Impact of Interference Between Local 5G Networks

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Introduction

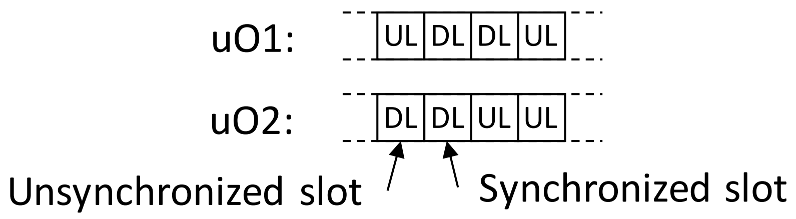
- With 5G the interest to allow also other stakeholders to deploy and operate local high-quality (indoor) networks has been increasing.
- Challenge: Provide an interference-free operation for the local license holders while not restricting the efficiency of the spectrum usage.
  - Required minimum separation distance between the operators

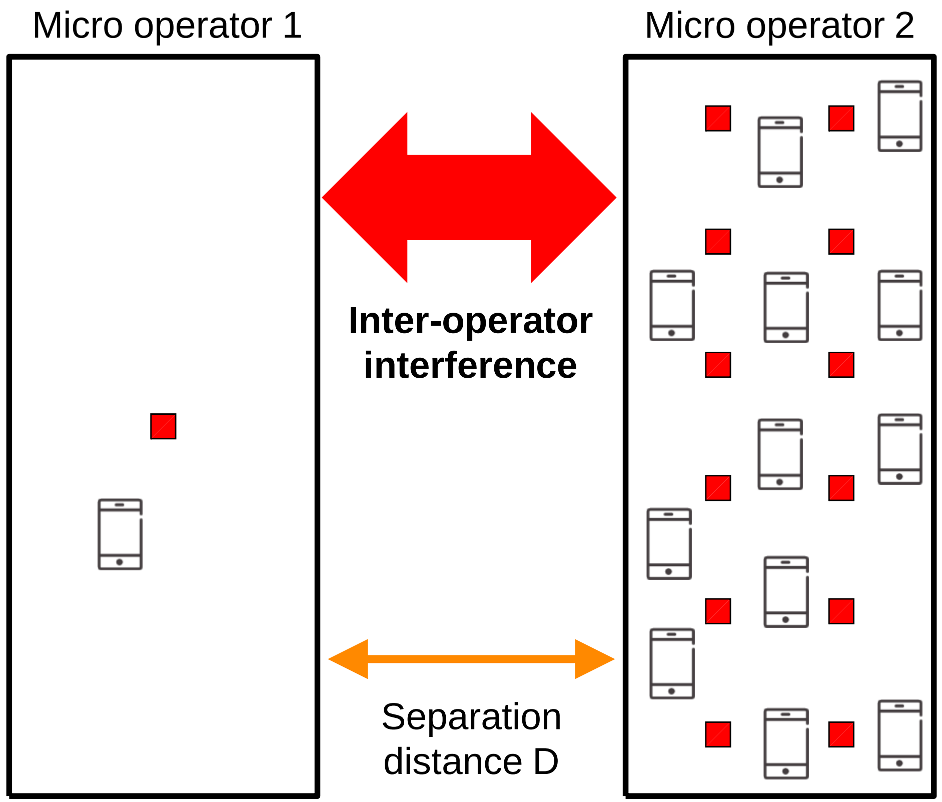
- This presentation will show some highlights of the performance evaluations done within the uO5G project

Kimmo Hiltunen, Marja Matinmikko-Blue, “Performance of Neighboring Indoor 5G Micro Operators with Dynamic TDD”, in Proc. EuCNC 2018

Micro Operator Deployment Scenario

- Two micro operators inside neighboring buildings.
  - Micro operator 1: victim
  - Micro operator 2: interferer
- Micro operators are sharing the same channel at 3.5 GHz.
- Micro operators are uncoordinated and utilizing dynamic TDD.
  - 50:50 DL:UL ratio in average





