Communication Networks

Lehrstuhl für Kommunikationsnetze an der RWTH Aachen

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Radio Network Dimensioning for GSM/GPRS Supporting Circuit- and Packet-Switched Services

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Structure

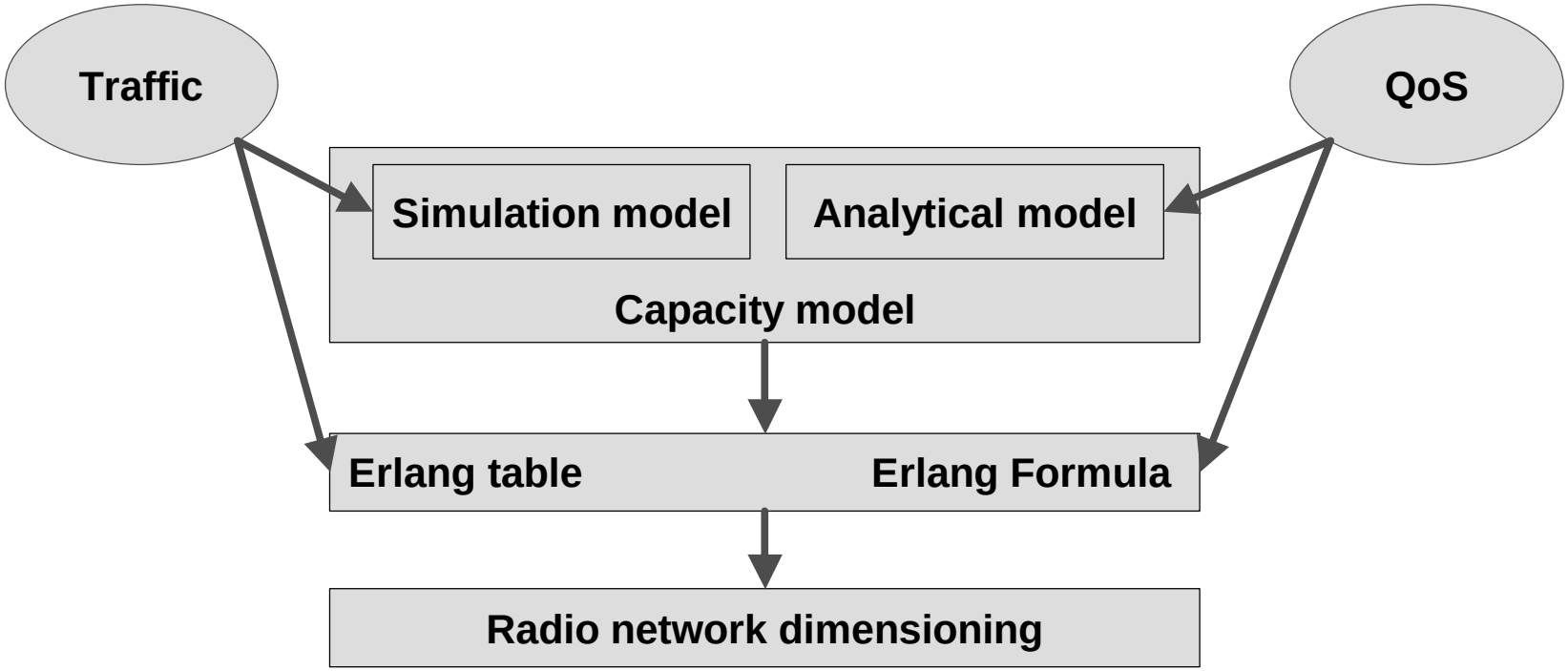
- the problem
- coexisting circuit-switched traffic
- dimensioning rules for fixed PDCH configurations
- dimensioning rules for on-demand PDCH configurations
- configurations with fixed and on-demand PDCHs

Motivation

- radio network dimensioning demands the relationship between
  - offered traffic predicted by operator
  - QoS desired by operator for his clients
  - radio resources needed (number of PDCHs and TRX)
- analytical complexity caused by
  - radio channel attributes
  - bursty traffic (no Erlang-B-formula like in CS)
- system complexity – no test bench or field trials with complete protocol software and hardware components available
- solution: computer simulation of the system that models
  - system components and their protocols
  - traffic sources
  - radio channel

