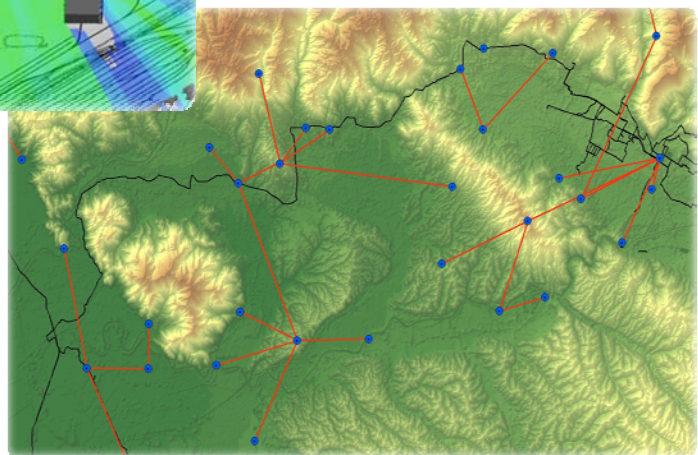
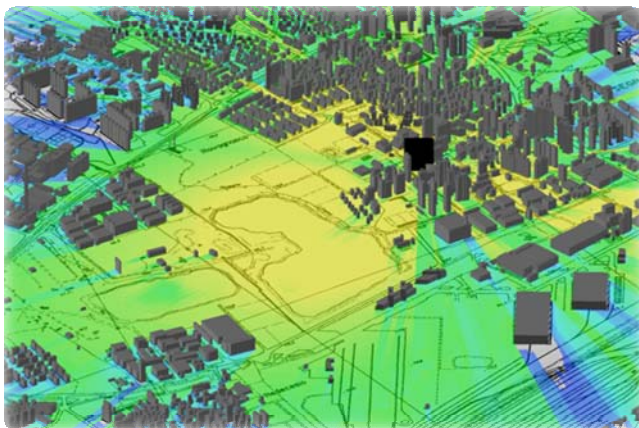


Are You a Greenfield or Emerging Operator Aiming at Building a Competitive Broadband Wireless Access Network?

**Don't Even Think You Can Go Without
Some Accurate and Professional Radio & Microwave Network Planning!**



WiTech

Your Wireless Future
Brought to You

Making Your Wireless Vision
a Reality



Executive Summary

If you are a greenfield or emerging operator aiming at building a competitive Broadband Wireless Access Network (such as, for example, a fixed or mobile WiMAX), you should not make the mistake of underestimating the effort you need to put in place. This is and will remain a complex undertaking, especially if your network has to stand out as a true carrier-class infrastructure delivering superior services while achieving business efficiencies.

In particular, the initial phases up to the definitive project are very critical to set a solid foundation for the success of the initiative. Misjudgments and mistakes made here will influence heavily the subsequent phases. Unfortunately, in these uncertain economic times, there is no room for risky and poorly analyzed business decisions that will be made even worst when entering into the network building phase after some approximate and unprofessional Radio and Microwave Network Planning. This requires the adoption of a robust and structured approach capable of taking into account all relevant aspects and ensure the best possible alignment among business objectives, technical constraints and operational efficiency.

This white paper gives you an overview of some best practices to perform accurate and professional radio and microwave network planning..

