Future Network & Mobile Summit 2013

Lisbon, July 5th, 2013

Impact of femtocell positions on traffic sharing in LTE enterprise scenarios

J.M. Ruiz Avilés, Salvador Luna Ramírez, M. Toril

Mobile Network Optimization Group

Communications Engineering Dept., University of Málaga, Spain

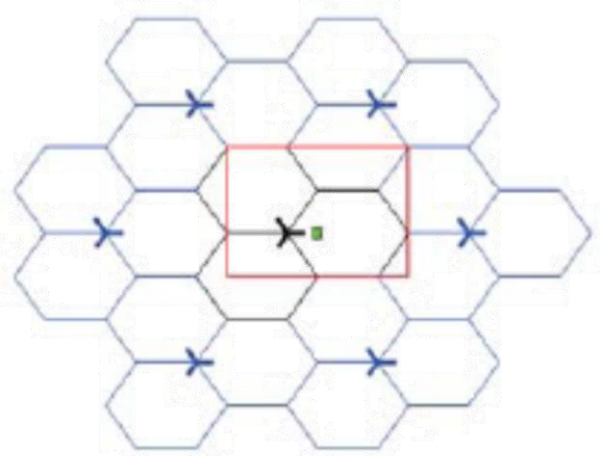
Outline

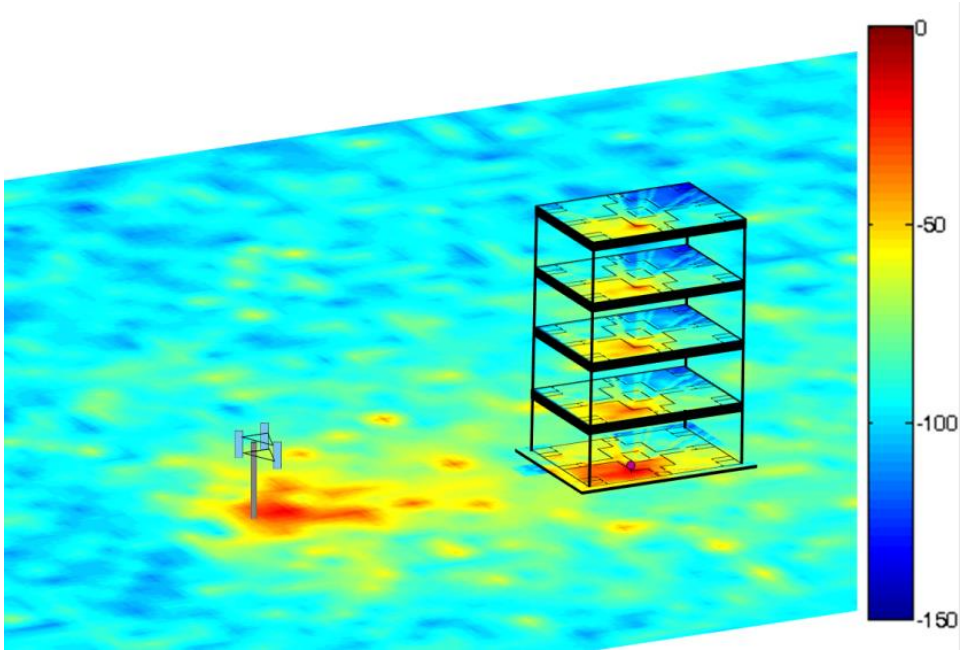
Outline

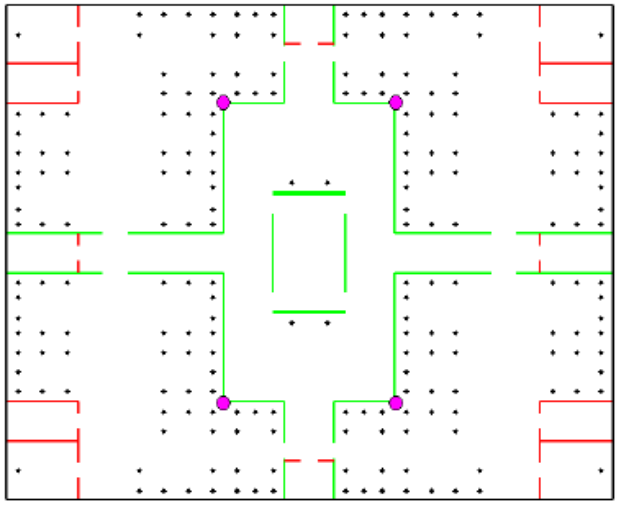
Introduction

- Previous work (COST meetings): Traffic Sharing Techniques in Enterprise LTE Femtocells

- Previous contribution
  a. Enterprise (opened) femtocell scenario (regular layout).