Capacity planning and radio network dimensioning

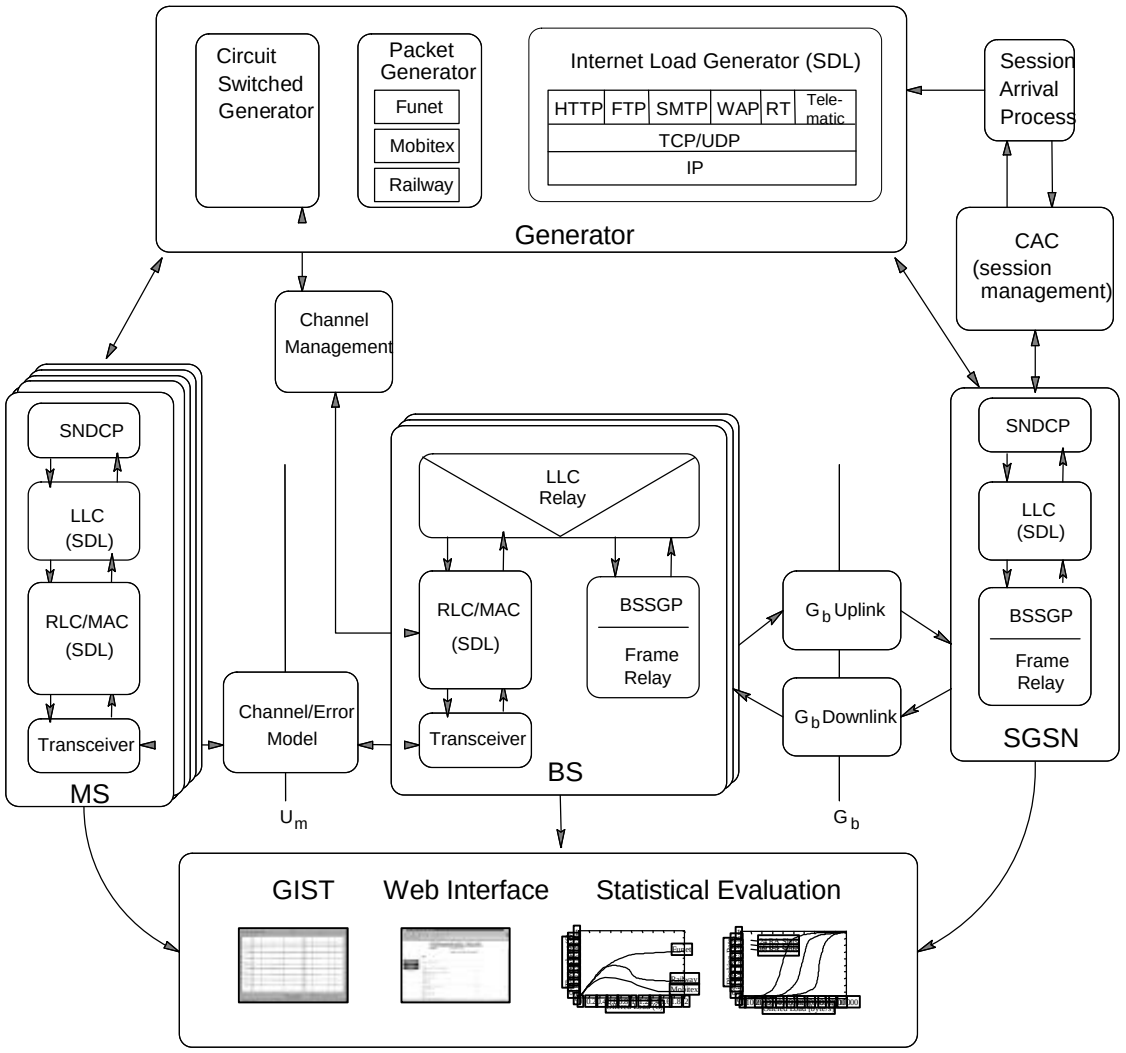
- relationship between
  - offered traffic
  - QoS desired
  - radio resources needed



