Optimal MAC PDU Size in IEEE 802.16

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Outline

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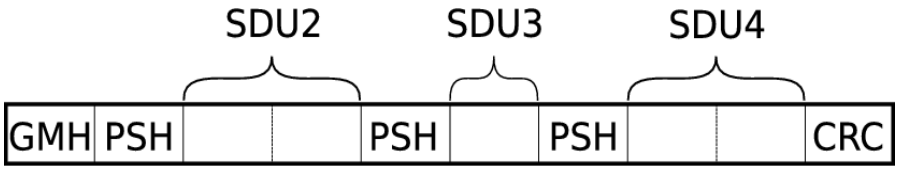
- Optimal PDU size without ARQ block rearrangement
- Optimal PDU size estimation with different error rates
- Simulation results for rearrangement
- Simulation results for PDU size
- Conclusions

Background

- Wireless channel, errors are always present and the error probability varies much
- Optimal PDU size selection problem
  - Bigger MAC PDUs have less MAC header overhead
  - Bigger PDUs are more prone to packet drops
- Also absence of ARQ block rearrangement might limit the optimal PDU size

ARQ (Automatic Repeat Request)

- ARQ mechanism informs errors so erroneous ARQ blocks can be retransmitted
- ARQ block rearrangement feature makes possible to fragment PDUs before retransmissions



Original PDU

Rearranged PDU

ARQ (Automatic Repeat Request) block rearrangement

- Assume that PDU to be retransmitted is larger than given bandwidth and rearrangement is not supported
  - Sending is not possible are bandwidth is wasted
- Therefore if rearrangement is not supported:

$$PDU\ size < Average\ burst\ size$$

Optimal PDU size on different error rates

- Bigger MAC PDU -> Less MAC header overhead
- Bigger PDU -> More likely to contain errors
- We assume some FEC block error rate (FEC BLER)
- Simple equation to estimate efficiency:

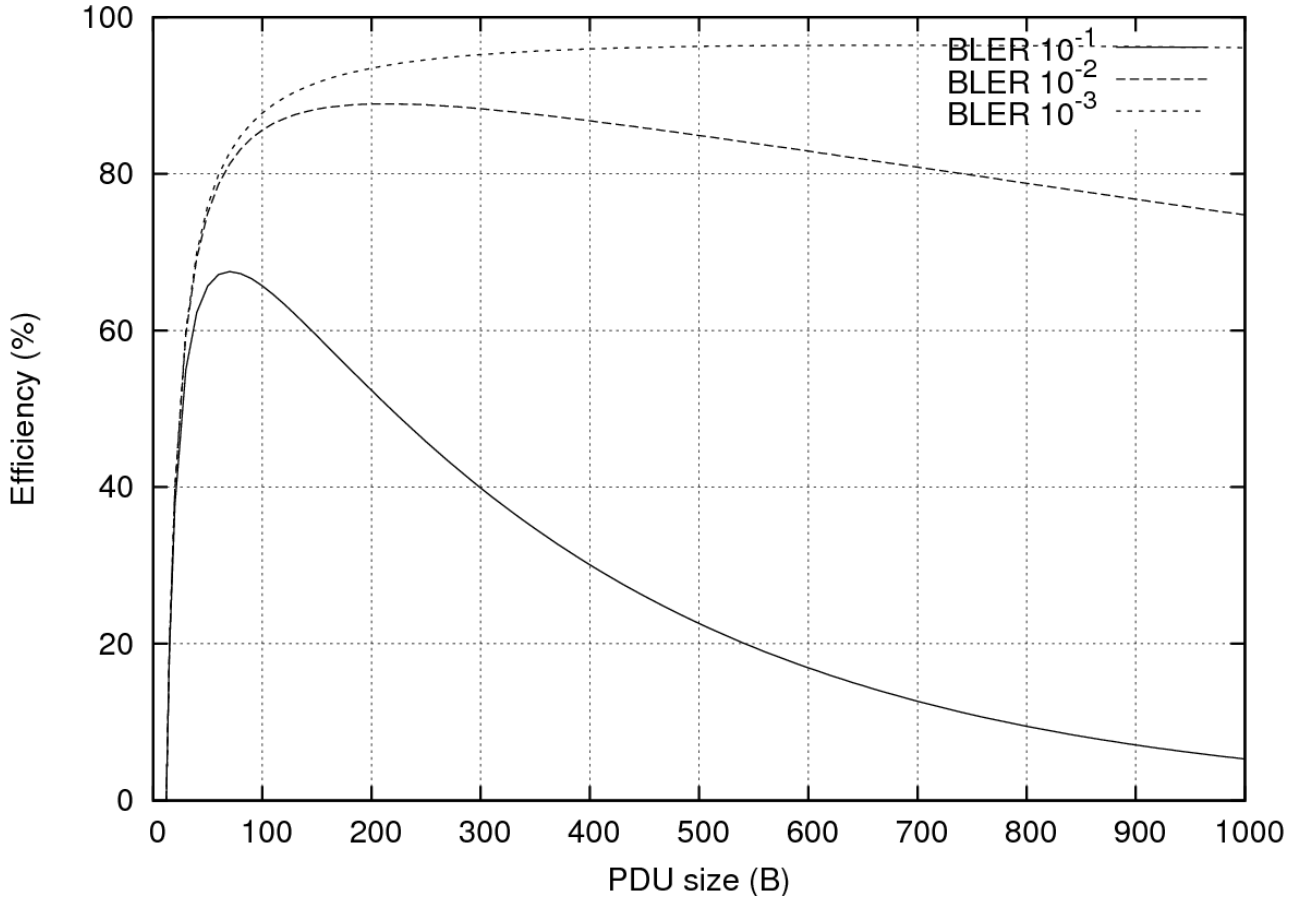
$$Efficiency = \frac{S}{L}(1-E)^{\frac{L}{B}}$$