Introduction

- Previous work (COST meetings): Traffic Sharing Techniques in Enterprise LTE Femtocells

- Previous contribution
  a. Enterprise (opened) femtocell scenario (regular layout).
  b. LTE dynamic system-level simulator
     - ✓ Propagation models (WINNER II)
     - ✓ Mobility model (traces)

Introduction

- Previous work (COST meetings): Traffic Sharing Techniques in Enterprise LTE Femtocells

- Previous contribution
  a. Enterprise (opened) femtocell scenario (regular layout).
  b. LTE dynamic system-level simulator
     - ✓ Propagation models (WINNER II)
     - ✓ Mobility model (traces)
  c. Several traffic sharing techniques are tested with service area changes (HO margins and power transmission)

HO margin changes: (i,j)

Transmission power changes: (i)

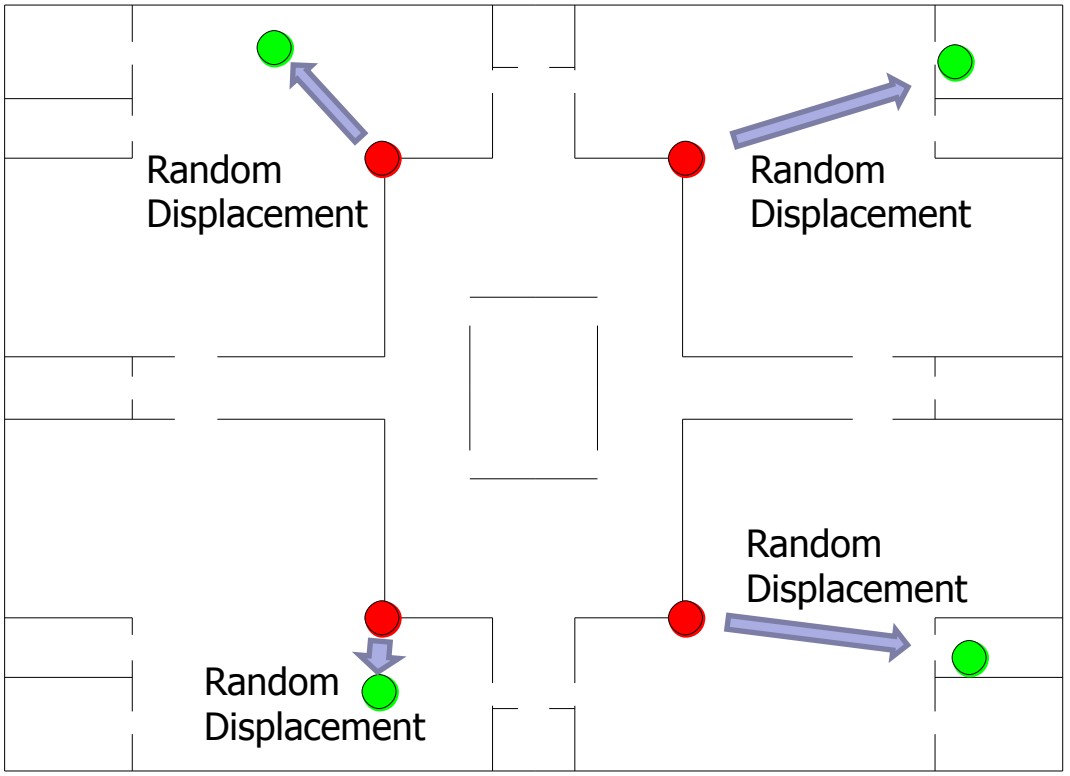
$$RxLEV(j) - RxLEV(i) \geq Margin_{PBGT}(i,j)$$

$\Delta P_{TX}(j)$ $\Delta P_{TX}(i)$ $\Delta Margin_{PBGT}(i,j)$

Introduction

- Additional performance assesment

The impact of femtocell positions (irregular layout) on traffic sharing techniques capability is evaluated.

