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A Power Efficient Reporting Algorithm for M2M Data Transmission

Jens Mueckenheim, Serhiy Samsonov*

19. ITG-Fachtagung Mobilkommunikation, Osnabrueck 2014

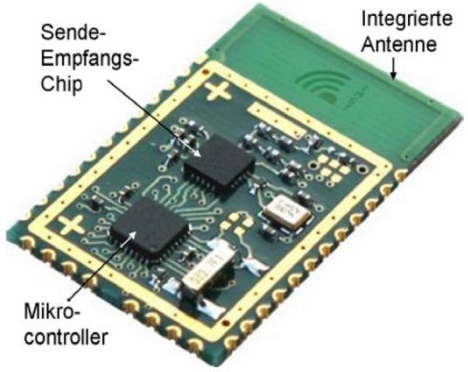
*National Technical University of Ukraine, Kyiv

Agenda

- Introduction
- Data Transmission for Stationary M2M Applications
  - Challenges of the Stationary Environment
  - Adaptive M2M Transmission Algorithm
- Simulation Study
  - Performance Comparison
  - Impact of the SNR Threshold Setting/ Dependency on Pathloss Parameters
- Conclusions/ Outlook

M2M Communication over Cellular Systems

- Cellular communication systems
  - In Europe nearly complete coverage
  - Low cost connection to even hardly accessible locations
- M2M over cellular communication systems
  - Currently there is already wide-spread usage for M2M communication
  - Because of low data volumes often 2G systems are still in use



M2M Radio Module
[Source: ITG M2M Position Paper]

Stationary M2M Applications

- There exist a large variety of M2M applications, which are used at fixed locations, for example
  - Metering of consumption data
  - Monitoring of vital data (telemedicine)
  - Environment monitoring
  - Condition monitoring of remote equipment (telemonitoring)
- Very often, communication over cellular systems is used to carry the M2M reports
  - Usually inside of a building
  - Occurrence of variable radio conditions
- M2M is usually generating relative small data reports but with probably a high number of M2M devices
  - Cellular communication systems are optimized for transmitting large data volumes to a relatively low number of H2H devices

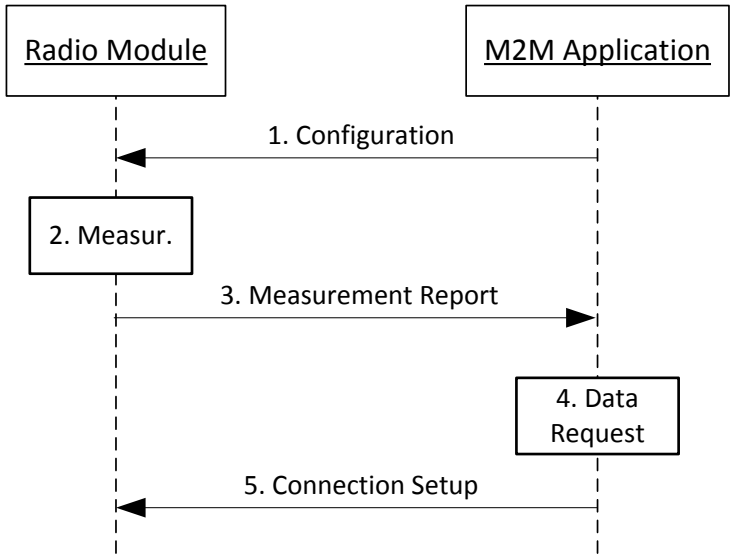
Mobility Effects

- Even for stationary M2M applications variable radio conditions to be expected, e.g. due to
  - Changes in the transmit power for traffic load adaptation
  - Temporary disabling of basestations for energy saving
- From this typical mobility effects result
  - ***Handover*** between adjacent cells
  - Temporary ***loss of radio coverage***
- Approaches for resolution
  - Improvement of the radio coverage inside the building by e.g. using of ***femto cells***
  - Adaptation of less time-critical M2M applications to the variable radio conditions: ***adaptive M2M applications***

