Addressing the Data Offloads Issue through Femtocell in Wireless Networks

Parvinder Kaur
Centre for Development of Advance Computing (CDAC), Mohali, Punjab, India

Abstract: Wireless data usage continues to increase at an exceptional pace due to the new types of user terminal and applications. As the demand keeps increasing, the capability of current networks will be put at stake in the next few years. One of the major challenges is still the delivery of high throughput at cell edge, indoor and dead-spots, which requires rethinking network paradigms. One of the recent trends is the introduction of femtocells, initially targeting deployments in residential and corporate environment, to get better indoor voice and data coverage, whilst offloading at the same time macrocell traffic and promising to be a cost-effective solution. Femtocells are called to be an integral part of high-performance next-generation wireless systems, (LTE and WiMAX networks) while keeping the seamless connectivity and mobility of conventional cellular networks. In this paper, we have discussed femtocells as a possible solution for data offloads including the concept of data offloading, health & safety issues and present & future market for femtocells.

Keywords: Femtocell, Data Traffic, Access point, Mobile Communication Networks.

I. INTRODUCTION

Capacity demands of modern mobile telecommunication networks are increasing year by year. People all over the world are using not only more voice call services but also a growing amount of data services with their cell phones. This is, consequently, driving the need for continued innovations in wireless data technologies to provide more capacity, high speed connections and generate large amounts of data traffic to the network along with higher quality of service.

The vendors have to constantly come up with solutions to make the best of the limited radio resources: space and spectrum. Microcells and nanocells as well as distributed antenna systems (DAS) have also been used to improve coverage inside buildings, basements and subway tunnels. These solutions are effective but also expensive. Femtocells offer a different approach to these challenges. Femtocells are low-power access points that can combine mobile and Internet technologies within the home. The femtocell unit generates a personal mobile phone signal in the home and connects this to the operator's network through the Internet. In this we shall discuss how data can offload with the help of Femtocell [1].

Femtocells are small cellular base stations that are installed in homes and offices and connect to a service provider's network via broadband. They work with any kind of cell device and use the same standards and protocols as external "macro" cells. When users are indoors, their cell phone or data card connects to the femtocell instead of searching for an external base station. Calls are smoothly handed off between inside and outside cells as the user moves [5].

Femtocells are aimed at providing high performance voice and data communications in and around the immediate home environment.Fig. 1 shows the diagram of Femtocell.

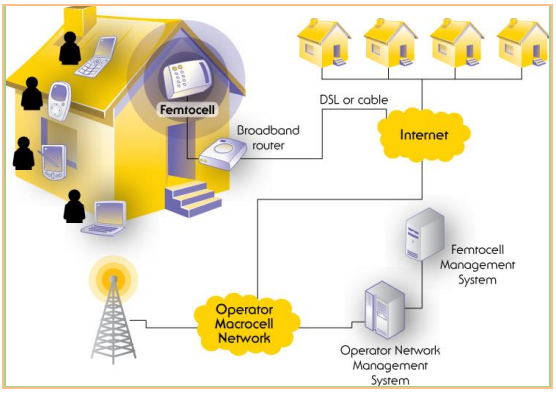

Fig. 1: Femtocell Diagram [5]

II. DATA OFFLOAD

The concept of data offload is very simple. In a traditional cellular network all of the traffic to and from mobile phones, mobile internet devices (MID), and mobile broadband enabled laptops travel from the device to a cell site that is typically a fraction of a mile away (in the city) to several miles away (in suburban or rural areas). Offload means that some other device – either a femtocell or a Wi-Fi router – carries that traffic from the phone/MID/laptop over an alternative network (typically a DSL or cable broadband connection) to the operator and/or to another internet destination. The effect of data offload is that the total traffic traveling over the operator's wide area radio network is reduced. Reduced traffic means reduced network cost (reduced capital investment and reduced operating expenses) for the operator [1,2,4]. Data usage occurs primarily indoors (i.e. home, office, and public places). According to Informa's 2008 report Mobile Broadband Access at Home3, 55% of data usage occurs in the home and 26% occurs in the office. The percentage of traffic indoors has been increasing over time and is expected to increase further. Fig. 2 shows the Expected Macro-Cellular Data Offload by Country in 2010-25. Indoor traffic demands greater radio resources from the macro-cellular network

than outdoor traffic because signals from the macro-cellular site must penetrate one or more walls to reach the indoor subscriber. Therefore, the benefit to the macro network is actually greater than the percentage of traffic offloaded, because those subscribers whose data is offloaded are not average users; they are the most demanding users, because they are all sitting behind radio-wave absorbing walls, which make them harder to reach than the subscriber sitting outdoors on a park bench.

