ASSET Design User Reference Guide

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Change History

This table shows the change history of this guide:

Edition	Date	Reason
1	30 April 2020	First edition.

Table of Contents

1 Introduction to ASSET Design

ASSET Design is an automated network optimization and design tool. Within a unified interface, it enables the optimization of macro cell network designs and/or the addition of new multi band sites.

The two modes it can perform are presented as:

- **Cell Planning**
- **Site Placement**

The above modes can be used separately or together.

The supported technologies are: GSM, UMTS, LTE, Wi-Fi and 5G.

ASSET Design's planning method can deliver impressive results and performance. Using a combination of radio network data and specific planning objectives such as coverage, capacity or quality, ASSET Design can search for the optimal network design based on that information.

ASSET Design is complementary to your existing planning and propagation software. It builds on your investment in that software by automating the multiple network processes. ASSET Design is licensed separately. If licensed, it is integrated with ASSET.

The ASSET Design optimization environment incorporates all the appropriate data in ASSET to optimize the network. This includes:

- Network settings
- Antenna patterns
- Clutter data
- Terrain data
- Information about the optimization area
- Pathloss data (propagation model data and prediction files)
- Optional traffic data (traffic weighting, traffic sharing throughput optimization)

2 System and Data Overview

Using ASSET Design

The integrated architecture of ASSET Design is designed to meet the following aims:

- Straightforward workflow
- Easy data preparation
- Simplified data flow

Licensing

ASSET Design uses the CodeMeter UFC (Universal Firmcode) licensing system. This system can use both dongles and software licenses.

For comprehensive information on licensing, please read Licensing Information on page 209.

System Requirements

For ASSET Design, the minimum operating system is Microsoft Windows 8.1 Professional 64-bit and the minimum CPU family is Intel Core 2.

Please contact your regional Product Support team for the latest recommended hardware specifications for review prior to installation.

Important:

- ENTERPRISE (ASSET) must already be installed *before* you install ASSET Design. This enables you to launch ASSET Design from ASSET.
- ASSET Design requires a 64-bit Oracle Database 11g, 12c, 12cR2 or 19c client installation (including Administrator option, ODBC Driver, and Oracle Data Provider for .NET).

  For Oracle 12c, 12cR2 or 19c, you need to create a TNS_ADMIN environment variable which points to the folder containing the tnsnames.ora file.
- The Prediction Access license (P13) needs to be appended to the ENTERPRISE license file.

Data Preparation

The data preparation in ASSET for the optimization in ASSET Design basically consists of:

- Definition of the optimization area
- Filters for cells - if required

(There are also optional inputs such as traffic rasters and cell activation settings.)

Optimization Area

The optimization process will modify the radio network parameters available for the optimization in order to maximize the optimization target within a certain area. This area is called the 'optimization area'. It represents the region where the optimization objectives will be evaluated. Any cells within this area can be optimized.

The definition of the optimization area needs to take place in ASSET, by using the Vector Editor to create a polygon.

Filters

Optionally, you can specify which filter(s) you are going to use to determine which cells are included in the optimization. You may wish to include an additional tier of sites around the optimization area so that interference from those cells (border effects) can be taken into consideration.

Contributing Cells

Cells that contribute to the optimization are those that are included in the filters (if used) and either inside the optimization area or outside the area but with overlapping coverage.

Important: For full details of the data preparation prerequisites in ASSET, see the 'Using ASSET with ASSET Design' section of the *ASSET User Reference Guide*.

Data Flow

The data flow between ASSET and ASSET Design is fully automated and consists of two steps:

- Data export from ASSET (before optimization)
- Data import into ASSET (after optimization)

The ASSET Design data flow is shown below.

The project data available in ASSET builds the basis for the optimization. This data is also the basis for the result data that goes back to ASSET.

Data Export from ASSET (Before Optimization)

Before starting an optimization in ASSET Design, the appropriate project data needs to be exported. You can launch ASSET Design directly from ASSET. This integration between the two tools is described in Launching ASSET Design on page 18.

An ASSET Design optimization environment is a snapshot of the ASSET project containing all relevant information for ASSET Design in compressed and quickly accessible data formats. The optimization environment will only be located on the file system, but can be copied to other computers if required.

The ASSET Design optimization environment includes all the required data to optimize the network, such as:

- Network settings
- Antenna Patterns
- Clutter Data
- Terrain Data
- Information about the optimization area
- Traffic data
- Pathloss data

  ASSET Design works with propagation models that generate unmasked predictions as well as with propagation models that generate masked predictions (such as ray-tracing models). In the case of masked predictions, ASSET Design de-masks the pathloss values when reading them from the pathloss files so that it can apply the masking algorithm according to the one used in ASSET. The parameter modifications should be limited to small ranges to minimize the potential for deviations between the predictions from each of the tools. For information on how to only select cells with ray-tracing models, see Extended Cell Selection on page 39.

Several optimizations can be performed for a single optimization environment. For example, different optimization objectives or different parameter settings can be used. Therefore, each individual optimization will result in an individual optimized network configuration. These optimized network configurations will automatically be stored in .con files.

The name of the ASSET Design optimized network configuration file consists of the name of the underlying optimization environment file with the suffix "**_OptResult(n).con**"

There are various settings you can specify with regard to folders for storing exported data such as temporary environments and also temporary optimization data. See Preferences on page 137.

Data Import into ASSET (After Optimization)

After the optimization in ASSET Design is finished, the results can easily be loaded into ASSET for verification.

For information on this, See Loading Optimization Results into ASSET on page 19.

Shortcut Keys

Like many other applications working under a Windows environment, ASSET Design provides a set of shortcuts which can provide convenience and speed when using the tool.

Many of these are especially useful when editing data in grids such as the clutter grids available in the network and service targets, and the traffic limit editing grid.

The available shortcuts are listed below:

Ctrl keys	Description
Ctrl+A	Select all records in tables (from the active table)
Ctrl+C	Copy the selected data.
Ctrl+D	Fill down selected data in tables (in the active table). This copies the value from the first field in a selection down to all selected fields.
Ctrl+U	Fill up selected data in tables (in the active table). This copies the value from the last field in a selection up to all selected fields.
Ctrl+V	Paste the content of the clipboard.
Ctrl+X	Cut the selected data.

These two additional shortcuts may be useful for grids where the standard copy (Ctrl+C) and paste (Ctrl+V) shortcuts work for a single field but not for a multiple selection of fields:

Ctrl keys	Description
Ctrl+Shift+C	Copy the selected (multiple) fields to the clipboard.
Ctrl+Shift+V	Paste the clipboard contents (must contain multiple fields) to the grid.

Function keys	Description
F1	Use this key from any window to obtain context-sensitive Help
F2	Edit the actual item.
F9	Toggle warning window.

Alternate keys

When a letter is underlined in a command, press Alt+letter to run it. Use the Alt button to make underlines active/inactive.

3 Integration between ASSET Design and ASSET

This chapter describes the integration between ASSET Design and ASSET.

Creating the Optimization Environment

You can launch ASSET Design directly from ASSET. This process loads the files (according to selected filters) from the ASSET project.

An ASSET Design optimization environment is a snapshot of the ASSET project containing all relevant information for ASSET Design in compressed and quickly accessible data formats. The optimization environment will only be located on the file system, but can be copied to other computers if required.

The optimization environment includes all required data to optimize the network, including network settings, antenna patterns, and so on (for a fuller list, see Data Flow on page 14).

The loading process is executed swiftly, based on the specification of the filter of cells to be used, the resolution and the optimization area.

Prerequisites

In summary, please ensure the following prerequisites have been set up in the ASSET project:

- A vector for the optimization area has been created. All sites within this vector can be optimized.
- Filters have been set up to contain the sites that are to be used in the optimization plan. These filters should include all sites that are to be optimized and at least one additional tier of sites around the optimization area so that interference from those cells (border effects) can be taken into consideration.
- Antenna patterns are grouped correctly and the electrical tilts are assigned properly.

Important: For clear details of how to prepare all the prerequisites (and other options) in ASSET, see the 'Using ASSET with ASSET Design' section of the *ASSET User Reference Guide*.

Shared Antennas and other Synchronized Parameters

There are cases where ASSET Design is not allowed to modify parameters independently, such as when antennas are shared between different cells. In such cases, mechanical parameters like tilt or azimuth can only be changed jointly for these different cells. Other examples are splitters or other configurations where cells use more than one antenna. Such configurations are referred to as *parameter synchronizations* in ASSET Design.

All information required for the parameter synchronizations is written to a file called *Asset.paramSync* in the optimization environment. The parameters will be synchronized in ASSET Design if the *.paramSync-file* is selected in the **ParamSync file (optional)** input box in the **Project Settings** screen of the user interface. This input box will automatically show the correct path to the *.paramSync-file*, which avoids the need to browse for that file manually.

However, if you do not want automatic synchronization to occur, delete the path to the *.paramSync-file* in the input box before loading the project.

Warning: If the automatic synchronization is not used, there may be a disparity between results in ASSET Design and ASSET, because antenna parameters can differ.

Launching ASSET Design

The first step in the creation of an optimization environment is the specification of the ASSET project.

Within the open ASSET project, you can click the  icon in the main toolbar to launch ASSET Design.

Important: For clear details of how to do this, as well as the related prerequisites in ASSET, see the 'Using ASSET with ASSET Design' section of the *ASSET User Reference Guide*.

After you click **Initialize**, ASSET Design will be launched. This can take several seconds to complete depending on the size of your project. When it is complete, you will see a message confirming the transfer of project data to the specified working folder.

Updating an ASSET Design Project with Changes from an ASSET Project

If you want to update your ASSET Design project with changed parameters from the ASSET project, you just need to run the ASSET Design wizard again with ASSET Design still open and the project loaded. The wizard will detect the running session and update the ASSET Design accordingly. Your optimization settings will be retained. If several ASSET Design sessions with the same project are open then the wizard will ask you to close all sessions except the one which you want to be updated.

Target File

Before ASSET Design is launched, the ASSET Design optimization environment (.coe) has to be created. It consists of a .coe-file together with a folder of the same name. This folder contains project information required for the optimization process. The proposed file name is the file name of the actual ASSET project file with the suffix "**_OptEnv(n).coe**". The index "n" is automatically incremented by ASSET Design in the case where the file name already exists (that is, if the same ASSET project file is used to generate multiple optimization environments).

The ASSET Design optimization environment includes all required data to optimize the network, including network settings, antenna patterns, and so on (for more information, see Data Flow on page 14).

Creating a Measurement Environment

ASSET Design measurement environments are similar to optimization environments with two major differences:

- The pathloss files in measurement environments are based on measurements while pathloss files in optimization environments are based on predictions.
- Measurement environments can only be used in combination with an optimization environment.

Measurement environments are used in ASSET Design by assigning them to individual target functions. The analysis for this target function will then be based on the measurement-based pathloss values rather than the prediction-based pathloss values. This allows maximum flexibility to combine different target functions for measurements and predictions with individual weights.

Follow these steps to use measurements in ASSET Design:

- Create an optimization environment for the project and launch ASSET Design.
- Create a measurement environment for the required measurement.
- Load the project and specify optimization ranges.
- Create target functions and assign weights. Assign measurement environments to the required target functions.

Target functions with measurement environments assigned are based on measurements, the remaining functions are based on the predictions in the optimization environment.

There is a stand-alone tool that you use to create measurement environments. This is the Measurement Converter. See Measurement Converter on page 193.

Example

Create two target functions to consider coverage based on predictions as well as coverage based on measurements, for example:

Target name:	Weight:	Path to measurement environment:
Coverage-Pred	1.0	(no measurement environment)
Coverage-Meas	0.5	D:\Data\DemoMeasurementEnvironment.cme

For more details on measurements, see Optimization with Measurements on page 160.

Loading Optimization Results into ASSET

After the optimization in ASSET Design is finished, the results can easily be loaded into ASSET for verification.

ASSET Design stores the optimized network configuration in XML format when the optimization is finished. The files have the name 'INDEX001.xml' in a subdirectory where the environment is located.

Please follow these steps to import the optimized network configuration into ASSET:

1. Open the project in ASSET. You should use the same project that was the base for the optimization environment.

   Note: It is recommended to create a copy of the project that was used to create the optimization environment.

2. In the ASSET main menu, select **File > Import > XML**.
3. Select the appropriate XML file created by ASSET Design.
4. Select the configurations you want to import.
5. Click **Import**.

4 Project-related Settings

This chapter provides project-related information:

- Project Mode
- Project Settings
- Quick guide to set up a Site Placement run
- Import settings from previous optimization

Project Mode

ASSET Design incorporates two modes:

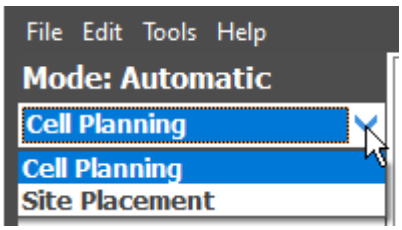
- **Cell Planning** mode

  For optimizing the cell parameters of an existing network, according to set targets.

- **Site Placement** mode

  For the creation and location of new multi band sites to reach set targets at a minimum cost.

You can switch between the two modes. To select the required mode, use the drop-down box at the top-left of the main user interface:



Selecting the Project Mode

Cell Planning Mode

You can use the Cell Planning mode to optimize your current network configuration with reference to coverage, interference, cell utilization, and so on, by tuning various cell parameters such as electrical tilt, mechanical tilt, azimuth, power, activation status and antenna type.

ASSET Design can perform optimization of single or multiple networks, as well as multi-technology.

You can upscale the traffic of your current traffic maps both globally as well as per clutter type to simulate future volumes of traffic, and to tune the network accordingly. This can be combined with the ASSET Design activation algorithm which can activate candidate sites where necessary.

Site Placement Mode

You can use the Site Placement mode to help extend your existing network with multi band sites for higher capacity as well as for site placement in a 'greenfield' scenario.

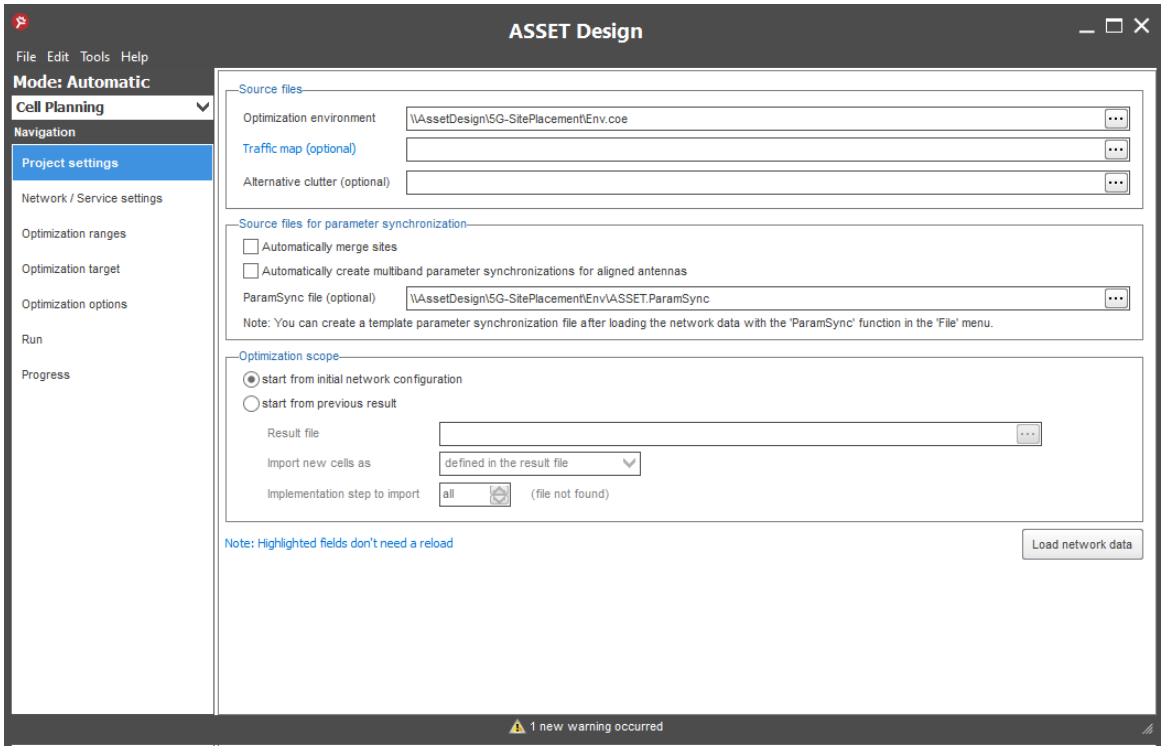
The ASSET Design Candidates Creator helps you place candidate sites in a certain area of interest, along roads or buildings, high traffic areas or places with bad coverage.

The algorithm of ASSET Design will then pick the best candidates for the defined targets and select the most efficient site template for each position. At the same time, ASSET Design will consider backhaul connectivity like microwave links or cable access points and find the 'cheapest' solution.

Project Settings

The **Project Settings** screen enables you to view and modify ASSET Design project information and settings.

This picture shows the ASSET Design main interface with Project Settings selected:



ASSET Design main interface - Project Settings

Tip: All file selection fields support Drag and Drop.

Important: Whenever you make any changes on this screen (except for the optional traffic map) you must click the **Load network data** button in order to activate the changes. You can also save the settings (see Save Optimization Settings on page 26).

When you make a change to the project settings, and then click **Load network data**, you are warned that your current optimization settings (ranges, targets etc.) will be lost.

If you want to keep them, you can firstly save the project (see Save Optimization Settings on page 26), then change the project settings as required, click **Load network data**, and then import the optimization settings from the saved project file (see Import Settings from Previous Optimization on page 26). When you do this, you can select which settings you want to import.

Source Files

The **Source Files** pane enables you to view or edit the following settings or options:

Setting/Option	Description
Optimization environment	This field displays the name of the ASSET Design optimization environment containing the ASSET project data. The optimization environment has to be created by launching ASSET Design directly from ASSET. See Creating the Optimization Environment on page 17. The ASSET Design optimization environment includes all required data to optimize the network, including network settings, antenna patterns, and so on (for more information, see Data Flow on page 14).
Traffic Map (optional)	To provide system coverage and performance where the traffic is, you can apply weighting of the optimization targets based on traffic density maps by loading a traffic map (see Traffic Density Weighting on page 88). A traffic map can be exported from the ASSET project during the creation of the optimization environment. This map must be large enough to completely cover the analysis area. **Note**: Only converted raster maps in 'band interleaved per line' (.bil or .cbil) formats or native ASSET (.trr /.tri) formats are supported. The traffic map is also needed to consider the captured traffic per cell during the optimization process. For details, see Captured Traffic and Traffic Sharing on page 89.
Alternative Clutter (optional)	ASSET Design allows the consideration of an alternative clutter file that can be used to focus on different requirements. Please note that only converted raster maps in 'band interleaved per line' (.bil or .cbil) formats are supported.

Source Files for Parameter Synchronization

The **Source Files for Parameter Synchronization** pane enables you to view or edit the following options:

Option	Description
Automatically merge sites	Enable this checkbox to automatically merge sites that are co-located with a distance of 2m or less. The cells of merged sites will be handled as if they are on the same site that is required for several synchronization settings, such as antenna synchronization, tilt and azimuth, and synchronization.
Automatically create multiband parameter synchronizations for aligned antennas	Enable this checkbox to automatically create synchronizations of the antenna azimuth, the mechanical antenna tilt and the physical antenna pattern of two co-located sectors. The synchronization occurs if the antennas are co-located and the mechanical tilt, the azimuth, and the height coincide (with small tolerances for rounding errors). To save these parameter synchronization settings, in the ASSET Design toolbar, select: **File > Create parameter synchronization template**. This function creates a template (.ParamSynch file) by first re-creating automatically synchronized sectors and then writing these synchronizations to the template file for further manual modifications or re-use in other projects.
ParamSync file (optional)	Use this file to include synchronizations between different network parameters and settings when optimizing networks that use shared infrastructure between different radio technologies, for example, multi band shared antennas. For details on how to generate such a parameter synchronization file, see Multi System on page 147. Merged sites can also be defined in the parameter synchronization file.

Optimization Scope

The **Optimization Scope** pane enables you to view or edit the following settings or options:

Setting/Option	Description
Start from initial network configuration	This option starts the optimization from the initial network configuration exported from ASSET.
Start from previous result	This option starts the optimization from an 'already optimized' network configuration. The optimized network configuration file contains the modified radio parameter settings. **Result file (optional):** Enables you to specify the 'result.json' file from a previous optimization that contains the pre-optimized parameter values. The file is located in the result directory of a previous run. **Import new cells as:** From the drop-down box, select the activation status for new cells generated from previous runs in the Site Placement mode: • **defined in the result file** • **active** • **inactive** **Implementation step to import:** Select all steps or specify a step. For more information, see Improvements up to a Specific Point in the Implementation Plan on page 173.

Example

Optimization environment file: UrbanSites_OptEnv(1).coe

Optimized configuration file: UrbanSites_OptEnv(1)_OptResult(1).con

If another optimization is done with the same data input, that is, the same optimization environment, then the suggested name would be UrbanSites_OptEnv(1)_OptResult(2).con.

How to Set Up a Site Placement Run

This section provides a brief overview and summary of how to set up a **Site Placement** run.

For more detailed information, see Run (Site Placement Mode) on page 110.

The purpose of the Site Placement mode is to create and place new sites to reach certain targets at a minimum cost.

This mode chooses the optimal site configuration from a list of templates.

The costs are separated in three parts:

- Optional site acquisition costs which can be defined in the candidate positions file. These costs apply if ASSET Design activates a site at this position.
- Backhaul costs for connecting the site with the backbone network. Different costs apply depending on whether the site is connected via cable access point, fiber cable (no access point), microwave or another method.
- Template costs as the actual hardware costs of each template.

Follow these steps to set up a Site Placement run:

Within ASSET

1. Within ASSET, launch ASSET Design so as to create an ASSET Design optimization environment. See Creating the Optimization Environment on page 17.
2. When the initialization has finished, ASSET Design will start automatically.

Within ASSET Design

1. Load the optimization environment.
2. In the Project Mode drop-down box at the top-left of the main user interface, ensure you select 'Site Placement'.
3. In the Navigation pane on the left, click the Optimization Target option and set up your targets. See Optimization Targets on page 59.

Setting Parameters for Site Placement

1. Specify one or more templates.

   Note:

   - You can save and reuse templates. For more details, see Run (Site Placement Mode) on page 110.
   - All templates should have a PropCalcRadius that is at least several pixels in size.
   - If you do not enter costs, ASSET Design will attempt to minimize the count of activated candidate sites.

2. Set the Network Selection to the network you want to populate with new sites.
3. Set a Target Objective. ASSET Design will try to reach this goal and then minimize the costs.

   Note: The target objective is optional. In cases where it is deactivated, the process aims to find the solution with the highest objective.

4. Choose a Candidate Positions file.
5. Optional: If you select a Microwave Hubs file, a Cable Vectors file and/or a Cable Access Points file, the cheapest available backhaul method will be used.
6. You can now start the optimization run. It is recommended that you use a coarse resolution if you are at an experimental stage with the settings.

Starting the Optimization

ASSET Design will now compute propagations and start trying to reach the given target objective. Once this target objective is reached, a cost minimization will occur. This will usually take longer than achieving the target objective.

ASSET Design will continue as long as it can still find improvements (cheaper solutions).

An ASSET Design run can be stopped at any time. The best result will be kept. After the optimization is stopped, plots will be generated. This might take a short while.

The results can be visualized by pressing the **Visualize results** button.

Import Settings from Previous Optimization

This functionality enables you to import parameter and optimization settings from previously conducted optimization projects, if those projects were saved into project files.

Save Optimization Settings

You can save the settings of a currently open optimization project using either:

- **File > Save** to save the current ASSET Design project.
- **File > Save As** to save the current ASSET Design project to a new file.

Within such a project file, the settings of the following screens of the interface are recorded:

- Traffic Map (in Project Settings)
- Network/Service Settings
- Optimization Ranges
- Optimization Target
- Optimization Options
- Run settings (including Result Folder setting)

Import Settings from Previous Optimization

You can load some or all the parameter settings from a previously saved optimization project.

This allows you to load the individual settings from previously saved optimization projects.

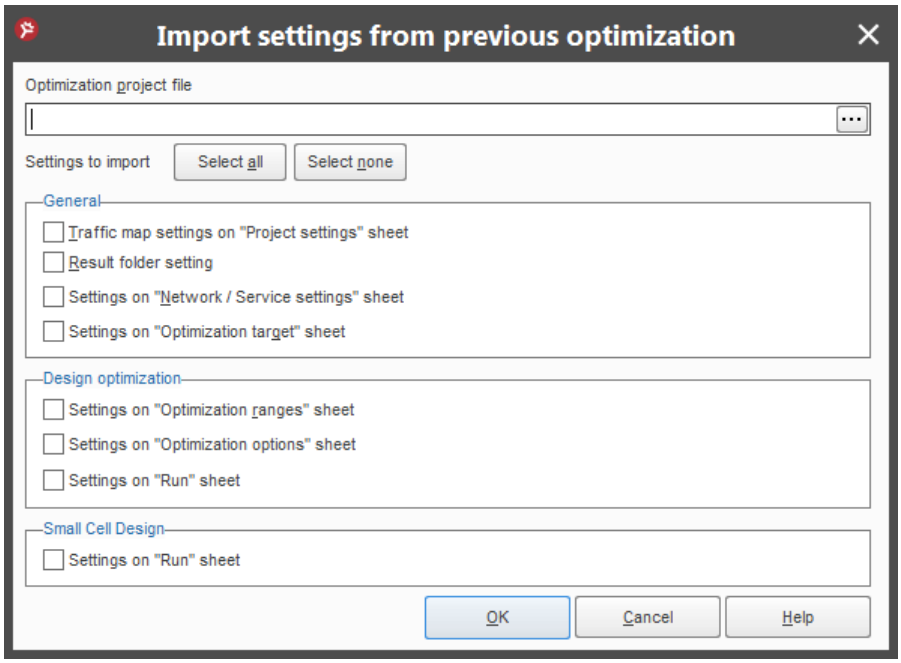
For example, it may be that you save the optimization project for certain networks at a given time, to include parameter settings as well as optimization requirements, targets and associated weights. In the case where you run another optimization for the same network, but with different optimization parameters, you can use the optimization targets (ONLY the optimization targets) of the previous optimization by selecting the option for **Optimization Target** settings. Only the optimization target settings will then be imported. However, if you want to keep the optimization parameters, but define different optimization targets, you would need to enable the option for **Optimization Ranges**. In this case, only the optimization ranges (and parameter settings and costs/time) will be imported, nothing else.

Note: The settings from previously stored optimization projects do not even have to be from the same project. This means that you can load optimization targets from any previously saved optimization project. The same applies to parameters settings, however, the same sites and sectors (recognized by their ID) have to be available in the project files in order to load parameter settings.

To use this functionality:

1. From the **File** menu, select **Import settings**.

   The following dialog box appears:



2. In the **Optimization project file** box, click the ... button to select the optimization project file which has the settings that you want to use for the current project.

3. Select the checkboxes of the settings that you want to use:

   General:

   - Traffic Map settings
   - Result Folder setting
   - Network/Service settings
   - Optimization Target settings

   Cell Planning mode:

   - Optimization Ranges settings
   - Optimization Options settings
   - Run settings

   Site Placement mode:

   - Run settings

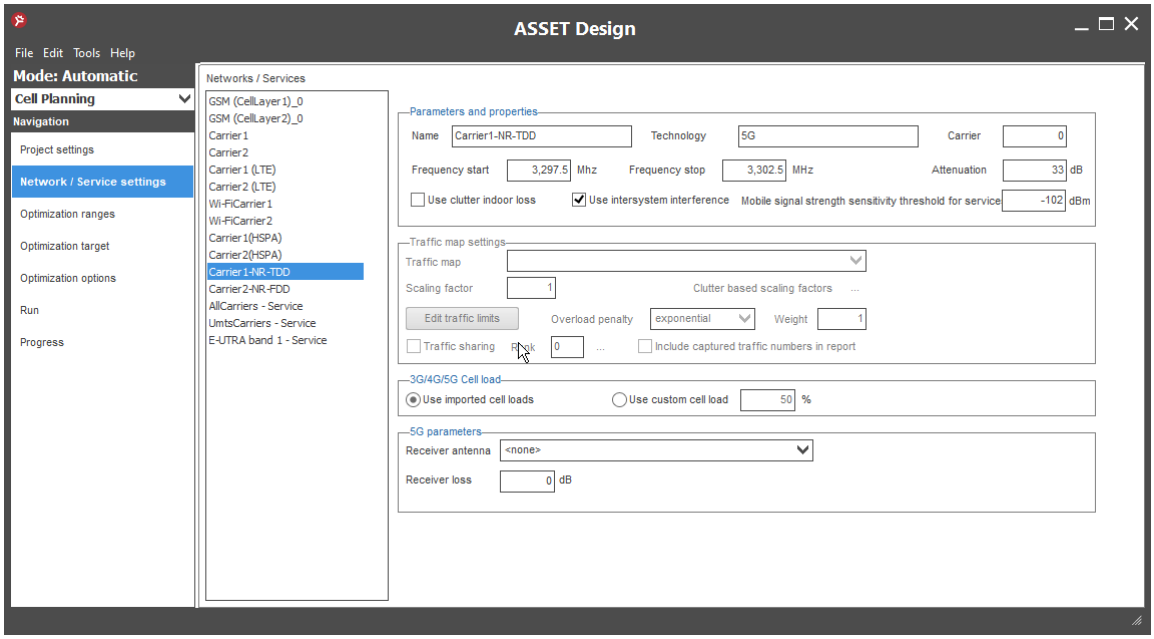
4. Click **OK**.

5. If you want to import additional settings from a different project, repeat the above steps as appropriate to your requirements.

5 Network/Service Settings

The **Network/Service Settings** screen enables you to view and modify the networks and/or services involved in the optimization tasks.

This picture shows the ASSET Design main interface with Network/Service Settings selected:



ASSET Design main interface - Network/Service Settings

Please read the following important note:

Important Terminology:

- In ASSET Design, '**Network**' is equivalent to a carrier in ASSET (that is a technology-specific carrier with its accompanying attributes, such as bandwidth). Examples would be a UMTS carrier, an LTE carrier, 5G carrier, and so on. For GSM, the example would be a frequency band.

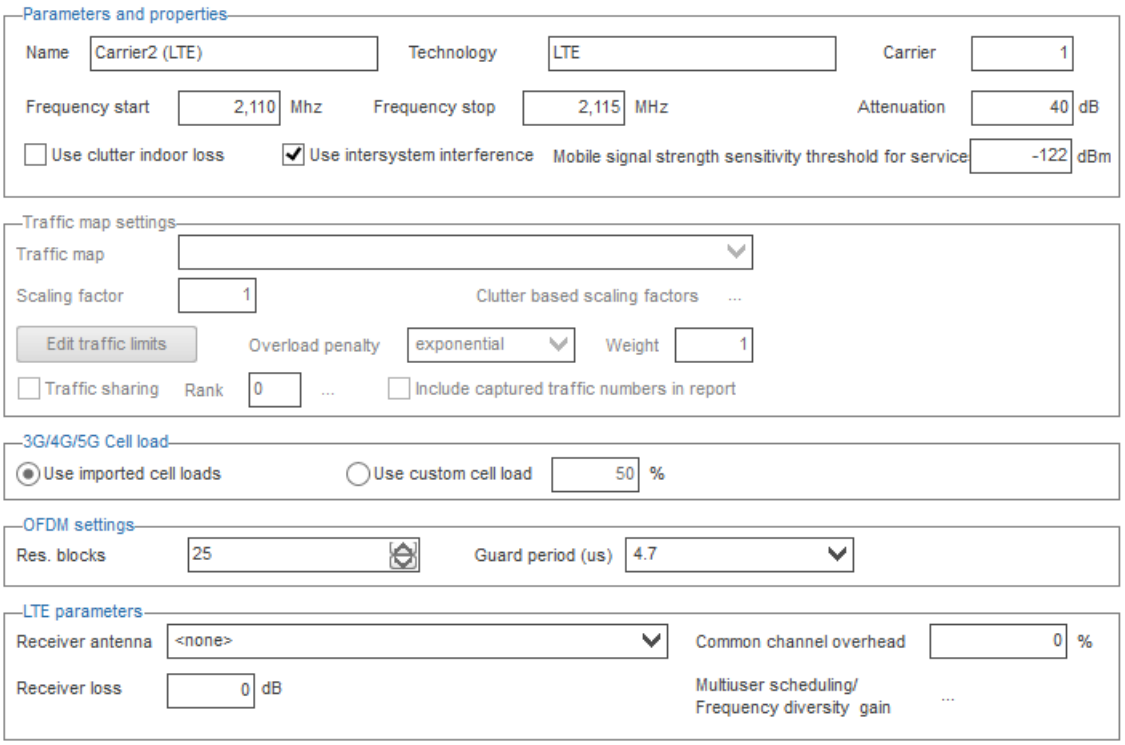
- In ASSET Design, '**Service**' is equivalent to a collection of priority-ranked ASSET carriers (carriers belonging to a service in ASSET). There is also a special LTE Frequency Band service, where the ranking of the carriers is equal. The ranking of the carriers appears on the Networks/Services Settings screen and also on the Services page of the optimization report.

Networks

In ASSET Design, '**Network**' is equivalent to a 'carrier' in ASSET (that is a technology-specific carrier with its accompanying attributes, such as bandwidth). Examples would be a UMTS carrier, LTE carrier, 5G carrier, and so on. For GSM, the example would be a frequency band.

The list of networks shows the network layers that are present in the project.

This picture shows an example:



Example of a network on the Networks/Services screen

You can select a network to view or edit its parameters, properties and settings. These are described in the following sections.

Parameters and Properties

The **Parameters and Properties** pane enables you to view or edit the following items:

Parameters/Properties	Description
Name	Here you can view and modify the name of the network selected in the networks list. The name of the network can be modified in ASSET Design but this does not change the name in the ASSET project or database.
Technology	The radio access technology as defined in the ASSET database.
Carrier	The carrier number for the particular network. For GSM, no carrier information will be displayed.
Frequency start/stop	The Start Frequency and Stop Frequency of the radio channel. The network's range (Frequency Stop - Frequency Start) determines the bandwidth per carrier. For UMTS, LTE, Wi-Fi and 5G, the frequencies automatically correspond to the values in ASSET, but for GSM, frequencies always have to be set manually.

Parameters/Properties	Description
Attenuation	The attenuation of the power transmitted by the interfering network layer to the power interfering with the victim network layer. This factor is in dB.
Use clutter indoor loss	Select this option to consider any additional clutter losses defined in ASSET in all predictions.
Use intersystem interference	Activates intersystem interference calculation for the specific network. All networks that have this setting activated will interfere with each other if their frequencies are close to each other (within 1x bandwidth). Networks that do not have this activated will not contribute to or receive intersystem interference.
Mobile signal strength sensitivity threshold for service	Only cells meeting this coverage threshold are considered as best servers for a service. **Note**: The above threshold does *not* influence the carrier best server calculation, in relation to network targets.

Traffic Map Settings

You can use the **Traffic Map Settings** pane to select a traffic map for weighting of optimization targets, to consider the traffic captured by the footprint of cells in the network, and to edit the traffic limits of the cells. For further details see Captured Traffic and Traffic Sharing on page 89.

The settings are as follows:

Settings	Description
Traffic map	You can select a traffic map for the weighting of the optimization targets based on a traffic density map. The traffic density map has to be scaled in units/km^2. The supported file format is band interleaved per line (.bil or .cbil). See also Traffic Density Weighting on page 88. The <default> traffic map is the traffic map defined in the Project Settings. This field is grayed out in the case where no default traffic density map is defined in the project settings. This ensures that at least one traffic density map is available for all networks, and therefore to avoid mistakes. Traffic maps used for captured traffic analysis or for density-based capacity targets need to be scaled in units/km^2 to provide useful results. See below how traffic maps can be re-scaled using the Scaling factor.
Scaling factor	Use this value to scale the entire traffic map. The scaling factor can, for example, be used to run studies with increased traffic demand (e.g. enter 1.25 for 25% more traffic) or to re-scale the traffic map from unit/pixel to unit/km^2 (enter 1000000/resolution^2).
Clutter based scaling factor	As well as the global scaling factor described above, the traffic map can also be scaled based on clutter. Press the … button to open the input dialog where you can define a scaling factor for each clutter class. The default value is 1. Each pixel of the clutter map will be multiplied by the factor according to the clutter class of that pixel and the global scaling factor. The list of clutter scaling factors can be saved to and read from files.