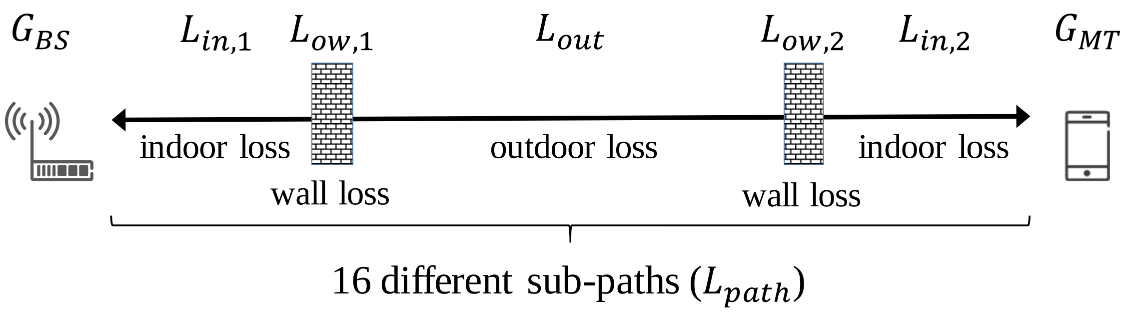
”Traditional” buildings in LOS with each other

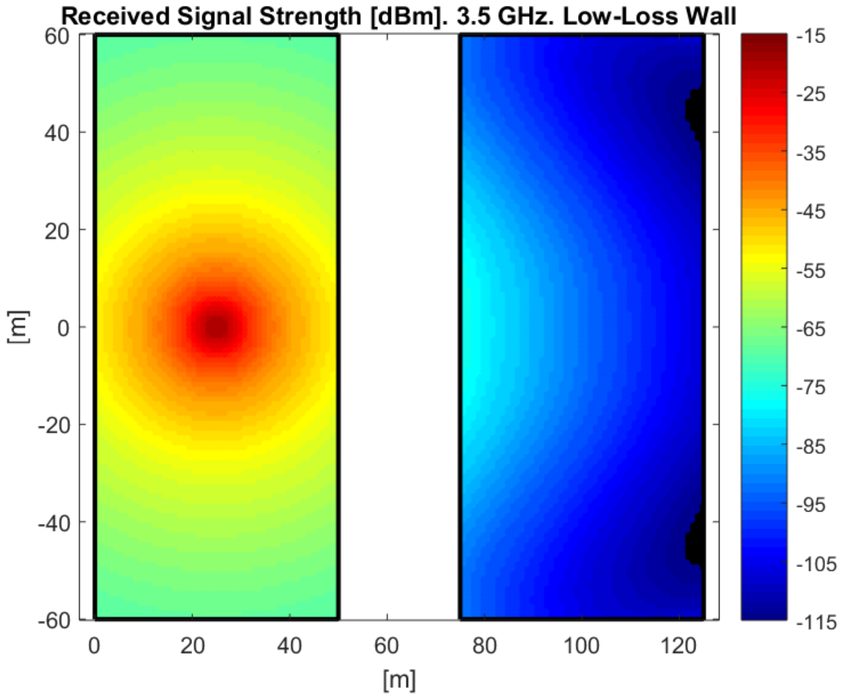
Propagation Model

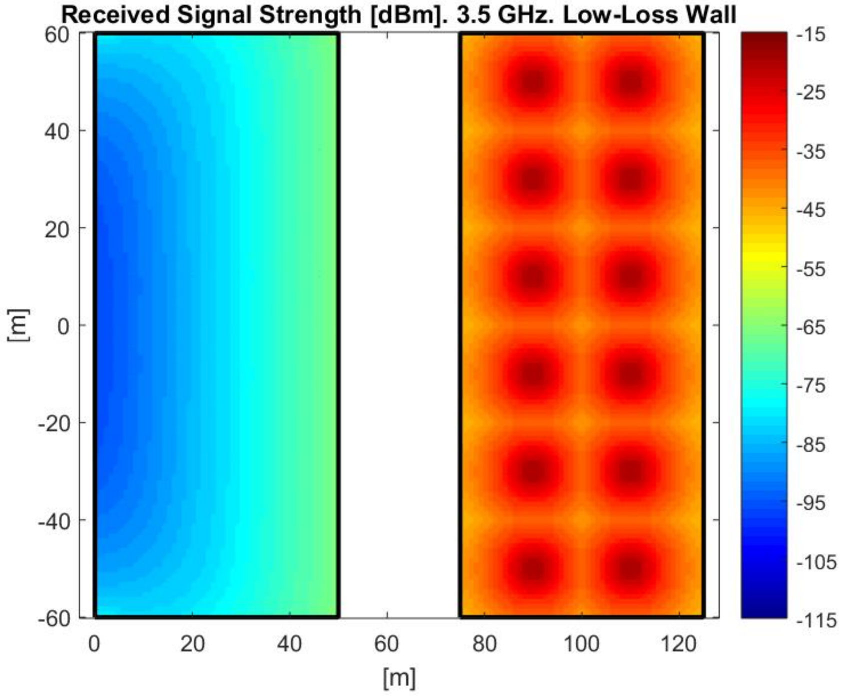
- **Indoor propagation**
  - 3GPP Indoor Hotspot – Mixed Office
  - Omnidirectional antennas

