Dynamic resource reallocation in cellular networks

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Background

- The number of subscribers of cellular networks grows all the time

-> Lack of network capacity

- Amount of offered traffic varies both spatially and temporally

-> Capacity requirements are not static

- The usage of the network resources could be optimised

-> Adaptive coverage / capacity

GSM subscriber growth 1993-2003
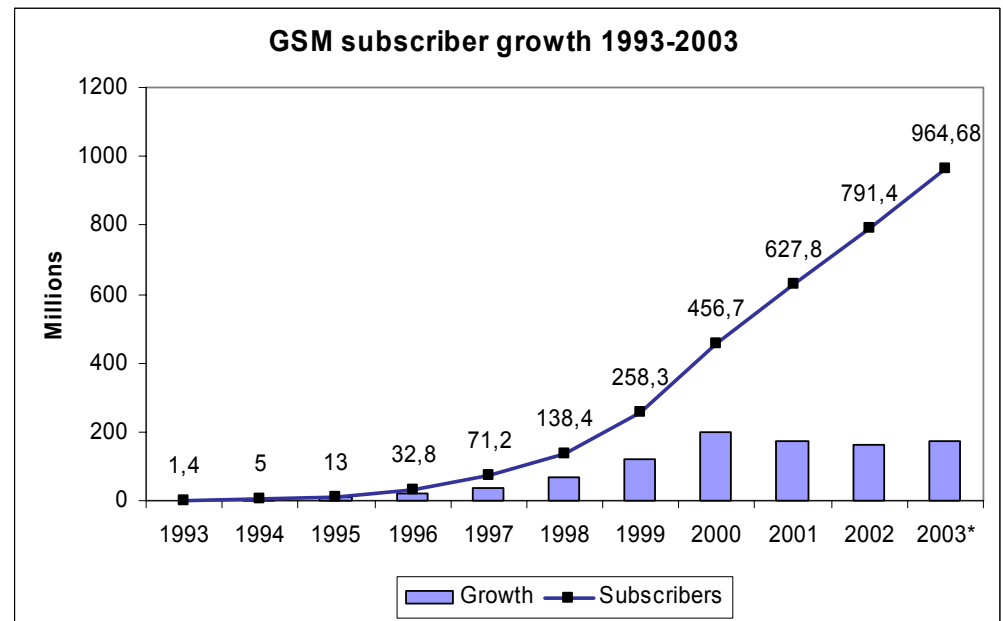
Source: GSM Association   * = forecast 5/2003

Adaptive Coverage System (ACS)

- ACS concept developed in EU IST project "CELLO" (= Cellular Network Optimisation based on Mobile Location)
- Objective was to enable adjusting of cellular network antennas in order to increase network capacity in hot-spot areas
- The system includes special antennas, databases and software applications
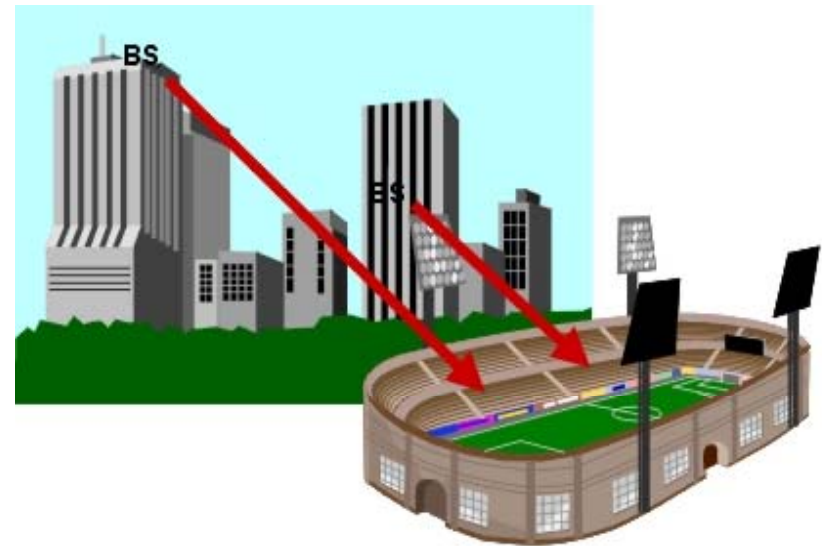
Thesis objectives