Measures and methodology

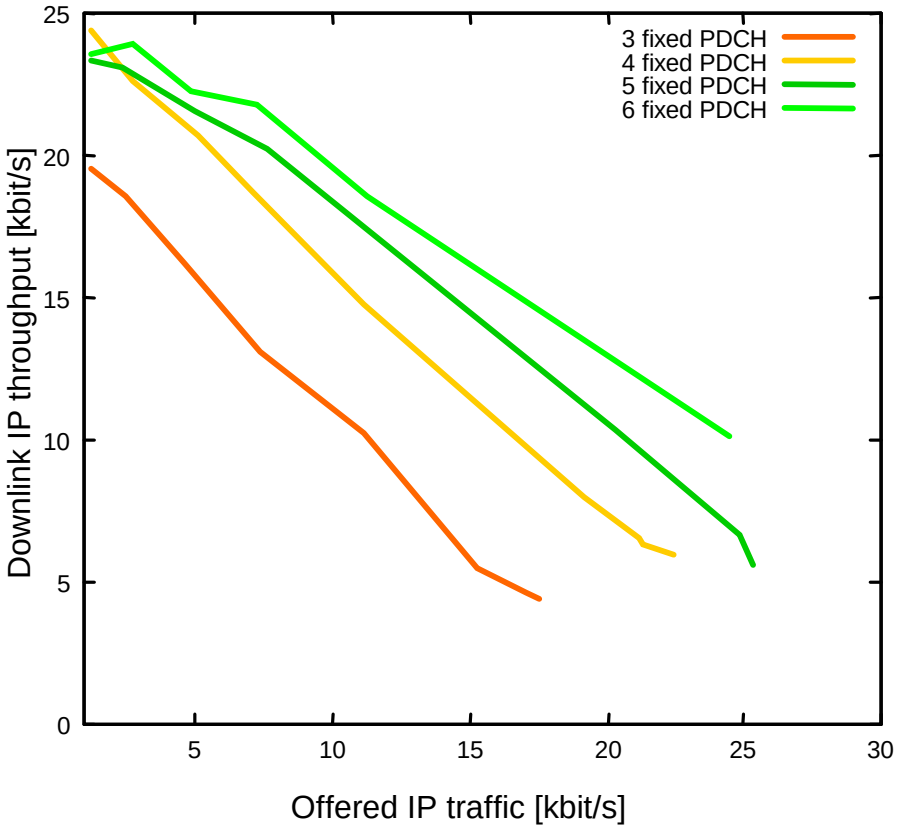
term	circuit-switched	packet-switched
traffic	offered traffic in Erlang	offered amount of data per time in kbit/s
QoS parameter	blocking probability (GoS)	throughput, delay,...
resources	traffic channels	packet data channels
tool	simple formula or table	dimensioning graphs or tables
methodology	Erlang-B formula	simulation results, analytical / algorithmic techniques

Simulation Environment (E)GPRSim

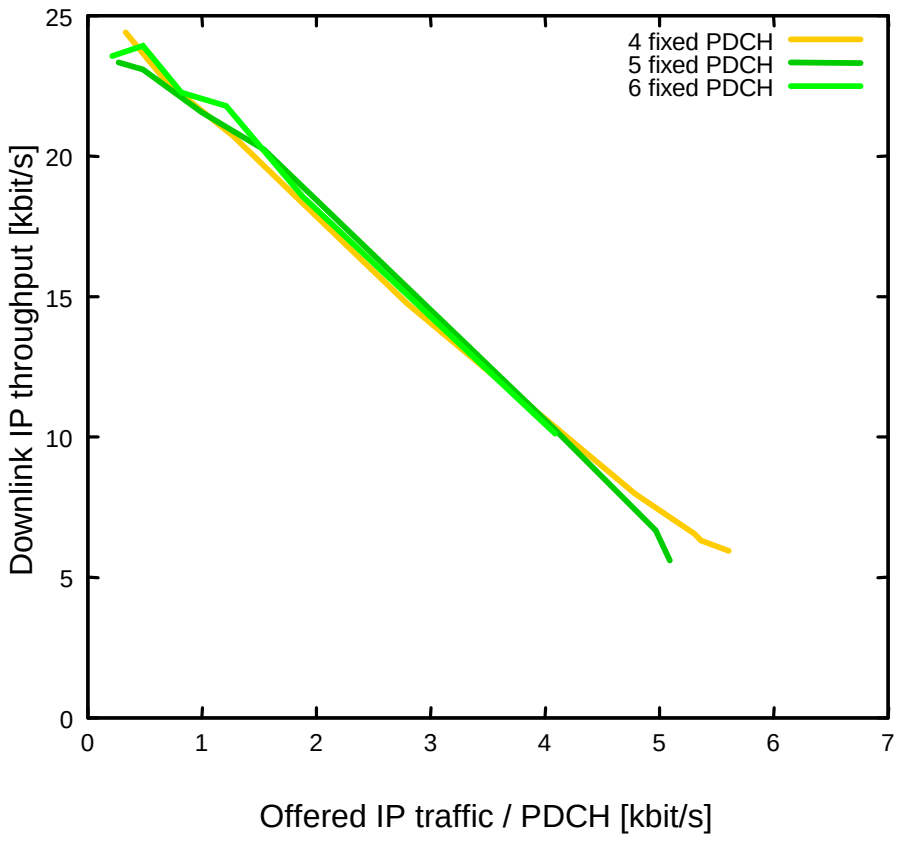


Dimensioning rules for fixed-PDCH scenarios (I)

downlink IP throughput over offered traffic



Dimensioning Graph



Dimensioning rules for fixed-PDCH scenarios (II)