- **Building-to-building propagation**

  Kimmo Hiltunen, Marja Matinmikko-Blue, “Propagation Model for Evaluating the Interference Between Neighboring Indoor Micro Operators”, in Proc. VTC 2018 Spring

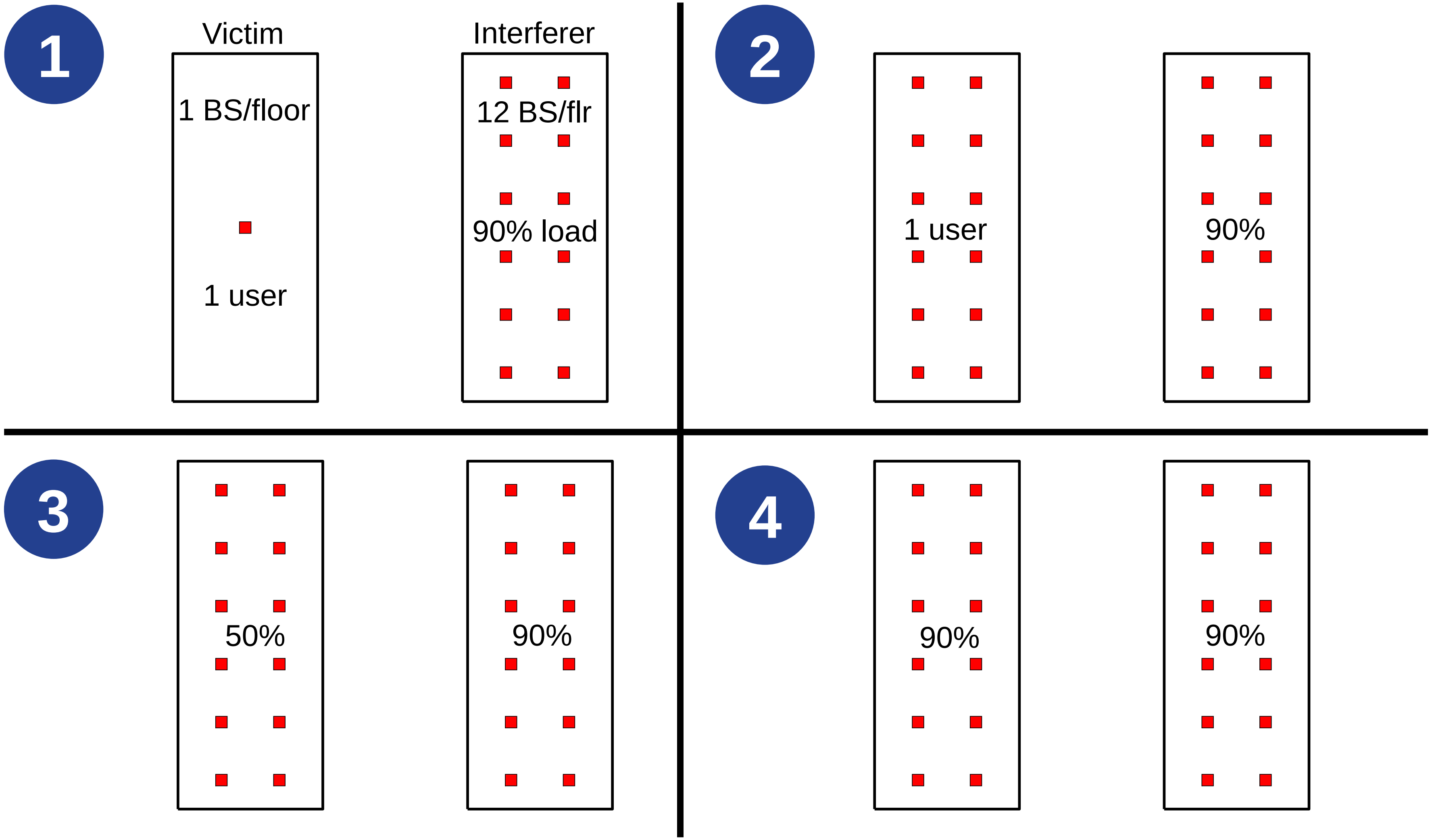




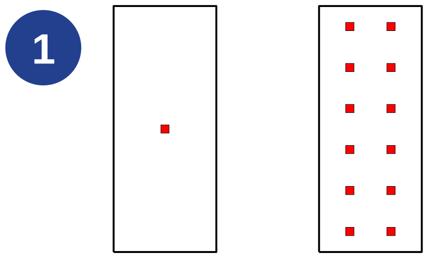


Evaluation Results

