Radio Network Dimensioning for GPRS Networks to support Mobile Internet Applications

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20.7.2000

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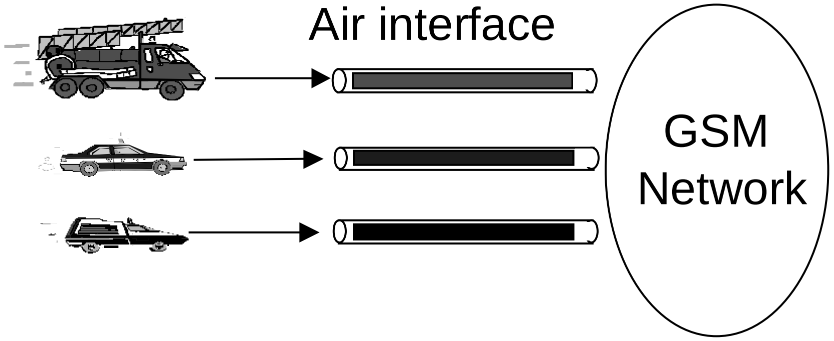
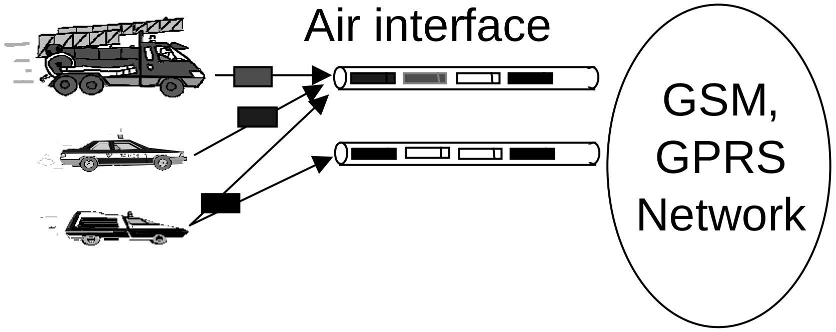
GPRS Principles

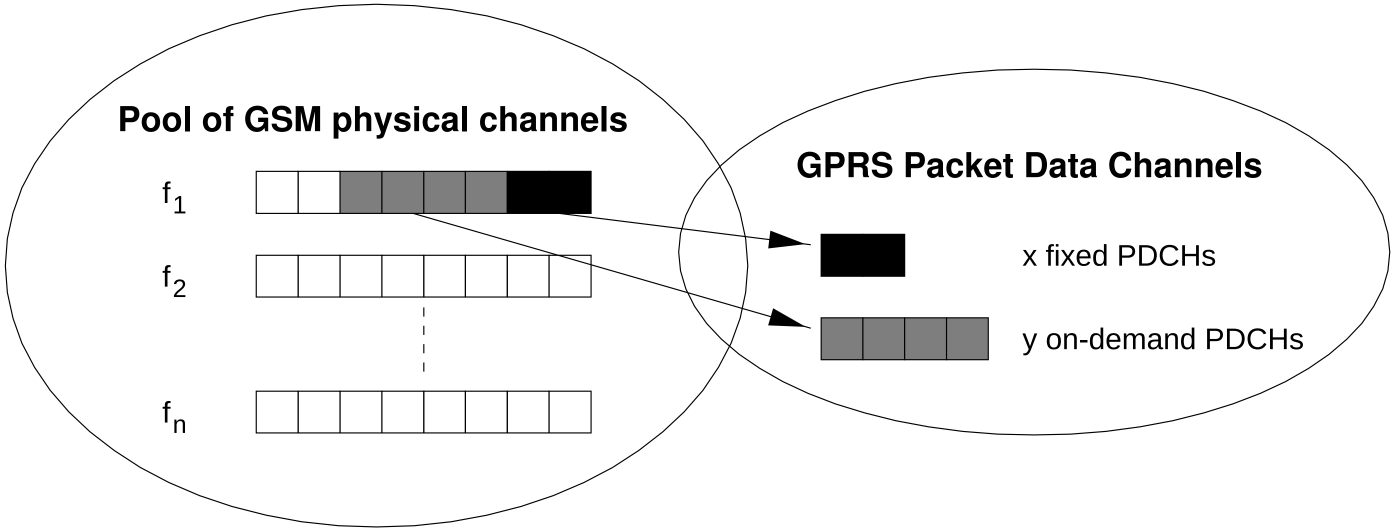
- integration into the GSM infrastructure
  $\rightarrow$ distribution of the available GSM radio resources for circuit- and packet-switched services
- packet-oriented use of GSM physical channels as Packet Data Channels (PDCHs)





