Zur Leistung von IEEE 802.16m Systemen

17. ComNets-Workshop Mobil- und Telekommunikation

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Performance indicators

VoIP capacity
: Number of concurrent served calls

User/Control Plane latency
: Delay of user or control plane data

Spectral efficiency
: Peak spectral efficiency, cell-edge user spectral efficiency, cell spectral efficiency

Spectral efficiency

- *Peak spectral efficiency*
  Theoretical spectral efficiency of user terminal with best possible link
- *Cell spectral efficiency*
  Mean spectral efficiency for all user terminals in one cell
- *Cell-edge-user spectral efficiency*
  Spectral efficiency of 5% worst performing user terminals

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$$\mu = \frac{T}{B}$$

T: Throughput
B: System bandwidth

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- Time domain overhead $\nu_t = 10.4\%$
  - Preamble and synchronization
  - Transmit-Receive Turnaround Gap (TTG) and Receive-Transmit Turnaround Gap (RTG)
  - Cyclic Prefix (CP)
- Frequency domain overhead $\nu_f = 18.2\%$
  - Guard band DL/UL
  - Pilot subcarrier
- Tone based overhead $\nu_s = 2.68\%...8.6\%$
  - Super Frame Header (SFH)
  - A-MAP (Resource allocation map)
  - Initial ranging, bandwidth request ranging, CQICH, ARQ feedback channel

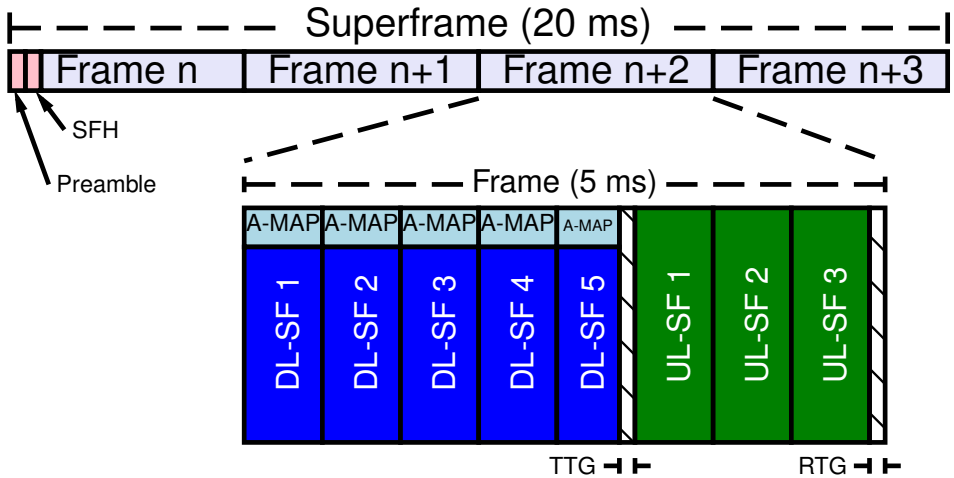

Figure: 802.16 TDD Frame

Overall protocol overhead

$$1-(1-\nu_t)(1-\nu_f)(1-\nu_s) = 28.75\%...32.95\%$$

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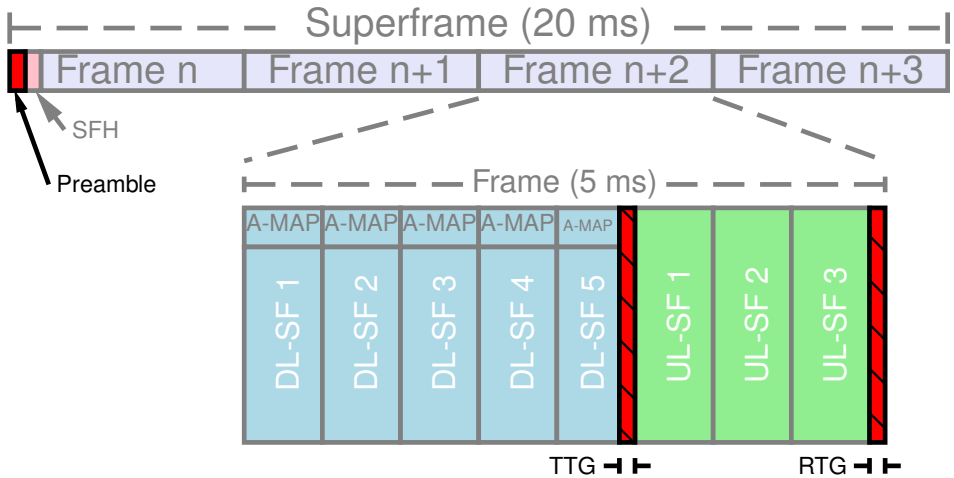