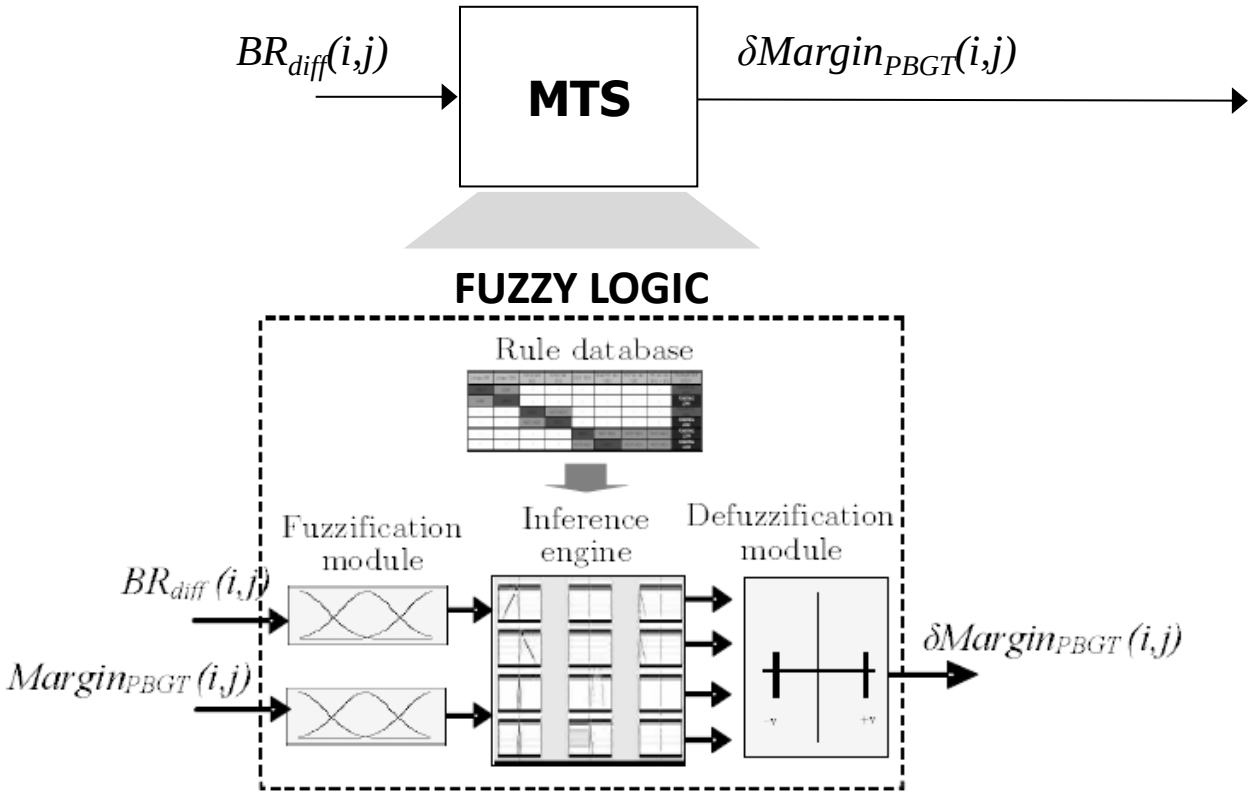


Outline

Algorithm outline

Basic algorithms (Individual approaches)

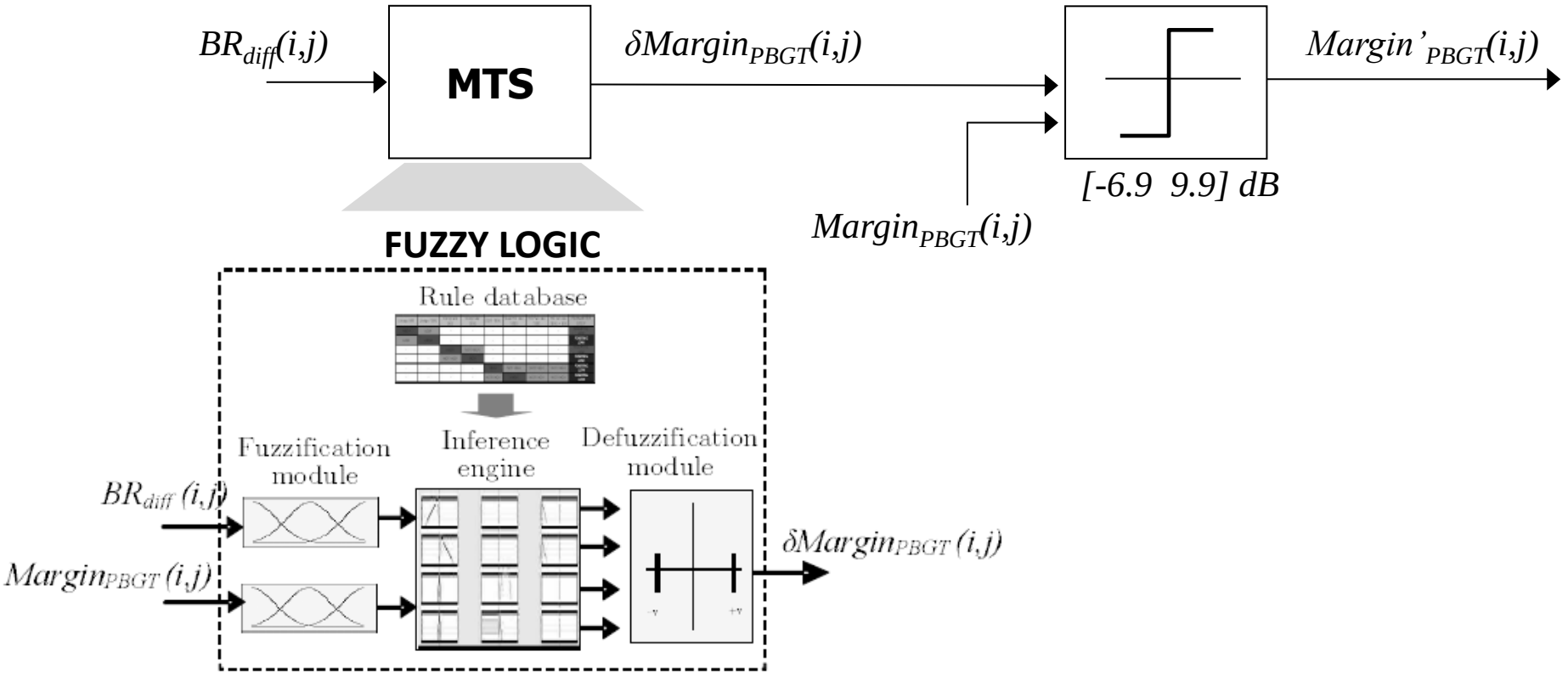
1) **MTS:** HO margin modifications depending on Blocking ratio differences (adjacent basis)



