3GPP TSG-RAN WG4 Meeting #44 **R4-071231**
Athens, Greece, 20-24th August, 2007

Source: Nortel, Vodafone
Title: Open and Closed Access for Home NodeBs
Agenda Item: 9.3
Document for: Approval

1 Introduction

This contribution discusses the impact of restricting UE access to Home NodeBs (HNBs). We consider two types:

1) Open Access – All UEs (authenticated by the operator) can be served by a Home NodeB
2) Closed Access – HNB only serves UEs belonging to a Closed Subscriber Group

Clear benefits are shown for Open Access Home NodeBs, and thus it is proposed that an analysis of them should be included in the Home NodeB Study Item.

2 Co-Channel vs Different Channel

Home NodeBs can be deployed in the same channel as the Macro NodeBs or a different one. Each has advantages and disadvantages as follows:

Co channel

- Co-channel interference between Macro and HNBs needs to be managed
- Macro<>HNB mobility is intra-frequency. Techniques needed to limit UE neighbor measurements
- Higher overall spectral efficiency expected: Macro+HNB equivalent to denser macro deployment.

Other Channel

- Less interference due to isolation between channels
- More control over mobility, since Macro<>HNB will be an inter-frequency handover
- Additional spectrum needed to provide HNB service. Once offered, operators may be obliged to maintain this allocation, even if HNB service take up is very low.

If the challenges of co-channel deployment can be over-come, then this would be a preferable option. However, other-channel deployment should also be considered as a fall back position.

Simulation results in this contribution are for co-channel deployment only.

3 Simulations

Simulations were performed to compare downlink capacity of networks with open access and closed access HNBs. A dense area of HNBs are placed in the centre of a 19 base tricellular network. Density is equivalent to 130 HNBs per macrocell. Transmit powers are 43dBm for Macro and 24dBm for HNBs.

Three scenarios were modeled, all considering a co-channel deployment:

1) Macrocells only HNBs not used
2) Open Access UEs served by node with strongest signal
3) Closed Access UEs only served by HNBs if: HNB signal is stronger than Macro and UE is within 5m of HNB.

Figure 1 shows SNIR distributions for the Macro and HNB served UEs in the above three scenarios. For both open and closed access, SNIR of macro served UEs is degraded by the presence of HNBs. Most UEs served by open access HNBs also experience lower SNIR than might be achieved from a macro only. UEs served by closed access HNBs experience very high SNIR. However, these represent only a small fraction of all UEs.

