



Methods for Interference Coordination in LTE Networks

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Life is for sharing.

Outline

- What's already there?
Overview on Interference Coordination in LTE Release 8
- What's going to come?
Multi Layer Networks with Femto Cells
- Exemplary interference coordination algorithms from literature
- Conclusions



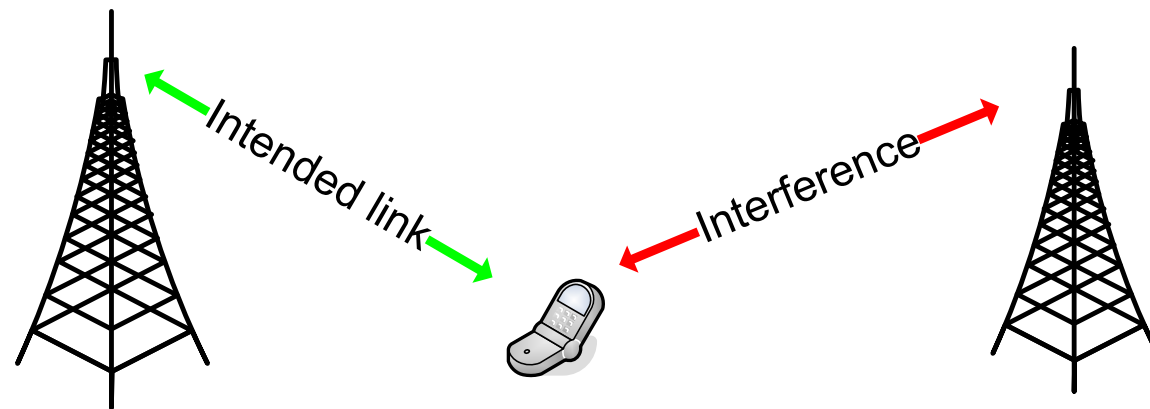
What's already there?

Overview on Interference Coordination in LTE Release 8

Overview on Interference Coordination in LTE Release 8

Existing mechanisms in the standard

- Three indicators to be transmitted via X2 interface
- Scheduler using CQI feedback



Communication via X2 interface:

- Overload indicator (Uplink)
- High interference indicator (Uplink)
- Relative narrowband transmission power indicator (Downlink)

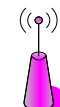
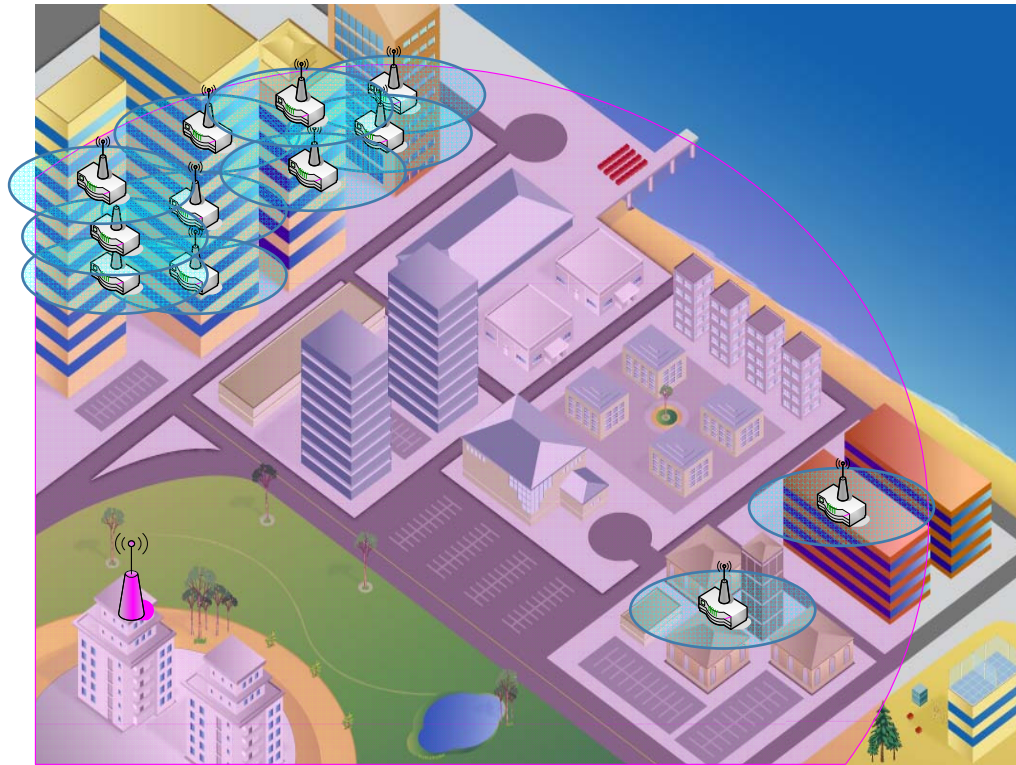


What's going to come?

