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A SURVEY ON 3GPP HETEROGENEOUS NETWORKS

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Outline

- Abstract
- Introduction
- *Heterogeneous network topology utilizing a mix of high-power(macro) and low-power base stations*
- *LTE heterogeneous network nodes and their interfaces*
- Interference
- *LTE DL physical layer structure for FDD*
- *Conclusions*

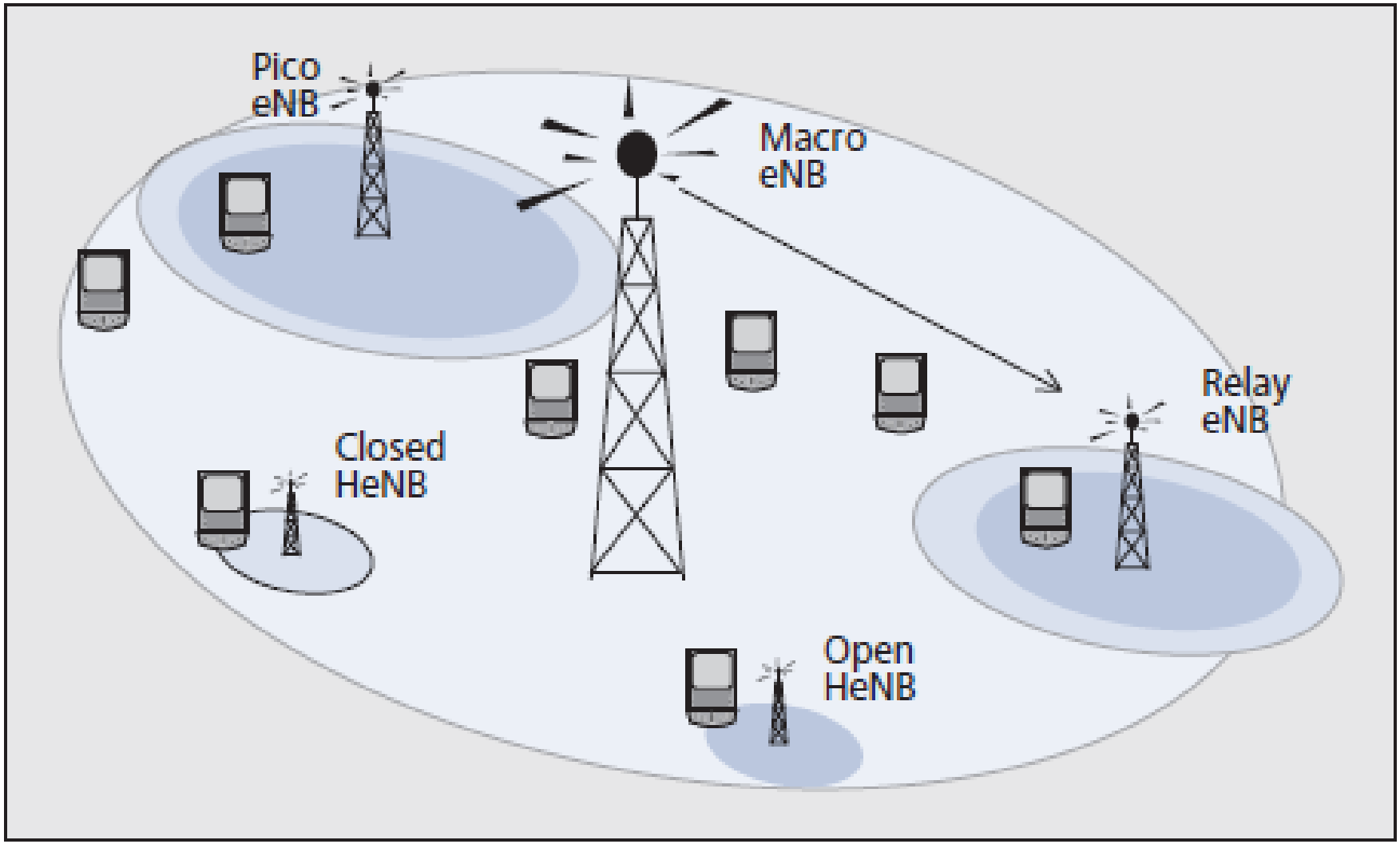
Abstract

- As the spectral efficiency of a point-to-point link in cellular networks approaches its theoretical limits, with the forecasted explosion of data traffic, there is a need for an increase in the node density to further improve network capacity.
- We survey current state of the art in heterogeneous deployments and focus on 3GPP LTE air interface to describe future trends.

