

Optimization and Parallelization Methods for the Design of Next-Generation Radio Networks

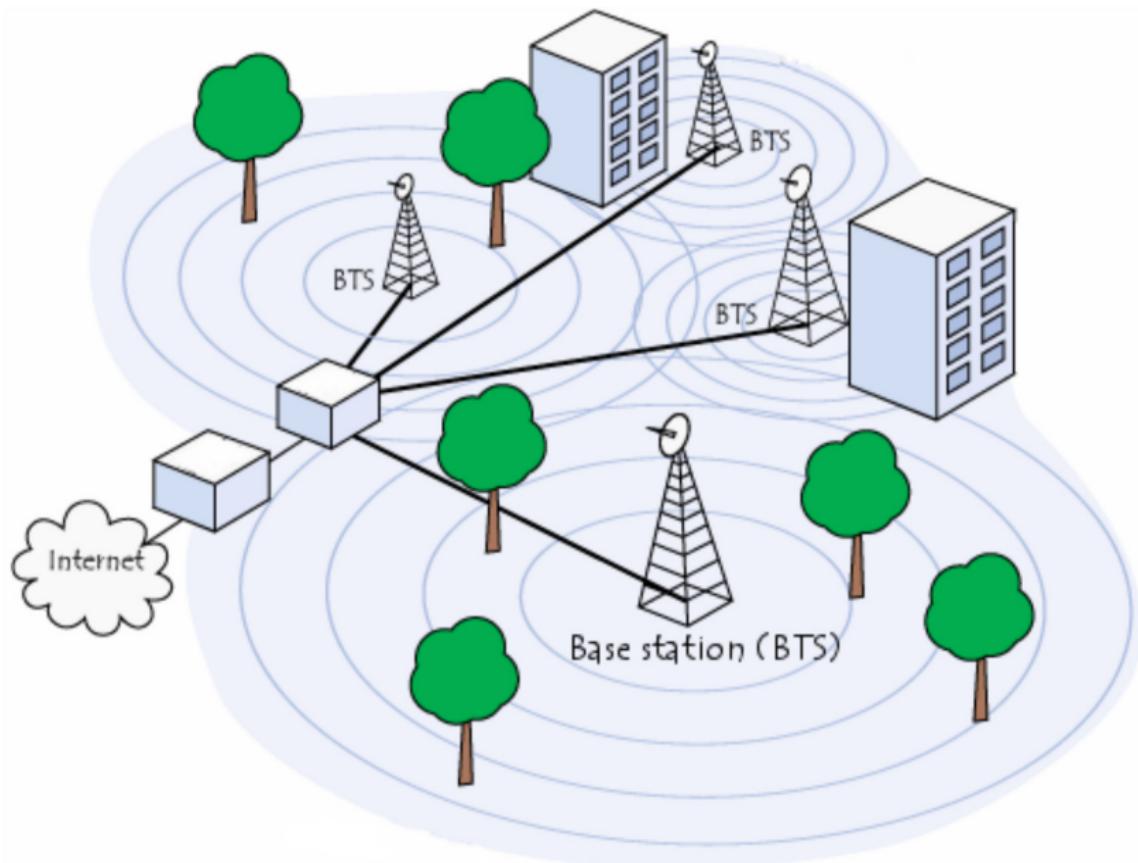
Lucas Benedičič¹

¹Research and Development department, Telekom Slovenije, d.d.
Jožef Stefan International Postgraduate School

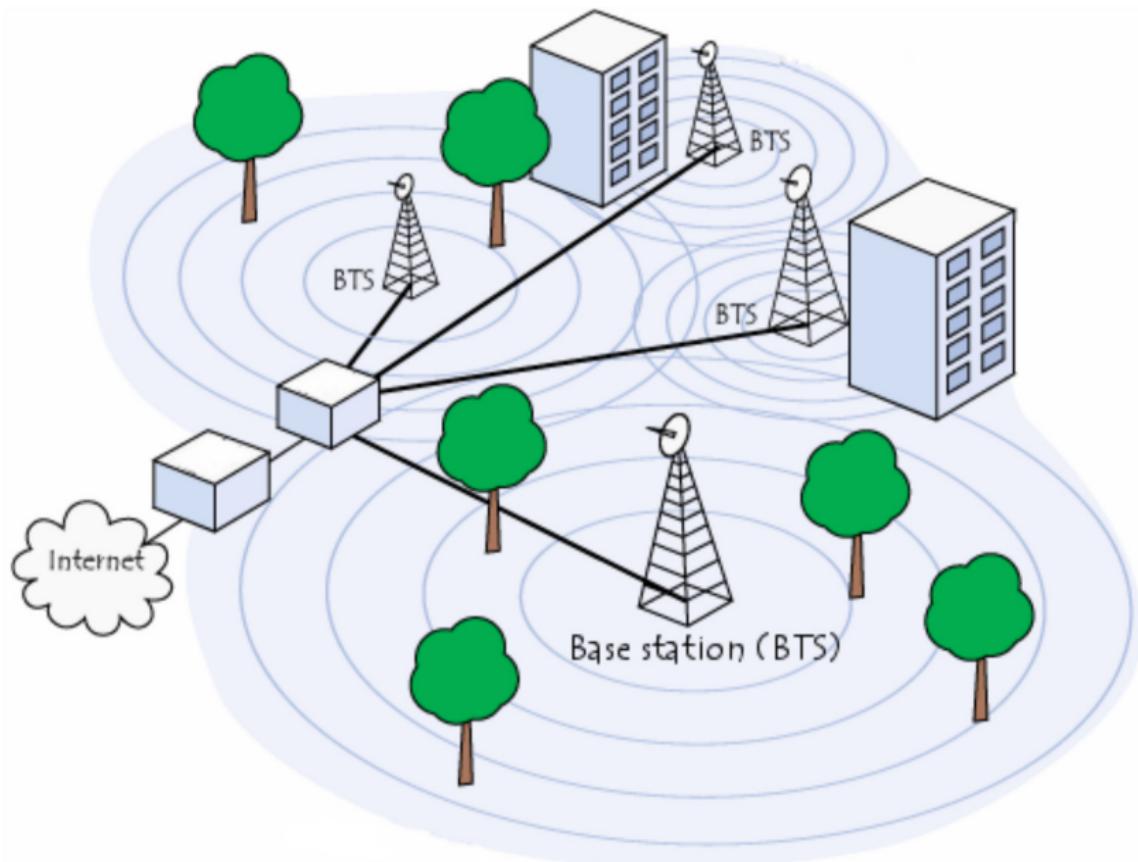
PhD Dissertation Defense,
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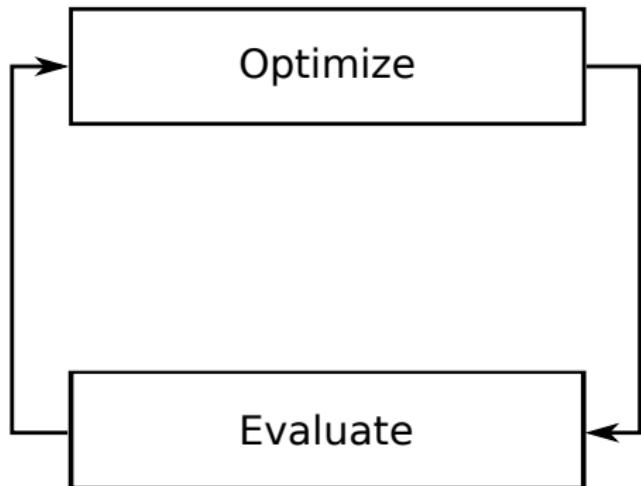
Radio network