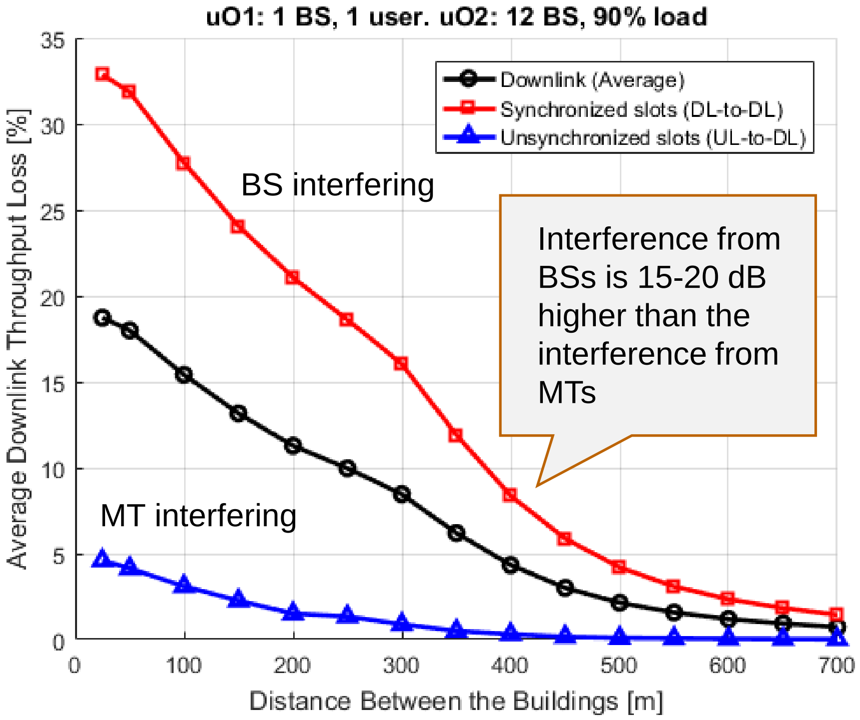
Evaluated Deployment Scenarios

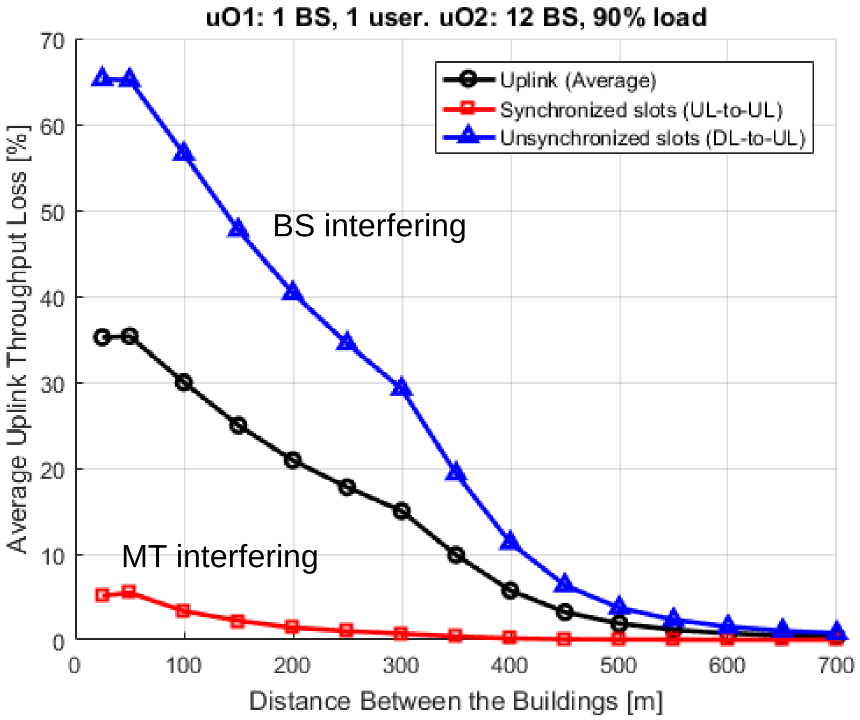


Average Throughput Loss



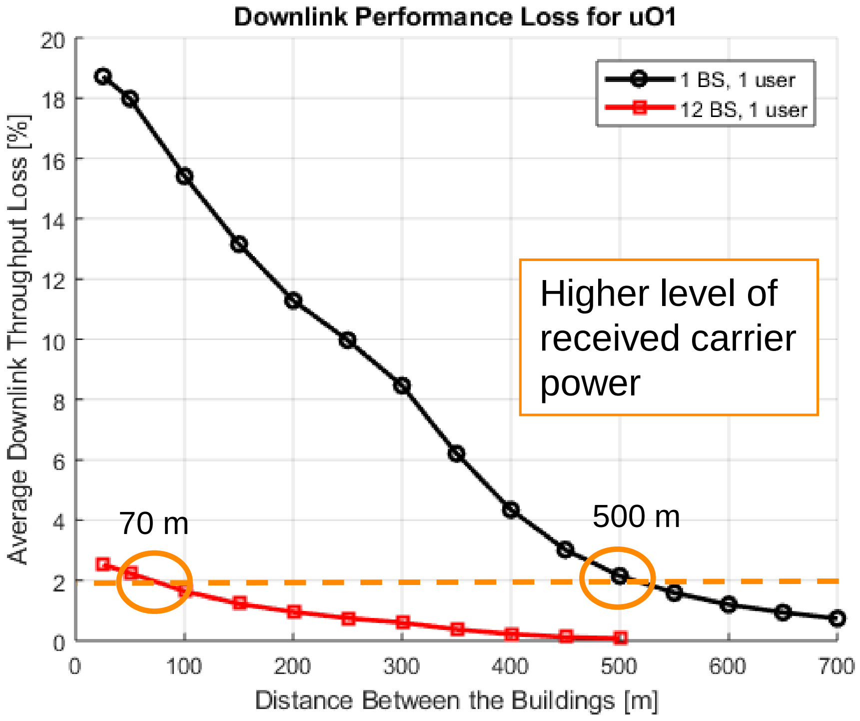
- Average downlink and uplink throughput loss for the victim operator as a function of the distance between the buildings