Algorithm outline

Basic algorithms (Individual approaches)

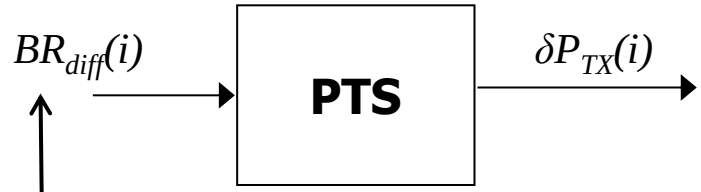
1) **MTS:** HO margin modifications depeding on Blocking differences (adjacent basis)
2) **MTSC:** Similar to MTS, but margin changes are restricted to a limited interval so as to avoid connection quality problems.



Algorithm outline

Basic algorithms (Individual approaches)

1) **MTS:** HO margin modifications depeding on Blocking differences (adjacent basis)
2) **MTSC:** Similar to MTS, but margin changes are restricted to a limited interval so as to avoid connection quality problems.
3) **PTS:** Tx power modifications depending on blocking differences (cell basis)

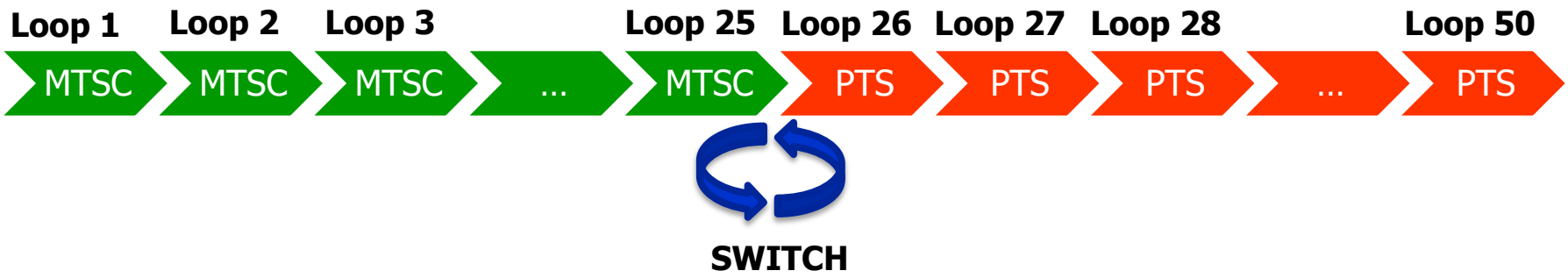


$$BR_{\text{diff}}(i) = BR(i) - \frac{\sum_{j \in N(i)} BR(j)}{|N(i)|}$$

Algorithm outline

Strategies (Combining individual approaches. 50 optimization loops)

1) **MTSC-PTS:** MTSC is enabled only for the first 25 loops and PTS is then activated for the rest of the simulation.

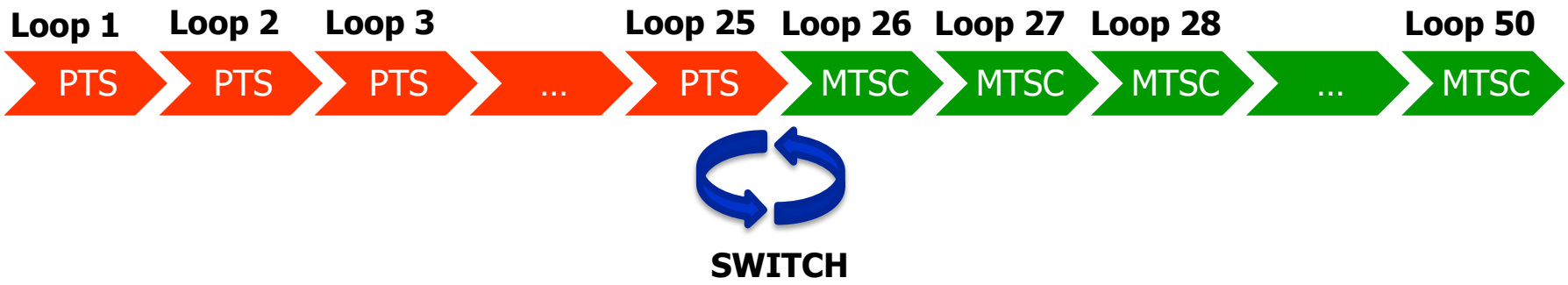


Algorithm outline

Strategies (Combining individual approaches. 50 optimization loops)

1) **MTSC-PTS:** MTSC is enabled only for the first 25 loops and PTS is then activated for the rest of the simulation.

