Interference mitigation with auto-coordinated beamforming

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Outline

Introduction

Algorithm

- Algorithm principle
- Cost functions

Simulation szenario

Evaluation

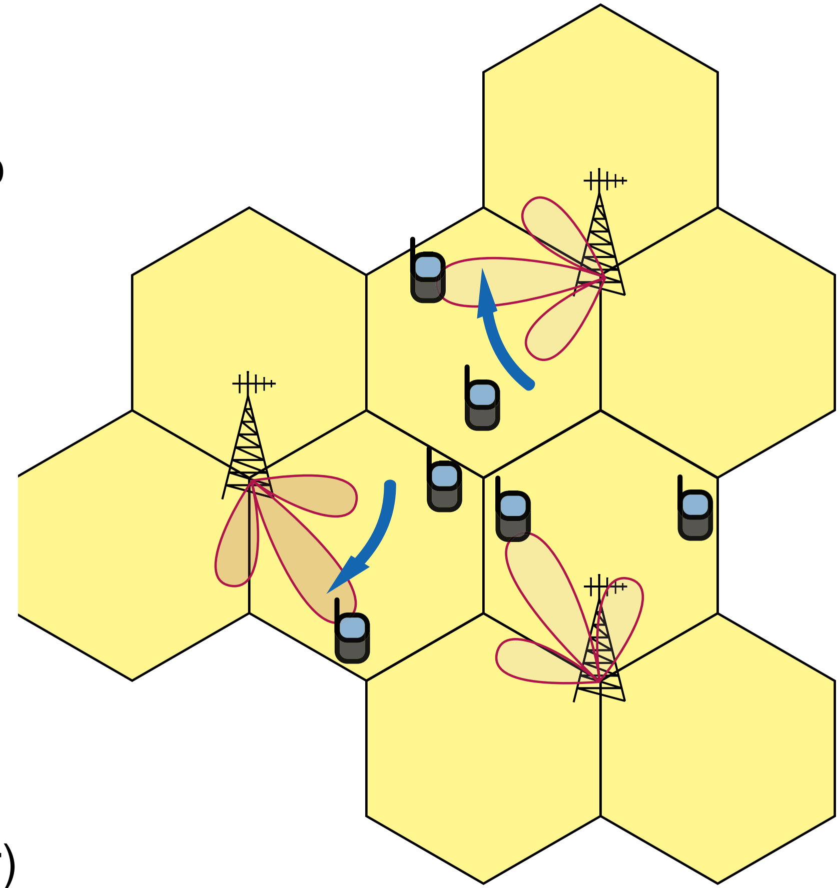
- Traffic dependency
- Throughput and fairness

Conclusion

Interference Coordination

Definition

Interference Coordination algorithms reduce the inter-cell-interference by coordinating multiple radio entities



Scenario

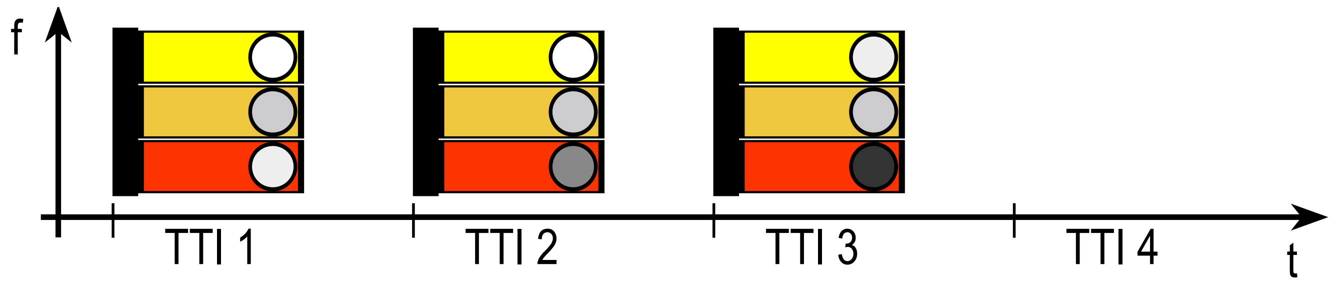
- Cellular radio network, OFDMA, frequency reuse 1
- Interference limited
- Mainlobe steering beamformers at base stations add degree of freedom for scheduling