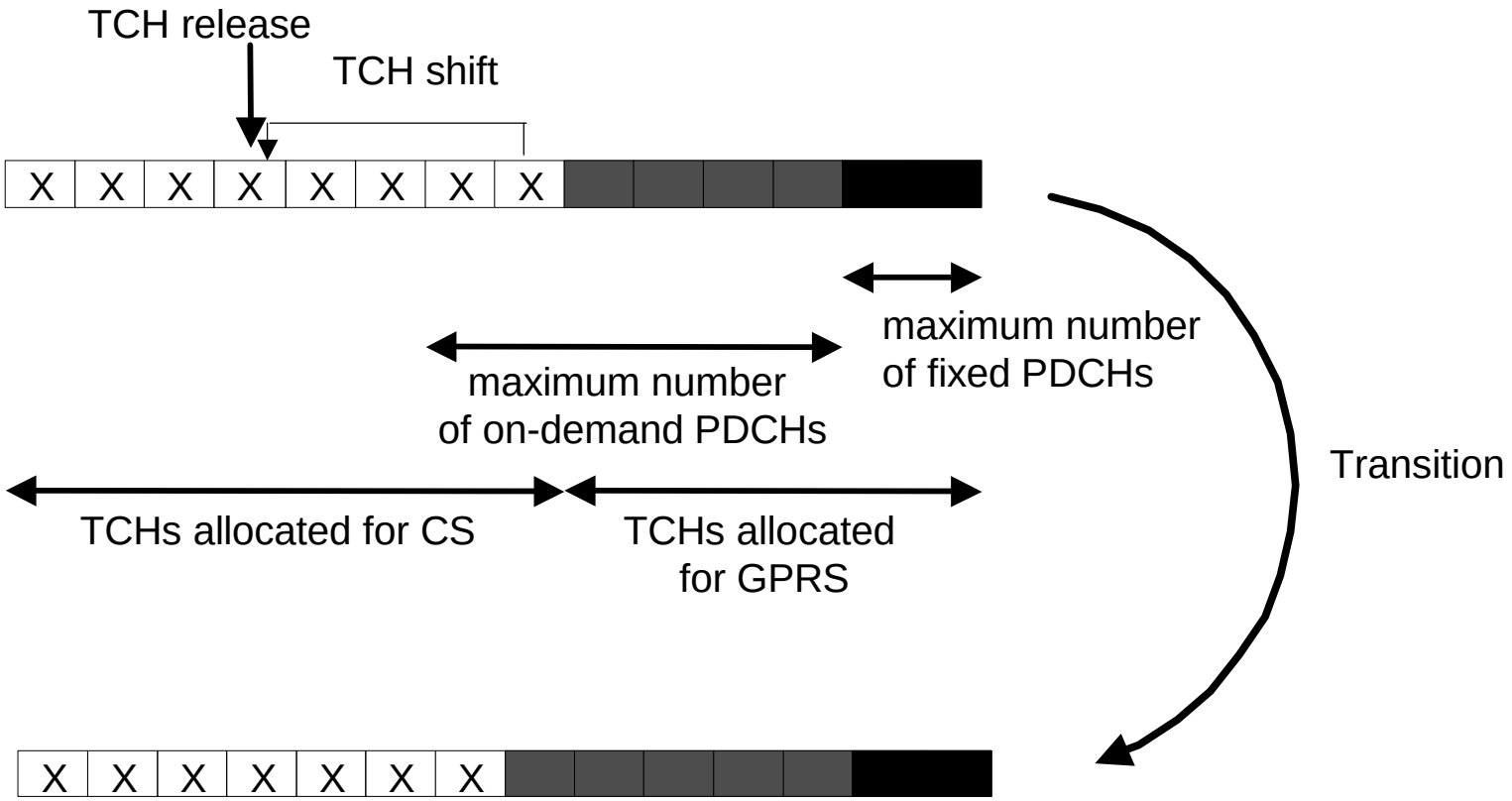
- define the desired QoS
- estimate the number of users per cell
- estimate the offered traffic per user
- calculate the total offered traffic per cell
- determine the acceptable traffic per PDCH with the desired QoS from the dimensioning graph
- calculate the needed number of PDCHs
- PDCH = estimated offered traffic / acceptable traffic per PDCH

Example

- define the desired QoS
  - example value: 12.5 kbit/s is desired
- estimate the number of users per cell
  - example value: 10 users with 540 kbyte/h per user
- calculate the offered traffic per user and the offered traffic per cell
  - offered traffic per user = 540 kbyte/h = 1.2 kbit/s
  - total offered traffic per cell = 12 kbit/s
- take the acceptable traffic per PDCH from the reference graph
  - acceptable traffic per PDCH = 3.5 kbit/s/PDCH
  - PDCH = 3.4
  - 4 PDCHs have to be allocated for GPRS