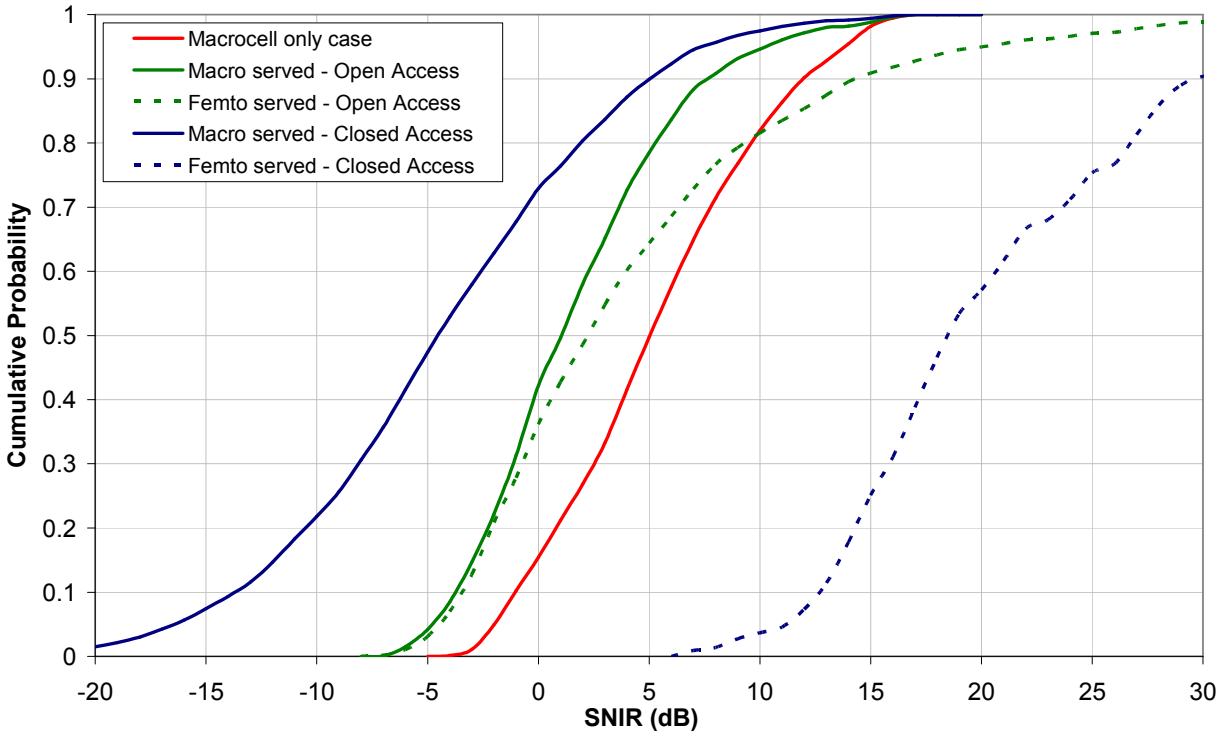

Figure 1 UE DL SNIR distributions for Macro only, Closed Access and Open access

Figure 2 shows the Effective Data Rate of UEs which is the spectral efficiency divided by the total number of UEs sharing the same server. Rates are based on the Shannon bound. Loading is 200 UEs per macro cell. For closed access, macro served UEs experience poor data rates, due to the degradation in SNIR. A small proportion of HNB served UEs experience very high rates, since they have good SNIR and are not sharing the HNB with many other UEs. For open access, HNB served UEs experience good rates, since loading is light. Despite a 3-4dB degradation in SNIR, macro served UEs achieve similar rates to the macrocell only case. This is because the HNBs reduce the loading on the macrolayer.

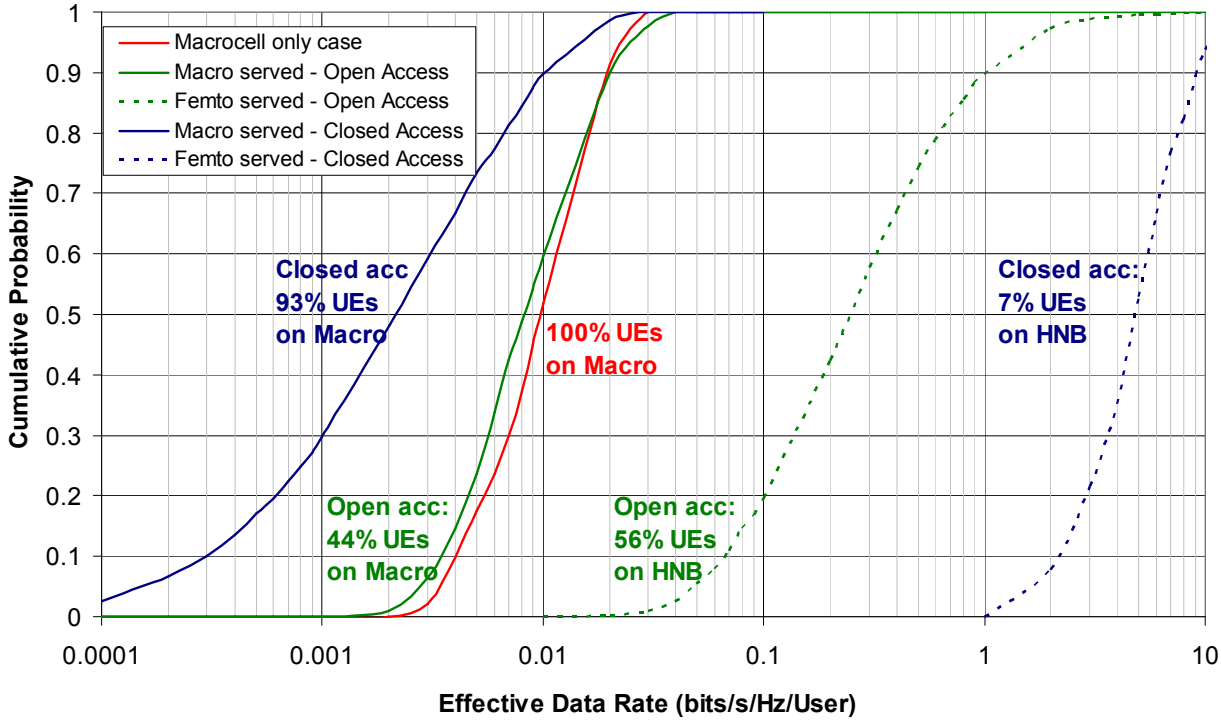

Figure 2 Effective Data Rate Distributions for Macro only, Closed Access and Open access