Radio-network optimization



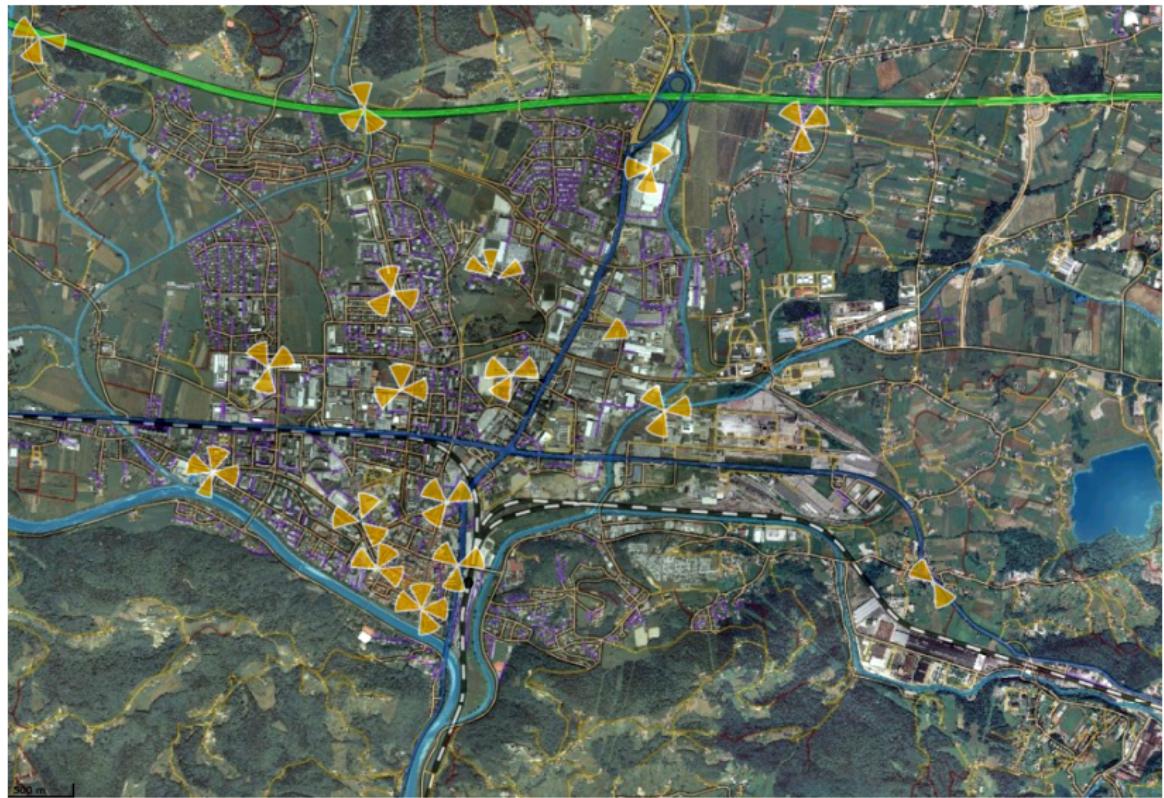
Radio-network optimization



Coverage evaluation: coverage maps



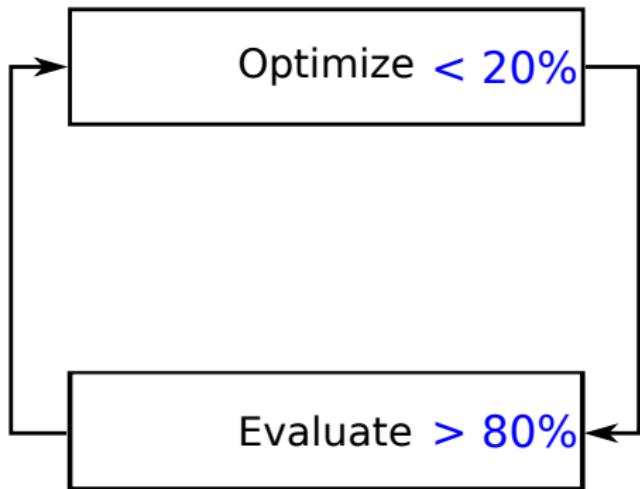
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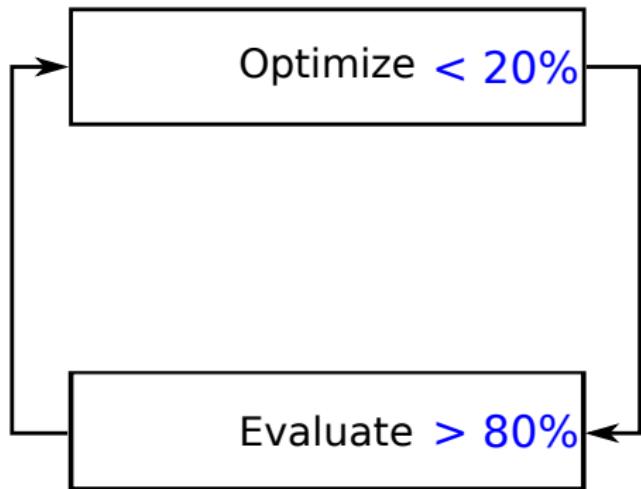


Radio-network optimization



- State-of-the-art approaches are suitable for small networks.