Adaptation of the M2M Application

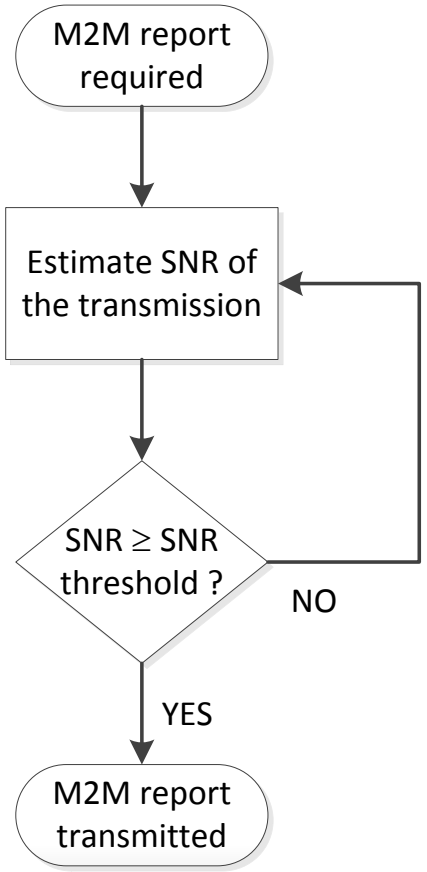
- There exist many M2M applications, which don‘t need necessarily time critical information
  - Examples: Metering with larger time horizon, uncritical status updates, …

- ***Adaptive M2M Application***
  - M2M modem measures regularly radio link quality at the location and informs the M2M application
  - M2M application does only start transmitting when sufficient radio link quality



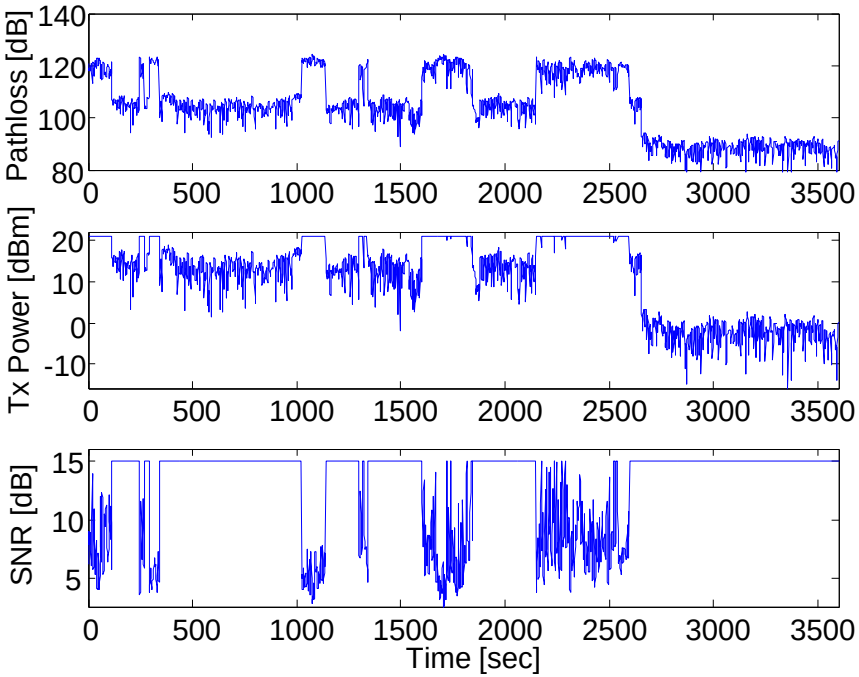
Enhanced M2M Transmission Algorithm

- Improved M2M algorithm performs a check for sufficient radio quality
  - The estimated SNR must be higher than a threshold before transmitting
  - Useless reports with likely high error probability are avoided
  - In case of bad radio link quality report has to wait until SNR improves