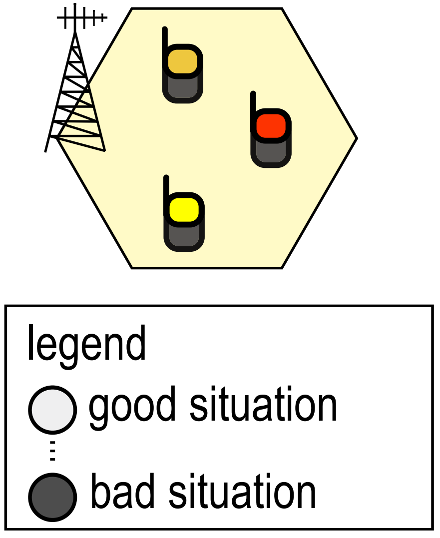
Our goal

Exploiting this degree of freedom (scheduling order)

- Without communication between neighboring base stations
- Without additional measurement and reporting

Algorithm principle





Keeping resource assignment as constant as possible

Keeping resource assignment stay constant

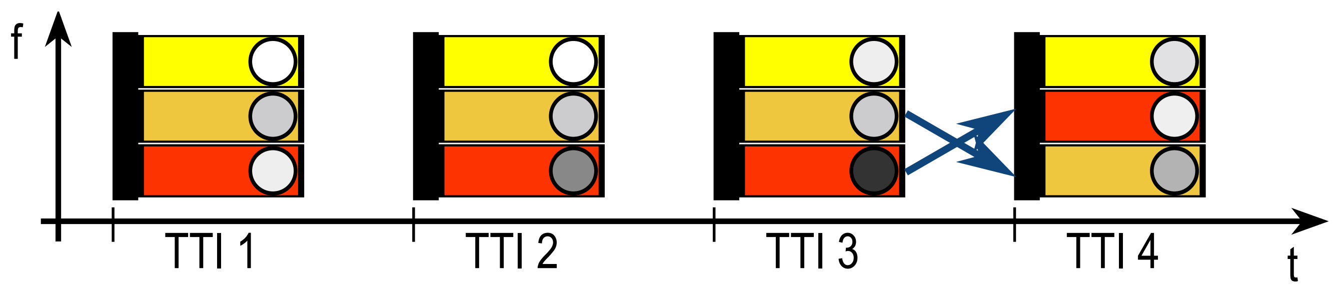
- Advantage

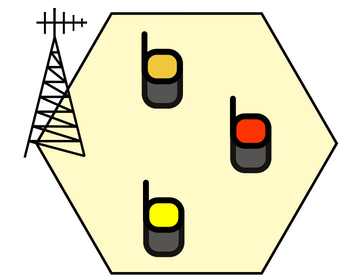
  Reduces variation of interference over time, improves channel measurement

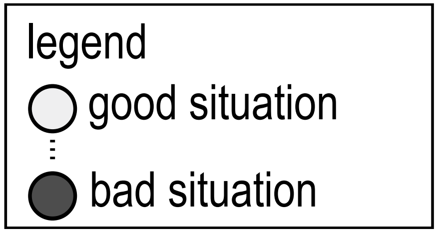
- Disadvantage

  No adaptation to interference situation

Algorithm principle







Keeping resource assignment as constant as possible

⇔ Trade Off

Swapping resource assignment when there is too much interference

Swapping resource assignment when there is too much interference

- Advantage

  allows for adaptation (tries to escape bad situations)

- Disadvantage

  higher variance of interference, resource assignment cannot converge

→ **Keeping assingment is the default, swapping has to occur only rarely**

Patent application no. 09 290 898.7:
"Interference Coordination Scheme with implicit Communication between neighboring basestations"

