MOBILE BACKHAUL AND SYNCHRONIZATION FOR HETEROGENEOUS NETWORKS

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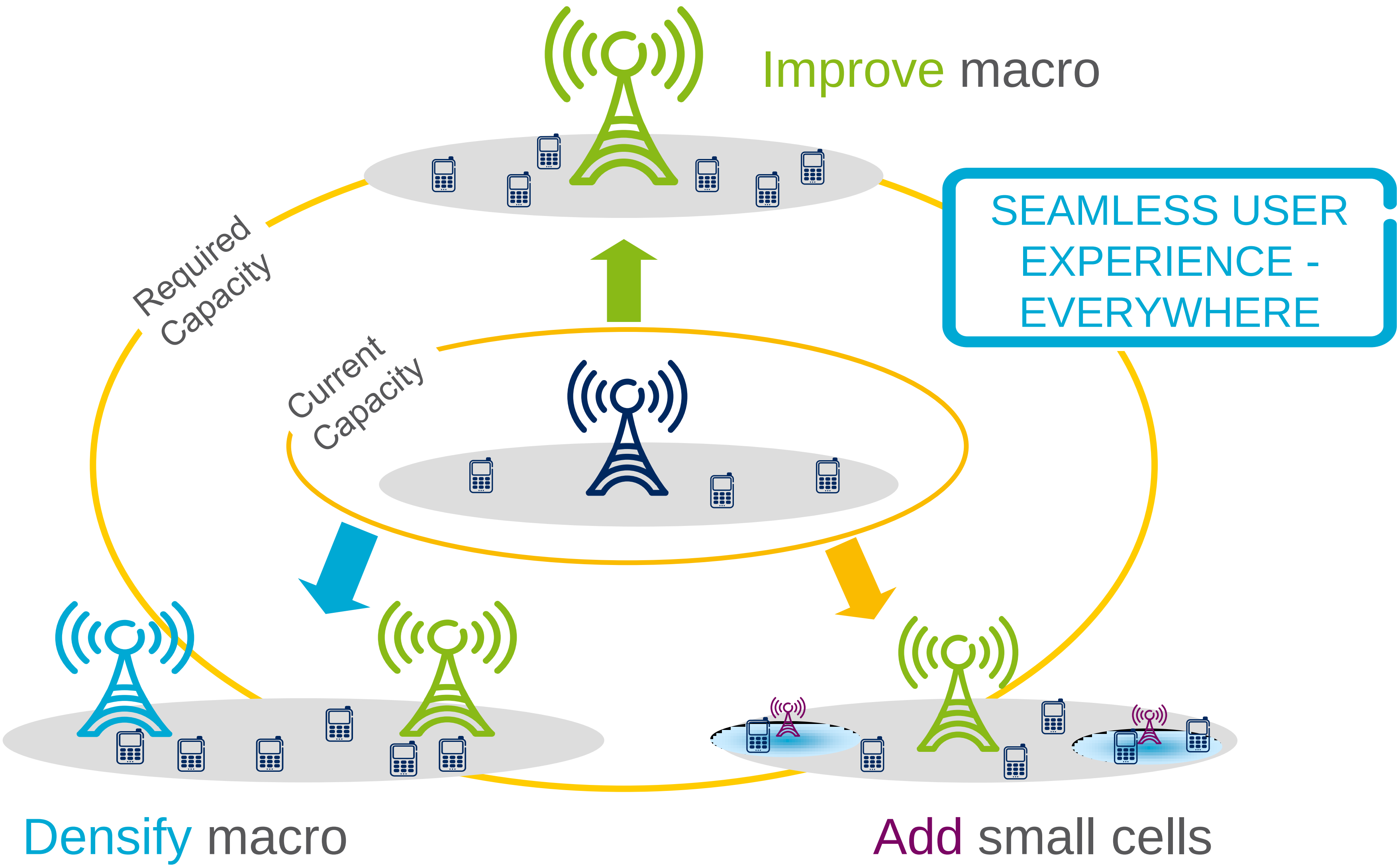
HETEROGENOUS NETWORKS……

… PROVIDING SEAMLESS USER EXPERIENCE–EVERYWHERE

WHAT IS A HETEROGENEOUS NETWORK?

