



# LTE Heterogeneous Networks

Oct 25<sup>th</sup> 2011

- **Backhaul**

- Infra-structure for small cell backhaul is a challenging issue in many markets
- Innovation from infra-structure side is needed

- **Effectiveness**

- Network loading varies in space with time
  - During the day (home, office, commercial districts)
  - During the life time of a small cell (new shops, residents, businesses)
- Pico cell coverage is often limited by co-channel macro cells
- Difficult to deploy pico cell that could effectively offloading macro cell traffic in a relative large area

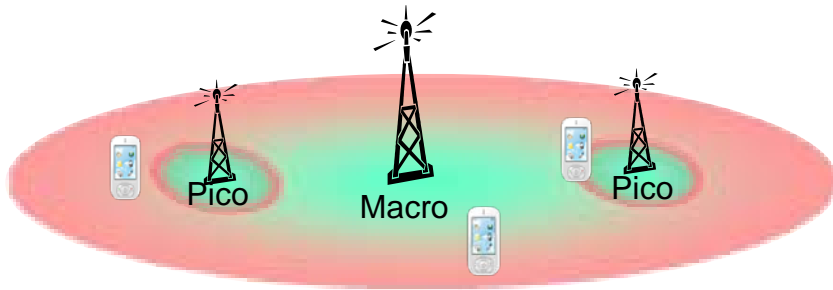
- **Robustness**

- Small footprint of pico cells allows little time for hand over of mobile users
  - Inter-frequency HO is slow
  - Co-channel deployment with macro is severely interference limited
- Small cells are often mounted under the rooftop → shadowing, blocking effect is more prominent

# Solution: Range Expansion

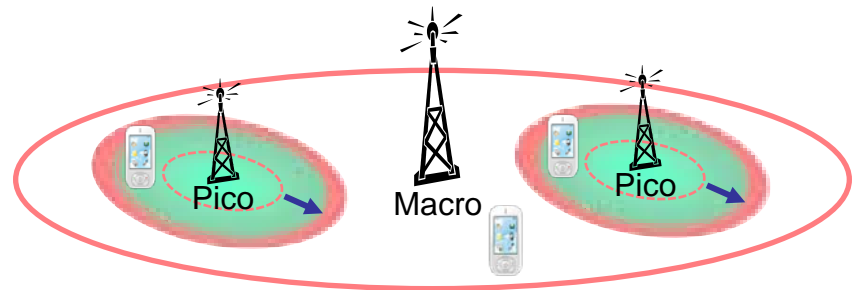
- **Range Expansion increases footprint of co-channel Picos/Femtos**
  - Effectiveness:
    - Allows more UEs to be served by low power eNBs
    - More equitable distribution of capacity among Macros and Picos/Femtos
  - Robustness:
    - Increased footprint allows more time and space for HO
    - Rel-10 eICIC removes macro/pico co-channel interference → High SINR HO
- **Enabled by resource partitioning and enhanced UE receiver**

## LTE Rel-8/9 Coverage



Limited footprint of Picos due to Macro signal

## LTE Rel-10 eICIC Coverage

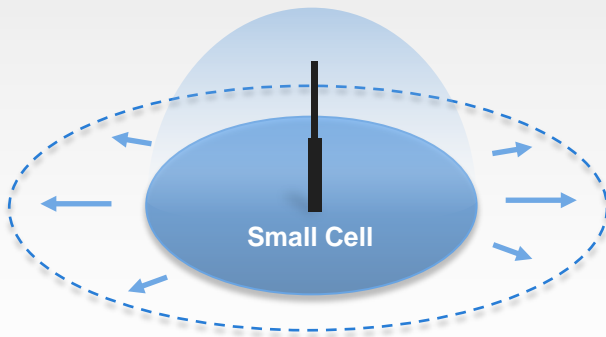


Increased footprint of Picos when Macro frees up resource

# Range Expansion Allows More Users to Benefit From Small Cells

SIGNIFICANTLY BETTER MACRO OFFLOAD

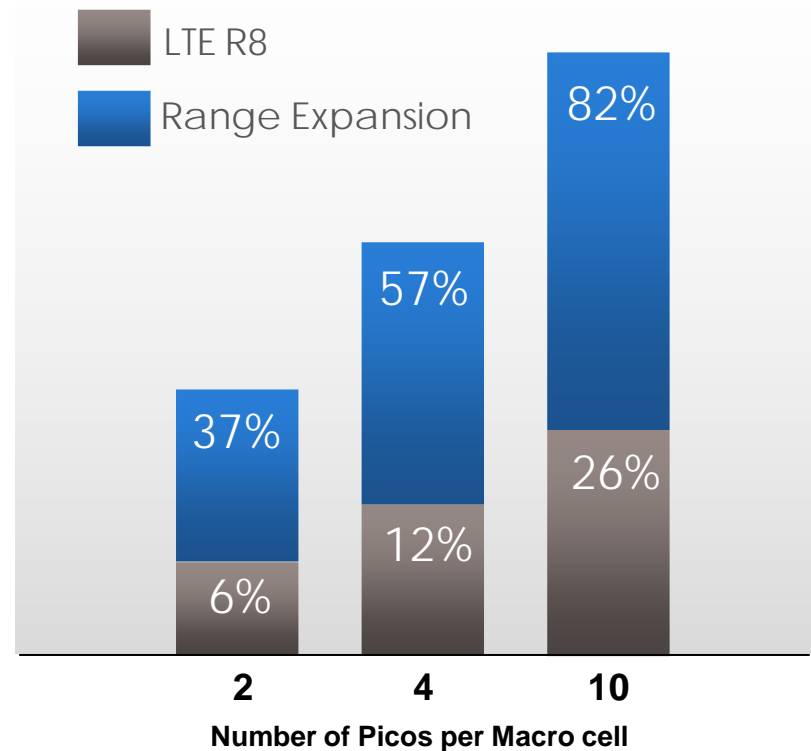
## RANGE EXPANSION



Enabled By:

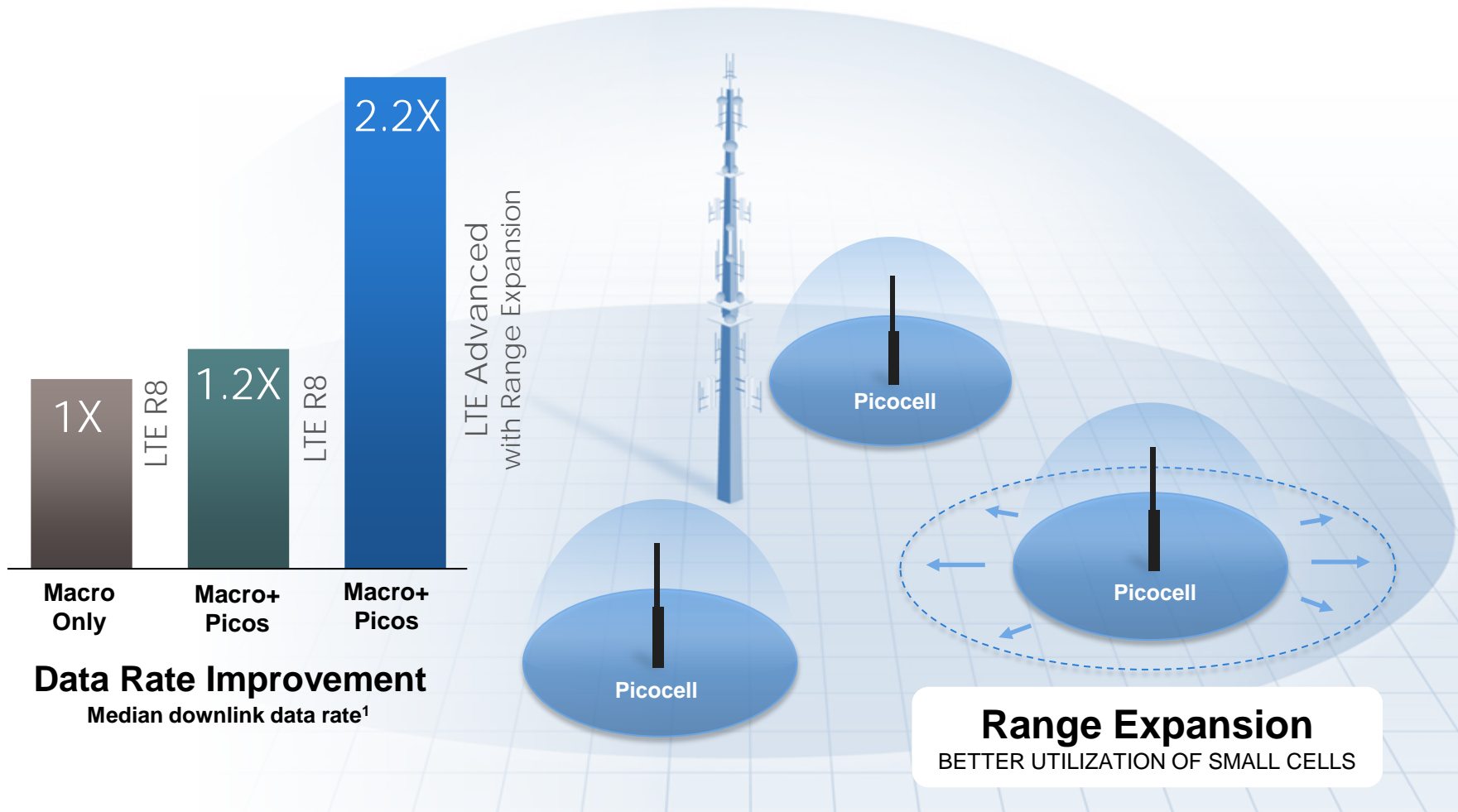
- 1) Adaptive Resource Partitioning<sup>1</sup>
- 2) Advanced Receiver Devices with Interference Cancellation

## Percentage of pico users<sup>1</sup>



Assumptions: TR 36.814, Macro ISD=500m, 10<sup>0</sup> antenna downtilt 25 UEs per Macro cell, uniform random layout, 10 MHz FDD, 2x2 MIMO. <sup>1</sup>And enhanced RRM and RLM to allow handover to weak cells, to maintain reliable link with weak cells, and to provide accurate feedback with resource partitioning. Standards name eICIC: Enhanced inter-cell interference coordination <sup>1</sup>For uniform, random user distribution

# Increased Network Capacity and Enhanced User Experience



Assumptions: 4 Picos per Macro randomly dropped within macro coverage, see 3GPP R1-101509. Based methodology in TR 36.814: 10 MHz FDD, 2x2 MIMO, 25 users and 500m ISD. Advanced interference management: enhanced time-domain adaptive resource partitioning, advanced receiver devices with enhanced RRM and RLM

<sup>1</sup>Similar gain for the uplink

# THE SECRET SAUCE:

ENABLES RANGE EXPANSION THAT ALLOWS MORE USERS TO BENEFIT FROM SMALL CELLS

ADAPTIVE  
RESOURCE  
PARTITIONING

ADVANCED  
RECEIVER  
DEVICES

FULL  
BACKWARD  
COMPATIBILITY<sup>1</sup>