Settings	Description
Edit traffic limits	Click this button to view and edit the maximum traffic settings for the individual sectors. These settings include the sensitivity that is required to capture the traffic. This sensitivity is the minimum power that has to be exceeded by the received down-link pilot signal. This global parameter can be edited in the field *Requirement for best server*. If no minimum signal level is entered, ASSET Design automatically considers a value of -200dBm. Enter the maximum traffic limits for every individual sector in the sector list. In addition to the sector limits, site (base station) limits can be defined as well in the '*Site Traffic*' column. Site limits are 'per network' limits, that is, the sum of the captured traffic of each sector of a site in a certain network layer is compared against the site limits. Both sector limits and site limits are optional. You can define either of them, none, or both. If both are defined, the more stringent limit will apply for the sectors of the site. Shortcuts and hot keys are available to provide quick ways to manipulate the data in the editing grid. See Shortcut Keys on page 16. **Note**: In order to consider the limitations correctly, the limits have to be entered in the same unit as the traffic density map. For example, if the traffic density map is given in Erlangs/km^2, a maximum traffic limit of "40" means a maximum traffic of 40 Erlangs that can be handled by this sector.
Overload penalty	Two penalty functions can be selected for overloaded cells: linear and exponential. A cell that is overloaded by 100% will add only 50% to the total target function value. If an exponential penalty function is selected it will count even less depending on the selected weight. This value can increase the preference to meet the captured traffic limits at the expense of optimization gain. A value of 1 will lead to similar results as previous versions (balance between captured traffic limits and other optimization objectives). With values between 1 and 10 the focus will be set more towards respecting the captured traffic limits (values greater than 10 should not give significantly different results). Values less than 1 will still try to meet the traffic limits but with more focus on increasing the objectives of the target functions. A value of zero is equivalent to ignoring the limits.
Weight	This value can increase the preference to meet the captured traffic limits at the expense of optimization gain. A value of 1 will lead to similar results as the linear penalty function (balance between captured traffic limits and other optimization objectives). With values between 1 and 10 the focus will be set more towards respecting the captured traffic limits (values greater than 10 should not give significantly different results). Values less than 1 will still try to meet the traffic limits but with more focus on increasing the objectives of the target functions. A value of zero is equivalent to ignoring the limits.
Traffic sharing	Enable this checkbox if the selected network shall share traffic with other networks. In this case, all the traffic-sharing networks will use the same traffic map as a basis; it will be the traffic map of the first network (with the lowest rank).
Rank (traffic sharing)	Use the  button to open a dialog where the traffic-sharing networks can be ordered. The first (lowest rank) network is shown on the bottom of the dialog. It will be the network which uses the original traffic map for the captured traffic analysis. The second network will use the traffic remaining from the first network rather than the traffic given by the traffic map, etc. Note that this analysis only makes sense if you define target functions that use *Apply captured traffic limit* (see Setting Network Targets and Service Targets on page 63) or use a shared traffic map for weighting. For further details see Weighting with Shared Traffic on page 92.
Include captured traffic numbers in report	Use this checkbox to compute the captured traffic during the optimization and present these numbers in the optimization report and in Inspector, but without taking the limits of the maximum traffic per sector into account in the optimization run. The captured traffic values are then listed for each sector in the optimization report. This checkbox can only be enabled if the *Apply captured traffic limit* checkbox is DISABLED for all optimization targets.

2G Neighbor List

The **2G Neighbor** pane only appears for GSM networks.

ASSET Neighbor lists are automatically included in the ASSET Design optimization environment if available. Select a neighbor list to reduce the calculated interference from neighboring transmitters to consider 2G frequency planning.

The settings are as follows:

Settings	Description
Use neighbor list for C/I targets	Check this option to use the neighbor list for GSM interference analysis.
Neighbor list	Select the neighbor list to be used. Neighbor lists are automatically exported from ASSET and included in the optimization environment.
Max number of neighbors	Limit the number of cells that are considered as neighbors. Neighbors are processed in the order that they appear in the neighbor list exported from ASSET.
Interference factor	This linear factor defines the fractional interference of a neighbor cell. For example, a value of 0 means no interference, a value of 0.5 means that a neighbor cell interferes with only half of its power (-3dB), and a value of 1 means full interference (that is, no difference between neighbors and non-neighbors).

3G/4G/5G Cell Load

The **3G/4G/5G Cell Load** pane only appears for UMTS, LTE, Wi-Fi or 5G networks.

The down-link cell loads (DL total power) for interference analysis can be either be as imported from the ASSET project, or custom-specified as a fixed percentage. The percentage is interpreted in the same way as in ASSET. For details about targets, see Optimization Targets 3G/4G/5G on page 72.

The two options are as follows:

Options	Description
Use imported cell loads	Select this radio button to use the DL loads from the ASSET project (that is, from the optimization environment). The setting is applied to all cells of the selected network.
Use custom cell load	Select this radio button to use constant cell loads for all cells of the selected network. Define the used cell load in the input field in %.

OFDM Settings

The **OFDM Settings** pane only appears for LTE or Wi-Fi networks.

Use this section to select the bandwidth or resource blocks and the guard interval for OFDM based technologies, such as LTE or Wi-Fi.

The settings are as follows:

Settings	Description
Res. blocks (LTE)	Enter the number of resource blocks that are used by the network. The number of resource blocks is calculated from the bandwidth of the network.

Settings	Description
Bandwidth (Wi-Fi)	Enter the bandwidth in MHz. The systems use constant sub-carrier spacing, thus the FFT size is deduced from the bandwidth. If possible, the bandwidth will be read from the project settings of ASSET. However, it can be modified here.
Guard period	Select the correct OFDM guard period length. This guard interval will be used for all transmitters.

LTE Parameters

The **LTE Parameters** pane only appears for LTE networks.

The parameters are as follows:

Settings	Description
Receiver antenna	An antenna pattern can be selected from this drop-down list. If a pattern is selected, all target functions that are used for this network will consider this antenna for the user equipment. In the analysis, the user equipment antenna will be pointed towards the best server on each pixel. For more details, refer to User Equipment Antenna on page 94.
Common channel overhead	Enter the percentage of resource units that the overhead channels occupy. This has an effect on a density-based capacity analysis.
Receiver loss	If a receiver antenna pattern is selected (from the drop-down list above), a receiver loss can be defined here. If no receiver antenna is selected, this loss will be ignored. The receiver loss will impact all target functions of this network; that is, received powers are attenuated and the noise level is increased.
Multi user scheduling/ Frequency diversity gain	Click the … button to open a table where you can specify clutter-dependent multi user scheduling gains and frequency diversity gains in dB. These gains are applied for C/(I+N) and capacity targets. The values for each clutter class are added together and used as one table. The values are used for the Capacity density based target, SINR and CA carrier availability SINR. Functions to save and load the clutter based values are available as well as clipboard functionality.

5G Parameters

The **5G Parameters** pane only appears for 5G networks.

The parameters are as follows:

Settings	Description
Receiver antenna	An antenna pattern can be selected from this drop-down list. If a pattern is selected, all target functions that are used for this network will consider this antenna for the user equipment. In the analysis, the user equipment antenna will be pointed towards the best server on each pixel. For more details, refer to User Equipment Antenna on page 94.
Receiver loss	If a receiver antenna pattern is selected (from the drop-down list above), a receiver loss can be defined here. If no receiver antenna is selected, this loss will be ignored. The receiver loss will impact all target functions of this network; that is, received powers are attenuated and the noise level is increased.

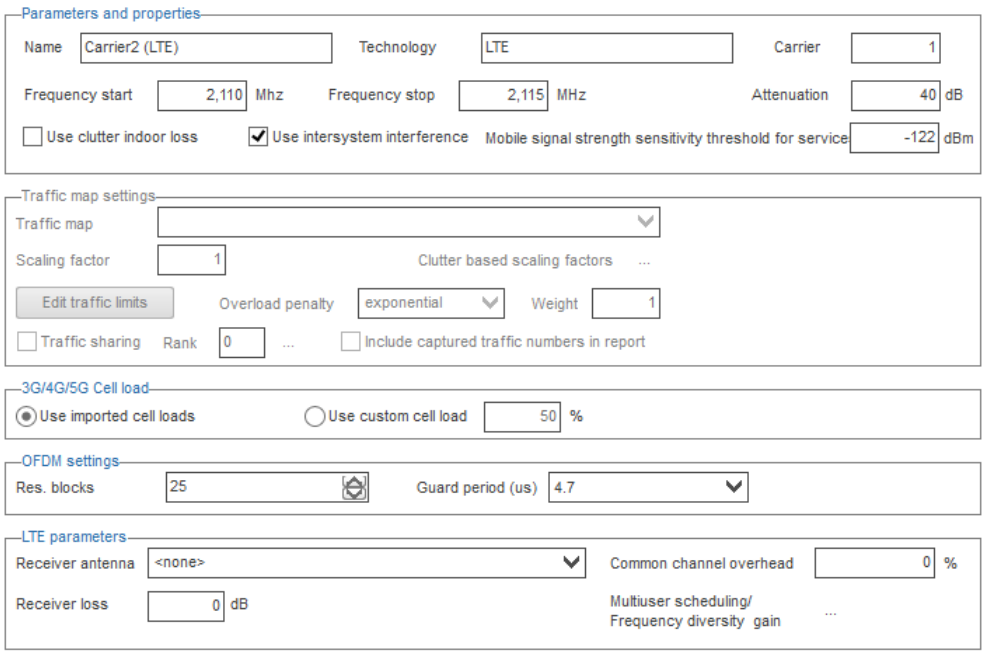
Services

In ASSET Design, '**Service**' is equivalent to a collection of priority-ranked ASSET carriers (carriers belonging to a service in ASSET). There is also a special LTE Frequency Band service, where the ranking of the carriers is equal. The ranking of the carriers appears on the Networks/Services Settings screen and also on the Services page of the optimization report.

The list of services shows the services that are present in the project.

When you launch ASSET Design directly from ASSET, the services from the ASSET project are automatically loaded into ASSET Design.

This picture shows an example:



Example of a service on the Networks/Services screen

You can select a service to view it.

For a description of how services are automatically loaded from ASSET, see How Services are Created from an ASSET Project on page 36. For these particular services, you cannot edit or delete them. However, you can copy a service, and then edit the new one.

You can also create a new service, by clicking the **Add new service** button (at the bottom of the screen).

The services are stored in the project files and can be loaded at any time using the settings import (see Import Settings from Previous Optimization on page 26).

How Services are Created from an ASSET Project

For the definition of a 'Service' in ASSET Design, see Network/Service Settings on page 29.

When launching ASSET Design from an ASSET project, the services that are made available in ASSET Design result from the configuration of the project in ASSET, restricted by the contents of the optimization plan filter. The following criteria provide clarification of the precise rules under which services are created.

Services can be used for the purpose of target definition (see Optimization Targets on page 59).

All services that contain 'used' carriers are loaded. A carrier is considered as 'used' if any cell within the ASSET Design environment has that specific ASSET carrier assigned to it.

So if there is no cell within the ASSET Design environment that uses a specific ASSET carrier, then the carrier is not loaded as part of the service. If a service contains only unused carriers then that particular service is not loaded at all.

Important: For all the criteria below, carriers are completely ignored if they are NOT assigned to any of the cells included in the optimization plan filter. In other words, if a service only contains carriers that are unassigned to those cells, then that particular service is not loaded at all.

Single Technology Services

If a service contains multiple carriers, and they are all of the same technology (either GSM, UMTS, LTE, Wi-Fi or 5G), a service will be made available in ASSET Design for the purpose of target definition.

Multiple Technology Services

If a service contains carriers of multiple technologies (involving any combination of GSM, UMTS, LTE, Wi-Fi or 5G), then a service will be made available in ASSET Design for the purpose of target definition.

All combinations are possible involving at least two different technologies of those listed above.

LTE Frequency Band Services

If the LTE cells coming from ASSET contain different carriers that use the same LTE frequency band, ASSET Design creates an additional separate service. This service creation bears no relation to the service definitions from ASSET; it only considers the carrier assignments on the filtered cells, and the carrier definitions with their frequency band associations. For easy identification, the name of the created service defaults to the original frequency band name in ASSET (for example, *E-UTRA band 1*).

In summary, this creates a service incorporating all the carriers that use a particular frequency band. In this specific case, the carriers are automatically ranked with equal priority.

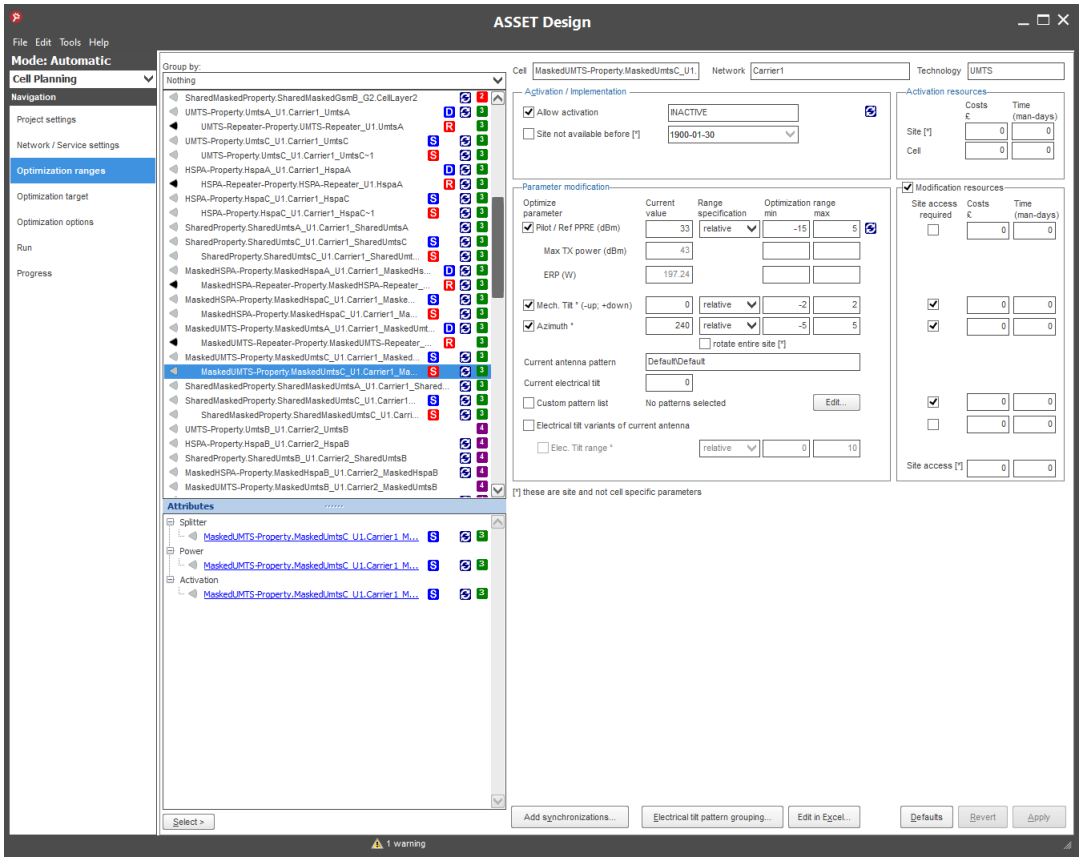
Shortcuts

Shortcuts and hot keys are available to provide easy and quick ways of using the different functions in the tool. See Shortcut Keys on page 16.

6 Optimization Ranges

The **Optimization Ranges** screen enables you to view and manipulate the parameter settings for the optimization process.

This picture shows the ASSET Design interface with the Optimization Ranges screen selected:



ASSET Design interface - Optimization Ranges screen

Cell List

The cell list (in the left pane) displays and describes the cells that can be considered in the optimization process.

If you click in the *Group by* drop-down box at the top, you can choose to group the cells by Site or by Network.

From the list of cells, you can choose which ones to optimize by specifying the cell-specific parameter ranges for the optimization process.

To the right of the cells, there are some colored icons, as in this example:

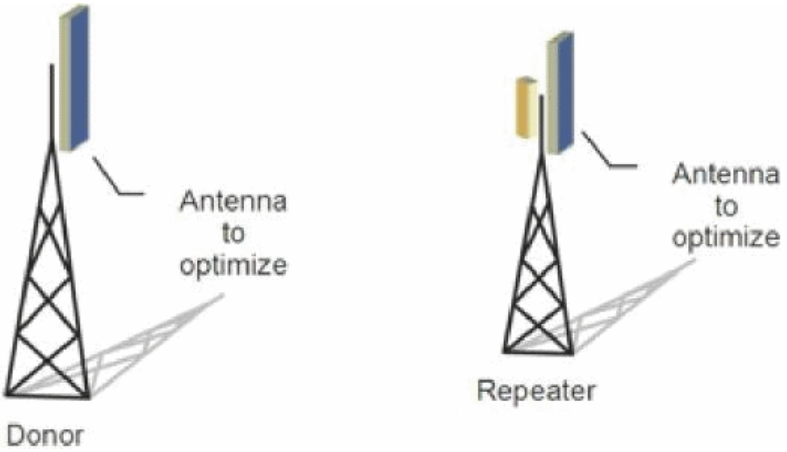
Here is a summary of what the icons represent:

Normal: Cell that uses a single antenna and has no repeaters. It will not be marked with D, R or S.

Donor: Cell marked with D indicates a donor cell. This means it has one or more repeaters.

Repeater: Cell marked with R indicates a repeater cell, which will always be parented to a donor cell.

Splitter: Cell marked with S indicates a splitter cell. This means it uses more than one antenna. The attached splitter(s) are marked with S.



Each repeater belongs to a donor cell. Each donor cell has at least one repeater. The connection of each donor and repeater cell is shown in the Attributes field. Repeaters for CDMA networks typically have a constant gain, while repeaters for GSM networks typically have a constant output power. Consequently, the power levels at the repeater cannot be optimized.

The icon that is shown in the cell list means that a cell is synchronized with another cell. This could involve one or more parameters. This is to show that there are connections to another cell. The specific connections are shown in the **Attributes** window at the bottom left, where (when you click the current cell) it lists the splitter/donor/repeater and the synchronized parameters.

The icon that sometimes appears in the Parameter modification pane shows which specific parameters are synchronized. If you click on the icon in that pane, you will see a list of the cells that are synchronized with the current cell for the same parameter.

For more information, see Shared Antennas and other Synchronized Parameters on page 17.

The network group used by each cell is indicated by different numbers. So for multi system, multi band projects, such as GSM900, GSM1800 and UMTS, this might be 1 2 3 for the different sectors. The number itself does not indicate which specific network the particular cell uses, but it *does* indicate that the cells marked with the same number belong to the same network group.

The following fields (in the right pane) provide additional information about the individual cells of the cell list.

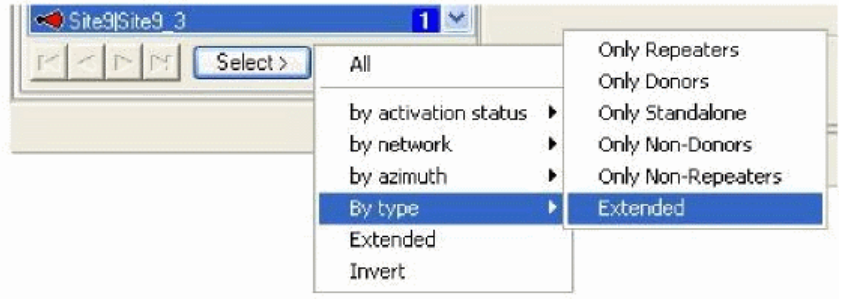
Cell: This field shows the name of the selected cell. If multiple cells are selected, this field shows the number of selected cells.

Network: This field shows the name and type of the network of the selected cell.

Technology: This field displays the technology of the selected cell.

Cell Selection

You can us the **Select >** button to access a variety of cell selection options. These include an 'extended' selection mechanism, allowing you to define your own specific selection criteria.



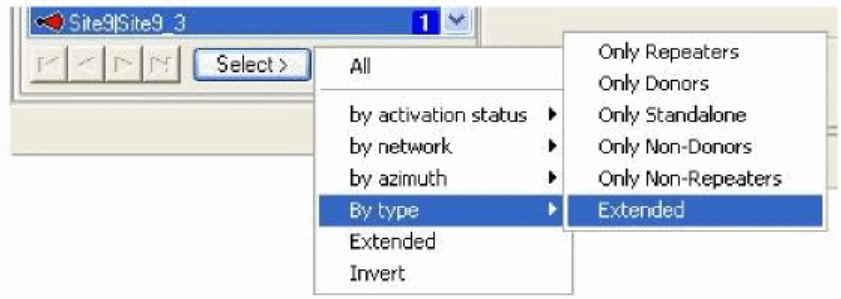
The options are as follows:

Option	Enables You To
All	Select all cells available for optimization.
By activation status	Select active or candidate cells
By network	Select cells of one network.
By azimuth	Select cells in +/- 60° range for various directions.
By type	Select cells by their donor/repeater status.
By technology	Select cells by their technology.
By ASSET filter	Import an ASSET filter and select the corresponding cells.
Newly placed cells	Select cells that were created by the Site Placement mode.
Extended	Open the extended selection dialog box. See Extended Cell Selection on page 39.
Invert	Invert the current selection.

A cell selection can be saved to and loaded from a file. A cell selection can also be saved to an ASSET filter file. Optionally, Properties, nodes and cells can be saved to the filter file.

Extended Cell Selection

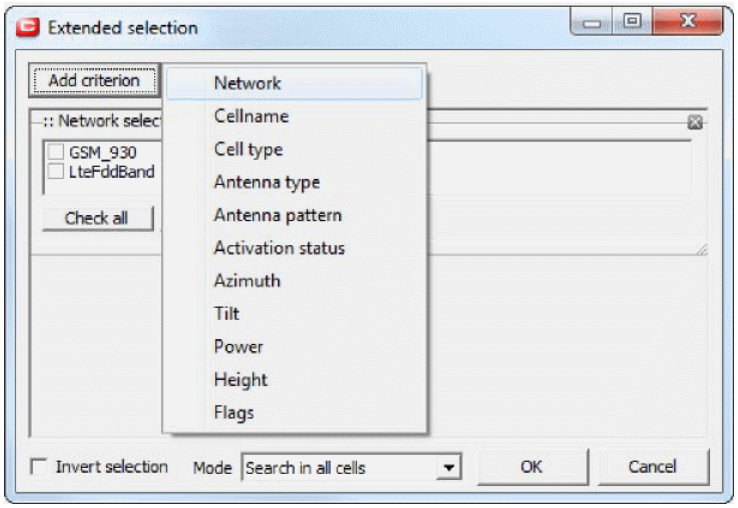
After you click the **Select >** button at the bottom of the Cell List, you have an option to choose **Extended** from the menu.



If you click **Extended** in the first menu, the **Extended selection** dialog opens with default settings (or with last-used settings).

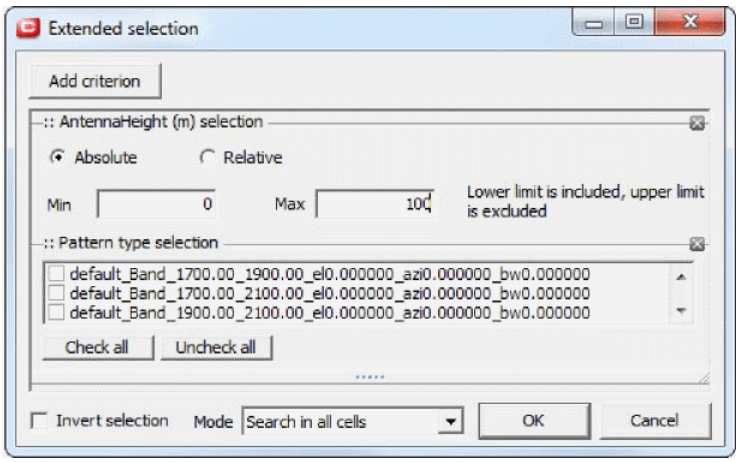
If you click it in one of the sub-menus, the dialog opens with the corresponding parameter preselected.

Within the **Extended selection** dialog, you can add as many criteria as you like by clicking the **Add criterion** button:



For example, if you add 'Network', you have the flexibility to restrict the selection operation to chosen networks or use all networks in the project.

This picture shows an example of the Extended selection dialog:



For items such as Azimuth, Tilt, Power, Height, the options are as follows:

Option	Enables You To
Absolute/Relative	Specify absolute or relative selection.
Absolute: Min/Max	Set the absolute selection range. The rule applied is (min <= sector_value < max). The upper limit is not included so as to allow distinct azimuth selections.
Relative: Value/Delta	Set the relative selection range. The rule is (value-delta <= sector_value < value+delta). The upper limit is not included to allow distinct azimuth selections.
Invert selection	Invert the specified criteria including the network selection. Inversion is executed before applying the search mode.

Option	Enables You To
Search mode	Three different search modes are available: • Search in all cells: the algorithm is applied to all cells and the current selection is replaced. • Search in selected cells: the algorithm is applied to the selected cells only, cells not fulfilling the criteria are removed from the selection. • Add to selected cells: the algorithm is applied to the non-selected cells, cells meeting the criteria are added to the selection.

Non-numeric parameter values can be selected in a list window. Unwanted criteria can be removed by pressing the *x* button on the top right side of each criterion. Criteria containing a list can be resized by pulling the dotted element on the bottom of each criterion pane.

Using the Apply and Revert Buttons (Cell List Locking)

When you make a change to one of the parameters in the **Optimization Ranges** screen for the selected cell (or cells), ASSET Design automatically sets a lock on the list of cells so that changes can only be made to the selected cell(s).

At this stage, when you have finished making your changes, you must either:

- Click the **Apply** button to save the parameter changes

  -or -

- Click the **Revert** button to cancel the changes

When you have done this, the list of cells is unlocked, and you can then select a new cell or cells to repeat the procedure.

Activation / Implementation Parameters

The **Activation / Implementation** pane enables you to view and manipulate the parameter settings for the site (cell) activation process during the optimization:

Option	Description
Allow activation	This checkbox is only editable if the current status of the transmitter (cell) is INACTIVE. This means that it has to be inactive in ASSET before creating an optimization environment. Active transmitters are not considered during the activation process. If the transmitter is inactive, you can enable this checkbox to allow the activation of this transmitter during the optimization. The field to the right of the checkbox displays the current status of an individual cell. It can be ACTIVE or INACTIVE. If all sectors of the list are selected, this field shows the number of active and inactive cells.

Option	Description
Site not available before [*]	You can enter a date for when the site will become available. This checkbox is editable if the current status of the transmitter (cell) is INACTIVE and the 'Allow activation' checkbox is enabled. This means that availability restrictions can only apply to inactive transmitters considered in the optimization process. You can enable this checkbox to consider the availability of this transmitter during the optimization. The drop-down box to the right of the checkbox allows you to select the date of availability in for this transmitter. The format for the date is given in ISO international standard date notation YYYY-MM-DD. For more information on this availability restriction, see below.

The availability restriction allows you to optimize your network that includes sites not yet available. Examples for such scenarios are:

- Availability of site permissions
- Site construction to be finished
- Equipment not yet available
- Site access permissions
- Availability of advanced RF technologies, such as tower mounted boosters

It may also be the case that additional sites are planned for a network extension phase some years in the future.

The availability restriction helps to optimize the radio network including sites that will be available in future, as well as future technologies.

Note: To learn more about the availability restrictions and the impact on the implementation plan, see Implementation Plan Details on page 100. There are some examples to help you understand how to use this.

Warning:

- During the optimization the individual sites will not be activated just because they are available. Sites are only activated if they provide a sufficient benefit to the overall network performance. Hence the availability of a site has a major impact on the implementation plan, in terms of when can this site be implemented to the network.
- Any parameter marked with [*] indicates that this parameter is SITE specific rather than cell specific. This means that changing such a parameter on a per cell basis will automatically change this parameter at the other cells (of the same site) to the same value. If you edit these parameters in Excel (see also Editing Parameters in Microsoft Excel on page 57) you can define different values for the individual cells. However, when re-importing them, the parameters of all cells will be adjusted to the value of the first cell at that specific site (if the values are different).

Activation Resources

The **Activation Resources** pane enables you to define cell-specific costs associated with the activation of an inactive site or cell.

The activation resources are split into two categories. **Site Costs/Time** and **Cell Costs/Time**:

Option	Description
Site [*]	The costs and time required to prepare the site for the activation of a new transmitter. They do not include the costs (and time) to install a new cell. **Costs:** The expected expense of site activation. **Time:** The associated amount of time in man-days required to implement site activation.
Cell	The costs and time to install (activate) a new cell on a specific site. **Costs:** The expected expense of cell activation. **Time:** The associated amount of time in man-days required to implement cell activation (on the site).

The Total Costs (and Time) are the sum of the Site Costs (Time) and the individual Cell Costs (Time).

Default values for the costs and time parameters are defined in the Range Defaults tab of the **Preferences** dialog box. Default values are applied to parameters when the **Load network data** button is clicked on the Project Settings screen. The currency for the cost data is defined in the General tab of the **Preferences** dialog box. The default value for currency is the one defined in the Regional and Language Options in the Windows Control Panel.

Warning: Any parameter marked with [*] indicates that this parameter is SITE specific rather than cell specific. This means that changing such a parameter on a per cell basis will automatically change this parameter at the other cells (of the same site) to the same value. If you edit these parameters in Excel (see also Editing Parameters in Microsoft Excel on page 57) you can define different values for the individual cells. However, when re-importing them, the parameters of all cells will be adjusted to the value of the first cell at that specific site (if the values are different).

Example

If the physical mast already exists, e.g. because it is used for an existing GSM network, then the Site Costs (and Time) are the costs and time required to upgrade the existing site to install (activate) a new cell.

The Cell Costs (and Time) consider the costs for the deployment of a new cell, i.e. it includes costs like the RF equipment, installation, etc.

The TOTAL costs assigned to the activation (deployment) of a new site with 3 sectors are hence: 1 x Site Costs + Costs Cell 1 + Costs Cell 2 + Costs Cell 3.

If the site already exists, e.g. one or more cells are already active at this site, only the Cell Costs will be considered; no additional costs for the site activation apply.

Parameter Modification

The **Parameter Modification** pane enables you to define sector-specific parameter ranges for the optimization process.

Default values for the parameters to optimize are defined in the Range Defaults tab of the **Preferences** dialog box. Default values are applied to parameters when the **Load network data** button is clicked in the Project Settings.

For each of the optimization parameters (Power, Mech. Tilt, Azimuth and so on), you can select the checkbox to enable modification of the parameter during the optimization process.

The options in the Parameter Modification pane are presented in the following two sections:

- Power, Mechanical Tilt and Azimuth
- Antenna Pattern and Electrical Tilt

Power, Mechanical Tilt and Azimuth

The **Parameter Modification** pane contains a variety of parameters to optimize.

The table below shows the parameters relating to Power, Mechanical Tilt and Azimuth.

Note: The parameters will only be used in the optimization if their corresponding checkbox is enabled.

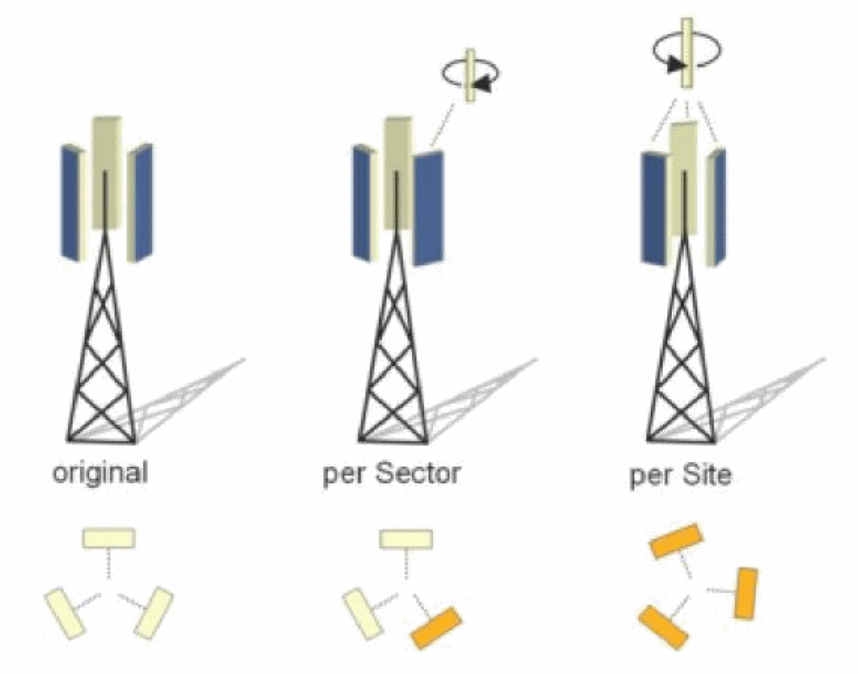
Option	Description
Power	**Current Value** for the pilot power parameter. The three read-only values under the Current Value column are: • Pilot / Ref PPRE (dBm)* • Max TX Power (dBm) • ERP (W) (due to beam-switching, ERP is not shown for 5G cells) *The Pilot / Ref PPRE parameter equates to: • GSM: BCCH / PA Power • UMTS: Pilot Power • LTE: RS-PPRE • 5G: SSS-PBCH power You can edit the Pilot / Ref PPRE value in the following columns: **Range Specification**: - Relative (relative to the current value) - Absolute (absolute value range) **Optimization Range**: - Min (minimum value) - Max (maximum value)

Option	Description
Mechanical Tilt *	**Current Value** for the mechanical antenna tilt parameter. **Range Specification**: - Relative (relative to the current value) - Absolute (absolute value range) **Optimization Range**: - Min (minimum value) - Max (maximum value)
Azimuth *	**Current Value** for the antenna azimuth parameter. **Range Specification**: - Relative (relative to the current value) - Absolute (absolute value range) **Optimization Range**: - Min (minimum value) - Max (maximum value) **Note**: For absolute values, the antenna azimuth 0° represents North. This means that negative values can also be used, since the optimization requires a range of possible angles. An absolute range of minimum -60° to maximum 60° is the range from 60° West to 60° East of the North. The maximum range for absolute azimuth settings is [-360°...360°]. All other values can be expressed within this range. **Rotate Entire Site***: If you select this checkbox, the tightest limitation of all sector setting on that site will be used for the limitation of the site rotation. For example: Sector 1: +/- 10°; Sector 2: +/-15°; Sector 3: +/-20°. If you enable Rotate Entire Site on Sector 3, this will lead to a maximum rotation of the entire site of +/-10°. For more information, see Antenna Azimuth on page 46.

Warning: Any parameter marked with [*] indicates that this parameter is SITE specific rather than cell specific. This means that changing such a parameter on a per cell basis will automatically change this parameter at the other cells (of the same site) to the same value. If you edit these parameters in Excel (see also Editing Parameters in Microsoft Excel on page 57) you can define different values for the individual cells. However, when re-importing them, the parameters of all cells will be adjusted to the value of the first cell at that specific site (if the values are different).

Antenna Azimuth

The antenna azimuth can be modified in a sector-per-sector specific manner. Sometimes the azimuth of a single sector cannot be modified, e.g. TriSector antennas (3 sector antennas within a single radome). Therefore, with ASSET Design you can either allow azimuth modifications per sector, or you can force the optimization algorithm to rotate the entire site.



Warning:

- Any parameter marked with [*] indicates that this parameter is SITE specific rather than cell specific. This means that changing such a parameter on a per cell basis will automatically change this parameter at the other cells (of the same site) to the same value. If you edit these parameters in Excel (see also Editing Parameters in Microsoft Excel on page 57) you can define different values for the individual cells. However, when re-importing them, the parameters of all cells will be adjusted to the value of the first cell at that specific site (if the values are different).
- If the pathloss prediction of a sector was done with a propagation model that provides masked pathloss values (e.g. ray-tracing models), then the azimuth range should be limited to +-5° relative to the current value at maximum, mechanical tilt changes should be limited to +-2°, and power changes can be done without further limitation. Any other parameter modification should be avoided (like pattern swaps). Warnings will be presented if these limits are violated. Use the extended selection functionality to select sectors distinguished by the propagation model.

Antenna Pattern and Electrical Tilt (Non-5G)

Note: This topic relates to all technologies except 5G. For 5G, see Antenna and Electrical Tilt (5G only) on page 49.

The **Parameter Modification** pane contains a variety of parameters to optimize.

This table shows the parameters relating to Antenna Pattern and Electrical Tilt.

There are two ways of allowing different antenna patterns (pattern exchanges) in the optimization process:

- Electrical tilt (different electrical tilts are represented by different antenna patterns)
- Antenna type (different antenna types are represented by different antenna patterns)

Both methods can be done separately or combined. This means that both the electrical and mechanical antenna tilts can be changed for a given antenna, and the physical antenna can be exchanged. The physical antennas can have multiple electrical tilt pattern, which are considered as well when the physical antenna is exchanged.

Note: The parameters will only be used in the optimization if their corresponding checkbox is enabled.

Option	Description
Current antenna pattern	The currently used value for informational purposes.
Current electrical tilt	The currently used value for informational purposes.
Custom pattern list	This option allows modifications of the antenna pattern. Next to the checkbox, ASSET Design displays the number of selected antenna patterns that are allowed for exchange during optimization. All antenna patterns in an ASSET project can be used, or you can edit the list, as below: **Edit**: Click this button to use the Antenna Selection Editor for further definition of the antenna parameters used in the optimization. For more information, see Antenna Pattern Selection Editor on page 51.
Electrical tilt variants of current antenna	This option allows modifications of the electrical tilts for the current antenna pattern. You can edit the available electrical tilt patterns by clicking the 'Electrical tilt pattern grouping' button (bottom of screen). See Electrical Tilt Pattern Grouping Editor on page 54.
Electrical Tilt range [*]	If you select this checkbox, only patterns whose electrical tilts fall within the range given by the min and max fields next to the checkbox will be used for exchange. This range can be absolute or relative to the current value according to the selected option. **Note**: When you export your data from ASSET into ASSET Design, the ranges you see here will default to the Minimum and Maximum Electrical Tilt values that were set for the cells' antennas in ASSET, but only if those antennas also had the Minimum and Maximum Electrical Tilt Fixed checkboxes selected. If this is the case, the 'Elec Tilt range' checkbox will be automatically selected.

Any parameter marked with [*] indicates that this parameter is SITE specific rather than cell specific. This means that changing such a parameter on a per cell basis will automatically change this parameter at the other cells (of the same site) to the same value. If you edit these parameters in Excel (see also Editing Parameters in Microsoft Excel on page 57) you can define different values for the individual cells. However, when re-importing them, the parameters of all cells will be adjusted to the value of the first cell at that specific site (if the values are different).