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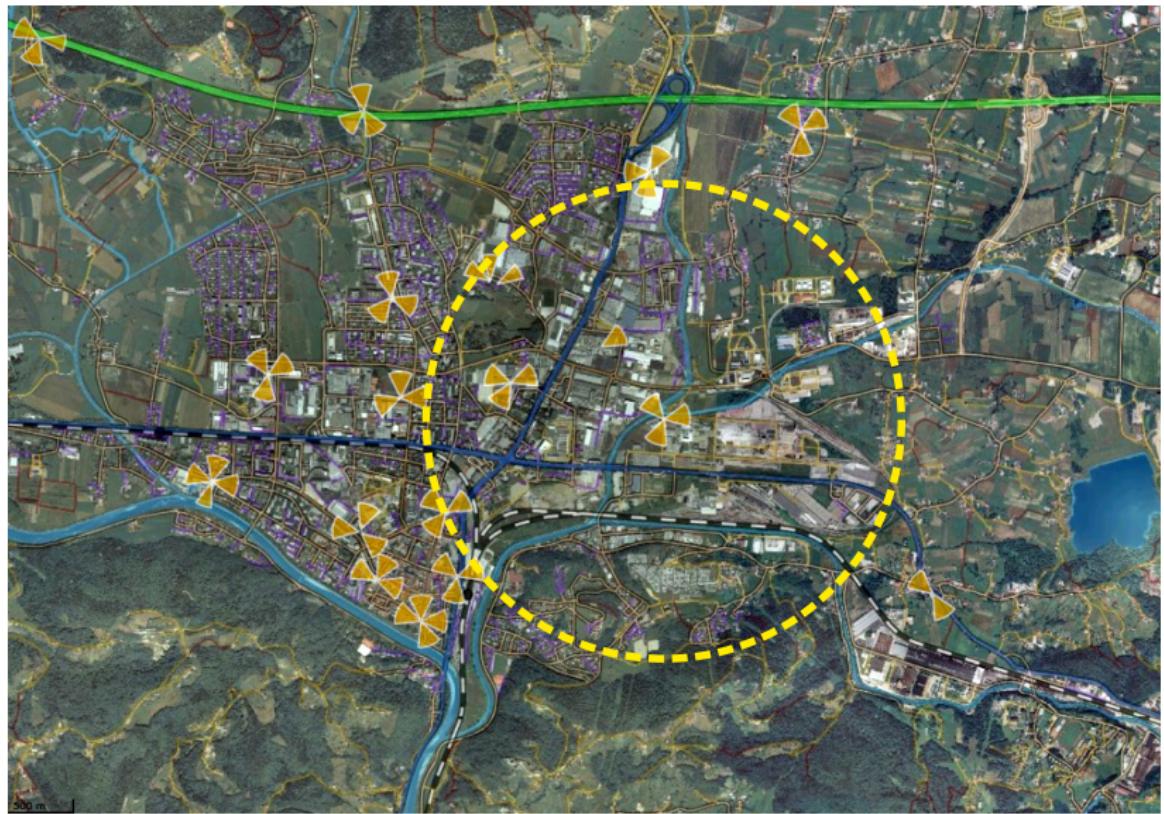
Radio-network optimization: open challenges

- Evaluate bigger networks (\sim 1000 BTS).

