

# Challenges in the Mobile Telecommunication Industry

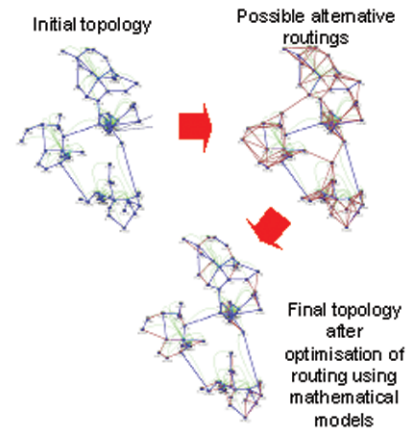
*Hartmut Kremling, chief technology officer of Vodafone D2 GmbH, gave an invited talk on "Telecom Day" (July 18), one of several Industry Days held during ICIAM '07.*

A discussion of challenges in the mobile telecommunication industry immediately brings to mind network development and optimisation. With increasing traffic, a highly complex and non-optimal network topology can cause major problems. Networks of the future will need a high degree of reliability; at the same time, costs have to be controlled.

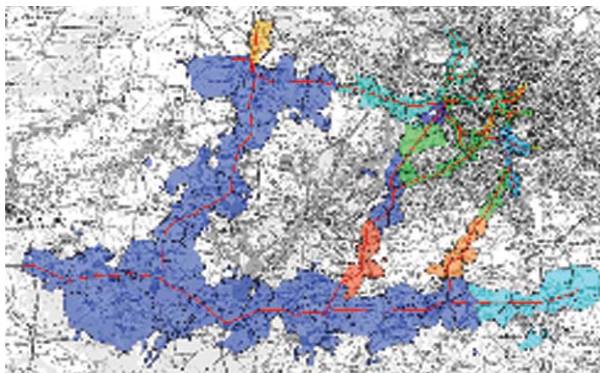
Mathematical models based on linear programming are used to optimise network topology. From an initial topology, possible alternative routings are evaluated, and an optimised topology is calculated (Figure 1). Constraints that can be imposed in the optimisation include routing restrictions, traffic load, overall reliability, and cost.

Network optimisation problems of this type are well known. Nowadays, companies face challenges not only on the network side, but also in the development of innovative new services.

Internationally, in most networks, early mobile services were GSM-based and fairly simple. With the introduction of third-generation, and subsequently high-speed downlink packet access, mobile data services have become more and more popular. In the last few years, many new service ideas have been based on a merging of mobile and fixed services, as in fixed-mobile substitution offers that allow customers to use just one call number and device for all their phone calls, special tariffs within customers' "home regions," and mobile broadband/DSL, offered for the most part in cooperation with fixed network operators. The future will hold a real convergence of mobile and fixed networks, resulting in greater convenience for customers, with portals that can be accessed with all devices, independent of the technology used.



**Figure 1.** Mathematical models based on linear programming are used to evaluate and optimise network topology.



**Figure 2.** Traffic Online. A highway traffic information system based on GSM data leads to improved detection of traffic jams.

Cross-linkages are among the ideas that will play a role in this new telecommunications world.

Other developments on the service side include a recently finalised project called "Traffic Online." It is supported by the Federal Ministry of Research and Education; prominent partners of Vodafone include Volkswagen, the German Centre for Aerospace, the University of Braunschweig, and the Traffic Management Centre in Berlin. The idea is to detect traffic jams based on GSM network data (Figure 2). Mobile phones and the network communicate on a regular basis (i.e., for location area updates and handovers). Based on the strength of signals received at several base stations and on shadowing effects, the locations and movement of mobile users can be known in the aggregate. Combined with information on typical traffic flows, this information helps to identify areas of slow traffic or traffic jams. No additional data needs to be collected, and no additional sig-

## Future Challenges – Services

- **Personalised Services**
  - Customers preferences/ interests
  - Customers position/ whereabouts
  - Real time information, directions, hints, links
  - Appropriate/ agreeable advertisement
  - "secure and trusted"
  
- **Convergence**
  - Advanced technology for authentication and e-Purchase
  - Security measures
  - Efficient use of bandwidth
  - Compression and rendering
  - "fixed-like" mobile usage

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**Figure 3**

nalling activities are necessary—the anonymous information and movement of switched-on mobile phones suffice.

Before a look toward future challenges (Figure 3), two additional new services that rely in part on mathematics warrant brief mention: MusicFinder, launched by Vodafone Germany in 2005, and VisualSearch, presented at this year's CeBIT fair. These ideas are related: You hear a song you like and want to know the title or the name of the artist. Or you visit a city and would like to know more about a building or landmark that has attracted your attention. These two new services will help you get the information you want.

For MusicFinder, you call a given number and aim your phone toward the music source. If the music can be identified, the call is terminated, and you will receive a short message (SMS) with the desired information. VisualSearch will provide similar services, based on a photo of the building in which you're interested. The mathematical challenges are similar for the two services: Pattern recognition and matching algorithms that can identify the piece of music or the building of interest are needed. In the case of MusicFinder, the data base used for the matching contains more than two million titles.