Note: If the 'Custom pattern list' and 'Electrical tilt variants' options are both enabled, ASSET Design will consider both. For examples of this, see Examples of Antenna Pattern and Electrical Tilt (Non-5G) on page 48.

Examples of Antenna Pattern and Electrical Tilt (Non-5G)

Here are some examples of different combinations of Antenna Pattern and Electrical Tilt options enabled in the **Parameter Modification** pane:

Example 1

Only Electrical tilt variants: Consider that only the Electrical tilt variants of current pattern are enabled. This means that during the optimization process only the electrical tilt changes are considered, but not the change of the antenna type. Furthermore, the electrical tilt variants can be reduced to a set of tilt variants. For example, if you want to allow a limited range of electrical tilts in the first roll-out (and keep the remaining electrical tilts for later adjustments during the network life cycle). This can be done by grouping only the limited number of electrical tilt pattern to the current antenna type by using the Electrical Tilt Grouping Editor (see Electrical Tilt Pattern Grouping Editor on page 54).

Example 2

Only Custom pattern list: We now consider that only the *Custom pattern list* is enabled. This means that during the optimization process only those pattern are considered that are included in the list. The selected antenna pattern are displayed in the associated list. This list can be edited by using the Antenna Selection Editor.

The definition of the grouping of the individual antenna pattern as electrical tilt variants of the same antenna type, i.e. which pattern belong to the same antenna, happens in the Electrical Tilt Grouping Editor. Whatever pattern are then selected for the custom pattern list, the algorithms automatically check if these pattern are electrical tilt variants of the current antenna pattern (based on the grouping in the Electrical Tilt Grouping Editor). Thus it can be ensured that a change in the electrical tilt will not result in higher costs associated to the exchange of a physical antenna type.

Example 3

Electrical tilt variants AND Custom pattern list: We now consider that both the *Electrical tilt variants of current pattern* and the *Custom pattern list* are enabled. This means that the best available antenna pattern will be found during the optimization process. Of course, all resource constraints will be considered as well.

Antenna and Electrical Tilt (5G only)

Note: This topic relates only to 5G.

The **Parameter Modification** pane contains a variety of parameters to optimize.

This table shows the parameters relating to Antenna and Electrical Tilt.

Option	Description
Current antenna	The currently used beam set for informational purposes.
Current electrical tilt	The currently used value for informational purposes.

5G Beam Sets

A beam set is a defined group of patterns that will be used by a 5G switched-beam antenna device.

ASSET supports beam sets and ASSET Design also supports beam sets.

However, one difference is that in ASSET, one beam set can contain patterns from different frequency groups. In ASSET Design, each beam set can only contain patterns of a single frequency band. Therefore, a beam set from ASSET containing patterns of two bands would be presented in ASSET Design as two separate beam sets.

A beam set in ASSET Design is presented in a specific way. Here is an example:

For more information on beam sets in ASSET design, see Beam Set Information in the Antenna Pattern Selection Editor on page 52.

Modification Resources

The **Modification Resources** pane enables you to define cell-specific costs associated to the implementation of the parameter modifications.

For example, changing the azimuth of an antenna may require a person to visit the site. Other parameters, such as power modifications, can be done remotely from the operation and maintenance center.

Default values for the costs and time parameters are defined in the Range Defaults tab of the **Preferences** dialog box. Default values are applied to parameters when the **Load network data** button is clicked on the Project Settings screen. The currency for the cost data is defined in the General tab of the **Preferences** dialog box. The default value for currency is the one defined in the Regional and Language Options in the Windows Control Panel.

The costs associated to parameter modifications of a cell are split into Site Access costs, which include costs to access the site (such as the use of a crane, permission costs), and the actual costs of the parameter modifications, that is, for the actual change of an RF parameter.

Synchronized cells automatically have their costs synchronized.

Note: Cells that have costs assigned but do not have the **Modification Resources** checkbox enabled will not use costs in the optimization process.

This table shows the Modification Resources parameters:

Option	Description
Modification Resources	This is the overall checkbox that enables the other settings and activates the costs in the optimization. **Note**: Cells that have costs assigned but do not have this checkbox enabled will not use costs in the optimization process.
Site Access Required	Enable the checkbox for the corresponding parameter (Power, Mech Tilt, Azimuth and so on) when it is necessary to visit the site to implement that parameter modification. **Costs:** Specify the expected expense of implementing the modification. **Time:** Specify the associated amount of time in man-days required to implement the modification.
Site Access [*]	**Costs and Time:** Site access costs occur only once per site, regardless of the number of sectors that are being changed. Site access costs could be different for the individual sectors if the sectors are not co-located. Therefore, the value you enter to ASSET Design should be the highest access costs per site for the optimization.

Warning: Any parameter marked with [*] indicates that this parameter is SITE specific rather than cell specific. This means that changing such a parameter on a per cell basis will automatically change this parameter at the other cells (of the same site) to the same value. If you edit these parameters in Excel (see also Editing Parameters in Microsoft Excel on page 57) you can define different values for the individual cells. However, when re-importing them, the parameters of all cells will be adjusted to the value of the first cell at that specific site (if the values are different).

Editing Options

At the bottom of the **Optimization Ranges** screen, there are several buttons:

Button	You can use this option to
Add synchronizations	Add synchronization parameters. See Adding Synchronization Parameters on page 53.
Electrical tilt pattern grouping	Group the antenna pattern associated to a single physical antenna. For further details on this functionality see Electrical Tilt Pattern Grouping Editor on page 54.
Export to Excel **Import from Excel**	Edit any or all of the parameters in the Optimization Ranges screen within Microsoft Excel. Editing the parameters in Excel provides significant flexibility and convenience to the parameter input. For further information, features and limitations, see Editing Parameters in Microsoft Excel on page 57.
Defaults	Change all parameter settings (parameter settings as well as costs and time) for the selected cell(s) back to their default values. The default values can be set on the Range Defaults tab of the **Preferences** dialog box.
Revert	Change all parameter settings (parameter settings as well as costs and time) for the chosen cells back to their previous values.
Apply	Apply all parameter changes (parameter settings as well as costs and time) to the chosen cells.

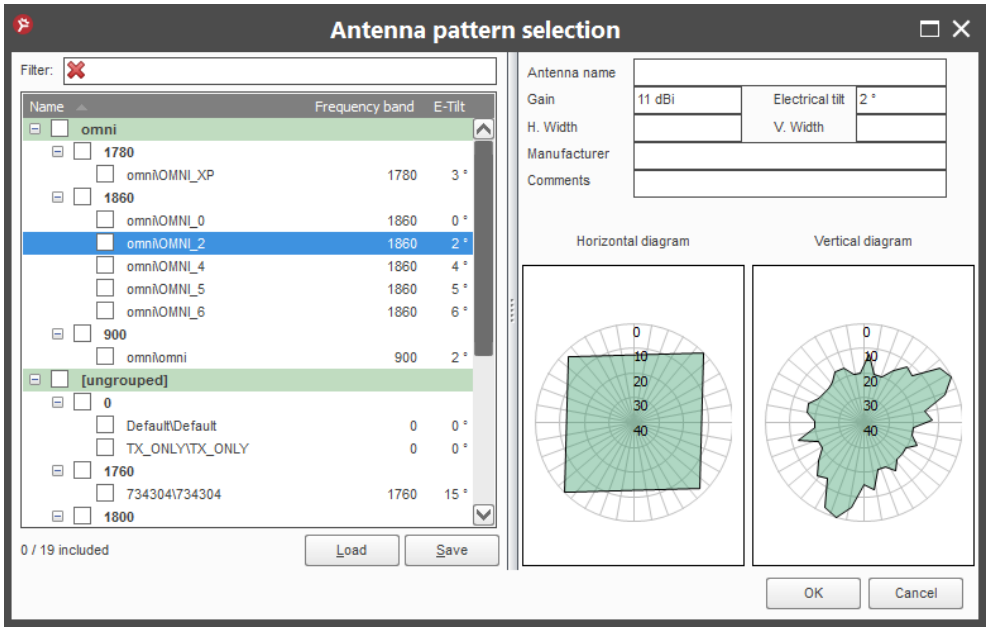
For more information on the Revert and Apply buttons, see Using the Apply and Revert Buttons (Cell List Locking) on page 41.

Antenna Pattern Selection Editor

Use this editor to view and modify the antenna pattern selection for the optimization process in ASSET Design.

Note: You can only do this for non-5G technologies. For 5G, the switched-beam antenna devices are already determined from the project data, and, in Cell Planning mode, cannot be changed. See Beam Set Information in the Antenna Pattern Selection Editor on page 52.

Here is an example of the Antenna Pattern Selection Editor:



Antenna Pattern Selection Editor

When you click on an individual pattern, you can see a display of its parameters:

- Antenna Name
- Antenna Gain
- Electrical Tilt
- Antenna Manufacturer
- Comments
- Horizontal antenna pattern diagram
- Vertical antenna pattern diagram

In the **Parameter Modification** pane, alongside the Custom pattern list checkbox, ASSET Design displays the number of selected antenna patterns that are allowed for exchange during optimization. All antenna patterns in an ASSET project can be used, or you can edit the list.

To edit the list:

1. Click the **Edit** button.

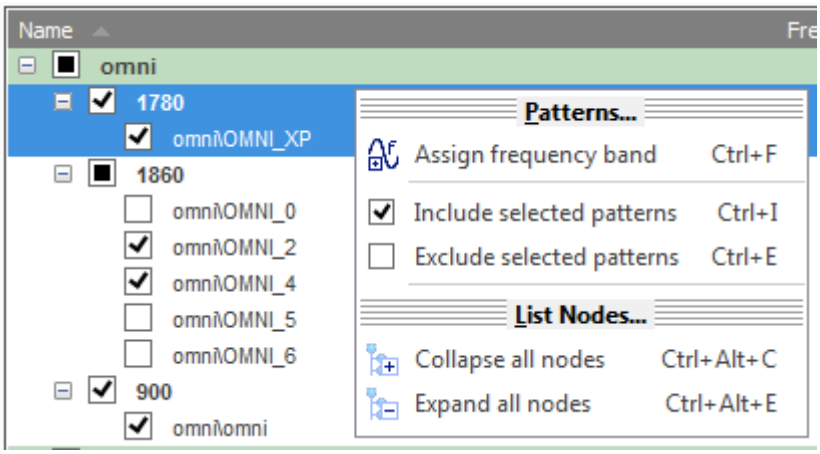
   The **Antenna pattern selection** dialog box appears.

2. In the left pane, use the checkboxes to select the patterns that you want to be considered for exchange during the optimization.

   (The number in the lower left corner indicates the number of antenna patterns selected.)

Other Editing Options

If you right-click on any of the patterns (this can be a multiple selection), a context menu appears:



It offers the following options:

Option	Description
Assign frequency band	You can assign a frequency band to an antenna pattern to allow sub-grouping of patterns within an antenna. Frequency band values can be alphanumeric (such as 1800/GSM/2100LTE). You can choose an existing band from the drop-down list, or type a new one. **Note**: The exact value of the frequency band is not used by ASSET Design, but the optimization will only allow antenna patterns with the same frequency band as the original sector to be selected.
Include selected patterns	Quick way to select the required patterns (if you highlight them first).
Exclude selected patterns	Quick way to select the required patterns (if you highlight them first).
Collapse all nodes	If ungrouped antenna patterns are grouped by frequency band, all nodes will be collapsed.
Expand all nodes	If ungrouped antenna patterns are grouped by frequency band, all nodes will be expanded.

Beam Set Information in the Antenna Pattern Selection Editor

The Antenna Pattern Selection editor contains normal (passive) antennas for non-5G, but it can also contain 5G switched-beam antennas, which it stores in beam sets.

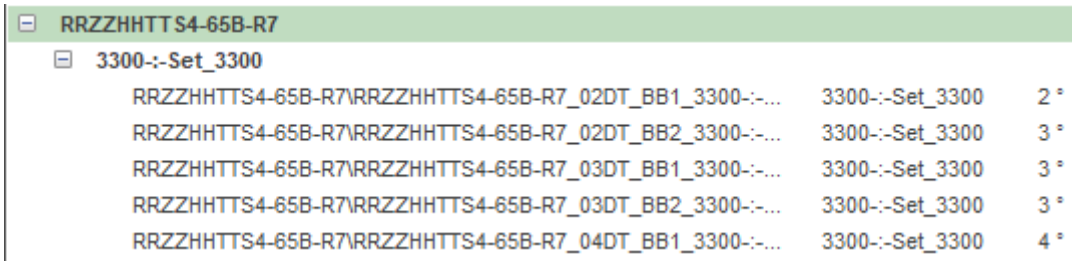
5G Beam Sets

A beam set is a defined group of patterns that will be used by a 5G switched-beam antenna device.

ASSET supports beam sets and ASSET Design also supports beam sets.

However, one difference is that in ASSET, one beam set can contain patterns from different frequency groups. In ASSET Design, each beam set can only contain patterns of a single frequency band. Therefore, a beam set from ASSET containing patterns of two bands would be presented in ASSET Design as two separate beam sets.

A beam set appears in the Antenna Pattern Selection editor in a specific way. This picture shows an example:



In the above example, "RRZZHHTT S4-65B-R7" is the name of the switched-beam antenna device, and "3300-:-Set_3300" is the name of the beam set, where:

- '3300' names the Frequency Band
- '-:-' acts as a delimiter
- 'Set_3300' names the Beam Set

Note: Another delimiter that is used is '|'. For this reason, '-:-' and '|' are not permitted in the antenna device name, pattern name, frequency band name, or beam set name.

And this is how the above antenna device would appear on the Optimization Ranges screen for a cell when in Cell Planning mode:

Adding Synchronization Parameters

At the bottom of the **Optimization Ranges** screen, there is a button named **Add synchronizations**. You can click this button to synchronize cell parameters for cells already share similar characteristics (see note below).

Note: Cell parameters can only be synchronized if cells are on the same site, have the same azimuth, tilt, height and antenna.

To add synchronizations:

1. Select the cells for which you want to change synchronization parameters.
2. Click the **Add synchronizations** button.

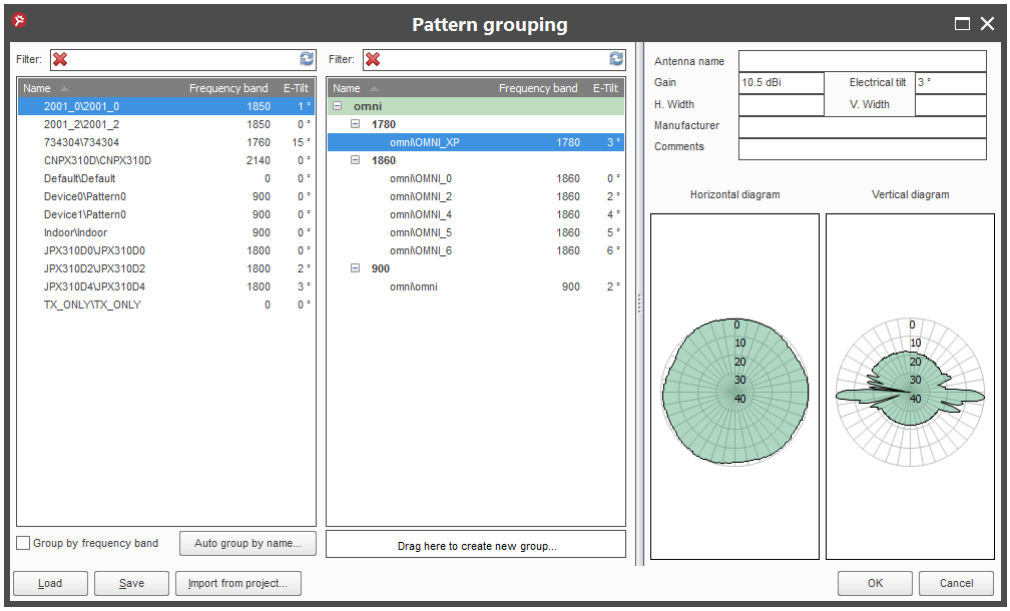
   The left pane of the **Add synchronizations** dialog box lists the groups of cells that can be synchronized.
3. On the right, you can add additional parameter synchronizations to the existing ones.
4. Click **OK**.

For more information about synchronization, including how to remove parameter synchronizations from a cell, see Multi System Parameter Synchronization on page 148.

Electrical Tilt Pattern Grouping Editor

At the bottom of the **Optimization Ranges** screen, there is a button named **Electrical tilt pattern grouping**. You can click this button to view and modify the electrical tilt pattern grouping for the optimization process in ASSET Design.

In addition to grouping antenna patterns, you can also save, load and import (from a project) lists of available antenna patterns:



Pattern Grouping Editor

There are three panes:

- Left pane lists the 'ungrouped antenna patterns'. See Ungrouped Antenna Patterns on page 55.
- Middle pane list the 'grouped antenna patterns'. See Grouped Antenna Patterns (Electrical Tilt Groups) on page 56.
- Right pane: when you click on an individual pattern, you can see a display of its parameters:
  - Antenna Name
  - Antenna Gain
  - Electrical Tilt
  - Antenna Manufacturer
  - Comments
  - Horizontal antenna pattern diagram
  - Vertical antenna pattern diagram

Ungrouped Antenna Patterns

The left pane of the **Pattern Grouping Editor** lists all ungrouped antenna patterns and their frequency band (if they have one assigned). The context menu (right click) offers several options.

Editing Options

If you right-click on any of the patterns (this can be a multiple selection), a context menu offers the following options:

Option	Description
Assign frequency band	You can assign a frequency band to an antenna pattern to allow sub-grouping of patterns within an antenna. Frequency band values can be alphanumeric (such as 1800/GSM/2100LTE). **Note**: The exact value of the frequency band is not used by ASSET Design, but the optimization will only allow antenna patterns with the same frequency band as the original sector to be selected.
Auto group by name	Opens another dialog box (which is also available via the 'Auto group by name' button at the bottom of the pane). This will automatically group antenna patterns according to their names. An antenna group will be created for all antenna pattern names that are identical on *n* characters. Prefix length: Sets the number of characters that have to be identical for patterns to be in the same group. Case sensitive: Determines whether the name comparison is case sensitive.
Group by frequency band	The display of the ungrouped antenna patterns will be grouped by their frequency name.

There is also a checkbox and button at the bottom of the left pane:

Option	Description
Group by frequency band	Change the display of the ungrouped antenna patterns so that they are grouped by their frequency name. You can switch back to the non-grouped list by de-selecting the checkbox.
Auto group by name	Function of this button is already described in the previous table.

Grouped Antenna Patterns (Electrical Tilt Groups)

The middle pane of the **Pattern Grouping Editor** lists all grouped antenna patterns and their frequency band. The context menu (right click) offers several options.

Editing Options

If you right-click on any of the patterns (this can be a multiple selection), a context menu offers the following options:

Option	Description
Assign frequency band	You can assign a frequency band to an antenna pattern to allow sub-grouping of patterns within an antenna. Frequency band values can be alphanumeric (such as 1800/GSM/2100LTE). **Tip**: The frequency band of already grouped antenna patterns can be changed in bulk by clicking F2 on the frequency band group name or clicking the name a second time. **Note**: The exact value of the frequency band is not used by ASSET Design, but the optimization will only allow antenna patterns with the same frequency band as the original sector to be selected. *Example*: A multi band antenna is defined which includes remote electrical tilts that can be modified for the 1800MHz and the UMTS band individually. Therefore, different antenna patterns for the different bands are available. In order to make sure that the RET change is done only in the correct frequency band, the patterns for the 1800MHz band are identified by the "1800" frequency band allocation. The UMTS patterns are marked by the "2000" identification. Thus, the optimization algorithms in ASSET Design will make sure that the correct antenna patterns are used.
Ungroup	Ungroups the selected antenna pattern and puts it in the list of ungrouped patterns.
Ungroup all	Ungroups all patterns and moves them to the list of ungrouped patterns.
Collapse all nodes	All antenna pattern groups and frequency bands will be collapsed.
Expand all nodes:	All antenna pattern groups and frequency bands will be expanded.
Rename current node	Allows renaming of the current frequency or group name field.

Creating New Groups and Mapping Antenna Patterns

In the **Pattern Grouping Editor** you can easily create a new antenna pattern group.

To do this:

1. In the left pane, highlight the antenna pattern(s) that you want to group.
2. Drag and drop your selection of antennas onto the box "Drag here to create new group" (which is at the bottom of the middle pane).
3. The name of the new antenna pattern group will automatically be the name of your antenna pattern. The name of the antenna pattern group can always be changed by pressing F2 or clicking the name a second time.

Alternatively, you can drag and drop antenna patterns from the left pane to the required antenna pattern group. If you drop the pattern on the group name the initial frequency band of the pattern will stay the same and if necessary a new frequency band sub-group will be created. If you drop the antenna pattern on a frequency band sub-group, the antenna pattern will be assigned with the frequency band of that group.

Editing Parameters in Microsoft Excel

At the bottom of the **Optimization Ranges** screen, there are two buttons: **Export to Excel** and **Import from Excel**.

This allows you to edit the data in Microsoft Excel (assuming it is installed on your computer).

- **Export to Excel**

  This saves an Excel workbook containing all relevant parameter settings, and launches Excel with this workbook loaded.

- I**mport from Excel**

  This allows you to import the new parameter values after saving and closing the workbook.

  ASSET Design will inform you when it has successfully imported the parameter changes.

  After successful import you still need to apply the parameter modifications by clicking the **Apply** button at the bottom-right of the Optimization Ranges screen.

  If the data import from Excel was not successful, the parameter settings in ASSET Design remain unchanged.

Additional Functions when using Excel with ASSET Design

The 'Export to Excel' and 'Import from Excel' functionality has some additional functions that can be very useful.

- While editing in Excel, you are allowed to change the order of the columns.
- All fields that should not be modified have a dark gray background color.
- You are also allowed to include NEW columns. This might be necessary when additional cost calculations are required. After saving the modified workbook, ASSET Design only re-imports the relevant data.
- You can also include formulas. This allows you to access external databases where, for example, data for the cost and time parameters for the implementation of the parameter modifications might be stored.
- Boolean parameters can always be called TRUE and FALSE, independent of local language settings. ASSET Design will recognize them correctly for the re-import.
- ASSET Design automatically identifies if the parameters have been modified in Excel.
- The column titles and the columns for site and sector ID are fixed in Excel for simple data identification.
- A description of each data column is given by notes in the column title.
- A list of all available antenna patterns is provided in a separate Excel worksheet.
- For better visibility, all used antenna pattern are separated by "|" in the parameter list.

Limitations when using Excel with ASSET Design

Some limitations apply to the modifications in Excel:

- You cannot change or remove the header line (column title).
- You cannot modify or remove key properties such as site name, sector name, and so on.
- You cannot add new lines.

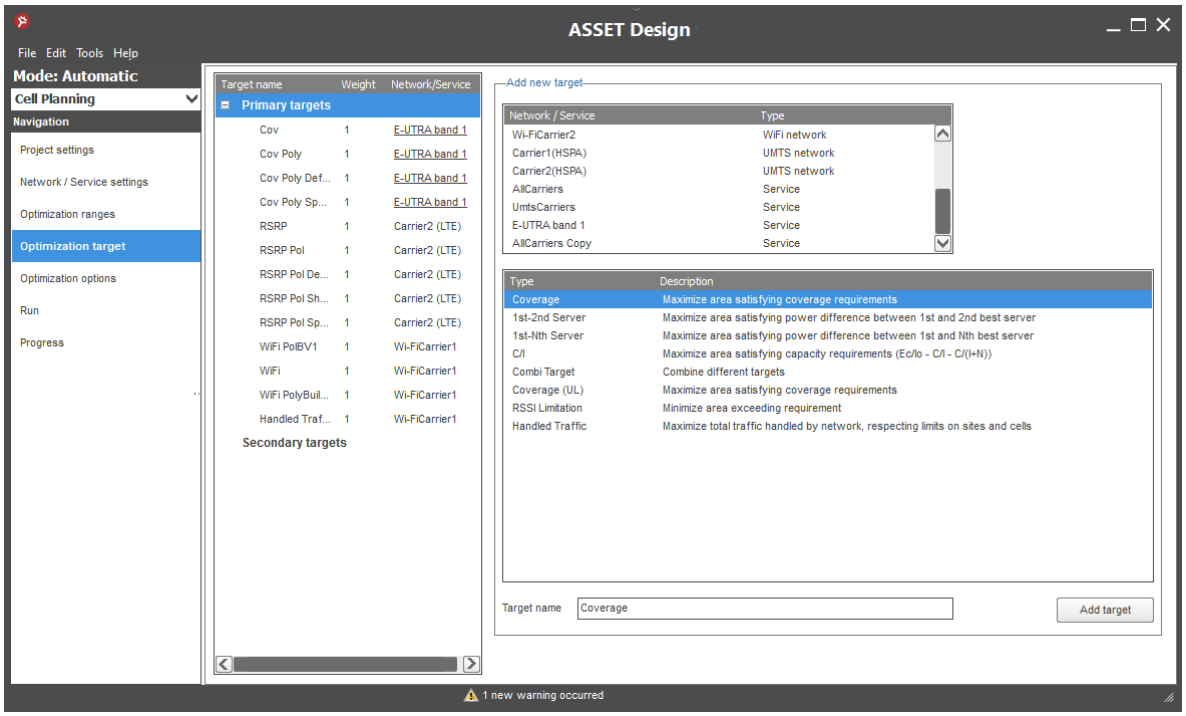
If you change parameter values that cannot be modified, the changes are ignored.

Each file will be checked during re-import. If errors or warnings occur, the data remains unchanged.

7 Optimization Targets

Here you can create, view and edit the targets for the optimization process.

This picture shows the ASSET Design interface with the Optimization Target screen selected:



ASSET Design interface - Optimization Target screen

Defining Targets

One or several target functions can be defined. Targets can be defined for networks and/or services.

Each target you create belongs uniquely to a particular network or service.

In ASSET Design:

- '**Network**' is equivalent to a carrier in ASSET (that is a technology-specific carrier with its accompanying attributes, such as bandwidth). Examples would be a UMTS carrier, LTE carrier, 5G carrier and so on. For GSM, the example would be a frequency band.
- '**Service**' is equivalent to a collection of priority-ranked ASSET carriers (carriers belonging to a service in ASSET). There is also a special LTE Frequency Band service, where the ranking of the carriers is equal. The ranking of the carriers appears on the Networks/Services Settings screen and also on the Services page of the optimization report. Please refer to How Services are Created from an ASSET Project on page 36.

The objective of the optimization will be to maximize the sum of all defined target functions multiplied by their relative weights. The target functions will be evaluated in the optimization area (polygon) defined in ASSET.

About Service Targets and Carrier Aggregation Targets

For the definition of a 'Service' in ASSET Design, see Defining Targets on page 59.

When launching ASSET Design from an ASSET project, the services that are made available in ASSET Design for defining the targets result from the configuration of the project in ASSET, restricted by the contents of the optimization plan filter. There are criteria which determine the precise rules under which services are created. See How Services are Created from an ASSET Project on page 36.

Service Target definition

The supported **3G/4G/5G service targets** are:

- Coverage - RX Pilot Power, RX DL Channel Power, RSRP, SS-RSRP
- Uplink Coverage
- Carrier Aggregation (LTE only)

For more information, see Optimization Targets 3G/4G/5G on page 72.

Carrier Aggregation Targets for LTE

In any scenario (single or multiple technology), whenever there are multiple LTE carriers supported on the service, or where there is an additional LTE Frequency Band service, you will be able to set **carrier aggregation** targets for that service in ASSET Design. See Setting LTE Carrier Aggregation Targets on page 68.

Primary and Secondary Targets

Primary Targets

Depending on the available networks in the optimization environment (see also Network/Service Settings on page 29), different optimization targets can be defined. These optimization targets include:

- **3G/4G/5G targets** (for UMTS, LTE, Wi-Fi, 5G):

  See Optimization Targets 3G/4G/5G on page 72.

- **2G targets** (for GSM technologies):

  See Optimization Targets 2G on page 83

Combinations of these targets can also be defined, as well as multi system, multi network targets.

Secondary Targets

You can specify one or more secondary targets. Secondary targets apply under the following conditions:

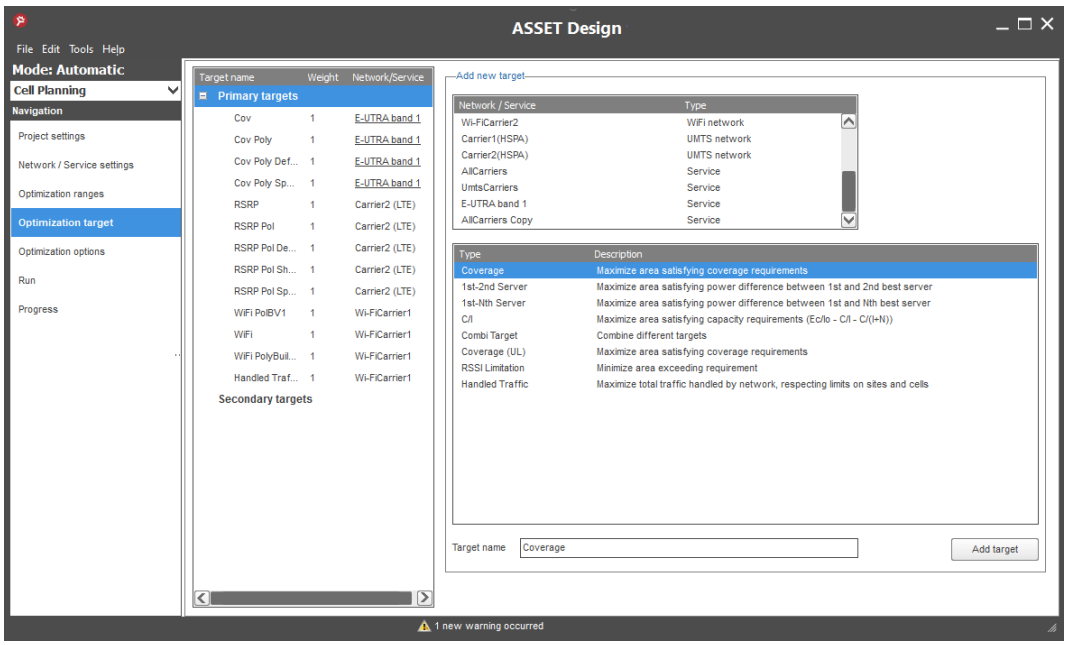
- Primary objectives of the solutions are (a) above the defined target objective or (b) have the same value but are below the defined target objective.
- Costs of the solutions are equal. (In ASSET Design, costs will be ignored if cost limits or cost minimization are not used.)
- Number of active sites of the solutions are equal.

Adding, Duplicating and Removing Targets

ASSET Design can handle a number of optimization targets jointly. The optimization target list (in the left pane) displays all optimization targets defined for the project.

- You can add, duplicate and remove targets.
- You can select a target from the list to view and edit its settings and requirements.
- There are Primary targets and Secondary targets (as described in the previous topic)
- In the Network/Service pane, each item is designated as a network or a service
- In the Type pane, there is a list of the target types (such as Coverage, Handled Traffic, and so on)

This picture shows the ASSET Design interface with the main Optimization Target screen:



ASSET Design interface - Optimization Target screen

The targets that will contribute to the total optimization objective (non-zero weight) are shown in normal font.

Any targets that will not contribute to the total optimization objective (zero weight) are shown in *italic* font.

Here is an example:

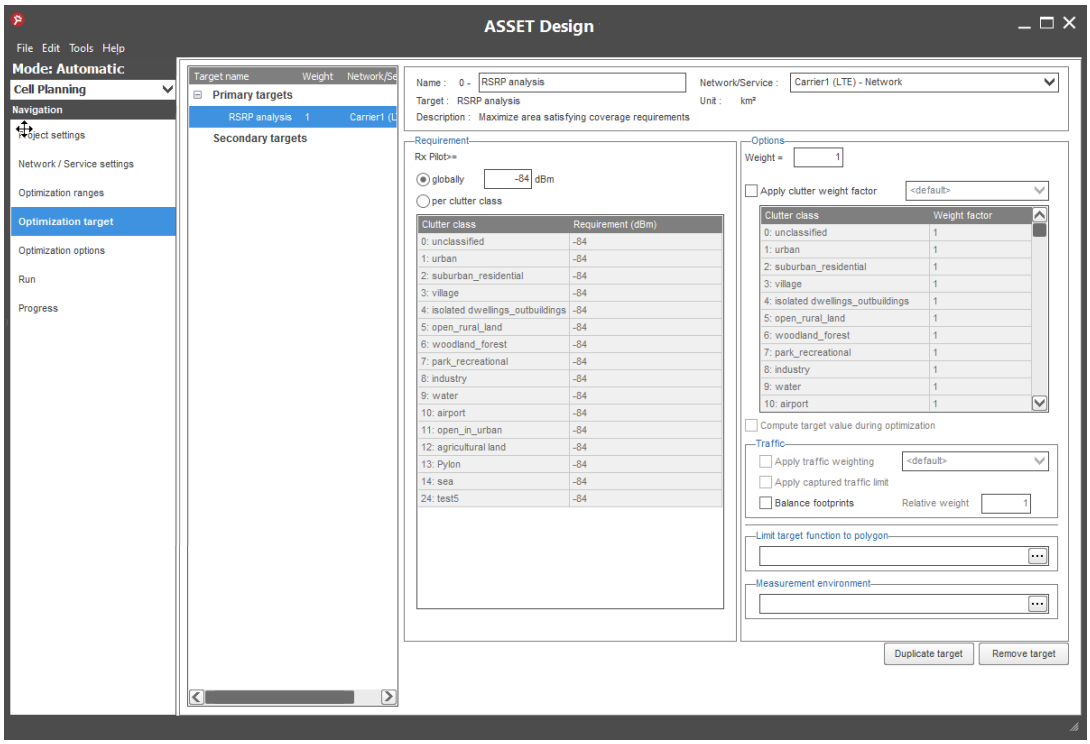
Target name	Weight	Network/Service
Primary targets		
RSRP analysis	1	Carrier1 (LTE)
C/(I+N)	*0*	*Carrier1 (LTE)*
Coverage (UL)	1	Carrier1 (LTE)

Example of Contributing and Non-Contributing Targets

To add a target:

1. Click on Primary targets or Secondary targets, as required.
2. In the Network/Service list box, select the required item.
3. In the Type list, select the appropriate target type that you require.
4. In the Target name box, you can edit the name as required.
5. Click the **Add Target** button.

   This picture shows an example with a specific optimization target selected:



6. In the left pane, under the 'Target name' column, click on the target that you have just created.
7. In the right pane, specify the Requirements and Options that you require, as described in Setting Network Targets and Service Targets on page 63 and the subsequent topics.

If you want to add multiple targets to the total objective, repeat the above process. Note that if you want multiple targets of the same type (e.g. Coverage) it may be quicker and easier to Duplicate an existing target and then adjust the parameters according to your requirements.

To duplicate a target:

1. Click on the appropriate target.
2. Click the **Duplicate target** button.

The target will appear in the list with 'Copy' appended to the name. You can then make the required adjustments.

To remove a target:

1. Click on the appropriate target.
2. Click the **Remove target** button.

Setting Network Targets and Service Targets

This section describes how to set network targets and service targets. For information on the difference between 'networks' and 'services' in ASSET Design, see Defining Targets on page 59.

Note: If you are setting LTE Carrier Aggregation targets, please see Setting LTE Carrier Aggregation Targets on page 68.

Basic target settings are:

- The requirements (for example, coverage threshold)
- Optional settings (such as: apply captured traffic limits, use measurements, weighting by a traffic map)
- Multiple height options (each target can be set at a specific height above ground level)

These settings are described in the following topics.

Multiple Height Optimizations for Network Targets

If you want to use multiple height optimizations (depending on your project's configuration in ASSET) you can specify a height above ground level for each network target:

This means that, by using several targets, you can optimize your network not only at ground level but also for a variety of higher levels by setting different target thresholds for the different heights. These higher levels could, for example, represent floors in a building, or paths for drones.

This capability depends whether, within ASSET, you have set up multiple receiver heights in your propagation models, in order to generate multiple height pathloss predictions.

The option is located in the Requirements pane. For more information, see Targets - Multiple Height Optimization on page 65.

Targets - General Information

On the right of the **Optimization Target** screen of the user interface, you can view general information about the selected target, edit the requirements of that target, and set any optional parameters.

The field descriptions are as follows:

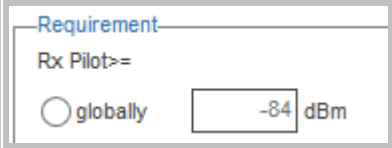
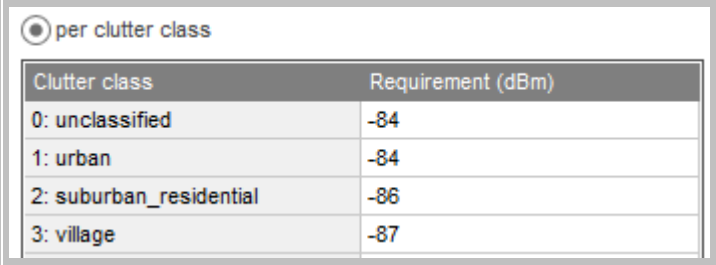
Field	Description
Name	After adding a new target, a default name is assigned automatically. However, it is recommended to modify the name for better identification.
Network or Service	Each target belongs uniquely to a particular network or service. For information on the difference between 'networks' and 'services' in ASSET Design, see Defining Targets on page 59.
Target	The type of target, such as 'Coverage'.
Description	A brief description of its function
Unit	The units of the target function (such as km^2 for coverage targets).