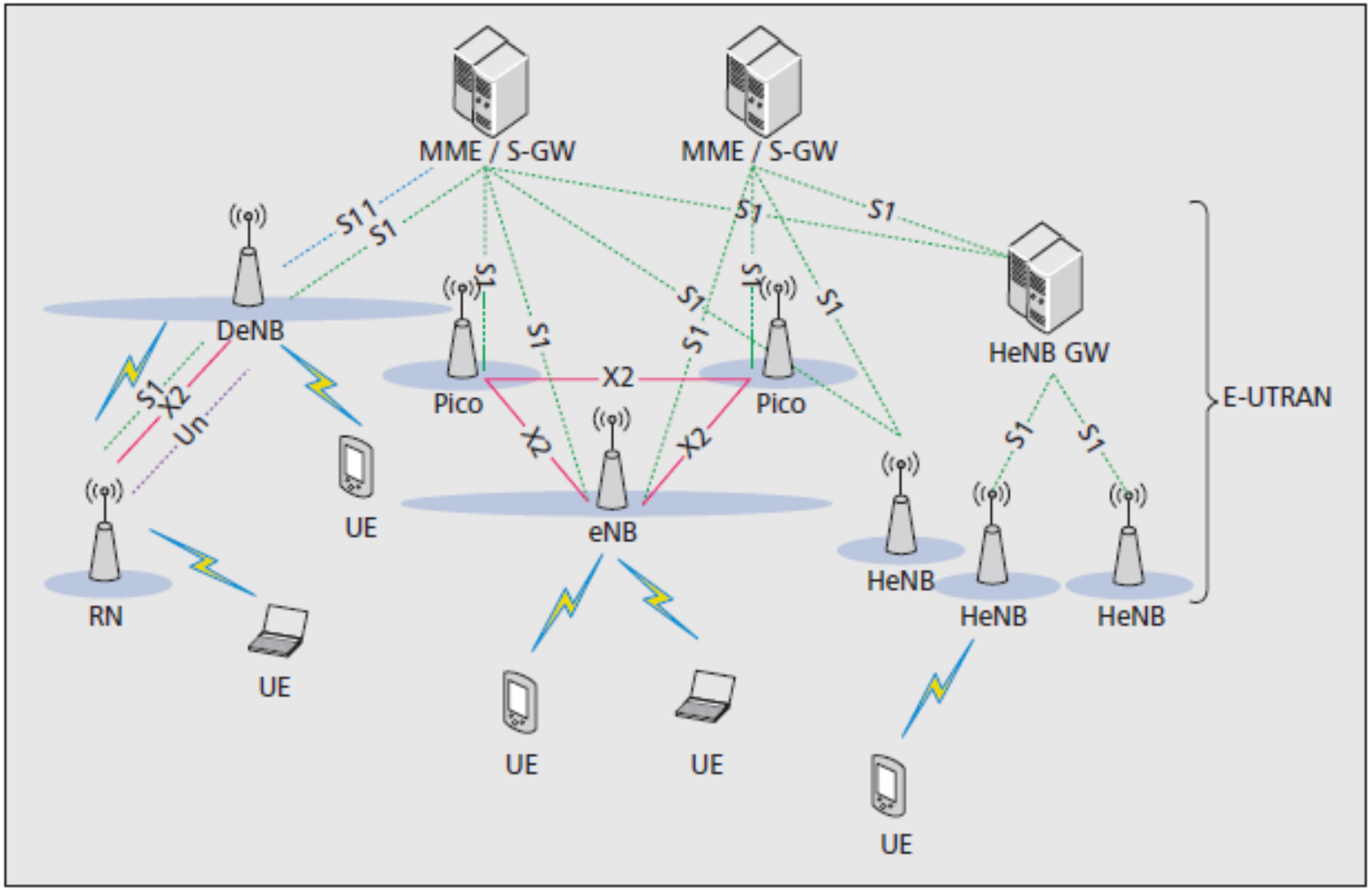
Introduction

- Data traffic demand in cellular networks today is increasing at an exponential rate.
- Further improvements in system spectral efficiency are only possible by increasing the node deployment density.