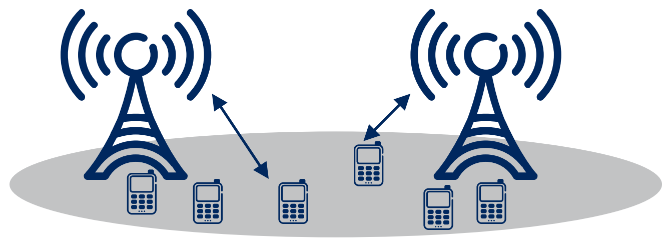


BACKHAUL IMPLICATIONS

1. Improve Macro

Backhaul modernization and capacity upgrades

2. Densify macro



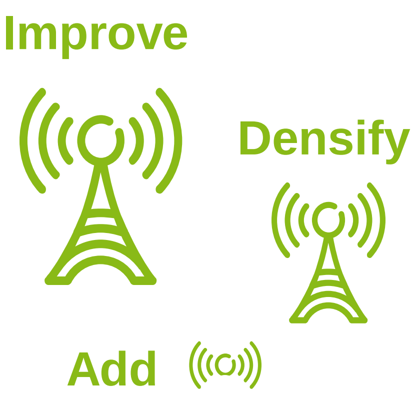
Backhaul expansion and densification

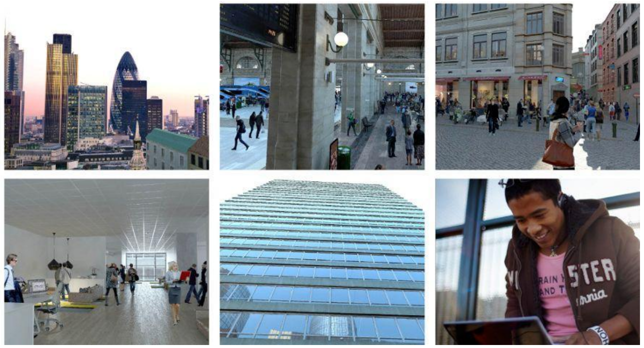
3. Add Small Cells
Additional low power nodes

Backhaul ⇔ coordination

WHEN TO DEPLOY SMALL CELLS?
WHY IS RADIO COORDINATION NEEDED?

- To improve uplink coverage
  - i.e.cell edge throughput
- To increase capacity
  - Capacity improves as coverage improves
- Offload congested macro cells
- Interference coordination between macro and small cells will
  - Boost coverage
  - Boost capacity

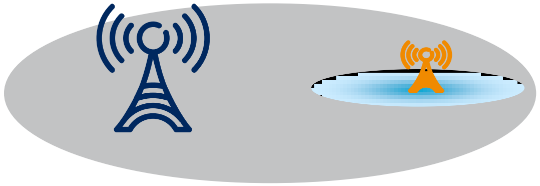




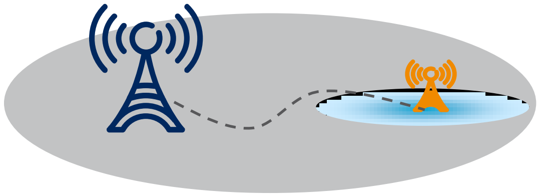
SMALL CELLS FOR
COVERAGE AND CAPACITY

DIFFERENT DEGREES OF MACRO-SMALL CELL COORDINATION

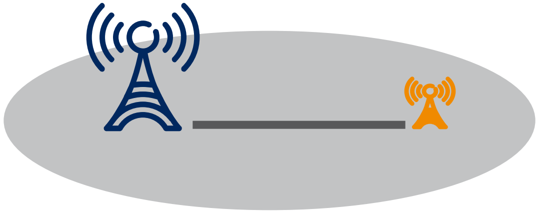
- No coordination
  - Example: Uncoordinated deployment with femtos in a macro network



- Moderate to tight coordination
  - Example: Coordinated deployment of pico RBSs in a macro network
  - SON , Mgmt, Transport, Radio



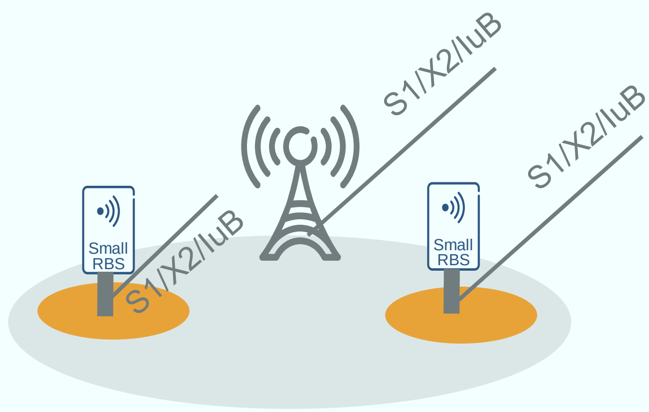
- Very tight coordination
  - Example: Main/remote radio network with joint scheduling (air interface) using CPRI