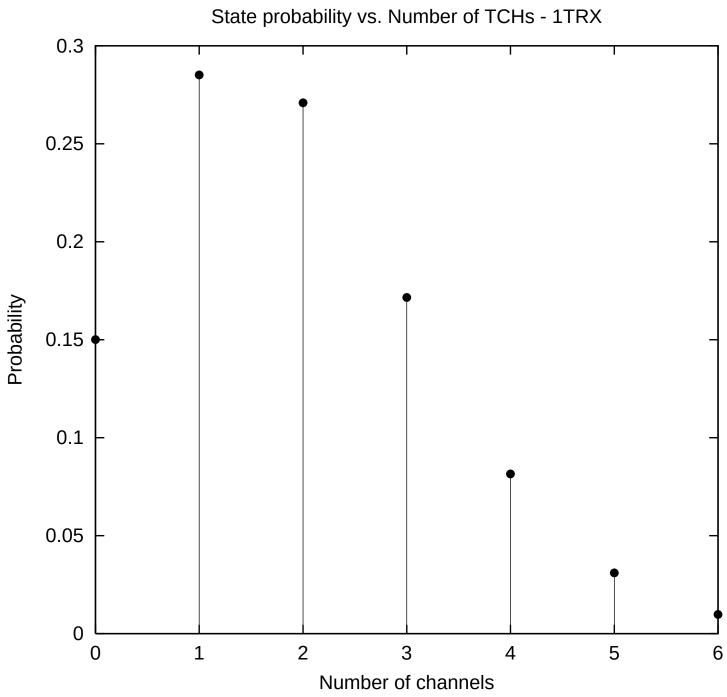
Radio Resource Management in GPRS Networks

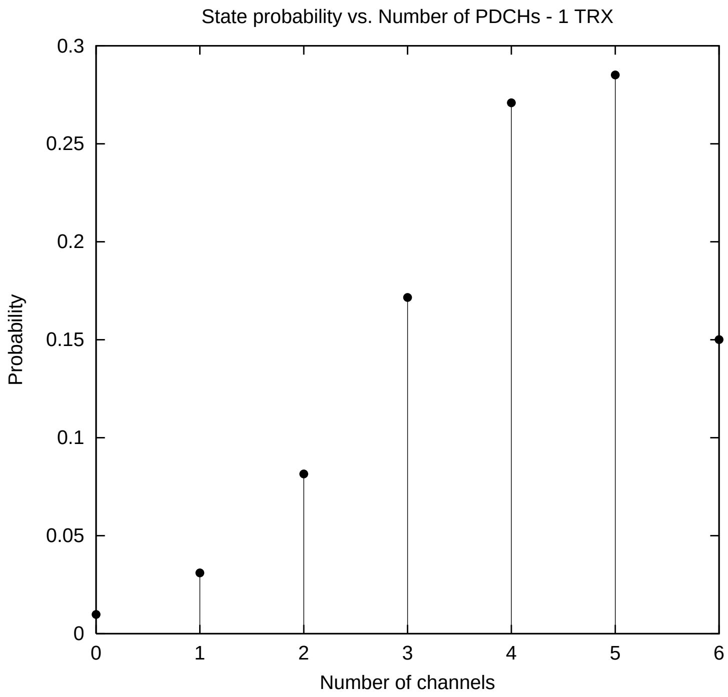
- channel management allocates PDCHs fixed and on-demand for GPRS from the pool of GSM physical channels (TCHs)
- fixed PDCHs are available permanently for GPRS
- on-demand PDCHs are only available for GPRS, if they are not used by circuit-switched services