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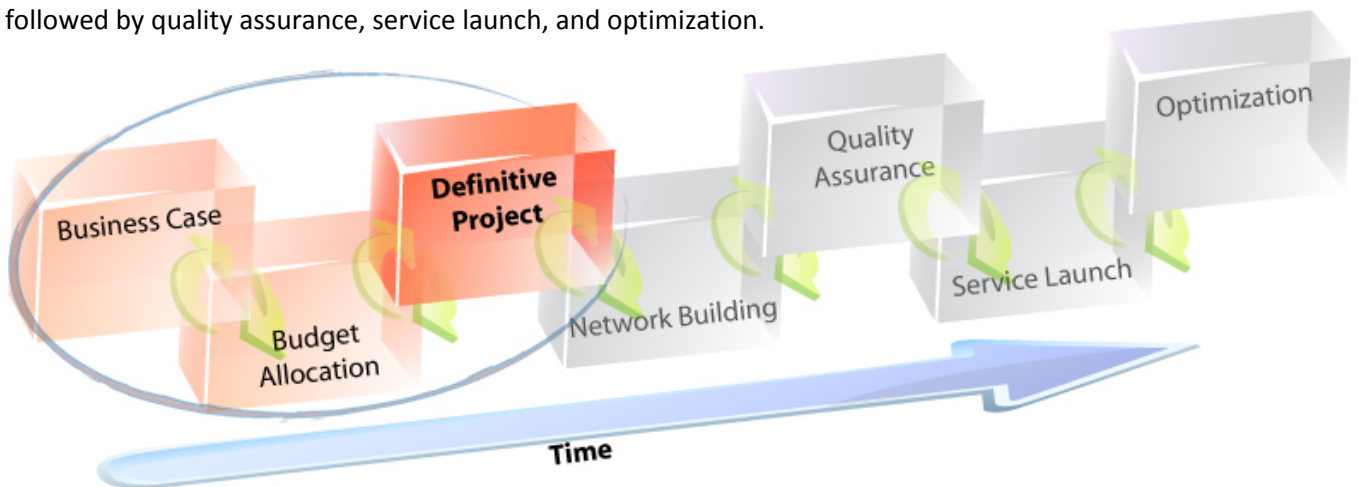
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1 Introduction

If you are a greenfield or emerging operator aiming at building a competitive Broadband Wireless Access Network (such as, for example, a fixed or mobile WiMAX), you should not make the mistake of underestimating the effort you need to put in place. This is and will remain a complex undertaking, especially if your network has to stand out as a true carrier-class infrastructure delivering superior services while achieving business efficiencies.

Following a typical network initiative life-cycle, also in this case you would need to go through a certain number of phases: from the initial planning stage (where you develop the business case and allocate the budget), to the definitive project phase (where you plan and design the network in detail), to the actual network building, followed by quality assurance, service launch, and optimization.



In particular, the initial phases up to the definitive project are very critical to set a solid foundation for the success of the initiative. Misjudgments and mistakes made here will influence heavily the subsequent phases. Unfortunately, in these uncertain economic times, there is no room for risky and poorly analyzed business decisions that will be made even worse when entering into the network building phase after some approximate and unprofessional Radio and Microwave Network Planning.

Your first objective should thus be the consolidation of a robust business case, to allocate the budget more reliably and, in turn, to enter into the network planning and design phase with more confidence and provided with the right input as far as market and technical requirements. The support of an appropriate business case analysis tool, such as TEA|WiMAX from WiTech (see www.witech.it/TEA), can improve considerably the quality and speed of this preliminary planning activity.

An accurate and professional planning of the access and backhaul network in the definitive project phase is the next critical step you should perform to achieve and maintain a high quality of services and, at the same time, to minimize investments and operational costs. This requires the adoption of a robust and structured approach capable of taking into account all relevant aspects and ensure the best possible alignment among business objectives, technical constraints and operational efficiency.

This white paper gives you an overview of some best practices to perform accurate and professional radio and microwave network planning.

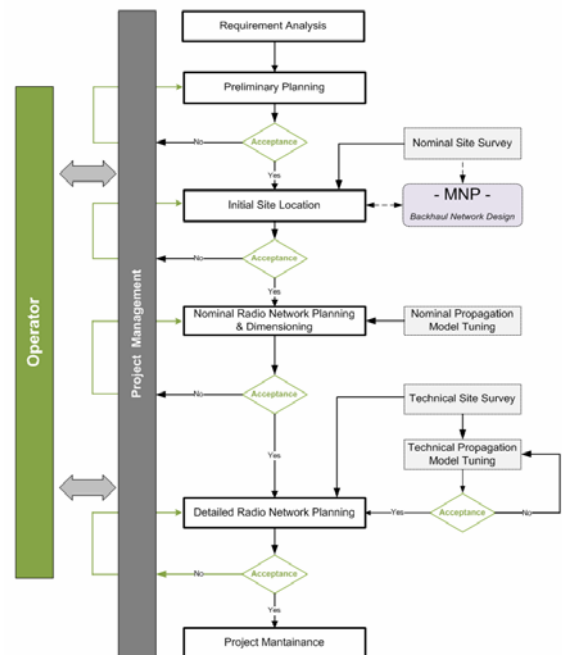
2 Radio Network Planning

Radio network planning (RNP) is the set of engineering activities, based on proven methodologies, sophisticated algorithms and specialized software tools, aiming at designing the access part of a wireless network with the objective of satisfying coverage and capacity requirements as derived from the preliminary analysis of the potential market to be addressed and the definition of the service bundles to be offered.