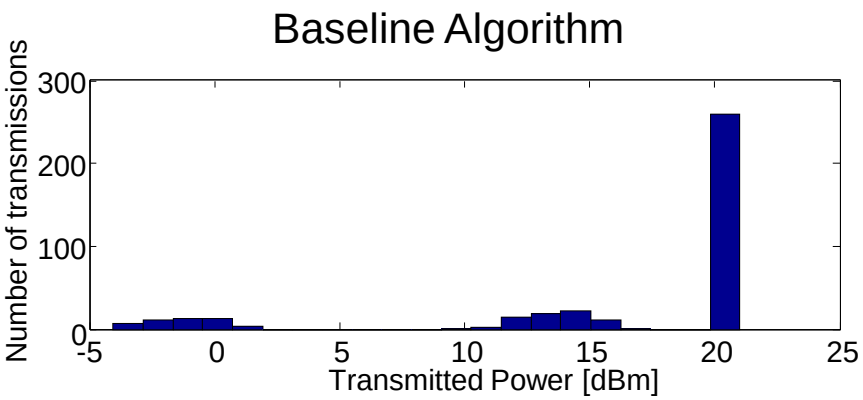
Pathloss Model

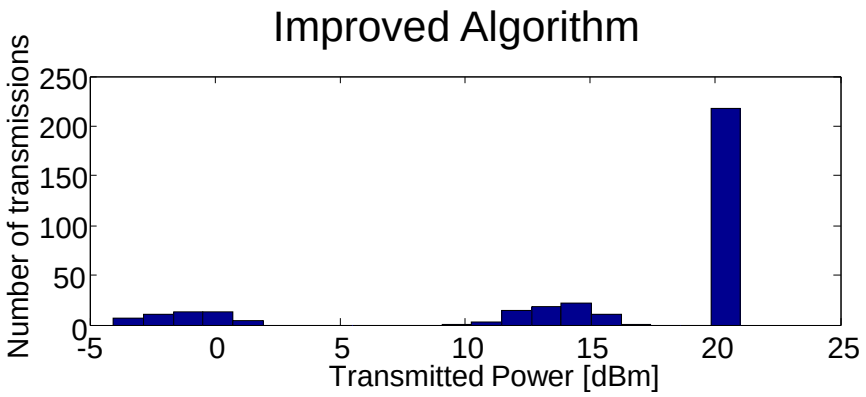
- Model of the variations in the RF environment for stationary M2M modems
  - Stepwise changes in uplink environment due to allocation at different basestations
  - Jakes-model to emulate channel variations at very low mobile speed
- Parameters
  - Average pathloss
  - Step size