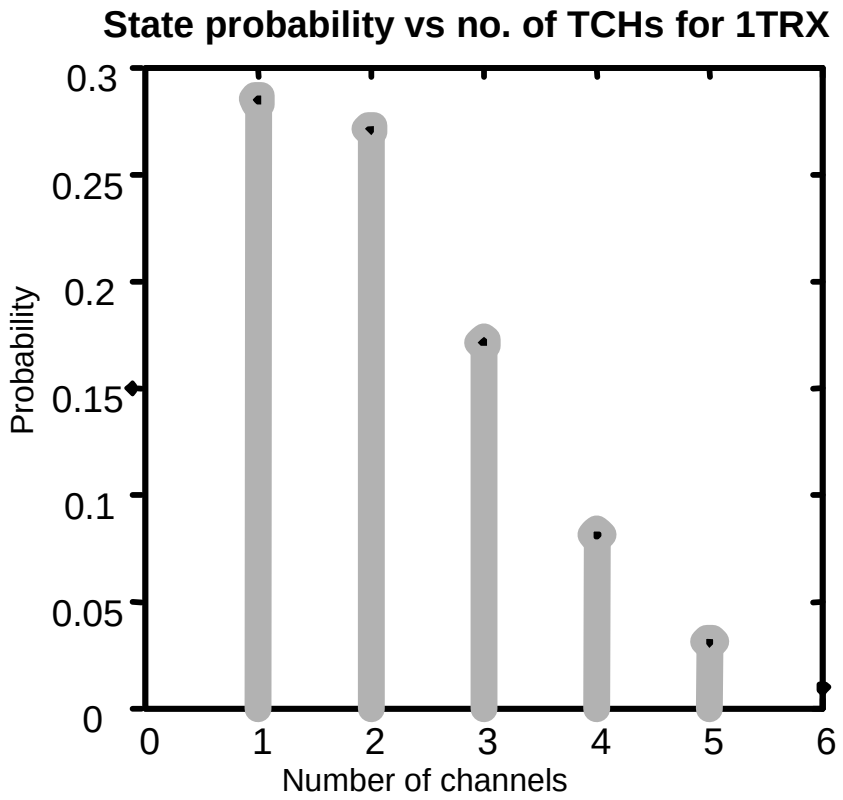
Radio resource management

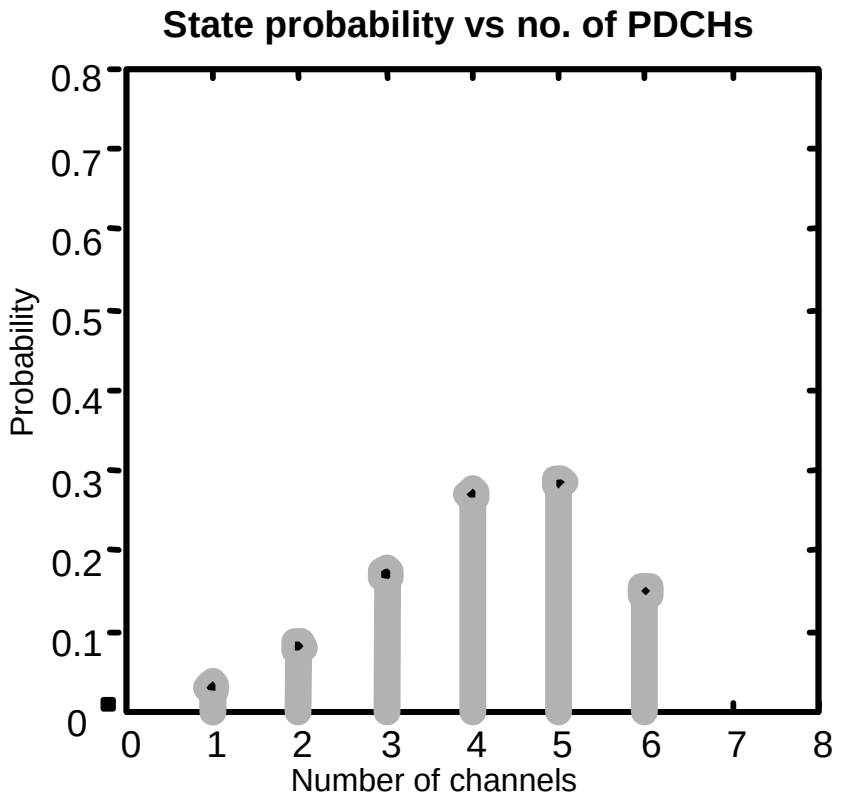
- on-demand assignment of PDCHs for GPRS
- voice connections are prioritized



