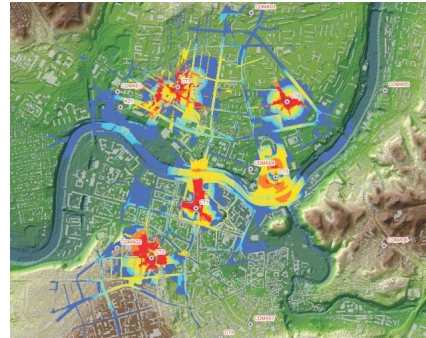
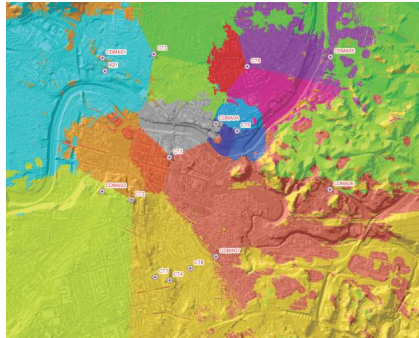
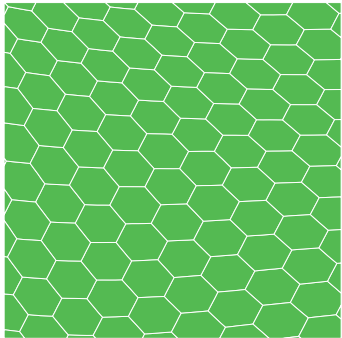
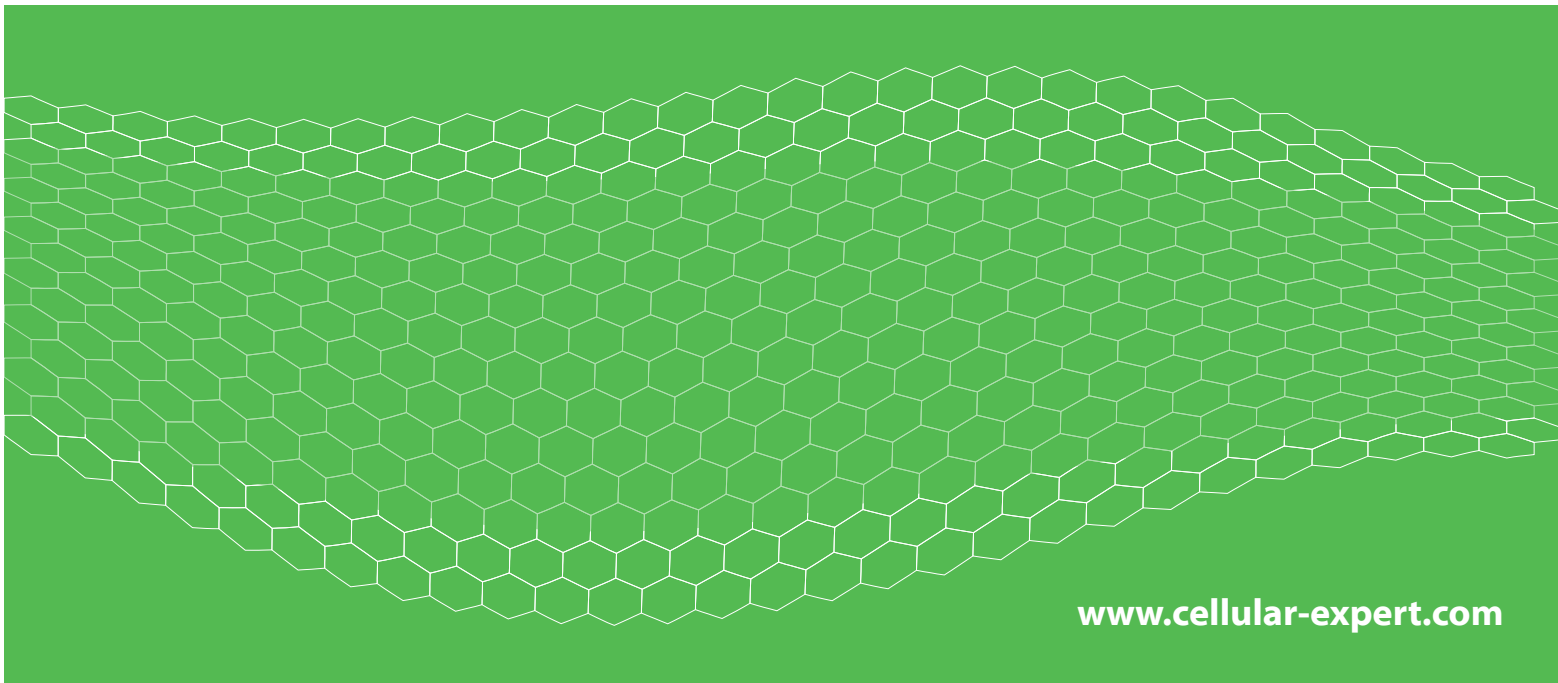
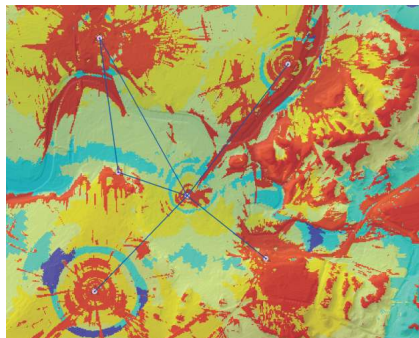