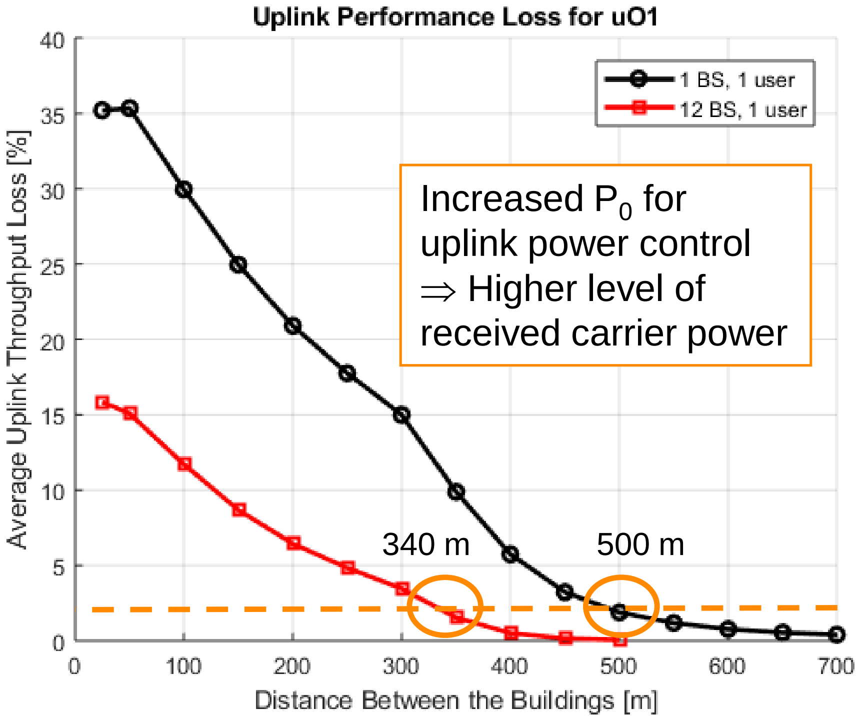


Average Throughput Loss

- Impact of victim network base station density (1 BS → 12 BS)



MSD for 2% loss