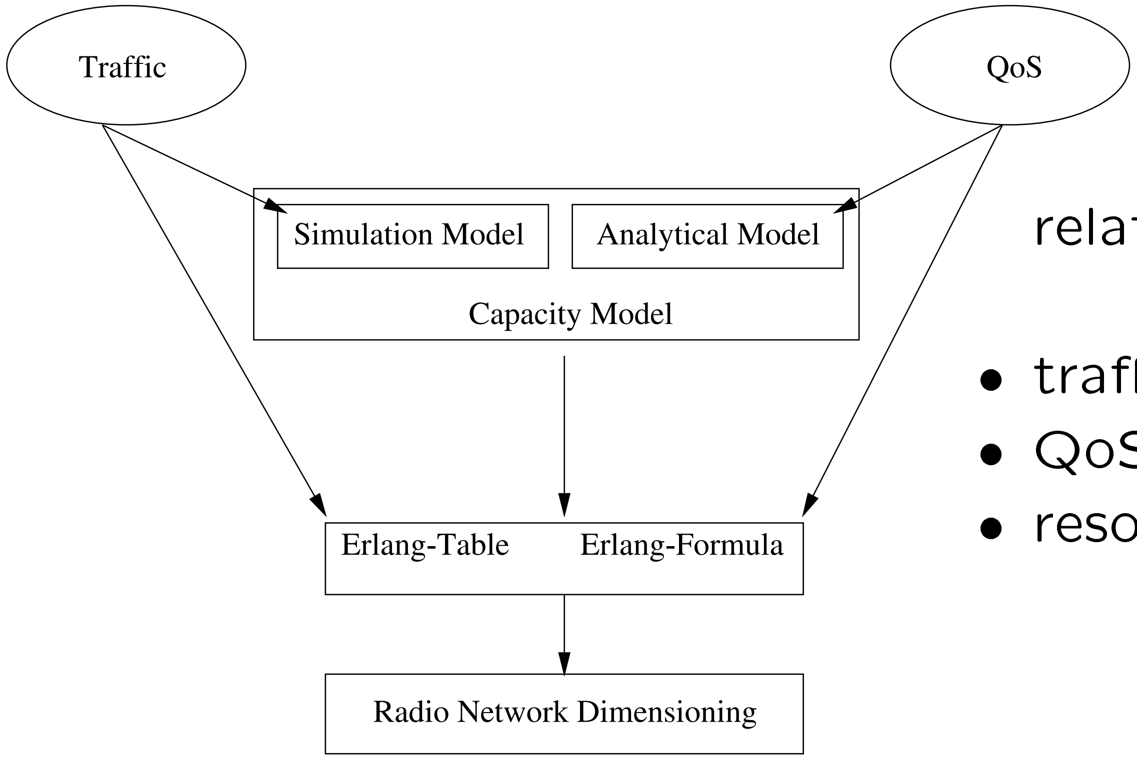
Circuit-switched Traffic Load

- radio network presently dimensioned for voice services with GoS of 1 %
- unused resources can be utilized by GPRS as on-demand PDCHs





Capacity Planning and Radio Network Dimensioning



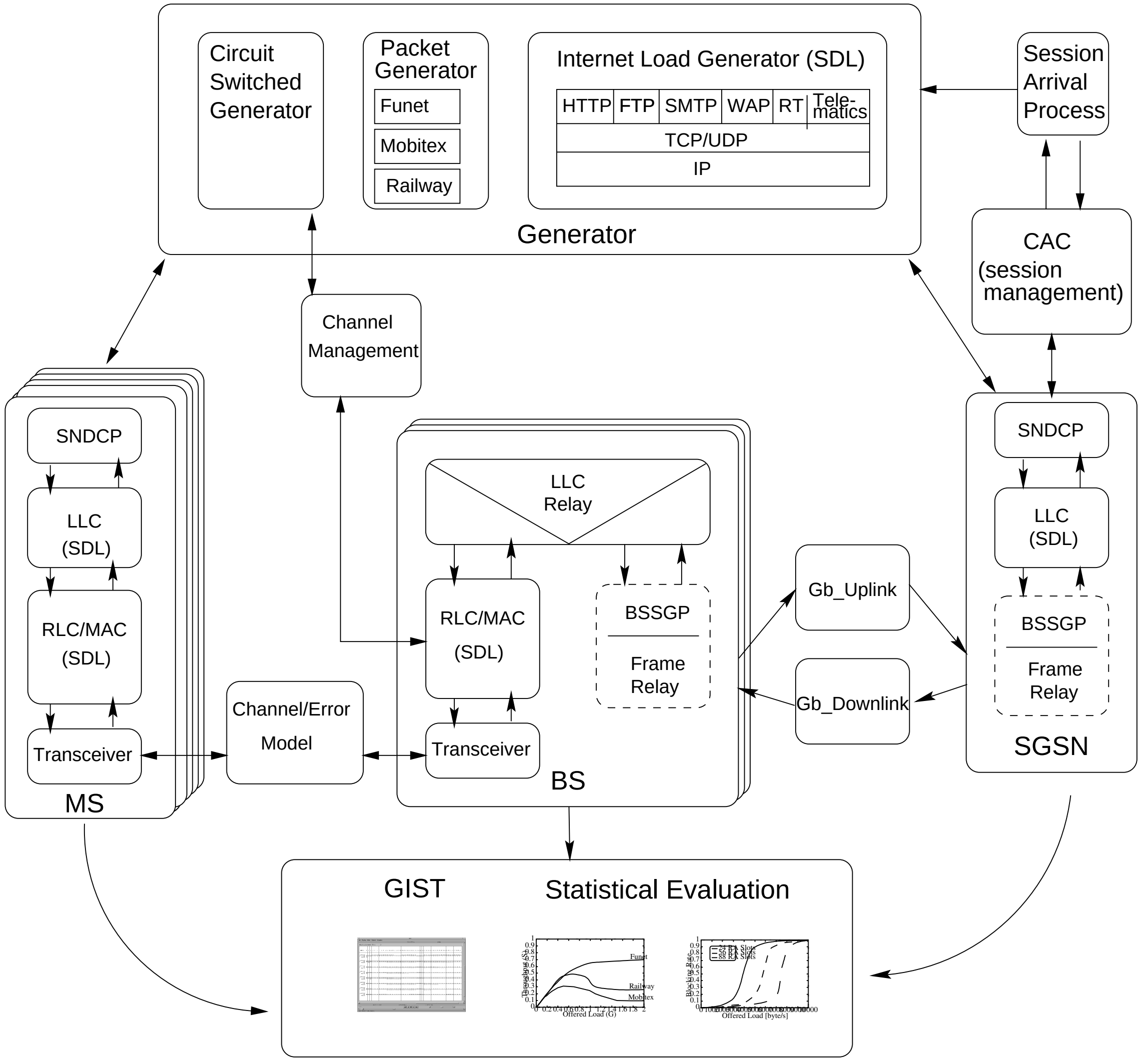
relationship between:

- traffic offered
- QoS desired
- resources necessary

Measures and Methodology

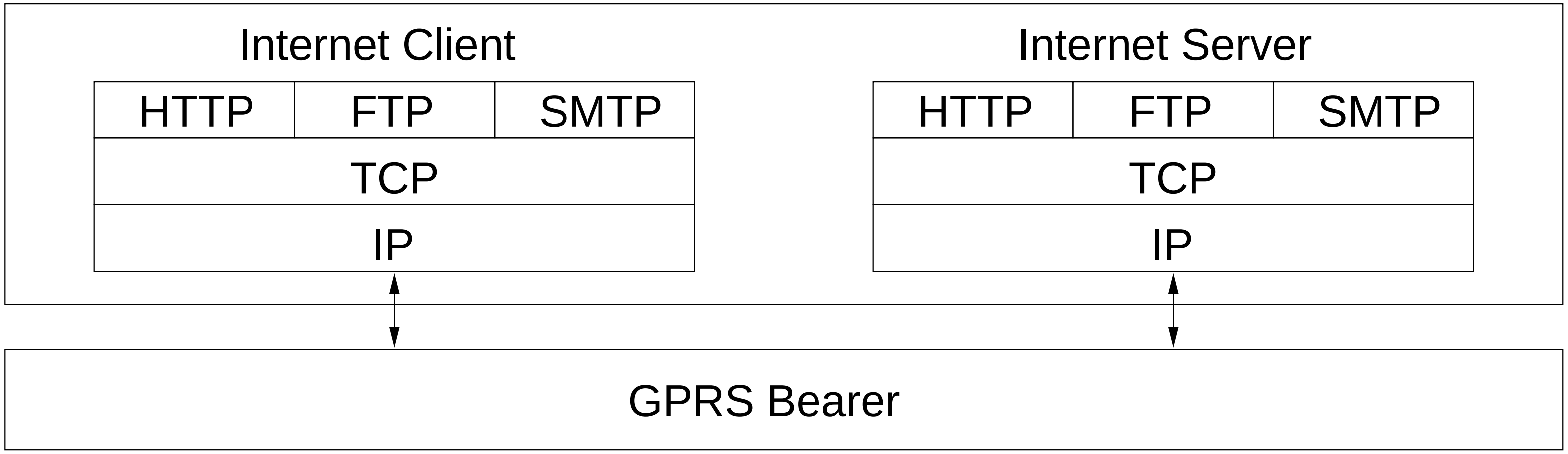
compared item	circuit-switched	packet-switched
traffic	offer in Erlang	offered amount of data per time unit in kbit/s
QoS	blocking probability	throughput, delay,...
resources	traffic channels	packet data channels
tool	simple formula or table	dimensioning graph or tables
methodology	Erlang-B-Formula	simulation results analytical/algorithmic methods

