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

Peter Stuckmann

Communication Networks
Aachen University of Technology
E-Mail: pst@comnets.rwth-aachen.de
WWW: http://www.comnets.rwth-aachen.de/pst

ABSTRACT

In this paper radio network dimensioning rules for GSM/GPRS networks focussing on Internet applications are presented. Taking simulation results for GPRS introduction and evolution scenarios as the basis, the radio resources needed for a given offered traffic and for given quality of service requirements can be estimated. Both circuit-switched voice traffic and packet-switched Internet traffic sources are considered that are sharing the radio resources available in a GSM radio cell. To achieve this, the simulation tool GPRSim is used that comprises a prototypical implementation of the standardized GPRS protocols.

In the context of the evolution towards 3rd Generation (3G) mobile radio networks, packet-switched data services like the General Packet Radio Service (GPRS) and the Enhanced GPRS (EGPRS) are presently introduced into GSM and TDMA/136 systems worldwide. For network operators, equipment vendors, and system integrators dimensioning rules have to be developed to plan and estimate the radio capacity that is needed for the predicted amount of user data, when the radio resources are shared between circuit- and packet-switched services.

For circuit-switched networks the Erlang-B-Formula has been successfully applied over decades, while for packet-switched networks such an applicable capacity model is still missing. The analytical discription of statistical multiplexing and Internet and Multimedia traffic modelling are more complex than for circuit-switched networks and have risen to a great challenge in traffic engineering. A suitable dimensioning approach for the busy hour is based on the number of active users and the corresponding applications and user behaviour. These parameters characterize the offered traffic that has to be served by the network. Second the quality of service, which the operator wants to offer his customers has to be defined. Giving these two parameters as input parameters to an adequate capacity model the needed radio capacity can be determined.

A. Methodology

Although analytical and algorithmic models for the performance analysis of packet-switched radio networks are under development, the full detail of the GPRS protocol architecture and the Internet protocols including TCP cannot be described simply by formulas or equations usable in practice. Since GPRS networks are presently introduced, performance results are needed very fast, so that capacity and performance estimations can be done for GPRS introduction and evolution scenarios.

Producing performance results by measurements in the existing GPRS networks is not easily possible, since scenarios with well-defined traffic load are hard to set-up, the calculation of performance and system measures are very limited, and the analysis of different alternative protocol implementations is not possible with the existing network equipment.

Therefore computer simulation with prototypical implementation of the standardized GPRS protocols and the Internet protocols, traffic generators for the regarded applications and a simple model for the radio channel is chosen as the methodology to get the needed results rapidly.

B. GPRS Radio Resources

In GPRS networks a radio cell may allocate resources on one or several physical channels in order to support the GPRS traffic. Those channels shared by the GPRS mobile stations are taken from the common pool of GSM physical channels available in the radio cell. The allocation of physical channels to circuit-switched services and GPRS is done dynamically according to the "capacity on demand" principle. The operator can decide to dedicate permanently or temporarily physical channels for the GPRS traffic. In this context GSM physical channels that are allocated permanently for GPRS are called *fixed Packet Data Channels (PDCHs)*, channels that are allocated temporarily for GPRS are called *on-demand PDCHs*.

Simulation results have shown that the performance for GPRS-based services does not increase dramatically, when few fixed instead of on-demand PDCHs are used. If the cell capacity is dimensioned with a low blocking probability, e.g., 1 %, for voice services, the use of on-demand PDCHs makes sense. This is plausible, since the probability that more than 2 channels are unused by voice services is around 90 %.

On the other hand operators might allocate fixed PDCHs to be able to guarantee the availablity of GPRS. So dimensioning rules for both fixed and on-demand configurations as well as for mixed configurations with a combination of fixed and on-demand PDCHs have to be developed.