# Radio Network Planning in ArcGIS



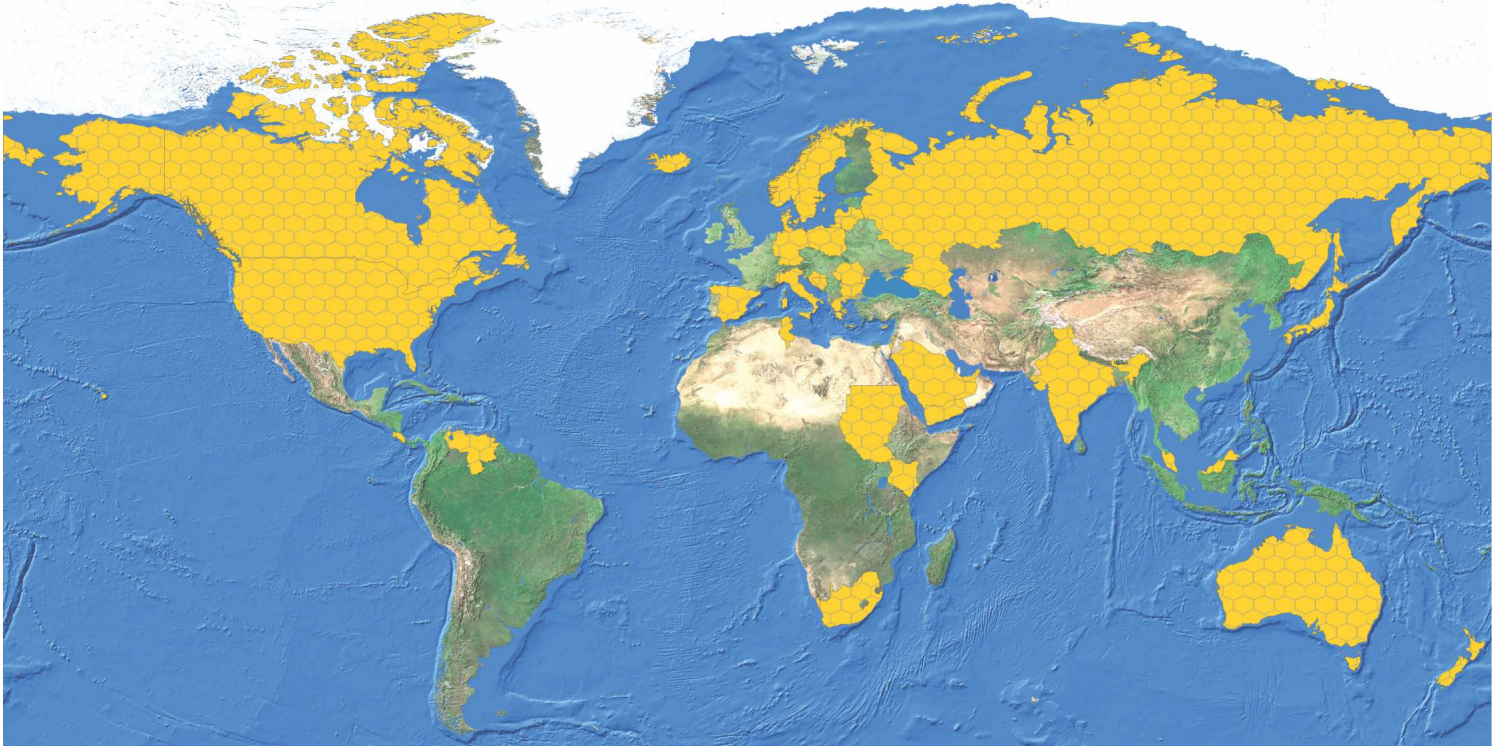
Planning. Optimization. Data management



# ABOUT

## THE COMPANY

Operating since 1993, HNIT-BALTIC is a constantly expanding international company, having more than 400 customers worldwide. The company has 10 years experience in international market focusing on software solutions for telecommunication companies. The company provides software solutions and professional services including software development, customization, implementation system integration, training, consultancy and support in more than 30 countries worldwide. HNIT-BALTIC business strategy focuses on an absolute commitment to customers to deliver high quality, reliable, competitive and innovative solutions, enabling customers to lower operational costs, increase profitability and customer satisfaction.



## THE SOLUTION

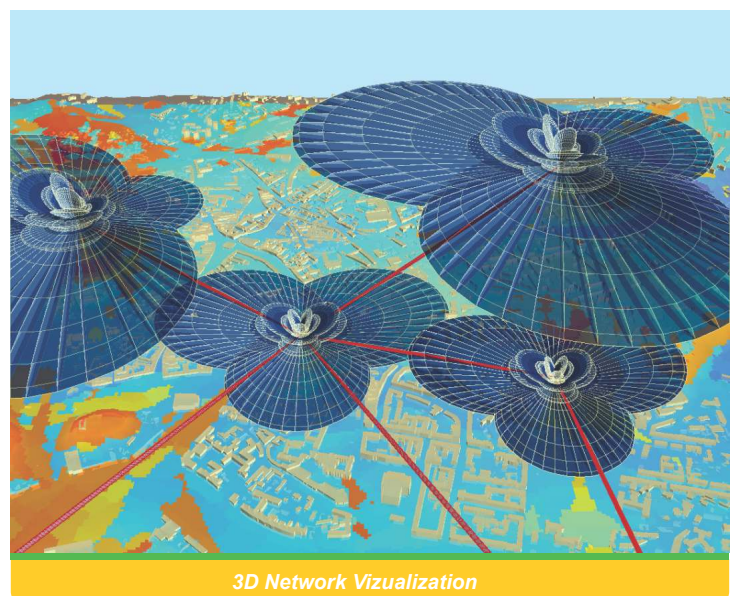
Cellular Expert is a wireless telecommunication network planning, optimization and data management solution, available to the telecommunication industry since 1995. Used in 37 countries by more than 100 customers, the software is distinctive for its versatile functionality, calculation precision, multi-technology, intuitive usage and powerful GIS platform. Cellular Expert allows users to plan, optimize network and analyze information efficiently, to lower costs, increase profitability, and improve the quality of customer support services.



### Supported wireless technologies:

- Transmission networks (Microwave)
- Broadband access networks (LMDS, MMDS, WLL)
- 2G/2.5G networks (GSM, DCS, CDMA)
- 3G/3.5G networks (CDMA2000, WCDMA, UMTS, HSPA)
- 4G networks (WiMAX, LTE)
- Military and rescue networks (TETRA, TETRAPOL, APCO)
- Broadcasting Networks (DVB-T, T-DAB)
- Other technologies in frequency range up to 100 GHz

The software is being constantly updated to support the latest technologies and includes the functionality based on real customer requirements giving a significant advantage for the user.