Simulation Tool GPRSim



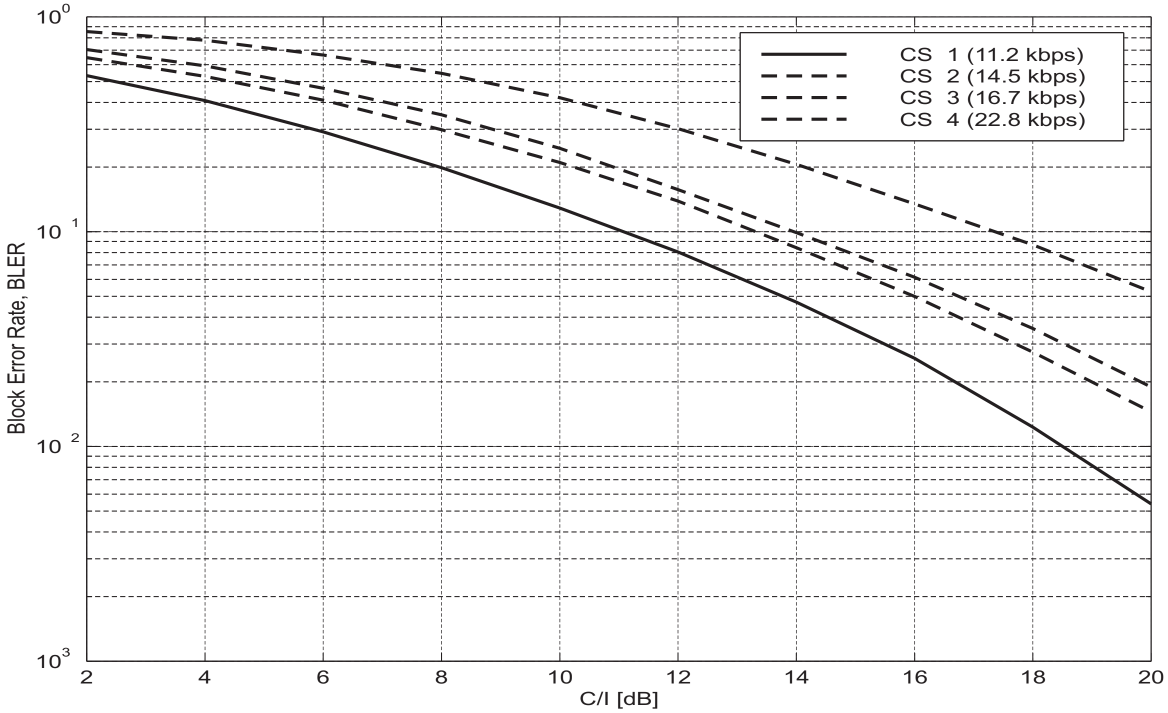
Load Generators and their Parameters

HTTP parameter	distribution	mean
pages per session	geometric	5.0
pause between pages [s]	negative-exponential	12.0
objects per page	geometric	2.5
object size [byte]	$\log_2$-Erlang-k	3700
SMTP parameter	**distribution**	**mean**
E-Mail size [byte]	$\log_2$-normal	10000