SMALL CELLS
- ARCHITECTURE OPTIONS

DISTRIBUTED BASEBAND ARCHITECTURE

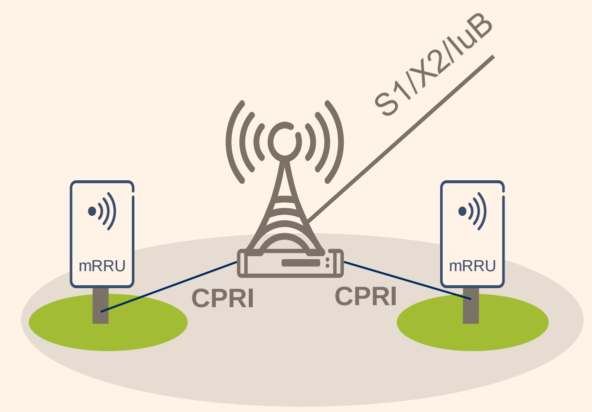
– 'NORMAL' BACKHAUL MACRO-SMALL RBS



- Backhaul: As for macro S1/X2/Iub
- Performance potential: Good
- Coordination: Moderate / Tight

COMMON BASEBAND ARCHITECTURE

– CPRI INTERCONNECTING RADIO UNITS AND BASEBAND



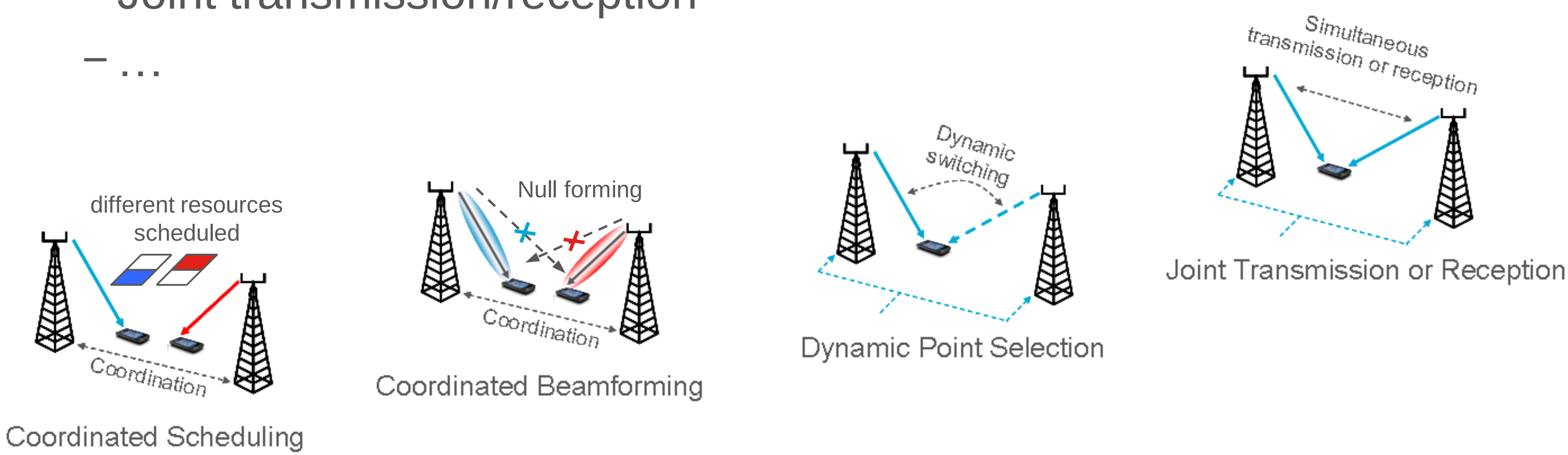
- Backhaul: As for macro S1/X2/Iub
- CPRI: Primarily Dedicated Fibre
- Performance potential: Best
- Coordination: Very Tight

[ADDRESSES DIFFERENT DEPLOYMENT SCENARIOS]

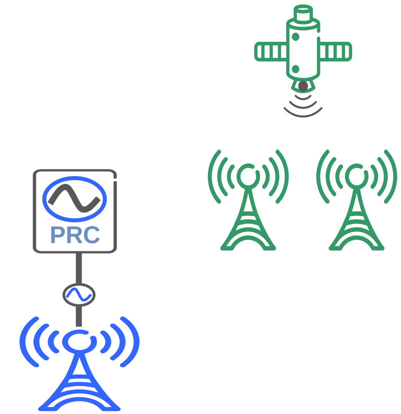
“WHAT IS COMP?”