Targets - Requirements

Each target function has its own requirements. These requirements depend on the type of the target. For example, the requirement of a *Coverage* target is the minimum received signal power. For more detailed information on each target type, see Optimization Targets 3G/4G/5G on page 72 and Optimization Targets 2G on page 83.

Define the target requirement for this type of target within the region defined by the optimization area (polygon) in ASSET. Default values for the target requirements are defined on the **Target Defaults** tab of the **Preferences** dialog box. Default values are applied to new ASSET Design projects. For details see Import Settings from Previous Optimization on page 26.

In the Requirements pane, there are two ways of setting the requirement thresholds:

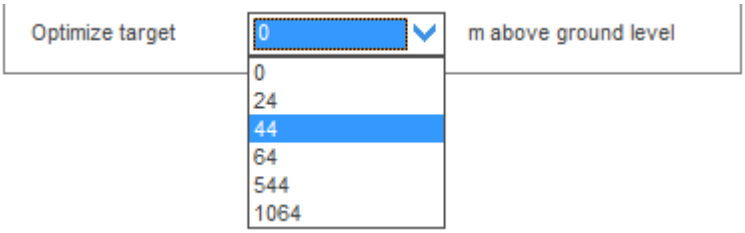
Option	Description
Globally	Use this option to define the requirements constantly for the entire network.  For each pixel of the optimization area, this requirements will be used.
Per clutter class	Use this option to define individual requirements for each class:  The classes are based on the clutter file included in the ASSET Design optimization environment chosen in the **Project Settings** screen.

Multiple Height Optimization for Network Targets

If you want to use multiple height optimizations (depending on your project's configuration in ASSET) you can specify a height above ground level for each network target. See Targets - Multiple Height Optimization on page 65.

Targets - Multiple Height Optimization

If you want to use multiple height optimizations (depending on your project's configuration in ASSET) you can specify a height above ground level for each network target:



This means that, by using several targets, you can optimize your network not only at ground level but also for a variety of higher levels by setting different target thresholds for the different heights. These higher levels could, for example, represent floors in a building, or paths for drones.

This capability depends whether, within ASSET, you have set up multiple receiver heights in your propagation models, in order to generate multiple height pathloss predictions.

Note: Targets set with height levels above ground do not support 'captured traffic', 'handled traffic', 'traffic limits' and 'balance footprints'. The traffic-related features and targets are only available for ground height.

Important: In an ASSET project it is possible to assign different propagation models to different cells, which means that a network may have different heights associated with it. When the export of the project data from ASSET to ASSET Design takes place, all different heights for all contributing* cells in that network are collected and listed in ASSET Design's Target Requirements drop-down list, and you can then specify one of those heights in a target. So, depending on the configurations coming from ASSET, this may result in the fact that:

- Some networks may not have multiple heights. In this case, only the ground level height will appear in the list. Where this is the case for all networks in the project, the height optimization option will not be present at all.
- Even if a network has multiple heights, some cells in that network may not have predictions for each height (in this case, all the heights will be listed, but only the cells with predictions can be optimized).
- The export to ASSET Design will fail if the height settings of the primary and secondary propagation models for a cell differ.

Therefore, if you want to avoid such inconsistencies, we recommend that, within ASSET, you ensure that all cells associated with a particular network have the same height settings in the propagation models that are assigned to them.

* Cells that contribute to the optimization are those that are included in the filters (if used) and either inside the optimization area or outside the area but with overlapping coverage. Only this set of cells for each network will determine which height levels are listed.

Targets - Options

In the **Options** pane, there are several settings/options:

Setting/Option	Description
Weight	Enter the relative weight of this target (relative to the other individual optimization targets). This is the weight of pixels exceeding the target requirement. Examples of how to apply different weights in the optimization process are given in Optimization Weight Examples on page 151. All defined targets will be summed up multiplied by their relative weight. This enables you to flexibly achieve a proper balance between different objectives (for example, concentrate more on coverage or capacity, and so on).
Apply clutter weight factor	Use this checkbox to enable clutter-dependent weighting of the optimization target. This option can only be used if the relative weight of this target is not zero. The clutter weights will then be multiplied with the relative weight of this target. Clutter-dependent weights allow you to focus on different optimization areas; to make regions more important or less important than others. See also Clutter-dependent Optimization Weights on page 154. Shortcuts and hot keys are available to provide quick ways to manipulate the data in the editing grid. See Shortcut Keys on page 16. **Zone files**: You can also (if required) use the drop-down list next to the checkbox to select an alternative file which replaces the default clutter file. This file usually identifies certain zones of interest, such as hot-spot areas. Hence the term *zone file*. The use of zone files enables you to additionally separate the optimization area into sub-areas with individual weights. Technically, zone files have identical format to clutter files.
Compute target value during optimization	This checkbox can only be enabled if the weight of the optimization target is zero. By this, ASSET Design will calculate and monitor the target function value of the optimization target, even though the applied weight is zero and this target will not contribute to the optimization. See also Progress (Cell Planning Mode) on page 126.

Targets - Traffic

In the **Traffic** pane, you can consider the traffic that is captured by the individual sectors in the network, to apply traffic limits to each of the cells, and to weight the target by a traffic map.

There are several options:

Option	Description
Apply traffic weighting	Use this checkbox to enable traffic density weighting for the optimization target. Traffic density weighting allows you to concentrate on the areas where the highest traffic occurs, so that high-traffic areas will be more important than low-traffic areas during the optimization process. See also Traffic Density Weighting on page 88. You can use the drop-down list next to the checkbox to either select the default traffic map (<default>) of the network or a separate weighting map (Select a file) for this target. Note that this weighting map must be large enough to completely cover the analysis area. Alternatively, you can select '<Shared>' from the drop-down list to apply a shared traffic map for the weighting of this target. This option is only available if 'Traffic sharing' is enabled in the **Network Settings** screen. For details see Captured Traffic and Traffic Sharing on page 89. **Note**: 'Traffic sharing' is only available for network targets (not service targets). Also, it is not supported if the target uses a measurement environment.

Option	Description
Apply captured traffic limit	Use this checkbox to enable the consideration of maximum traffic limits for each sector in the network. This option can only be enabled if the relative weight of the target is not zero and a global traffic density map has been defined. The traffic limits per sector are defined in the **Network Settings** screen. For details, see also Captured Traffic Description on page 90. If traffic sharing has been defined for the network, then the captured traffic will be calculated using the remaining traffic from the previous network rather than using the traffic map. **Note**: 'Apply captured traffic limit' is only available for network targets (not service targets). Also, it is not supported if the target uses a measurement environment.
Balance footprints	Use this checkbox to enable footprint balancing. If the option is active, the optimization algorithms will generate a compromise between the largest possible target objective and balanced footprints. "Balanced" in this sense means that neighboring footprints should have one or more of: • Similar size (if no traffic density map is used) • Similar captured traffic (if a traffic density map is used for this network, but not all of the sectors have a maximum captured traffic defined) • Similar traffic utilization (i.e. captured traffic divided by maximum captured traffic if a density map is used and all sectors have a maximum captured traffic defined). Balancing is achieved by creating additional target functions. These target functions are not visible in the target function list, but they will appear in the optimization progress and the reports. The 'Relative weight' option can be used to specify a weight of the footprint balancing target function relative to the "parent" target function (i.e. the weight at the top of the Options pane). The equivalent absolute weight is the parent target function's weight multiplied by the relative weight. **Note**: 'Balance footprints' is only available for network targets (not service targets). Also, it is not supported if the target uses a measurement environment.

Note: Targets set with height levels above ground do not support 'captured traffic', 'handled traffic', 'traffic limits' and 'balance footprints'. The traffic-related features and targets are only available for ground height.

Targets - Using Limiting Polygons

In the **Limit Target Function to Polygon** pane, you can select a MIF/TAB (*.mif or *.tab) vector file to restrict the optimization to only consider pixels that are inside the associated polygon(s). This will limit the area of a target function so that the target will only be evaluated within the boundaries of the intersection of the polygon(s) and the optimization area.

Tip: Inspector can show limiting polygons. See Optimization Area and Limiting Polygons on page 170.

Targets - Measurement Environment

The pathloss data that is used to calculate the target function value usually derives from the ASSET calculations based on propagation models, and is then written to the *Optimization environment*. Alternatively, the pathloss information can be derived from measurements by ASSET Design and is then written to a *Measurement environment*.

If you want to use measurements for the target, select the .cme file that was defined when creating the measurement environment by pressing the ... button. As soon as a measurement environment has been selected for the target, the pathloss data for the propagation calculations of the analysis will be read from the files which were derived from the measurements.

If you want to use both a prediction based target and a measurement based target, add this target type twice and apply the measurement environment to one of them. Then you can do all the settings for both targets individually (such as the requirements), also the weights of the two targets can be chosen individually.

Note:

- Measurements are supported for GSM, UMTS and LTE.
- 'Measurement Environment' is only available for network targets (not service targets).

'Traffic sharing', 'Apply captured traffic limit' and 'Balance footprints' are not supported if the target uses a measurement environment. The reason is that measurements usually do not cover the entire area but only isolated parts like streets or even single pixels. However, those features do require pathloss information of every pixel of the optimization area, otherwise the results will not be accurate.

Guidelines how to use measurements for optimizations can be found in Optimization with Measurements on page 160.

Setting LTE Carrier Aggregation Targets

In ASSET Design, the service targets (on the **Optimization Target** screen) provide the opportunity to set LTE Carrier Aggregation targets.

This means that ASSET Design can consider the Carrier Aggregation settings from ASSET and then run the optimization to achieve, for example, the maximum number of connections.

There are three types of target available:

- **LTE CA Connections**:

  Number of connections available through Intra-eNodeB Carrier Aggregation or Inter-eNodeB Carrier Aggregation, limited by (Maximum DL Carriers + 1).

- **LTE CA Carriers**:

  Number of carriers available through Intra-eNodeB Carrier Aggregation or Inter-eNodeB Carrier Aggregation, limited by Maximum DL Carriers.

- **LTE CA Bandwidth**:

  The total aggregated bandwidth, resulting from the achieved 'LTE CA Connections'. The combination of connections that maximizes the total aggregated bandwidth is selected for each pixel.

  Bandwidth per carrier is equal to the network's range (Frequency Stop - Frequency Start).

Note: The bandwidth unit is deliberately neutral, allowing for any used frequencies (Hz, kHz, MHz, GHz...)

Each of the above CA target types comprises service-level target settings and, underneath these, individual carrier-level target thresholds.

In other words, in addition to the service-level target settings, there is a separate set of sub-targets (thresholds) for each LTE carrier belonging to the service.

In the case of multi-technology services, any non-LTE carriers of the service will be ignored.

Note: LTE Carrier Aggregation Targets are *not* available for Combi targets.

Service-level CA Target Settings

This topic describes the Service-level Target settings for LTE Carrier Aggregation. (The carrier-level sub-targets are described in the next topic.)

The fields/settings/options descriptions are as follows:

General Information pane

Field	Description
Name	After adding a new target, a default name is assigned automatically. However, you can modify the name for better identification.
Service	Each CA target belongs uniquely to a particular service.
Target	The type of target (CA Connections, CA Carriers or CA Bandwidth).
Description	A brief description of its function
Unit	The units of the target function.

Requirements pane

Option	Description
Maximum DL Carriers	The maximum number of downlink carriers a mobile supports.
Maximize **-** or**-** **Achieve**	Choose one of these two options, which are described as follows: • **Maximize (Connections / Carriers / Bandwidth)**: Value per pixel is the available carriers / connections / bandwidth, so the aim is to maximize total connections / carriers / bandwidth. • **Achieve (Connections / Carriers / Bandwidth)**: Value per pixel is "Yes" or "No", so the aim is to maximize the *area* where the goal is reached.

Options pane

Setting/Option	Description
Weight	Enter the relative weight of this target (relative to the other individual optimization targets). This is the weight of pixels exceeding the target requirement. Examples of how to apply different weights in the optimization process are given in Optimization Weight Examples on page 151. All defined targets will be summed up multiplied by their relative weight. This enables you to flexibly achieve a proper balance between different objectives (for example, concentrate more on carriers or bandwidth, and so on).
Apply clutter weight factor	Use this checkbox to enable clutter-dependent weighting of the optimization target. This option can only be used if the relative weight of this target is not zero. The clutter weights will then be multiplied with the relative weight of this target. Clutter-dependent weights allow you to focus on different optimization areas; to make regions more important or less important than others. See also Clutter-dependent Optimization Weights on page 154. Shortcuts and hot keys are available to provide quick ways to manipulate the data in the editing grid. See Shortcut Keys on page 16. **Zone files**: You can also (if required) use the drop-down list next to the checkbox to select an alternative file which replaces the default clutter file. This file usually identifies certain zones of interest, such as hot-spot areas. Hence the term *zone file*. The use of zone files enables you to additionally separate the optimization area into sub-areas with individual weights. Technically, zone files have identical format to clutter files.
Compute target value during optimization	This checkbox can only be enabled if the weight of the optimization target is zero. By this, ASSET Design will calculate and monitor the target function value of the optimization target, even though the applied weight is zero and this target will not contribute to the optimization. See also Progress (Cell Planning Mode) on page 126.

Traffic pane

	Description
Apply traffic map weighting	Use this checkbox to enable traffic density weighting for the optimization target. Traffic density weighting allows you to concentrate on the areas where the highest traffic occurs, so that high-traffic areas will be more important than low-traffic areas during the optimization process. See also Traffic Density Weighting on page 88. You can use the drop-down list next to the checkbox to either select the default traffic map (<default>) of the network or a separate weighting map (Select a file) for this target. Note that this weighting map must be large enough to completely cover the analysis area.

Carrier-level CA Target Settings

This topic describes the Carrier-level Target settings for LTE Carrier Aggregation, enabling you to specify the per-carrier requirements for carrier availability, within the service. (The service-level targets are described in the previous topic.)

The fields/settings/options descriptions are as follows:

General Information pane

Field	Description
Name	After adding a new target, a default name is assigned automatically. However, you can modify the name for better identification.
Service	The name of the parent service.
Target	The type of target.
Description	A brief description of its function

Requirements pane

Option	Description
Globally	Use this option to define a consistent requirement to be used for the entire network. For each pixel of the optimization area, this requirement will be used. • RSRP (always) • RSRQ (optional) • SINR (optional) If a carrier cell satisfies all the specified thresholds of the carrier, it is available for carrier aggregation.
Per clutter Class	Use this option to define individual requirements for each class, based on the clutter file included in the ASSET Design optimization environment chosen in the Project Settings screen. Shortcuts and hot keys are available to provide quick ways to manipulate the data in the editing grid. See Shortcut Keys on page 16.
Noise figure	Specify the noise figure of the user equipment in dB with this input field. This will be used for interference calculation.
Mobile total gain	Specify the total user equipment gain in dB (usually antenna gain minus body loss) in this input field. This will be used for the signal to interference calculation.

Saving and Loading Target Function Settings

The settings for the different optimization targets can be saved as optimization projects and loaded for new optimizations.

Tip: Previously saved target function settings can be used as templates for new optimization tasks. This is a very convenient way to save time if similar settings will be used for multiple projects.

For details on how to save and load the optimization targets, see Import Settings from Previous Optimization on page 26.

Optimization Targets 3G/4G/5G

The supported **3G/4G network targets** are:

- Coverage - RX Pilot Power, RX DL Channel Power (all 3G/4G/5G technologies)
- Quality - Pilot Pollution and SHO Overhead: Difference between 1st - 2nd strongest RX power
- Quality - Worst Polluter and Overshooting: Difference between 1st - Nth strongest RX power
- Capacity - Ec/Io, C/(I+N) and RSRQ (all 3G/4G/5G technologies)
- Capacity - Downlink Eb/Nt (UMTS)
- Capacity - Uplink Eb/Nt (UMTS)
- Capacity - Density Based (HSDPA, LTE, and Wi-Fi)
- Uplink Coverage
- RSSI Limit (all technologies)
- Handled Traffic (all technologies)
- Traffic Offloading (all technologies)

The supported **3G/4G service targets** are:

- Coverage - RX Pilot Power, RX DL Channel Power (all 3G/4G/5G technologies)
- Uplink Coverage (all 3G/4G technologies)
- Carrier Aggregation (LTE)

In addition, Combi Targets are available for network targets and service targets. See Derived Targets (Combi) on page 87.

Coverage - RX Pilot Power, RX DL Channel Power, RSRP, SS-RSRP

If a Coverage target is not already defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

The RX pilot/RX DL channel power target is a coverage target. In order to meet coverage requirements, a minimum received signal power is required.

LTE: ASSET Design calculates RSRP (Reference Signal Received Power) calibrated to ASSET.

5G: ASSET Design calculates SS-RSRP (Synchronization Signal - Reference Signal Received Power) calibrated to ASSET.

Sufficient pilot coverage is a necessary requirement to launch wireless services. The required received pilot depends on the receiver sensitivity of the mobile handset. The received pilot power is typically given in dBm.

Requirements on the RX pilot are often given for outdoor environments, since propagation models do not always take penetration losses into account directly.

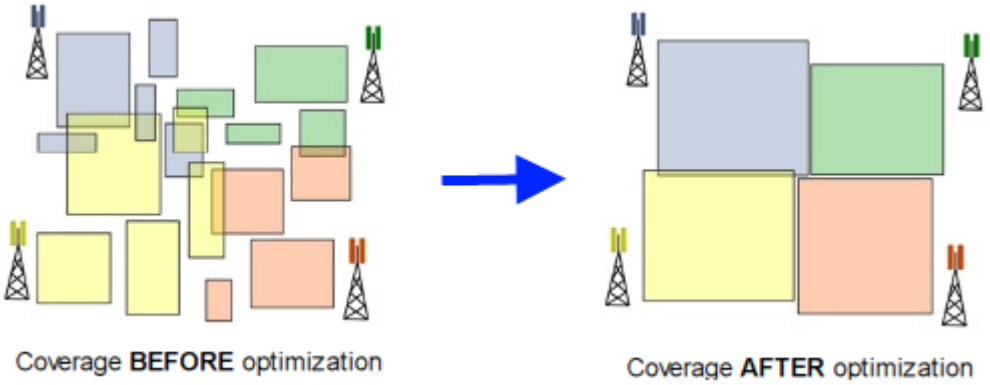
Therefore, in order to provide sufficient indoor coverage, the RX pilot requirement might be higher for indoor areas.

In the optimization targets you can set different requirements for various environments based on clutter classes. Depending on the environment (deep indoor, indoor, outdoor, in car, and so on) typical values for the received pilot are in the range of -70...-110dBm.

Selecting this optimization target will result in improved pilot coverage/DL channel coverage in your optimization area according to your requirements.

Optimizing for coverage will:

- Increase overall service area
- Improve the coverage probability
- Reduce the probability of coverage holes
- Provide sufficient indoor coverage



Requirements

The coverage requirements specify the threshold for the best RX pilot power (UMTS), DL channel power (GSM, Wi-Fi), RSRP (LTE) or SS-RSRP (5G). For example, a coverage requirement of -90dBm means that the optimization area should exceed a received power of -90dBm after the optimization for as many pixels as possible taking into account the individual weights of the pixels (clutter weighting, traffic map weighting).

Notes:

- The requirement for the coverage (defined either globally or per clutter class) will also be considered if the *Coverage requirement fulfilled* checkbox is enabled for another optimization target. If you do not want the coverage target to contribute to the optimization and just use it as condition for another target, set its global weight to zero.
- Indoor losses are considered for this target, but mobile station antenna gain or body loss are not considered.

Shortcuts and hot keys are available to provide quick ways to manipulate the data in the editing grids. See Shortcut Keys on page 16.

Ec/Io, C/(I+N), RSRQ

If a C/I target has not already been defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

Ec/Io, C/(I+N), or RSRQ are a network quality and capacity objective. For UMTS, Ec/Io will be calculated as the ratio of the received pilot signal energy per chip and the received interference and noise. The down-link interference can be calculated adopting the DL cell loads as given in ASSET, or by using constant, user defined cell loads. Refer to 3G Cell loads for details. For Wi-Fi, C/(I+N) will be calculated as the ratio of the received signal power and the received interference and noise. For LTE, RSRQ calibrated to ASSET will be calculated.

The higher C/(I+N) is, the higher the service quality and the data rate, and the higher the overall system capacity will be.

LTE: The analysis can optionally be based on RSRQ or SINR (PDSCH C/(I+N)).

5G: The analysis is based on PDSCH-SINR.

RSRQ: Will be calculated as a reference signal C/(I+N) analysis, which is the ratio of the RSRP and the total received interference power including the interference from the best server.

SINR: Will be calculated as a PDSCH C/(I+N) analysis where the received power of the best server is ignored. For this analysis, the number of interferers that will be considered in the interference power accumulation can optionally be limited in the range 1 to 6. If, for example, this is set to 1, only the interference received from the second best server (= first interferer) will be used for the SINR analysis. This is useful if the SINR will be compared with analyses done by scanners that often only consider up to 6 interferers.

The frequency band and channel number information are also used to accurately analyze the interference in the LTE network. The frequency band overlap and any intersystem interference is considered according to the frequency position and bandwidth of the carriers as specified in ASSET.

Wi-Fi: The C/(I+N) will be calculated as channel power C/(I+N) analysis.

A sufficient level of Ec/Io or C/(I+N) is a necessary requirement to provide services in wireless networks. Typical values for required Ec/Io are in the range of -8...- 15dB, or 0...15dB for C(I+N).

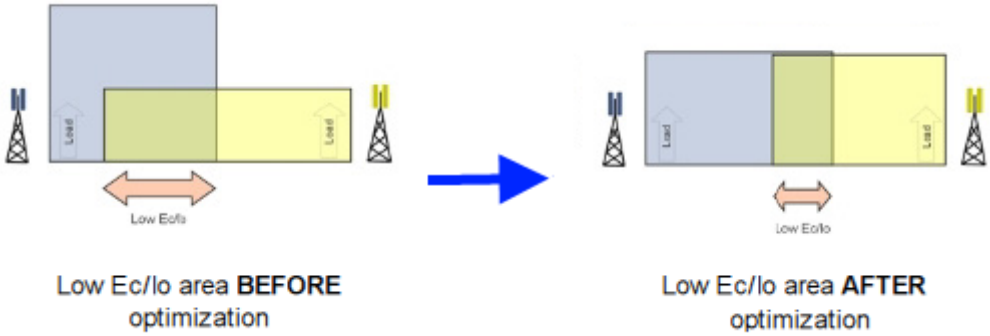
The received Ec/Io at the mobile depends on both the transmitted pilot power, as well as the received interference from the entire network.

Since the base station transmit power is limited, Ec/Io depends on the interference produced by other base stations. The total interference thus depends on the downlink load of the individual interferers, this is their total transmit power.

Optimizing for Ec/Io or C/(I+N) will harmonize the system load in the network. It balances the signal and interference contributions so that the requirements will be met wherever needed.

Optimizing Ec/Io or C/(I+N) will result in:

- Increased service availability
- Higher possible data rates
- Balanced network loads
- Higher system capacity

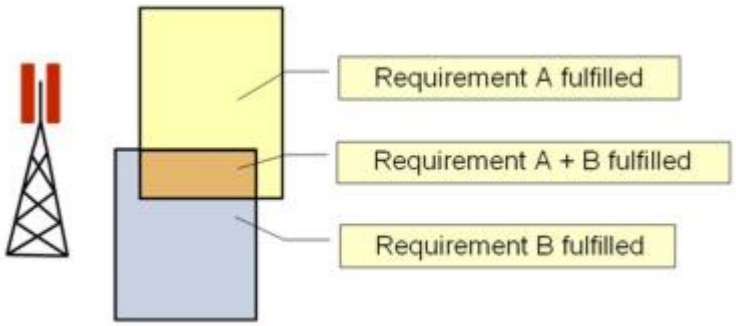


Requirements

The requirements specify the threshold of the Ec/Io (UMTS) or C/(I+N) (LTE, Wi-Fi). For example, a requirement of -15dB means that as many pixels in the optimization area as possible should have an Ec/Io ratio of more than -15dB after the optimization.

Limit number or interferers to: Select the number of interferers that will be considered for the LTE SINR analysis. This option is only available for LTE. If set to unlimited, all interfering cells will add to the total interference. If set to 1, 2, ..., 6, only the first, second, ..., sixth best servers will add to the total interference. The ranking of the 6 interfering cells is based on their RSRP and is done individually for each pixel.

Coverage requirements fulfilled: Enable this checkbox if you want to maximize the area where the requirements for Ec/Io or C/(I+N) AND the coverage requirement are fulfilled. If multiple coverage targets are defined for the same network (see also Network/Service Settings on page 29) select the appropriate one from the presented list.



Note: From a practical point of view, the enabled Coverage *requirement fulfilled* functionality means that you optimize the area where your optimization target is fulfilled AND the minimum coverage requirement is given. For this, you do not even have to optimize for coverage explicitly (e.g. by setting the weight of the coverage target to zero).

Shortcuts and hot keys are available to provide quick ways to manipulate the data in the editing grids. See Shortcut Keys on page 16.

Quality - Pilot Pollution and SHO Overhead

If a 1st - 2nd RX pilot target is not already defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

1st - 2nd RX pilot difference is a network quality target. In order to reduce the pilot pollution, unnecessary soft-handover (SHO, for UMTS) areas, and irregular best server plots, this type of target can be used.

In CDMA systems, the number of simultaneously active connections in soft handover is defined by the *Active Set*. The number of connections within the Active Set is influenced by the *Active Set threshold*, which is typically in the range of 5-8dB.

This means that all base stations in the Active Set have to transmit the same information to this mobile. This is the SHO overhead.

By reducing the difference between 1st - 2nd RX pilot, the number of pilots "seen" by the mobile (pilot pollution) is reduced. The reduced pilot pollution will result in a lower SHO overhead.

Minimizing the overlapping area between two adjacent cells will lead to short borders. This will provide clear and regular cell borders and best server plots.

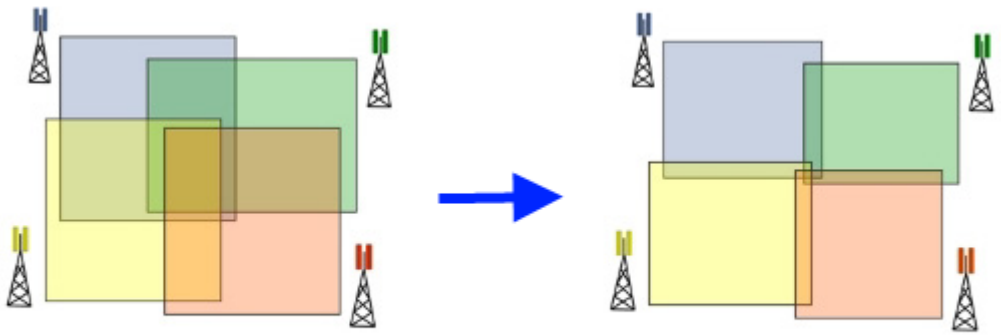
Reducing the area where the difference between the 1st - 2nd RX pilot are within a predefined power range automatically also reduces the overlapping area with other pilots than the 2nd strongest one.

Optimizing for the difference between the 1st - 2nd RX pilot results in

- Significantly lower pilot pollution
- Reduced handover overhead
- Clear structured cell borders
- Clear and regular best server plots

SHO can never be eliminated completely by optimizing the difference between 1st - 2nd RX pilot, because there must be a point where the pilots from two base stations are equally strong. Set the Active Set threshold properly according to your needs.

However, optimizing for the difference between 1st - 2nd RX pilot makes sure that unwanted SHO overhead, pilot pollution, and irregular best server plots will be mitigated.



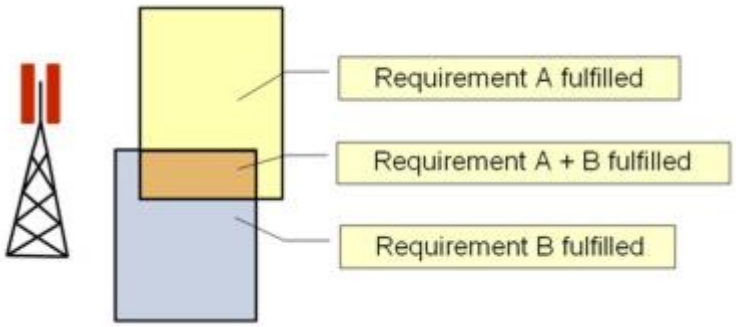
Pilot pollution and SHO overhead **BEFORE** optimization

Pilot pollution and SHO overhead **AFTER** optimization

Requirements

The requirements specify the threshold for the difference between the first and the second strongest received pilot power or signal power. For example, a requirement of 4dB means that as many pixels in the optimization area as possible should have a difference between first and second strongest received power of more than 4dB after the optimization.

Coverage requirement fulfilled: Enable this checkbox if you want to maximize the area where the requirements for the difference between 1st - 2nd RX pilot AND the coverage requirement are fulfilled. If multiple coverage targets are defined for the same network (see also Network/Service Settings on page 29) select the appropriate one from the presented list.



Notes:

- From a practical point of view, the enabled *Coverage requirement fulfilled* functionality means that you optimize the area where your optimization target is fulfilled AND the minimum coverage requirement is given. For this, you do not even have to optimize for coverage explicitly (set the weight of the coverage target to zero).
- Indoor losses *are* considered for this target, but mobile station antenna gain and body loss are *not* considered.

Shortcuts and hot keys are available to provide quick ways to manipulate the data in the editing grids. See Shortcut Keys on page 16.

Quality - Worst Polluter and Overshooting

If a 1st - Nth optimization target is not already defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

1st - Nth RX pilot difference is a network quality target. In order to reduce the impact of the worst polluter and to reduce far-off connections (overshooting), this type of target can be used.

CDMA receivers usually have a number of RAKE fingers implemented in order to combine the signal contributions of the individual base stations/sectors in soft-handover. Due to this combination, about equally strong signals are summed up and deliver the "soft-handover gain".

Due to the limited number of RAKE fingers in the receiver, not all connections can contribute to the received signal. Those who cannot be combined are interferers or polluters. The worst polluter is the connection that can just not be considered in the RAKE.

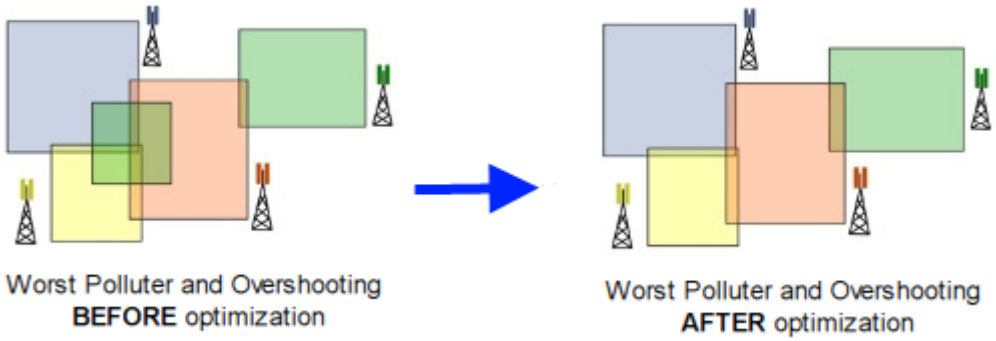
Therefore it depends on the implementation of the RAKE receiver, which of the Nth RX pilot the worst polluter is.

Another crucial effect in CDMA networks is caused by far-off connections, also called "overshooting". In this case, a far-off base station is either the best server, or at least contributes to the SHO. This unwanted effect can be caused by high altitude base stations, insufficient antenna down-tilts, the topography, etc.

Optimizing for the difference between the 1st - Nth RX pilot will result in:

- Reduced overshooting
- Improved network performance due to the reduction of far-off connections
- Reduction of the effective interference caused by the worst polluter
- Overall interference reduction

Optimizing for the difference between 1st - Nth RX pilot can be used in combination or as an alternative to the difference between the 1st - 2nd RX pilot.

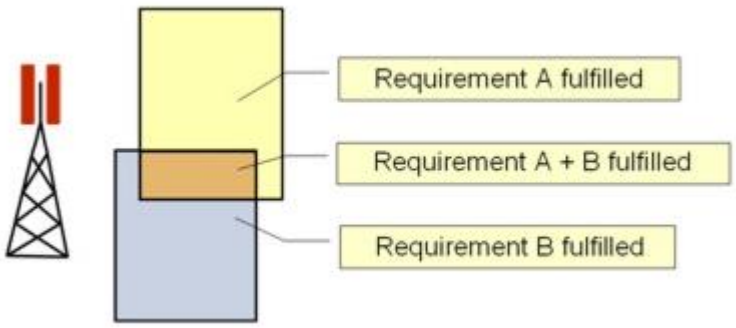


Requirement

The requirements specify the threshold for the difference between the first and the N-th strongest received pilot power or signal power. For example, a requirement of 8dB means that as many pixels in the optimization area as possible should have a difference between first and N-th strongest received power of more than 8dB after the optimization.

The Nth signal can be selected in the range of 3 - 5.

Coverage requirement fulfilled: Enable this checkbox if you want to maximize the area where the requirements for the difference between 1st - Nth RX signal AND the coverage requirement are fulfilled. If multiple coverage targets are defined for the same network (see also Network/Service Settings on page 29) select the appropriate one from the presented list.



Notes:

- From a practical point of view, the enabled *Coverage requirement fulfilled* functionality means that you optimize the area where your optimization target is fulfilled AND the minimum coverage requirement is given. For this, you do not even have to optimize for coverage explicitly (set the weight of the coverage target to zero).
- Indoor losses *are* considered for this target, but mobile station antenna gain and body loss are *not* considered.

Shortcuts and hot keys are available to provide quick ways to manipulate the data in the editing grids. See Shortcut Keys on page 16.

Downlink Eb/Nt (UMTS only)

If a Downlink Eb/Nt target is not already defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

Downlink Eb/Nt is both a network quality and a capacity objective. In order to provide service coverage in the downlink, the minimum required Eb/Nt level needs to be satisfied for the individual service. The down-link interference can be calculated adapting the DL cell loads as given in the ASSET, or by using constant, user defined cell loads. Refer to 3G/4G/5G Cell Load for details.

For all other settings refer to Ec/Io, C/(I+N), RSRQ on page 74.

Uplink Eb/Nt (UMTS only)

If an Uplink Eb/Nt target is not already defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

Uplink Eb/Nt is both a network quality and a capacity objective. In order to provide service coverage in the uplink, the minimum required Eb/Nt level needs to be satisfied for the individual service.

For all settings refer to Ec/Io, C/(I+N), RSRQ on page 74.

Capacity - Density Based (HSPA, LTE, Wi-Fi)

If a Capacity Density based target has not already been defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

'Capacity density based' is a capacity objective that considers the cell throughput in kbit/s and the resulting cell utilization. It is based on a mandatory traffic density map.

Note: 'Capacity density based' calculates the potential throughput based on the resource utilization for HSDPA, LTE or Wi-Fi networks. The target is not appropriate for UMTS R99 networks. If this target is selected for a UMTS network, a HSDPA analysis is done with 10 (of 16) available codes.

The target function evaluates the possible modulation scheme and throughput for every pixel and estimates the required resource units for the cell by evaluating all pixels of the cell footprint. If the accumulated required resource units are less than the cell's limit (that is implicitly given by the technology settings, the bandwidth, the overhead, etc.), the cell is not overloaded and the traffic can be handled. The cell's contribution to the target function is the captured traffic (in kbit/s in this case, and of course normalized to the maximum possible captured traffic). If the required resource units exceed the cell's limit, the cell can only contribute the traffic according to the maximum possible resource utilization to the target function and hence the target function value will be lower.

Note: Clutter-dependent weights are applied **before** the resource units are calculated, the target function weight is applied **after** the calculation of the resource units. this means that clutter weights can be used to scale the traffic map while a global weight scales the target function value. The target always uses the identical traffic map both for calculating the resource units and the weighting of the pixels.

The output of the target function is the successfully handled traffic. In addition, the percentage of required resource units for every cell can be found in the report and visualized in Inspector. For overloaded cells, this number will be greater than 100%.

Inspector will also show the corresponding plot to this target which is the RLC throughput possible at each pixel. Note that this is not what this target function calculates and optimizes in ASSET Design, rather it is the theoretical throughput limit on that pixel based on the assumption that no other user is active in the network.

Note: The raw (non-normalized) target function output is the network capacity in kbit/s. If no cell is overloaded, this is equal to the offered traffic in the traffic map. If all cells are overloaded, it is the theoretic throughput capacity of the network. The target function plot that can be visualized in Inspector shows the effective layer 2 throughput in kbit/s for every pixel given the modulation table and bandwidth. Please note that the target function statistics in Inspector evaluate this layer 2 throughput per pixel individually ignoring all cell limits (as if there were traffic only on this pixel), and not the technically feasible throughput per cell that is evaluated in the target function objective.

Requirements

The requirements specify the threshold of Eb/Nt (for HSDPA), C/(I+N) (for Wi-Fi), or SINR (for LTE). For example, a requirement of 5dB means that only pixels exceeding 5dB can contribute to the target function objective. Please note that the cell utilization or resource units are calculated considering the specified threshold, too.

Note: Only the pixels that exceed both the specified global or clutter based threshold and the lowest value in the modulation thresholds table are used for the calculation of the resource units and the target function objective. Usually you should use low thresholds to ensure the entire offered traffic is assigned to the cell.

Noise figure: Specify the noise figure of the user equipment in dB with this input field. This will be used for interference calculation.