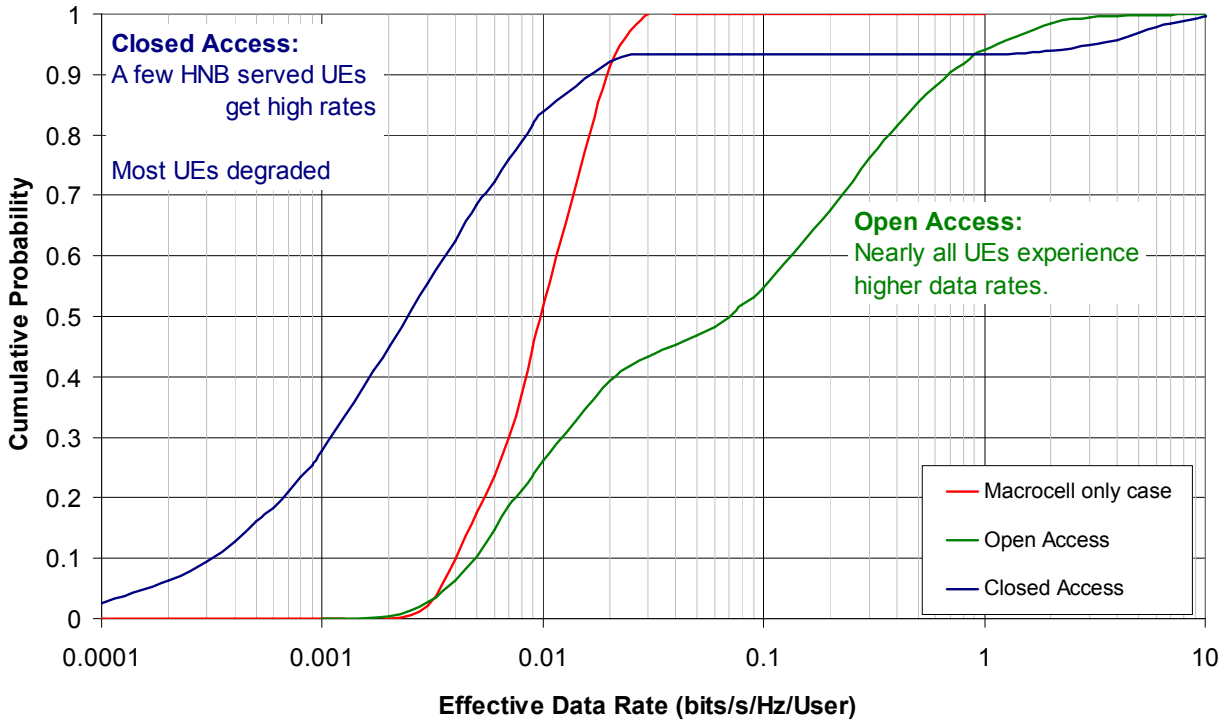

Figure 3 Effective Data Rate distributions for all UEs. Macro only, Closed Access and Open access

Figure 3 shows effective rates for the combination of both macro and HNB served UEs. Note that this takes into account the relative number of UEs served by Macros and HNBs. This clearly illustrates the benefit of Open Access: Nearly all UEs experience higher data rates than in the Macro only case. In the Open Access case, adding HNBs has a similar effect to increasing the density of bases – it increases capacity per unit area.

With closed access, the small number of UEs served by HNBs experience excellent rates. However the remaining Macro served UEs are significantly degraded. This large difference between HNB and macro served UEs does however reveal potential for improvement in the closed access case. Interference mitigation techniques could be used to improve SNIR of the macro served UEs. Even if this comes at the cost of HNB served UEs, they can experience significant degradation before rates are similar to the macro only case. Such techniques should be studied further.

The closed access results presented here agree with those in [1], which show significant capacity degradation in the macro layer for the co-channel case.

4 Discussion

Figure 4 illustrates the key findings from the results. In the closed access case (2), a HNB effectively steals coverage area from the macro layer. UEs in this area not served by the HNB see it as interference with their link to the existing macro. Techniques have been proposed to mitigate this, such as adjusting HNB power when this interference is detected.