3D Network Visualization

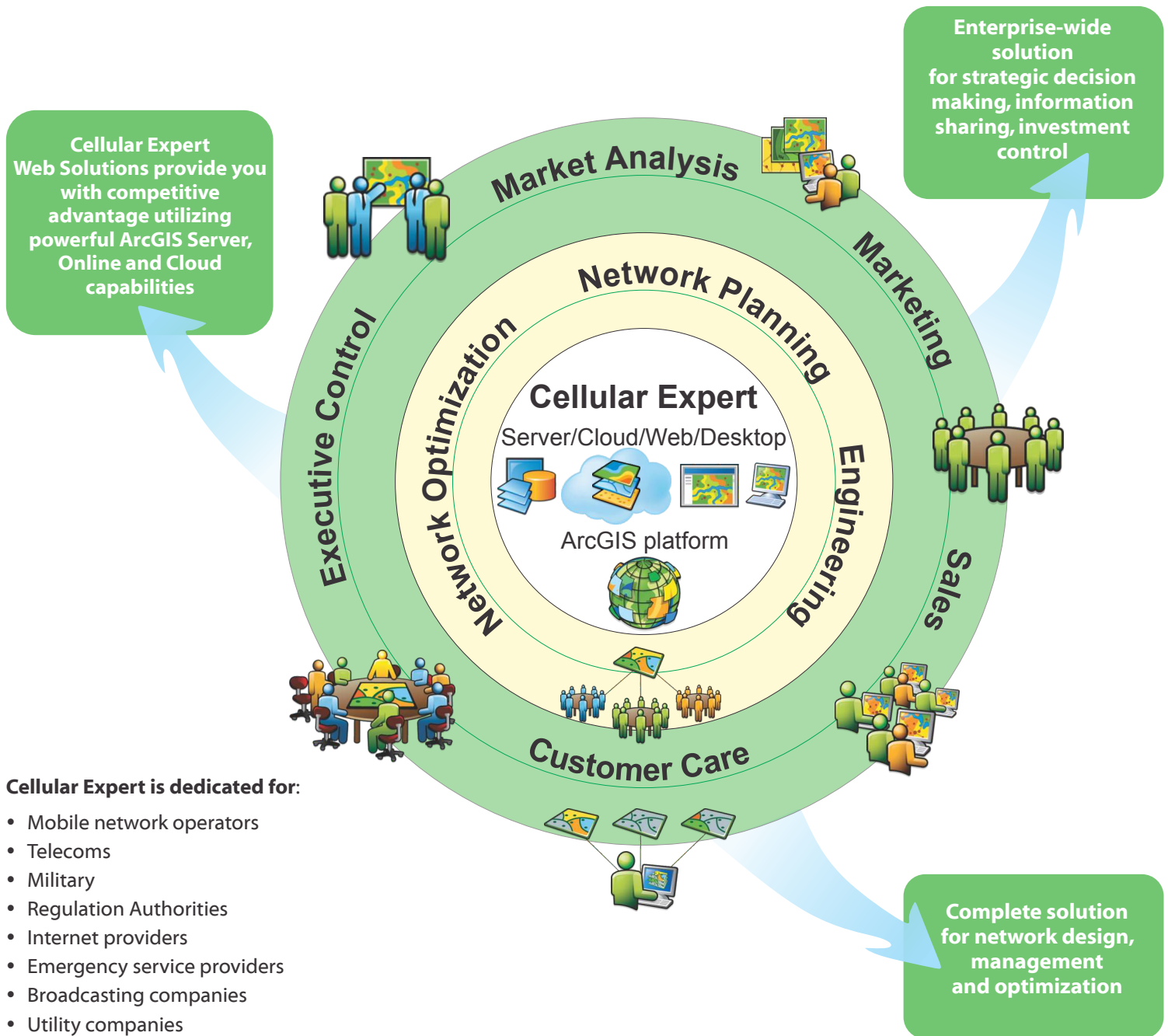
# ENTERPRISE SOLUTION

## POWERFUL GIS PLATFORM

Cellular Expert is built on the most powerful and versatile geographic information system - Esri ArcGIS. ArcGIS allows analyzing data and author geographic knowledge to examine relationships, test predictions, and ultimately make better decisions. Use ArcGIS to discover and characterize geographic patterns, model and analyze against all sources of geographic data, optimize network and resource allocation, automate workflows through a visual modeling environment and use comprehensive spatial modeling and analysis tools to reveal answers in your data. Extensions for ArcGIS add more capabilities and allow performing extended tasks such as spatial analysis, raster geoprocessing, three-dimensional analysis, map publishing and other tasks.

**ArcGIS®**

**ArcGIS Online** provides a managed infrastructure for organizing and sharing geographic information in the cloud. This infrastructure gives organizations the ability to store, manage, and host their mapping services, easily publish their geographic content, and off-load selected processing activities using cloud services. Cellular Expert users can access and use ArcGIS Online basemaps and thematic maps.



### Cellular Expert is dedicated for:

- Mobile network operators
- Telecoms
- Military
- Regulation Authorities
- Internet providers
- Emergency service providers
- Broadcasting companies
- Utility companies
- Engineering companies
- Educational institutions
- Consultancy service providers
- Other companies performing planning, analysis, optimization and reporting tasks for radio networks

# VERSATILE

## Network Data Management

Cellular Expert is equipped with the set of various tools for management of base station radio equipment data. The data can be represented and analyzed using map view, tabular representation, graphs and reports. The Object Inspector allows previewing and editing network objects such as sites, sectors, constructions, repeaters structured in hierarchical order. Data Exchange Tools allow the user to import and export any equipment and network data.

## Radio Equipment Data Management

To edit and preview radio equipment data use Equipment Manager. It handles the following categories of radio system equipment: antenna patterns, digital radio channels, frequency plans, radio models, feeders, passive components and mobile user profiles. Equipment Manager allows importing, viewing and modifying antenna patterns and parameters.

## Coverage Prediction

Cellular Expert has several types of advanced coverage prediction algorithms for the modeling of microwave point-to-point, point-to-multipoint, fixed and mobile radio systems based on ITU-R, ETSI, COST 231 and IEEE standards and recommendations. The models can be calibrated using drive test data, and customized for certain types of terrain and land-use. The propagation models cover a distance range from several meters up to 150 kilometers and frequencies from 20 kHz up to 100 GHz. Cellular Expert supports Line of Sight, Hata, COST 231, Walfish-Ikegami, SUI type models and the ability to implement additional prediction models. Cellular Expert has the unique ability to use combined prediction models according to environmental conditions.

## Visibility Analysis

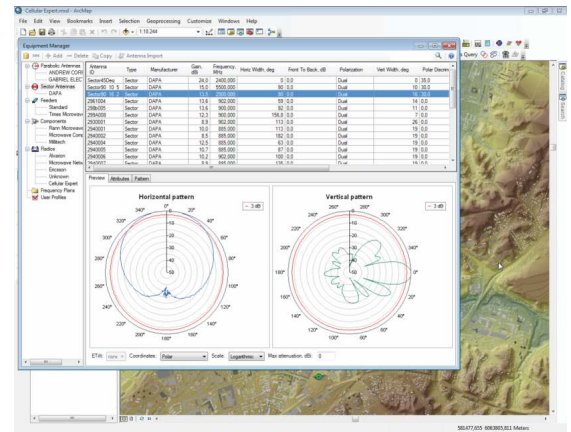
Various visibility calculation tools allow creating line of sight visibility coverage, taking into account real or effective Earth radius, transmitter, receiver and obstacle heights. The user can calculate Clearance, Fresnel zones visibility and the number of visible sites for the analyzed area.

## Path Profiling

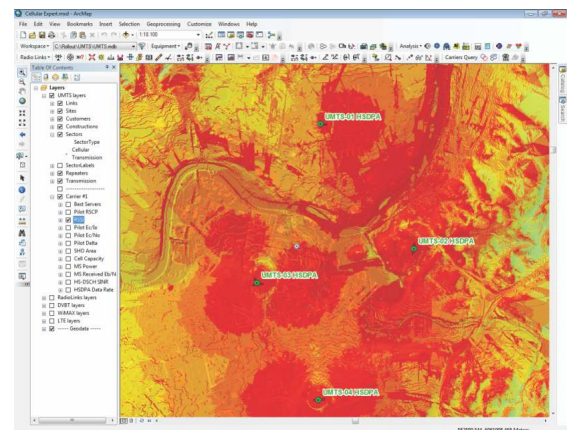
Cellular Expert has powerful radio path profiling functionality for performing dynamic and static profiling calculations. The tool evaluates the terrain and multiple layers of obstacles. A multi-path and reflection analysis enables the estimation of influence of different propagation conditions on radio path performance. Several diffraction calculation methods are available.

## Visualization and Reporting

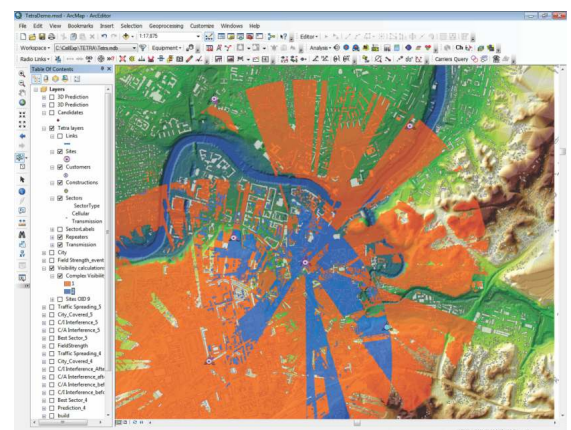
Network data and calculation results can be represented on the map or in tables. Prepared Crystal Reports® templates are used to generate reports for selected network elements. Various customized reports can be created and printed using standard ArcGIS functionality.



Equipment Manager - Antenna Radiation Patterns

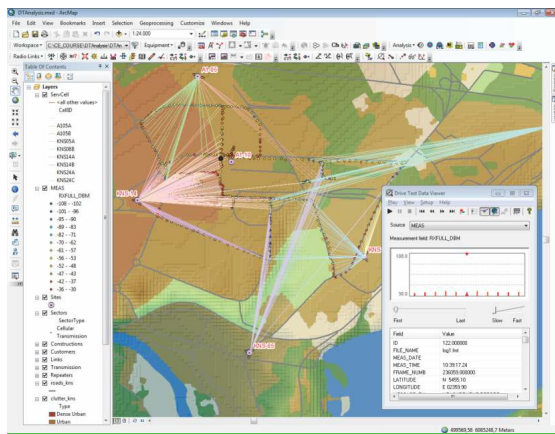


Coverage Prediction



Visibility Analysis

# FUNCTIONALITY



Drive Test Data Analysis

## Drive Test Data Analysis and Model Tuning

The product allows importing drive test data from Ericsson TEMS, Motorola iFTA, NEMO or any other tool which has ASCII export capabilities. A powerful set of post-processing, querying, reporting and visualization functions enables to analyze drive test data and use it for prediction model calibration. Drive test post-processing allows filtering data points by distance, frequency and other parameters and using different statistical methods to process drive test data. Evaluation of prediction accuracy allows users to tune prediction model parameters and achieve high precision calculation results. The connection of drive test data points to serving cells can be visualized on the map.