Multi Layer Networks with Femto Cells

Multi Layer Networks with Femto Cells

Overview



Macro Cell



Femto Cell



Multi Layer Networks with Femto Cells

What's realistic to assume?

- Very high number of femto cells in one macro cell sector
- Femto cells have to be cheap!
 - Reduced functionality
- Macro cell will most probably have no information about femto cells in it's area
- Communication between femto cells and macro cells for interference coordination would have to be standardized and is complicated
- Closed subscriber group



Implications

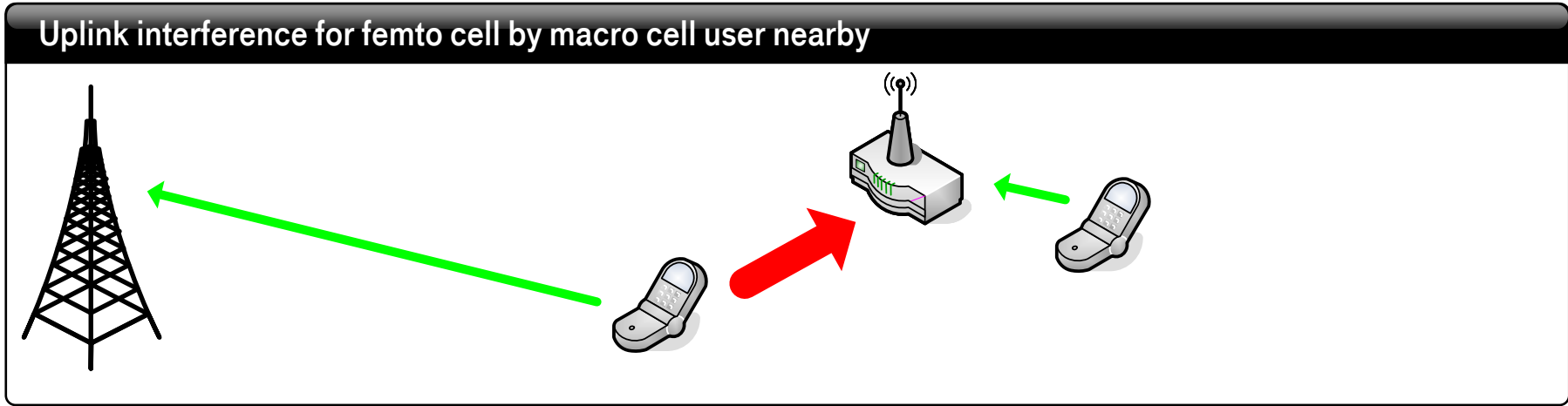
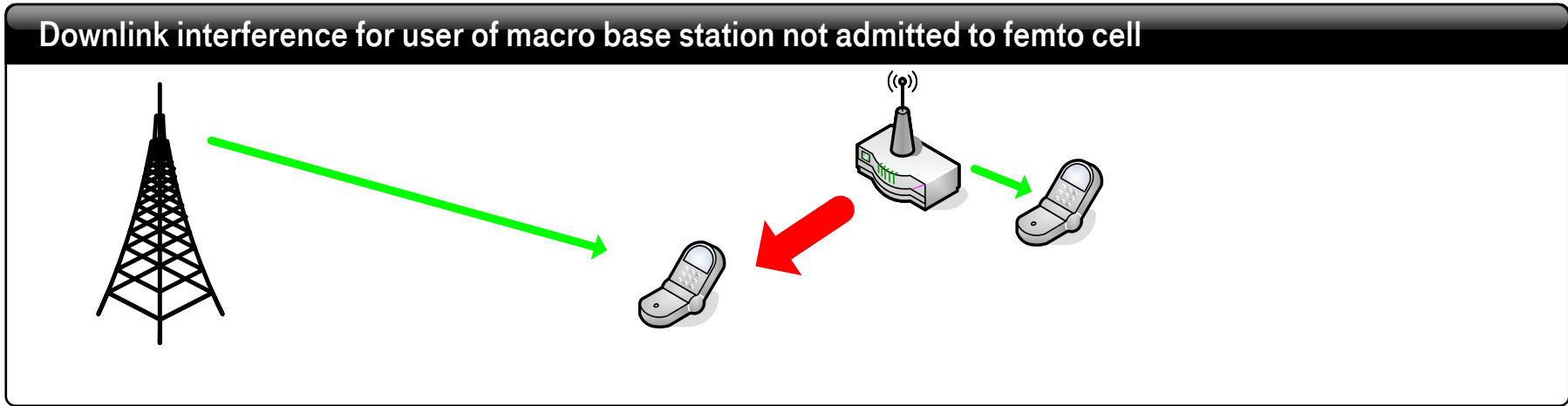
- Configuration by operator not realistic (too high effort)
- Self-configuration
 - Femto cell has to sense it's environment via
 - Integrated receiver
 - UE measurement report
- Interference coordination algorithms without communication more realistic
- Close subscriber groups create new interference scenario