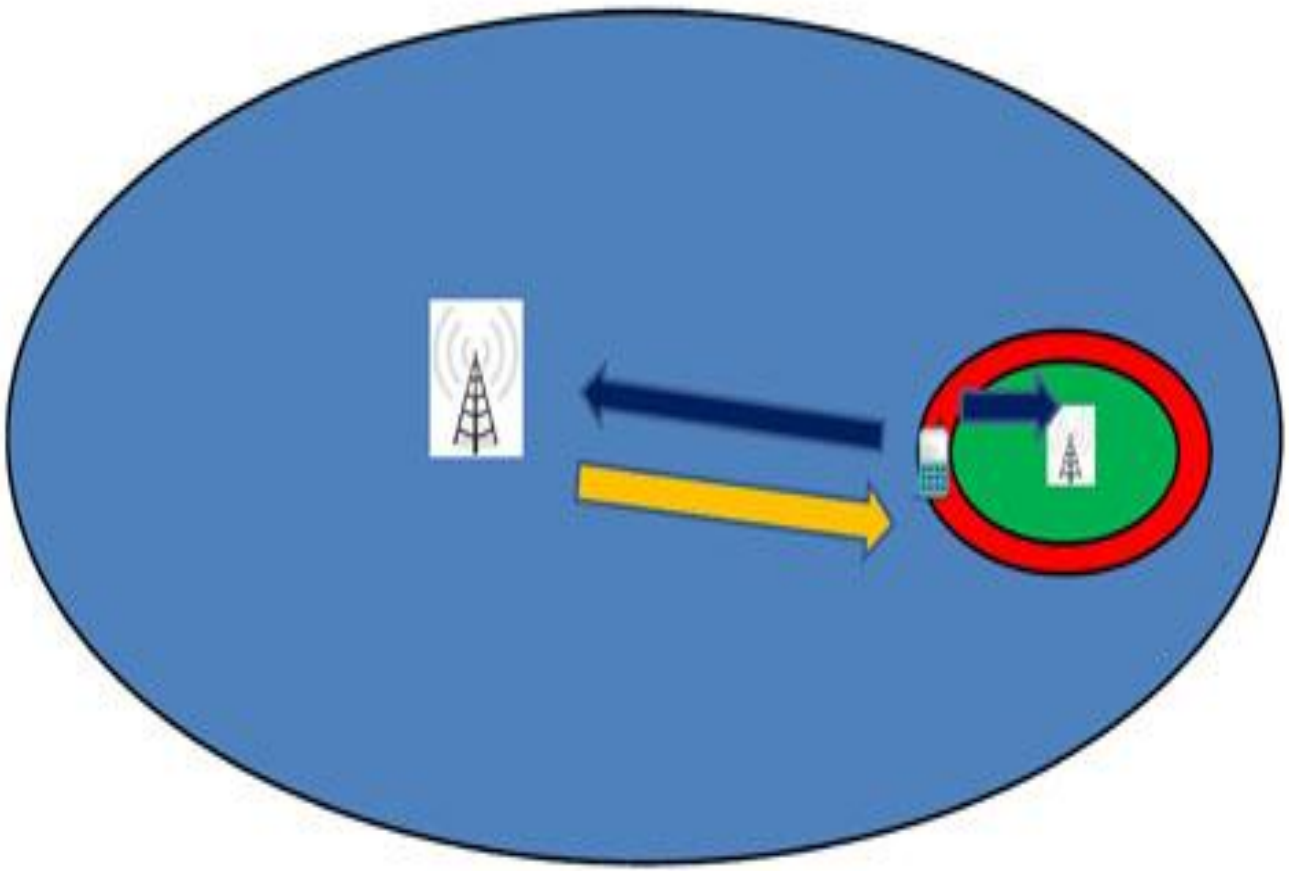
Heterogeneous network topology utilizing a mix of high-power(macro) and low-power base stations



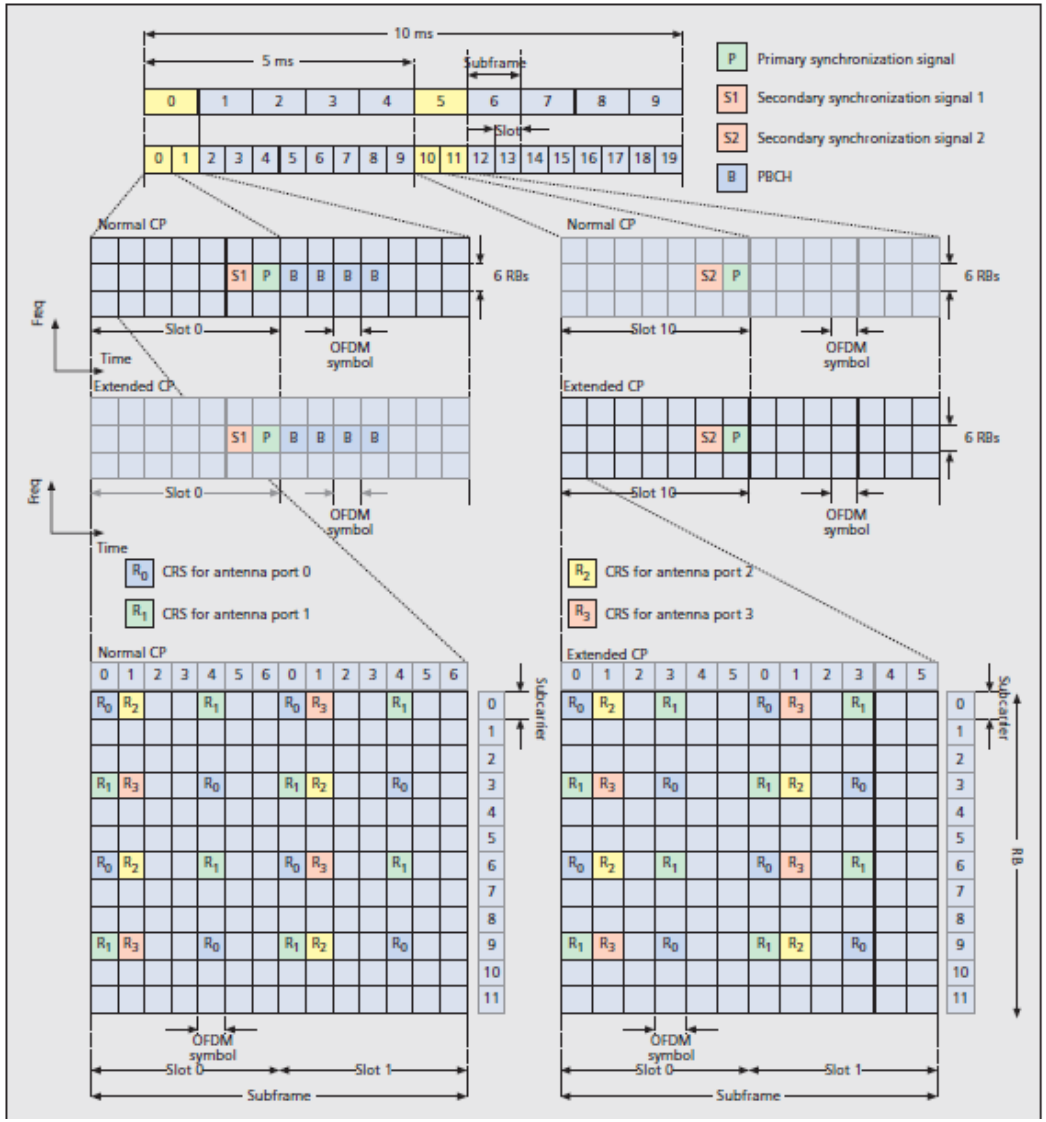
LTE heterogeneous network nodes and their interfaces