## Automatic Cell Planning

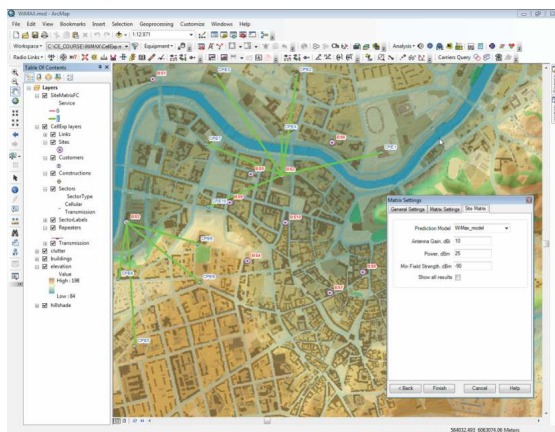
Automatic cell planning allows finding optimal antenna tilt and azimuth required to serve assigned area. Antenna tilt angles can be calculated based on defined polygon or cell area. Antenna gain pattern for a given tilt and azimuth can be plotted on the map.

## Automated Site Candidates Selection

Automated Site Candidates Selection provides functionality for automated connection of fixed customers to serving sites according to visibility or signal strength conditions. Optimal number of sites from all candidates is selected according to signal quality requirements.

## Automated Task Processing

Automated Task Processing is dedicated for large volume calculations. It allows users to create configuration files and use them for batch processing. Automated Task Processing utilizes multi-processors and multi-core processors, so the performance of prediction operations is increased depending on the number of processors/cores installed on the machine. Each configuration file can use different prediction model or any other settings used for prediction. The tool allows scheduling the start of prediction jobs on specific date/time.



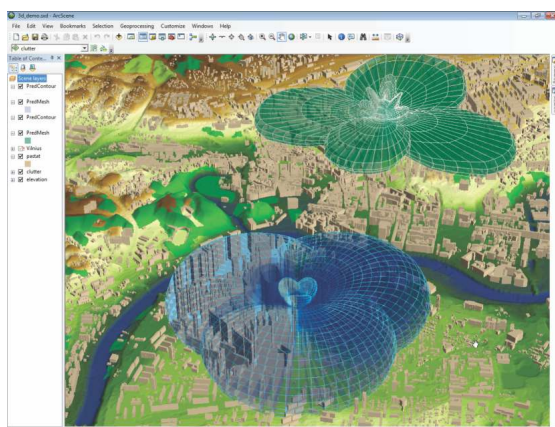
Automated Site Candidates Selection

## GIS based Network Analysis

GIS technology provides advanced geo-statistical analysis, reporting and visualization capabilities. It complements Cellular Expert software with technologies which allow integration of location-based data in network planning and operations, customer care, sales and marketing, as well as many other tasks. Unlimited number of separate coverage, interference, traffic and other rasters can be created, combined and analyzed. Statistics, raster analysis and other functions of Spatial Analyst for advanced analysis are available.

## 3D Analysis

Besides comprehensive capabilities of 3D Analyst, Cellular Expert provides additional 3D analysis functionality. It includes generation and visualization of 3D antenna pattern using Free Space, Hata or SUI algorithms for optimization of antenna orientation. Cellular Expert allows you to overlay 3D antenna pattern and prediction results such as field strength, best server or interference prediction on 3D terrain. This feature is very useful for planning in dense urban areas with high resolution data. 3D Fresnel zone pattern can be calculated and visualized in 3D environment.



3D Analysis

# 4G NETWORK PLANNING

## LTE, FIXED WiMAX, MOBILE WiMAX

### LTE Coverage Prediction

LTE coverage prediction allows calculating point-to-area LTE signal characteristics: Reference Signal Received Power (RSRP), Reference Signal Received Quality (RSRQ), Signal to Interference plus Noise Ratio of Reference Signal (RS-SINR), average data rate in downlink map including effects of adaptive modulation and MIMO antennas. Lognormal shadowing is included into coverage probability analysis. The calculated coverage results provide the planner with the ability to make right decisions for optimal planning of LTE network.

### WiMAX Coverage Prediction

SUI (Stanford University Interim) prediction model is implemented in Cellular Expert for WiMAX network planning. It allows users to define specific propagation parameters for different terrain types. The model can be combined with Line of Sight model and include correction factors due to diffraction, clutter and building penetration loss. The functionality allows you to calculate the received signal strength and serving areas for the best and following servers. WiMAX coverage prediction allows calculating Received Signal Strength Indication (RSSI), Preamble and Data & Pilot Carrier to Interference plus Noise Ratio (CINR), throughput and bitrate maps.

### WiMAX Frame Parameters and Power Budget

Different WiMAX frame parameters can be used for throughput/bitrate and carrier to interference plus noise ratio calculations. WiMAX Link Budget calculator is used to calculate system gain, receiver sensitivity, maximum allowable loss calculations according to the chosen system parameters such as modulation type, radio model, sub-carriers, loss margins. Downlink and uplink direction analysis is available.

### MIMO Antenna Performance

Multiple antenna configurations can be used to increase signal coverage, traffic throughput and reduce interference. Transmitter/receiver diversity and beamforming configurations are supported.

### Adaptive Modulation

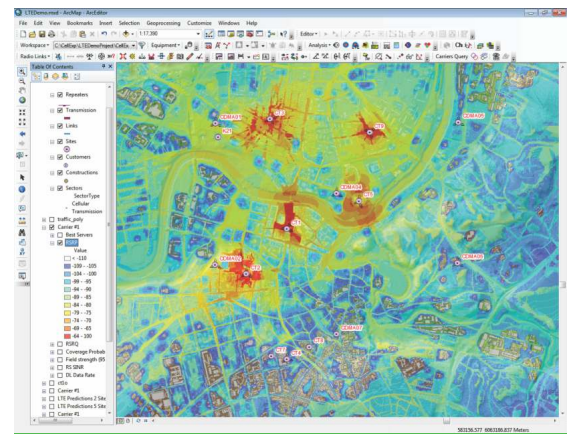
Adaptive Modulation can be calculated with or without interference evaluation. Cellular Expert allows you to define modulation parameters for each radio equipment model and calculate adaptive modulation, throughput and data rate distribution.

### Fractional Frequency Reuse

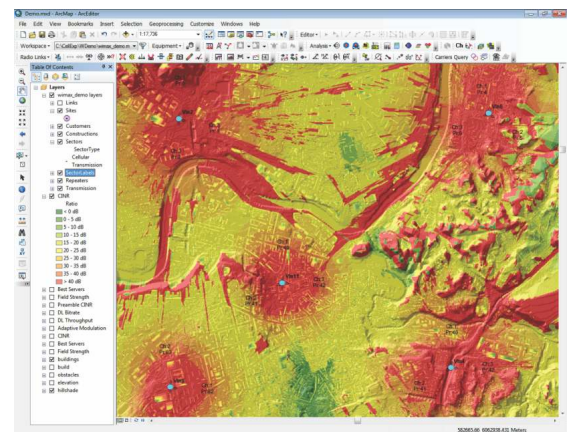
Fractional frequency reuse enables allocation of different powers to OFDM sub bands for cell center and cell edge users, thus reducing interference. Fractional Frequency Reuse (FFR) and Soft Frequency Reuse (SFR) schemes available. For WiMAX network planning different sub-channel groups can be assigned for cell edge.