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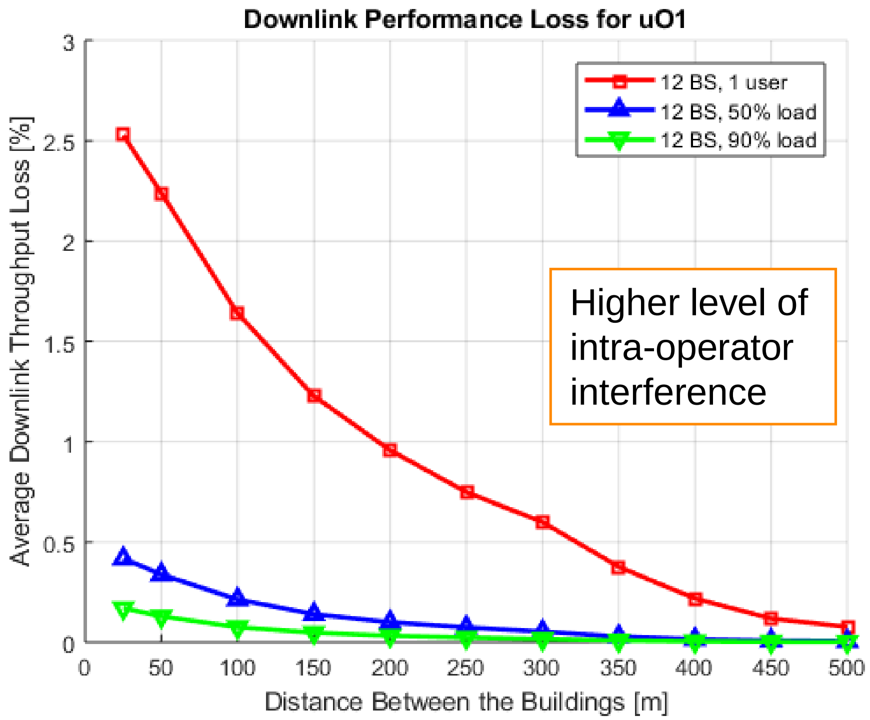
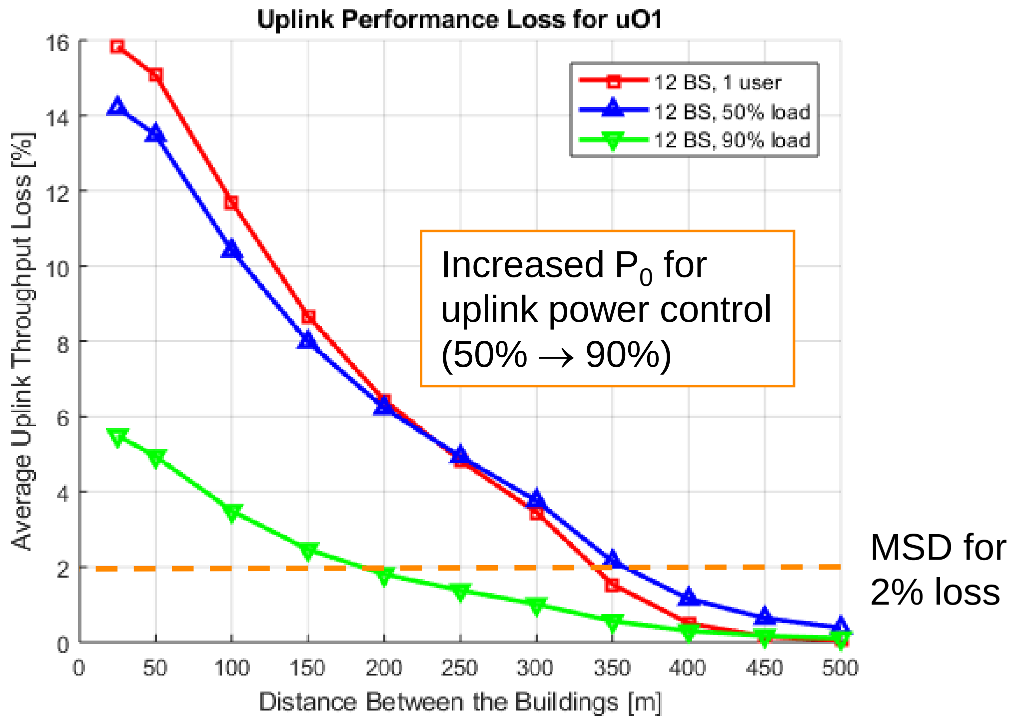
Average Throughput Loss