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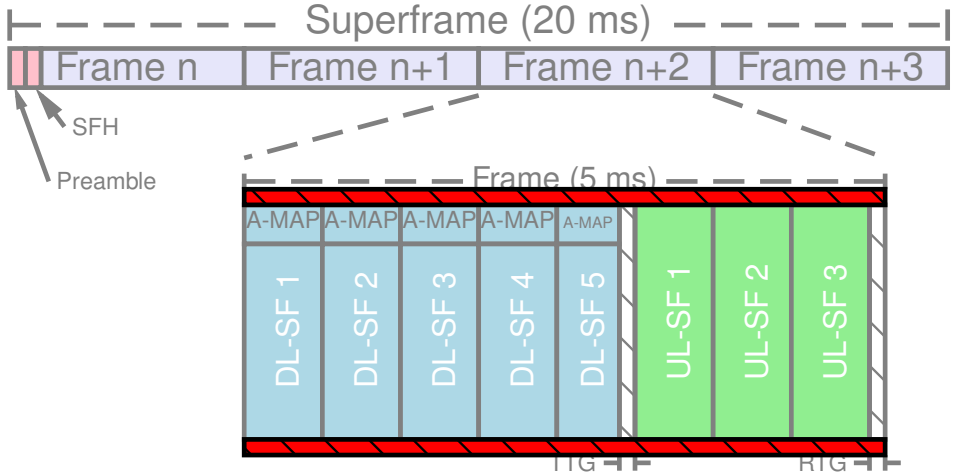

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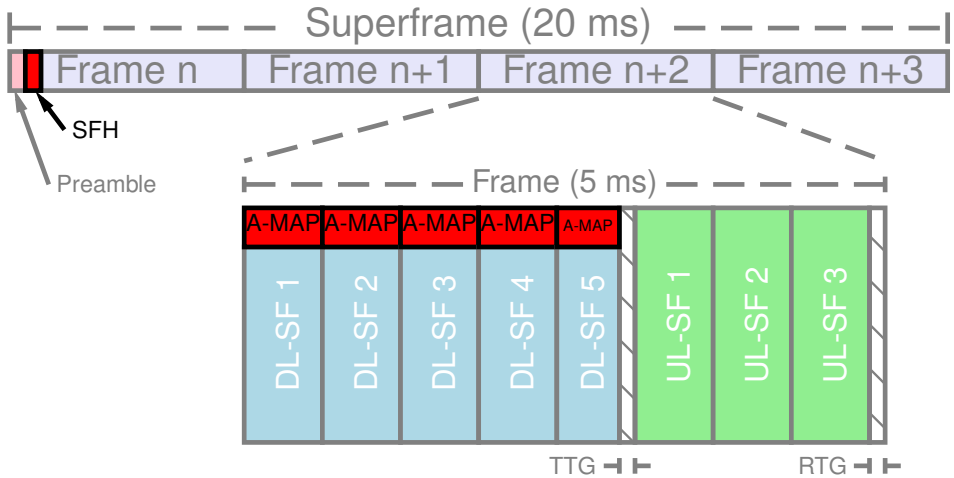