### Network Design and Optimization

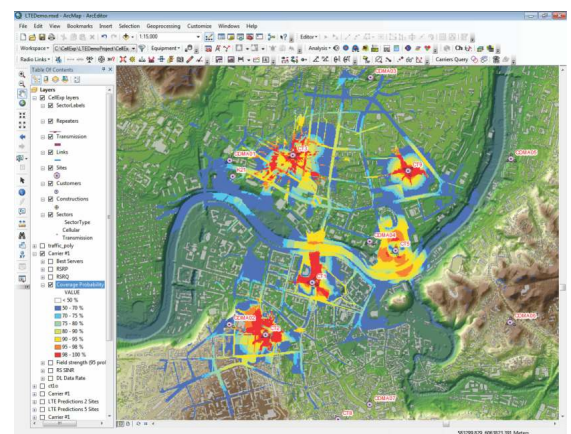
Monte Carlo traffic simulations allow estimating average traffic capacity per mobile user according to random distribution per cell area. Sector tilting and azimuth optimization functions can be used for 4G network optimization. Prediction model calibration based on drive-test data measurements allows optimizing prediction accuracy for 4G frequency bands. Line of sight visibility analysis can be used for higher frequency 4G network site design.



LTE Reference Signal Received Power



WiMAX Carrier to Interference plus Noise Ratio



Coverage Probability

# 3G/3.5G NETWORK PLANNING

## HSPA,UMTS, WCDMA, CDMA2000

### Network Configuration

Cellular Expert has a co-planning capability for 3G/3.5G/4G with the earlier generation networks. Network planning capabilities include support of multiple carriers and a capability to use flexible sector modifications like active, passive repeaters, quasi and TMA sectors.

### Nominal Planning

Nominal planning is performed using Dimensioning Calculator. It has a capability of calculating cell size based on specified targets like the required coverage area, a number of users, traffic demand throughput and number of sites. Dimensioning Calculator allows evaluation of both cell loading and range according to the traffic demand profile. The calculations are based on the power budget for downlink and uplink. As a result, the required network equipment configuration and cell dimensions for predefined traffic can be obtained. Different cell placement patterns are available.

### Coverage Prediction

Cellular Expert has implemented prediction algorithms for outdoor and indoor penetration, pedestrian, vehicular test environments. Walfish-Ikegami model can be used for planning of the third generation networks. The comprehensive Walfish-Ikegami algorithm supports detailed buildings data and can be used for microcells and picocells planning in dense urban environment. Walfish-Ikegami model can be combined with line of sight model and include correction factors due to diffraction, clutter and building penetration loss.

### The following calculation results are generated:

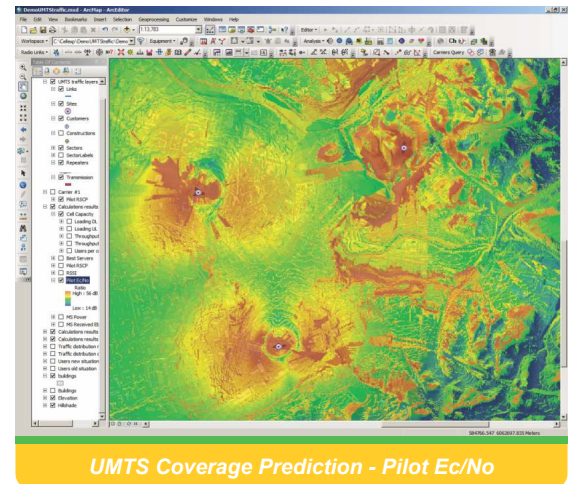
- Received signal strength and serving areas for best and following servers
- Ec/Io, Ec/No, pilot pollution, soft and softer handover
- Cell loading, throughput for DL and UL, number of users per cell
- Traffic service areas for DL and UL, received Eb/No and required power of user equipment, total noise and noise rise, HSPA SINR and data rate

### Traffic Modeling and Simulation

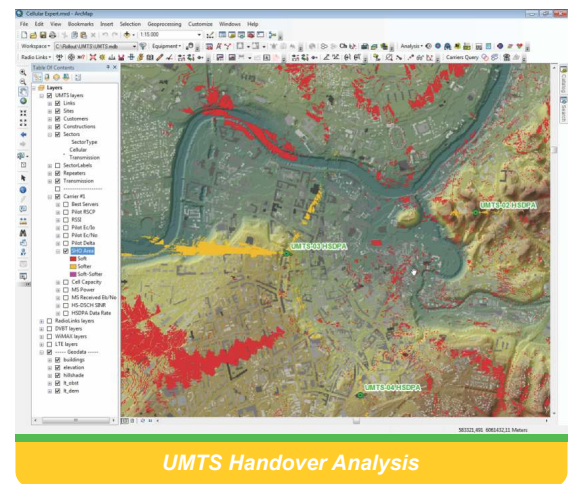
Monte Carlo traffic simulation method is implemented for UMTS, HSPA and LTE networks. Simulations are based on statistical performance analysis of randomly generated mobile users. Monte Carlo snapshots are generated according to given scenario parameters and performance and throughput of each individual mobile user are analyzed. Based on this analysis, graphical output in the form of loading curves per cell and per user are provided. In addition, traffic rasters showing average throughput per user are generated to illustrate the influence of user location on throughput.

### Automated Task Processing

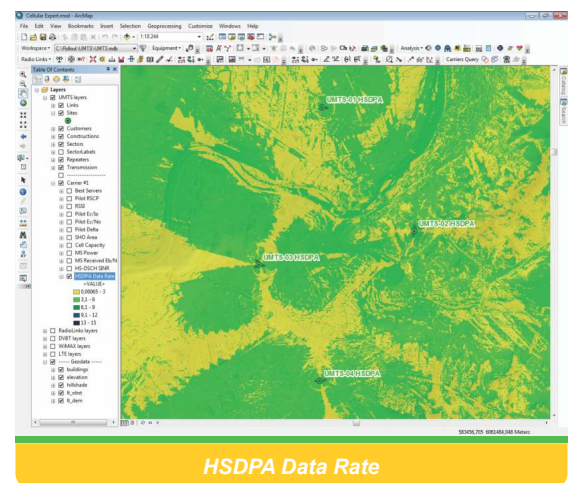
Automated Task Processing is dedicated for large volume 3G network calculations. It allows you to create calculation tasks and use them for batch processing. Each task can use different prediction model or any other settings used for calculation.



UMTS Coverage Prediction - Pilot Ec/No



UMTS Handover Analysis



HSDPA Data Rate

# 2G/2.5G NETWORK PLANNING

## GSM, DCS, CDMA, GPRS, EDGE, TETRA, TETRAPOL

### Coverage Prediction

Coverage prediction includes field strength and best server calculations. Cellular Expert supports the following prediction models for 2G/2.5G networks: Line of Sight type models for open area, Hata type models for urban and suburban areas, Walfish-Ikegami type models for city environment and Diffraction model for open areas with solitary obstacles. Walfish-Ikegami and Hata models can be combined with Line of Sight model and include correction factors like diffraction, clutter loss offset or building penetration. Cellular Expert has the ability to tune models by drive test data or implement additional prediction models. Best server prediction functionality includes first and N<sup>th</sup> best server calculations.