- RADIO COORDINATION USING COORDINATED MULTIPOINT (COMP) SCHEMES

- Multiple schemes and possibilities, often used in combination
  - Coordinated scheduling
  - Coordinated beamforming (null forming)
  - Dynamic point selection
  - Joint transmission/reception
  - …



TRANSPORT REQUIREMENTS
- FROM RADIO COORDINATION FEATURES



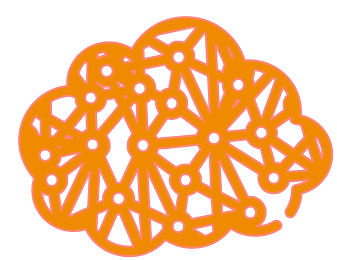
SYNCHRONIZATION

LATENCY

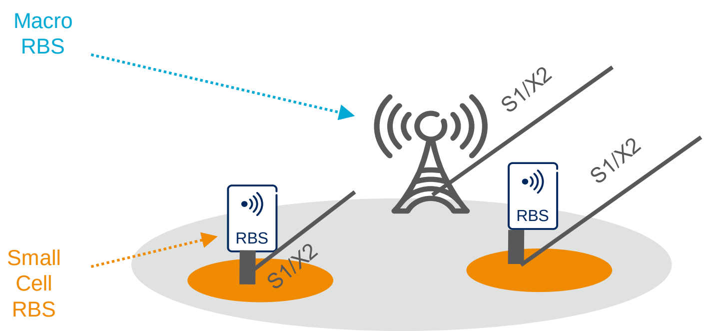
DEMANDS ON THE BACKHAUL

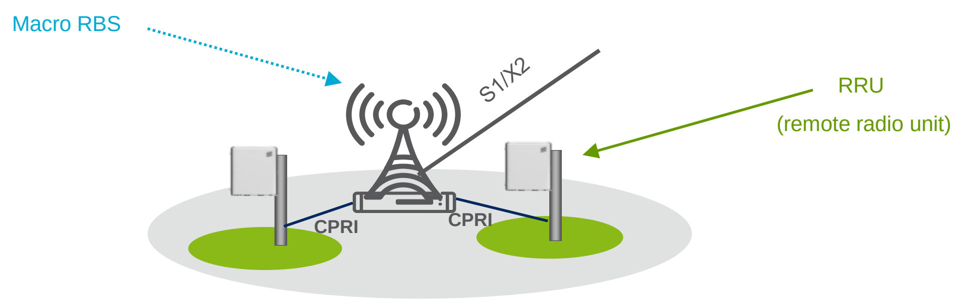
BANDWIDTH

TYPE OF BACKHAUL?



TRANSPORT REQUIREMENTS
- RADIO COORDINATION FEATURES FOR LTE





Type of Radio Coordination	Absolute time accuracy - Applicable at the antenna reference point	Latency (1-way) - Macro..Small Cell	Feature Bandwidth Requirements	Likely Deployment Scenario
Very Tight Co-ordination	+/- 1.5 us	< 0.5 ms	Up to 1Gbps/antenna (internal RBS interface)	› CPRI case only
Tight Co-ordination	+/- 1.5 us	1-10 ms[1]	Medium..Low	› CPRI case › Small Cell RBS, only if low latency + time alignment needs are supported
Moderate co-ordination (time alignment needed)	+/- 5 us	None[2]	Low	› CPRI case › Small Cell RBS, only if time alignment needs are supported
Moderate co-ordination (no time alignment)	None[3]	None[2]	Low	› CPRI case › Small Cell RBS