Mobile total gain: Specify the total user equipment gain in dB (usually antenna gain minus body loss) in this input field. This will be used for the signal to interference calculation. For LTE, this is inactive if a receiver antenna has been selected in the **Network Settings** screen.

Modulation thresholds: Use this button to edit the modulation parameters versus Eb/Nt or C/(I+N) thresholds. The button opens a window with one line per

- **Eb/Nt or C/I threshold:** Specify the signal to interference threshold for the modulation format. Thresholds must be ascending from top to the bottom of the table. Use the **insert key** on your keyboard to insert new rows, or navigate to a new row at the bottom with the **cursor keys**.
- **Bits per symbol:** Specify the bits per modulation symbol for the threshold (e.g. 2 for QPSK/4- QAM, 4 for 16-QAM, 6 for 64-QAM)
- **Code rate:** Specify the rate of the used coding scheme at that threshold (e.g. 0.33 for 1/3 rate codes, 0.5 for 1/2 rate codes).
- **MIMO multiplexing gain:** Specify the number of parallel MIMO streams the multiplexing scheme is able to transmit.
- **Error ratio:** Specify the ratio between 0 and 1 of re-transmitted packets to total packets for that threshold. The expression (1-ErrorRatio) will be multiplied to the other terms in that row.

Load and Save: The modulation threshold table can be saved to a file using the "Save" button or loaded from a previously saved file using the "Load" button.

Coverage requirement fulfilled: Enable this checkbox if you want to maximize the area where the requirements for Ec/Io or C/(I+N) AND the coverage requirement are fulfilled. If multiple coverage targets are defined for the same network (see also Network/Service Settings on page 29) select the appropriate one from the presented list.

Note: From a practical point of view, the enabled Coverage requirement fulfilled functionality means that you optimize the area where your optimization target is fulfilled AND the minimum coverage requirement is given. Please note that only the pixels fulfilling both criteria are used to calculate the cell's required resource units.

Shortcuts and hot keys are available to provide easy handling and provide a quick way for using the different functionalities. See Shortcut Keys on page 16.

Uplink Coverage

If an Uplink coverage target is not already defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

The uplink coverage target calculates the received signal power from a test mobile handset at the base station transmitter. The transmitted power of the handset must be defined together with the mobile total gain (antenna gain minus losses) in the Requirement pane on the **Optimization Target** screen. For LTE, the mobile total gain field is inactive if a receiver antenna has been selected on the **Network Settings** screen.

RSSI Limitation

If an RSSI Limitation target is not already defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

The RSSI Limitation target will, in contrast to a coverage target, try to not exceed the given threshold. By means of this target you can maximize the area where a certain threshold is not reached.

Requirement

The target will optionally be based on an RSSI or coverage analysis. The selection between RSSI and coverage is done with the radio button in the requirement section.

RSSI: The total transmitted DL power of the transmitters is used for the analysis. The received powers of all transmitters is cumulated. This analysis is identical to the interference layer of the according C/(I+N) target.

Coverage: The coverage layer is used for this analysis. This is the received pilot power of the strongest server only.

Note: Indoor losses are considered for this target, but mobile station antenna gain or body loss are not considered.

Handled Traffic (All Technologies)

If a Handled Traffic target has not already been defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Note: The Handled Traffic target supersedes the (formerly available) Traffic Limit target.

Description

The Handled Traffic target will maximize the total handled traffic of your network. Cell and site limits are used to specify the maximum traffic each cell can handle. Only traffic within these limits counts towards the target. The resulting effect is that overloaded cells will shift traffic to non-overloaded cells.

In other words, if you have a cell with a limit of 100, it will only be worth 100 traffic units even if it captures 200 or 500 traffic units.

A common approach for the Handled Traffic target is to use it in combination with Traffic Sharing to maximize total handled traffic.

If you use Handled Traffic targets with weight '1' on all networks in the traffic sharing, then their summed target function value will give you the total percentage of handled traffic.

Example: If the target function value for each of three networks is 0.2, 0.4 and 0.2 respectively, then the summed target function value of 0.8 would indicate that 80% of the total shared traffic is handled.

Note: When the 'Min. captured site traffic' threshold for Site Placement templates is set (see Site Level Template Parameters on page 112), sites that do not meet this threshold do not contribute to the weighted objective of a Handled Traffic target. Nevertheless, the raw values show the amount of traffic handled by these sites.

Traffic Offloading (All Technologies)

If a Handled Offloading target has not already been defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

The Traffic Offloading target offloads traffic from existing cells. The use case for this target is a high traffic area with existing cells, where you want to place new capacity cells with the Site Placement mode. ASSET Design will optimize the new cells to handle as much traffic as possible and offload the existing cells. Captured traffic of existing sites will be ignored and will be considered as unhandled.

Carrier Aggregation Targets (LTE)

Carrier Aggregation targets are available for LTE under the category of service targets.

If a CA target has not already been defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

For information about how and when the services are created, see How Services are Created from an ASSET Project on page 36.

There are three CA targets:

- LTE CA Connections
- LTE CA Carriers
- LTE CA Bandwidth

Description

When using this target, ASSET Design will consider the Carrier Aggregation settings from ASSET and then run the optimization of the network to achieve (as appropriate) the maximum number of connections or carriers or connections with reference to bandwidth.

For full information, see Setting LTE Carrier Aggregation Targets on page 68.

Optimization Targets 2G

The supported **2G network targets** are:

- Coverage - RX BCCH
- C/I - Carrier to Interference Ratio
- Quality - Pilot Pollution and SHO Overhead: Difference between 1st - 2nd strongest RX power
- Quality - Worst Polluter and Overshooting: Difference between 1st - Nth strongest RX power
- Uplink Coverage
- Handled Traffic (all technologies)

In addition, Combi Targets are available for network targets and service targets. See Derived Targets (Combi) on page 87.

Coverage - RX BCCH

If a Coverage target is not already defined, it can be created with the *Add target* button (see Adding, Duplicating and Removing Targets on page 61).

Description

The RX BCCH is a coverage target. It analyzes the received power of the Broadcast Control Channel (BCCH). In order to meet coverage requirements, especially indoor coverage requirements, a minimum received BCCH power is required.

Sufficient BCCH coverage is a necessary requirement to launch wireless services. The required received BCCH depends on the receiver sensitivity of the mobile handset.

Requirements on the RX BCCH are often given for outdoor environments, since propagation models do not always take penetration losses into account directly.

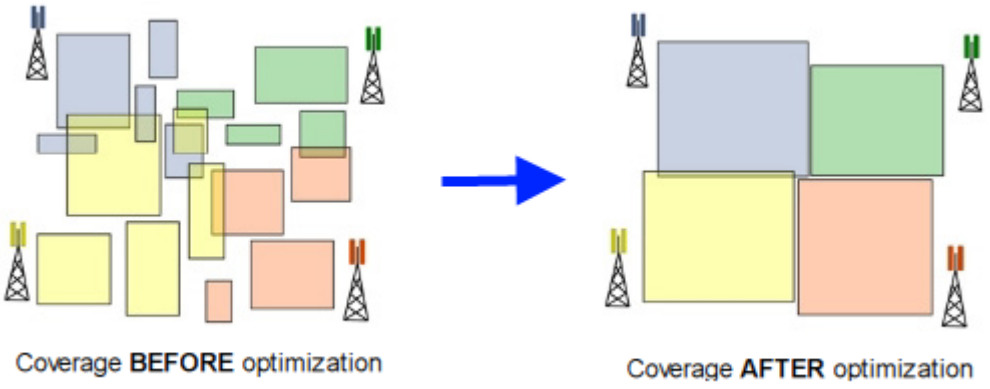
Therefore, in order to provide sufficient indoor coverage, the RX BCCH requirement might be higher for indoor areas.

In the optimization targets you can set different requirements for various environments and clutters. Depending on the environment (deep indoor, indoor, outdoor, incar, etc.) typical values for the received BCCH are in the range of -60...-100dBm.

Selecting RX BCCH as optimization target will result in improved BCCH coverage in your optimization area according to your requirements.

Optimizing for RX BCCH will:

- Increase overall service area
- Improve the coverage probability
- Reduce the probability of coverage holes
- Provide sufficient indoor coverage
- Effectively increase the service availability area



Requirements

The coverage requirements specify the threshold for the best RX BCCH power. For example, a coverage requirement of -90dBm means that the optimization area should exceed a received power of -90dBm after the optimization for as many pixels as possible taking into account the individual weights of the pixels (clutter weighting, traffic map weighting).

Note: Indoor losses are considered for this target, but mobile station antenna gain or body loss are not considered.

C/I - Carrier to Interference Ratio

If a C/I target is not already defined, it can be created with the *Add target* button (see also Optimization Targets on page 59).

Description

Carrier to interference ratio (C/I) is a 2G network quality target. More precisely, this optimization target should be called C/(I+A+N), since it considers all interference sources as well as the thermal noise. In order to reduce the interference in TDMA based access technologies and increase the C/I ratio, this type of target should be used.

ASSET Design distinguishes different frequency bands (e.g. GSM-900, GSM-1800), but the GSM channels are not considered when analyzing the interference. It is assumed that all transmitters use exactly the same frequency. Hence, the analyzed C/I is a worst case scenario. The reason is that the C/I target shall be independent from a certain frequency plan, and, besides that, in frequency hopping GSM systems all transmitters will be mutual interferers.

In TDMA systems the interference is mainly caused by co-channels operating at the same carrier frequency. This is indicated in the picture on the left hand side. The base stations with the same color transmit with the same carrier frequency.

In the areas where two colors overlap, the co-channel interference is dominant and hence limits the system performance. Overlapping areas with different colors do not contribute to the co-channel interference.

The co-channel interference hence depends on the implementation of the frequency plan. Frequency plans are computed to reduce the overall co-channel interference.

It is well known that TDMA systems experience an additional gain by applying frequency hopping, i.e. interference diversity. In state of the art network equipment, frequency plans and frequency hopping pattern can be modified via software. This means they can be changed very rapidly.

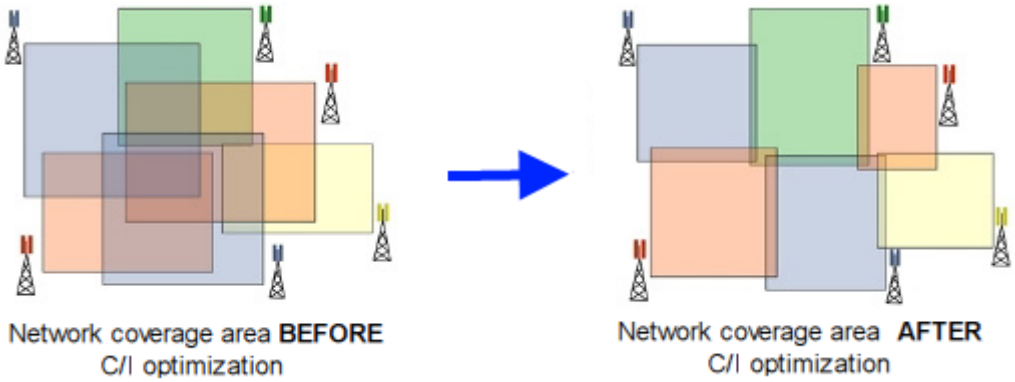
The aim of RF optimization for TDMA based access technologies hence is to minimize the likelihood of co-channel interference independent of the implemented frequency plan and hopping pattern.

Optimizing for the carrier to interference ratio results in:

- Significantly lower co-channel interference
- Reduced interference from far-off cells
- Significant reduction of potential co-channel interference for a different frequency plan / hopping pattern
- Clear structured cell borders
- Clear and regular best server plots

Since all potential interference sources, i.e. potential co-channel interferers are considered, the parameter optimization enables an improved performance for all possible frequency plans and hopping pattern.

Problems that cannot be solved by frequency planning alone will be fully addressed by the optimization of the RF configuration.



Requirements

The requirements specify the threshold of the co-channel interference ratio. For example, a C/I requirement of 5dB means that as many pixels in the optimization area as possible should have a C/I ratio of more than 5dB after the optimization.

Note: Indoor losses and the mobile station noise figure *are* considered for this target, but mobile station gain and body loss are *not* considered.

Coverage requirement fulfilled: enable this checkbox if you want to maximize the area where the requirements for the C/I AND the coverage requirement are fulfilled. If multiple coverage targets are defined for the same network (see also Network/Service Settings on page 29) select the appropriate one from the presented list.

Quality - Pilot Pollution and SHO Overhead (2G)

See Quality - Pilot Pollution and SHO Overhead on page 76.

Quality - Worst Polluter and Overshooting (2G)

See Quality - Worst Polluter and Overshooting on page 77.

Uplink Coverage

See Uplink Coverage on page 81.

Handled Traffic (All Technologies)

See Handled Traffic (All Technologies) on page 82.

Derived Targets (Combi)

Combi Targets

A *Combi target* is a logical combination (AND, OR, XOR) of previously defined targets. This allows a flexible, user-specific definition of individual requirements, for example increasing the area with both UMTS and GSM coverage.

Note: Most types of targets are available to combine within a Combi target. This includes Targets with measurements. However, Inter-system handover targets and LTE Carrier Aggregation Targets are *not* available. Also, Combi targets cannot be nested inside other Combi targets. A logical XOR (exclusive OR) combination of 2 targets is equal to the one or the other target but not both at the same time (e.g. coverage by a single network only).

To define a Combi target, please use the following workflow:

1. In the **Optimization Target** screen of the user interface, select **Combi target** from the list of available target types.
2. Click the *Add target* button.
3. Using the *Add* button in the Requirement pane, select the optimization targets for combination (from the list of already defined targets). Then select one of the available logic operators (AND, XOR, OR). This operator applies to all chosen targets.

   Note: Only targets which have already been defined can be selected for combination.

   ---

4. Define a weight for the Combi target. To contribute to the total objective, an optimization weight greater than zero needs to be defined. By default a weight of 1 is used. Select the weight carefully according to the weights of other – already defined – targets.

   Note: If a Primary target is only used in a Combi target without contributing to the total objective, define the Primary target as usual, set its requirements, and assign it a weight of zero.

   ---

5. GROUPS: To be able to group targets, that is, to define expressions with brackets like (Target-A AND Target-B) OR Target-C, the bracketed targets must be assigned to a group.

   Define a group with the *Group* button. Select the new group by clicking on it, then assign targets to the new group and define the logic operator as explained in item 2. The logic operator of the group will be applied to all targets within the group. The group itself contributes to the Combi target with the logic operator of the Combi target.

   Groups within groups are possible.

6. To delete a target, select it in the target list and press the *Remove target* button.

Traffic Density Weighting

With the aim of providing network coverage and performance where it is needed most, ASSET Design considers a given traffic density map for the weighting of the significance of that area.

To enable this, a traffic map has to be loaded for the optimization in ASSET Design. This traffic density map and the associated traffic weighting can then be applied for each individual optimization target. Note that you can load separate weighting maps for each target if required.

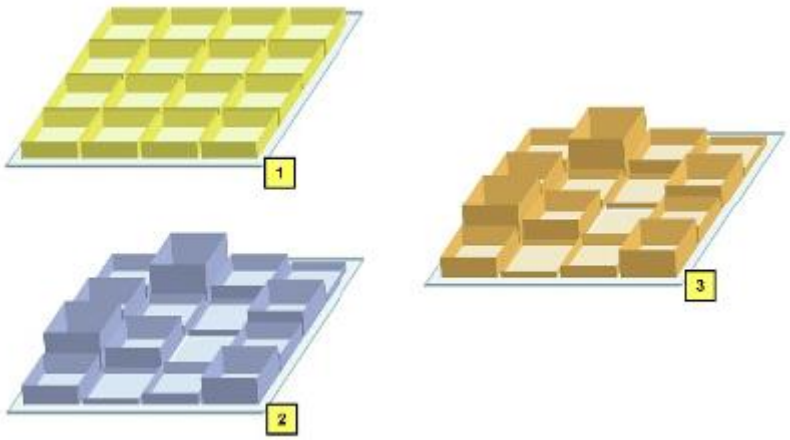
The traffic maps should represent absolute or relative traffic measures, such as traffic density in Erlangs, average number of users, or any other proper measure. For the optimization these weights represent the significance of the optimization target.

The traffic maps show that the traffic density is distributed in a highly inhomogeneous way. In the city center the traffic density is high per bin (dark areas), while in the surrounding areas of this city the traffic density is less (almost white areas).

A weight of "0" means that the performance measure is not considered at all in the optimization.

Basic Principle of Traffic Density Weighting

The traffic density weighting (that is, importance) of the different areas, based on the available traffic map, is schematically described in this picture:



- Map [1] represents the optimization target (for example, coverage).
- Map [2] incorporates different traffic density values for each pixel.
- Map [3] depicts the traffic density weighted values, showing the 'important' pixels for the coverage, based on the given traffic map.

In the above picture, the pixels in Map [1] are all equally weighted. If we assume that this map represents coverage, it means that each pixel has the same importance and hence delivers the same contribution to the overall coverage probability.

In Map [2] the pixels have different values. In the case where a traffic map is used, such a map would represent the traffic density in Erlangs, average number of users, or any other proper measure. The importance of the map is that there are areas where there is a higher traffic value, and areas where there is a lower traffic value. According to these traffic values it is important to an operator to provide service coverage where it is needed most.

In order to apply the traffic weighting to a specific optimization target, ASSET Design enables you to load traffic maps and to apply them individually to each optimization target. The result is that the weighted optimization target is the pixel per pixel multiplication of the overall optimization weight for a specific optimization target and the actual value of the traffic map. This is shown schematically in Map [3].

In summary, if we consider Map [1] as the coverage requirement, we can then multiply these requirements with the traffic map (Map [2]) and the result is the weighted coverage target (Map [3]). With this information, the optimization algorithms in ASSET Design will ensure that the best performance is achieved for those areas (pixels) where the importance is highest.

Captured Traffic and Traffic Sharing

You can use the Captured Traffic settings to limit the maximum captured traffic of cells.

- For details on editing traffic limits, refer to Traffic Map Settings on page 31.
- For using traffic maps in the context of other target functions, refer to Targets - Traffic on page 66.

Definition of Terms

Captured Traffic:

Defines all traffic within the captured traffic threshold of a cell. This traffic is independent of cell or site limits.

Handled Traffic:

Defines the captured traffic that can also be handled by a cell/site.

If the captured traffic is lower than the cell limit then handled traffic = captured traffic.

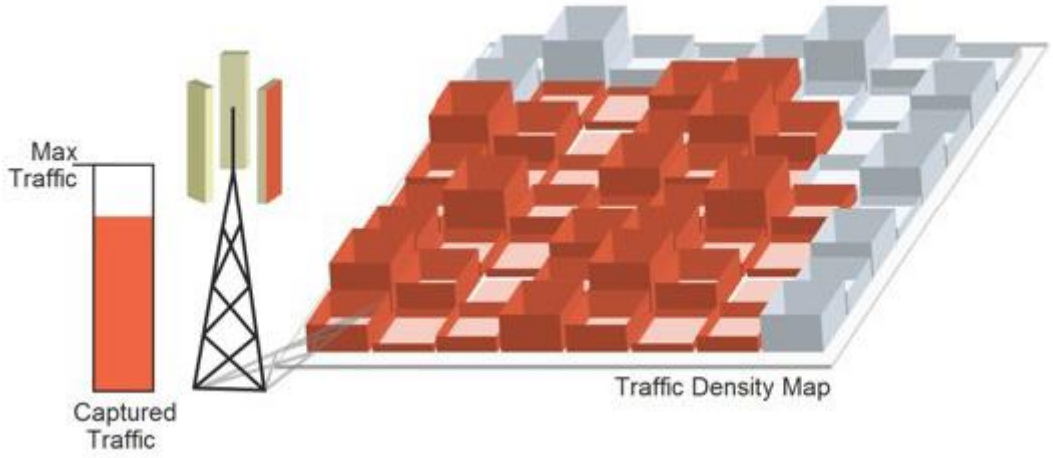
If the cell limit is lower than the captured traffic then the handled traffic = cell limit, and the additional traffic remains as unhandled but captured.

Beyond a cell limit, the handled traffic can be further limited by a site limit.

Captured Traffic Description

Basically, the captured traffic is calculated once per network (if required), based on the best server footprint plot and using a traffic density map.

In order to consider the captured traffic during the optimization, a traffic density map has to be included in the optimization. This can be done by loading a traffic map in the Project Settings or individually for a network layer in Networks and Parameters. Based on this traffic density map, ASSET Design then computes how much traffic occurs in the footprint of each cell. The captured traffic of a cell is the accumulation of the traffic map pixels over the cell's footprint; the size of the pixels is considered. Therefore, in order to provide useful results and be independent from different resolutions, the traffic map data should be given as a surface density map, for example, Erlangs / km^2, Users / km^2, (KBits/s) / km^2, and so on.



Caution: ASSET Design does not check the unit of the traffic map data. If the unit is not a density unit, then the result will strongly depend on the resolution.

A maximum traffic value can be defined on a cell by cell and/or site by site basis. During the network optimization, these maximum traffic limits per site/cell are considered. If the captured traffic of a site/cell exceeds its limit, the optimization algorithms will modify the network parameters so that this overload is mitigated as good as possible.

Note: The captured traffic limits are soft limits rather than hard limits. There are cases where cell overloads cannot be avoided. In any case, ASSET Design will always try to limit cell overloads as much as possible on average, while considering all other constraints as well (area depending weights, etc.).

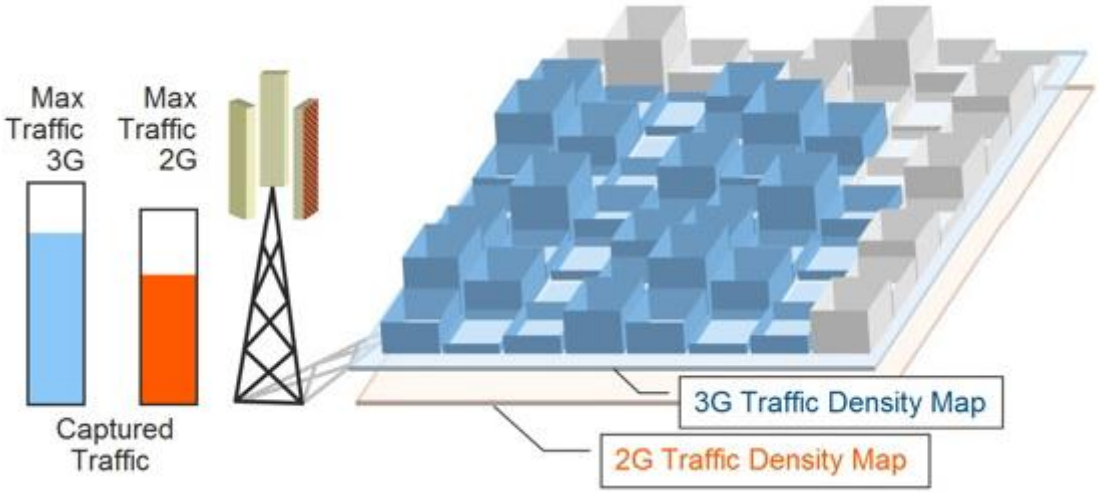
The effect of considering the captured traffic in the optimization is:

- Possibility to balance the load between different sectors.
- Mitigation of overloaded sectors.
- Trade-off between interference reduction and cell size. Small cells minimize interference. However, if the surrounding cells become overloaded as a result of capturing the traffic initially captured by the reduced cell, balance will be restored by enlarging the cell again.
- Consideration of the actual traffic demand in the network.
- Consideration of the hardware capabilities of the individual sectors.

Captured Traffic for Multiple Systems

In the case that multiple systems are planned and optimized jointly in ASSET Design, multiple traffic maps can be considered for the individual networks. Refer to Networks and Parameters to learn how to load individual traffic maps per network

Using multiple traffic maps enables to examine the captured traffic individually per radio technology. The sector specific traffic limits can be defined separately for 20 and 30 radio technologies in ASSET Design. An example is schematically described below:



The best server footprints for both the 20 and the 30 radio networks, which share a multi band antenna in this case, capture a certain traffic per sector. In ASSET Design, a maximum traffic for each sector can be defined for each individual technology. This allows the consideration of the maximum traffic in each technology separately during the planning and optimization process.

Traffic Sharing for Captured Traffic

This function has an impact on the way the captured traffic is calculated.

Usually, the captured traffic is calculated for the network layer using a traffic density map, which is either defined in the Project Settings window or individually for the network in the network settings window. Networks can be defined to share traffic (at least 2 and up to all networks defined in the project). This is managed on the Network/Service settings screen. Note that for this function to be available, all involved networks must define maximum captured traffic limits for each cell. The networks which shall share traffic, have to be ordered by rank.

There is a dialog available for the definition of the ranks of the involved networks. It is opened by using the ... button. The captured traffic of each involved network is calculated based on the same traffic map starting with the rank 1 network. Consequently, the rank 1 network uses the traffic map itself for the captured traffic analysis. Based on its maximum captured traffic limits, the traffic remaining after network 1 is calculated and temporarily stored in a traffic map for the rank 2 network. Network 2 uses this traffic map with the remaining traffic for the captured traffic analysis and subsequently stores the remaining traffic in another traffic map for network 3 (if required) considering its maximum captured traffic limits. This process is continued up to the last network.

The shared traffic maps can be displayed in Inspector.

Note: Traffic sharing only makes sense if at least one target function uses *Apply captured traffic limits* or uses shared traffic for weighting. This target function must use the highest ranked network, otherwise shared traffic analysis for this network is not required. ASSET Design outputs an error if these conditions are not met.

Weighting with Shared Traffic

In addition to using captured traffic limits with shared traffic, weighting with shared traffic is also available.

This is a very powerful feature. For example, it can be used to activate sites of a capacity layer (LTE) only in locations where a basic coverage layer (UMTS) cannot handle the entire offered traffic.

The basic settings to use this function are explained in the previous section Traffic Sharing for Captured Traffic on page 91.

As described above, ASSET Design calculates internal maps with traffic remaining from network layer n-1 to be used for the captured traffic analysis in the network layer n. This is the traffic remaining from network n-1 after subtracting the captured traffic while considering the captured traffic limits of the cells of network n-1. This internal traffic map will be used as weighting map for targets of network n where the corresponding option is enabled; this corresponds to weighting targets with shared traffic (see Targets - Traffic on page 66).

Note: Targets with shared traffic weighting will be multiplied with the ratio of the total traffic of the network and the total traffic of the original traffic map. This ensures that the relative impact of such targets of different networks corresponds to the amount of traffic in the shared maps. In other words, such targets will be normalized to less than 1, while targets using weighting with regular traffic maps (non-shared) or without traffic maps will be normalized to 1.

Example
Objective: Activation of sites of a capacity layer with traffic remaining from a coverage layer.
Coverage layer – UMTS:
Use a traffic map for the network defining the total offered traffic of all subscribers
Define captured traffic limits for the cells
Capacity layer – LTE:
All cells inactive
Allow activation
Define captured traffic limits for the cells
Traffic sharing group:
Rank 1 – UMTS
Rank 2 – LTE
Coverage target 1:
LTE
Shared traffic weighting
Apply captured traffic limits
Coverage target 2:
UMTS
Apply captured traffic limits
As both targets apply captured traffic limits, their maximum objective value will be bounded above with the ratio of the maximum captured traffic of the entire network (sum of all max. captured traffic of the cells) and the total offered traffic of the shared traffic map. For the UMTS network, this is the ratio of the traffic that can be handled by the cells considering the coverage threshold and the total offered traffic of all subscribers. For the LTE network, this is also the ratio of the traffic that can be handled by the LTE cells and the total offered traffic of all subscribers. But for LTE, the used traffic for the analysis will only be what is remaining as unhandled traffic from UMTS. Thus, the objective value will usually be smaller than that of the UMTS target.
Thus, the sum of both target function objective values will not be larger than 1.

LTE cells will preferably be activated in areas with large unhandled traffic remaining from UMTS.

Note that the actual target function objective values will usually be smaller that their upper bound (defined above) depending on the coverage threshold used for the targets. If not the entire area can be covered with the given threshold, then the traffic in these areas will not be considered for the target function weighting and the objective value is smaller. The sum of both target function objective values will thus be smaller than 1.

This table shows a typical result:

	Init (Raw)	Curr (Raw)	Max (Raw)	Weight	Init (Weighted)	Curr (Weighted)	Max (Weighted)
[UMTS] Coverage	10.4	10.4	10.8	1*TRF	0.764	0.764	1
[LTE] RSRP analysis	0	2.3	10.8	1*TRF	0	0.224	1
TOTAL TARGET VALUE					0.764	0.988	2

The area is almost entirely covered by the UMTS network (10.4 of 10.8 km²), but only 76.4% of the traffic can be handled as indicated by the column Init (Weighted).

Therefore, a few LTE sites have been activated which cover 2.3km² and are able to handle the remaining traffic from the UMTS network up to 98.8%.

The residual 1.2% of the traffic might be in areas where neither UMTS nor LTE coverage can be achieved with the given site locations and coverage thresholds.

As explained above, the sum of the two shared traffic weighted targets is bounded above by 1 while the sum of the individual target weights is 2. If both targets together can handle the entire traffic, the sum of their weighted objective values is 1 rather than 2. This needs to be considered in particular when combining shared traffic weighted targets with regular targets.

Extended Example

Objective: Additionally optimize the UMTS network.

Coverage layer – UMTS:

Additionally allow optimization of azimuth and tilts of the transmitters

Thanks to the implicit weighting of the target functions with the accumulated shared traffic per network (because shared traffic weighting is used), the optimization will concentrate on that network where more traffic can be captured. If optimizing azimuth and tilt of the existing UMTS sectors is more beneficial than activating an LTE cell, then these azimuth and tilt modifications will be preferred.

Note: If using targets (of different networks!) with shared traffic weighting and captured traffic limits together with targets without shared traffic weighting, then the sum of the maximum objective values of the former targets cannot be reached while it can be reached for the latter targets. This should be considered when selecting the weights of the targets.

User Equipment Antenna

For LTE or 5G networks, an antenna pattern can be considered in the analysis for the evaluation of the target functions.

For details on defining the antenna pattern and additionally a receiver loss, see LTE Parameters on page 34 or 5G Parameters on page 34, as appropriate.

In the evaluation of the target functions of the network, for which the user equipment antenna pattern is used, the antenna will be pointed towards the best server of each pixel. Hence, the uplink and downlink coverage analyses will be boosted by the antenna gain (minus receiver loss if different from zero).

Interference from the best server will be boosted by the same factor, while interference from other cells will be suppressed by the antenna masking in the direction between the best server and the interfering cell. Both the horizontal angle and the vertical angle are considered for the antenna masking.

If a receiver loss different from zero has been defined, it will be subtracted from the user equipment antenna gain for the calculation of all up-link and down-link signals. The received downlink noise power will be increased by the same value (in addition to the noise figure of the user equipment, which can be defined for each target function individually).

Note: If a user equipment antenna pattern is selected, it will be used for all target functions that are defined for the corresponding network. Target functions of other networks will not consider this pattern.

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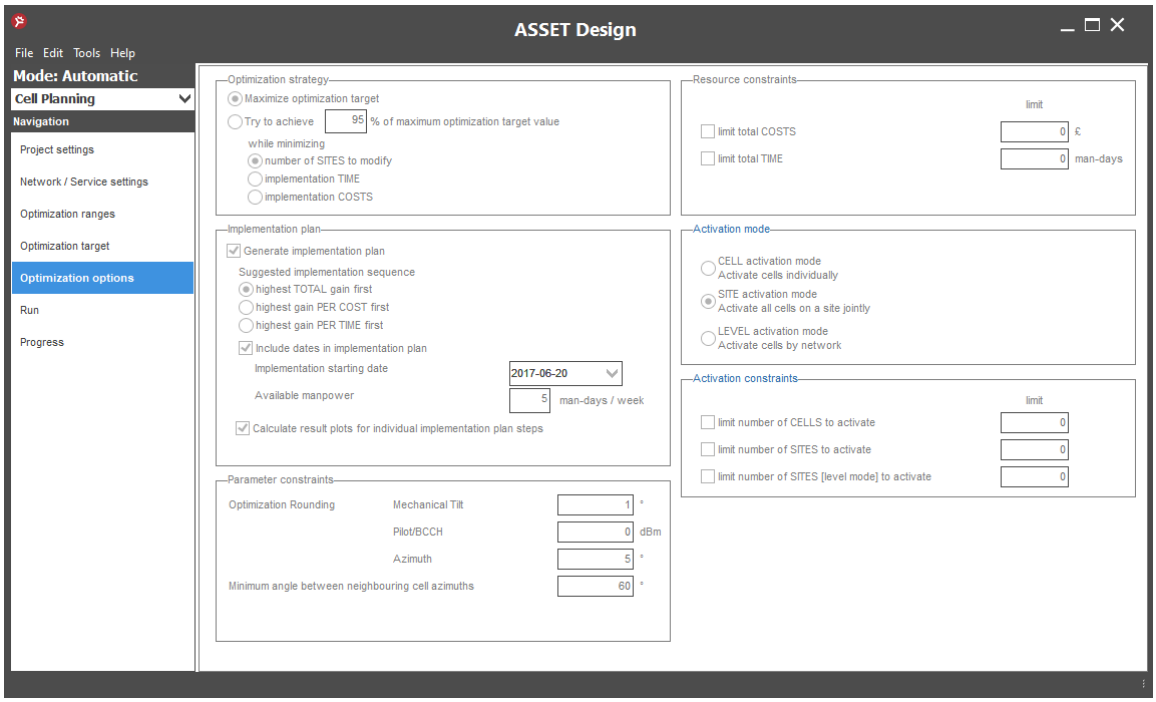
8 Optimization Options

Here you can view and manipulate a number of options for the optimization process.

This picture shows the ASSET Design interface with Optimization Options selected:



ASSET Design interface - Optimization Options

Optimization Strategy

Use the Optimization Strategy pane to define the strategy for the automated optimization.

You can either maximize the performance for given resources including available budget, time and infrastructure, or you can optimize to achieve a required optimization target for minimum costs.

The options are as follows:

Option	Description
Maximize optimization target	Select this option to maximize the optimization target as defined in the Optimization Target screen. This assumes that the resources in terms of the number of base stations/sectors are given.

Option	Description
Try to achieve n% of maximum optimization target value while minimizing	Select this option to achieve a certain percentage of the optimization target. For example, if only the coverage requirement (RX pilot) is set in the optimization target, the aim is to satisfy that coverage requirement for, say, 95% of the area. The result will then be the required infrastructure in order to achieve this. On top of that, the ultimate goal of the optimization is to achieve the optimization target, or a percentage of it, by minimizing the resources required to achieve that. This includes: • Minimizing the number of **SITES** to modify: Select this option to achieve the defined optimization target while minimizing the number of sites that need to be modified. • Minimizing the implementation **TIME**: Select this option to achieve the defined optimization target while minimizing the time required to implement the modifications in the network. This includes the time required for site preparation and infrastructure installation for new base stations and cells (sectors), as well as the additional time for parameter modifications of the existing infrastructure (if any available). • Minimizing the implementation **COSTS**: Select this option to achieve the defined optimization target while minimizing the costs for implementing the modifications to the network. This includes both the activation costs for new base stations and cells (sectors), as well as the costs for parameter modifications of the existing infrastructure (if any available).

Example 1: Network roll-out at MINIMUM COST

The area where a service coverage should be provided is given (optimization area). 95% of the area should receive a minimum pilot coverage level of, say, -85dBm. A number of potential sites (existing 20 base stations) can be used as potential 30 base stations. The costs for the installation of a 3 sector base station is known. The question is: What is the minimum cost for the roll-out that satisfies the 95% coverage probability at -85dBm.

Solution: Use the inactive sites for your potential network deployment. Define the coverage target of -85dBm in the Optimization Target screen. Select the *Try to achieve 95% of maximum optimization target value while minimizing COSTS* option. ASSET Design will automatically provide the list of sites that should be activated. It will also provide the best parameter configuration for all sectors.

Example 2: Network extension for MINIMUM COST

Additional areas need to be covered; higher network capacity is required; better indoor-coverage needs to be provided. For this, a number of base stations already exist. The question is how should the network be extended or modified in order to reach the new performance requirement at minimum cost.

Solution: Within the mix of already active and inactive sectors, define the optimization targets. Select the *Try to achieve n% of maximum optimization target value while minimizing COSTS* option. ASSET Design will then automatically provide the list of sites that should be activated. It will also provide the best parameter configuration for all sectors, both the newly activated as well as the existing ones. The objective however is to provide the solution at minimum costs.

Example 3: MAXIMUM PERFORMANCE for given resources

The resources (budget, base station equipment, transmitters, and so on) are given. The objective is to squeeze the network in order to get the maximum performance in return of the existing investment.

Solution: Select the optimization target in the Optimization Target screen. Select the *Maximize optimization target* option in order to get the best performance of the network.

Note: This optimization strategy requires the generation of an implementation plan.

Implementation Plan

Use the Implementation Plan pane to enable the calculation of an implementation plan for the suggested parameter modifications in the optimization process. The implementation plan will provide an ordered list of parameter modifications. It can be ordered so that the implementation will ensure that the most significant changes can be done first. It also makes sure that the overall network performance will improve during the implementation of the individual changes.