### Interference Analysis

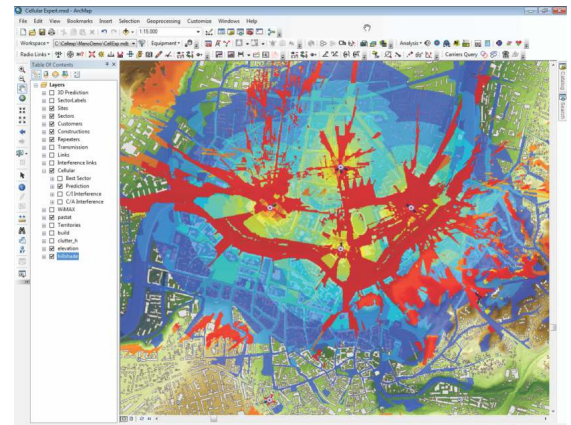
Cellular Expert has the capability to calculate total C/I and C/A interference coverage and coverage of interference for each channel. Channel Query allows users to perform a quick check of C/I interference without setting the frequency information. Interference Matrix is used to calculate the interference level values between a carrier and the victim sectors.

### Automated Frequency Planning

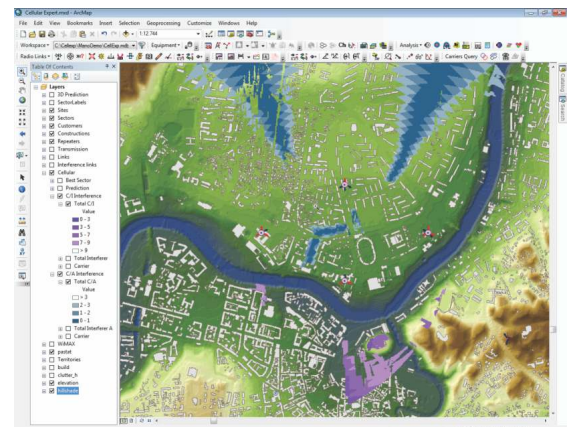
Automated Frequency Planning for 2G/2.5G networks is used to find the minimum number of carriers required to serve defined area within a given interference threshold. The assignment of frequencies are based on metrics calculated from sector or cell traffic demand, number of neighbors, area of neighborhood and other parameters. As a result, new frequency plan, containing non interfering frequency channels for each sector or cell, is created.

### Traffic Planning and Analysis

Live traffic data provided by network equipment can be imported to Cellular Expert and automatically linked to particular cells. Live traffic data spreading can be calculated using a weighted clutter and the best server rasters. As a result, the traffic load for each sector/cell/site can be estimated.



Field Strength Prediction - Hata + LOS



Interference Analysis - C/I, C/A

# BROADCASTING NETWORK PLANNING

## DVB-T, T-DAB

Cellular Expert supports design and analyze of single frequency broadcasting networks – DVB-T (Digital Video Broadcasting - Terrestrial) and T-DAB (Terrestrial Digital Audio Broadcasting).

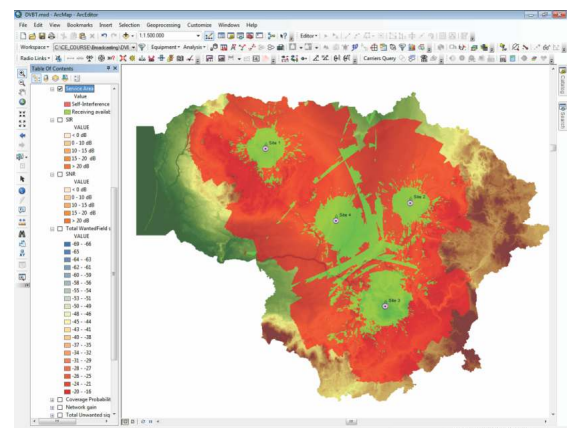
### Network planning capabilities:

- EBU recommended receiver synchronization strategies
- Different receiving conditions (rooftop, indoor, handheld)
- Network coverage with preferred probability
- Service area with included self-interference visualization

### Main calculation results:

- Main Signal Source and Delay rasters
- Total Wanted Signal Field Strength and Total Unwanted Signal Field Strength rasters
- Network gain raster
- Total Wanted Field Strength With Included Probability
- Coverage Probability in percent
- SNR (Signal to Noise Ratio) and SIR (Signal to Interference Ratio) rasters.

As a final result the Service Area raster is created, which clearly shows where the receiving is available (all conditions fulfilled) and where the main problem is self-interference or signal is too weak.



DVB-T Service Area



# MICROWAVE NETWORK PLANNING

## TRANSMISSION, LMDS, MMDS, WLL, WIMAX

### Path Profiling

Profiling and link power budget calculation functions are available for point-to-point analysis. Fresnel zones, Earth curvature and obstacles on the path are displayed in the path profile. The location and the height of the obstacles can be edited, automatically updating the radio link budget calculation worksheet. Single knife-edge, Deygout, and Average methods can be selected for diffraction calculation. Dynamic Path Profiling provides the capability to quickly display path profile and its main characteristics. Anti-correlation analysis helps to estimate the need for antenna diversity. Profiling is based on prediction models that allows user to analyze propagation loss not only for networks requiring line of sight conditions, but also for any other network (like LTE, WiMAX, etc.), which can operate in non line of sight conditions.

### Radio Links Design and Management

Point-to-point and point-to-multipoint radio links can be created between transmitting and receiving sites. Radio Links Manager enables the creation of one-way or duplex radio links, adjusting transmitter-receiver parameters, and selection of diversity and protection configurations. Reflective and back-to-back antenna repeaters can be created and placed on the map. Point-to-multipoint networks can be created and managed as a set of wireless links connecting base stations and customer sites.

### Power Budget Analysis

Radio link power budget analysis includes detailed propagation loss calculations and power budget prediction at the receiver side. Power budget analysis describes a received signal level, total gains and losses, thermal and composite fade margins, signal-to-noise ratio (SNR) and resulting bit error rate (BER). The calculations take into account antenna discrimination, attenuation in feeders and passive components.

### Performance Prediction

Propagation reliability is evaluated based on multi-path and rain fading outages, including protection and diversity improvement. Quality and availability performance of a radio link is assessed according to ITU-T recommendations G.821, 826, 827 and 828. Error performance parameters are defined in terms of bit and block error parameters: Errored Second Ratio (ESR), Severely Errored Second Ratio (SESR), Background Block Error Ratio (BBER) and Unavailable Time Ratio (UATR).

### Interference Analysis

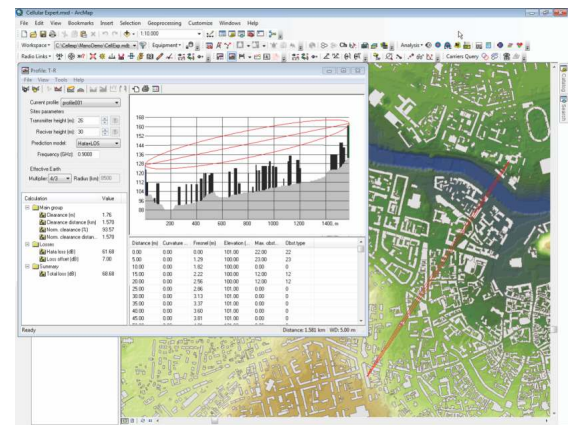
Interference analysis enables the identification of unwanted interference between the radio links. It includes interference level estimation, net filter discrimination loss, interference objectives for co- and adjacent-channels and fade margin loss assessment. Lists of interfering and interfered with stations are generated for each radio link. Scattering analysis calculates mutual interference between intersecting radio paths due to terrain scattering. Intermodulation analysis is also available.