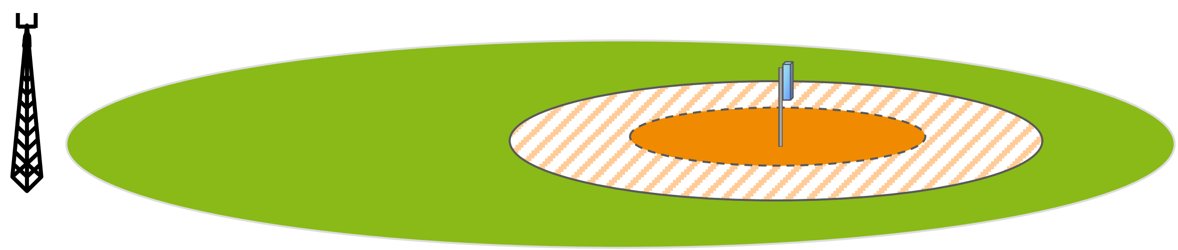
Note1: Performance benefit larger with lower latency

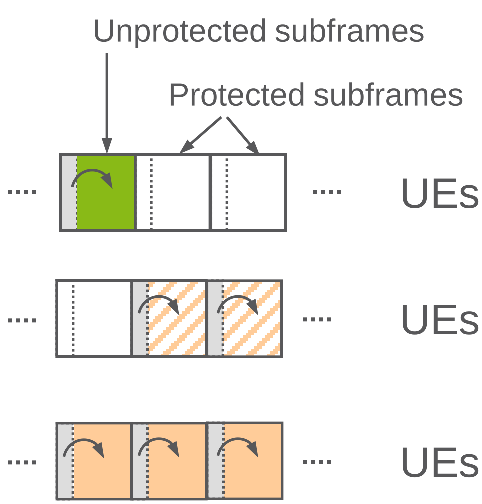
Note2: No special requirements for coordination features

EXAMPLE 1: MODERATE COORDINATION

eICIC - ENHANCED ICIC

- Macro cell avoids scheduling in “protected” subframes
  - Capacity loss in macro layer and pico layer
  - Reduced interference from macro cell in “protected” subframes
- Advanced Rx in Ue required for range expansion
- Cell size: Dense urban environment
- Time alignment: +/-5us required between macro and small cell
- Latency: No special demands
- Bandwidth Needs: Low





UEs in macro cell scheduled in non-protected subframes only

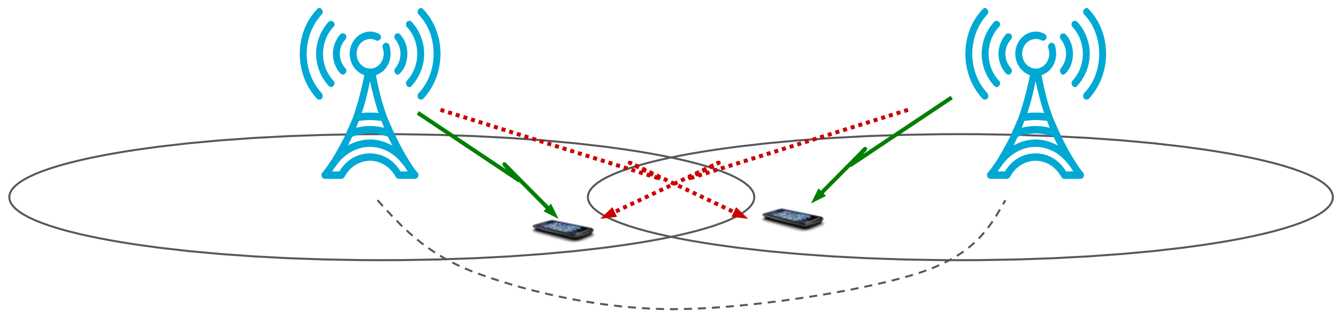
UEs in range expansion zone scheduled in protected subframes only