Circuit switched traffic

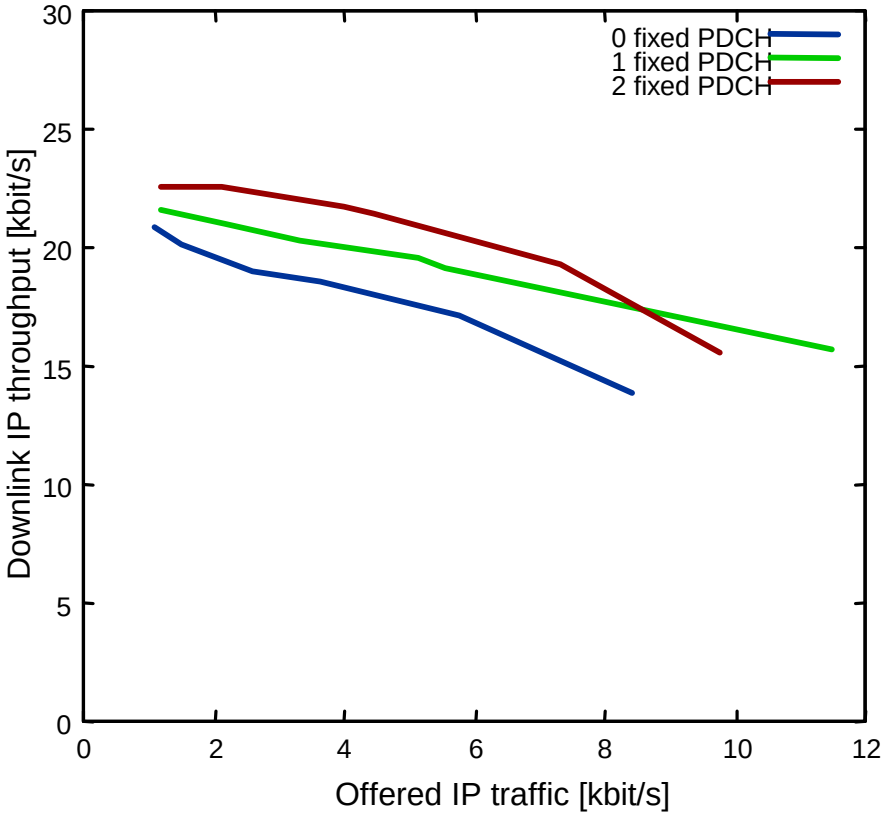
- radio network dimensioned for voice services with blocking probability of e.g. 1 % (blocking probability = Grade of Service (GoS))
- unutilized resources can be used for GPRS



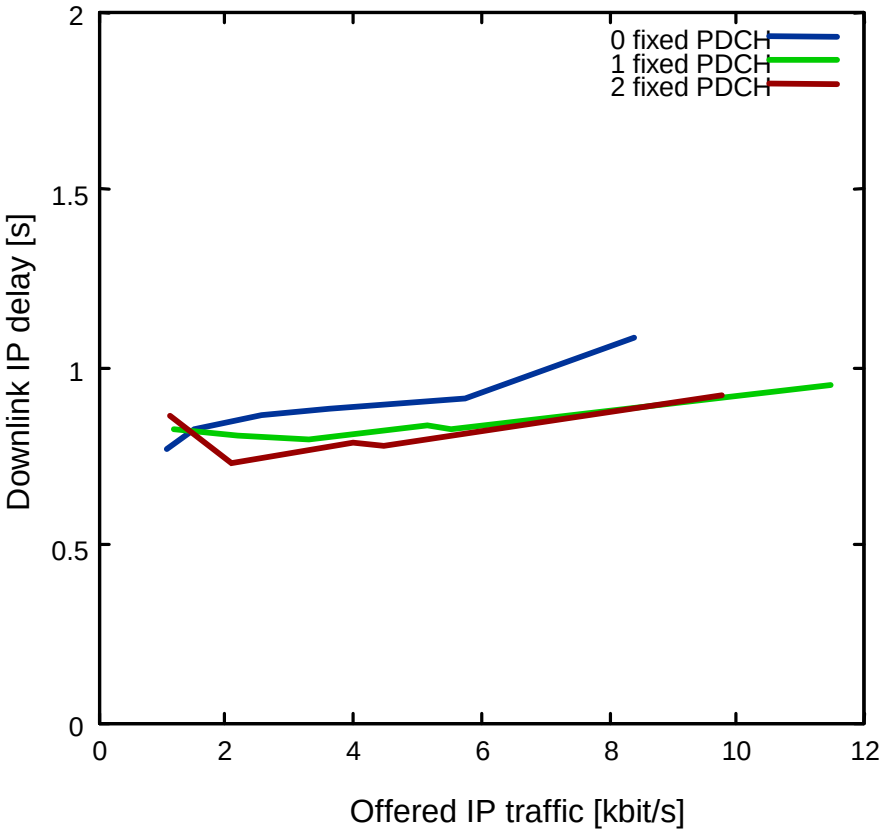


GPRS performance with coexisting CS traffic (I)