- The objectives of the thesis include the following:
    - Study the requirements of dynamic resource reallocation
    - Develop a software module for analyzing network performance data in order to optimize cellular network resources and to create a schedule of network configurations to be used by the ACS

Requirements of resource reallocation

- Knowledge about the performance problems in the network

  -> Network performance data

- Location of the problem area

  -> Location information

- Possibility to reallocate network resources

  -> Adjustable antennas

Requirements of resource reallocation, continued...

Network performance data

- E.g. GSM network has the Operations and Maintenance Center (OMC) from which performance data on cell level is obtained
- Specific measurement samples (signal levels + locations) can be used for modelling the users of the network
- Data has to be analyzed and thresholds for high traffic must be set

Location information

- OMC data provides information on cell level
- Mobile positioning techniques can be utilized for more accurate location information
    - GPS and DCM method (developed by VTT) have been used in this project

Requirements of resource reallocation, continued...

Adjustable antennas

- Conventional antennas are static
- Modular Antenna Array (MAA) provides 5 different beam patterns, 4 narrow and 1 wide
- The radiation pattern can be dynamically changed via GSM modem
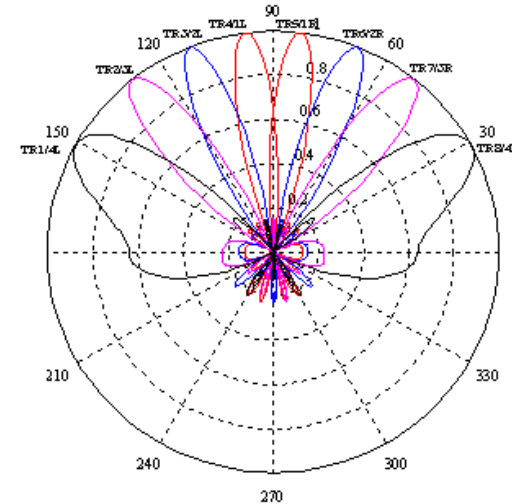
Data Analyzer Module (DAM)

- Data Analyzer Module (DAM) analyzes the network performance data
- Objective is to create a schedule of network plans optimizing the network resources
  - Network plan defines the configuration of each cell of the network
  - The areas with capacity problems can be served by other cells
- The analysis has three phases
  - Detecting problematic cells
  - Defining more accurate location
  - Defining changes to the network configuration
    - So that more coverage / capacity can be provided to the problem locations