A methodical radio network planning will allow you to further consolidate the budget allocation before starting with the real network deployment, and will better ensure the profitability of the network since the initial commercial launch.

RNP activities can be classified into:

- **Preliminary Planning**
- **Propagation Model Tuning**
- **Site Location and Positioning**
- **Site Survey**
- **Nominal Radio Network Planning**
- **Detailed Radio Network Planning.**



Preliminary Planning

This activity focuses on analyzing customers requirements and fixing all technological assumptions in order to set the most effective network configuration. This is achieved through:

- Definition of KPI's and target levels of performance
- Estimation of service and traffic mix
- Definition of a strategy for frequency planning
- Analysis of link budget
- Analysis of coverage and capacity requirements
- Antenna configuration selection.

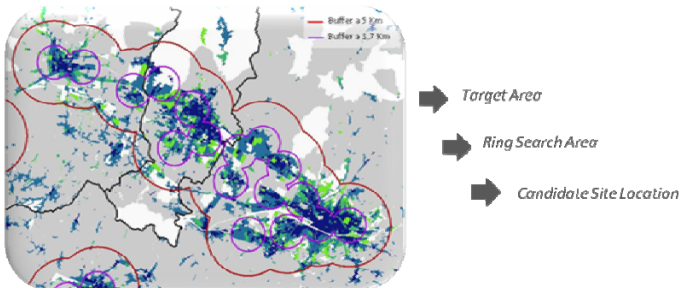


Propagation Model Tuning

This activity allows calibrating the propagation model based upon the data set collected during field measurements and drive test activities. It is needed in order to perform the detailed RNP, since a well-tuned propagation model ensures the optimal network resources allocation (in terms of base stations, radio transceivers and antennas) and guarantees the target quality of services.

Site Location & Positioning

This activity assesses the list of candidate site locations. In particular, it locates the target areas, on the basis of a geo-marketing analysis; it also identifies the ring search areas and, finally, selects one or more candidate site locations taking into account the requirements defined in the Preliminary Planning, whilst performing a joint pre-analysis of the access and backhaul network.



locations taking into account the requirements defined in the Preliminary Planning, whilst performing a joint pre-analysis of the access and backhaul network.

Site Survey

The **Nominal Site Survey** aims to characterize the RF environment using a terrain based planning tool (Google Earth Pro, Virtual Earth, GIS, etc.) in order to nominally validate the candidate site locations.

The **Technical Site Survey** allows collecting on-site information about the RF environment, identifying potential obstructions in the surrounding area and individuating physical requirements for the installation.



Rural Scenario



Sub-Urban Scenario



Urban Scenario

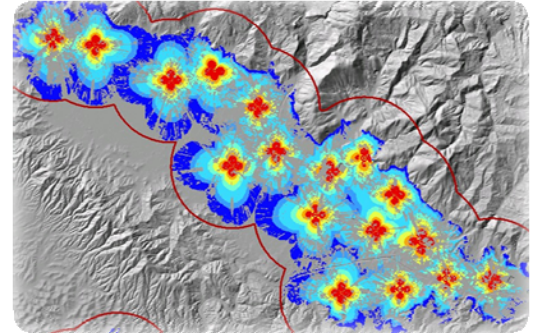


Dense Urban Scenario

Nominal Radio Network Planning

This activity aims to estimate the expected network performance, by means of sophisticated radio planning tools, in order to validate the business model and technological assumptions through:

- Coverage prediction analysis (Coverage, Signal strength, Received Modulation, Best Server, Data Rate)
- Advanced techniques modeling (MIMO, FFR, Beamforming)
- Preamble and frequency planning
- Estimation of coverage and traffic KPI
- Roll-out planning.

