QoE in Femtocells

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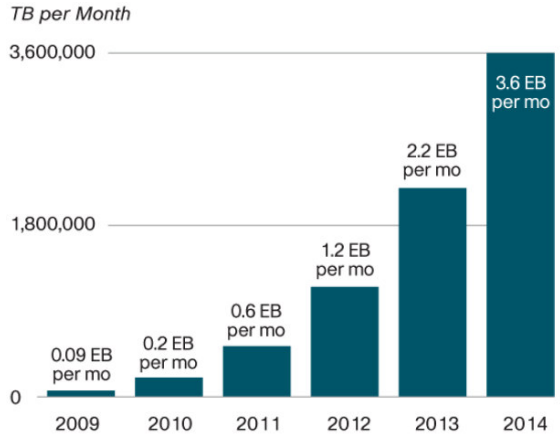
Abstract: This paper reviews existing Femtocell architecture deployment options proposed by the 3GPP, highlights the increase on data consumption expected in the home environment and proposes a simulation study to assess the achievable QoE with each one of the proposed architectures taking into account the backhaul technologies.

1 Introduction

In recent years the Mobile Network Operators (MNOs) in UK and the rest of the world have seen an exponential increase in the data consumption over their networks. This is due to the success of what is called "Mobile Broadband" contracts for laptops, which consume 100 times more data than a normal mobile device, the appearance of high-end smartphones which consume 8 times more data than a normal mobile device and the introduction of "all you can eat" data plans.

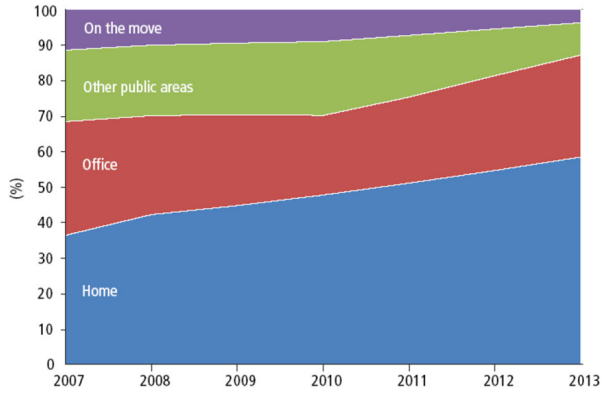
These disproportionate increase of data consumption [1] is not followed by a similar revenue increase as in developed areas the penetration of the mobile market is already close the maximum possible and competition is driving the prices down.



1. Cisco Forecasts 3.6 Exabytes per Month of Mobile Data Traffic by 2014[1]

One of the options the MNOs have is to start the deployment of 4G or 3.9G technologies like LTE, but even that won't be enough, because according to Cisco, mobile data traffic is expected to grow 20 times over the next 5 years [1].

Because the great majority of the data is consumed at home and this trend, as the graph below shows, will continue to increase, and because the high frequencies currently in use offer bad coverage indoors, operators will have to offload traffic to smaller cells to solve the issues of coverage and to increase the user data allocation[2].



2. Global mobile traffic distribution by location. Informa study forecasts over 50% of the mobile data Consumption at home by 2013[3].

These smaller cells can be 802.11 APs or femtocells. The advantages of femtocells over 802.11 APs is the usage of the same spectrum and radio in the device and that from the point of view of the MNOs the user data is still under their control.

2. 3GPP proposed architectures

In 3GPP there has been several proposed scenarios for LIPA (Local IP Access, where via the femtocell the device will have access to local resources) and SIPTO (Selected IP Traffic Offload, where some of the traffic sent from the femtocell is offloaded to the internet before reaching the MNO core) [3]. The 6 proposed solutions are:

1. LIPA and SIPTO solution based on traffic breakout performed within H(e)NB using local PDN (Packet Data Network) connection: separate PDN connection(s) are used to send traffic to the MNO core network (CN). The Femtocell AP (FAP) is capable of offloading the traffic locally using a co-located LGW (local PDN Gateway).
2. LIPA and SIPTO at H(e)NB by NAT: Uses an Offload Processing Module (OPM) in the residential/enterprise network. This OPM has the ability to drag/insert from/into the PDN connection per operator policies. Only one PDN connection used for all traffic. There is a NAT inside the OPM to ensure the correct reception of traffic offloaded by LIPA and SIPTO.
3. GGSN allocation to offload point: where the SGSN is provided by the RAN (Radio Access Network) off a list of GGSNs with better traffic routing capabilities. Also the HSS indicates which CSG (content Service Gateway) can perform LIPA/SIPTO for each APN subscribed.
4. SIPTO at Iu-PS: The traffic is offloaded after the RNC and before the SGSN in the Traffic Offload Function (TOF). Using Deep Packet Inspection (DPI) in the TOF a great level of granularity can be achieved.
5. SIPTO based on LGW selection: The LGW is not co-located with the H(e)NB but is close by in the network.
6. LGW based architecture: Where the LGW is co-located with the H(e)NB and there is an “extension tunnel” connecting it to the PGW/GGSN which will control the LGW.

From these solutions the ones that seem to get more traction are solution 5 for SIPTO and solution 1 for LIPA.

3. Proposed simulation study

The 3GPP has defined 4 traffic types: conversational (e.g. voice/video conference, where low delay and low jitter is required but some packet loss is acceptable), streaming (e.g. TV on demand, where

jitter and delay are less important), interactive (e.g. web browsing, where a fast response is expected), and background (e.g. email or file transfer, which as the lowest requirements).

Because the femtocells will be using a non-dedicated shared (with non-femto traffic) backhaul access technology (such as xDSL), the importance of delivering QoE is greater and more complex than in the macrocell case. Especially in the uplink as many of the fixed broadband technologies use asymmetrical link capacities.

This means that some type of SLAs will need to be in place between the owner of the femtocell (MNO) and the owner of the backhaul access (ISP) to assure the required QoE for the different traffic flows [5]. Depending on the implementation solution used (from the 3GPP proposed ones) the technical difficulties to deliver an acceptable QoE will change.

So although femtocells are a very good solution for offloading data from an overloaded mobile network, if the implementation/architecture is not correct it can affect the Quality of Experience (QoE) of the end-user, which will prompt the end-user to use the macrocell.

5. Conclusion and further work

To avoid this situation, a simulation study will be carried on using as parameters: the future in-home data demands with the future femtocell voice and data demands, the different proposed architectures by 3GPP for femtocells, the available fixed broadband technologies and the different types of traffic that will need different QoS to achieve an acceptable QoE for the end-user. Further study will show which SLAs will be needed between MNOs and ISPs and how can these be achieved. It also will try to solve some of the open issues detected by the 3GPP on their proposed architectures.

References

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