  Result: A schedule of network plans

Tests

Simulator

- DAM analysis data can be saved to a file and run in the simulator for:
    - Visualizing the decisions made in the analysis
    - Verifying the schedule created by DAM
    - Visualizing the changes in the network capacity in the problem area
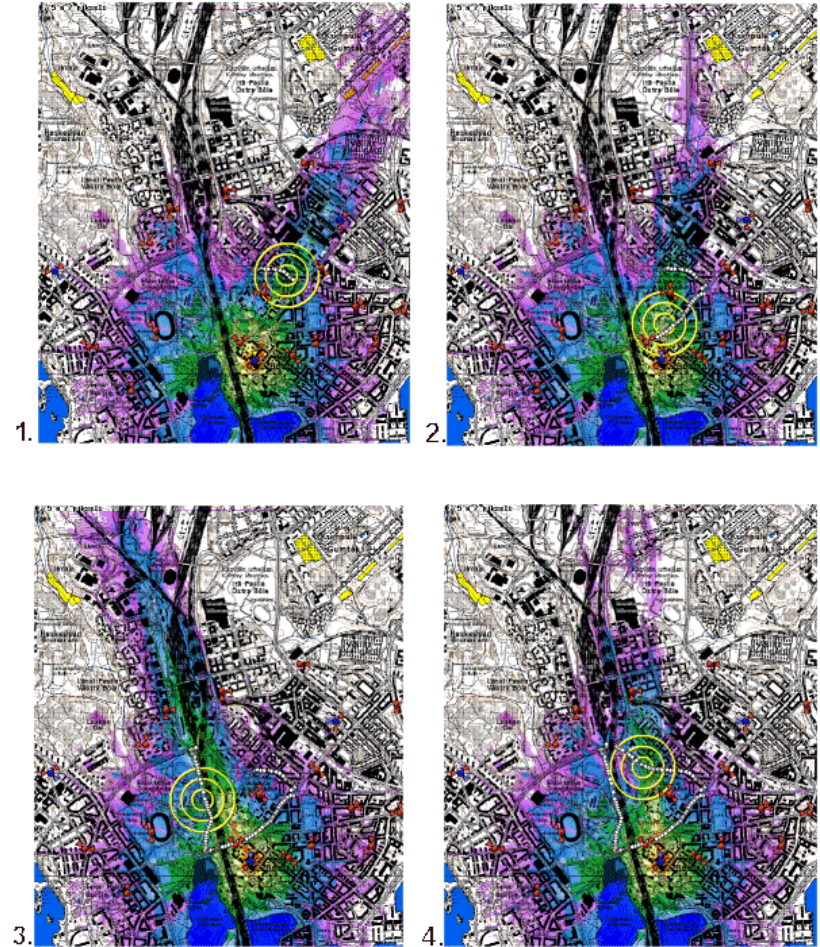
Field trial

- ACS and DAM have been tested in a GSM network
    - Network plan schedule created by DAM has been used
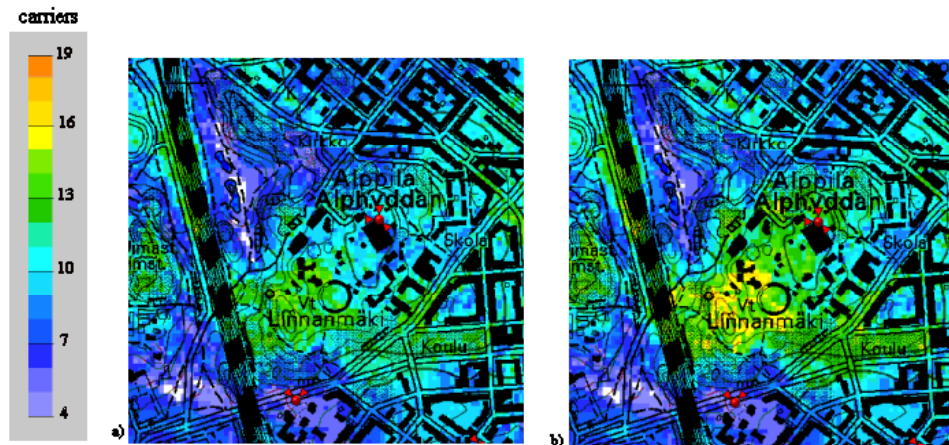   - The operation of the ACS for changing the antenna configurations has been verified

Results

- DAM analysis was found to work as expected

Simulation results

- Detecting the hot-spot areas
- Creating the schedule of network plans
- The potential capacity of the network increases in the desired area (next slide)

Results, continued...

Field trial results

- Network plan can be changed according to the specifications in a short time by ACS

Conclusions

- Dynamic resource reallocation requires
  - The understanding of
    - Network planning
    - Network performance
    - Mobile positioning
    - Advanced antennas
  - … and a system that combines all these
- DAM is capable of carrying out the analysis of network performance data and creating a network plan schedule
- ACS can be effectively used for running this schedule

Future work

- The analysis of the network performance could be enhanced
    - Only simple analysis in the current version
    - More cells should be taken into account
- Real-time updates to the databases are needed
    - "Emergency messages" could be utilized

Questions?

Thank you!