### Automatic Radio Link Frequency Allocation

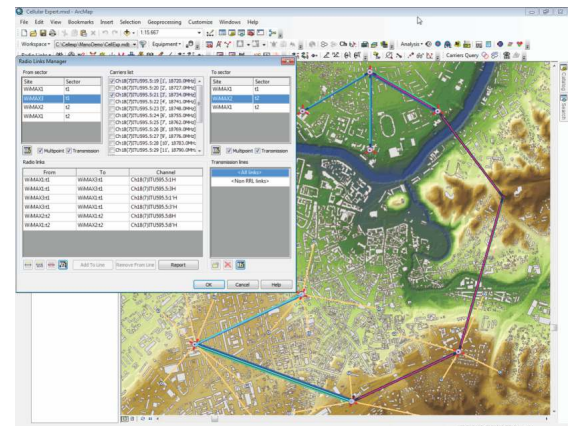
Automatic Frequency Planning is used to find the minimum number of carriers required to serve selected radio links within a given interference threshold. The interference threshold can be defined in terms of absolute interference level, signal to interference ratio or fade margin loss.

### Radio Link Capacity Planning

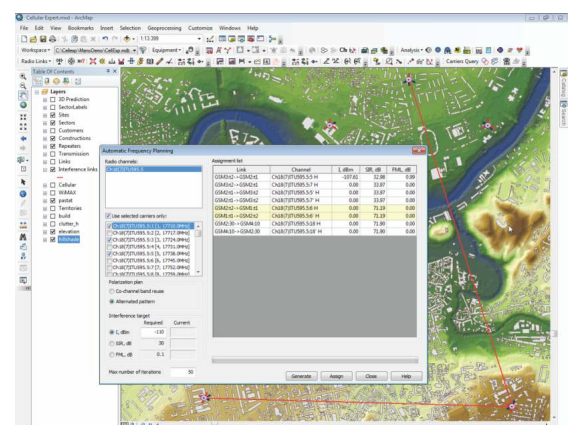
A number of tools are provided to manage traffic connectivity on each site, to perform traffic flow routing and trace network on the map.



Path Profiling



Radio Links Design



Automatic Frequency Planning

# NETWORK VIEWER

## Engineering and information sharing

Cellular Expert Viewer is radio network data access solution to preview, analyze, report and perform calculations directly in your web browser. Network viewer can access all forms of network data maintained by Cellular Expert as well as data from other RF planning solutions or other systems. Simple and user friendly interface makes it easy to navigate, select, display and filter any network equipment and configuration information.

Network Viewer extends data access possibilities for a different group of users: network planners, engineers, customer care, sales and marketing and others. Configuration possibilities enable to provide different data access for each group of users and use specific functions for analysis and reporting. Various network information is accessible for internal and external use.

In addition to standard network data view manipulations (preview, analysis and reporting possibilities) Cellular Expert Network Viewer enables users to solve a set of specific radio network analysis and calculation tasks.

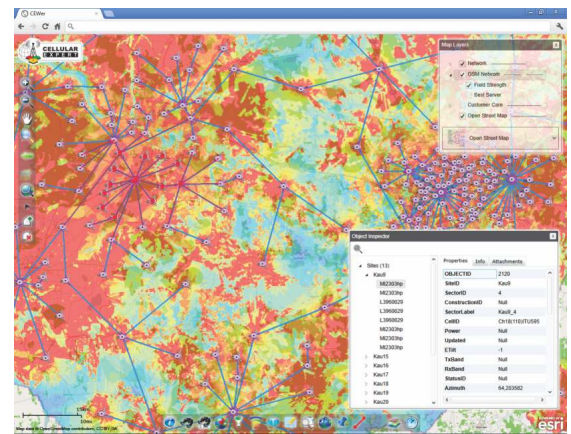
## Network inspection

Object Inspector allows users to preview attribute information of network objects (sites, sectors, radio links, etc.) as well as attach and view the pictures and other documentation related to the object. The user can load and preview signal strength and best server coverage of the network, calculate coverage of selected sectors and check the signal strength value at selected location.

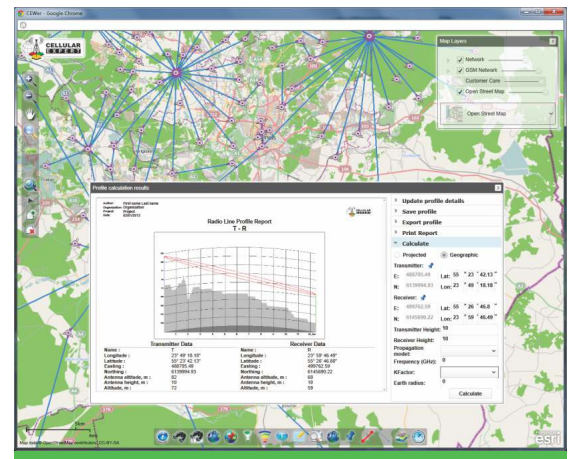
## Profiling

The user gets complete online path profiling functionality. It allows calculating radio path profile by selecting 2 points on the map. Profiling uses pre-created prediction models for evaluation of digital terrain model and/or obstacles, radio frequency, height of transmitter and receiver and other parameters to calculate power budget and create visual radio path profile report. Calculated profiles can be saved to the database for later use as well as exported as reports or printed.

Cellular Expert Viewer can be easily expanded with custom functionality to meet customer needs and demands.



Network Viewer - Object Inspector, Coverage



Network Viewer - Profiling

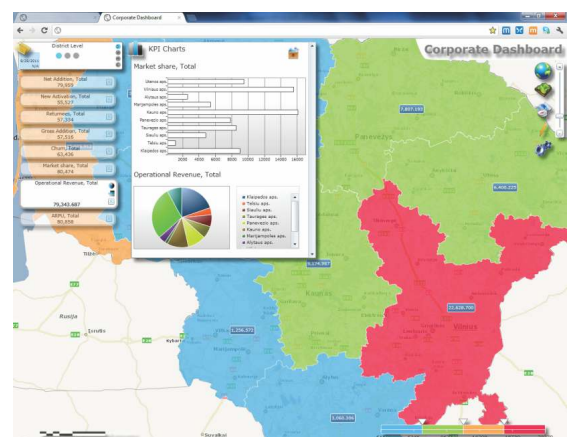
# ENTERPRISE DASHBOARD

## Executive Control

Enterprise Dashboard is company's performance evaluation and monitoring solution. It enables user to visualize, analyze and create reports based on key performance indicators. Enterprise Dashboard can display different sets of KPI's for specific user groups: executives, managers, marketing, sales, customer care, technical personnel and other. Simple and easy understandable graphical display makes it easy to track KPI's, analyze and make decisions according to the situation.

Enterprise dashboard provides the ability to evaluate KPIs in a different time periods (day, week, month or freely selectable period) and drill down to any geographical level of detail for each KPI parameter - country, municipality, city, sales territory, maintenance area, site or any other level.

Flexible configuration possibilities enable to define required number of levels to drill, create specific sets of KPI's for different users or create custom KPIs using new or existing data parameters.



Enterprise Dashboard - KPI Charts

# SERVICES

## PROFESSIONAL SERVICES

HNIT-BALTIC offers professional services related to the wireless telecommunication network planning: feasibility studies, data preparation, software implementation and customization, system integration, network planning and optimization projects as well as other services that are in great demand both in local and international markets. Our experts have deep experience in running international projects and can provide high-qualified professional services for corporate customers.

### Customization, Implementation and Integration

A high level of Cellular Expert customization and data integration guarantees effective application of the software for specific company needs. To meet the specific needs and workflow of the current Cellular Expert user experts of our company offer a wide range of custom services: the localization of the user interface, integration of Cellular Expert with the existing information systems, implementation of additional functionality or modification of the existing one. HNIT-BALTIC professionals are always ready to provide the software implementation, configuration, data preparation and import services, which have a great value for the companies demanding flawless and immediate start of the software usage.