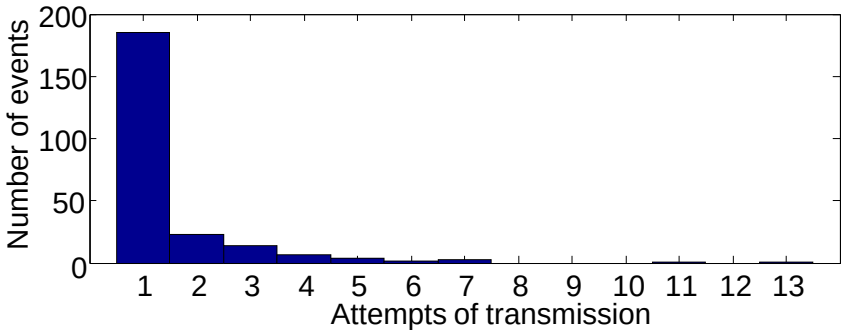


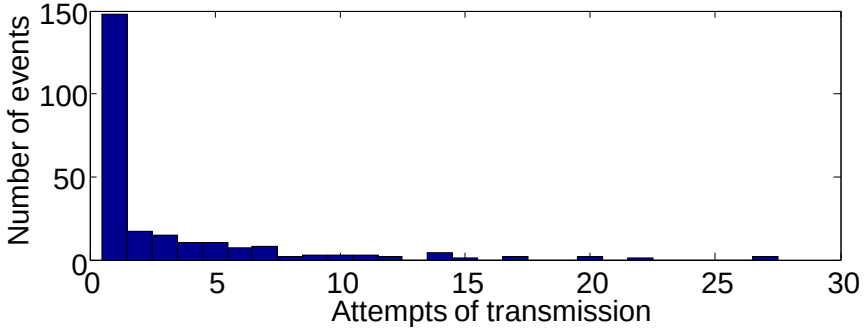
Average = 90 dB, Delta = 15 dB

Performance Results





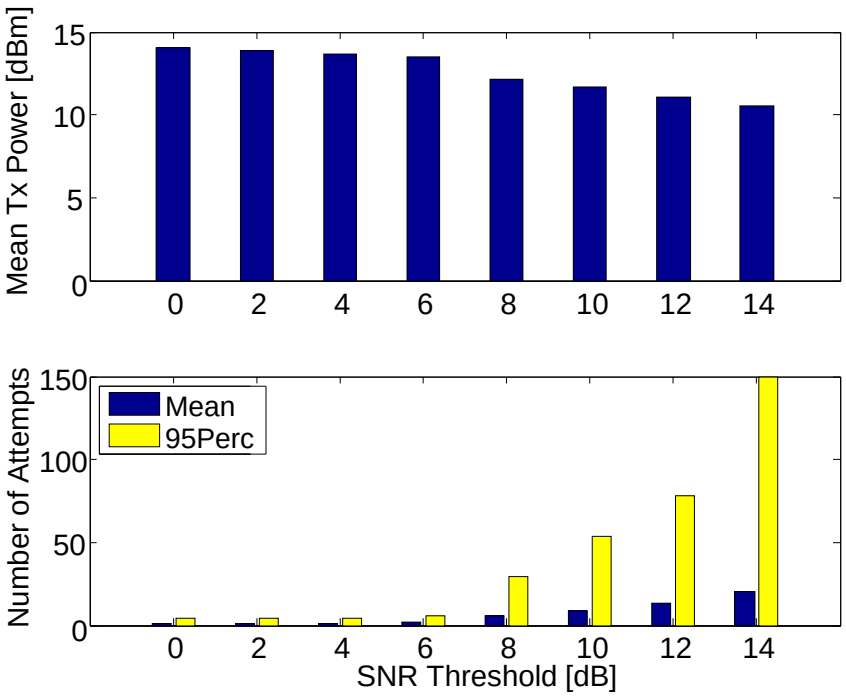




- Improved algorithm avoids transmissions at maximum power
  - Slightly more transmit attempts increase the delay

