Provisioning, Administration system in a alike way to that used by the macro network.

New services and applications – Femtocells are likely to become an integral part of managing all communications in and out of the house surroundings. Operators of femtocells allow to cost-effectively offer in-home pricing and integrate mobile services into triple-play / quad-play service contributions. Femtocell architectures consist of provision for a services environment on which applications may be supplementary, thereby facilitating new revenue opportunities.

Service Assurance – Remote Management to enable an operator to provide the end-user quality of service at the edge of the network.

IV. APPLICATION

4.1 DSL Modem:

The step is to integrate the femtocell into an existing DSL broadband modem design. No additional external connections[11] are needed – the modem will already have power and data connectivity, and regularly a catalogue of other pattern description too. The femtocell component is hardwired into the modem and can be given priority of voice calls to ensure improved performance[14].

The overall cost of the combined unit is much less than two part boxes, it is the relieve of setting up and remote management which profit this option. Many mobile operators have underway offering DSL broadband as an added service, mainly in Europe. If the extra cost of a combined modem/femtocell is acceptable[12], then this could be shipped to customers as division of a enclose.

4.2 Cable Modem:

More households in the USA receive their broadband internet service from their cable TV supplier than from the phone company. The modem can be separate from the TV Set-top box or a combined unit. In US, the large Cable TV companies, such as Comcast, beforehand had agreements to resell mobile services on the Sprit network. This networks appears to have been discontinued in the manner. Though Cable TV companies do personal some spectrum (via the Spectrum Co) business, and so could lawfully launch and operate a rather than conventional mobile phone[14].

V. FUTURE SCOPE

Femtocell market struggled in the first half of 2012. After that market has been bounced back in the second half of the year. Shipments reaching slightly above 2 million units and this rising updated with ABI Research's latest femtocell in 2012. In the second half of the year shipment is double from first half which creation up for some of the lost momentum.

The forecast covers the enterprise and consumer femtocells market, with venture femtocells making up one-third of the entirety shipments. On the former hand, revenues from enterprise femtocells completed up to two-thirds of the total revenue for femtocell access points. NEC/Ubiquisys , Alcatel-Lucent, and Airvana remained the top vendors in terms of shipments making up 78% of the total shipments in 2012. These result are element of ABI Research's Enterprise and Consumer Femtocells and Mobile Enterprise Technologies Research Services.

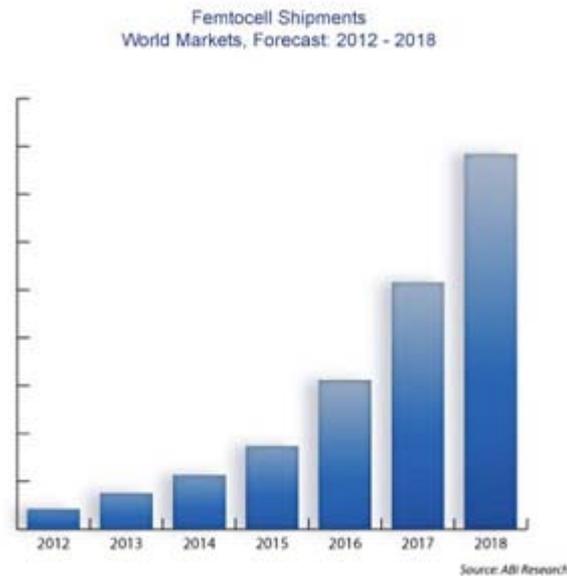


Fig. 5 . Femtocell Shipment

Femtocells have the possible to offer high-quality network access to indoor users at low cost

- improve coverage
- Provide huge capacity gain

From technical standpoint, some challenges shall be overcome

- New network architecture
- Interference mitigation
- Synchronization
- End-to-end QoS support
- Seamless handover support

Femtocells are an alternative way to deliver the benefits of Fixed Mobile Convergence[18]. The distinction is that most FMC architectures require a new (dual-mode) handset which works with existing home/enterprise Wi-Fi access points, while a femtocell-based operation will work with existing handsets but requires fitting of a new access point.

References

1. The Femto Forum (2010), "Wireless in Home & Office", [Online] Available: www.femtoforum.org
2. Amit Kumar, Divya, Tanvir Singh, Dr. Sawtantar Singh Khurmi "Femtocella- A review" IJCST(International Journal of Computer Science and Technology)Vol. 2, Issue 3, September 2011
3. Tanvir Singh, Amit Kumar, Dr. Sawtantar Singh Khurmi, "Scarce Frequency Spectrum and Multiple Access Techniques in Mobile Communication Networks", IJECT Vol. 2 Issue 2, June 2011
4. Mikko Jarvinen, "Femtocell Deployment in 3rd Generation Networks", Espoo, Finland, 03 June 2009.
5. Tiejun Ma, Peter Pietzuch, "Femtocell Coverage Optimisation Using Statistical Verification". [Online] Available: <http://lsds.doc.ic.ac.uk/research/doc/networking11-coverage.pdf>
6. Cisco (2010), "Cisco Femto Solution". [Online] Available: http://www.cisco.com/en/US/solutions/collateral/ns341/ns523/ns941/solution_overview_c22-597334.pdf
7. CNN Money (2011). "4G won't solve 3G's problems". [Online] Available: http://money.cnn.com/2011/03/29/technology/4g_lte/index.htm
8. Informa telecoms & Media (2011), Femtocell Market Status. [Online] Available:http://www.dolcera.com/wiki/images/Informa_Femtocell_Market_Status_Q1_2011.pdf
9. White Paper,"Femtocell-The Gateway To Home",Motorola,[Online]Available:http://www.motorola.com/web/Business/Products/Cellular%20Networks/Femtocell/_Document/Static%20Files/Femtocell_Gateway_to_Home_WP-%20FINAL.pdf

10. Se-Young Yun, Yung Yi, Dong-Ho Cho, and Jeonghoon Mo(April 2012),”The Economic Effects of sharing Femtocell”,IEEE journal on selected areas in Communications,vol 30,no 3,April 20112
11. Cisco,”Cisco visual networking index:Global mobile data traffic forecastupdate,20102015,”February2011,http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html
12. Analysis Of Femtocell-Opportunities and challenges,School Of Integrated Technology,Yonsei University,June 2011
13. Se-Young Yun, Yung Yi, Dong-Ho Cho, and Jeonghoon Mo(April 2012),”The Economic Effects of sharing Femtocell”,IEEE journal on selected areas in Communications,vol 30,no 3,April 20112
14. Cisco,”Cisco visual networking index:Global mobile data traffic forecastupdate,20102015,”February2011,http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html
15. Analysis Of Femtocell-Opportunities and challenges,School Of Integrated Technology,Yonsei University,June 2011
16. Femtocell – A Review, Amit Kumar, Divya, Tanvir Singh, Dr. Sawtantar Singh Khurmi, IJCSTVol. 2, Issue 3, September 2011
17. Cognitive Femtocell-Future Wireless Networks fir indoor Application,IEEE Vehicular technology Magazine.March2011

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