UEs in inner part of pico cell scheduled in any subframe

TIME ALIGNMENT NEEDED

EXAMPLE 2: TIGHT COORDINATION

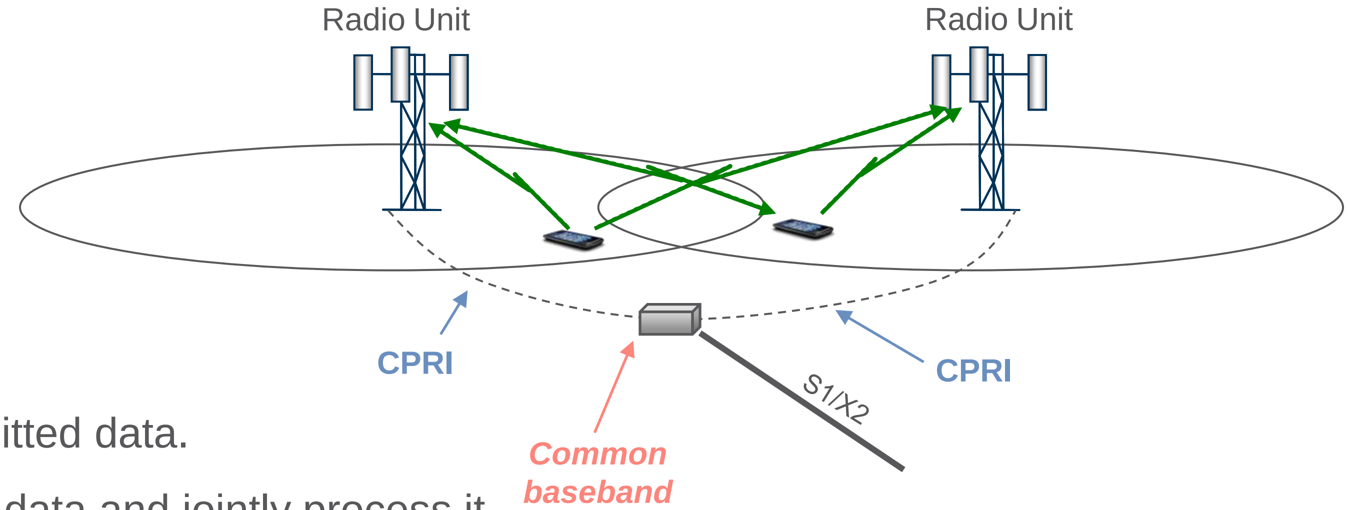
DOWNLINK COORDINATED SCHEDULING



- Share information.
- Based on received information, perform coordinated scheduling
- Cell size: Dense urban environment
- Time alignment: +/-1.5us required between macro and small cell
- Latency: 1..10ms – the lower the latency, the better the cell edge gain
- Bandwidth: Up to 20Mbps, per coordinated cell pair

TIME ALIGNMENT & LOW LATENCY NEEDED

EXAMPLE 3: VERY TIGHT COORDINATION
UL JOINT RECEPTION (UL L1 COMP)



- Schedule UE:s.
- Receive transmitted data.
- Share received data and jointly process it

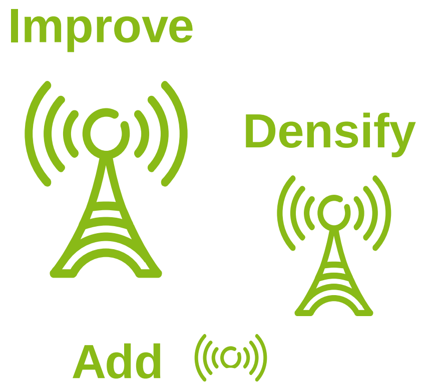
  (Communicate back ACK/NACK to BS responsible to certain UE.)
- Cell size: Dense urban environment
- Time alignment: +/-1.5us required between cells
- Latency: <0.5ms one way
- Bandwidth: 1Gbps per antenna,

  internal RBS interface
- **No impact on mobile backhaul**

TIME ALIGNMENT, HIGH BW & VERY LOW LATENCY => BASEBAND INTERNAL ONLY

SUMMARY

- Some radio coordination features require Time Alignment between radio subframes
- CoMP features:
  - Optional, radio coordination features
  - Cost of deployment vs actual gain must be considered
- Radio coordination features with very stringent synchronization, BW and latency demands realistically will be run only over CPRI
- CPRI is an internal RBS interface, not part of mobile backhaul



TIME ALIGNMENT OF <+/-5US OVER X2 FOR *SOME* FEATURES

ACRONYMS

- **CPRI**: Common Public Radio Interface
- **CoMP**: Coordinated Multipoint
- **eICIC**: Enhanced Inter Cell Interference Coordination
- **EPC**: Evolved Packet Core
- **RRU**: Remote Radio Unit
- **UE**: User Equipment
- **X2**: Standardized interface between LTE RBSs
- **S1**: Standardized interface between LTE RBS and EPC
- **SON**: Self Optimizing Networks

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