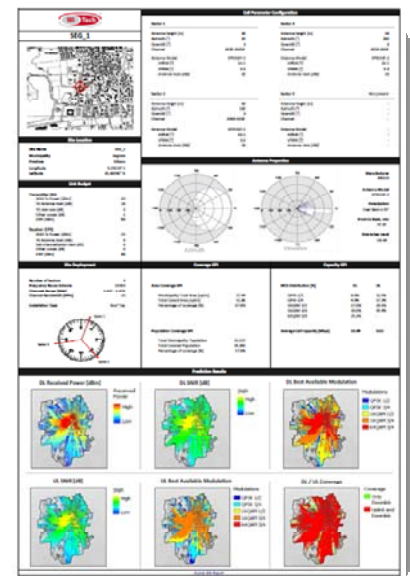


Detailed Radio Network Planning

This activity performs a complete and detailed cluster-based simulative analysis by means of sophisticated radio planning tools to evaluate coverage, QoS and traffic performance and to validate the candidate site location once and for all, taking into consideration all technological parameters, such as output power, channel bandwidth, permutation and sub-channelization model, antenna height and related azimuth and elevation, etc..

The following activities are carried out:

- Coverage predictions analysis (outdoor/indoor, multi-floor)
- Neighbor and interference planning
- Frequency planning
- Customer estimation
- Capacity / load analysis
- Handover planning.



Deliverables

- Prediction Maps** (supported by appropriate platforms such as WiTech’s TelcoGIS or ArcReader Project)
- Technical data**
 - Interactive Database on a Web-based Operator Platform
 - Customized outputs
- Detailed Reports**

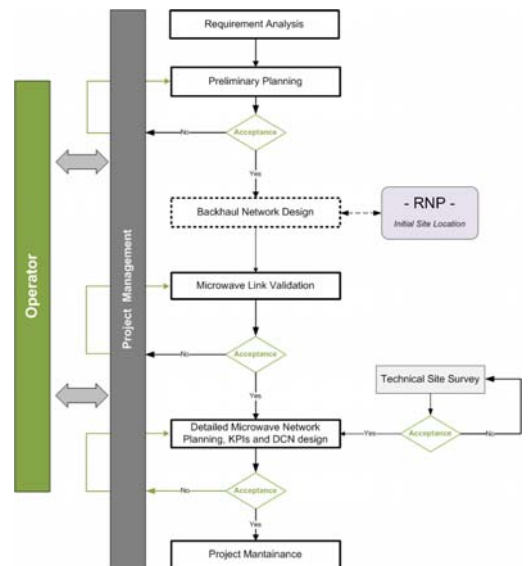
- Site Summary Card**
 - Technical & RF Parameters
 - Traffic & Coverage KPI
 - Antenna System Design
- 3D View**
 - Plots
 - Google Earth

3 Microwave Network Planning

Microwave Network Planning (MNP) aims to design the microwave backhaul network according to technology features and environment constraints, evaluating different network alternatives and individuating the best topology.

MNP activities can be classified into:

- **Preliminary Planning**
- **Backhaul Network Design**
- **Microwave Link Validation**
- **Detailed Microwave Network Planning.**



Preliminary Planning

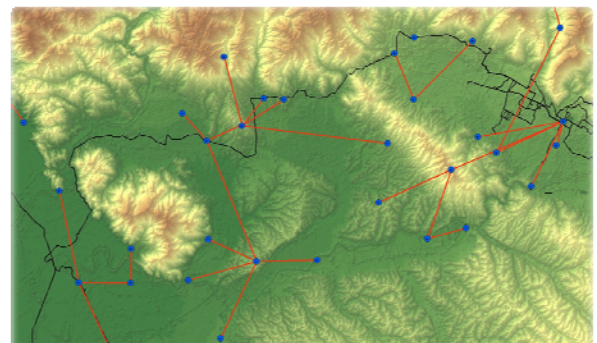
This activity fixes microwave backhaul design guidelines and goals, based on customer requirements such as the required capacity, QoS, access network type and connection to the wireline backhaul, through:

- Definition of KPIs and target levels of performance
- Equipment and technology selection
- Definition of a strategy for frequency planning
- Analysis of link budget
- Antenna configuration selection.