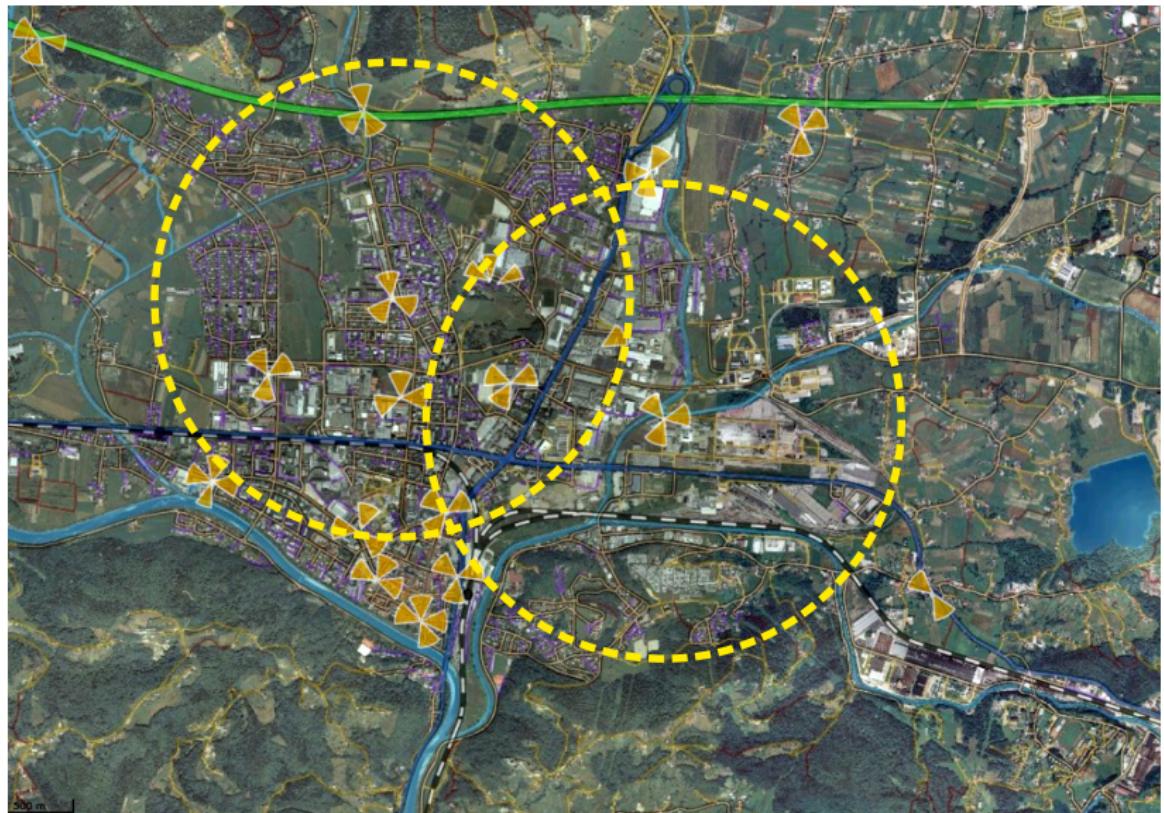
Coverage maps: serial implementation



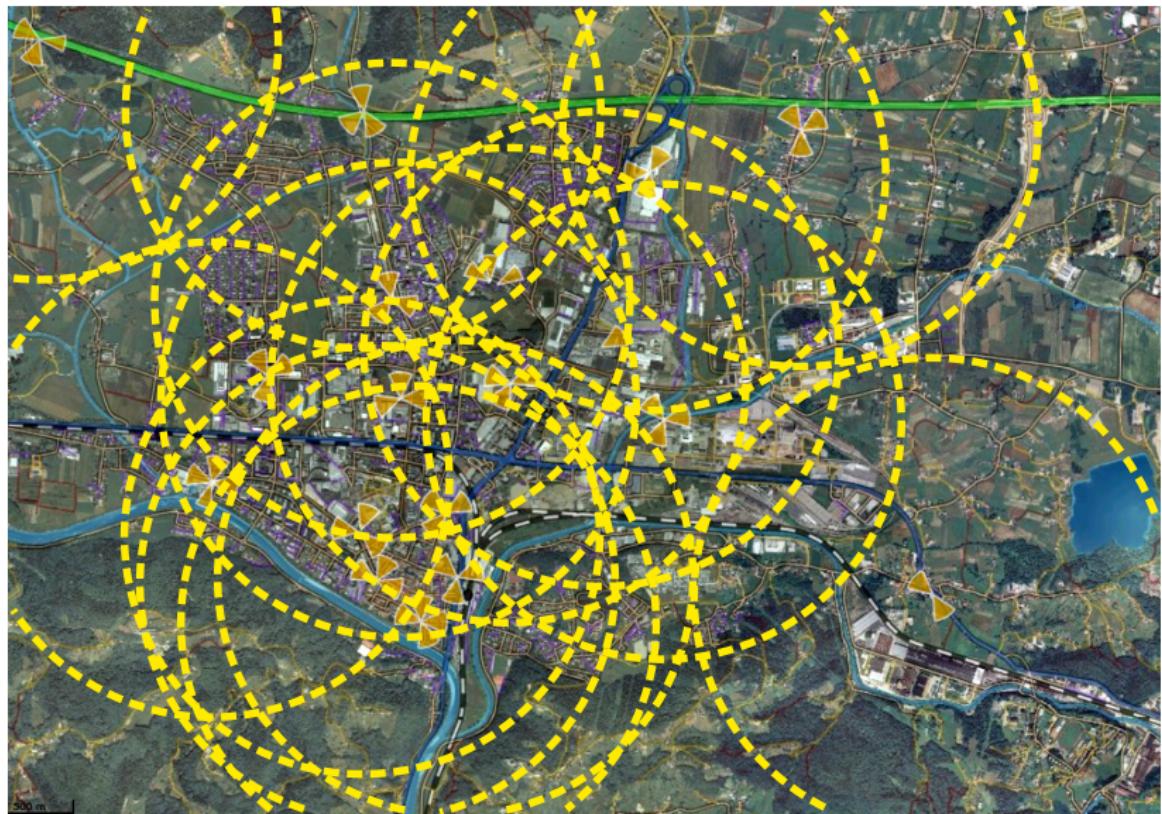
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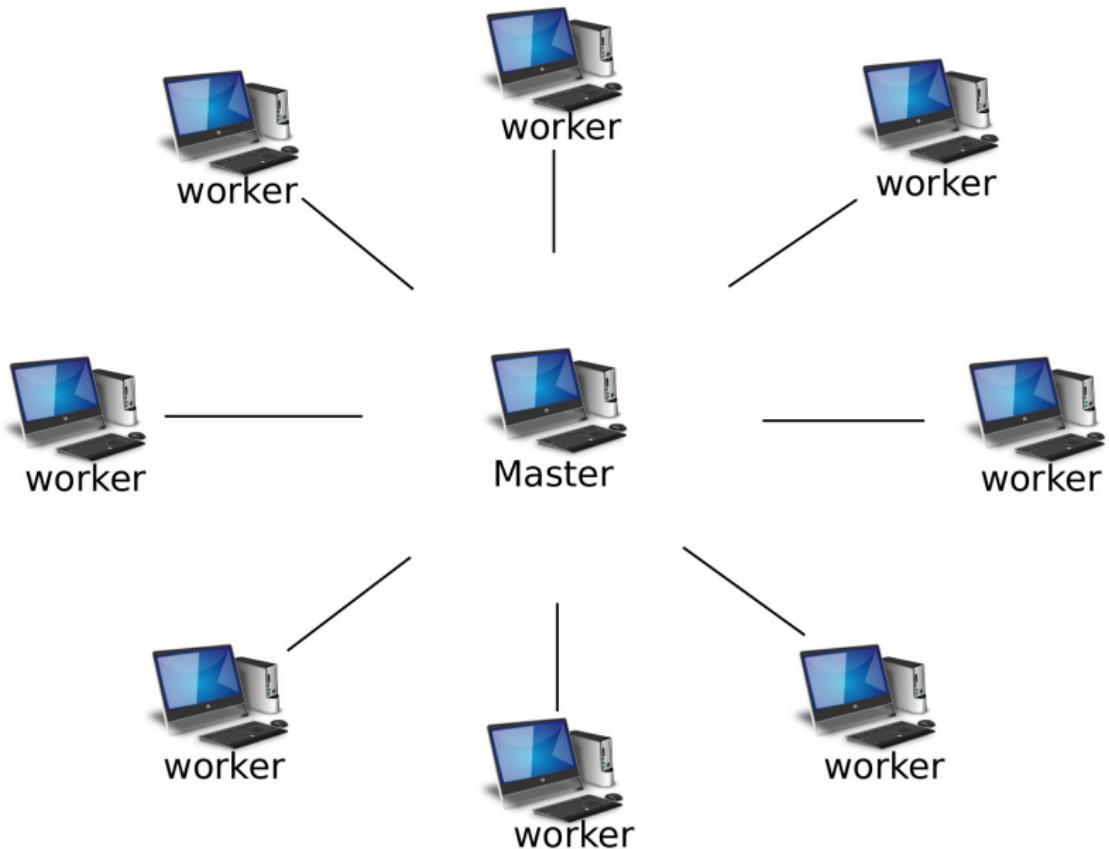
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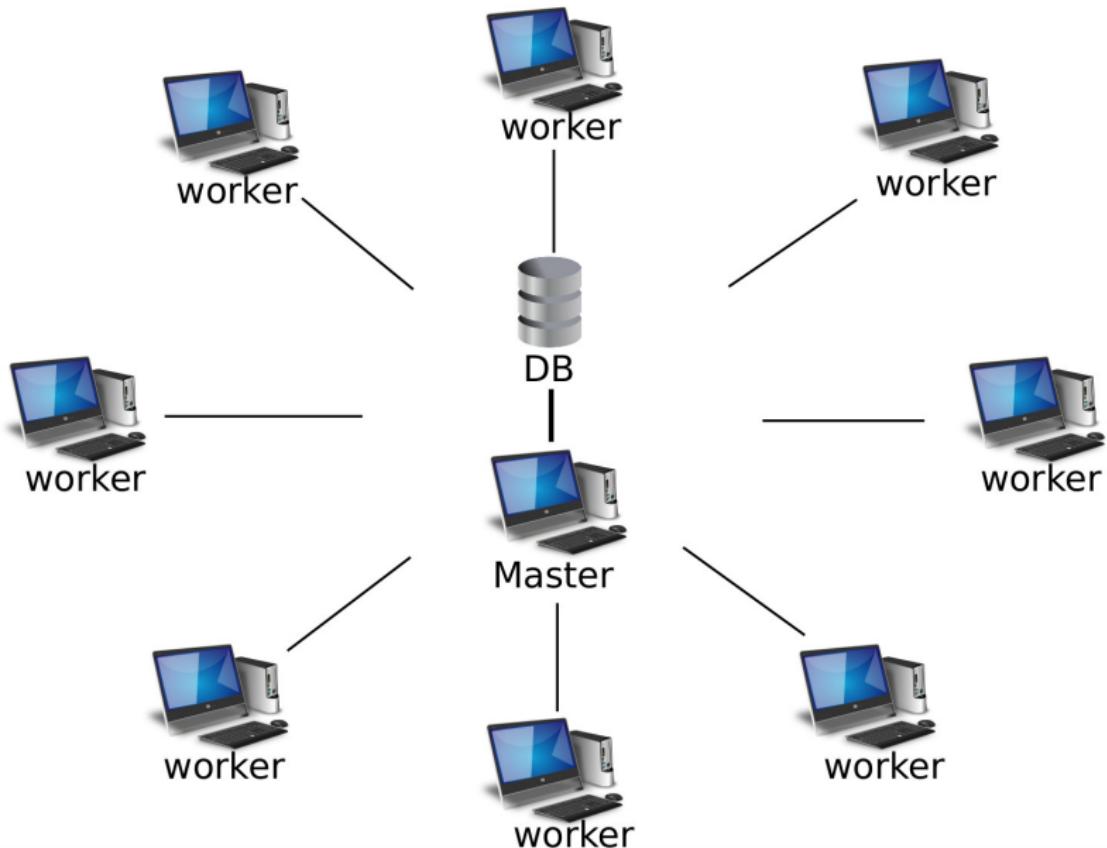
Coverage maps: parallel implementation