In (3) the open access case, the HNB is still taking coverage from the macro layer, but all UEs in this area are served. UEs moving from macro to femto experience much higher rates, as the resource is not shared as much. The simulation results showed that whilst there is some degradation in SNIR on the macro layer, this is compensated for by the lighter loading. Overall, UEs on the macro layer experience no significant change in data rates.

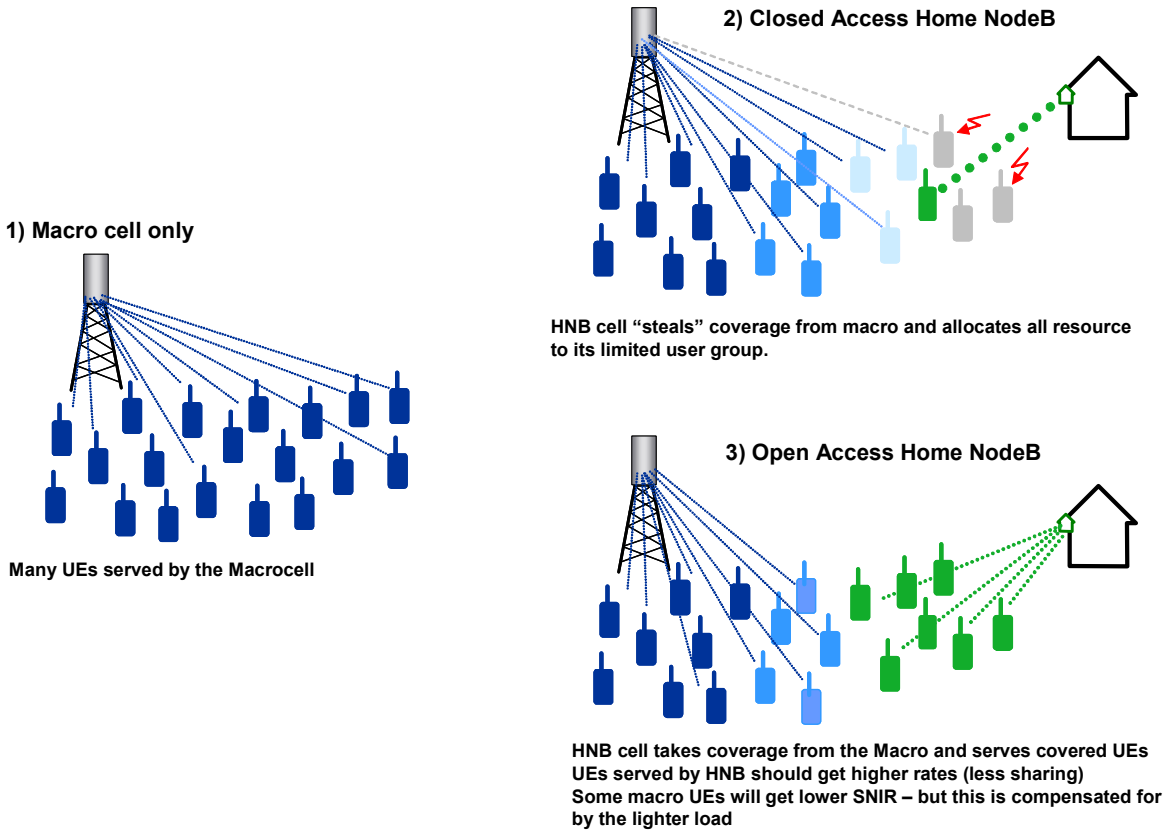

Figure 4 Comparison of Open and Closed Access Scenarios

5 Summary

- Deployment of HNBs in a different channel to the Macro NodeBs is expected to be simpler than co-channel, since the isolation between channels reduces interference
- Co-channel deployment is expected to give higher spectral efficiency
- Co-channel deployment may be a technical necessity in bandwidth limited deployments
- Co-channel deployment is more technically challenging
    - Closed access HNBs have been shown to cause significant interference to the macro layer. e.g. where a UE is in the coverage area of a HNB but cannot use it. Techniques to mitigate such interference have been proposed and are FFS
    - Open access HNBs avoid such pathological interference cases and enhance network capacity and coverage
- Whilst it is recognised that open access has implications for backhaul sharing, backhaul quality, etc, these are considered to be beyond the scope of the RAN4 study

It is proposed that the RAN4 Home Node B Study Item should include an analysis of the open access case.

6 References

[1] R4-070902 "*Initial home NodeB coexistence simulation results*," Nokia-Siemens Networks