Backhaul Network Design

This activity, critical above all when the access and backhaul network have to be designed from scratch, focuses on outlining the best network topology after having evaluated in detail all possible alternatives through:

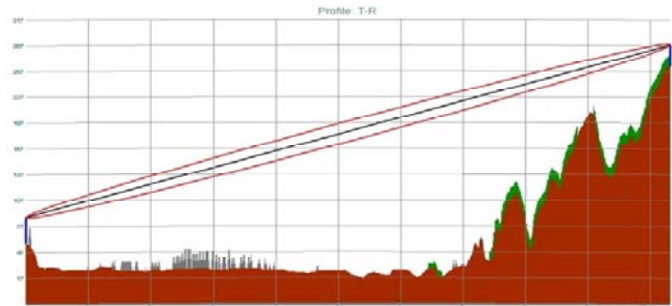
- Access sites location analysis
- Microwave link LOS verification
- Network design and topology definition
- Fixed network and POP interconnection design
- Network roll-out planning.



Microwave Link Validation

This activity evaluates the point-to-point visibility for each radio link, checking the Fresnel Zone by means of radio planning tools that take into account all morphological information, such as Digital Terrain Model (DTM), vegetation clutter and building model. The following activities are performed:

- Microwave LOS and clearance analysis
- Minimum antenna height requirement estimation
- RF link analysis.



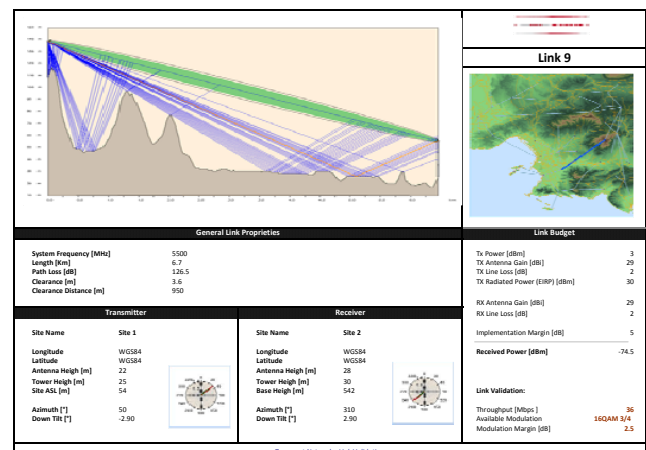
Site Survey

The field site survey verifies the physical feasibility of the radio link, checking the line of sight conditions by means of optical instruments, identifying potential obstructions and collecting all information needed for the installation, such as mechanical and electrical requirements, antenna height, interference conditions, etc..

Detailed Microwave Network Planning

Once the network layout and topology are consolidated, this activity aims to define for each radio link the final configuration, in order to finalize the Bill of Materials and to start the implementation and commissioning phase. The main activities performed here are :

- Link capacity dimensioning
- Link budget calculation
- Frequency planning
- Network design
- Radio and antenna equipment selection and configuration
- KPIs & reliability calculation.