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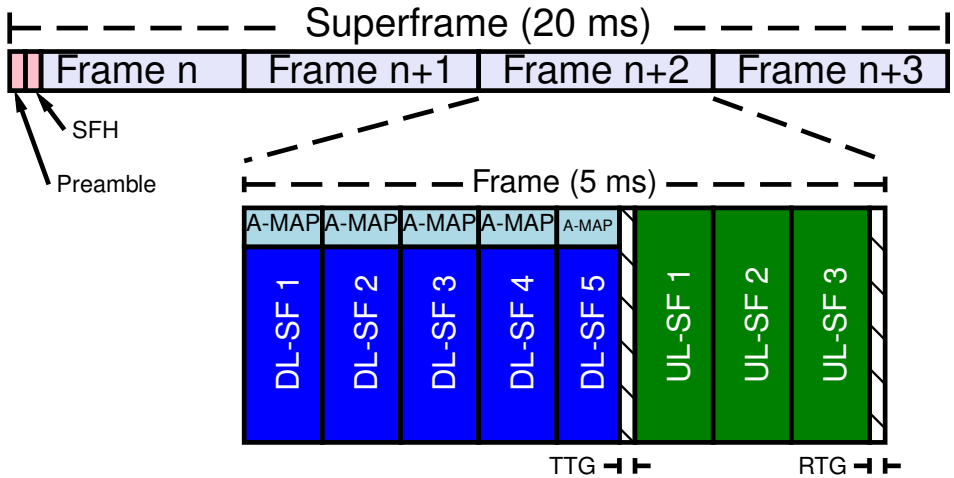

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Peak spectral efficiency

- PHY-Mode with highest data rate: 64 QAM, code rate 1
- 4x4 MIMO configuration with MIMO gain 4
- Minimum protocol overhead of 28.75%

Duplex mode	**Peak DL data rate**	**Peak UL data rate**	**Peak DL spectral efficiency**	**Peak UL spectral efficiency**
FDD ($2 \cdot 20\,\mathrm{MHz}$)	356 $\mathrm{Mbit/s}$	188 $\mathrm{Mbit/s}$	17.8 $\mathrm{bit/s \cdot Hz}$	9.4 $\mathrm{bit/s \cdot Hz}$
TDD ($20\,\mathrm{MHz}$)	169 $\mathrm{Mbit/s}$	92.2 $\mathrm{Mbit/s}$	17.0 $\mathrm{bit/s \cdot Hz}$	9.2 $\mathrm{bit/s \cdot Hz}$

Simulation scenario

Find upper bound of cell spectral efficiency through Monte Carlo simulation of ITU-T urban macro scenario

Table: Simulation Parameters

Inter-site distance	500 m
BS Tx-Power	49 dBm
BS antenna tilt	-12 °
System bandwidth	20 MHz
Sectors per cell	3
Antenna	directed 120°

