NETWORK PLANNING SOLUTIONS FOR 3G/4G MOBILE SYSTEMS

Andrey Krendzel, Yevgeni Koucheryavy

Institute of Communication Engineering, Tampere University of Technology
{krendzel,yk}@cs.tut.fi

A large diversity of 3G services based on packet switching leads to dramatic changes in the characteristics and parameters of the data traffic. It is expected that the traffic in the 3G systems will expand considerably. The growing data/multimedia traffic may lead to increasing the total load on PS CN domain elements, especially, when the IM-subsystem involved because this subsystem will contain a uniform way to maintain Voice over IP (VoIP) calls and offer a platform to multimedia services. Besides, traffic patterns generated by 3G services are quite different from traditional Poisson models used for circuit switched voice traffic. When modeling packet-switched multiservice networks it is necessary to take into account the notion of self-similarity. Due to the high variability of burstiness of the traffic, the use of the classical teletraffic theory for a performance calculation of PS CN domain elements may give essential faults, in particular, the network parameters can be underestimated. Such possible faults are highly undesirable specially for IM-subsystem planning.

As a result of it, certain *3G network planning problems arise*, in particular:

- the estimation problem of the potential number of 3G users
- the prediction problem of data traffic characteristics
- the problem of the performance estimation of PS CN domain elements taking into account the self-similar nature of the multiservice traffic
- the estimation problem of the necessary number of trunk lines to support an interaction between CN domain elements and others

One more aspect of an evolution in wireless communications concerns changes in RAN of the 4G systems (4G RAN). 4G systems should offer significantly higher bit rate than 2 Mb/s by 3G (100 Mb/s currently defined as maximum target); have high capacity with a low bit cost and be able to support all type of telecommunication services from the viewpoint of multimedia communication. These requirements will make 4G RAN different from current RANs and will innovate in its architecture. In particular, in 4G systems, because there will be a need to deal with the enormous amount of traffic, the BS radius cell is supposed to be shorter than that of 3G systems. Therefore, 4G RAN will comprise more Base Stations (BSs) and more frequent handover will occur resulting in a heavy load on the links between such elements of RAN as Remote Network Controller (RNC) and BSs, suggesting changes to the RAN architecture. It may raise valuable funds for the RAN construction.

For the 4G RAN a new and innovative physical links configuration has been proposed and analytically argued with the viewpoint of a load and routing capabilities only, so-called ‘cluster-cellular’ topology or, in other words, it is known as a ring topology. In such topology BSs are grouped in a ‘cluster’ and there is a ‘cluster-main’ BS connected to the RNC. BSs in a cluster may be connected to each other by optical fiber links that are preferred as the dominant links to construct the 4G RAN, first of all, from the viewpoint of link capacity. It should be emphasized that the infrastructure cost of optical fiber networks is quite expensive because of high installation cost. For this reason, *it is very important to analyze* the ring topology of RAN physical links with respect to its reliability and cost, to compare it with other ones and give recommendations by applying of different topologies of a physical links configuration in the 4G

RAN. Besides, it is worthwhile to determine the optimal links configuration between BSs in order to decrease 4G RAN construction cost.

Taking into account the considerations above, our research is focused mainly on two topics. The first part of the research is devoted the Core Network planning problems of the 3G systems. This is because of the fact that the CN evolution is quite conservative. On the CN side of the 4G systems the main purpose is *to minimize changes and utilize exist* 3G CN elements and 3G CN functionality as much as possible. It is supposed that the CN of the 3G systems will be able to support the functionality of 4G system services.

On the other hand, in the 4G systems the RAN will experience the major changes, in particular, on a physical transmission layer. Network physical links configuration *is one of the most important problems* of mobile communication network planning because it will determine the long-term performance and service quality of networks. For this reason, the second main topic of the research deals with the architecture aspects of 4G RAN physical links configuration.

Solution methods for the above-mentioned problems *have been developed*. The results of the research allow establishing both the requirements to equipment of the internal IP-networks such as throughput of channels, performance of nodes and routers in the 3G/4G systems, and the requirements to equipment of gateways providing the interaction between 3G/4G systems and external networks. It enables making easier both the preparation of business-plans for development of wide range of 3G/4G services and the preparation of system projects for deployment of PS CN domain and, afterwards, IM-subsystem. Besides, *based on obtained results we produce recommendations* on using different topology of physical links configuration in the 4G RAN depending on a number of BSs in the RAN. Cost optimization of physical links configuration give a possibility *to minimize expenses* when of 4G RAN deployment. The developed methods of effective 3G/4G systems planning are *easily software implemented*.