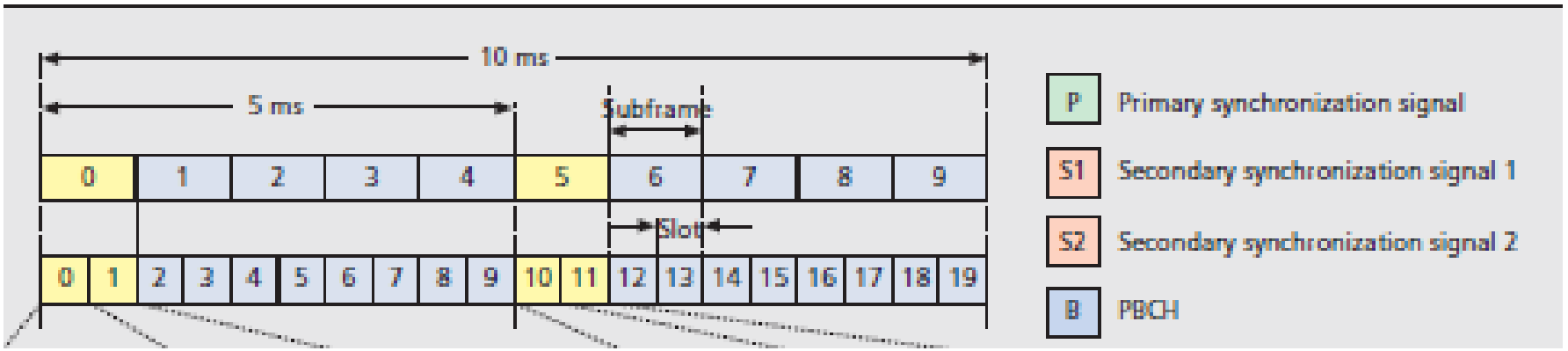
Interference



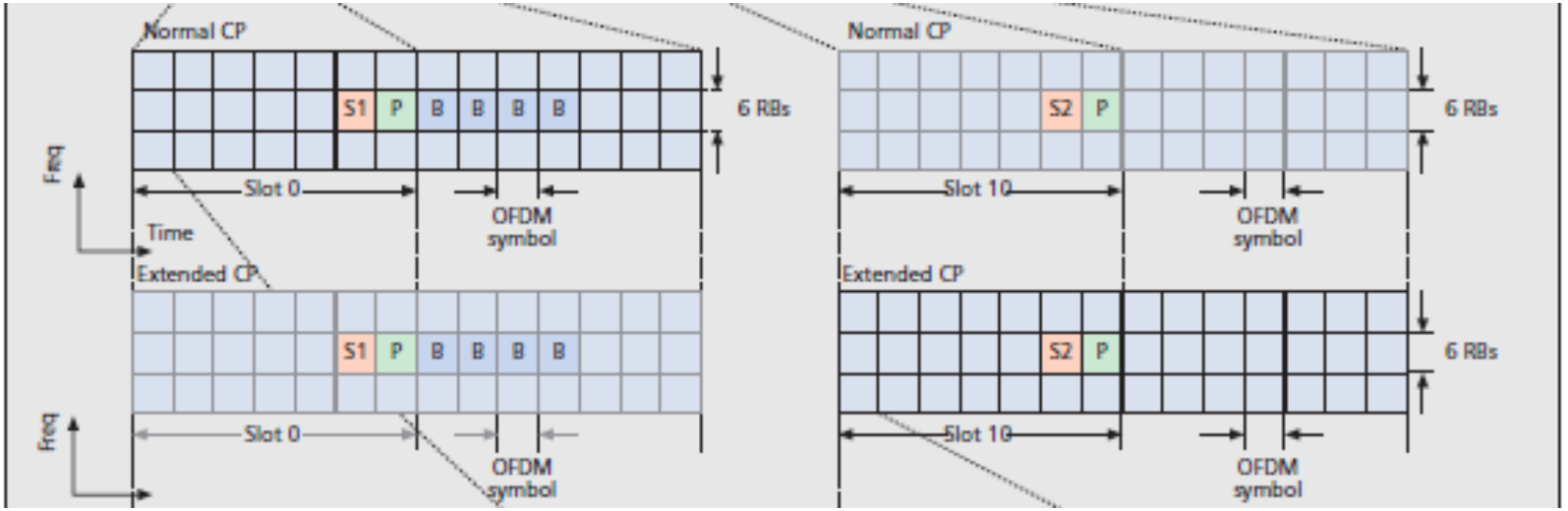
LTE DL physical layer structure for FDD



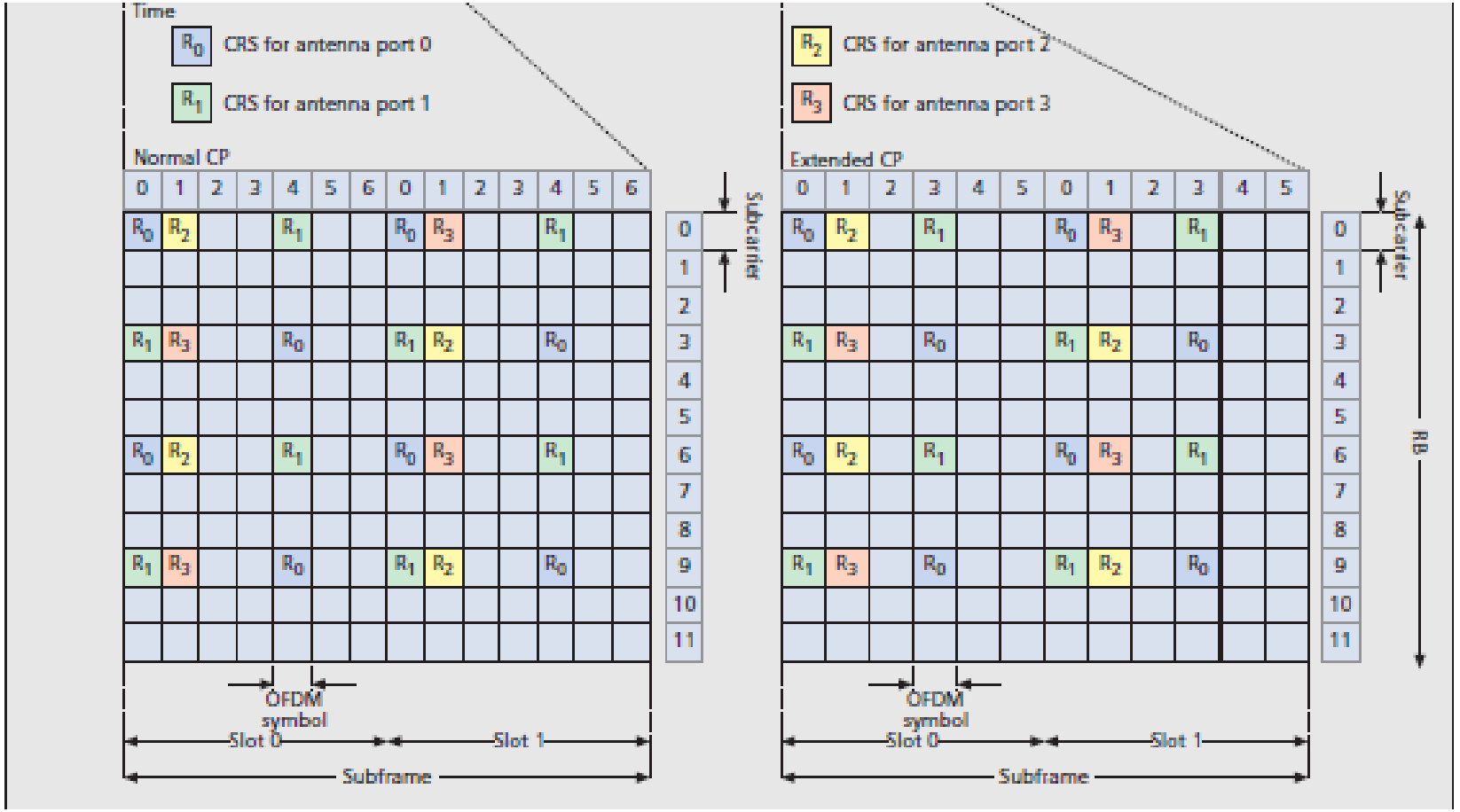
Cont.


10 ms
5 ms
Subframe
0 1 2 3 4 5 6 7 8 9
Slot
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
P
Primary synchronization signal
S1
Secondary synchronization signal 1
S2
Secondary synchronization signal 2
B
PBCH