Deliverables

Radio Link Summary Card

- RF Parameters
- KPIs and link reliability
- Link performance

Detailed Reports

Technical data

- Interactive Database on a Web-based Operator Platform
- Customized outputs

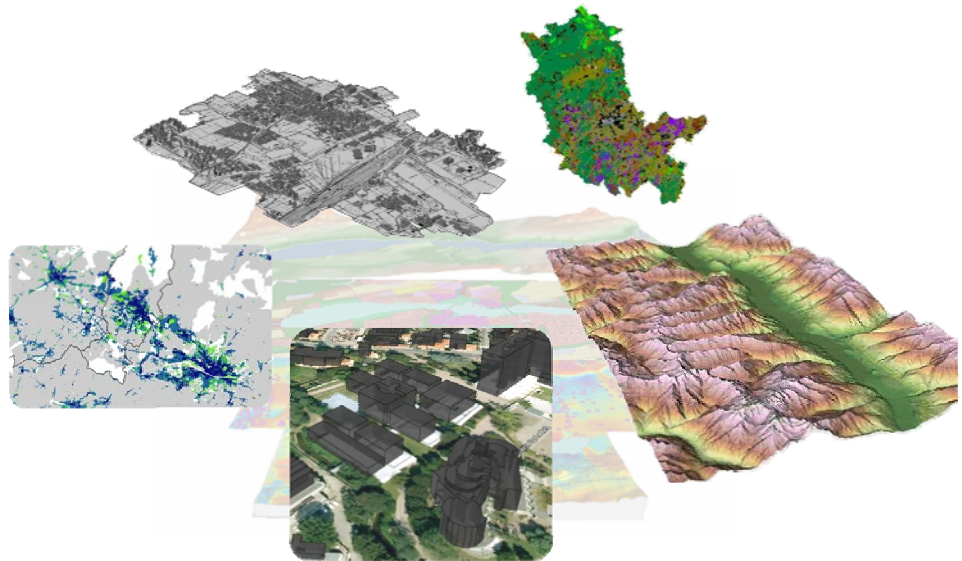
3D View

- Plots
- Google Earth

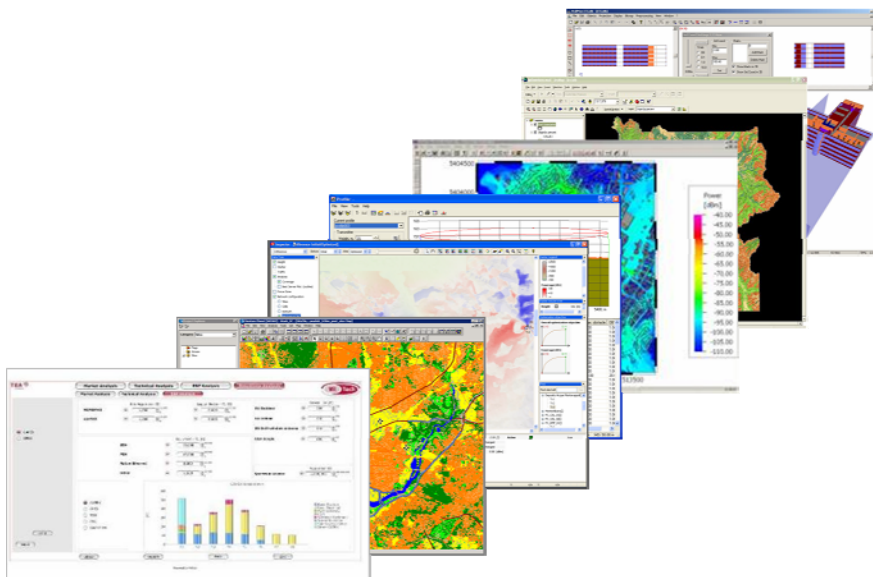
4 Data and tools

To perform an accurate and reliable Radio and Microwave Network Planning, data of different nature have to be managed:

- DTM / DEM / DSM
- Land clutter
- 3D Building Model (vectorial and raster format)
- Geo-Marketing and statistics database
- Thematic maps
- Ortho-photo



In addition, sophisticated software tools have to be used in order to carry out all aforementioned analyses, from the link budget analysis to the calibration of the propagation model, from the coverage prediction analysis to the link validation.



5 Focus on TelcoGIS

TelcoGIS is WiTech's GIS-based integrated platform tailored to support Service Providers addressing key operational needs. In particular, it provides a foundation to implement applications and services in the areas of:

- Network Optimization & Maintenance
- Customer Provisioning & Assurance
- Geomarketing Analysis & Commercial Planning.