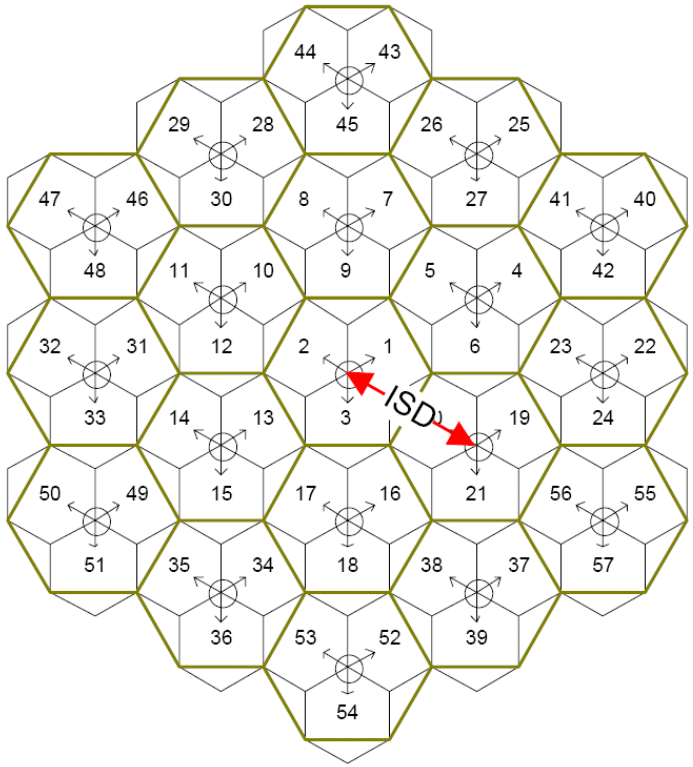

Figure: Simulation scenario

TDD DL-SINR

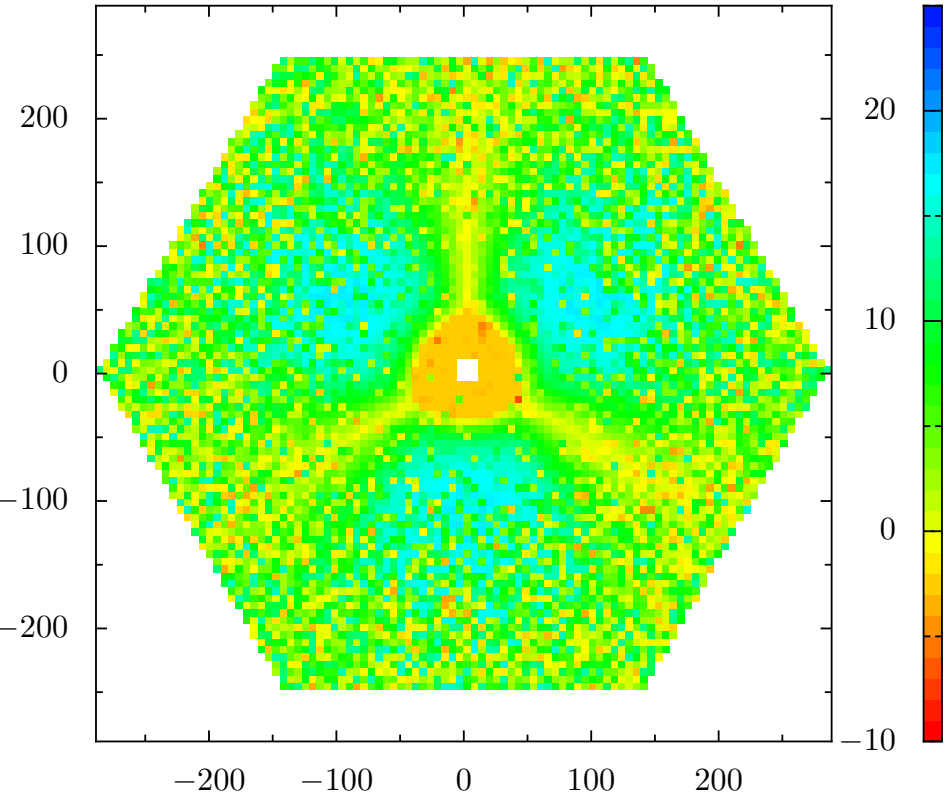

Figure: Distribution of SINR

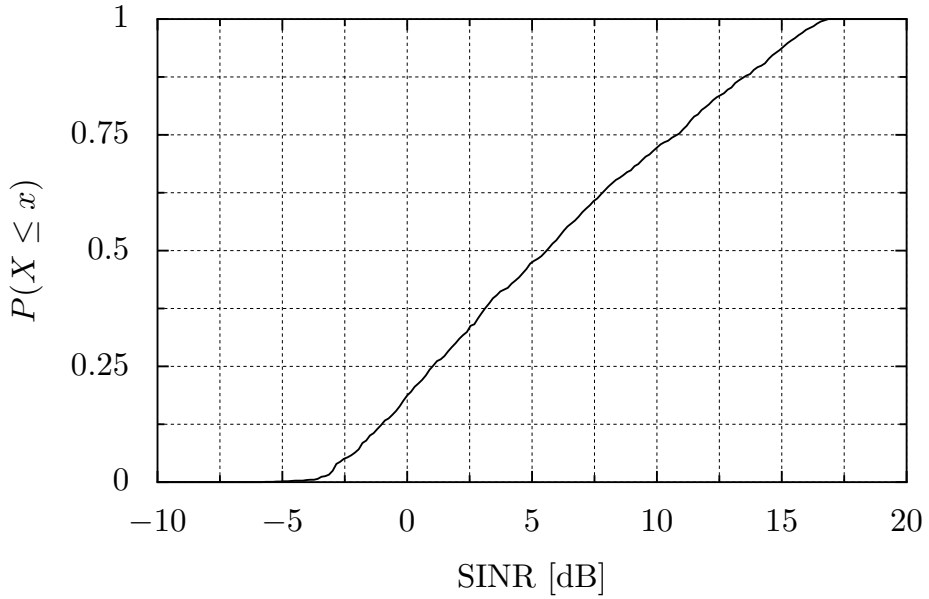

Figure: PDF of DL-SINR

SINR and channel capacity

Table: PHY Mode bitrates (20 MHz System bandwidth)

Modulation	Code	Bitrate [$^{\text{bit}}/_{\text{s}\cdot\text{Hz}}$]	min. SINR [dB][1]
QPSK	CTC 1/2	1.41	2.9
QPSK	CTC 3/4	2.11	6.3
16 QAM	CTC 1/2	2.82	8.6
16 QAM	CTC 3/4	4.23	12.7
64 QAM	CTC 1/2	4.23	13.8
64 QAM	CTC 2/3	5.65	16.9
64 QAM	CTC 3/4	6.35	18
64 QAM	CTC 5/6	7.07	19

Capacity for SINR below 2.9 dB is approximated with Shannon capacity.

[1] WiMAX Forum PHY Profile

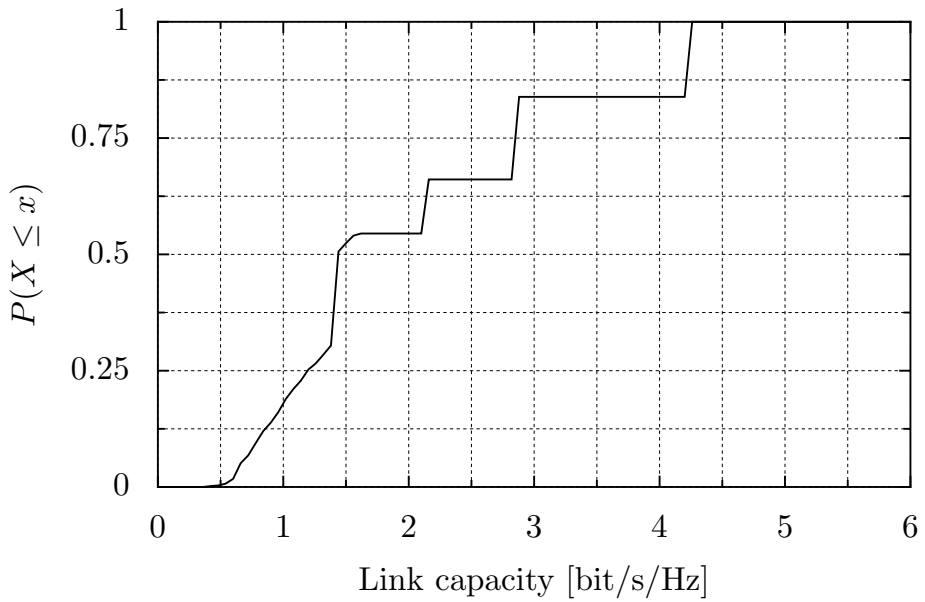

Figure: CDF of capacity

Cell spectral efficiency

$$\eta = \frac{1}{B}\left(\frac{1}{A}\iint_A \frac{1}{c(a)}\,da\right)^{-1}$$

A: Cell area
B: System bandwidth
$c(a)$: Capacity at cell segment a

TDD cell spectral efficiency is: 2.48 $\mathrm{bit/s \cdot Hz}$
ITU-T requirement is 2.2 $\mathrm{bit/s \cdot Hz}$

Conclusion and Outlook

Conclusion

- Spectral efficiency of the 802.16m system meets the ITU-T requirements
- Radio resource management would improve cell capacity

Future work

- Event driven simulative evaluation
  - Channel estimation error in scheduler
  - Consider retransmissions of packet error
- System capacity increase through relay stations

Thank you

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