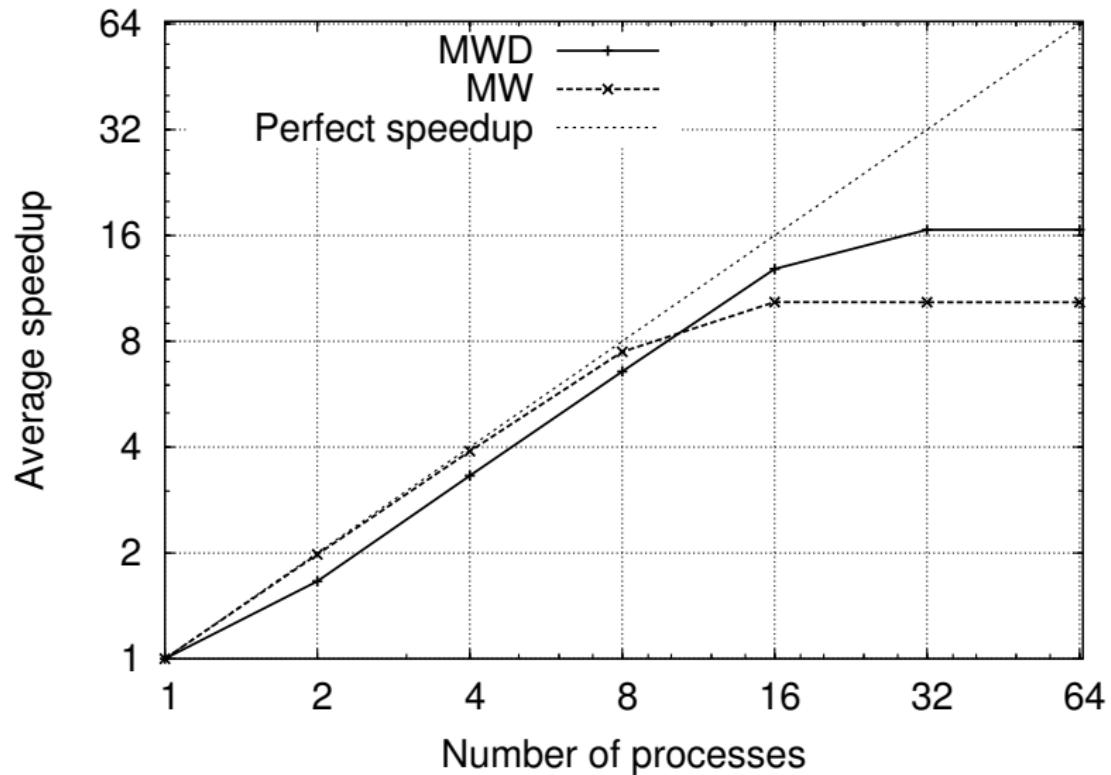
Parallel implementation - architecture



Parallel implementation - architecture



Parallel implementation - speedup



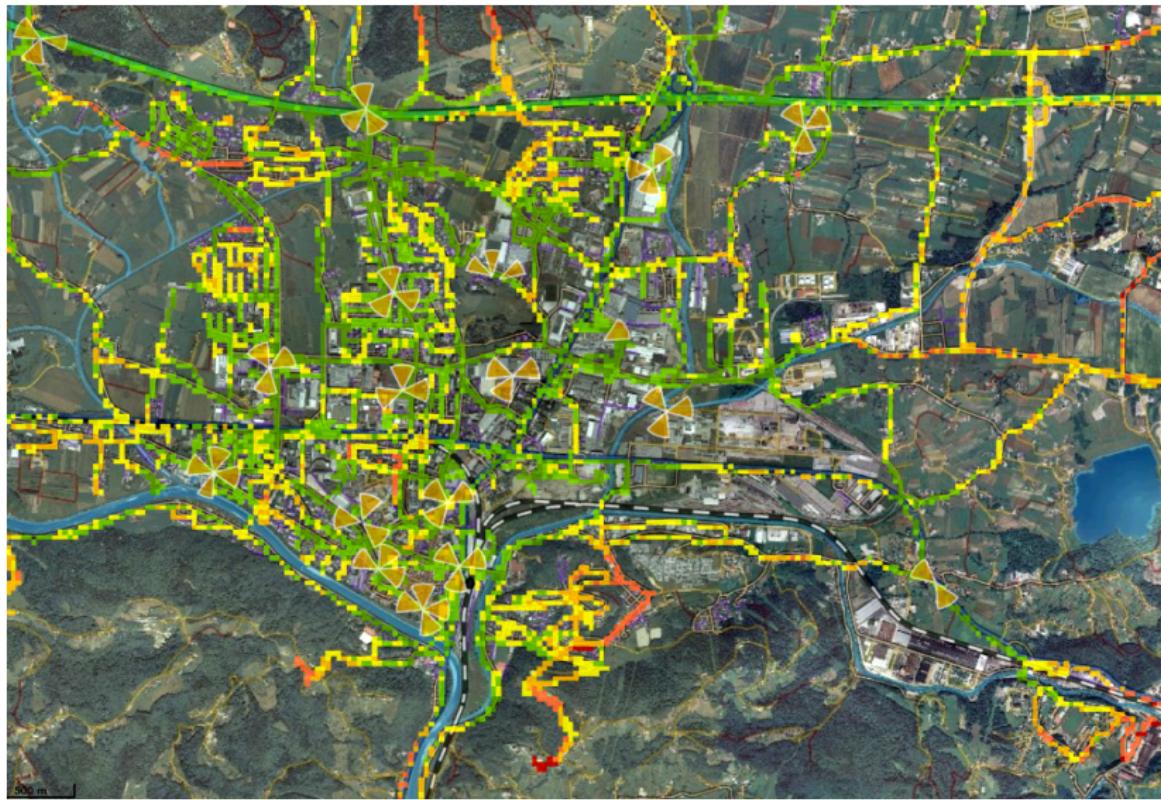
Radio-network optimization: open challenges

- Evaluate bigger networks (~ 1000 BTS).
- Improve solution accuracy.

Accurate coverage maps



Accurate coverage maps



Accurate coverage maps

- Given
 - an empirical mathematical model, and
 - a set of field measurements.
- Find
 - for each installed BTS,
 - different parameter values.
- Such that
 - the difference between the coverage map and the field measurements is minimized.