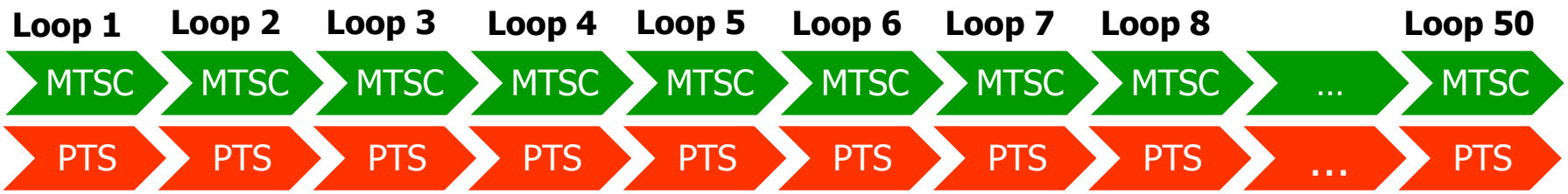
2) **MTSC-PTS:** PTS is enabled only for the first 25 loops and MTSC is then activated for the rest of the simulation.



Algorithm outline

Strategies (Combining individual approaches. 50 optimization loops)

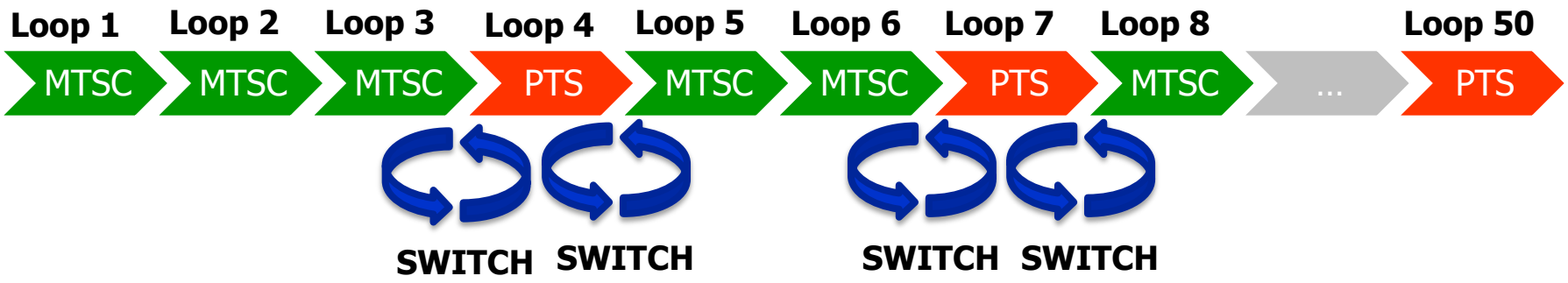
1) **MTSC-PTS:** MTSC is enabled only for the first 25 loops and PTS is then activated for the rest of the simulation.
2) **MTSC-PTS:** PTS is enabled only for the first 25 loops and MTSC is then activated for the rest of the simulation.
3) **MTSC&PTS:** Both MTSC and PTS are executed simultaneously in all the 50 loops.



Algorithm outline

Strategies (Combining individual approaches. 50 optimization loops)

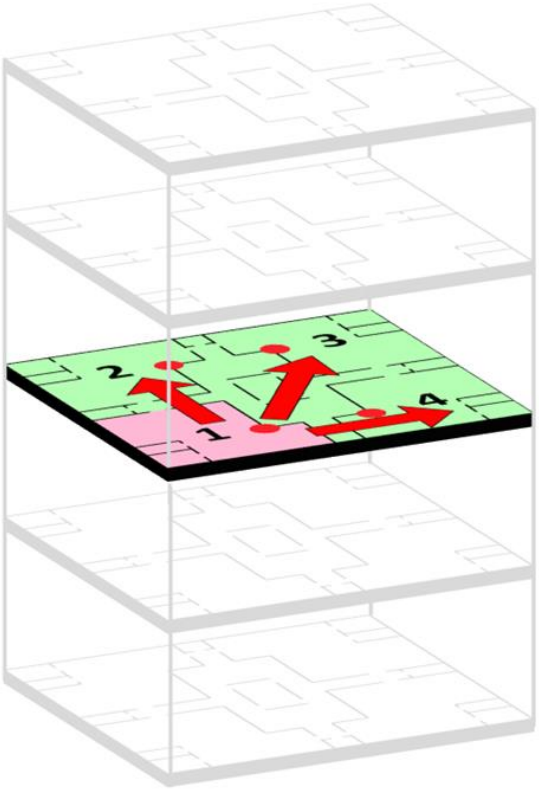
1) **MTSC-PTS:** MTSC is enabled only for the first 25 loops and PTS is then activated for the rest of the simulation.
2) **MTSC-PTS:** PTS is enabled only for the first 25 loops and MTSC is then activated for the rest of the simulation.
3) **MTSC&PTS:** Both MTSC and PTS are executed simultaneously in all the 50 loops.
4) **CTS:** MTSC is activated first. Then, switching to PTS occurs when MTSC cannot improve network performance (MTSC reachs its limits or traffic balance is reached).