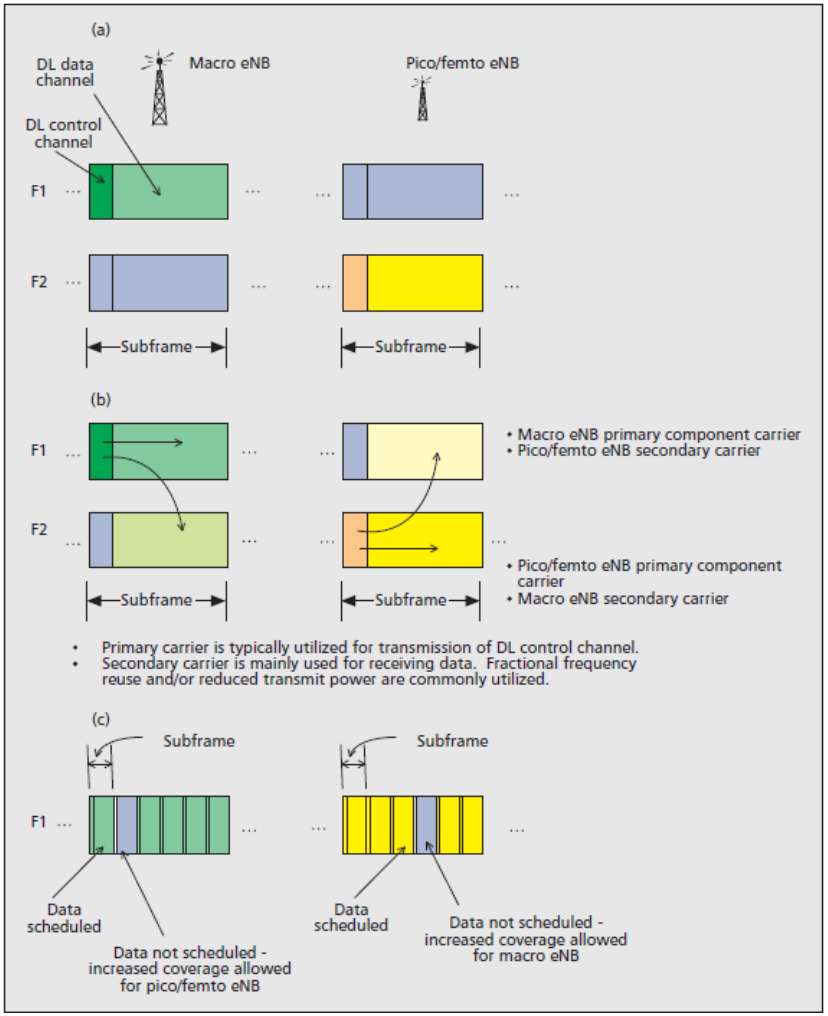
Cont.


Normal CP
S1
P
B
B
B
B
6 RBs
Freq
Slot 0
OFDM symbol
Time
Extended CP
S1
P
B
B
B
B
Freq
Slot 0
OFDM symbol
Normal CP
S2
P
6 RBs
Slot 10
OFDM symbol
Extended CP
S2
P
6 RBs
Slot 10
OFDM symbol

Cont.


Time
R0 CRS for antenna port 0
R1 CRS for antenna port 1
R2 CRS for antenna port 2
R3 CRS for antenna port 3
Normal CP
Extended CP
Subcarrier
RB
OFDM symbol
Slot 0
Slot 1
Subframe

Multicarrier, carrier aggregation, and co-channel deployments



Backhaul-based interference management, illustrated on a macro/pico example for FDD systems. The same mechanism can be applied for the macro/relay scenario.