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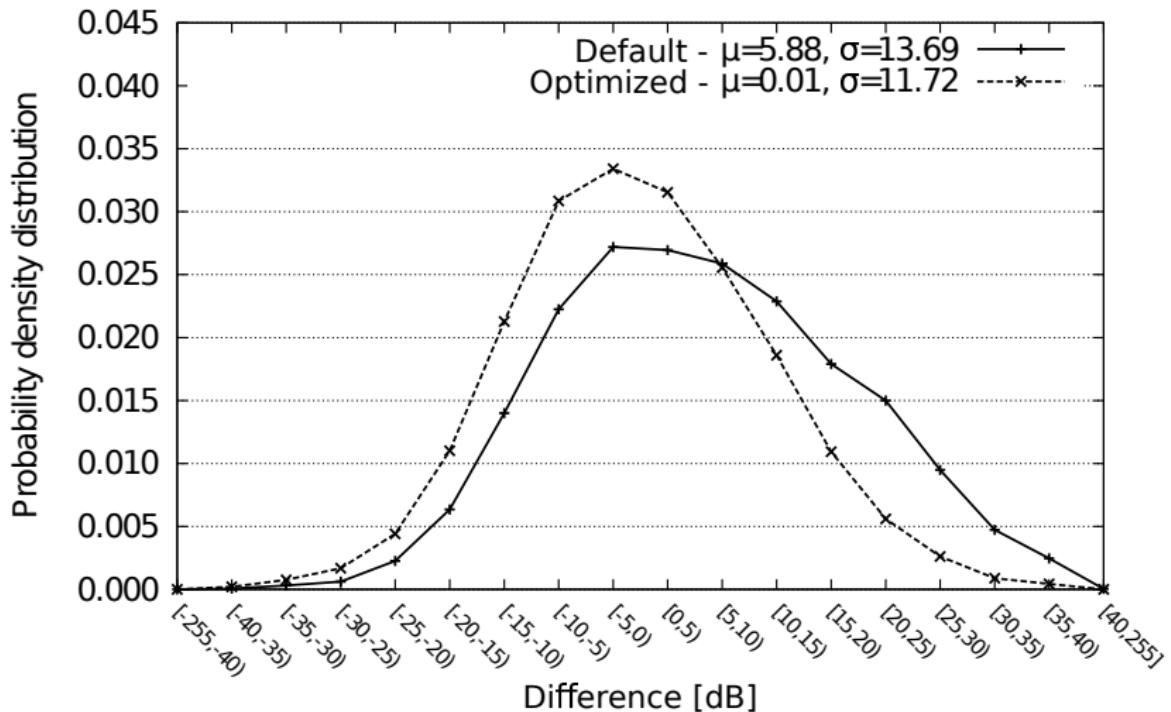
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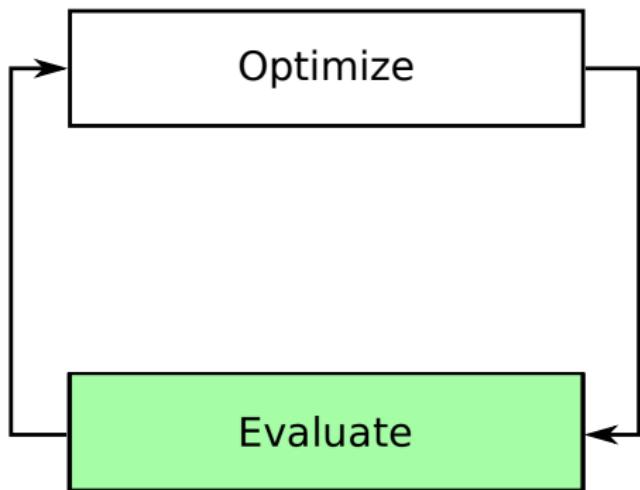
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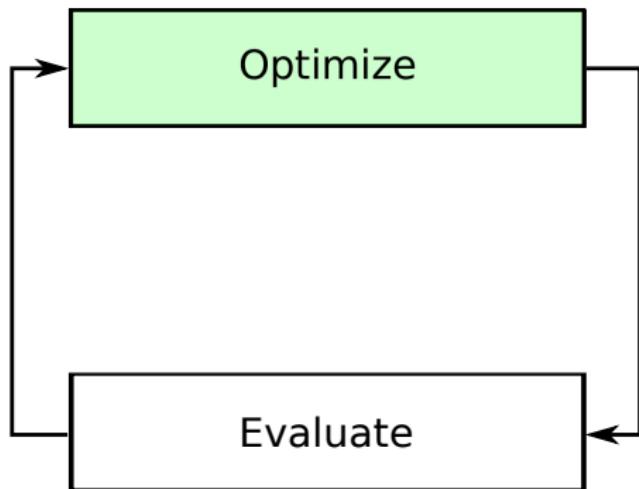
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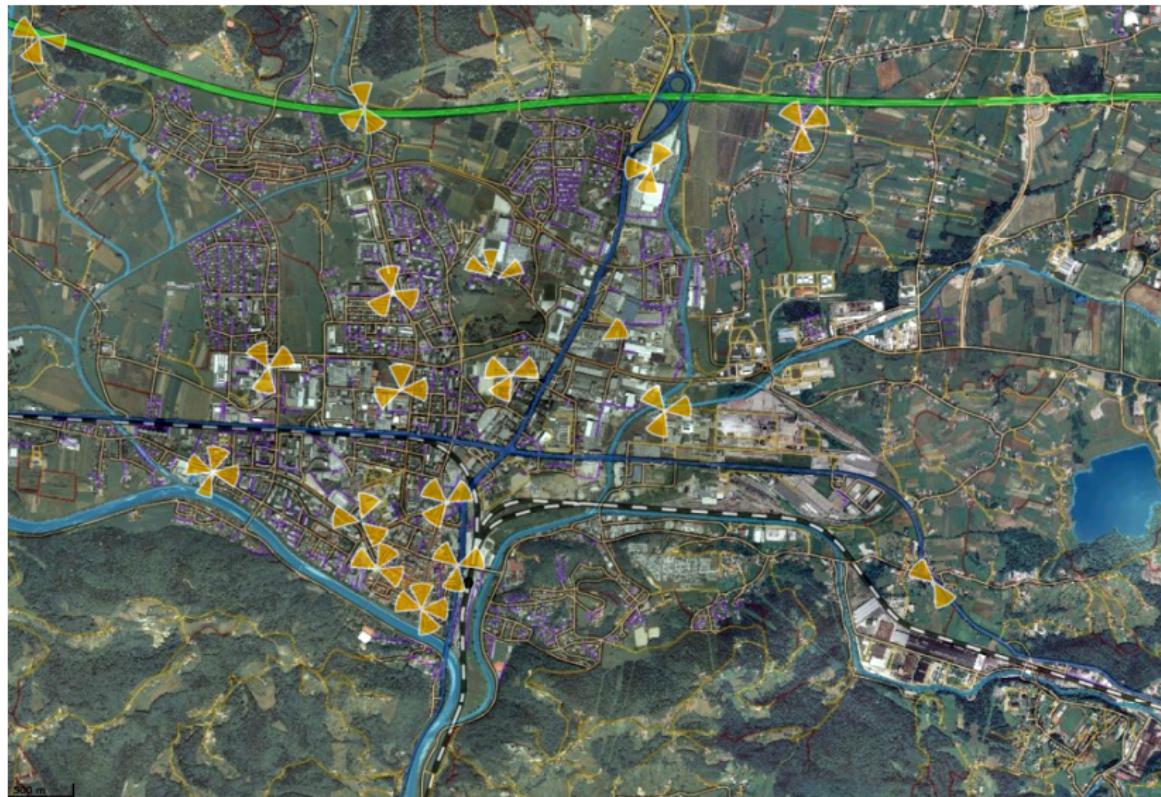