Cost Functions

Definition

Cost function describes how "bad" the current situation (resource allocation) is

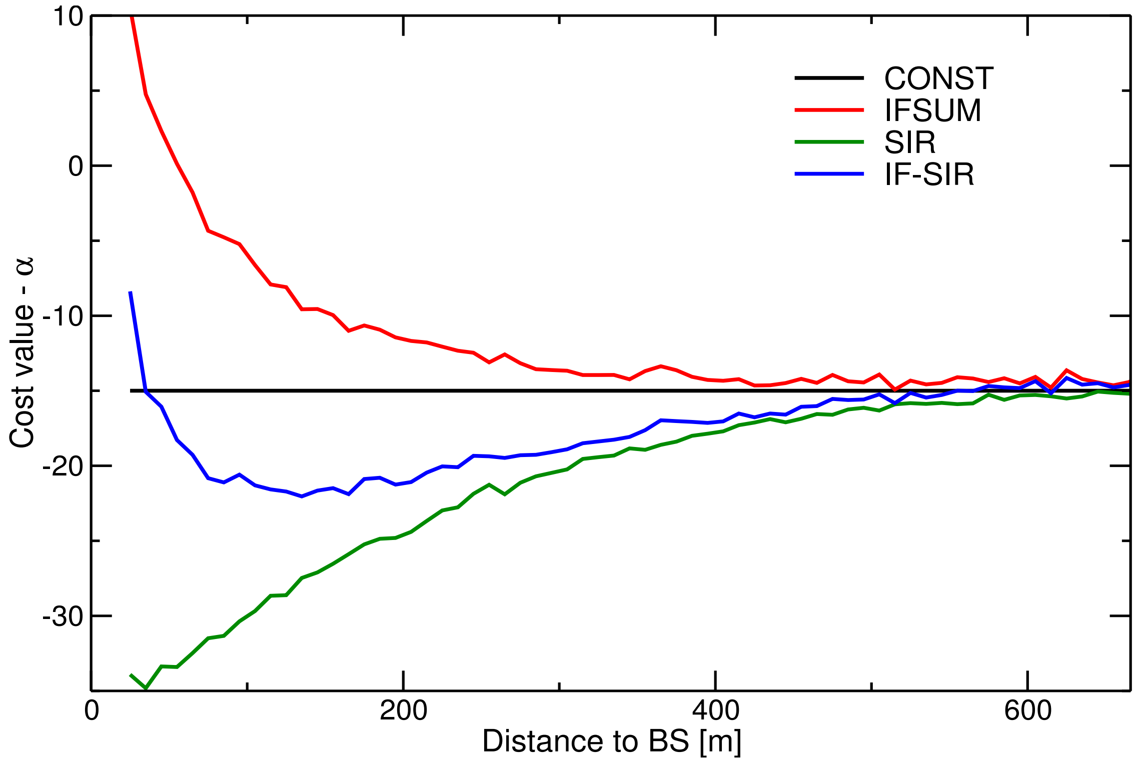
Fuzzy threshold α for swap decision

The higher the cost value, the higher the chance that the resource assignment is changed

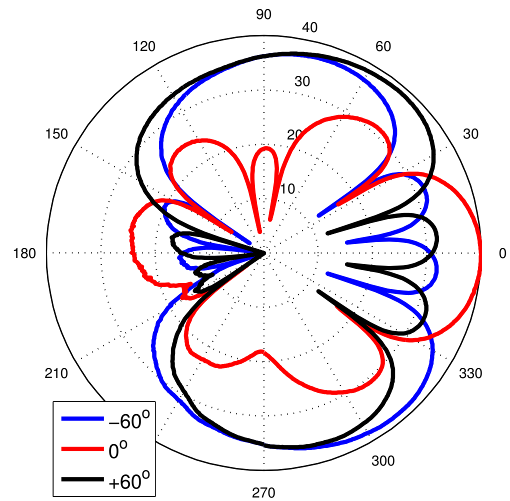
Evaluated functions

- **CONST**: Fixed swap propability as comparison
- **IFSUM**: Interference level
- **SIR**: - SIR
- **IF-SIR**: Combination: interference level - SIR