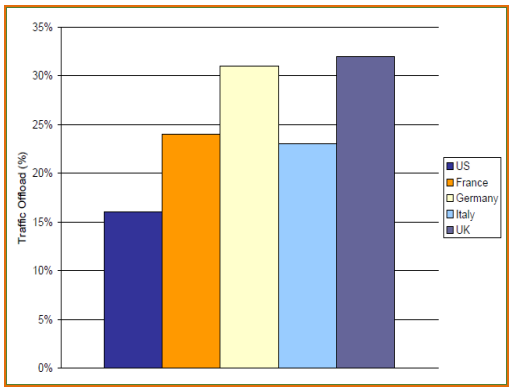

Fig. 2: Expected Macro-Cellular Data Offload by Country in 2010-25

III. STRENGTH OF FEMTOCELL

The strength of femtocells, from an offload perspective, is that they capture 100% of the

Traffic, whether it is voice or data, and whether it originates from a feature phone, a smart phone, or a mobile broadband-enabled laptop. An end user can choose to send traffic over other networks (e.g. Wi-Fi) by unplugging a laptop's USB dongle or otherwise disabling the wide area radio. In the absence of a conscious decision, however, data will flow over the femtocell. Since a femtocell is an extension of the operator's network, mobile devices find the femtocell automatically and authenticate themselves using the same protocols they use on the macro-cellular network. There are no passwords to memorise and no need to choose among available networks. Femtocells are effective, in large part, because they require no effort on the part of the subscriber. Some operator managed networks of Wi-Fi hotspots have also automated registration, bringing cellular and Wi-Fi radio access technologies closer together.

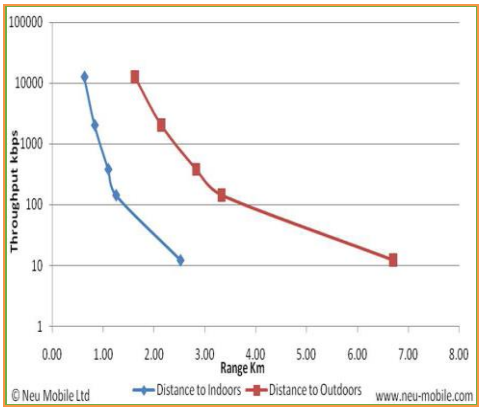

Fig. 3: Cell Range versus Data Rate, Indoors and Outdoors [2]

IV. TRAFFIC OFFLOAD: HOW IT WORKS

In a femtocell environment the operator supplies a femtocell. The consumer attaches it to his or her broadband connection. Traffic then flows over the air to the femtocell then over the internet to the operator's core network, and/or to other internet destinations. In a residential environment a femtocell is likely to supply as much data bandwidth as the subscriber is able to consume. If there is a limitation it is most likely in the speed of the residential or enterprise broadband connection, but this same limitation also applies to wired and Wi-Fi connected devices in the home or office. When a subscriber enters his home or office the devices automatically associate with the femtocell. Traffic that would have flowed between the macro-cellular site and the subscriber's phone/PDA/MID/laptop flows instead through the femtocell and the subscriber's broadband connection.

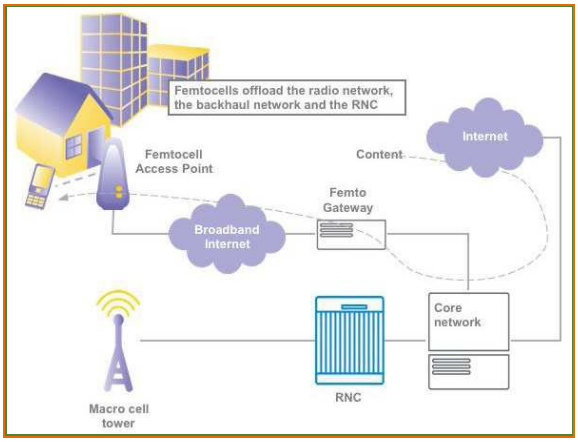

Fig. 4: Internet Access via a Femtocell

V. BENEFITS

1. Femtocells can reduce network cost i.e. it will reduce capital investment and operating expenses.
2. Frequency reuse is possible from one building to other building.
3. It benefits the operators by strengthening the dependence upon operator managed services.
4. It also reveals the identity of end-user and also the type of device customer is using, the current downloads and

purchases from operators provided to customers that further helps the operator to take the share of revenue (in contrast to Wi-Fi)
5. Increasing total network capacity by deploying or using femtocell effectively, will save the macrocell investments in the future.
8. Data offload benefit operators by allowing cost savings while it also benefits consumers as it may offer a higher quality of service (e.g. bandwidth) for the mobile data connection.
9. Femtocells improves customer satisfaction.
10. Femtocells Significantly increased voice revenue.
11. Femtocells also improve coverage.
12. Femtocells do not increase battery drain.