Radio-network optimization: open challenges

- Power optimization of a deployed network
- Interference optimization in a deployed network.



Power optimization



Power optimization



Power optimization

- Given
 - a network layout (i.e., BTS positions are fixed),
- Find
 - for all installed BTS,
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- Providing
 - full coverage (constraint).
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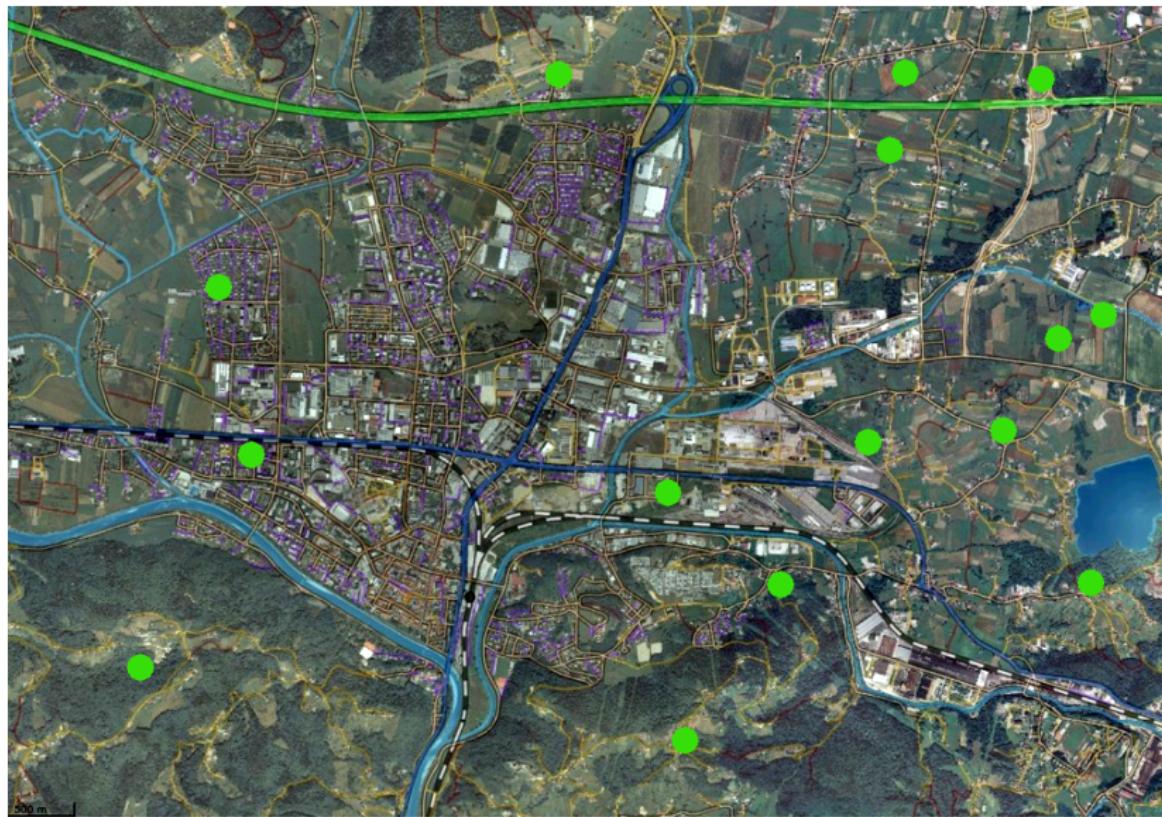
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Power optimization



Power optimization

	No optimization		Siomina et al. (2008)		Multi-agent	
	Total power (W)	Average power (W)	Total power (W)	Average power (W)	Total power (W)	Average power (W)
Net ₁	422	2.187	–	–	147	0.764
Net ₂	345	2.331	115	0.778	112	0.757

Radio-network optimization: open challenges

- Evaluate bigger networks (~ 1000 BTS).
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Interference optimization

- High interference areas of the network are prone to malfunctioning.
- Difficult to identify with coverage maps.
- Formalize and tackle the problem with metaheuristic optimization.