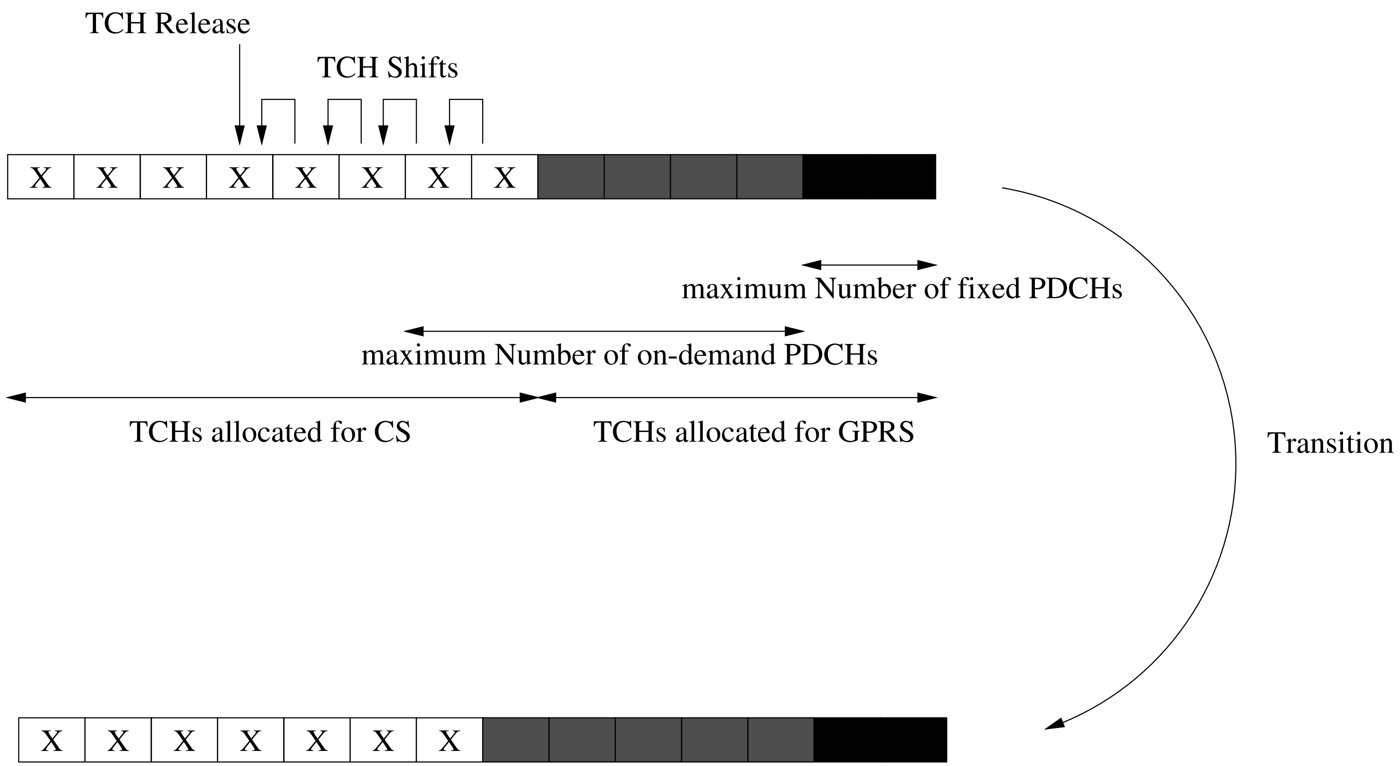
Channel/Error Model

- mapping of C/I to RLC/MAC block error probability
- reference function based on link level simulations (GSM 05.05 TU3, 900 MHz, no frequency hopping, 3 km/h)



Channel Management

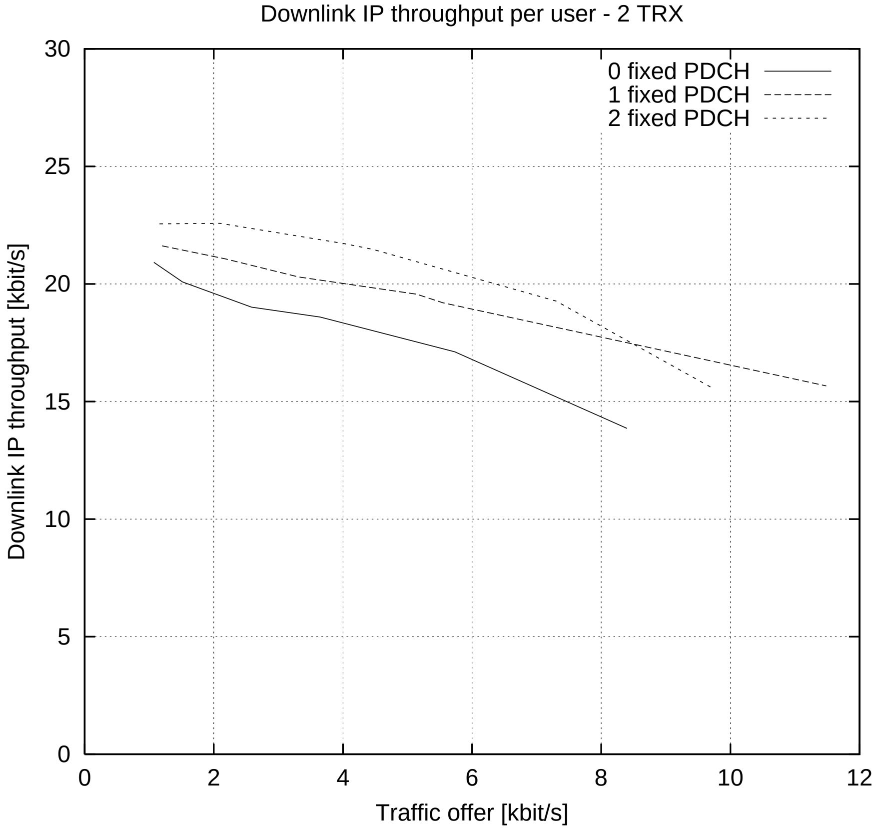
- dynamic allocation of on-demand PDCHs
- voice connections are served prioritized