VI. HEALTH AND SAFETY ISSUES

Femtocells emit very low levels of radio waves (also known as radiofrequency (RF) electromagnetic fields) when being used. The safety of radio waves has been extensively studied for more than 50 years. Numerous independent scientific expert panels, health agencies and standard-setting organisations around the world regularly review this large and growing body of research. These organisations have all reached the same general scientific conclusion: that there is no established health effects from exposure to radio waves below the limits applicable to wireless communications systems. Femtocells must comply with the same safety limits that are applied to other wireless devices such as mobile phones and their antenna sites. These safety limits have been established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). They have been endorsed by the World Health Organisation (WHO) and widely adopted by governments around the world [3].

VII. FEMTOCELL MARKET: PRESENT AND FUTURE

The femtocell market is starting to diverge with enterprise, public and rural femtocells appearing in the market. Femtocell technology is extending beyond the home environment and several operators are launching dual femtocell access points for consumer and enterprise environments. Vodafone, T-Mobile, Movistar, Singtel and Softbank have launched non-consumer femtocell services.
According to Informa Telecoms and Media and Femto-forum 1.7 million femtocell access points deployed in the market and 2.2 million macro base stations as of Q4 2010. As of February 2011, there are 19 commercial services (from 18 in December 2010) and a total of 34 Deployment commitments (compared to 30 in December 2010). Deployments and commitments have tripled during 2010. The Femto Forum has grown to include 60 mobile operators representing 1.71 billion mobile subscribers worldwide, across multiple wireless technologies (WiMAX, UMTS and CDMA) and account! for 33% of total mobile subscribers worldwide plus 74 vendors, illustrating that the femtocell ecosystem is experiencing healthy growth. Femtocell specific 3GPP, 3GPP2 and WiMAX standards have been completed, signalling that femtocell Technology has been ratified by the highest profile standardisation bodies worldwide [7].
Recently, Infonetics Research has conducted a series of studies that have shown that sales of fixed-mobile convergence (FMC) network elements as well as femtocells are expected to record a compound annual growth rate (CAGR) of 86 percent from 2009 to 2014. The research company has also reported that revenues generated by 2G and 3G femtocell networks worldwide rose with approximately 154 percent in 2009 compared to the previous year. The same research study also predicts that, in 2011, over 2.5 million femtocells would be sold [6].

The following chart (Fig.5) illustrates a historical representation of deployments and commitments, both of which Have increased almost 300% within a year.

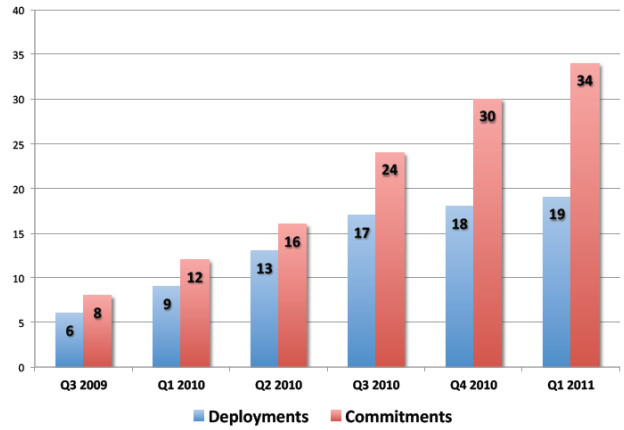

Fig. 5: Historical femtocell service deployments and commitment (Source: Informa Telecoms & Media)

VIII. CONCLUSION

Growing capacity and coverage demands are driving operators to use smaller and smaller cell sizes to offer better service to higher number of users. Femtocells will provide a one-box solution: a small, low-cost, low power unit that can be self- installed to provide mobile 3G coverage to the home. For the end-user femtocell solutions will provide dedicated and reliable mobile 3G coverage in the home with opportunities for preferential tariffs. For the Operator, femtocells deliver cost effective coverage where the business-case or practicalities of deploying a macro base-station might not be feasible. Femtocell technologies accelerate the cost effective provision of ubiquitous broadband services by convergence between fixed and wireless broadband. In this paper, we have discussed femtocells as a possible solution for data offloads including the concept of data offloading, health & safety issues and present & future market for femtocells.

IX. REFERENCES

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