- Impact of victim network load (8% → 50% → 90%)





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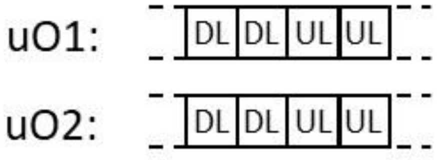
Required Minimum Separation Distance

- MSD is reduced together with the increased victim network density and load
- MSD can be reduced by allowing a higher loss of performance
- Dense deployments are limited by the uplink MSD (BS-to-BS interference!)

Deployment Scenario	Minimum Separation Distance (DL/UL) [m]		
	1% Loss	2% Loss	5% Loss
1 BS, 1 user	638 / 571	513 / 496	382 / 415
12 BS, 1 user	192 / 376	70 / 338	0 / 245
12 BS, 50%	0 / 415	0 / 357	0 / 248
12 BS, 90%	0 / 301	0 / 185	0 / 47

Impact of Synchronization

- Both micro operators follow the same TDD pattern, and also the slot borders are aligned
  - Only DL-to-DL and UL-to-UL interference
  - Average DL interference increased, average UL interference reduced



- Introduces additional limitations (e.g., ~~dynamic TDD~~)

Deployment Scenario	Minimum Separation Distance [m]		
	1% Loss	2% Loss	5% Loss
1 BS, 1 user	638 → 789	513 → 635	415 → 476
12 BS, 1 user	376 → 320	338 → 188	245 → 20
12 BS, 50%	415 → 74	357 → 0	248 → 0
12 BS, 90%	301 → 0	185 → 0	47 → 0

Conclusions

Conclusions

- For a deployment with uncoordinated micro operators utilizing dynamic TDD:
  - Interference received from the other operator's base stations is the main cause for the performance losses
  - Impact of the inter-operator interference is reduced together with the increasing victim network density and load
- Synchronized deployment reduces the required MSD for uplink-limited deployments, but introduces additional limitations
- The required MSD can be reduced also by adjusting the base station transmission powers

Kimmo Hiltunen, Marja Matinmikko-Blue, "Interference Control Mechanism for 5G Indoor Micro Operators Utilizing Dynamic TDD", in Proc. PIMRC 2018

A single MSD designed for the worst case situation can lead to overly protective requirements and an inefficient use of spectrum.

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