downlink IP throughput per user

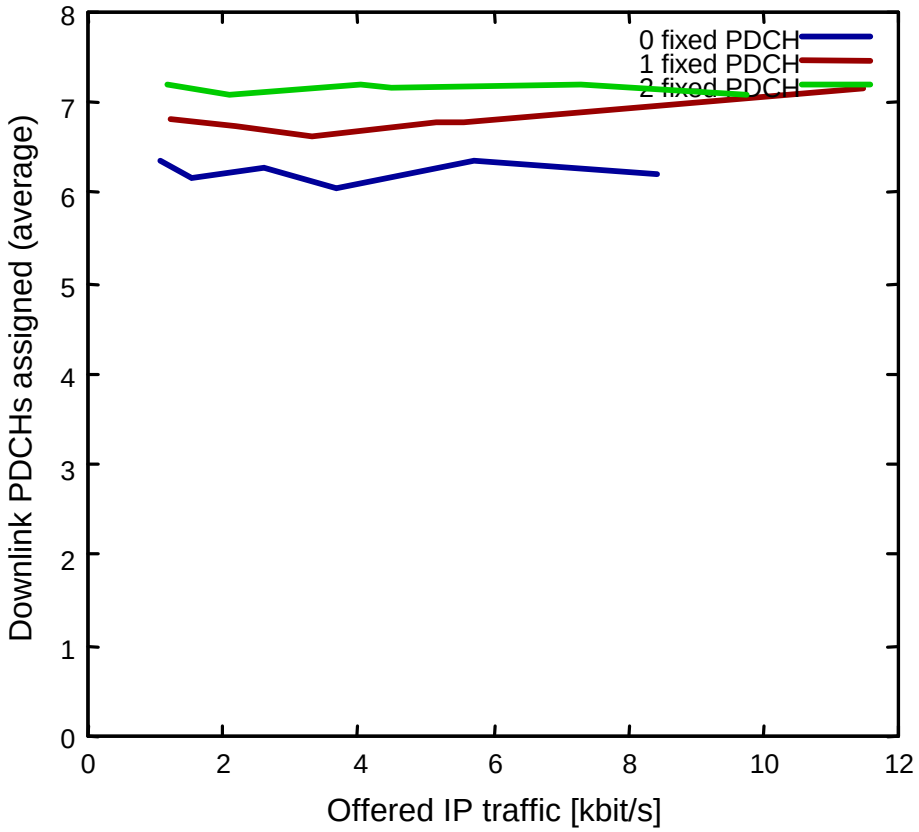


downlink IP packet delay

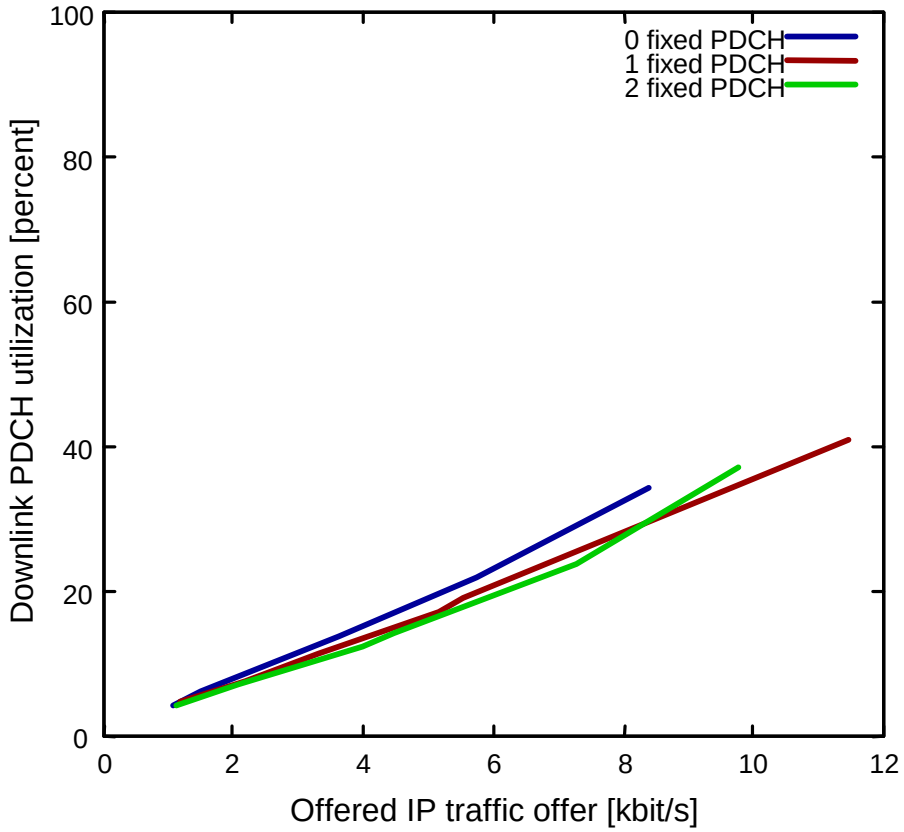


GPRS performance with coexisting CS traffic (II)

downlink PDCHs assigned (average)