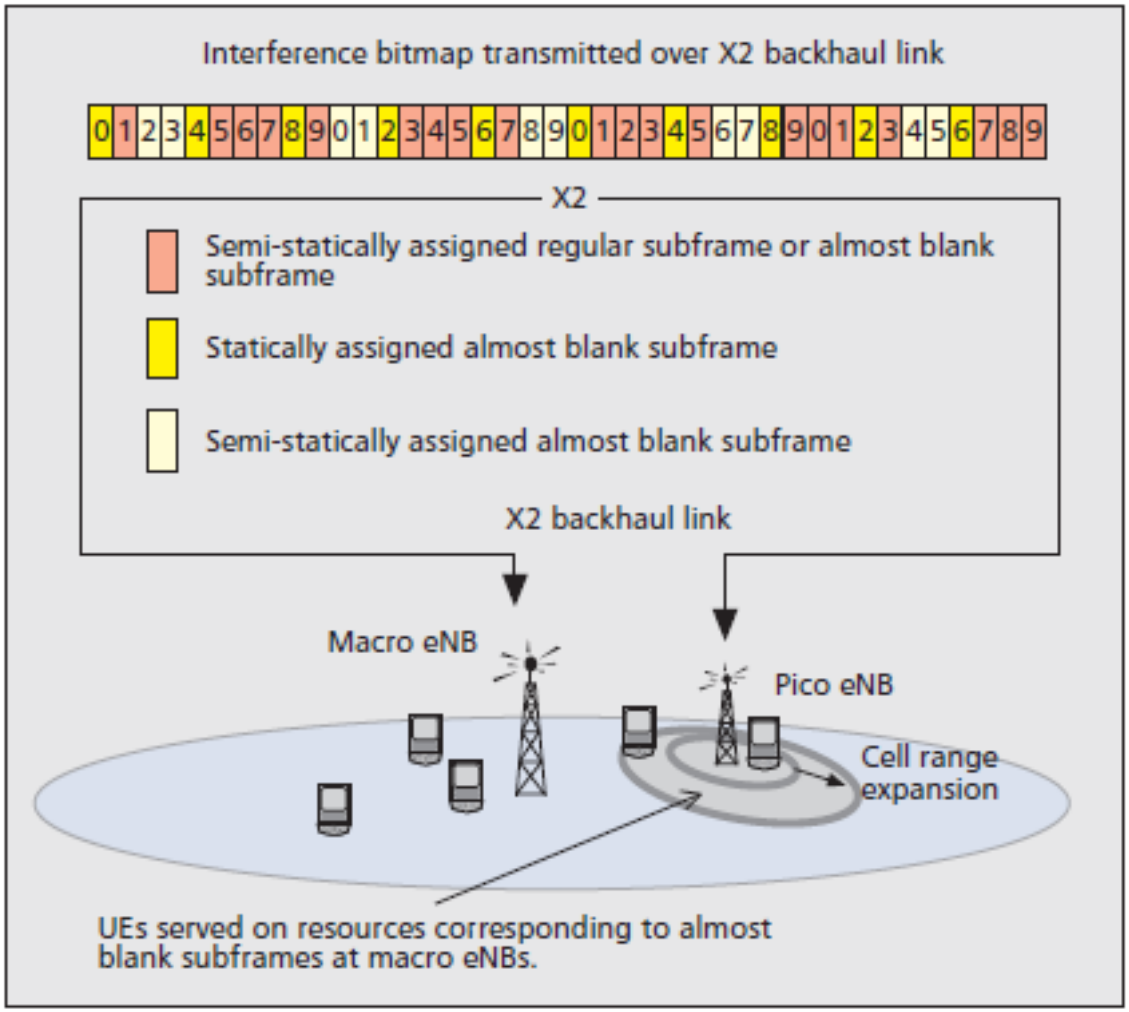
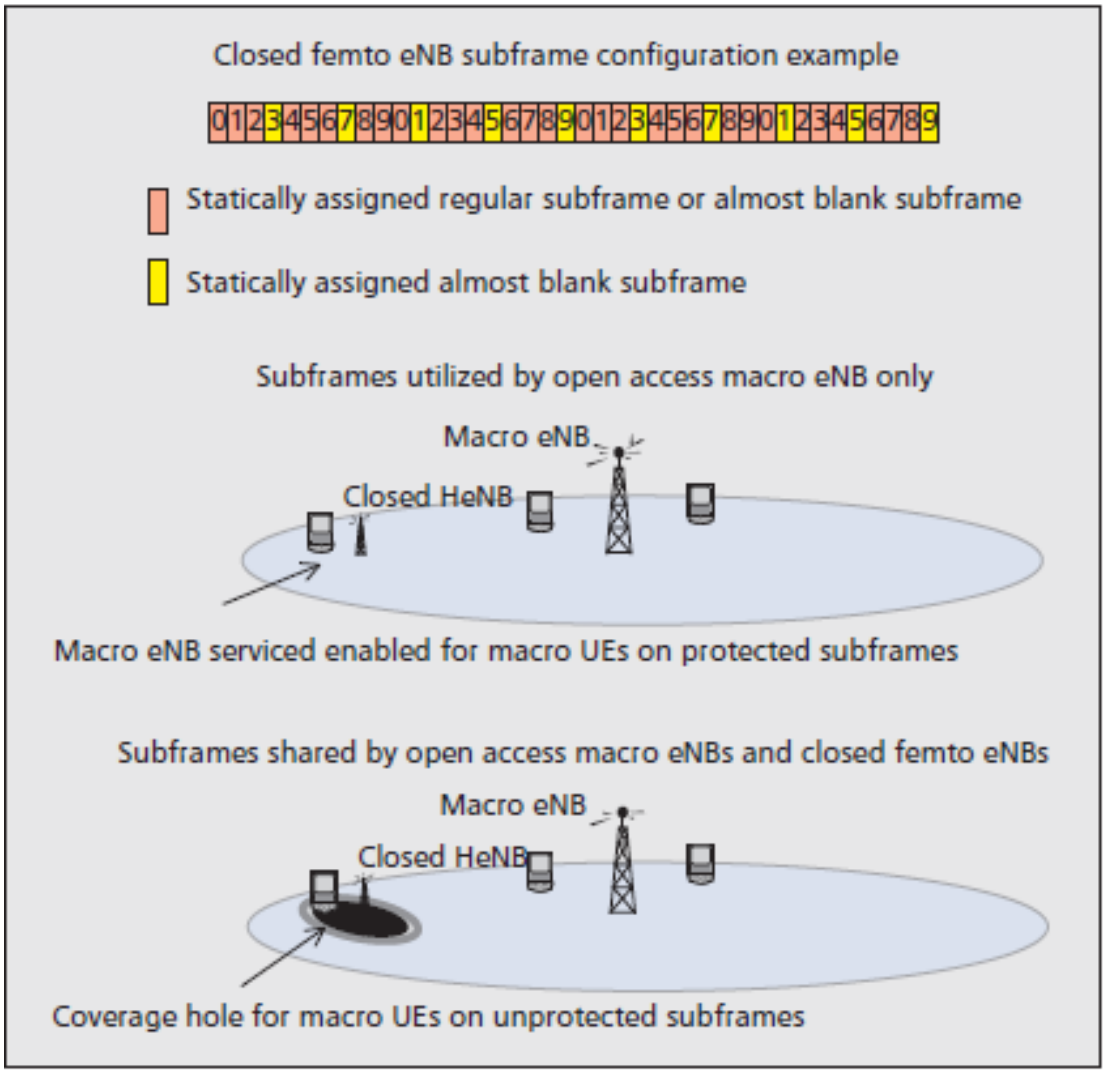