All these can be derived from RSSI and CQI reports



Simulation scenario

Parameter	Setting
Scenario geometry	hexagonal 19 site, 3 sectors per site, wrap-around
BS distance	1000m
Pathloss	Cost 231 (modified HATA)
Shadowing	Gudmundson, time-correlated (8dB)
Fast fading	none
Beamforming antennas	Measured pattern 
MS Velocity	10km/h

Parameter	Setting
MS Mobility model	Random direction on the playground, mobiles use the same wraparound as the radio propagation
Handover	Ideal handover to BS with strongest signal
HARQ	not enabled
AMC	LTE transport formats with ideal selection
Powercontrol	none
Traffic	On-Off Traffic, 200ms average on-time, full buffer during on phase
Number of MS	8 active (switched ON) MS per sector
Framelength (TTI)	1ms
Bandwidth	10MHz
Measurement of throughput	Over 10ms intervals

Throughput and fairness results

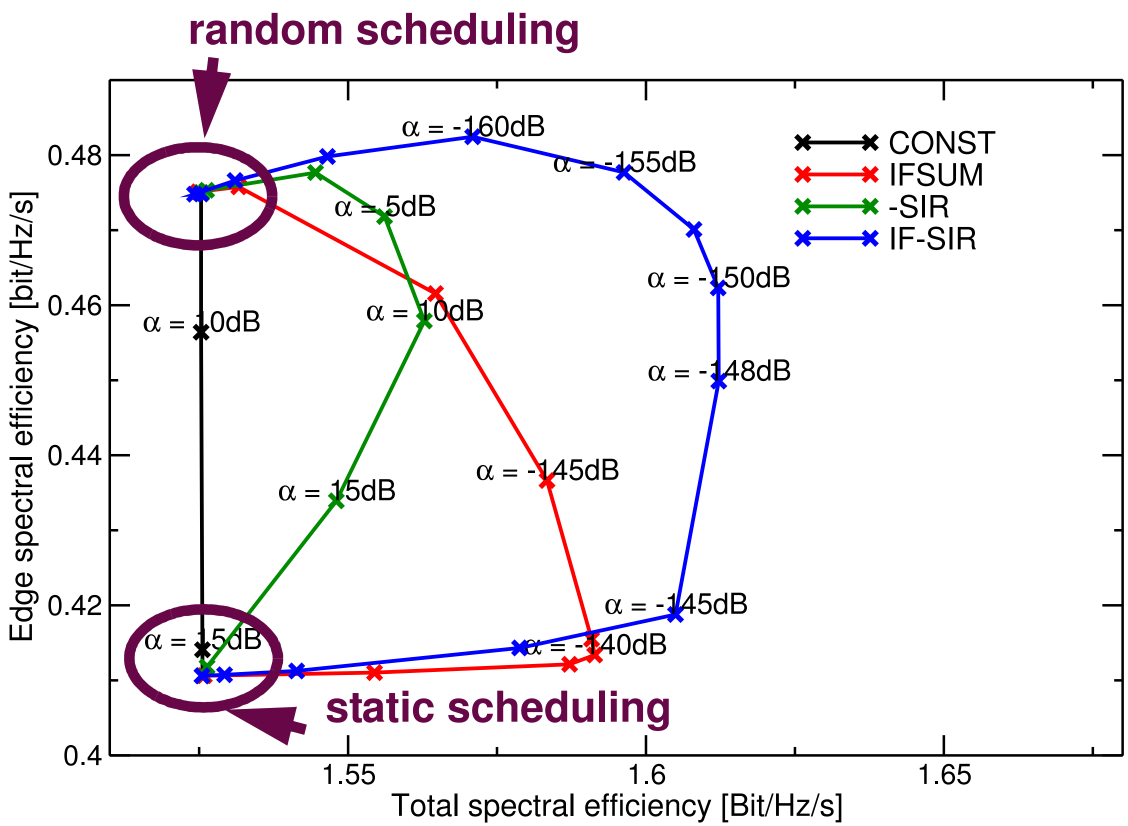
Common

- 200ms ON time
- Random scheduling has higher edge throughput, due to measurement interval