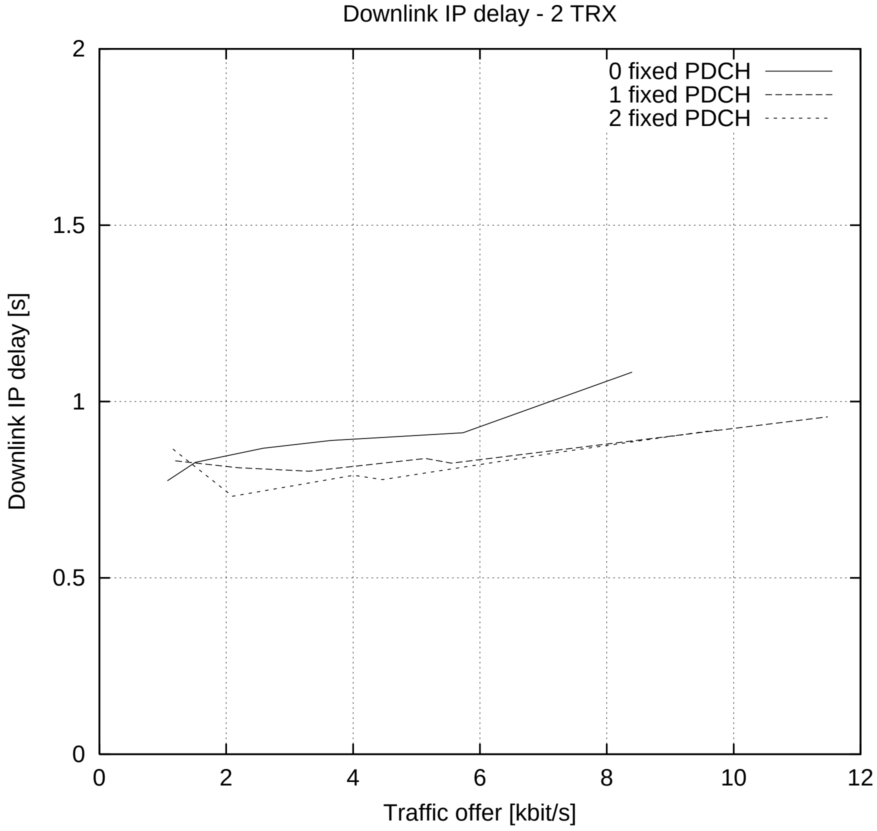


Simulations for Radio Network Dimensioning

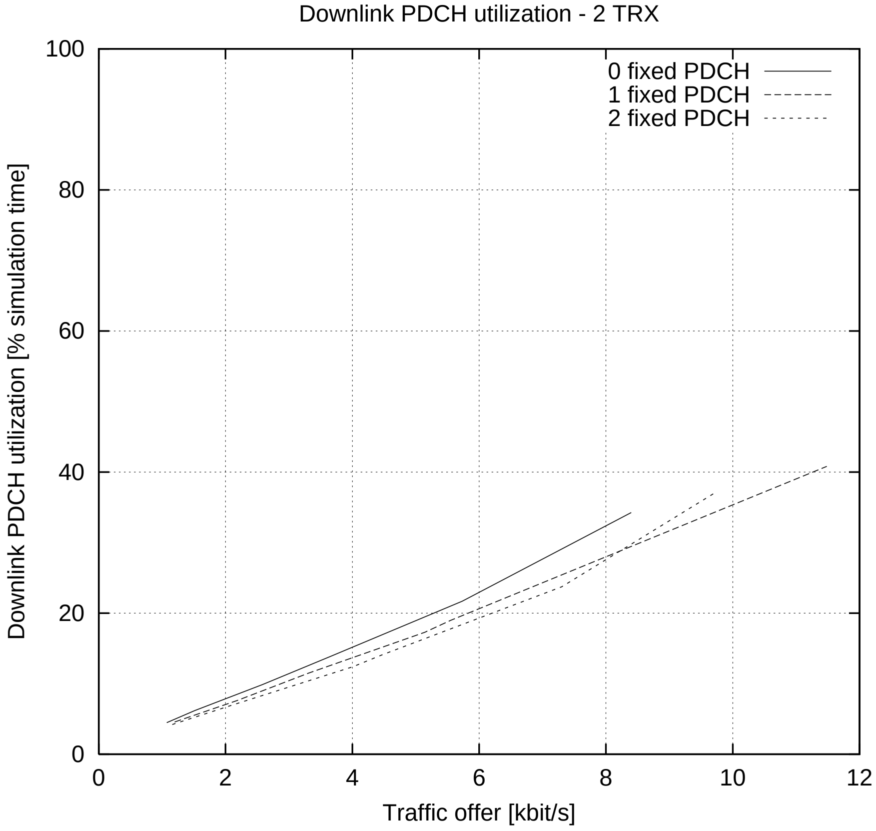
- Regarding cell configurations with 1, 2, 3, 4 und 5 Transceiver Units (TRX) — here 2 TRX
- Variation of PS offered traffic
- Variation of the number of fixed PDCH
- PS Traffic: 33 % WWW sessions, 67 % E-Mail
- Coexisting CS Traffic, so that GoS = 1 %

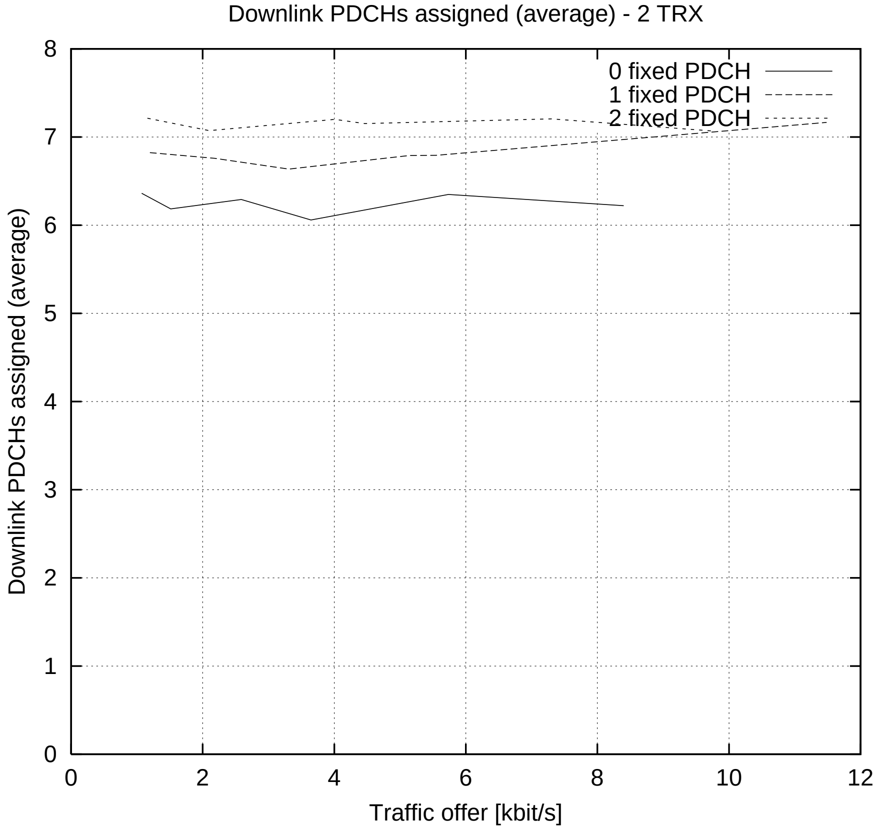
Performance Measures (User View)





System Measures (Operator View)





Conclusions

- Maximum IP data throughput per user of ca. 22 kbit/s for realistic HTTP object sizes and 4-DL-slot mobiles
- Only low performance gain of 10-30 % with fixed PDCHs with low offered traffic
- High availability of GPRS even if no fixed PDCH is allocated
- Performance analysis with the GPRSim gives system and performance measures for chosen scenarios
- Simulation results usable for radio network dimensioning considering specific system and application scenarios
- Analytical capacity models to comprise a wider range of scenarios are under development