$$Throughput\ estimation = Efficiency * Bandwidth$$

S = User bytes
L = PDU length
E = FEC BLER
B = FEC Block size

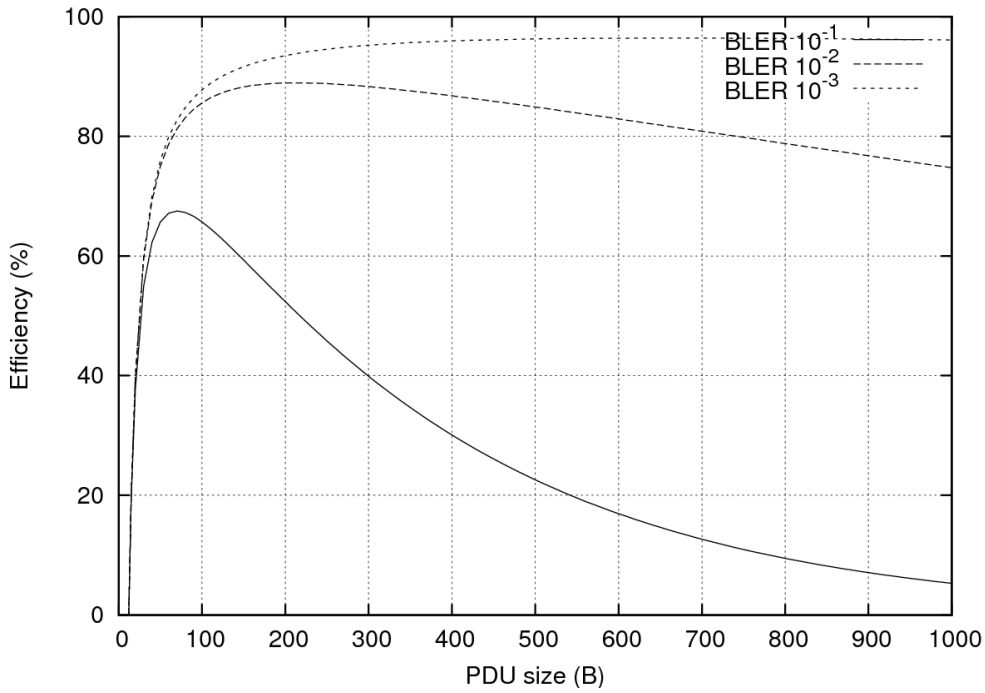
Optimal PDU size

- Theoretical efficiency for different BLER values



Optimal PDU size

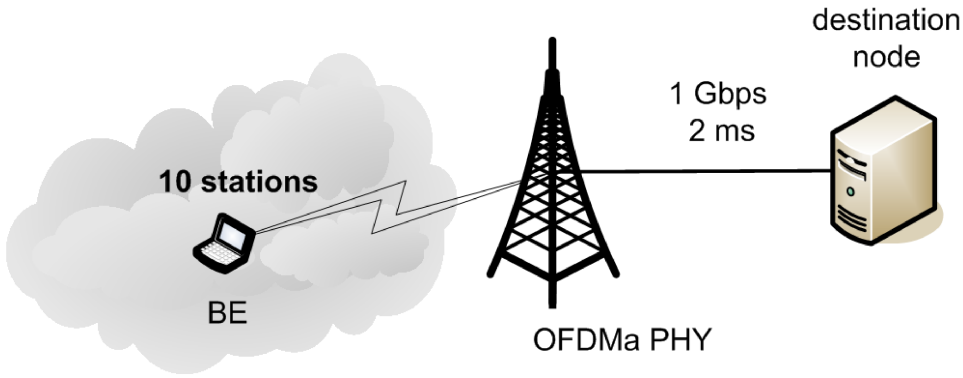