Analysis set-up

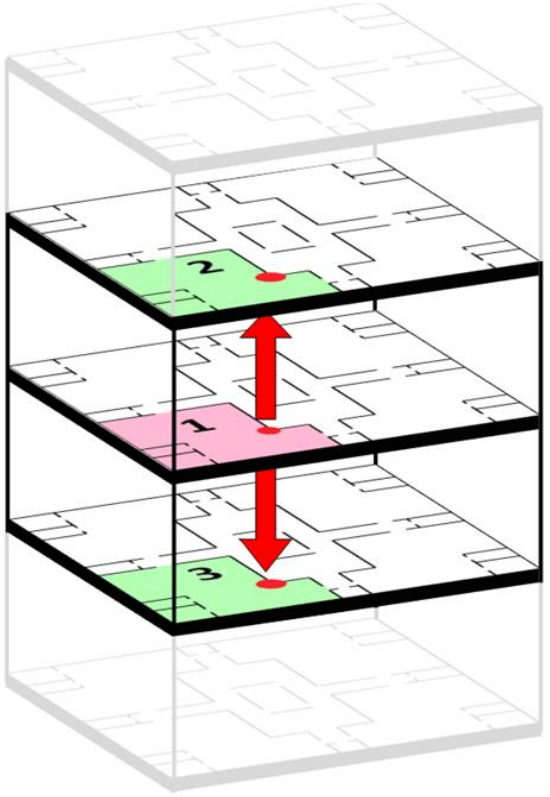
Scenarios

Scenario 1



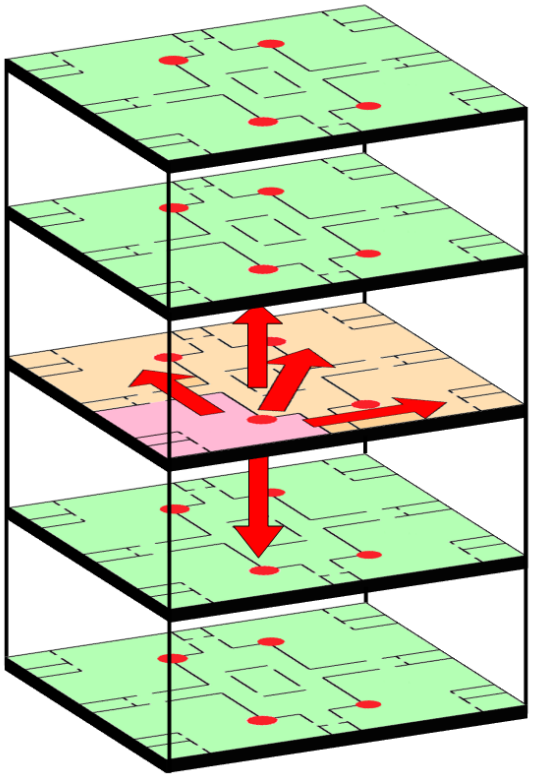
Traffic sharing in the same floor

Scenario 2



Traffic sharing between different floors

Scenario 3



Complex scenario

Analysis set-up

Simulations

10 simulations with different femtocell positions (**irregular layout**) per each of the following cases have been carried out:

1) **S1 MTS.** Algorithm MTS in scenario 1.
2) **S1 MTSC.** Algorithm MTSC in scenario 1.
3) **S1 PTS.** Algorithm PTS in scenario 1.
4) **S2 PTS.** Algorithm PTS in scenario 2.
5) **S3 MTSC-PTS.** Strategy MTSC-PTS in scenario 3.
6) **S3 PTS-MTSC.** Strategy PTS-MTSC in scenario 3.
7) **S3 MTSC&PTS.** Strategy MTSC&PTS in scenario 3.
8) **S3 CTS.** Strategy CTS in scenario 3.

Results are compared with **regular layout** simulated in previous work (benchmark).