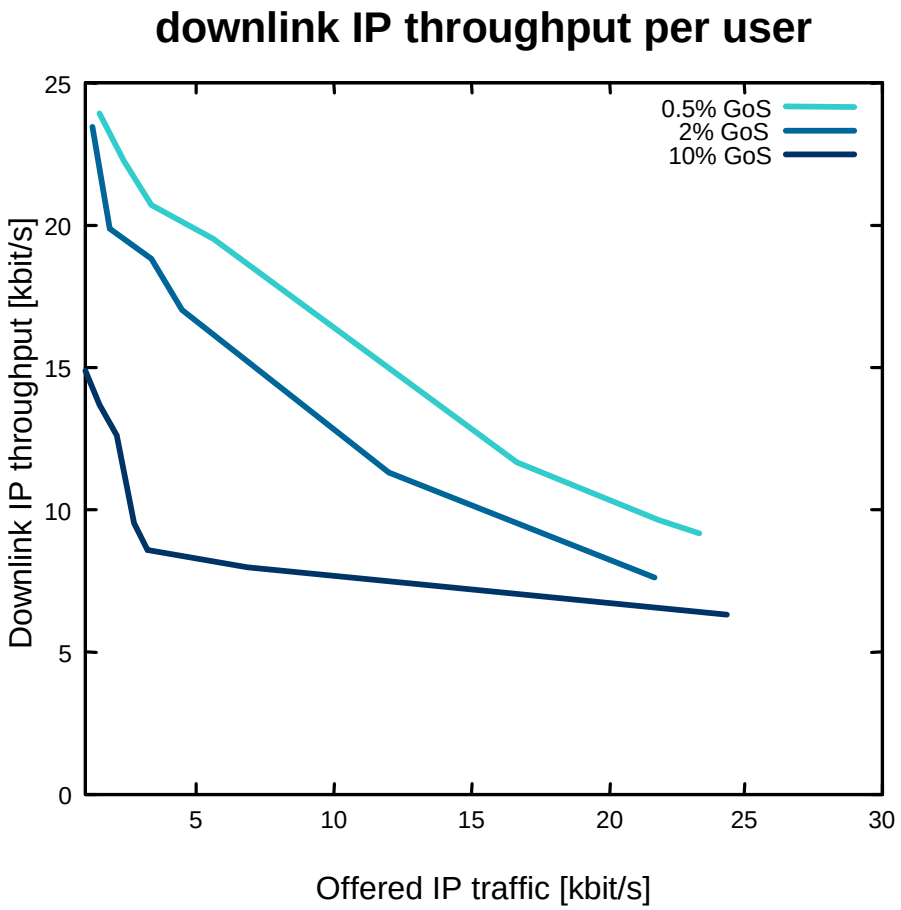
downlink PDCH utilization



Dimensioning rules for on-demand-PDCH scenarios

- simulation results show that the shared use of GSM physical channels both for CS and GPRS makes sense
- dimensioning rules for on-demand-PDCH scenarios are needed
- the aim is to take an existing TRX scenario as the basis and find the acceptable CS traffic so that the desired GPRS performance can be achieved
- if the predicted offered traffic is exceeded a new TRX module should be added to the base station
- in the following an example is given for a 3 TRX scenario

Example: 3 TRX scenario (I)



- Example values
  - offered CS traffic with 1.5 % GoS
  - 10 GPRS users per cell
  - 540 kbyte/h offered per user
  - desired QoS of 12.5 kbit/s

Example: 3 TRX scenario (II)

- calculate the offered traffic per cell
  - total offered traffic per cell = 10 * 540 byte/h = 12 kbit/s
- regard the operating point p defined by the desired user performance on the y-axis and the offered traffic per cell on the x-axis and choose the adequate GoS curve as the next that lies above the operating point
  - p = (x = 12 kbit/s, y = 12.5 kbit/s)
- if the offered CS traffic corresponding to the GoS is predicted to be exceeded, a new TRX should be added
  - the operating point p lies just below the 2 % GoS curve
  - coexisting CS traffic up to 2 % GoS is acceptable
  - since 1.5 % GoS was assumed an additional TRX is not necessary in this cell

Mixed configurations

- to be able to guarantee the availability of GPRS, operators might provide fixed PDCHs and the rest as on-demand PDCHs
- in this case simple estimations can be done:
  - scenarios with 1,2 or 3 fixed PDCHs: take pure on-demand configurations for dimensioning (probability that the first PDCHs are used by CS is low)
  - scenarios with more than 3 fixed PDCHs: take a pure fixed PDCH configuration for dimensioning (probability that the on-demand PDCHs are used by CS is high)

Conclusions

- fixed PDCH configurations can be dimensioned with one simple dimensioning graph
- on-demand PDCH configurations are recommended, since not all physical channels are highly utilized by CS
- dimensioning of on-demand PDCHs can be done by taking dimensioning graphs for the regarded TRX scenario as the basis
- for mixed scenarios with both fixed and on-demand PDCHs simple estimations can be done and pure fixed or pure on-demand dimensioning rules can be applied