New methods for interference coordination needed!



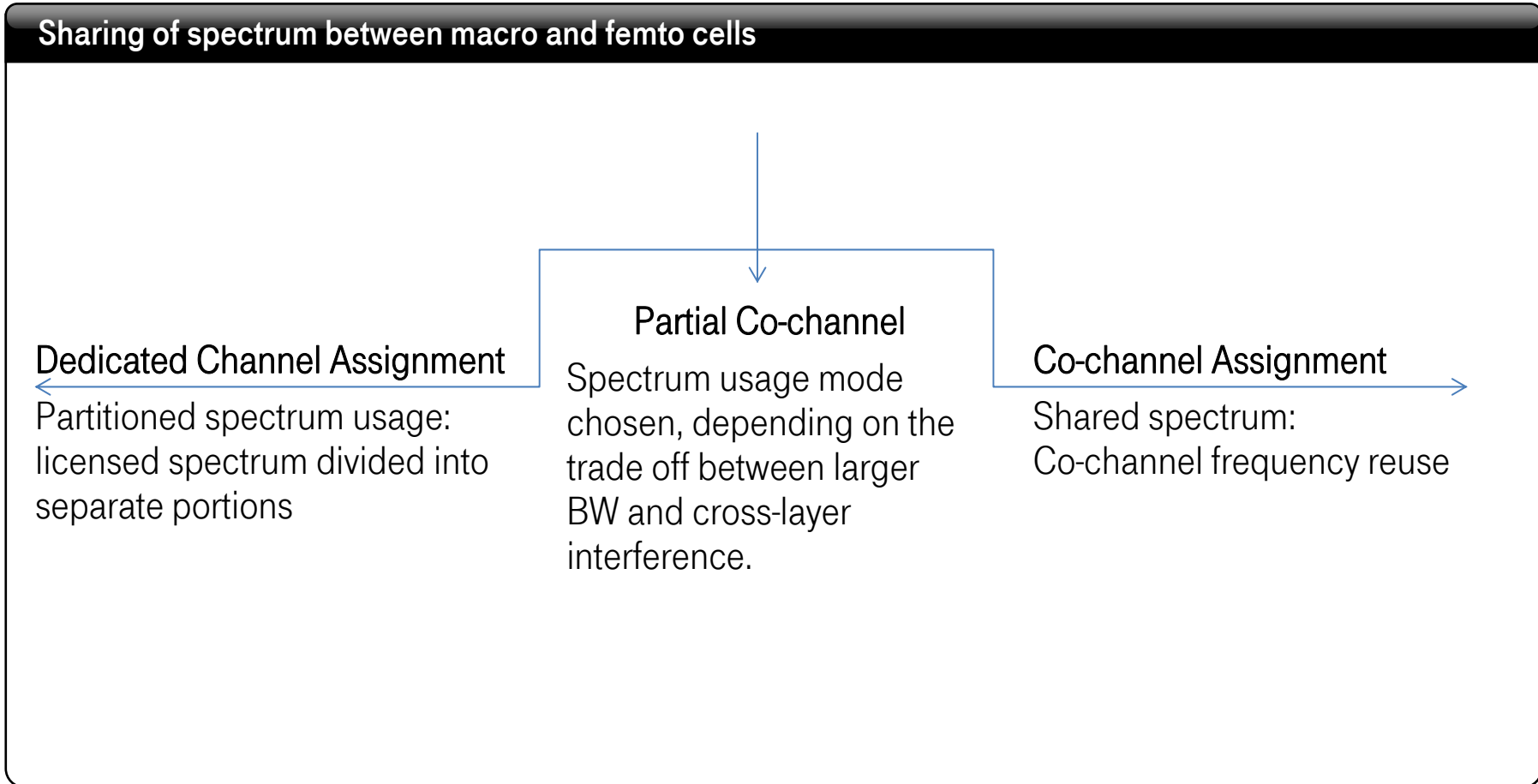
Multi Layer Networks with Femto Cells

Closed subscriber group interference scenario



Multi Layer Networks with Femto Cells

Spectrum allocation



Exemplary interference coordination algorithms from literature

Exemplary interference coordination algorithms from literature

Femto Interference Pool

Source: Yi Wu "A Novel Spectrum Arrangement Scheme for Femto Cell Deployment in LTE Macro Cells"

Criteria for adding a user into the FIP:

UE moving speed:
(Low speed macro UE is threat to femtocell)

- Doppler Frequency Estimation
- Handover rate

Femto aware CQI reporting:
If CQI difference between the two bands exceeds a certain threshold

Femto-interference Pool:
Macro BS schedules UE having potential threat on femtocells here

No communication between femto and macro cell needed.

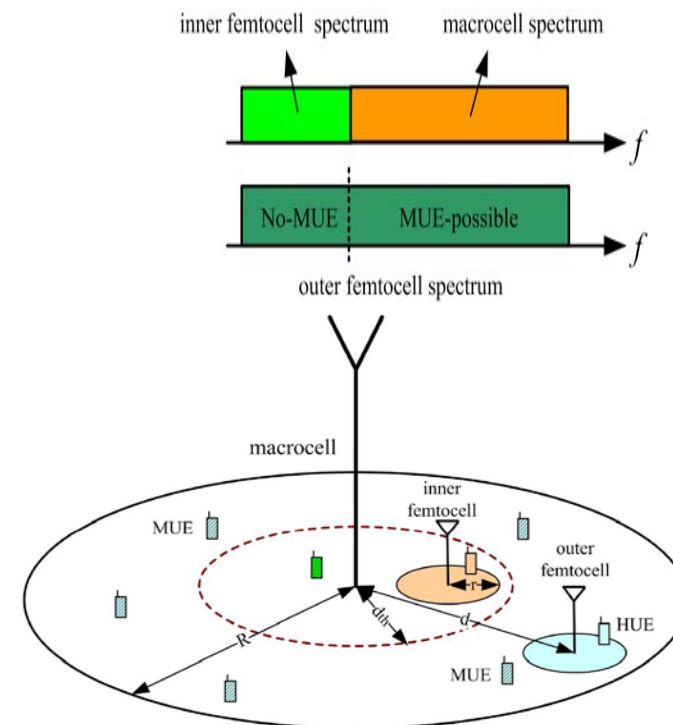


Exemplary interference coordination algorithms from literature

Hybrid Spectrum Sharing with Inner Femtocells

Source: Yong Bai "Resource Coordination and Interference Mitigation between Macrocell and Femtocell"

- Femto cells divided into inner and outer cells
- Inner femto cells: Orthogonal mode with macro BS
- Outer femto cells: Co-channel mode with macro BS
- Uplink: Outer femto cell always has a spectrum part that is not used by macro UEs (MUEs)
→ UL interference from MUEs to femto cell can be avoided.
- Downlink: FBS interfering MUE remains
 - Two approaches proposed to solve this
 - Require communication from macro cell to femto cell or MUE to femto cell.



Exemplary interference coordination algorithms from literature

Limited access

Source: A. Valcarce et al. "Limited Access to OFDMA Femtocells"

- Femto Cell: Closed user group, but:
 - Allow non-subscribers to access a limited amount of the femto cell resources
 - Non-subscribers should first try to connect to macro cell
 - A non-subscriber can be denied due to insufficient PRBs, i.e. if there are not enough PRBs left to guaranty minimal necessary throughput for this user.
- As soon non-subscriber is granted access it does not:
 - Produce uplink interference to the femto cell
 - Suffer from downlink interference by femto cell
- Commercially challenging, but not as much as open femto cell



Conclusions

Summary

- Multi layer networks create new interference scenarios
 - Esp. femto cells with closed user groups
- LTE release 8 interference coordination mechanisms not sufficient for multi layer networks
- Many promising concepts in literature
- Communication for interference coordination is critical
 - Mass market (home use): Maybe no communication possible at all
 - Enterprise solutions (office buildings): Communication between femto cells via backbone might be possible (→WiFi controllers)



Thanks for your attention!