Option	Description
Generate implementation plan	Enable the checkbox if you want to provide the implementation plan after the optimization. The implementation plan will be delivered as part of the optimization report file. See also View Report (Cell Planning Mode) on page 133. **Note**: This is the overall checkbox that enables the other settings and activates them in the optimization. **Important**: To learn more about the implementation plan, the effects of the limited availability of sites/sectors/ equipment and the impact of other individual constraints, see Implementation Plan Details on page 100.
Suggested implementation sequence	**Highest TOTAL gain first:** Select this option to generate the implementation plan in such a way that the parameter modification with the highest gain will be implemented first. The parameter modification with the lowest impact on the total optimization target will be implemented last. **Highest gain PER COST first:** Select this option to generate the implementation plan in such a way that the parameter modification with the highest gain - compared to the associated costs it is generating - will be implemented first. The parameter modification with the lowest gain versus costs will be implemented last. **Highest gain PER TIME first:** Select this option to generate the implementation plan in such a way that the parameter modification with the highest gain - compared to the time that is required to implement it - will be implemented first. The parameter modification with the lowest gain versus required time will be implemented last.
Include Dates in Implementation Plan	Enable this checkbox to consider absolute dates in the generation of the implementation plan. For a full description, see Implementation Plan Details on page 100.
Implementation starting date	This drop-down calendar is only visible if the '*Include Dates in Implementation Plan'* checkbox is enabled. If this is the case you can then select the date when the implementation plan should start.
Available manpower	This data field is only visible if the Include Dates in Implementation Plan check box is enabled. You can define the amount of manpower available per week. This value is given in man-days/week and represents an AVERAGE number for the working power available per week. The available manpower should also include public holidays as well as weekends.
Calculate result plots for individual implementation plan steps	Enable this checkbox to compute the different plots for the visualization of the implementation plan steps in Inspector. For further details see how to visualize the different plan steps in Implementation Plan in Inspector on page 172. **Warning**: For very large networks with a high resolution and many sites involved in the optimization process, this option will take extra time and a lot of extra memory to handle all plots for the implementation plan steps.

Examples of Available manpower

- 1 "average" person, 250 working days a year (49 weeks at 5 days - 3 weeks holidays) gives an average number of about 4.7 man-days/week.
- 3 "average" people give about 3-times the manpower of a single person, which would be (3 x 4.7) = 14.1 man-days/week.
- External consulting work can be ordered up to a certain workload of X man-days/week.

Note: The following points should be considered when defining the average manpower available:

- Average working days per person vary between different countries and companies, especially if they are project related
- External support teams have a different behavior in terms of available manpower. It might just be expressed in cash costs, rather than time consumption.
- The amount of holidays vary from country to country
- Public holidays should be considered in the definition of the average available manpower

Parameter Constraints

Use the Parameter Constraints pane to view and manipulate the parameter constraints for the optimization process.

Setting	Description
Optimization Rounding (Precision)	**Mechanical tilt:** Use this box to view and modify the granularity of the mechanical tilt changes allowed during the optimization process. **Pilot/BCCH:** Use this box to view and modify the granularity of the power changes allowed during the optimization process. **Azimuth:** Use this box to view and modify the granularity of the azimuth changes allowed during the optimization process. **Note**: If "0" is entered in the fields for the individual optimization precisions, no constraints to the parameter values apply.
Minimum angle between neighboring cell azimuths	In cases where Azimuth optimization is enabled, a minimum angle separation between two sectors (cells) at the same site can be required. This is sometimes necessary due to construction-conditioned antenna deployment.

Resource Constraints

Use the Resource Constraints pane to define the maximum cost and time budgets that limit the number of modifications in the optimization process.

The optimization will consider both costs and time required to implement the individual parameter modifications. The individual costs and time parameters can be set for each sector in the 'Activation Resources' and 'Modification Resources' panes in the **Optimization Ranges** screen. Default values for the cost and time parameters are defined on the **Range Defaults** tab of the **Preferences** dialog box.

Option	Description
Limit total COSTS	Enable this checkbox to limit the optimization by the costs for the implementation of the individual modifications. The individual costs for each modification are defined in the parameter settings in the Optimization Ranges screen. **COSTS limit:** Specify the maximum budget assigned to the optimization of the current optimization project. The currency for the cost data is defined on the General tab of the Preferences dialog box. The default value for currency is the one defined in the Regional and Language Options in the Windows Control Panel.

Option	Description
Limit total TIME	Enable this checkbox to limit the optimization by the time required for the implementation of the individual modifications. The individual time requirements for each modification are defined in the parameter settings in the Optimization Ranges screen. **TIME limit:** Specify the maximum time budget assigned to the optimization of the current optimization project. The unit name for time data is defined as man-days.

Note: To learn more about the impact of resource constraints on the optimization result and the implementation plan, see Implementation Plan Details on page 100.

Activation Mode

Use the Activation Mode pane to select the activation mode for your optimization.

Setting	Description
CELL activation mode	Select this option to activate *inactive* transmitters on a cell by cell basis. This means that cells can be activated individually. If CELL activation mode is selected, the number of transmitters to activate can be limited.
SITE activation mode	Select this option to activate *inactive* transmitters on a site by site basis. This means that all cells/transmitters on a site will be activated jointly. If one or more, say, 2 out of 3, cells are already active at a particular site, the site activation mode will activate all remaining cells/transmitters. Cells already active prior to activation will remain active. If the SITE activation mode is selected, the number of sites to activate can be limited.
LEVEL activation mode	Select this option to activate *inactive* transmitters on a site, where all transmitters belonging to the same network layer will be activated jointly but independently from transmitters of other network layers on the same site. Use this mode if you want to activate one or more network layers on a site by site basis. This mode is particularly useful for site sharing analysis to find out which sites to share between different layers (such as different operators). Cells/transmitters already active prior to activation will remain active. If the LEVEL activation mode is selected, the number of sites to activate can be limited.

Activation Constraints

Use the Activation Constraints pane to define the maximum number of sites that limit the activation process during the optimization.

Setting	Description
Limit number of CELLS to activate	Enable the checkbox to limit the number of cells available for activation during the optimization process. This constraint is only visible if the CELL activation mode is selected. **CELLS limit:** Specify the maximum number of cells that can be activated during the optimization.

Setting	Description
Limit number of SITES to activate	Enable the checkbox to limit the number of sites available for activation during the optimization process. This constraint is only visible if the SITE activation mode is selected. **SITES limit:** Specify the maximum number of sites that can be activated during the optimization.
Limit number of SITES [level mode] to activate:	Enable the checkbox to limit the number of sites [level mode] available for activation during the optimization process. This constraint is only visible if the LEVEL activation mode is selected. **SITES [level mode] limit:** Specify the maximum number of sites [level mode] that can be activated during the optimization.

Examples

Activation constraints examples:

- Constrained to 10 sites: The optimization is limited by the joint activation of the cells on a maximum of 10 sites in total. The order of the per-site activations is shown in the implementation plan.
- Constrained to 15 cells: The optimization is limited by the individual activation of 15 cells. This can be on a maximum of 15 sites (one cell per site each). The order of the per-cell activations is shown in the implementation plan.

Note: To learn more about the impact of activation constraints on the optimization result and the implementation plan, see Implementation Plan Details on page 100.

Implementation Plan Details

The implementation plan provides an ordered list of parameter modifications. The ordering means that the parameter modifications can be implemented in such a way that the most significant changes occur first. It also ensures that the overall network performance will improve during the implementation of the individual changes.

This section will help you understand the Availability Restrictions, with some examples as well as additional general comments.

Availability Restrictions

Availability restrictions have a major impact on the implementation plan. It does not make sense to optimize the configuration and the best implementation of a site into a network, if we do not know when this site will be available. Only when the site is available it can be considered in the process of improving the network performance.

Definition of Availability Restrictions

In the activation section in the Optimization Ranges you can define the availability restrictions of any individual transmitter considered for the radio network optimization. To each transmitter an availability date can be applied. The site availability is given on an absolute time scale.

Using Dates in the Implementation Plan

In order to consider the absolute availability dates for the generation of the implementation plan, you need to enable the *Include dates in implementation plan* checkbox in the Optimization Options screen. ASSET Design will then automatically consider the absolute dates for the best implementation of the modifications in the network.

Examples

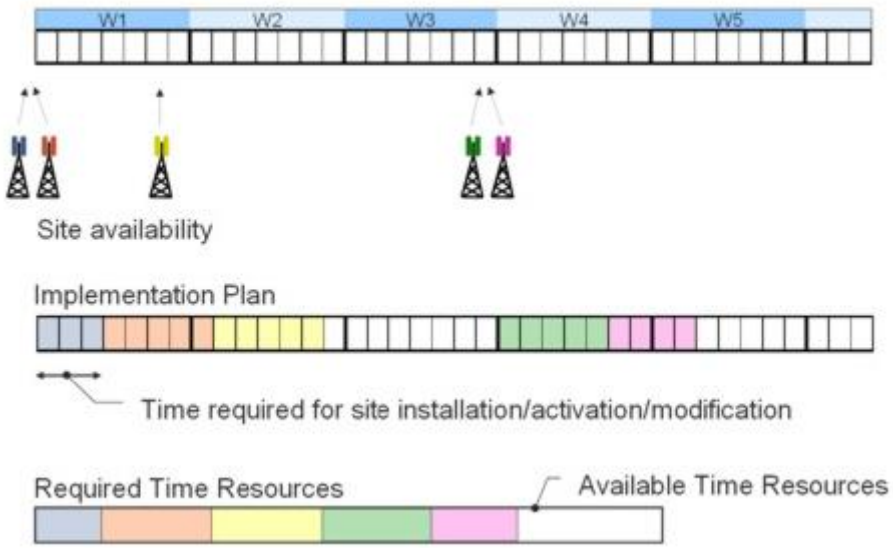
In order to get a better understanding of the elapsed time feature in the implementation plan, please see the three examples below:

Ex.1: Implementation Plan with Availability Restrictions

Assume that we have 5 different sites available for a network cluster. All of them will be available within a time frame of, say, 3 weeks (beginning of W1 till end of W3). The blue and the red as well as the green and the pink site are available at the same time.

All of these sites require certain resources to be implemented, such as the time required to install, activate and modify the sites, the costs, and so on. These parameters are defined in the Optimization Ranges.

When enabling the *Include dates in implementation plan* checkbox in the Optimization Options screen, the implementation plan will look like this:



It includes the following information:

- If sites are available at the same time, ASSET Design will implement the most effective one (according to the setting for the implementation plan - see the description of the implementation plan settings in the Optimization Options screen). In the example the blue site is obviously more effective and hence implemented first.
- A site can only be implemented/modified once it is available. After finalizing the implementation of the blue site the yellow site is still not available. Hence, it cannot be implemented (whether it is more effective than the red one or not is a different question).
- If no sites are available, nothing can be implemented. Hence, there is a hole in the implementation plan after the finalization of the implementation of the yellow site until new sites are available.

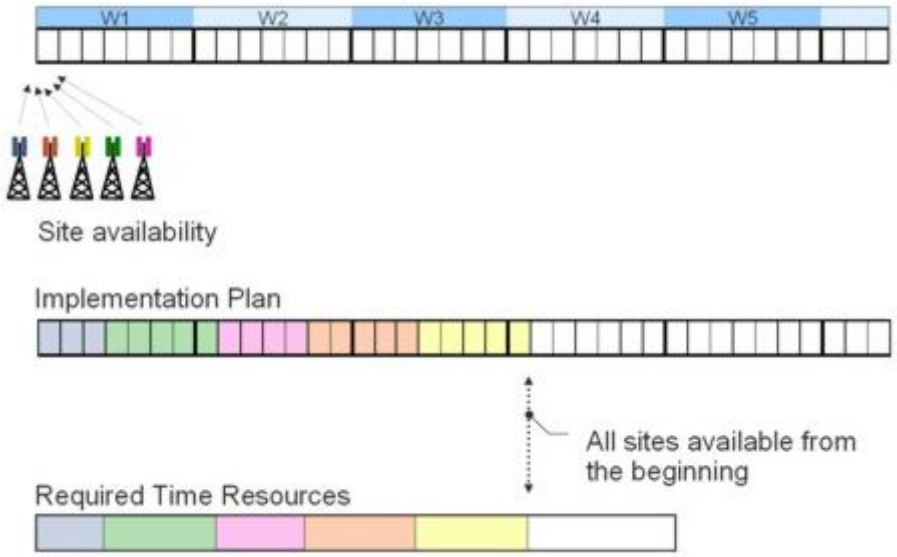
  Warning: This means that the starting date for the implementation time PLUS the time it takes to implement the network modifications does not give the completion date of the modifications in the implementation time!

- As long as the available time resources are larger than the time it takes to implement the modifications, ALL changes can be implemented. The constraints are not limited to time resources, any other constraints like number of available sites, or costs are considered as well.
- The available time does not need to be consumed all together, that is, the resources available can be split into several projects separated by times where no implementations are done.

Ex.2: Implementation Plan when All Sites are Available

Assume that we consider the same network scenario as in Example 1. The difference however is that all sites are available from the very beginning, that is, they are available before the completion of the integration/modification of the first site.

By selecting the option *Include date in the implementation plan* all site availability restrictions are considered. However, practically no restrictions will appear in the implementation plan due to the fact that all sites are available from the start.



The conclusions from this example are:

- The time from the start of the implementation to the completion date will be the same as the required time resources needed for the implementation.
- The alignment of the difference between start and completion time in the implementation plan and the required resources and also happen if no availability restriction occurs after the completion of a single site. This means that as long as there are sites available that should be build, the time will be aligned.

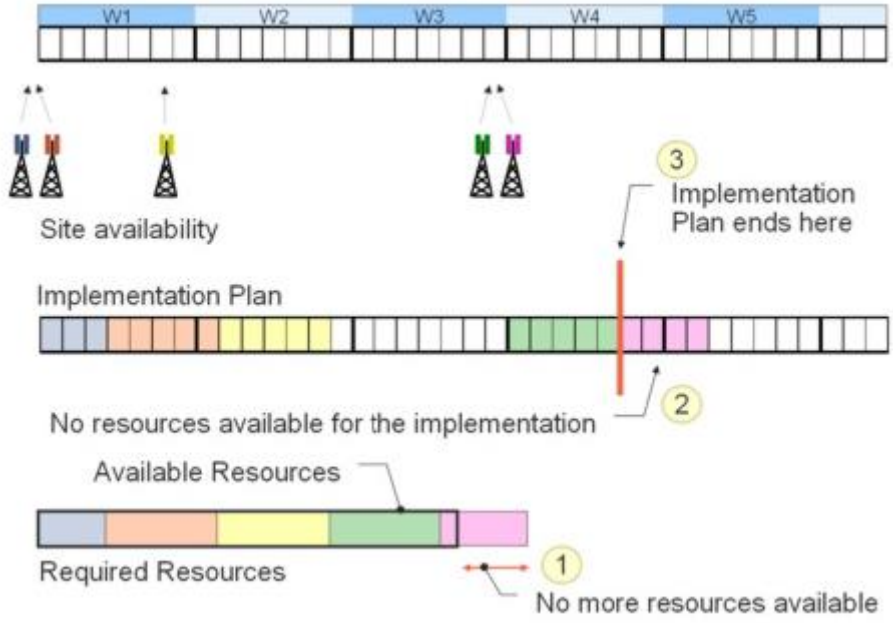
Ex.3: Implementation Plan with Limited Resources

Assume that the scenario is the same as in Example 1. Sites will be available within a time frame of about 3 weeks. According to the requirements defined in ASSET Design the different sites will be implemented.

The difference in this example however is the amount of resources available to complete the site activation/implementation/modification. The limitation in the available resources leads to the following conclusions:

- Resource limitations can be available time, costs, equipment, number of sites, number of sectors, etc.
- If the overall resources required to implement all of the suggested modifications is larger than the amount of resources available, the implementation plan will limit the number of modifications so that all available resources are not exceeded.
- In case of multiple limitations, that is, available cost budget and time budget, the constraint exceeded first will be the limiting factor.

- The available time does not need to be consumed all together, that is, the resources available can be split into several projects separated by times where no implementations are done.



Additional General Comments

Here are some general comments for consideration when using an implementation plan with availability restrictions and resource constraints:

- In the Optimization Ranges the time required to activate/implement/modify a particular site/ sector/parameter is given in man-days. The time resources are given in man-days per week. Therefore, the time it takes to implement a modification in the implementation plan is calculated as
  - Required Calendar WEEKS = man-days (required) / available man-power (man-days/week)
  - Required Calendar DAYS = Required Calendar WEEKS * 7
  - Completion DATE = Starting date + Required Calendar DAYS
  - The direct consequences of this scheme are:
- Weekends do not represent non-working days.
- Public holidays do not represent non-working days.
- The completion date can be any day, including Saturdays, Sundays and public holidays
- The completion date should not be interpreted as an exact date, but rather as a good estimate.

9 Running an Optimization

Here you can set optimization options and start the network optimization process. There are different processes according to whether you have chosen:

- **Cell Planning** mode

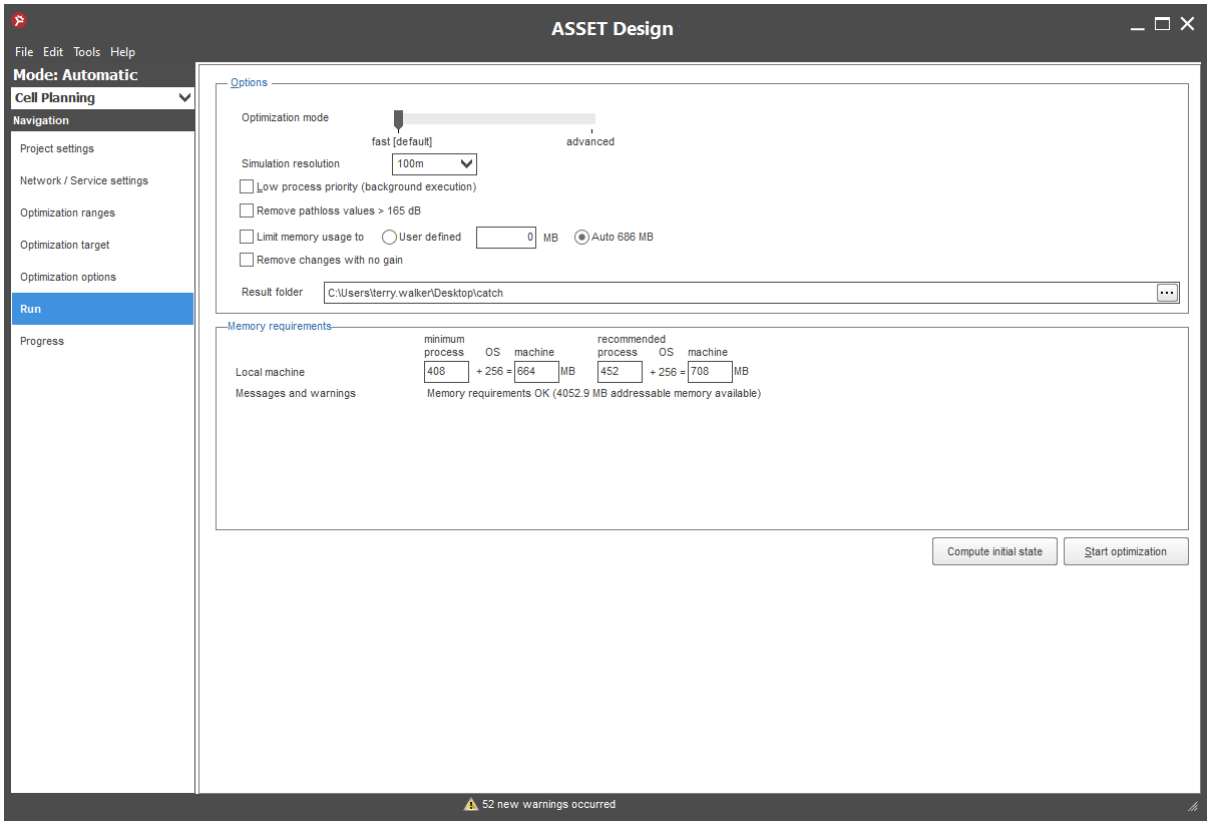
  - or -

- **Site Placement** mode

Run (Cell Planning Mode)

Here you can set the **Cell Planning** options and start the network optimization process.

This picture shows the ASSET Design interface (in Cell Planning mode) with 'Run' selected:



ASSET Design interface - Run (Cell Planning Mode)

Run Options

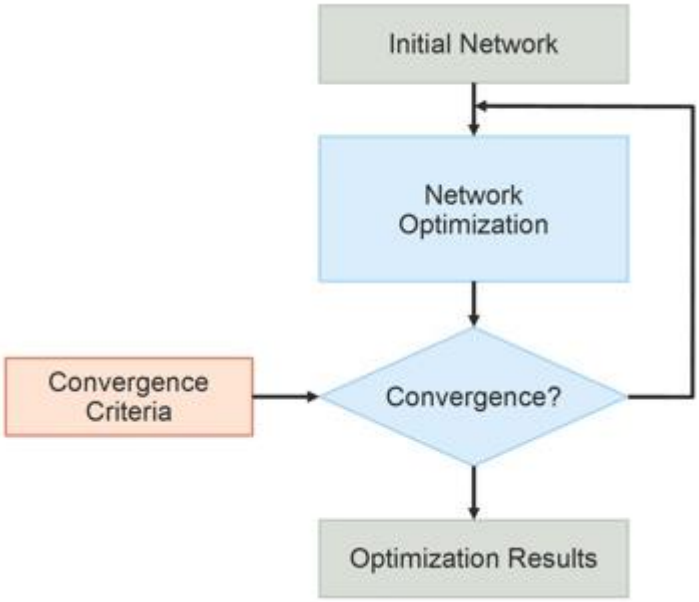
On the **Run** screen (**Cell Planning** mode), there is an Options pane with the following settings:

Option	Description
Optimization Mode **(Fast <=> Advanced)**	Use the Optimization Mode slider to control the compromise between optimization speed and optimization quality. The key objectives of the options on the Optimization Mode slider are as follows: **Fast** - achieve good optimization results within a very short time frame. This end of the slider places an emphasis on optimization speed. **Advanced** - achieve the best achievable solution. This end of the slider places an emphasis on optimization accuracy. The best results are obtained when optimizing in Advanced mode with the finest possible simulation resolution. For a more detailed description see About the Optimization Algorithms on page 107.
Simulation Resolution	Choose from this menu the grid (pixel) resolution to use during the optimization process. Choosing a higher simulation resolution yields a smaller grid cell (pixel) size and delivers more accurate results. Four simulation resolutions are available, based on the initial resolution set for the export of the ASSET Design optimization environment. **Important**: Especially for large area radio networks (that span several thousand square kilometers), we highly recommend to start the optimization with a coarse resolution to save calculation time! In the case where the simulation resolution chosen in ASSET Design is coarser than the used analysis resolution in the ASSET project, the indicated optimization gains on the **Progress** screen will deviate from the optimization gain when verified in ASSET directly. This means that the improvement of the optimization speed comes along with the reduced optimization quality. For an example, see Simulation Resolution Example on page 108.
Low process priority	Enable this checkbox to decrease the priority of the optimization engine. With low priority, the optimization runs in the background and only uses idle resources on the machine. Use this option when optimizing a network while working in ASSET or any other application.
Remove pathloss values > n dB	Use this option to reduce the size of the pathloss data in memory while the optimization is running. ASSET Design will find the smallest possible rectangle for each pathloss matrix only containing pathloss values smaller than the given threshold. The threshold can be defined on the General tab of the Preferences dialog box. Select the threshold carefully to avoid removing areas of the pathloss file which might be important for the network simulation. The default value for the threshold is 165dB. If an optimization uses too much memory to fit into the physical RAM of the computer, enable this checkbox to minimize the memory demand.
Limit memory usage	Limits RAM use to a user defined or automatically selected amount (based on current optimization settings). This may help to prevent ASSET Design from needing to swap from memory to disk in cases where more than one optimization is run concurrently on the same machine. The closer the limit is to the recommended amount, the better the optimization performance. The automatically selected value is the average of the minimum and the recommended memory.
Remove changes with no gain	Use this option to add a post-processing step at the end of the optimization run to detect recommended changes that actually do not provide any target function improvement. Such changes will be eliminated. Note that this post-processing step will use up to about 10% extra run-time. Changes without gain might occur, for example, in optimizations that do not use costs to limit the number of changes.

Option	Description
Result folder	The result folder will contain the optimization results, the optimization report and importable files to get results back into ASSET. For each optimization a sub-folder with an ascending number will be created. The optimization report file stores all relevant information regarding the optimization process, which includes the following: • Optimization settings • Optimization ranges • Results overview • Roll-out report • Implementation Plan **Note**: If the optimization is terminated by the 'Stop' button on the **Progress** screen, NO implementation plan is generated. The implementation plan can only be computed if the optimization is completed successfully. Otherwise an intermediate state would be the result that does not satisfy the requirements of the implementation plan.

About the Optimization Algorithms

The optimization algorithms in ASSET Design include a number of methods to analyze and optimize the overall network behavior. Based on the analysis the algorithms determine probabilities and hypotheses for expected performance improvements. These hypotheses are evaluated and confirmed in an iterative process by network simulations.



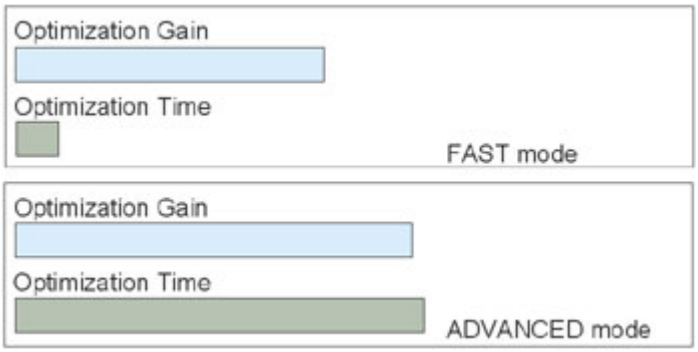
This iterative process uses a number of different methods to investigate the potential of the improvement of the network. For each iteration stage the proprietary optimization algorithms are applied. Based on the result of the individual iteration stage, a subsequent iteration stage is started. This iteration process can be terminated when the convergence criterion is fulfilled. Typically this convergence criterion is either a maximum number of iteration stages, or by a minimum level for the performance improvement per iteration stage. If the improvement per iteration stage is lower than this minimum required improvement, the optimization converged and hence the iteration process terminates.

ASSET Design incorporates the following convergence criteria for the different optimization modes:

- **Fast:** Terminates after a maximum number of iteration runs
- **Advanced:** Terminates after satisfying performance-based convergence criteria

The best results are obtained when optimizing in **Advanced** mode with the finest possible simulation resolution. However, this mode will require the highest optimization time. Therefore, it is recommended to start with the **Fast** mode.

The different optimization modes allow the user to control the compromise between optimization speed and optimization gain that can be achieved.



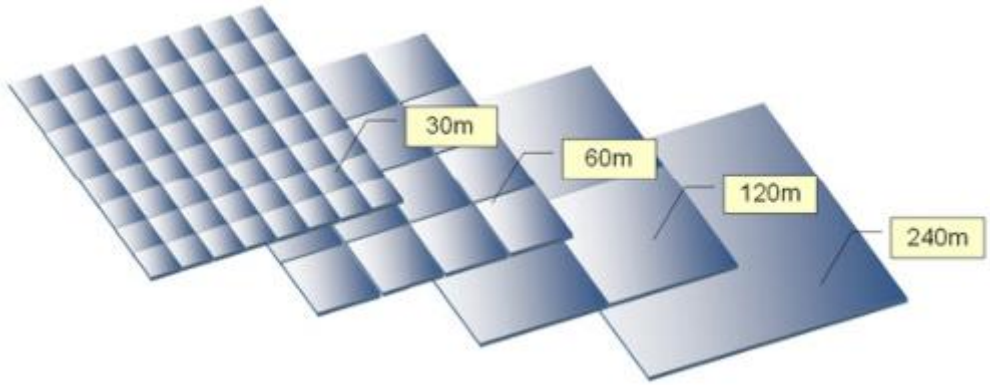
This compromise depends on the actual network behavior, the optimization environment, the optimization targets, the resolution of the prediction files and other influencing factors.

Simulation Resolution Example

Four simulation resolutions are available, based on the initial resolution set for the export of the ASSET Design optimization environment.

For example, based on a 30m resolution chosen for the export, the following optimization resolutions are available:

- 30m—64 runtime units
- 60m—16 runtime units
- 120m—4 runtime units
- 240m—1 runtime unit



Note: The above figure indicates the impact of the resolution on the optimization speed and memory requirement. The difference between 30m and 240m grid resolution results in a ratio of optimization times of 64:1 when pixel based results are of interest, i.e. for all results based on coverage plots! In the same way, the different grid resolutions influence the amount of memory used for the optimization.

Memory Requirements

ASSET Design uses smart memory management to run very large area optimizations. The Memory Requirements pane shows the amount of memory required for the optimization parameters (size of the area, resolution, and so on) you have set. It is assumed that no other applications with major memory requirements are running at the same time.

Overview: An overview of memory requirement details, comprising:

- **Process:** This field displays the minimum physical memory that is required to run the optimization process
- **OS:** This field displays the assumed memory occupied by the operating system (OS)
- **Machine:** This field displays the total required memory necessary to run the optimization on this machine.
- **Minimum versus recommended:** The difference between minimum and recommended is that data compression is used for the minimum requirement. In case of recommended, the required data is uncompressed and hence no performance degradation (slower optimization) occurs. If more memory is available more data will be kept in caches and the optimization will be even faster.

Memory requirement messages: This field displays warnings and error messages, if the machine does not fulfill the memory requirements.

- A warning will occur if the physical memory on the machine is below the *for best performance memory* requirement
- An error message will occur if the physical memory on the machine is below the *minimum* memory requirement

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Important: If the minimum required memory is not available, the optimization cannot be started. In that case you can do the following:

- Use a coarser simulation resolution.
- Increase the amount of physical memory in your machine.
- Reduce the size of the Optimization Polygon within your project.

Starting the Optimization

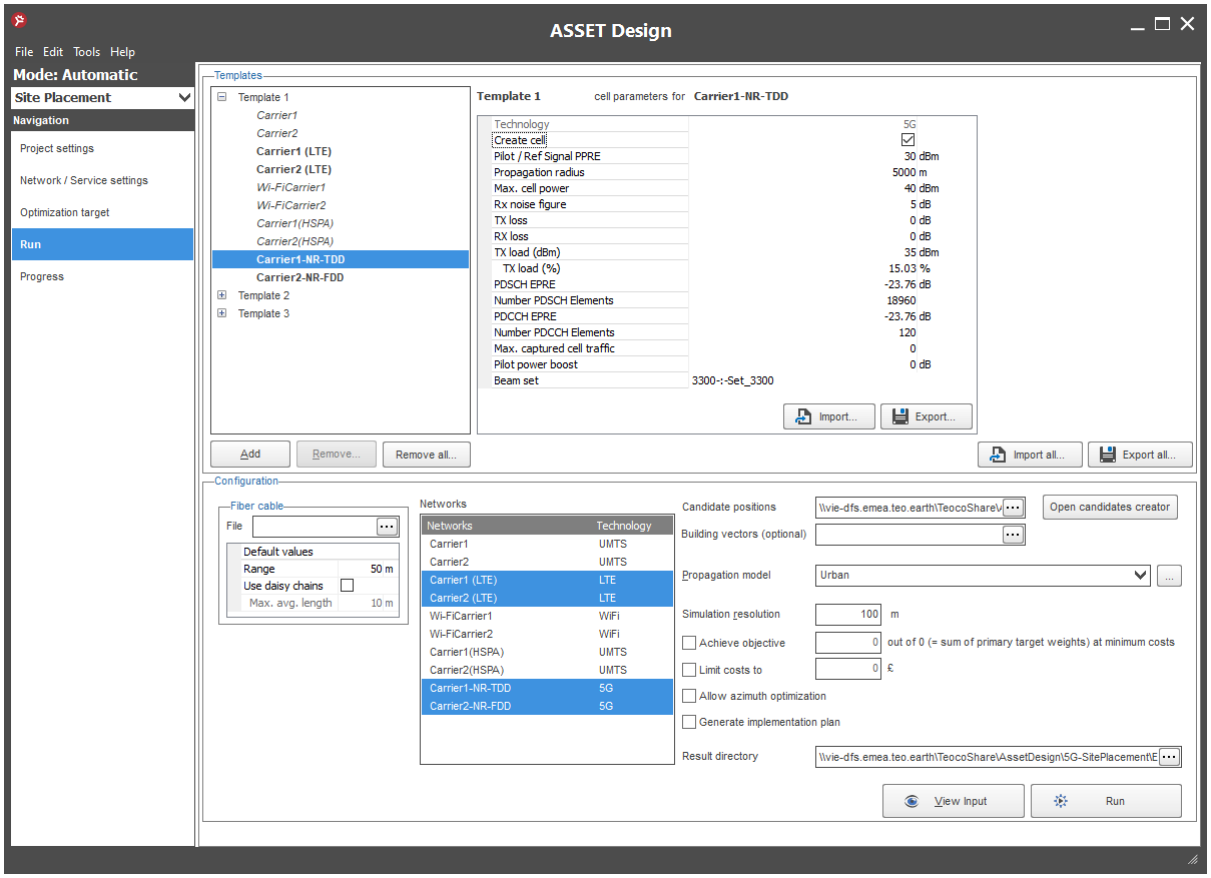
At the bottom of the **Run** screen (**Cell Planning** mode), there are two buttons:

Button	Action
Compute Initial State	This will simulate the network and evaluate all the defined target functions for the initial network configuration. You can use this to analyze the network, check if the used parameters and target function settings are correct, or get captured traffic numbers from the Excel report file. Note that in the case of site activations, the (potentially active) transmitters are active in the optimized state.
Start Optimization	Click this button to start the optimization process. Starting the optimization includes copying relevant data and initializing network optimization. After starting, the user interface will switch to the Progress screen.

Run (Site Placement Mode)

Here you can set the **Site Placement** options and start the design process.

This picture shows the ASSET Design interface (in Site Placement mode) with 'Run' selected:



ASSET Design interface - Run (Site Placement Mode)

Note: The Site Placement mode supports LTE, UMTS, Wi-Fi and 5G. Multiple technologies can be included in the same run.

For more information, see How to Set Up a Site Placement Run on page 24.

Defining Templates for Site Placement

This section shows how to use the **Run** screen when setting it up for **Site Placement** mode.

Important: In the same run, the Site Placement templates can create cells that use different technologies/carriers/bands sharing the same location, antenna device and height.

The setting up of templates plays a central role in a Site Placement run. The templates include:

- Site level parameters (property, antenna, backhaul)
- Cell level parameters (technology, cell creation, power, load, pattern, and so on)

You can set up and use as many templates as you require, depending on your design plan. It may help if each template is given a meaningful name.

Note:

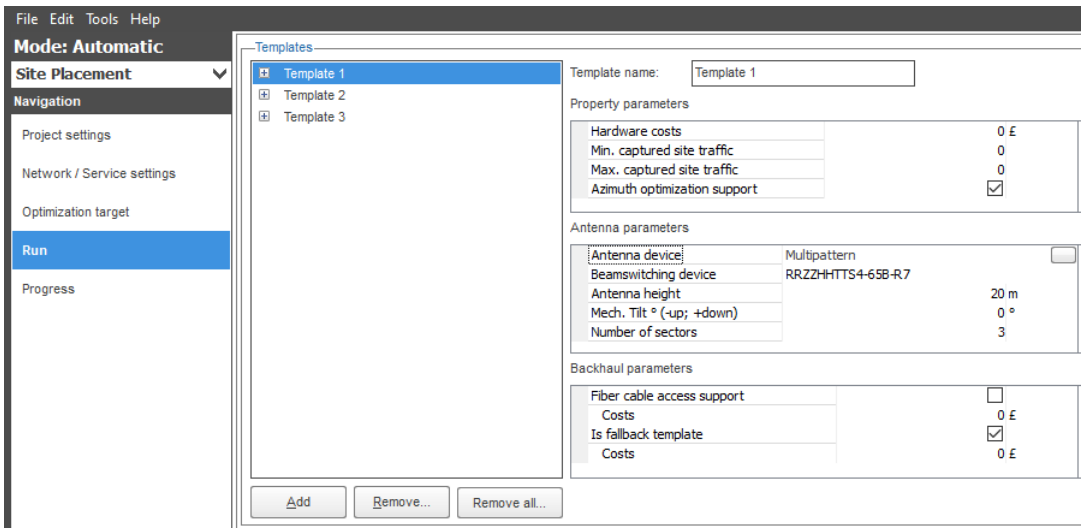
- In general, the setting up of templates should be a one-off procedure, and you should only need to revisit them when making occasional strategic changes.
- You can import and export templates by using the **Import all** and **Export all** buttons. This includes all the templates with their site level and cell level parameters.
  - Note: If you use **Import All**, this will replace all the existing templates in the project.
- You can import and export individual sets of cell parameters by using the **Import** and **Export** buttons. A saved set can be loaded into any network of any template.

To create and set up your templates:

1. At the bottom-left of the Templates pane, click the **Add** button.
2. Name the template.
3. Specify the site-level parameters that are generic to the networks contained in the template.

   Please refer to Site Level Template Parameters on page 112.

