Dynamic resource reallocation in cellular networks

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Contents

• Background
• Thesis objectives
• Requirements of resource reallocation
• Data Analyzer Module (DAM)
• Tests
• Results
• Conclusions & future work
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

Source: GSM Association  
* = forecast 5/2003

GSM subscriber growth 1993-2003

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<th>Year</th>
<th>Growth</th>
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<td>2003*</td>
<td>964,68</td>
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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!