Influence of cost functions

- **CONST**: only trade-off between static and random scheduling, no coordination gain
- **IFSUM**: improves mainly average cell throughput
- **SIR**: improves mainly edge throughput
- **IF-SIR**: improves averave throughput and edge throughput

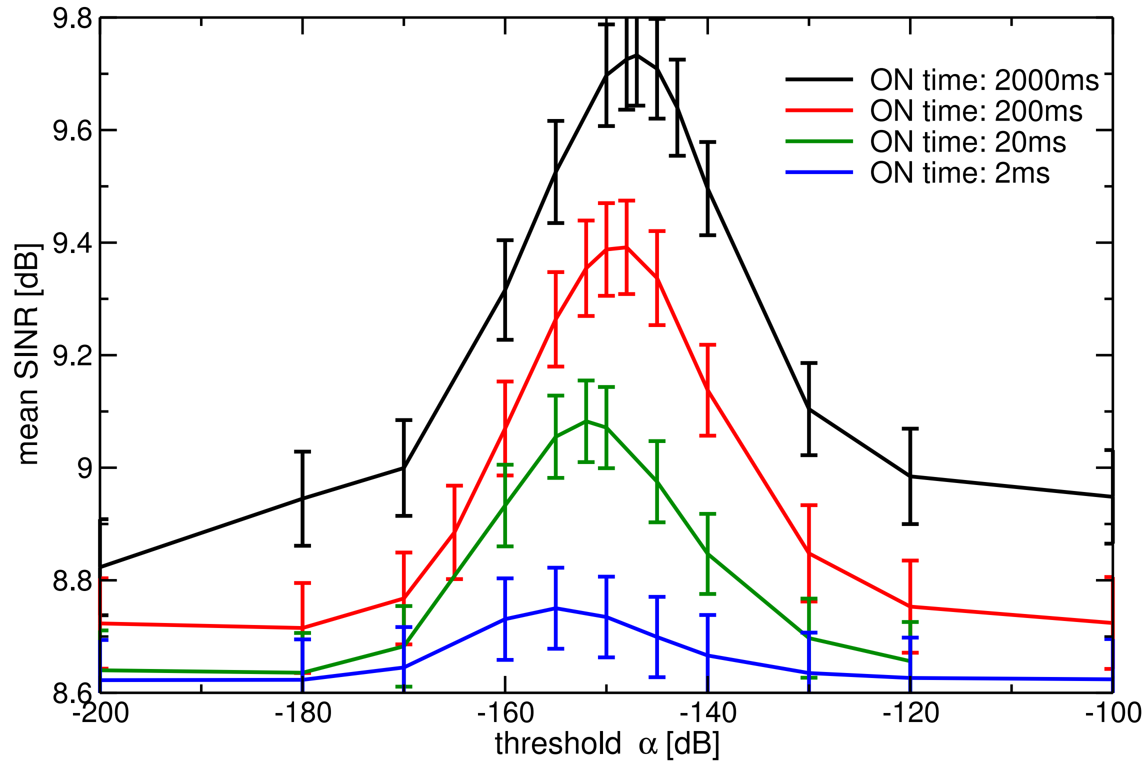
→ **Coordination algorithm improves cell and edge throughput**



Traffic dependency

Average SINR

- Cost function: **IF-SIR**
- ON-time geometrically distributed
- Full buffer during ON time



Discussion

- 2s average ON time: close to greedy traffic
- Measurements suggest, that 200ms includes large proportion of traffic

→ **The longer the traffic is constant, the higher is the coordination gain**

Conclusion

Presented interference coordination algorithm achieves coordination gain

- Without BS-to-BS communication
- Without extensive measurement
- With non-greedy traffic

Outlook

- Separating coordiated and uncoordinated traffic
- Situation-dependent cost function (e.g. including history)