Performance indicators

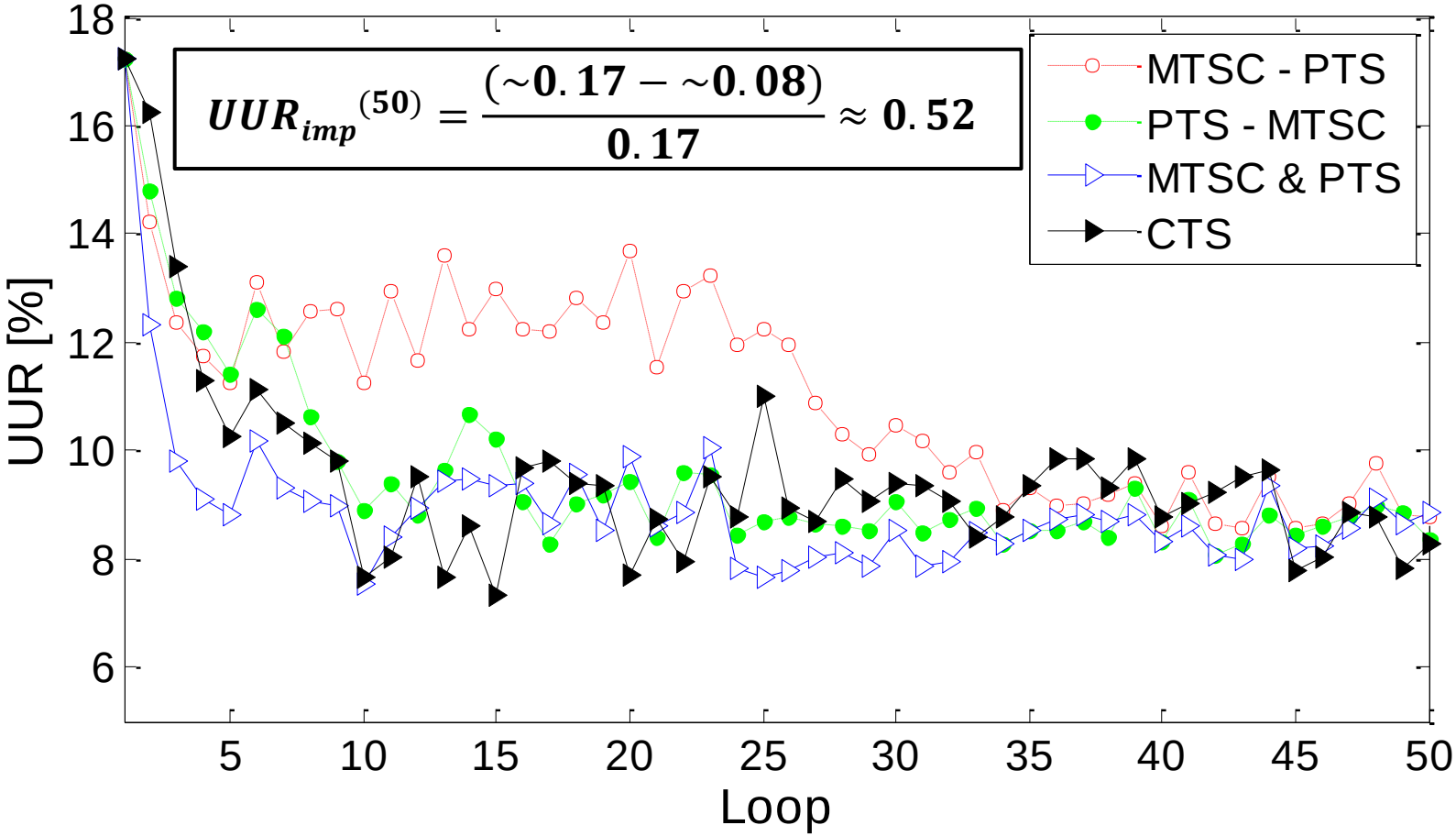
CBR = Blocked calls / total calls

OR = Unserved time / (served time + unserved time)

$$\Rightarrow \boxed{UUR^{(0)} = BR + OR(1 - BR)} \qquad \boxed{UUR_{imp}{}^{(n)} = \frac{(UUR^{(0)} - UUR^{(n)})}{UUR^{(0)}}}$$