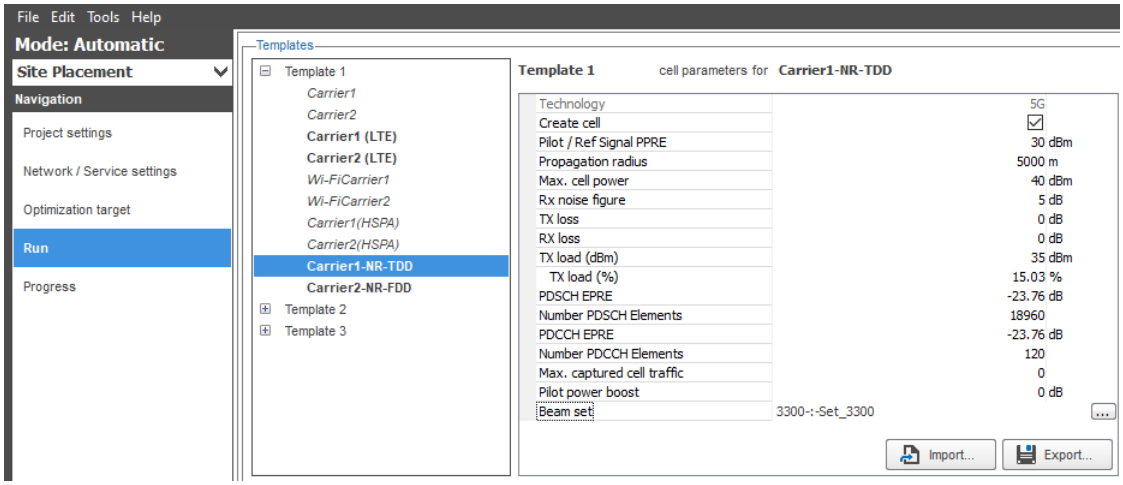
   This picture shows an example.



4. Expand the template node (⊞), which will show the networks (supported technologies only) that are present within your project.
5. On each of the networks, specify the cell-level parameters that are specific to that network.

   Please refer to Cell level Template Parameters on page 113.

This picture shows an example:



6. Repeat the above steps, depending on how many templates you require.

You can subsequently edit any of your templates, and you can remove any unwanted templates by using the **Remove** or **Remove all** buttons.

For information on selecting the networks to include in the run, see Selecting Networks for Site Placement on page 115.

Site Level Template Parameters

Here are the parameters (generic to all the networks within the template) at the site level:

Property Parameters

Parameter	Description	Type and Value Range
Hardware costs	The hardware costs for the site template	
Min. captured site traffic	Minimum traffic for the site. (same unit as used in the traffic map) **Note**: This setting affects Handled Traffic. See Handled Traffic (All Technologies) on page 82.	Real in [0, MinCapturedSiteTraffic]
Max. captured site traffic	Maximum traffic for the site. (same unit as used in the traffic map) **Note**: If you set Min and Max together, you must specify a sensible difference between them to produce meaningful results.	Real in [0, MaxCapturedSiteTraffic]
Azimuth optimization support	Enable this checkbox if you want this template to be considered during azimuth optimization. Otherwise, it will not be considered. For example, it would make sense to de-select this checkbox in the case of omni antennas. **Note**: This checkbox is only applicable if the 'Allow azimuth optimization' option has been selected in the Configuration pane of the Run screen.	

Antenna Parameters

Parameter	Description	Type and Value Range
Antenna device	Name of the antenna device. **Note**: This relates only to non-5G networks.	String
Beamswitching device	Name of the beamswitching device. **Note**: This relates only to 5G networks.	Please see the information in Beam Set Information in the Antenna Pattern Selection Editor on page 52.
Antenna height	Height of the antenna (in meters).	
Mech. Tilt	Mechanical tilt for each cell (in degrees).	Real in [-180, 180]
Number of sectors	Number of sectors/cells.	Integer > 0

Backhaul Connection Parameters

Parameter	Description	Type and Value Range
Fiber cable access support	Does the template support backhaul connection via fiber cable?	Binary checkbox: on/off
Costs	Costs for the above.	
Is fallback template	If fiber cable not available, does the template support a fallback connection method?	Binary checkbox: on/off
Costs	Costs for the above.	

Cell level Template Parameters

Here are the network-specific parameters at the cell level:

Cell Parameters (network-specific)

Parameter	Description	Type and Value Range
Technology	Not editable, as it is already determined by the network item itself.	
Create cell	Determines whether a cell will be created for this specific network instance. **Tip**: When this checkbox is not selected, the font of the network instance name is presented in italics (for example, *Carrier1*). This is a visual indicator that the network instance (under its particular template) can play no part in the run.	Checkbox
Pilot / Ref Signal PPRE	Pilot power for each cell (in dBm).	Real in [0, MaxCellPower]
Propagation radius	Radius for which the signal loss is calculated (in meters).	
Max. cell power	Maximum power for each cell (in dBm).	
RX noise figure	A measure of degradation of the up-link signal-to-noise ratio, caused by components in a radio frequency signal chain (in dB).	
TX loss	Transmitter loss (in dB).	
RX loss	Receiver loss (in dB).	

Parameter	Description	Type and Value Range
TX Load (dBm)	Transmitted interfering power (in dBm).	Real in [0 , Any value <= MaxCellPower: [0, MaxCellPower]]
TX Load (%)	Transmitted interfering power (in %).	Real in [0 ,100]
TX traffic channel power	Traffic channel power (in dBm). **Note**: This is only shown for non-5G networks.	Real in [0, MaxCellPower]
PDSCH EPRE	Physical Downlink Shared Channel. The power or energy of a single downlink resource element that carries the PDSCH sent over the traffic antenna beam. **Note**: This is only shown for 5G networks.	
Number PDSCH Elements	DL transmit antenna elements for PDSCH. **Note**: This is only shown for 5G networks.	
PDCCH EPRE	Physical Downlink Control Channel. The power or energy of a single downlink resource element that carries the PDCCH sent over the traffic antenna beam. **Note**: This is only shown for 5G networks.	
Number PDCCH Elements	DL transmit antenna elements for PDCCH. **Note**: This is only shown for 5G networks.	
Max. captured cell traffic	Maximum traffic for the cell. (same unit as used in the traffic map)	Real in [0, MaxCapturedCellTraffic]
Pilot power boost	Pilot power boost (in dB).	
Antenna pattern	Name of the antenna pattern file. The pattern must be a member of the antenna device that was defined in the site-level parameters. **Note**: This is only shown for non-5G networks. **Note**: In cases where there are multiple templates with different associated patterns, involving masked predictions, there is a procedure which speeds up the process of changing the pattern for the cell. This involves re-processing the original prediction. Although this improves the speed, it can impact the accuracy. If you want to prioritize accuracy over speed, there is a setting in the General tab of the Preferences which forces the optimization to re-predict for every different pattern that is associated with each template. For more information, see the 'Re-predict new patterns for new cells' option in General tab on page 138 (part of Preferences chapter).	String
Beam set	Name of the beam set. The beam set must be a member of the beamswitching device that was defined in the site-level parameters. **Note**: This is only shown for 5G networks.	Please see the information in Beam Set Information in the Antenna Pattern Selection Editor on page 52.

Selecting Networks for Site Placement

This section continues to shows how to use the **Run** screen when setting it up for **Site Placement** mode.

Having set up the templates (see Defining Templates for Site Placement on page 110), the Networks pane is crucial in determining which networks you want to include in the run.

To specify which networks you want to include:

1. In the Configuration pane, you will see a **Networks** list, showing the networks (supported technologies only) that are present within your project. This picture shows an example:

Networks

Networks	Technology
Carrier1 (UMTS)	UMTS
Carrier2 (UMTS)	UMTS
Carrier1 (LTE)	LTE
Carrier2 (LTE)	LTE
Wi-FiCarrier1	WiFi
Wi-FiCarrier	WiFi
Carrier1-NR-TDD	5G
Carrier2-NR-FDD	5G

2. Select the network(s) that you want to include in the run. To do this, click the appropriate networks. You can use the keyboard (Ctrl, Ctrl+Shift, and so on) to multi-select items.

Note: If you are using multiple templates, the networks you select will potentially be included across all the templates, but that is dependent on whether the **Create cell** checkbox is selected for the network instance under each separate template. Only the combination of both settings will create a cell for the selected networks in a candidate location during the run. This provides wide flexibility in how you can set up the run.

To act as a visual aid in the Templates pane, for each network instance under its particular template:

- When the **Create cell** checkbox is selected, the network instance name is presented in normal font.
- When the **Create cell** checkbox is not selected, the network instance name is presented in italic font.
- When the network is selected in the **Networks** list (in the Configuration pane), the network instance name (in the Templates pane) is presented in bold font if its **Create cell** checkbox is selected. In other words, the italic font serves as an indicator that the network instance (under that particular template) can play no part in the run.

In summary, a network instance will only play a part in the run if (A) its **Create cell** checkbox is selected and (B) it is selected in the Networks list.

For an example, see Example of Site Placement Setup on page 116.

When you have finished setting up the templates and choosing the networks, continue with the rest of the configuration settings, as described in the subsequent sections:

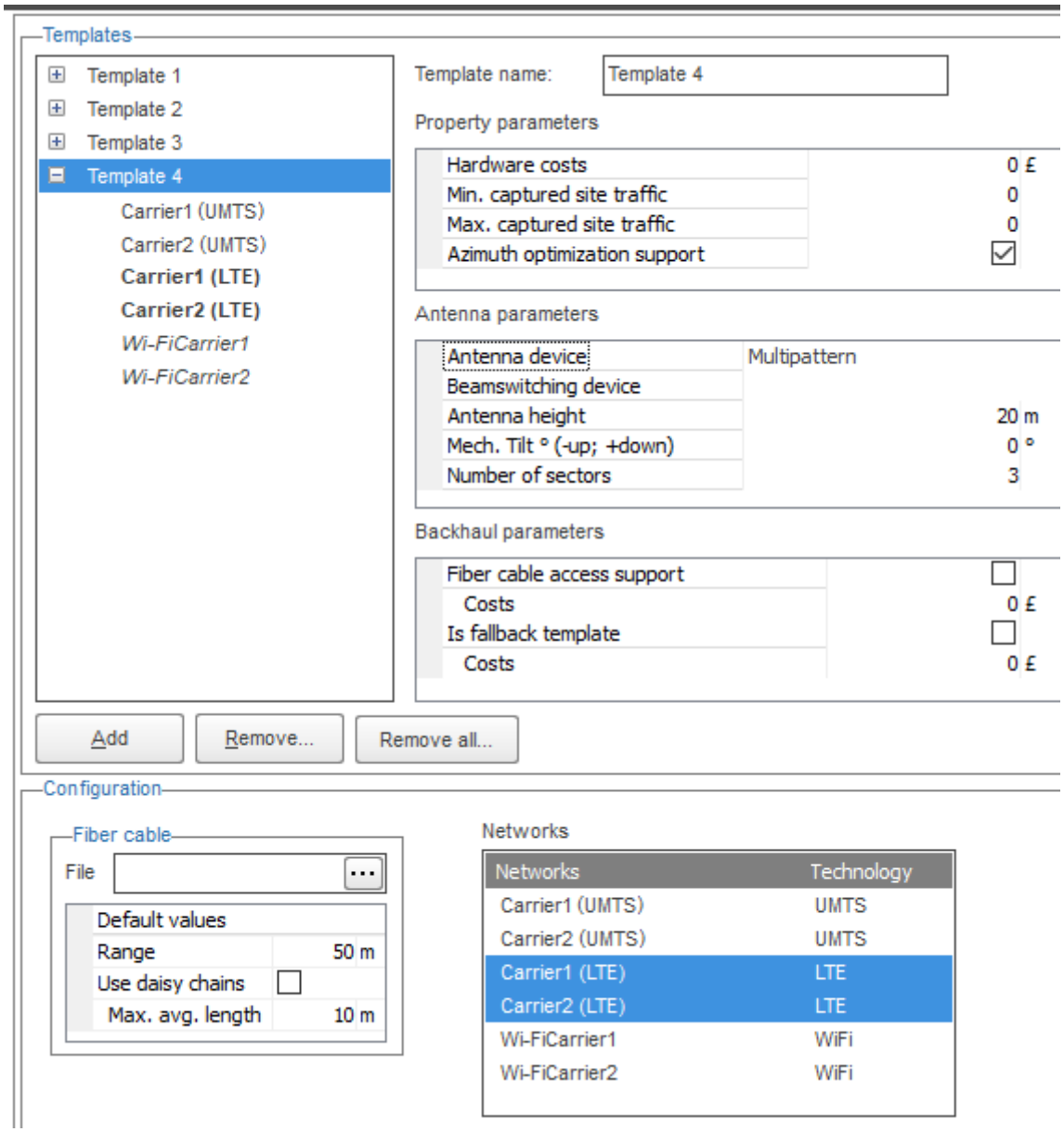
- Run Configuration - Fiber Cable on page 117
- Run Configuration - Candidates on page 118
- Run Configuration - Other Settings on page 119

Note: All the template settings and network selections can be saved if you choose to save the settings when closing the project.

Example of Site Placement Setup

The following picture shows an example of a Site Placement setup, where there are multiple templates (Templates pane), and where two of the networks are selected in the Networks list (Configuration pane).

The visual presentation of the network instances (under the templates) helps you to monitor the setup. The table below the picture explains this.



This table explains how the network instances (under the templates) are visually presented:

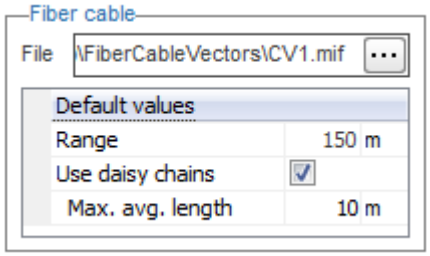
Visual Aid (this example)	Create Cell checkbox selected in the cell-level parameters?	Chosen in Networks List?
The two UMTS network instances are presented in normal font	Yes	No
The two LTE network instances are presented in **bold** font	Yes	Yes
The Wi-Fi network instances are presented in *italic* font	No	Yes or No (has no impact when Create Cell is not selected)

Therefore, in the above example, for that particular template, only the two LTE network instances will play a part in the run. (This example uses technology-based segregation just for simplicity in demonstrating the principle. The network selection for your setups is totally flexible and does not have to be segregated based on technology).

Note: All the template settings and network selections can be saved if you choose to save the settings when closing the project.

Run Configuration - Fiber Cable

File (Cable Vectors)



This is a .mif or .tab file containing a set of cable vectors that the new sites can physically connect to. (ASSET Design supports polylines only.)

Default values

Default Values	Description
Range	Defines the maximum distance (in meters) from the fiber cable to a new site.
Use daisy chains	Only enable this checkbox if you want to compute daisy chains.
Max. average length	This threshold is only applicable when 'Use daisy chains' is enabled. It defines the maximum average connection length between two sites or to the fiber cable.

If 'Use daisy chains' is enabled, ASSET Design will connect all active candidate sites that are within the fiber cable range using either a connection to the fiber cable or a connection between two sites. Any connection constraints, capacity and hop limits are not considered in the calculation. The computed result is a tree-like backhaul network where the average connection length cannot exceed the specified maximum.

Run Configuration - Candidates

Candidate Positions File

This is a .csv file containing a set of candidate site locations and optional costs and names.

Tip: If a candidate positions file is unavailable, you can create one with the Candidates Creator. See section below.

Mandatory columns

File Column	Description
X	The x coordinate.
Y	The y coordinate.

Optionally, columns for costs and names can be added.

The columns must be comma-separated.

ASSET Design will only place new sites at the provided positions.

Example of a valid .csv file without costs and names:

X	Y

Example of a valid .csv file including optional costs and names:

X	Y	Costs	Name

Candidates Creator

The Candidates Creator is a tool that can help you to generate a valid candidate position file.

To use this tool:

1. Click the **Open candidates creator** button.

   The options are as follows:

File Column	Description
Creation method	Candidate positions can be created in a grid or along vectors. The drop-down box contains these two modes: • **Grid**: Specify the grid distance ('Place candidates every n.nn meters'). • **Along Vectors**: Select a vector file using the Browse button. Then specify the grid distance ('Place candidates every n.nn meters'). Then choose either 'on the vector' or 'left and right n.nn meters away from the vector'. This choice enables you to create candidates on a street, or along the sides of a street (lamp posts, for example). Valid vector files are *.mif or *.tab files.

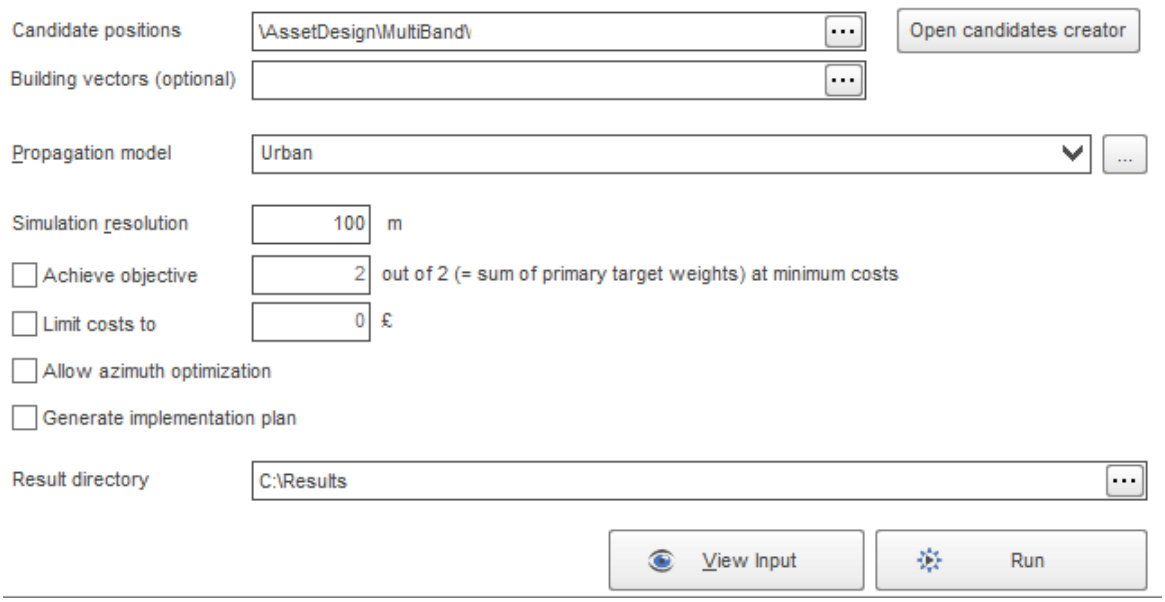
File Column	Description
Optional Filtering	Independent of the creation method, the candidate positions can be filtered. Click the **Add Filter** button to choose from: • **Only inside polygon**: Only candidate positions inside a polygon are considered. Valid polygon files are *.mif or *.tab files. • **Only outside polygon**: Only candidate positions outside a polygon are considered. Valid polygon files are *.mif or *.tab files. • **Only in distance to vector**: Only candidate positions within a user-specified maximum distance to a vector are considered. This distance may represent the proximity to fiber cable. • **Only on pixels with map value**: The Candidates Creator can interpret map data and place candidates only where the map has a particular value. For example, a height map can be used to place sites only above or below a certain height level. Other maps, such as traffic maps or coverage maps, can be used. Valid map formats are *.bil, *.cbil,*.trr and *.3ga. Several filters can be combined.
Resulting candidate positions file	Specify the name and location for the resulting candidate position file. For convenience, you can use the  button to copy the file location to the clipboard, so that you can re-use it in the ASSET Design main interface.

2. When you have chosen the above options, click **Start**.

Run Configuration - Other Settings

There are various other settings on the **Run** screen, before you start the Site Placement process.

This picture shows an example:



Setting	Description
Candidate positions file	See Run Configuration - Candidates on page 118.
Building vectors (optional)	This is a .mif or .tab file containing a set of building vectors with height. These are used for line of sight checks and pathloss calculations with the Urban and Rural propagation model. ASSET Design supports polylines only.

Setting	Description
Propagation model	Choose between Urban, Rural (COST-Hata) and third party* propagation models. The propagation model has a direct influence on the signal losses simulated during the optimization process. The Urban model assumes a denser area with higher signal loss compared to the Rural model. **Indoor / Outdoor loss**: For the Urban/Rural models, if you want to distinguish between the signal loss inside a building and outside, you can use the ... button to set a constant indoor and outdoor loss (in dB). **Note**: In order to use indoor loss, building vectors must be provided in the form of a .mif or .tab file containing the vectors that define the buildings. ASSET Design supports polygons and rectangles. *For details about third party models please see the documentation shipped with the models. **Important Notes about the 'MYRIAD 500' Models**: • If you use any of the MYRIAD 500 models, you cannot configure them using the ... button. Instead, you must configure them in ASSET. • The building vectors that can be defined in ASSET Design are ignored by the MYRIAD 500 models. Instead, they use the vector settings from the same ASSET project where the models were configured. • Frequency: In ASSET Design, you can define a start and stop frequency for each network. For MYRIAD 500 models, ASSET Design uses the average frequency [(Start + Stop) * 0.5] for the predictions. This is especially important for multi band templates because you can only define a single propagation model for all networks. So ASSET Design always uses the average frequency of each network for the predictions. So if you want to be aligned with the ASSET predictions, you must set your frequencies in ASSET and ASSET Design accordingly. • For more information, refer to the MYRIAD User Reference Guide.
Simulation resolution	All map data will be re-sampled internally to the given resolution. This parameter has significant influence on duration and quality. For a preview ASSET Design run, we recommend using a multiple of the environment resolution.
Achieve objective	The target objective is optional. If deactivated, the process aims to find the solution with the highest objective. If activated, the value, which ASSET Design aims to achieve at minimum costs, specifies a proportion of the sum of the primary target weights. Therefore, the value depends on the optimization targets defined on the Optimization target screen of the user interface. Example A: Optimization target defined as: One coverage target with weight of '1'. If you set the 'Achieve' value to 0.95, the optimization tries to fulfil enough pixels to reach the objective of 0.95, by minimizing the required resources to achieve this. Example B: Optimization target defined as: One coverage target with weight of '3' and one interference target with weight of '1'. The sum of the weights of the two targets is '4'. If you set the 'Achieve' value to 3.2, the optimization tries to fulfil enough pixels for each of the targets to reach the objective of 3.2, by minimizing the required resources to achieve this.
Limit costs to	Define a global cost limit that ASSET Design must not exceed.
Allow azimuth optimization	Enable this checkbox if you want optimized azimuths for the antennas of activated sites. **Note**: In the Templates pane, you can specify whether each specific template is considered during azimuth optimization. For example, it would make sense to exclude templates that use omni antennas. See Site Level Template Parameters on page 112.

Setting	Description
Generate implementation plan	Enable this checkbox if you want to generate an implementation plan. It will sort the sites according to their total target objective gain.
Result directory	This folder will be used to store all results.

For information on the **View Input** and **Run** buttons, see Checking the Input and Starting the Design Process on page 121.

Checking the Input and Starting the Design Process

At the bottom of the **Run** screen (Site Placement mode), there are two buttons:

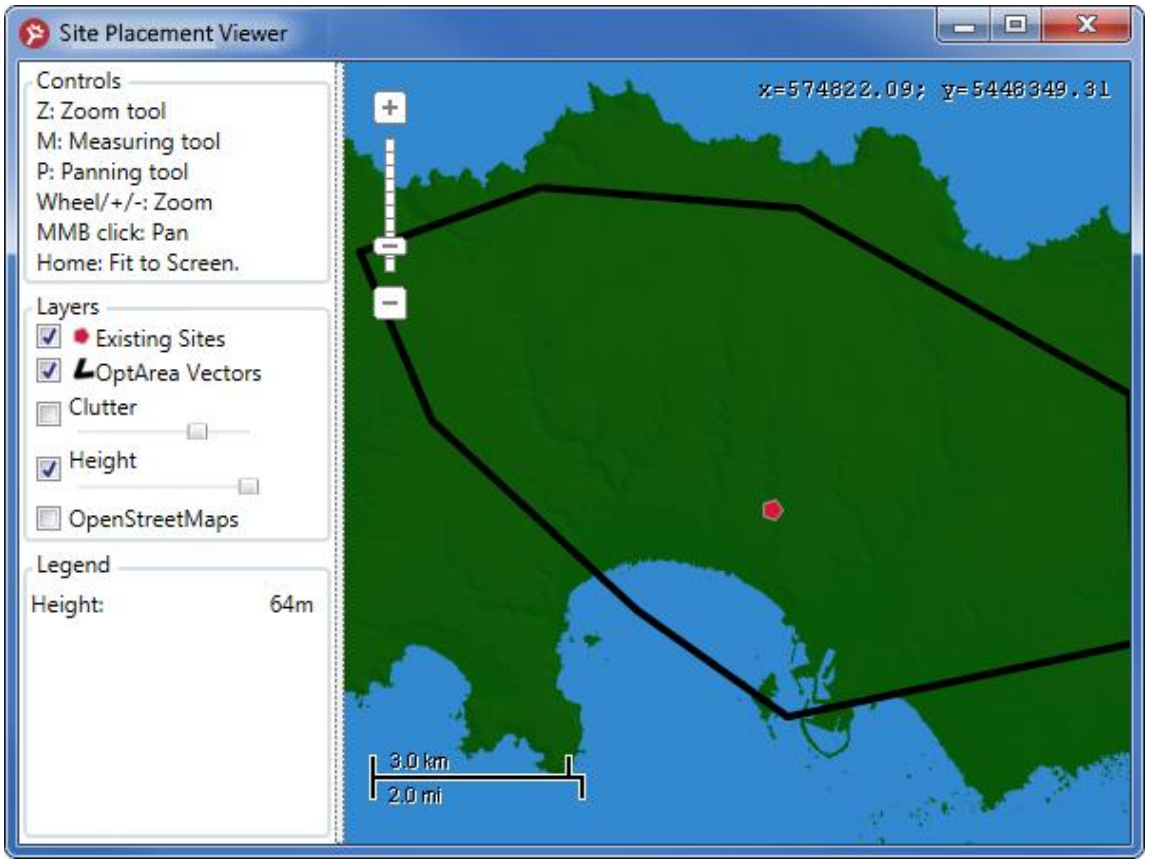
The purpose of the Input Viewer is to have a quick and easy way to visualize the input data before starting the design process. When you have finished doing this, you can then feel more assured to click **Run**.

When you click the **Run** button, this will start the process, and the user interface will switch to the **Progress** screen.

Site Placement Input Viewer

The purpose of the Input Viewer is to have a quick and easy way to visualize the input data before starting the optimization.

This picture shows an example:



Example of the Site Placement Input Viewer

Controls

Keyboard	Description
Z	Enables the zoom tool. When the zoom tool is enabled you can use the left mouse button to draw a rectangle to zoom to. A click with the right mouse button will zoom out one zoom level. The zoom level can also be set with the slider in the main window.
M	Enables the measurement tool. Select the start position of the ruler with a left mouse click and the end position with a double click. It is possible to add additional way-points with a single click of the left mouse button. The distance is displayed in meters.
P	Enables the panning tool. While this is enabled, you can pan the content of the main window by holding the left mouse button down and moving the mouse.
Wheel/+/-	The mouse wheel and the +/- buttons can be used to zoom in and out of the main window.
Middle mouse button	A click of this button re-positions the main window. The position of the click will be the new center.
Home	Sets a zoom level so all data fits to the screen.

Layers

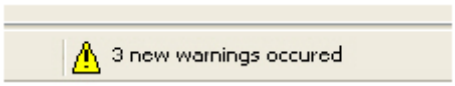
In the layers section of the Input Viewer, the display of all data layers can be enabled and disabled. Additionally the transparency of map layers can be changed. Available layers are all maps and position files selected for an optimization run. An OpenStreetMaps layer is available if vector files are set. The OpenStreetMap data will not be used in the optimization run.

Legend

The legend section of the Input Viewer offers height and clutter information of the position of the mouse pointer. The height value is displayed in meters. This value is taken from the height map and not from the OpenStreetMap data. The clutter code is read from the clutter map.

Optimization Warnings

In some cases there may be warnings that are generated during an optimization. If so, a yellow warning sign is displayed in the status bar and the text *new warnings occurred* flashes:



To view the warning details, double-click on the icon or text message, press the F9 key or choose **Tools > Warnings** in the main menu. The text message will then stop flashing (until the point where new warnings may occur).

Warning Window

The warning window displays a hierarchical view of the different warnings:

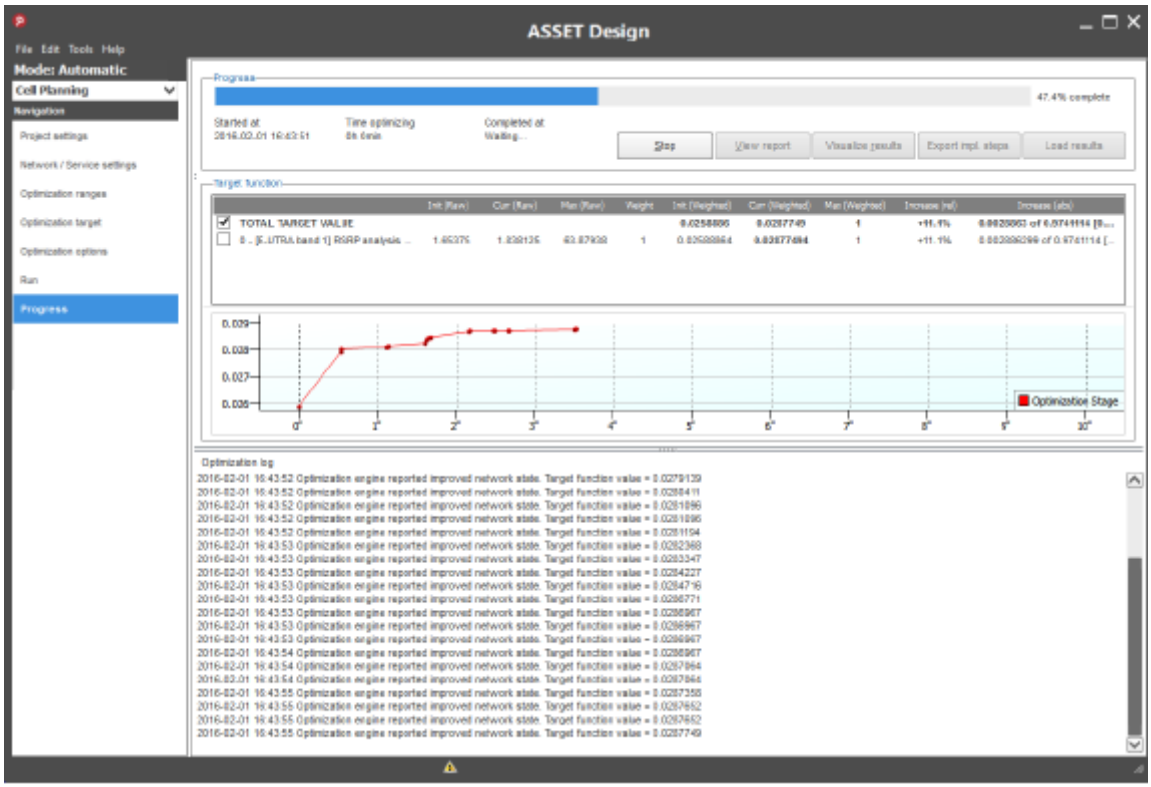
Warning type	Description
Tree view	The warnings are displayed in hierarchical order. If the details are not expanded to provide a fast overview, you can click on the '+' button to view all the warning items. If you select an item, the date and time of the first occurrence and the detail text are displayed.

Warning type	Description
Only new warnings	If this box is selected, only new warnings (that have occurred since the warning window was closed the last time) are displayed. Deselect this option if you want to view all warnings.
Date	Displays the selected warning's first occurrence time stamp.
Text	Displays the selected warning's detail information. The text might be easier to read in this formatted field than in the tree view.

10 Progress of an Optimization (and Reports)

Here you can monitor the progress of the Cell Planning or the Site Placement process.

This picture shows the ASSET Design interface (in Cell Planning mode) with 'Progress' selected:

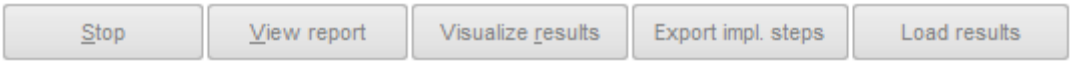


ASSET Design interface - Progress (Cell Planning Mode)

Progress (Cell Planning Mode)

At the top of the **Progress** screen (Cell Planning mode), there is a Progress Bar that displays the overall advance of the optimization process:

There are also several interactive buttons on this screen:



Button	Description
Stop	Use this button to terminate the optimization at any time. If you click Stop after ASSET Design has found an improved network state, you will be able to export the intermediate result.
View report	Use this button to view the optimization report file. This button is only available after the optimization is complete. When an optimization was terminated by clicking Stop, the result files can be generated, and a report file for the intermediate result can be viewed.
Visualize results	Click this button to open **Inspector**, where you can view the optimization results before and after the optimization, as well as each individual step in the implementation plan. This button is only available after the optimization is complete. When an optimization was terminated by clicking Stop, the result files can be generated, and a report file for the intermediate result can be viewed. For further details see Inspector on page 165.
Export implementation steps	Use this button to create XML files to a specific step of the implementation plan, in addition to the XML files that were generated at the end of the optimization. The results for the selected step will be saved to a new sub-directory of the result directory. **Note**: To view the optimization report, Microsoft Excel or a compatible viewer is required. The optimization report file stores all relevant information regarding the optimization process as well as the implementation plan. **Note**: If the optimization is terminated by the STOP button in the **Progress** tab, no implementation plan is generated. The implementation plan can only be computed if the optimization is completed successfully. (Otherwise an intermediate state would be a result that does not satisfy the requirements of the implementation plan.) For further details see View Report (Cell Planning Mode) on page 133.

Button	Description
Load results	Loads the results of the current optimization so that they can be used in a new optimization run. This is a shortcut for the same functionality as in the **Project Settings** screen of the user interface - the 'start from previous result' option. A dialog will pop up with the options to import new cells as: • defined in the result • active • inactive **Note**: If the option to import new cells as active/inactive is selected, the activation status of all cells generated in all previous Site Placement runs will be changed. Cells that were placed by the Site Placement mode will internally be marked as new cells for certain targets like the Traffic Offloading target. **Example**: In a 'greenfield' scenario you might place new cells with the Site Placement mode of ASSET Design. Then you might press the *Load results* button and select *import new cells as active* because you want to run a cell parameter optimization in the Cell Planning mode. If you decide to add additional cells, you can click the *Load results* button again with the option to import new cells with the activation status as defined in the result.

Target Function

Use the **Target Function** pane of the **Progress** screen to view information about the advance of each optimization target value. The target function values are shown for the different optimization targets described in the **Optimization Target** screen. Only those target function values that have a weight higher than zero are displayed, or - if the weight is zero - the *compute target value during optimization* checkbox is enabled in the **Optimization Target** screen.

The information on the Target Function pane is as follows:

Item	Description
Init (Raw)	This column displays the initial value of the selected optimization targets that fulfilled the target requirement prior to optimization. The initial area satisfying the particular optimization target is shown, independent of the weight assigned for this optimization target (this is why it is named 'raw').
Curr (Raw)	This column displays the current value of the selected optimization targets that fulfill the target requirement during the optimization. The current value satisfying the particular optimization target is shown, independent of the weight assigned for this optimization target.
Max (Raw)	This column displays the maximum value of the selected optimization targets that could theoretically satisfy the target requirement within the optimization area.
Weight	This column displays how the individual optimization objectives are weighted and summed up to the total target value. **Note**: If the optimization target uses clutter based optimization weights, this will be indicated by "*CLT" in the weights column. Traffic map weighting will be indicated by "*TRF". As an example: Overall weight = 5 and clutter weights are applied on top of that, the value in the Weight column will be "5*CLT".
Init (Weighted)	This column displays the initial value of the selected optimization targets that fulfilled the target requirement prior to optimization, weighted by the individual clutter and area dependent optimization weights and normalized to the target function's weight.
Curr (Weighted)	This column displays the current value of the selected optimization targets that fulfill the target requirement during the optimization, weighted by the individual clutter and area dependent optimization weights and normalized to the target function's weight. This current value represents the resulting performance improvement achieved by the optimization process. Therefore, it is highlighted in bold numbers.