□ Functionalities

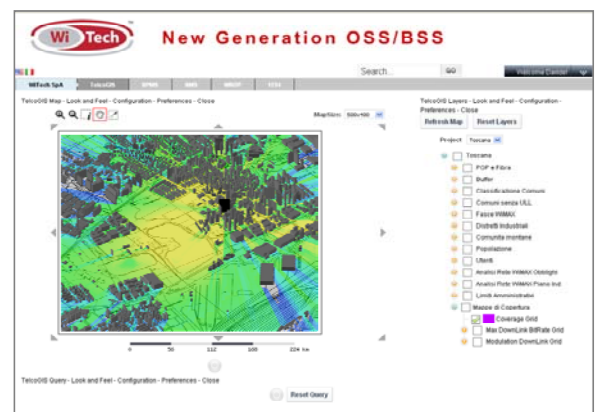
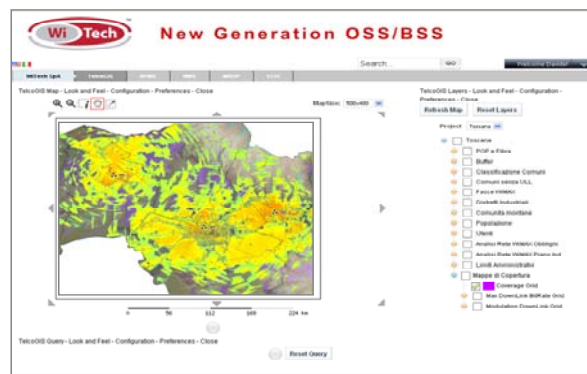
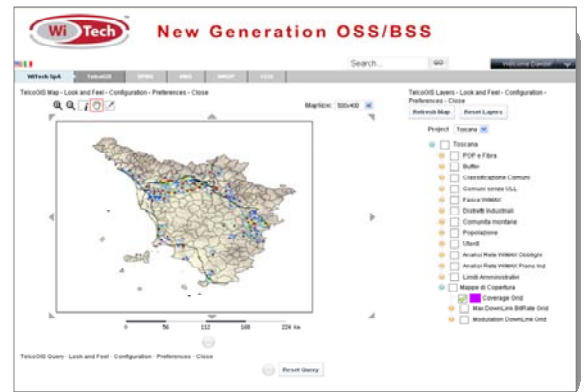
- RNP Prediction Maps View
- Spatial Information Queries
- Check Coverage
- Network Layout & Inventory
- Drive Test data collection support

□ Usage

- Web-based interface
- Standalone & SaaS License

□ Portlet-based Implementation

- Import of Geographic data
- Spatial Data Visualization
- Network Monitoring Support
- User Maps
- Capacity Planning Support
- Direct integration with leading CRM systems/services
- Customizable GUI



6 Conclusions

For a greenfield or emerging operator building a competitive Broadband Wireless Access network is a complex undertaking. This commands the adoption of a robust and structured approach, especially in the initial phases of the initiative life-cycle up to the definitive project and, particularly, while planning the access and backhaul network.

Only with a robust business case followed by an accurate radio and microwave network planning you can achieve and maintain high quality of services and, at the same time, minimize investments and operational costs, being sure of the best possible alignment among business objectives, technical constraints and operational efficiency

Acronyms

BWA	Broadband Wireless Access
CRM	Customer Relationship Management
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
FFR	Fractional Frequency Reuse
GIS	Geographic Information Systems
GUI	Graphical User Interface
KPI	Key Performance Indicator
LOS	Line Of Sight
MIMO	Multiple Input Multiple Output
MNP	Microwave Network Planning
POP	Point Of Presence
QoS	Quality Of Service
RF	Radio Frequency
RNP	Radio Network Planning
SaaS	Software as a Service
WiMAX	Worldwide Interoperability for Microwave Access

About WiTech

WiTech, founded in 2003 as a spin-off of the University of Pisa, Italy, has become shortly one of the most interesting reality in the Next Generation Networks/Next Generation Services (NGN/NGS) scenario, with a focus on BWA (Broadband Wireless Access) and standard technologies like 3G/HSPA, WiMAX and 4G/LTE.

In the consulting & engineering area, thanks to its in-depth expertise, WiTech provides the market with high-value services ranging from strategic consulting on investment plans to engineering services for network design and network planning.

On the solution side, the company is engaged in the development of specialized business case analysis tools, capable of performing thorough technical-economic analyses of wireless initiatives in an integrated manner, and in the development and integration of innovative BPM-enabled NGOSS/BSS (Business Process Management-enabled Next-Generation Operation Support System/Business Support System) frameworks and components, aimed at allowing more automation and better control of key telecommunications processes.

WiTech is a Regular Member of the WiMAX Forum and a Member of the TM Forum.

WiTech S.p.A.

Polo Tecnologico di Navacchio, Via Giuntini 25
56023 Cascina - Loc. Navacchio (Pisa), Italy
www.witech.it
Phone: +39 050 77 50 56
Fax: +39 050 75 47 22
E-mail: info@witech.it