- Optimal PDU size should be smaller when there are more errors in the channel
- When then are more errors, big PDUs give bad results
- Small PDUs (~100 bytes) give quite good results in all cases



Simulation Environment

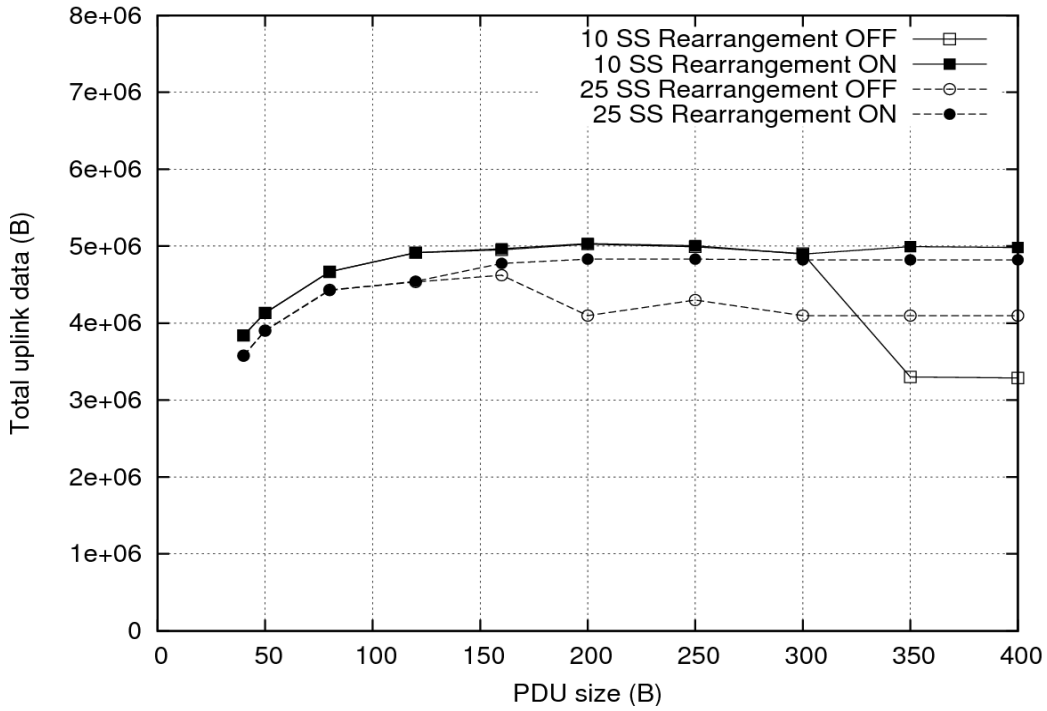
- WINSE (WImax NS-2 Extension) for NS-2 was used
- FTP application over TCP/IP