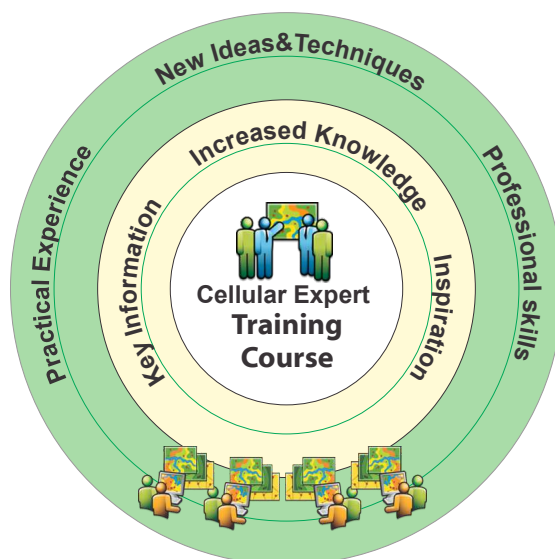


## TRAINING SERVICES

HNIT-BALTIC offers different training courses for Cellular Expert users. During the trainings the participants gain theoretical knowledge and practical experience how to work with Cellular Expert software. The training topics explain the concepts of Cellular Expert and fully cover the software functionality. The courses are oriented to specific technologies according to the customer needs.

### Topics

- Management of equipment data and network objects
- Nominal network planning
- Path profiling
- Visibility analysis
- Radio link design
- Radio link signal prediction and interference analysis
- Prediction model types, creation of prediction models
- Coverage prediction and best server calculation
- Interference calculations
- Network planning tasks for LTE, WiMAX, UMTS, TETRA, DVB-T, Wi-Fi
- Traffic planning and analysis
- Network Optimization
- Statistical GIS analysis
- Drive test data analysis and prediction model calibration
- Database creation
- Troubleshooting



# FUNCTIONALITY CHART

## Network Data Management

Site, Construction, Customer, Repeater management:

Add, Edit, Move, Copy, Delete  
Site re-use patterns for nominal planning

Sector and antenna management:

Add, Edit, Copy, Delete  
Create/Edit Antenna Pattern  
Vertical and Horizontal antenna pattern every 1°  
3D antenna pattern creation, display, export  
Import/Export of antennas

Radio Links Management:

Add, Delete, Edit, Attach profile document

Network equipment data:

Parabolic and Sector antennas, Feeders, Combiners, other components  
Modulation performance tables  
Carriers list, Radios, Spectrum masks  
Mobile user profiles

## Radio Link Budget Analysis

Path profile analysis:

Free space loss  
Clearance  
Sub-path diffraction  
Atmospheric attenuation  
Diffraction (Average, Single knife-edge, Deygout)

Power budget:

Received signal level  
Thermal fade margin  
Composite fade margin  
BER

Radio link performance analysis:

Propagation reliability due to multipath and rain  
Protection and diversity improvement factors  
ITU-T G.821, 826, 827 and 828 target parameters: BBER, ESR, SESR, UATR

## Interference Analysis

Interference level prediction

Net filter discrimination

C/I protection ratios for co- and adjacent-channels

Fade margin loss

Interference predictions for single frequency networks

## Propagation Modeling

Basic algorithm: **Okumura - Hata**

Model type: Point-to-multipoint

Frequency: ~ 150 MHz - 2 GHz

Distance: up to 100 km

Hata Model Parameters:

Standard (ETR 364, COST 231, ITU-R P.529)

Macro Model

9999 Model (Ericsson)

Effective Antenna Height methods:

Absolute, Profile, Average, Relative, Slope

Basic algorithm: **ITU-R P.452**

Model type: Point-to-point and Point-to-multipoint

Frequency: about 700 MHz - 40 GHz

Distance: up to 150 km

Percentage of Time: 0.001 to 50.

Specific attenuation:

ITU-R P.676 using input from ITU-R P.837, ITU-R P.838 and ITU-R P.839.

Rain Attenuation: ITU-R P.530

Basic algorithm: **COST 231 Model** (ETR 364, COST 231)

Model type: Point-to-area (multipoint)

Frequency: about 800 MHz - 2 GHz

Distance: up to 5 km

Basic algorithm: **SUI** (IEEE 802.16)

Model type: Point-to-multipoint

Frequency: ~ 2 GHz - 5 GHz

Distance: up to 70 km

Effective Antenna Height methods: Absolute, Profile, Average, Relative, Slope

Model combination according to environment

## Diffraction Modeling

Single knife-edge (ITU-R P.526)

Deygout (ITU-R P.526)

Average (ITU-R P.530)

## Coverage Prediction

Prediction model creation and assignment to each sector

Selectable cell size, prediction mask, radius and extent

Filter according to minimum required field strength

Coverage probability and field strength with included Shadowing probability

Single frequency networks:

Wanted (useful) and Unwanted (interfering) signal

Main Signal Source and Delay

Service area

CDMA, UMTS:

RSCP, Pilot RSSI, Ec/Io, Ec/No, Eb/No, HS-DSCH SINR

LTE:

RSRP, RSRQ, RS-SINR

WiMAX:

RSSI, Preamble and Pilot CINR

## Best Server Calculation

N<sup>th</sup> best servers coverage, number of servers coverage

N<sup>th</sup> best servers field strength coverage

## Frequency Planning

Nominal channel assignment

Quick interference checking between two sectors

Co-channel (C/I) and Adjacent channel (C/A) interference:

Separate C/I and C/A rasters for each channel

Total C/I and C/A rasters for all channels

Separate and combined C/I raster for hopping and non-hopping cells

Carrier and interferer ID raster

Single frequency networks:

Signal summation

Receiver synchronization

Delay optimization

## Drive Test Analysis

Import formats: Ericsson TEMS™, Motorola iFTA, NEMO, ASCII files

Drive test post-processing: Statistical analysis; Filtering; Averaging

Drive test decomposition

Prediction update with drive test data

Measurements to Serving cell connection

Drive test data player

## Prediction Model Tuning

Evaluation of prediction accuracy

Hata model:

9999 model parameters adjustment

Macro model parameters adjustment

Clutter loss offset determination for each type of clutter

Line of sight model:

One slope model tuning

Dual slope model tuning

SUI model tuning

Walfish-Ikegami model tuning

## Traffic Analysis

Traffic spreading by best server coverage

Traffic spreading using clutter weights

Monte Carlo Traffic Simulation

## Wireless Systems

Mobile:

GSM, DCS, PCS, NMT, TETRA, TETRAPOL, CDMA, CDMA2000, WCDMA, UMTS, HSPA, LTE

Broadband wireless access:

LMDS, MMDS, WLL, WiMAX

Single Frequency Broadcasting:

DVB-T, T-DAB

Transmission networks

## Optimization Tools

Antenna tilting, azimuth and height optimization

Antenna loss grid projection

## Automation Tools

Automated Site Candidates Selection

Automated Cell Planning

Automated Frequency Planning

Automated Task Processing

## 3D Analysis

3D antenna pattern visualization

3D Fresnel zone visualization

Hata, Free Space, SUI algorithms for field strength calculation

## Architecture Features

Unicode Characters support

English/Metric units support

Powerful GIS analysis, Labeling, Visualization, Reporting

Parallel computing on multi-processor/multi-core systems

HNIT-BALTIC, UAB

S. Konarskio 28A, 03127 Vilnius, Lithuania

Tel: 370 5 2150575, Fax: 370 5 2150576

E-mail : [info@cellular-expert.com](mailto:info@cellular-expert.com)

[www.cellular-expert.com](http://www.cellular-expert.com)