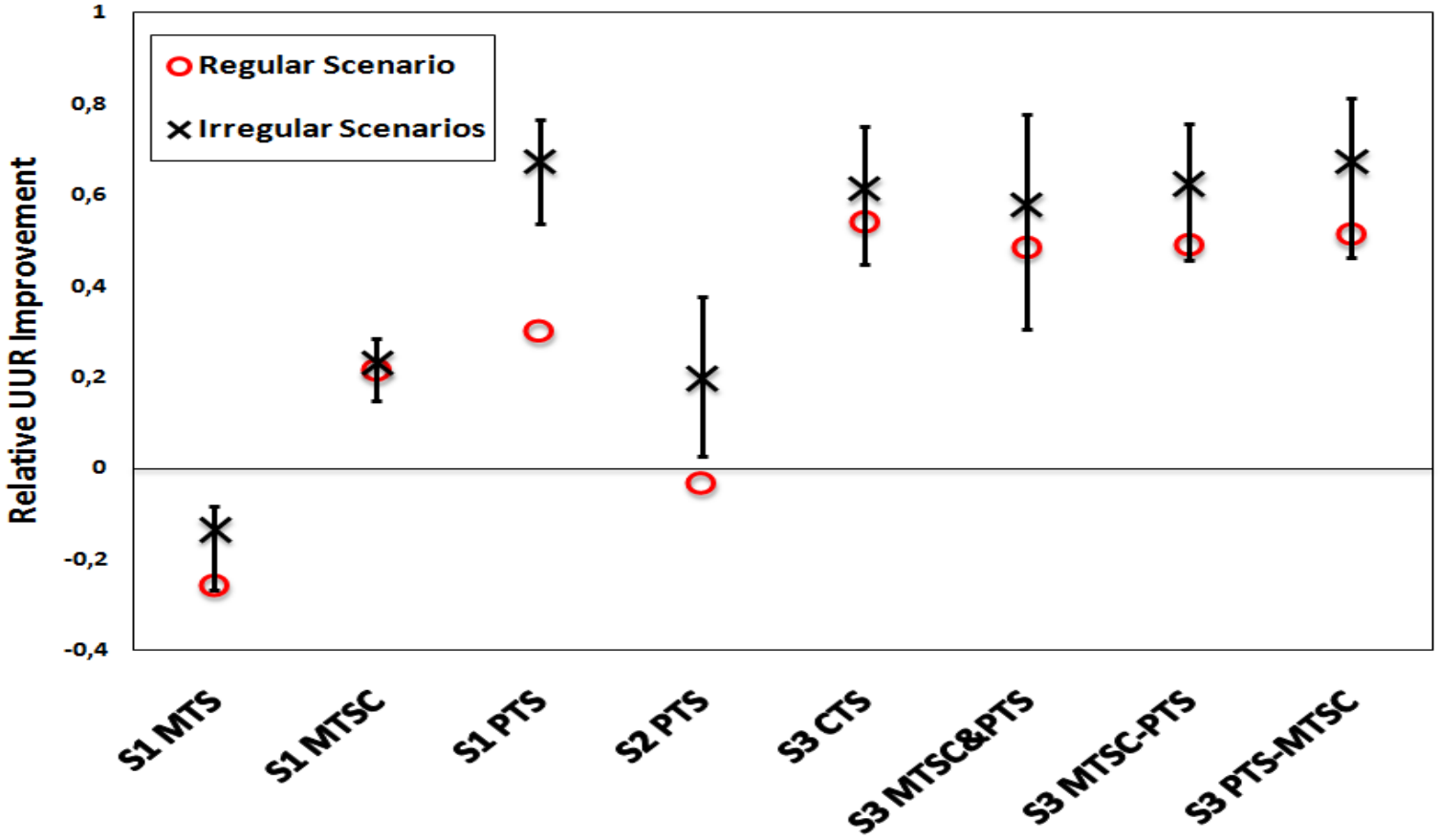
Results

Benchmark results (Regular layout in Scenario 3)



⇒ Any of the strategies reach a $UUR_{imp}^{(50)}$ higher than 40%.

Results (Irregular layout)



⇒ Regular layout can be considered as a worst case for S1 MTS, S1 PTS and S2 PTS, and a representative case for S1 MTSC, S3 CTS, S3 MTSC&PTS, S3 MTSC-PTS and S3 PTS-MTSC.

Results

Results. **S3 CTS**

Positions	$UUR^{(0)}$	$min(UUR)$	$UUR^{(50)}$	max(UUR_{imp})
Regular	17,2%	7,44%	7,87%	56,74%
Irr. 1	20,9%	4,36%	5,24%	79,14%
Irr. 2	11,2%	3,55%	4,15%	68,30%
Irr. 3	4,57%	2,15%	2,52%	52,95%
Irr. 4	10,4%	3,66%	4,33%	64,81%
Irr. 5	18,3%	6,64%	7,57%	63,72%
Irr. 6	16,5%	6,1%	7,11%	63,03%
Irr. 7	10,4%	2,93%	3,59%	71,83%
Irr. 8	20%	5,14%	5,93%	74,30%
Irr. 9	16,1%	4,38%	5,18%	72,80%
Irr. 10	8,16%	2,69%	3,94%	67,03%

$\Rightarrow$ Maximum UUR_{imp} is between **79.14%** (best) and **52.95%** (worst).

$\Rightarrow$ This is a clear evidence of the robustness of CTS strategy, wherever femtocells are located.

Results

Results. **S3 MTSC&PTS**

Positions	$UUR^{(0)}$	$min(UUR)$	$UUR^{(50)}$	max(UUR_{imp})
Regular	17,2%	7,52%	8,86%	56,28%
Irr. 1	20,9%	4,41%	5,2%	78,90%
Irr. 2	11,2%	3,54%	4,25%	68,39%
Irr. 3	4,57%	2,21%	2,56%	51,64%
Irr. 4	10,4%	3,26%	3,67%	68,65%
Irr. 5	18,3%	6,06%	7,01%	66,89%
Irr. 6	16,5%	5,99%	6,65%	63,70%
Irr. 7	10,4%	1,43%	2,32%	86,25%
Irr. 8	20%	7,25%	10,3%	63,75%
Irr. 9	16,1%	7,43%	11,2%	53,85%
Irr. 10	8,16%	2,75%	3,74%	66,30%

$\Rightarrow$ Maximum UUR_{imp} is between **86.25%** (worst) and **51.64%** (best).

$\Rightarrow$ This is a clear evidence of the robustness of MTSC&PTS strategy, wherever femtocells are located.

Conclusions

- The impact of femtocell access point positions when redistributing traffic demand between LTE femtocells in an enterprise scenario have been analyzed.
- Several traffic sharing techniques have been tested with different positions of femtocells access points. Regular layout (previously simulated) and irregular layout have been compared.
- Results show that **regular layout can be considered as a worst case** in terms of traffic sharing capability (representative case in some scenarios).
- In the worst case, the UUR_{imp} for combined strategies in irregular scenarios is higher than 50%. A clear evidence of the traffic sharing techniques **robustness**.