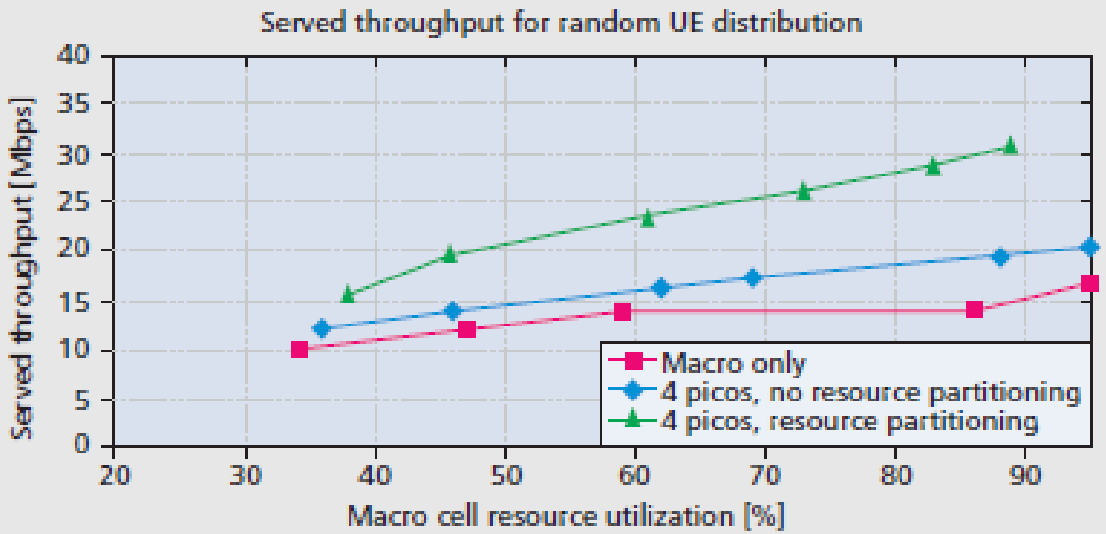