Parameter	Value
PHY / Bandwidth	OFDMa / 10 Mhz
FFT	1024
Cyclic prefix length	1/8
TTG+RTG	464 PS (0.082857 ms)
Duplexing mode	TDD
Frames per second	200 (5 ms per frame)
OFDM symbols	47
DL/UL symbols	26/21
MCS	16-QAM1/2 (12 bytes/slot)
FEC block size	3 slots (36 bytes)
Ranging transm. opportunities	2
Ranging backoff start / end	2/15
Request transm. opportunities	8
Request backoff start / end	4/15
Fragmentation / packing	ON / ON
CRC / ARQ	ON / ON
ARQ feedback / ARQ types	Standalone / all
ARQ block size / ARQ window	16 bytes / 1024
ARQ block rearrangement	ON
ARQ retry timeout / block lifetime	40 ms / 300 ms



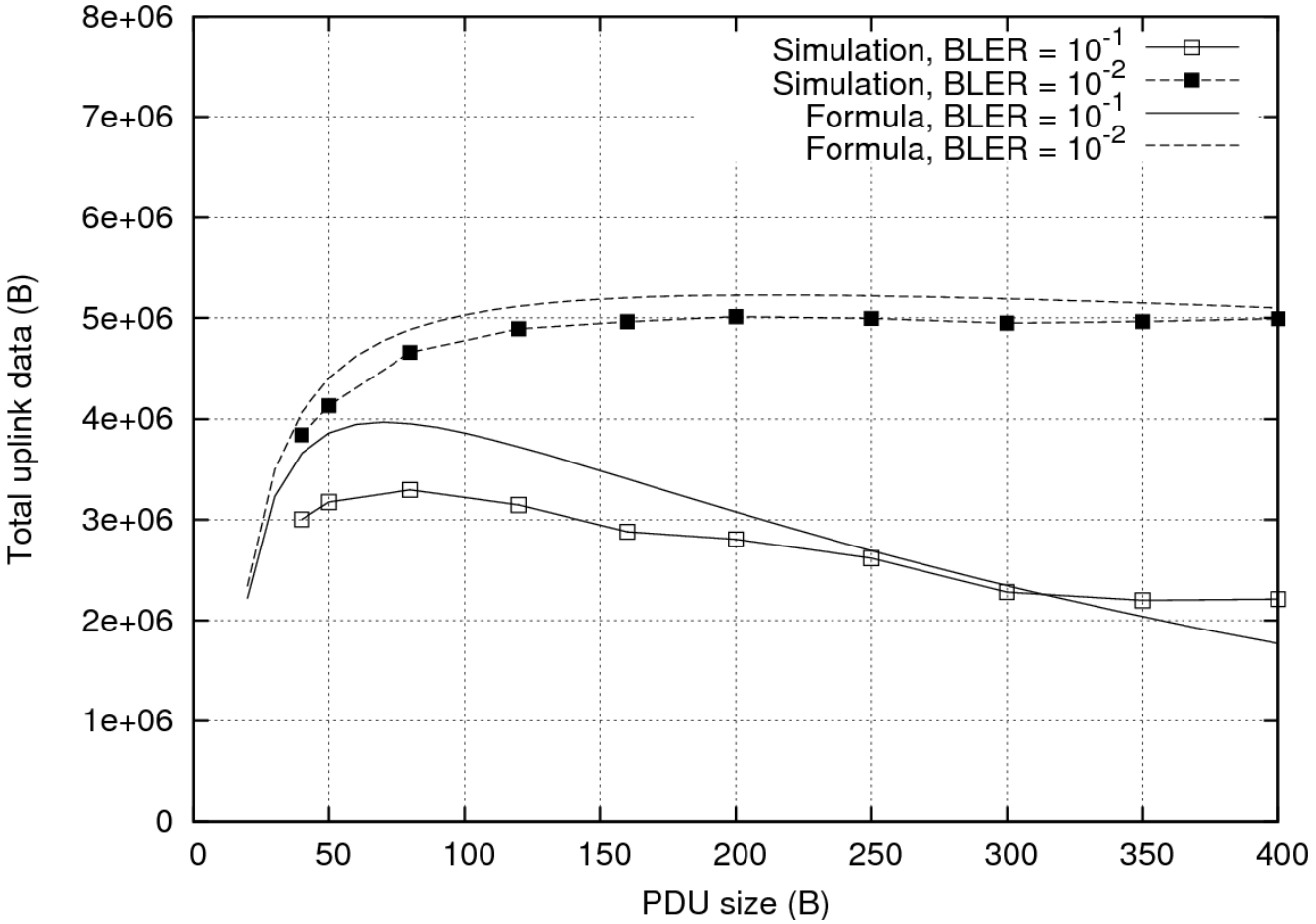
Rearrangement Simulation results

- Total uplink data for 10/25 SS, rearrangement on/off.