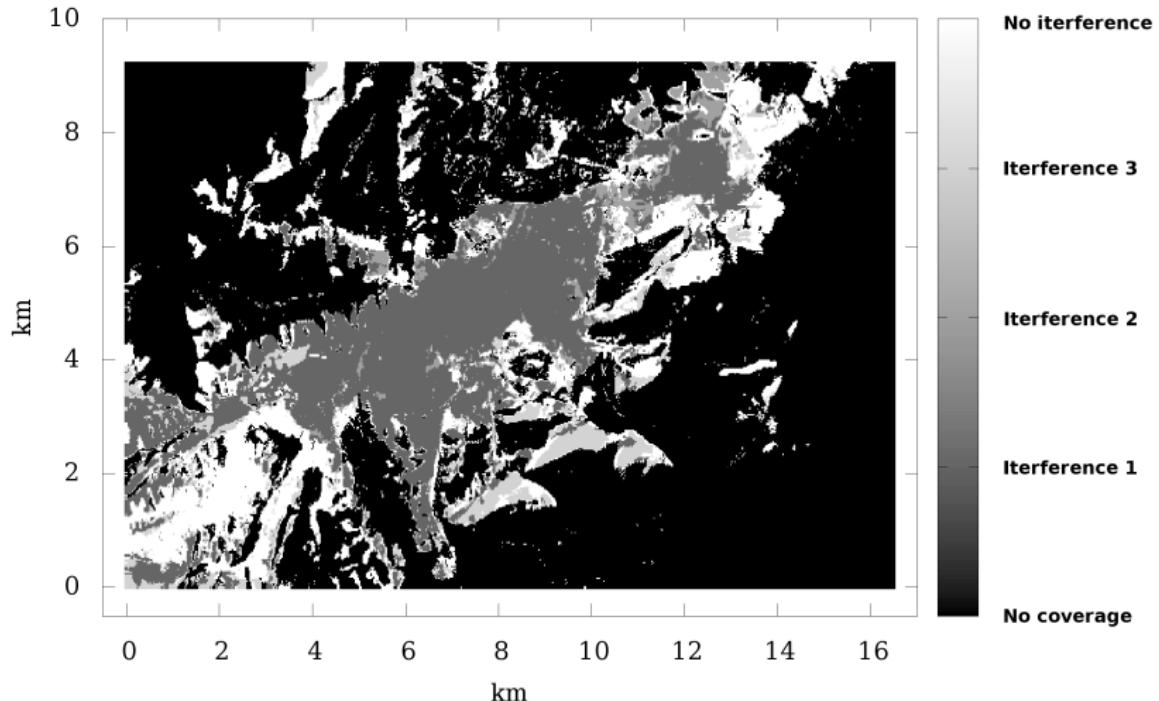
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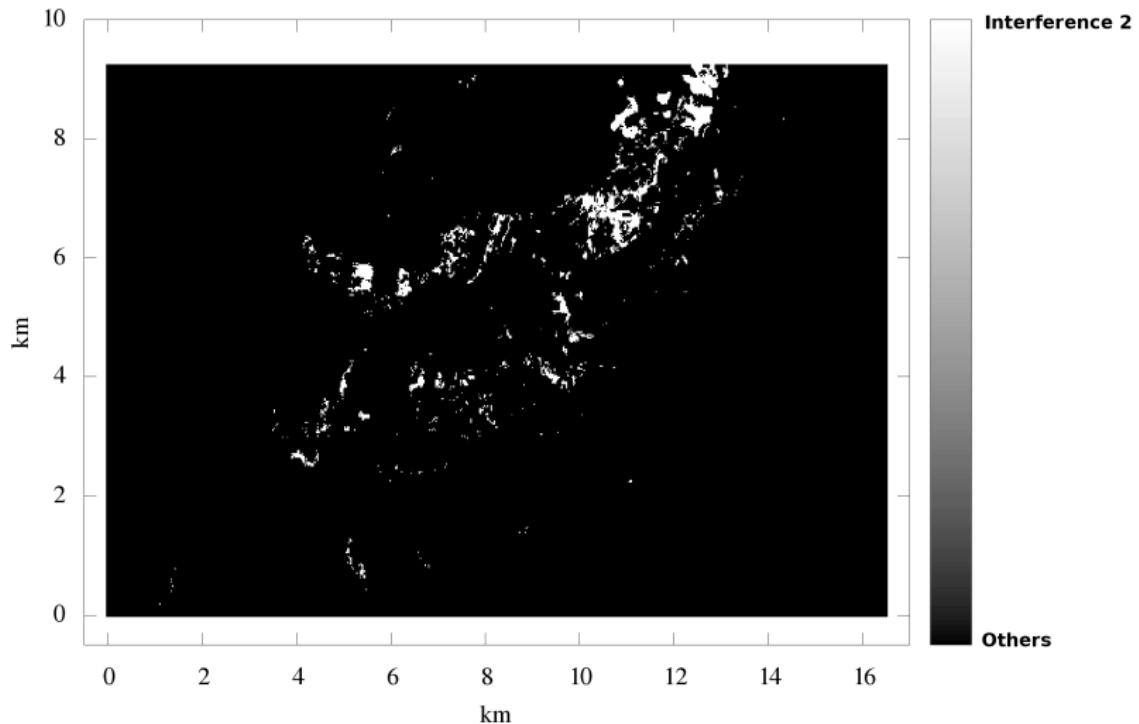
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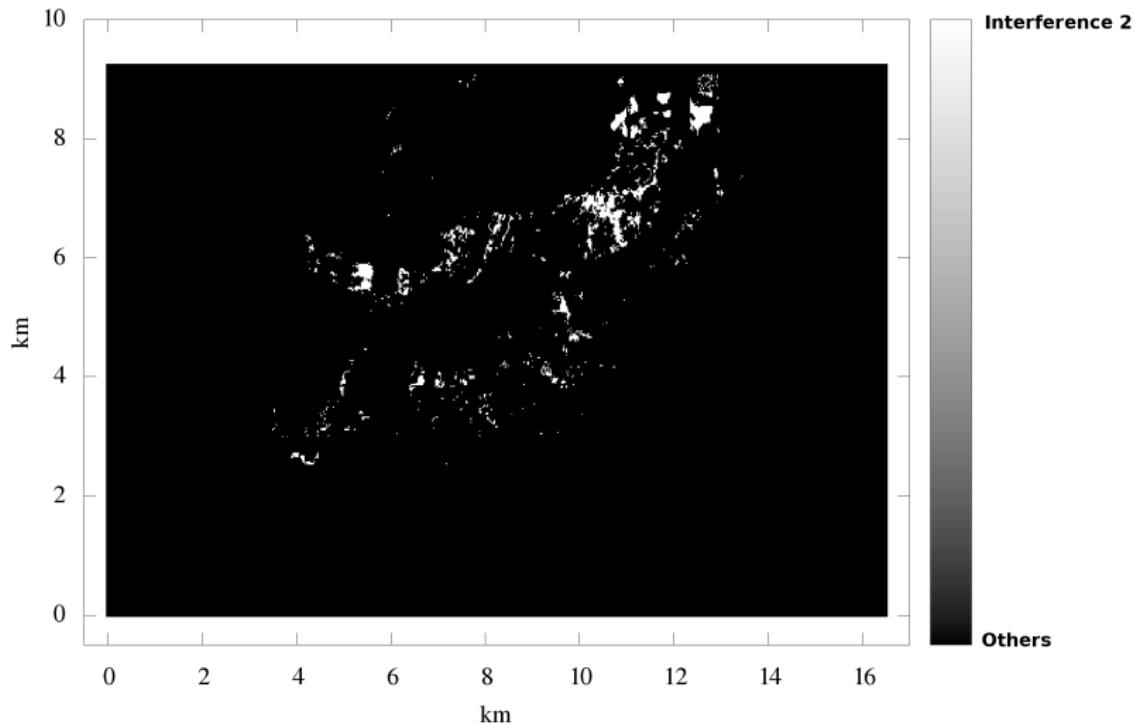


Interference optimization



High interference - results

High interference - results



High interference - results

	No Interference	Interference 2
Before	15.11 %	1.80 %
DE	+6.75 %	+18.33 %
DASA	+6.95 %	+18.88 %
SA	+9.53 %	+13.33 %
Average	+7.74 %	+16.85 %

Conclusions

- Evaluate bigger networks (~ 1000 BTS).
 - novel hybrid approach
 - 22x faster than a commercial tool (reached hardware limit).
- Improve solution accuracy.
 - the parameter optimization improved the coverage maps more than 2 dB.
- Power optimization of a deployed network.
 - novel algorithm improved the results of a state-of-the-art method.
- Interference optimization in a deployed network.
 - formalized mathematical model to improve the interference area in a working network without altering other services.
- Several approaches are already being applied in Telekom Slovenije, d.d. (i.e., optimization of real-world networks).

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Acknowledgments

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OPERATION PART FINANCED BY THE EUROPEAN UNION
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