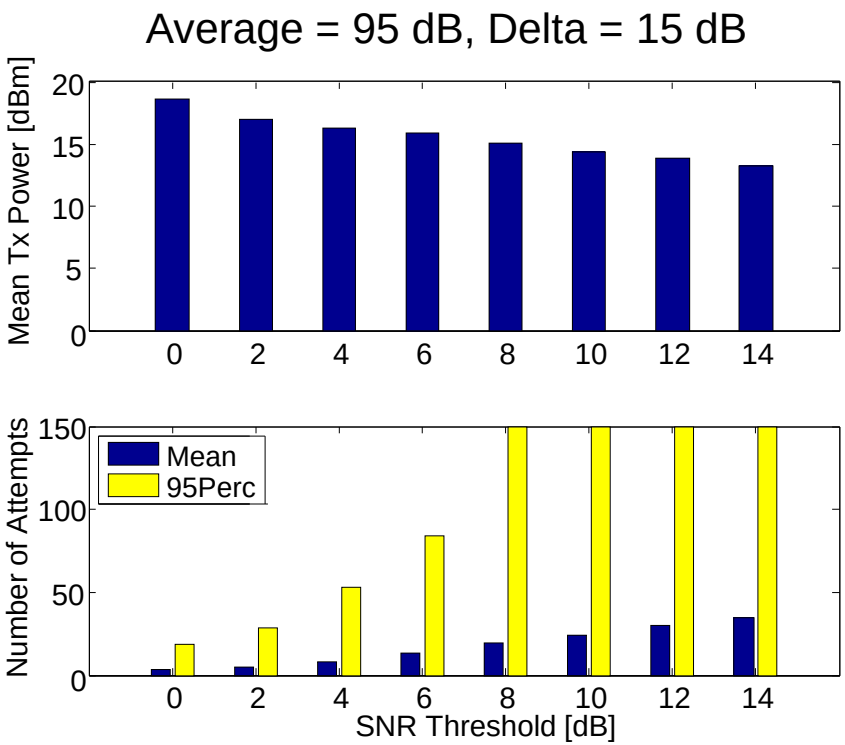
Impact of SNR Threshold Setting

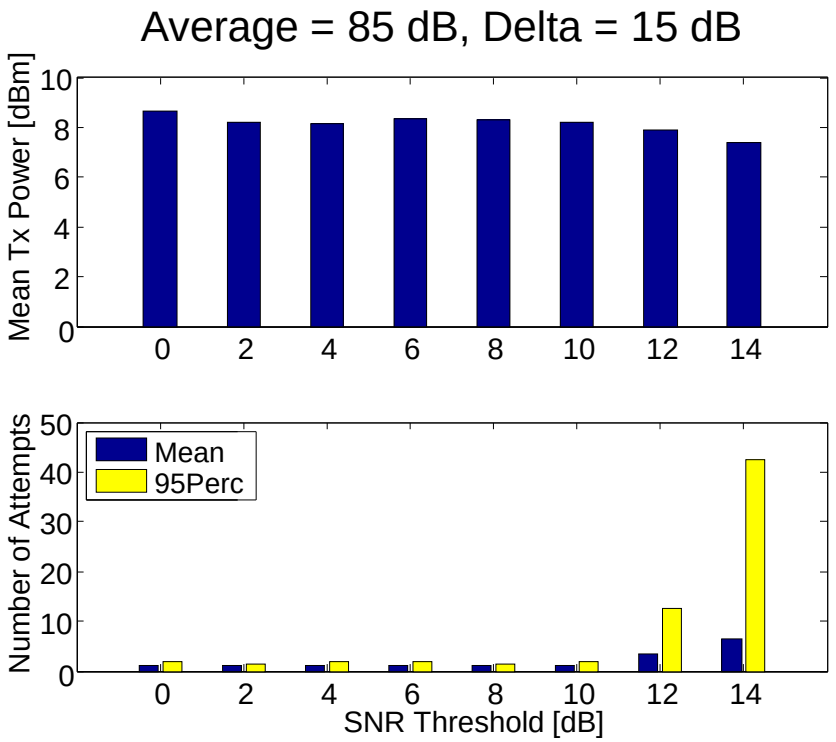
- Performance can be tuned by adjusting the SNR threshold
- Higher SNR thresholds reduce the average tx power
  - Less useless attempts at higher tx power
- Delay increases
  - Longer time for waiting until transmission
  - Strong increase of the maximum delay when high SNR threshold setting