- If rearrangement disabled, the MAC PDU should be
  - Less than 300 B for 10 SS (average burst ~ 300 B)
  - Less than 120 B for 25 SS (average burst ~ 120 B)



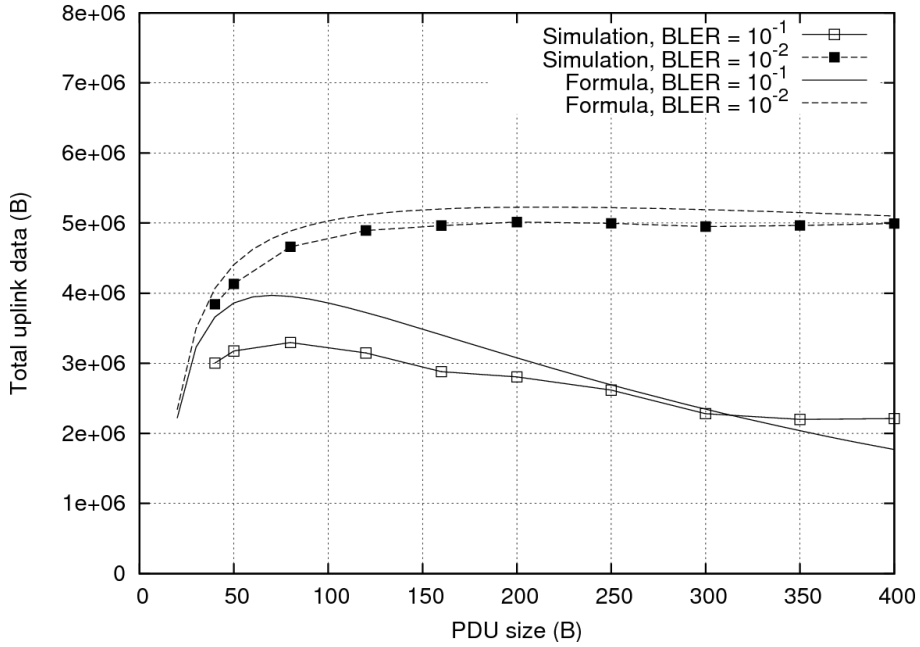
Optimal PDU size Simulation results

- Comparison between theoretical model and simulation results



Optimal PDU size Simulation results

- Efficiency formula and simulation results have the same optimal PDU size
- Efficiency formula overestimates throughput, not all overhead is taken into account



Conclusions

- If rearrangement is not supported, PDU size should less than average burst size
- Presented efficiency equation can be used to estimate the optimal PDU size, if information of the FEC BLER can be obtained
- If PDU size is fixed, the PDU should be small