Illustration of the static interference management technique for FDD systems, applicable to the macro/closed femto scenario



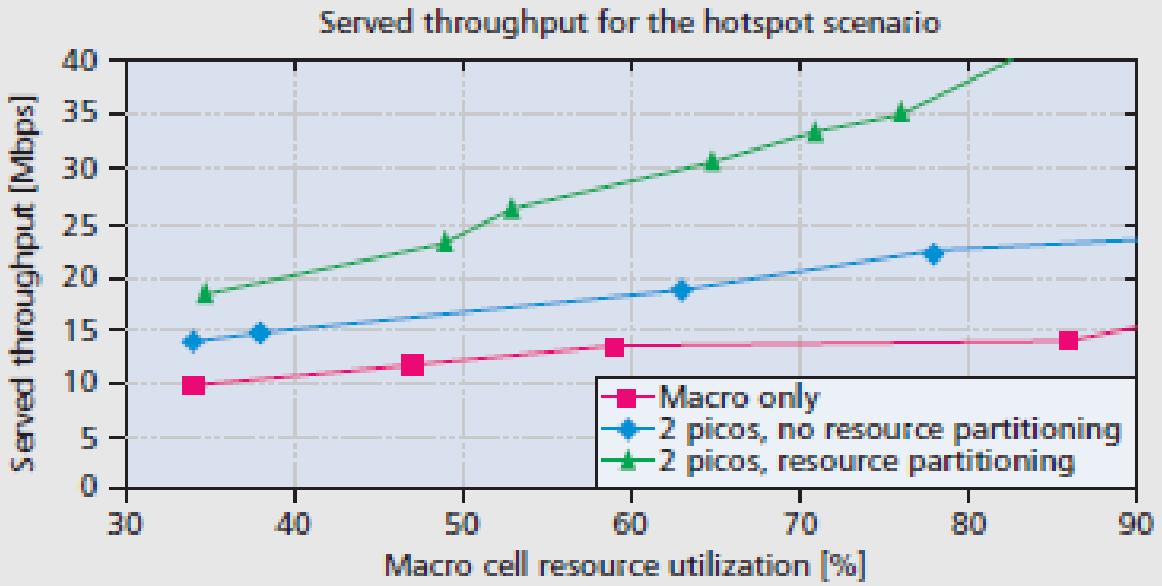
Served cell throughput gains with 4 picos/macrocell — scenario 1: random UE distribution and 18 dB biasing toward picocell for resource partitioning.

Performance summary			
Served cell throughput (gain vs. macro only/gain of resource partitioning)	Macro only	4 picos, no RP	4 picos, RP
50% Macro utilization	12.3 Mbps	14.2 Mbps (1.15x/1x)	20.5 Mbps (1.67x/1.44x)
75% Macro utilization	13.9 Mbps	17.7 Mbps (1.27x/1x)	26.6 Mbps (1.91x/1.50x)



Served cell throughput gains with 2 picos/macrocell — scenario 2: hotspot and 18 dB biasing toward picocell for resource partitioning.

Performance summary			
Served cell throughput (gain vs. macro only/gain of resource partitioning)	Macro only	2 picos, no RP	2 picos, RP
50% Macro utilization	12.3 Mbps	16.9 Mbps (1.37x/1x)	24.2 Mbps (1.96x/1.43x)
75% Macro utilization	13.9 Mbps	21.7 Mbps (1.56x/1x)	35.8 Mbps (2.57x/1.65x)



Conclusions

- Heterogeneous deployment is seen as a pragmatic and cost-effective way to significantly enhance the capacity of LTE cellular networks.
- Interference management represents the first crucial component of this strategy as severe interference from the macro nodes significantly limits the offloading potential of low-power nodes.