Average = 90 dB, Delta = 15 dB

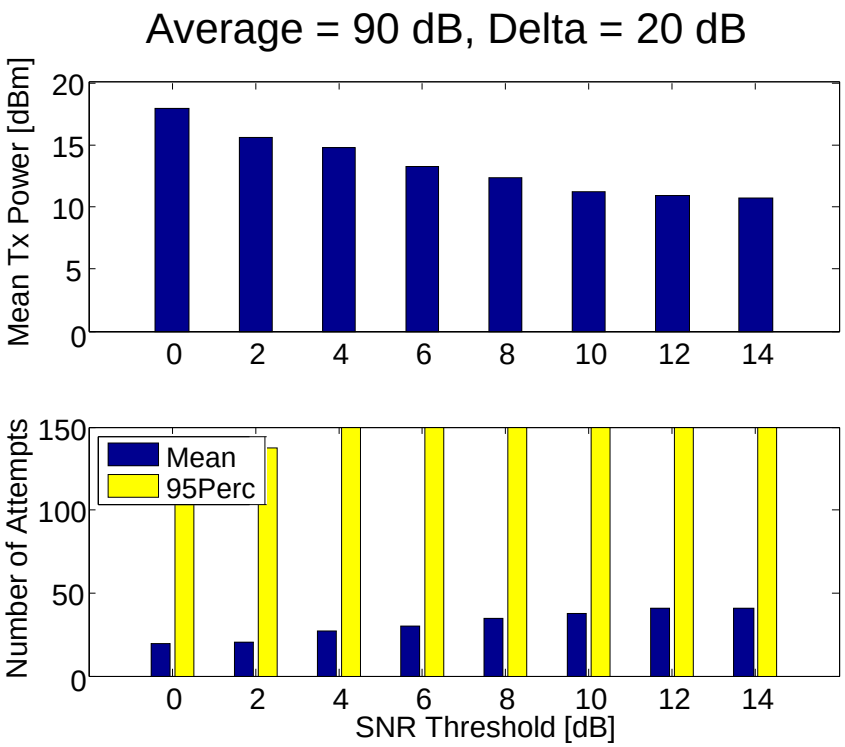
Dependency on Pathloss

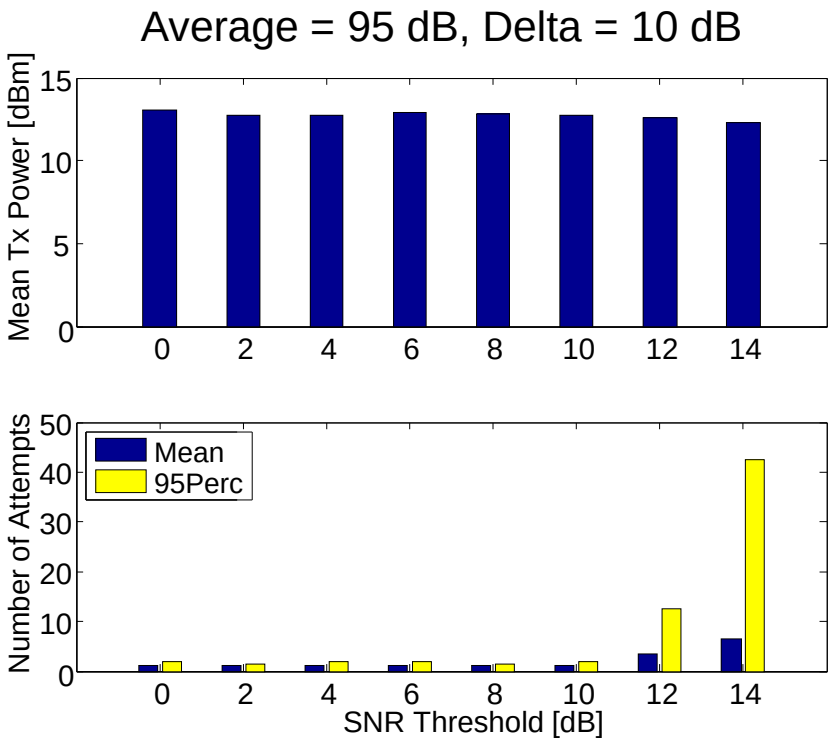




- Different performance when modifying the average pathloss
  - Changes the overall radio condition at the M2M modem location

Dependency on Pathloss (contd.)





- Efficiency depends on the variations of the pathloss
  - Changes the duration of the bad radio conditions

Conclusions/ Outlook

- A power efficient reporting algorithm for M2M communication of stationary applications has been proposed
  - Transmission attempts only performed in good SNR conditions
  - Useless transmissions avoided when in bad situation
  - Criterion based on a check of the SNR against a SNR threshold
- The algorithm has been studied by means of simulations
  - Trade-off between the reduction of transmit power and an increase of the transmission delay
  - Tunable performance by adjusting the SNR threshold
- Future work will focus on refinement of the algorithm and simulations
  - Application to other pathloss models, e.g. for mobility
  - Improvement of the algorithm: dynamic SNR threshold setting

Thank You !

Prof. Dr.-Ing. Jens Mueckenheim
Hochschule Merseburg
Fachbereich Informatik und Kommunikationssysteme
Geusaer Straße
D-06217 Merseburg
Tel: 03461-462925
Fax: 03461-462900
E-Mail: jens.mueckenheim@hs-merseburg.de
Internet: www.hs-merseburg.de

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