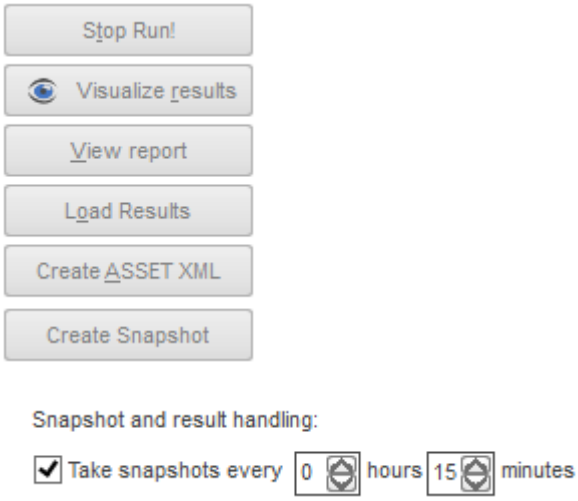
Item	Description
Max (Weighted)	This column displays the maximum value of the selected optimization targets that could theoretically satisfy the target requirement within the optimization area, weighted by the individual clutter and area dependent optimization weights. Due to the normalization to the target function's weight the value is identical to the weight. **Notes**: • The weighted values are normalized to the target function's weight to balance the influence of different target function types, clutter weighting and traffic map weighting. This means that for example all target functions with weight 1 have the same weighted maximum of 1, regardless if there is a traffic map with an average of 0.001 Erl/km² or clutter weights of 1000. • The weighted values can be calculated as: Init (Weighted) = Init (Raw) / Max(Raw) * Weight Curr (Weighted) = Curr (Raw) / Max(Raw) * Weight Max (Weighted) = Max (Raw) / Max(Raw) * Weight = Weight
Increase Relative	This column displays the performance improvement relative to the value that initially fulfilled the requirement. **Example**: Assume a total optimization area of 100 km² and an initial area fulfilling the coverage requirement of 80 km². An increase of 10 km² then equals an improvement of 12.5% compared to the original area of 80 km². Therefore, 100km² equals "1", where 80km² equals "0.8", as the numbers are all normalized for comparison reasons. If the optimization weight is "2", then 100km² equals "2". **Note**: With this method the maximum improvement that can be reached is limited by 25% (20km² on top of 80km² initially), since the total optimization area is limited to 100 km².
Increase Absolute	This column displays the performance improvement of the potential improvement in normalized numbers, as well as percentages of the maximum achievable value. Curr(Weighted) - Init(Weighted) of Max(Weighted) - Init(Weighted). **Note**: If the optimization target uses clutter based optimization weights, there is no longer a single "maximum" value fulfilling the requirement. There are now as many "maximum" values as there are clutter classes. To display all of these values would be confusing and therefore, NO maximum value is displayed. With no maximum value available, the absolute increase (as percentage of what could be achieved) is not possible.
Total Target Value	The bottom line of the target function section displays the TOTAL TARGET VALUE improvement due to the optimization process. The total target value is the weighted sum of the individual optimization targets. **Note**: The values shown in the **Progress** screen in ASSET Design can slightly differ from the results shown in the report in ASSET. The relative deviation of the results is typically much less than a percent. Reasons for this deviation are different calculations of the optimization areas, i.e. which pixel at the border is considered to be in or outside the optimization area, and different simulation resolutions. In the case where a much rougher resolution is used in ASSET Design than in ASSET, the size of the border pixels supports the uncertainty of the "which pixel is in or out" calculation.
Performance Chart	This chart displays the progress in the total target value over time. The time frame for the display is set on the General tab of the Preferences dialog box. The color of the graph indicates different phases of the optimization process, network analysis and parameter optimization, cost/time optimized analysis and modifications and calculation of the implementation plan.
Optimization Log	This window displays information and warning messages generated by the optimization engine.

Progress (Site Placement Mode)

On the **Progress** screen (Site Placement mode), you can see the following information:

Item	Description
Objective	The primary objective of the currently best solution found during the Site Placement process (as set on the Optimization Target screen). **Note**: If 'Achieve objective' on the Run screen is deactivated, the optimization process aims to find the solution with the highest objective.
Secondary Objective	The secondary objective (if set on the Optimization Target screen).
Costs	The costs of the current best solution.
Active Sites	The number of active sites in the current best solution. **Note**: This is the number of already existing active sites from the original project PLUS any newly activated sites determined during the optimization process.
Improvement chart	Visualizes the ongoing Site Placement process and shows the improvement of the target objective (and secondary objective, if set) and costs over time.
Output log	Shows logging information concerning the start and end of the process, new best found solutions, as well as errors.

In addition, there are some interactive buttons and options:



Button or Setting	Description
Stop Run	Terminates the Site Placement process.
Visualize results	Click this button to view the results before and after, as well as each individual step in the implementation plan in Inspector. This button is only available after the run is complete. When a run was terminated by clicking Stop, the result files can be generated, and a report file for the intermediate result can be viewed. For further details see Inspector on page 165.
View report	Open the report in Excel.

Button or Setting	Description
Load results	Loads the results of the current optimization so that they can be used in a new optimization run. This is a shortcut for the same functionality as in the **Project Settings** screen of the user interface - the 'start from previous result' option. A dialog will pop up with the options to import new cells as: • defined in the result • active • inactive **Note**: If the option to import new cells as active/inactive is selected, the activation status of all cells generated in all previous Site Placement runs will be changed. Example: In a 'greenfield' scenario you might place new cells with the Site Placement mode of ASSET Design. Then you might press the *Load results* button and select *import new cells as active* because you want to run a cell parameter optimization in the Cell Planning mode. If you decide to add additional cells, you can click the *Load results* button again with the option to import new cells with the activation status as defined in the result.
Create ASSET XML	Create ASSET importable xml files.
Create Snapshot	This option may be particularly helpful for longer Site Placement mode runs, because it provides a way of intermittently assessing the current results, and checking that the optimization is heading in the direction that you intended. **Note**: This button is active when a new best solution is available and for which a snapshot has not yet been created (either manually or automatically). Snapshots that have been computed will appear in a listbox on the Progress screen. This enables you to select an individual snapshot and show the corresponding results in the Inspector or Excel, or to create ASSET XML files during the optimization. Whenever a new item in the snapshot listbox is added, it will appear at the top of the list and will be automatically selected, but you can select a different snapshot in the list. After the optimization has finished, snapshot results can be loaded into ASSET Design for subsequent optimizations. You can also set up automatic snapshots. See 'Snapshot and result handling' in the row below.
Snapshot and result handling	In addition to creating snapshots manually (see above row), you can activate automatic snapshots by selecting the corresponding checkbox and setting a time interval. The initial setting (on/off) and interval (hh:mm) depends on the default in the Preferences dialog box (see Site Placement Snapshot Defaults on page 146). After you start an optimization, you can activate or deactivate the automatic snapshots, and/or change the time interval, on the Progress tab during the optimization. **Important**: If you activate the automatic snapshots (when previously inactive), the time interval is restarted. This is also true if you change the interval itself. So when you do this, you should consider taking a manual snapshot directly before or after you change the interval. (Creating a snapshot manually has no impact on the automatic snapshot setting.) **Note**: An automatic snapshot will not be created if a snapshot already exists for the current best solution.

View Report (Site Placement Mode)

By clicking the *View report* button in the **Progress** screen, you can view the Site Placement report file. This button is only available after the run is completed. When a run was terminated by clicking 'Stop', the result files can be generated, and a report file for the intermediate result can be viewed.

Note: To view the Site Placement report, Microsoft Excel or a compatible viewer is required.

The Site Placement report file stores all relevant information regarding the optimization process, which includes the following spreadsheets:

Overview spreadsheet

The overview spreadsheet includes a short summary of input parameters and result values:

- Results (Status, Costs, Initial Preexisting Sites Captured Traffic, Final Preexisting Sites, Captured Traffic, New Sites Captured Traffic, Activated Candidates, Active Pre-existing Sites)
- Objective:
  - Initial and final objective of the primary targets
  - Initial and final objective of the secondary targets if these have been defined
- Statistics
- Settings (Resolution, Network, Technology, Optimization Area, Candidate Positions, Building Vectors File, Fiber Cables, Max Distance to Cable)

New Sites and Cells spreadsheet

This spreadsheet provides lists of the activated new sites and cells.

- Position in meters (X, Y)
- Name:
  - New Sites Tab: The generated name, or the name of the position (if specified in the candidate position file)
  - New Cells Tab: The generated name of the cell with the site name as prefix
- Activation, Hardware and Backhaul Cost (only for New Sites tab)
- Traffic:
  - Captured
  - Handled: The handled traffic is equal to the captured traffic if the site and cell limits are not exceeded. Otherwise a RED value means it's only a part of the captured traffic.
  - Limited By: Indicates whether the handled traffic is limited by Site, Cell or Both.
- Best Server Area
- Connection Type

Pre-existing Sites and Cells spreadsheet

This spreadsheet provides lists of the Pre-existing sites and cells.

- Position in meters (X, Y)
- The name of the site or cell
- The activation status
- Azimuth (only for Pre-existing Cells tab)
- Traffic:
  - Captured
  - Handled: The handled traffic is equal to the captured traffic if the site and cell limits are not exceeded. Otherwise a RED value means it's only a part of the captured traffic.
  - Limited By: Indicates whether the handled traffic is limited by Site, Cell or Both.
- Best Server Area
- Connection Type

Backhaul Connection Points spreadsheet

This spreadsheet provides a list of the available Backhaul Connection Points.

- Position in meters (X, Y) (Only for cable access and µ-wave backhaul connection points)
- Height (Only for µ-wave backhaul connection points)
- Name (if specified in the input data)
- Type of the connection
- The possible range (in meters) from the connection point to a site
- The connection limit and number of used connections
- Peak traffic
- Capacity limit

Backhaul Connections spreadsheet

This spreadsheet shows the backhaul connection chain for each of the new sites.

- Position in meters (X, Y)
- Name of the site
- Template
- Activation, Hardware and Backhaul Cost
- Traffic:
  - Captured
  - Handled: The handled traffic is equal to the captured traffic if the site and cell limits are not exceeded. Otherwise a RED value means it's only a part of the captured traffic.
  - Limited By: Indicates whether the handled traffic is limited by Site, Cell or Both.
- Best Server Area
- Connection Type

View Report (Cell Planning Mode)

By clicking the *View report* button in the **Progress** screen, you can view the optimization report file. This button is only available after the optimization is completed. When an optimization was terminated by clicking Stop, the result files can be generated, and a report file for the intermediate result can be viewed.

Note: To view the optimization report, Microsoft Excel or a compatible viewer is required.

The Cell Planning report file stores all relevant information regarding the optimization process, which includes the following spreadsheets:

Optimization Settings spreadsheet

The **Optimization settings** spreadsheet includes all relevant optimization settings such as, but not limited to:

- Input parameters such as optimization environment or traffic maps
- Result parameters such as output files
- Optimization settings such as targets and constraints

Traffic Information spreadsheet

The **Traffic information** spreadsheet shows sector-specific parameters:

- Sector name, technology, network layer
  - Sites that have been added by Site Placement have sector names with an appended '*'
- GSM neighbor list input parameter
- Traffic limit
- Initial and optimized state:
  - Captured traffic: Units of the traffic map × km²
  - Handled traffic: The handled traffic is equal to the captured traffic if the site and cell limits are not exceeded.
  - Limited By: Indicates whether the handled traffic is limited by Site or Cell
  - Resource usage in % of the total available resource units

Network/Service Settings spreadsheet

This page shows all input parameters of the Network/Service Settings screen of the user interface, such as:

- Parameters and properties
- Traffic map settings
- 3G/4G/5G Cell Load
- OFDM settings
- LTE parameters

Services spreadsheet

The **Services** spreadsheet includes the Service Targets, with details of:

- Service Names
- Licensed/Unlicensed
- Carrier Names
- Technologies
- Carrier Rank

Optimization Ranges spreadsheet

The **Optimization Ranges** spreadsheet includes all parameter settings for the optimization:

- Parameters allowed for modifications
- Parameter ranges
- Initial settings
- Costs and time required for the implementation of the modifications

Optimized Network spreadsheet

The **Optimized network** spreadsheet includes the values for the optimization parameters for each sector by means of:

- Original value
- Optimized value
- Difference between original and optimized value

Note: Sector names with an appended '*' indicate sites added by Site Placement mode.

Results Overview spreadsheet

The **Results overview** provides information about:

- Number and type of parameter modifications
- The required costs and time
- Analysis and improvements of the used target functions
- Additional information about the computer and the run-time

Implementation Plan spreadsheet

The implementation plan details are only available if its calculation was enabled in the Optimization options.

The implementation plan provides an ordered list of parameter modifications. It can be ordered so that the parameter modifications will be implemented to ensure that the most significant changes can be done first. It also makes sure that the overall network performance improves from step to step during the implementation of the individual changes.

The implementation plan displays the different steps that have to be made. For each step the site and the sectors are shown where parameter modifications should be implemented. Of course, the associated parameter modifications are shown as well.

Furthermore, the overall optimization target is listed, as well as the costs and time required to do the implementation for the ordered list of parameter changes.

In addition to the parameter changes, the performance of the individual optimization targets (coverage, quality, and so on) is shown as well.

With this the user can get a very good picture of what should be implemented first and how it influences the overall network performance.

Since the implementation plan is provided in Microsoft Excel, you can use all available Excel features to manipulate and display the data. For example you can easily AUTO-FILTER the first column of the implementation plan to get a good overview in case of very large networks. The implementation plan therefore provides a number of categories so that you can easily use this functionality.

You can also create charts, graphs and statistics very easily. An interesting graph of course is to display the overall target function versus the costs. Depending on the network implementation you can analyze for example if it is worth while to invest more money for optimization or if you could gain 85% of the improvement with only 50% of the budget you are prepared to spend.

The most important improvement diagrams are generated automatically in the *Improvement Diagrams* spreadsheet (see below).

Note: If the optimization is terminated by the 'Stop' button on the **Progress** screen, no implementation plan is generated. The implementation plan can only be computed if the optimization is completed successfully. Otherwise an intermediate state would be the result that does not satisfy the requirements of the implementation plan.

Improvement Diagrams spreadsheet

The improvement diagrams are only available if the implementation plan was enabled in the Optimization options.

The improvement diagrams provide a series of analysis diagrams for the individual optimization targets selected in the Optimization targets.

In the improvement diagrams spreadsheet, the improvement diagrams for each selected optimization target is shown versus the:

- Number of implementation steps
- Implementation costs
- Implementation time

This allows you to directly analyze the efficiency of the network optimization for your selected radio network. Furthermore, the improvement diagrams allow you to compare the performance of the individual optimization targets head-to-head.

The mouse-over functionality provides you with additional information about the implementation steps, costs and required time to implement the network modifications.

ASSET Design also allows you to re-import and verify any implementation step shown in the implementation plan into ASSET. The selection of the step to be imported back to the planning tool can be selected with the *Export impl. steps* button.

Warnings spreadsheet

The **Warnings** spreadsheet displays any warnings that occurred while ASSET Design was processing.

The number of details is limited to 50 per warning category. The remaining messages can be found in a file which is named the same as the report followed by "_warning.xml".

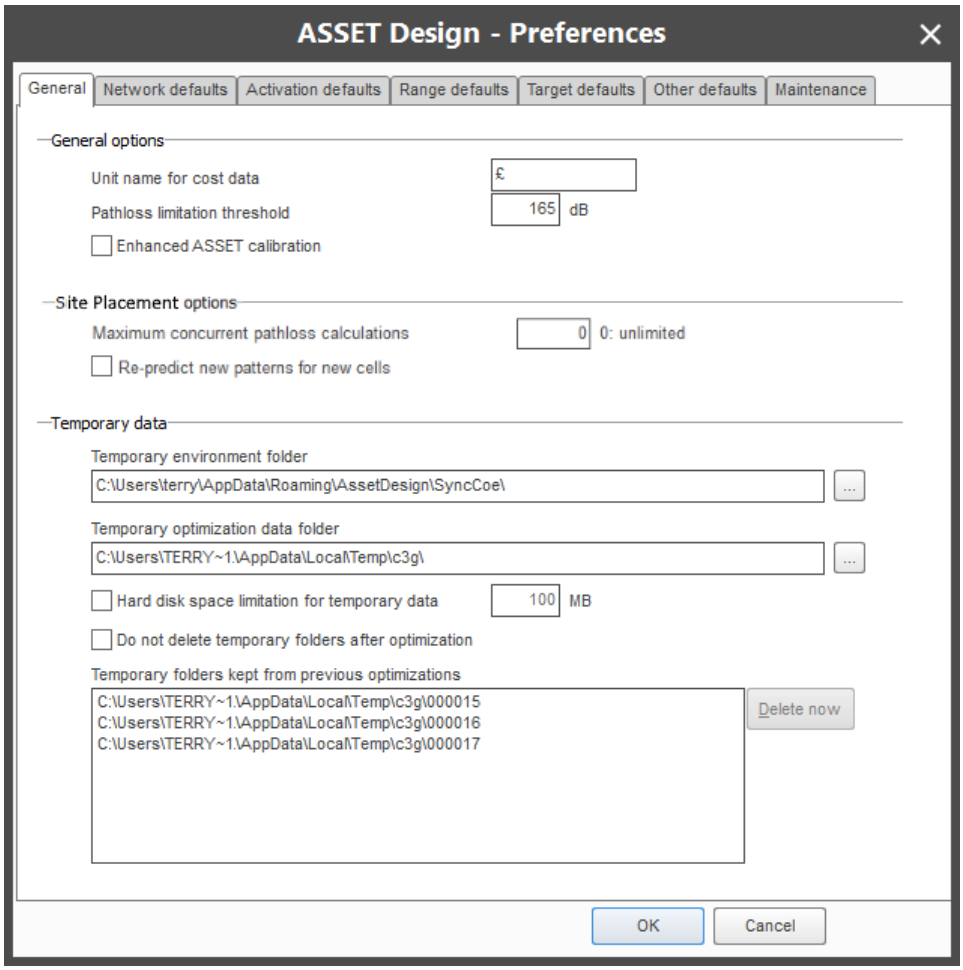
11 Preferences

Use the **Preferences** dialog box to access the ASSET Design options.

To do this:

From the **Tools** menu, click **Preferences**.

The following dialog box appears:



ASSET Design - Preferences dialog box

General tab

In the **Preferences** dialog box, you can use the **General** tab to view and modify:

General options

(General optimization process settings)

Setting or Option	Description
Unit Name For Cost Data	You can specify the currency unit to use for the cost data entered on the Optimization Ranges screen. The default value for currency is the one defined in the Regional and Language Options in the Windows Control Panel.
Pathloss limitation threshold	You can define the threshold for the pathloss limitation function. See also Running an Optimization on page 105.
Enhanced ASSET calibration	Enable this if you want to use the same rounding algorithms as ASSET. If you do not enable this, you will get more accurate results.

Site Placement options

(Settings that relate only to Site Placement)

Setting or Option	Description
Maximum concurrent pathloss calculations	You can use this to limit parallel propagation calculations in case there are not enough third party propagation model licenses available. A value of '0' means that there is no limit. Please note that if you run multiple optimizations at the same time, each of them will try to use the allowed maximum.
Re-predict new patterns for new cells	By default, even though there may be multiple templates for the optimization run, Site Placement creates a prediction for a cell only once, using the pattern associated with the first chosen template. In cases where there are templates with different associated patterns, involving masked predictions, there is a procedure which speeds up the process of changing the pattern for the cell. This involves unmasking the first pattern from the prediction and then re-masking the original prediction with the new pattern. The trade-off for the improved speed is that if the patterns differ significantly, the accuracy of the re-masked original predictions can be compromised. If you want to prioritize accuracy over speed, this setting enables you to force the optimization to re-predict for every different pattern that is associated with each template. Re-predictions will only occur where different templates have different patterns. If the patterns associated with the templates are all the same, there would be no re-predictions.

Temporary data

(Settings for the temporary availability of data required during the optimization process)

Setting or Option	Description
Temporary Environment Folder	Here you can set the path where the temporary environments that are directly exported from ASSET will be stored. (This is only applicable to the environments that are automatically generated.)
Temporary Optimization Data Folder	Displays the name of the folder used to store temporary data. You can click the Browse button to locate and choose the folder used to store temporary data.

Setting or Option	Description
Hard Disk Space Limitation For Temporary Data	Enable this if you want to limit the maximum available disk space for temporary data. Type the disk space limit in MB in the box to the right. If the required disk space for temporary data exceeds the defined limit during the optimization process, ASSET Design automatically increases the limit to successfully complete the optimization process.
Do Not Delete Temporary Folders After Optimization	**Warning**: Always check with TEOCO Product Support before you enable this checkbox. Normally you would only enable it when instructed to do so. You can enable this checkbox if you want to to keep the temporary data after the optimization process finishes.
Temporary Folders Kept From Previous Optimizations	This window lists the temporary data folders that were kept from previous optimization runs. When an optimization process fails, optimization folders are kept for Support inquiries. You can delete any or all of the temporary folders by selecting them and clicking the **Delete Now** button.

Network Defaults tab

In the **Preferences** dialog box, you can use the **Network defaults** tab to view and modify the network defaults settings. (For more information, refer to Network/Service Settings on page 29.)

Parameters and Properties

Setting or Option	Description
Use clutter indoor loss	Default value for the checkbox to use clutter indoor losses.

Traffic Map Settings

Setting or Option	Description
Scaling factor	Default value for the global scaling factor. Each pixel of the traffic map will be multiplied by this value.
Include captured traffic numbers in report	Default value for whether or not to compute a captured traffic analysis and include the numbers in the report.

3G/4G/5G Cell Load

Setting or Option	Description
Use imported cell loads - or - Use custom cell load	Default value for the choice between imported cell loads or custom cell loads. (Radio buttons.)
Custom cell load	Default value for the cell loading in %. Only applicable to custom cell load.

LTE Parameters

Setting or Option	Description
Common channel overhead	Default value for the common channel overhead in % for LTE density-based capacity targets.

Activation Defaults tab

In the **Preferences** dialog box, you can use the **Activation defaults** tab to view and manipulate the activation options.

Cell Activation Defaults

Use this pane to define the cell activation default for the INACTIVE transmitters.

The site (cell) activation feature allows you to optimize:

- **Network roll-out:** Based on a number of potential site (cell) locations, ASSET Design automatically selects and configures the sites (cells) required to fulfill the optimization targets in the best way for the network roll-out. The potential candidates are defined by inactive sites (cells) in the ASSET project.
- **Network extension:** Based on a predefined set of potential site (cell) locations, ASSET Design automatically selects and configures the sites (cells) required to fulfill the optimization targets in the best way for the network extension. The potential candidates are defined by inactive sites (cells) in the ASSET project.

Setting or Option	Description
Allow activation of inactive cells	Select this option if you want to allow the activation of INACTIVE transmitters (cells) by default.
Site is not available before	Select this option if you want to define the default availability of all sites in the network. Use the drop-down calendar to define the date for the default site availability. You can use the current date as default availability for all sites, by clicking the **Use current date** button.

For more information on the activation settings, see Activation / Implementation Parameters on page 41.

Activation Resource Requirement Defaults

Use this pane to define sector-specific costs associated to the activation of an inactive site or cell.

Default values for the costs and time parameters are defined in the Range Defaults tab of the **Preferences** dialog box. Default values are applied to parameters when the **Load network data** button is clicked on the Project Settings screen. The currency for the cost data is defined in the General tab of the **Preferences** dialog box. The default value for currency is the one defined in the Regional and Language Options in the Windows Control Panel.

Setting or Option	Description
Site	The costs and time required to prepare the site for the activation of a new transmitter. They do not include the costs (and time) to install a new cell. **Costs:** The expected expense of site activation. **Time:** The associated amount of time in man-days required to implement site activation.
Cell	The costs and time to install (activate) a new cell on a specific site. **Costs:** The expected expense of cell activation. **Time:** The associated amount of time in man-days required to implement cell activation (on the site).

For more information on the activation resource settings (including an example), see Activation Resources on page 43.

Range Defaults tab

In the **Preferences** dialog box, you can use the **Range defaults** tab to view and modify default values for the optimization ranges of following parameters:

- Antenna tilt
- Pilot power
- Antenna azimuth
- Antenna pattern:
  - Electrical tilt (electrical tilt variants of the current pattern)
  - Antenna type (by using a pattern list)
  - Electrical tilt limits
  - Limiting the electrical tilts of the individual antenna types
- Site access costs

All default settings in this tab are global and apply to all sectors for the group of sites chose to optimize, listed in the Project Settings screen of ASSET Design.

Range defaults apply when no other individual settings are applied, for example, from a previously saved optimization project. Range defaults are adopted by clicking 'Load network data' in the Project Settings screen, to load site data.

Modification Range Defaults

Use this pane to view and modify the default parameter settings for the optimization process. Optimization ranges are configured separately depending on whether associated predictions are used in unmasked or masked form (masked predictions are used for ray tracing models).

This table shows the parameter default values relating to Mechanical Tilt, Power and Azimuth, as well as Antenna Pattern and Electrical Tilt.

Note: The parameters will only be used in the optimization if their corresponding checkbox is enabled on the Optimization Ranges screen.

Setting or Option	Description
Mechanical Tilt	**Range Specification** for the parameter: - Relative (relative to the current value) - Absolute (absolute value range) **Optimization Range** for the parameter: - Min (minimum value) - Max (maximum value)
Power (Pilot/BCCH)	The common power levels corresponding to the pilot power are changed accordingly so that the same ratio is maintained after the optimization. **Range Specification** and **Optimization Range** as described in top row.

Setting or Option	Description
Azimuth	**Range Specification*** and **Optimization Range** as described in top row. ***Note**: For absolute values the antenna azimuth 0° represents North. This means that negative values can also be used, since the optimization requires a range of possible angles. An absolute range of minimum -60° to maximum 60° is the range from 60° West to 60° East of the North. The maximum range for absolute azimuth settings is [-360°...360°]. All other values can be expressed within this range. **Rotate Entire Site**: If you select this checkbox, the tightest limitation of all sector setting on that site will be used for the limitation of the site rotation. For example: Sector 1: +/- 10°; Sector 2: +/-15°; Sector 3: +/-20°. If you enable Rotate Entire Site on Sector 3, this will lead to a maximum rotation of the entire site of +/-10°.
Electrical tilt variants of current antenna	This option allows modifications of the electrical tilts for the current antenna pattern.
Electrical Tilt limits	If you select this checkbox, only patterns whose electrical tilts fall within the range given by the Min and Max fields next to the checkbox will be used for exchange. This range can be absolute or relative to the current value according to the selected option.

For more information on the modification range settings, see Parameter Modification on page 44.

Modification Resource Requirement Defaults

Use this pane to view and modify the default settings for the resource requirements.

Option	Description
Modification Resources	This is the overall checkbox that enables the other settings and activates the costs in the optimization. **Note**: Cells that have costs assigned but do not have this checkbox enabled will not use costs in the optimization process.
Site Access Required (checkboxes for each corresponding parameter)	Enable the checkbox for the corresponding parameter (Mech. Tilt, Power, Azimuth and so on) when it is necessary to visit the site to implement that parameter modification. **Costs:** Specify the expected expense of implementing the modification. **Time:** Specify the associated amount of time in man-days required to implement the modification. **Site access (Costs and Time):** Site access costs occur only once per site, regardless of the number of sectors that are being changed. Site access costs could be different for the individual sectors if the sectors are not co-located. Therefore, the value you enter to ASSET Design should be the highest access costs per site for the optimization.

For more information on the modification resource settings, see Modification Resources on page 49.

Target Defaults tab

In the **Preferences** dialog box, you can use the **Target defaults** tab to view and modify target default values. Target Defaults are automatically adopted by new ASSET Design projects.

3G/4G/5G Optimization Target Defaults

Use this pane to define the target default values for 3G/4G/5G:

Setting or Option	Description for Requirement Values
RX pilot (Coverage)	The default target value for the optimization within the optimization area. The coverage requirement specifies the default optimization objective for the best pilot field strength. The optimization objective should be exceeded after the optimization. Example: A coverage requirement of -90dBm means that all grid cells (pixels) in the optimization area should exceed a best pilot field strength of -90dBm after the optimization.
1st - 2nd RX Pilot	The default target value for the optimization within the optimization area. This requirement specifies the default optimization objective for the difference between the first and the second best pilot field strength. The optimization objective should be exceeded after the optimization. Example: A 1st-2nd RX pilot requirement of 4dB means that all grid cells (pixels) in the optimization area should have a difference between first and second best pilot field strength of more than 4dB after the optimization.
1st - Nth RX Pilot	The default target value for the optimization within the optimization area. This requirement specifies the default optimization objective for the difference between the first and the Nth best pilot field strength. The optimization objective should be exceeded after the optimization. N can be set between 3 and 5. Example: N can be set to 5. A 1st-5th RX pilot requirement of 6dB means that all grid cells (pixels) in the optimization area should have a difference between first and 5th best pilot field strength of more than 6dB after the optimization.
Ec/Io	The default target value for the optimization within the optimization area. This requirement specifies the default optimization objective for the Ec/Io requirement. The optimization objective should be exceeded after the optimization. Example: An Ec/Io requirement of -15dB means that all grid cells (pixels) in the optimization area should exceed an Ec/Io value of -15dB after the optimization.
Uplink Eb/Nt (UMTS only)	Uplink Eb/Nt is both a network quality and a capacity objective. In order to provide service coverage in the uplink, the minimum required Eb/Nt level needs to be satisfied for the individual service.
Downlink Eb/Nt (UMTS only)	Downlink Eb/Nt is both a network quality and a capacity objective. In order to provide service coverage in the downlink, the minimum required Eb/Nt level needs to be satisfied for the individual service.

For more information, see Optimization Targets 3G/4G/5G on page 72.

2G Optimization Target Defaults

Use this pane to define the target default values for 2G:

Setting or Option	Description for Requirement Values
RX BCCH (Coverage)	The default target value for the optimization within the optimization area. The coverage requirement specifies the default optimization objective for the best BCCH field strength. The optimization objective should be exceeded after the optimization. Example: A coverage requirement of -90dBm means that all grid cells (pixels) in the optimization area should exceed a best BCCH field strength of -90dBm after the optimization.
C/I	The default target value for the optimization within the optimization area. This requirement specifies the default optimization objective for the carrier to interference ratio (C/I) for all potential co-channel interferers. The optimization objective should be exceeded after the optimization. Example: A C/I requirement of 5dB means that all grid cells (pixels) in the optimization area should have a C/I of more than 5dB after the optimization.

For more information, see Optimization Targets 2G on page 83.

For each of the above targets, there are three other settings/options:

Setting/Option	Description
Weight	The default weight of this target (relative to the other individual optimization targets). This is the weight of pixels exceeding the target requirement. Examples of how to apply different weights in the optimization process are given in Optimization Weight Examples on page 151. All defined targets will be summed up multiplied by their relative weight. This enables you to flexibly achieve a proper balance between different objectives (for example, concentrate more on coverage or capacity, and so on).
Apply clutter weight factor	The default for whether or not to enable clutter-dependent weighting of the optimization target. This option can only be used if the relative weight of this target is not zero. The clutter weights will then be multiplied with the relative weight of this target. Clutter-dependent weights allow you to focus on different optimization areas; to make regions more important or less important than others. See also Clutter-dependent Optimization Weights on page 154.
Compute value during optimization	The default for whether or not to enable the calculation of the target function value of the optimization target. This setting is only relevant if the weight of the optimization target is zero. If enabled, ASSET Design will calculate, monitor and display the target function value of the optimization target, even though the applied weight is zero and this target will not contribute to the optimization. See also Progress (Cell Planning Mode) on page 126.

For more information, see Setting Network Targets and Service Targets on page 63.

Other Defaults tab

In the **Preferences** dialog box, you can use the **Other defaults** tab to view and modify a variety of default settings relating to strategies, plans, constraints and activation modes.

Optimization Strategy Defaults

You can use this pane to define the default strategy for the automated optimization. For information on these default settings, see Optimization Strategy on page 95.

Implementation Plan Defaults

You can use this pane to enable, by default, the calculation of an implementation plan for the suggested parameter modifications in the optimization process. For information on these default settings, see Implementation Plan on page 97.

Implementation Date Defaults

You can use this pane to enable the calculation of an implementation plan with an absolute date by default. For information on these default settings, see Implementation Plan on page 97.

Parameter Constraint Defaults

You can use this pane to view and modify default parameter constraints for the optimization process. For information on these default settings, see Parameter Constraints on page 98.

Resource Constraint Defaults

You can use this pane to define the default maximum cost and time budgets that limit the number of modifications in the optimization process. For information on these default settings, see Resource Constraints on page 98.

Activation Mode Defaults

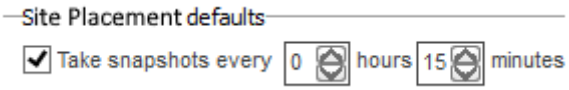
You can use this pane to select the default activation mode for your optimization. For information on these default settings, see Activation Mode on page 99.

Activation Constraint Defaults

You can use this pane to define the default maximum number of sites/cells that limit the activation process during the optimization. The optimization will consider both site and cell limits. For information on these default settings, see Activation Constraints on page 99.

Site Placement Snapshot Defaults

Here, for the Site Placement mode, you can set the default for switching automatic snapshots on or off, and a set a time interval (hh:mm).



Note: The actual setting for the automatic snapshot handling resides on the **Progress** screen. The above option only represents the default.

For more detailed information on how this setting works, see Progress (Site Placement Mode) on page 129.

Maintenance tab

In the **Preferences** dialog box, you can use the **Maintenance** tab to view ASSET Design maintenance information.

License Information

Setting or Option	Description for Requirement Values
Licensed to	This box displays the name to which the used license is issued.
License valid until	This box displays the date and time when the current license expires.
Optimizer licenses	**Total:** Displays the number of available licenses for ASSET Design. For a local license key this box displays 0. For a network license this box displays the total number of available licenses. If both a local and network licenses are available, the box will show the number of network licenses. **In Use:** Displays the number of ASSET Design licenses currently in use. For a local license key this box displays 0. For a network license this box displays the total number of used network licenses. If both a local and network licenses are available, the box will show the number of used network licenses regardless which license is currently used for ASSET Design. You can click the **Refresh** button to update the Licenses In Use values.
Simulation engine licenses	**Total:** Displays the number of available licenses for the simulation engine. For a local license key this box displays 0. For a network license this box displays the total number of available licenses. If both a local and network licenses are available, the box will show the number of network licenses. **In Use:** Displays the number of simulation engine licenses currently in use. For a local license key this box displays 0. For a network license this box displays the total number of used network licenses. If both a local and network licenses are available, the box will show the number of used network licenses regardless which license is currently used for the simulation engine. You can click the **Refresh** button to update the Licenses In Use values.
Licensed modules	This box displays the available modules under the available license.

Logging Information

Setting or Option	Description for Requirement Values
Application Log File	Displays the location of the ASSET Design log file. You can use this log file for maintenance purposes.

12 Multi System

This chapter describes the multi system planning and optimization functions within ASSET Design, and how the multi system parameter synchronization of different radio networks, technologies and frequency bands can be handled.

Multi System Overview

This sub-section gives an overview of the multi system planning and optimization functions within ASSET Design.

Multi Technology Support

The multi system optimization technology in ASSET Design enables the joint consideration of multiple radio network technologies for advanced radio network planning and optimization. The key advantage of this technology hence is the ability to jointly design and improve different but interdependent radio networks in ASSET. Interdependencies typically apply in networks with:

- Shared antennas between multiple radio technologies and frequency bands
- Services that are offered independently of the radio access network
- Inter-system handover between multiple technologies
- Traffic sharing (for example UMTS900/GSM900).

The multi system technology in ASSET Design allows the combination of two or more radio networks in different frequency bands, on different carriers, or with different radio access technologies. Examples include, but are not limited to:

- GSM, Band 1 + GSM, Band 2 linked with dual band antennas
- GSM, Band 1 + WCDMA, Band 3, Carrier 1 with shared or dual band antennas
- GSM, Band 1 + GSM, Band 2 + WCDMA, Band 3, Carrier 0 + WCDMA, Band 3, Carrier 1 with shared multi band antennas

This allows improved plans for multiple technologies, in multiple frequency bands, on multiple carriers.

The joint optimization algorithms in ASSET Design are not limited by the number of frequency bands, carriers or technologies. Multiple frequency bands, carriers and technologies can be combined in a single task. Typical applications include:

- Improvement of two network plans at different frequency bands or carriers
- Merging two networks that must be combined as a result of takeovers or mergers
- Joint 2G and 3G radio network design, planning and optimization
- Optimized planning of cell overlays and inter-system handover areas
- Traffic sharing, where a network layer captures traffic remaining from a previous network layer

Shared Multi Band Antennas

Multi band antennas are widely used for the deployment of 2G and 3G networks.

In the case that multi band antennas are shared between 2G and 3G systems, they limit the ability to improve the network performance of 3G networks, while the 2G performance has to be at least maintained. For example, the 3G coverage cannot be improved by simply just changing the antenna azimuth, as it would influence the 2G network performance at the same time.

In order to ensure that the 3G network is improved by modifying RAN parameters, the 2G network performance has to be considered at the same time. This is possible with the multi-system functionality of ASSET Design. The shared multi-band antennas are considered directly for the different frequency bands, carriers, and technologies, as different frequency bands are allocated to the individual antenna pattern.

This can be done in the Electrical Tilt Grouping Editor. See Electrical Tilt Pattern Grouping Editor on page 54.

If shared antennas are defined in the ASSET project, this information will be written to a file called *SharedAntennas.paramSync* stored in the optimization environment. For more details about paramSync-files, refer to Multi System Parameter Synchronization on page 148. This synchronization file is a text file and can also be modified with a text editor to add, remove, or modify synchronizations between cells and/or antennas. A more comfortable way of editing cell synchronization is to use the synchronization editor which is available in the **Optimization Ranges** screen. The paramSync-file needs to be loaded together with the optimization environment. To do that, specify the file name in the **ParamSync file (optional)** input box in the **Project Settings** screen. Parameter synchronizations are the way to model dependencies of parameters of cells and/or antennas of different transmitters. This can be, but is not limited to, shared antennas.

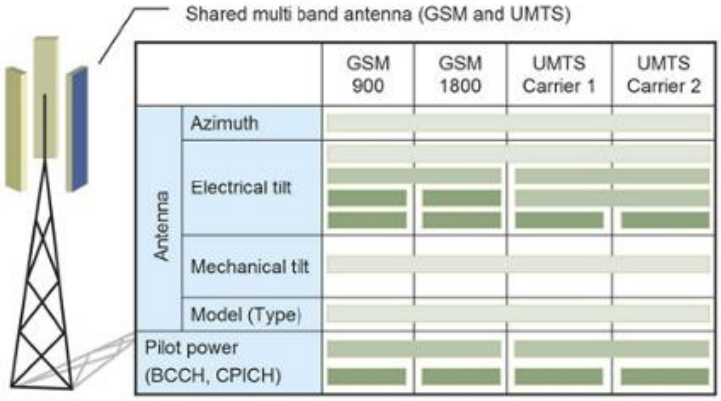
Multi System Parameter Synchronization

This sub-section describes how the multi system parameter synchronization of different radio networks, technologies and frequency bands can be handled in ASSET Design.

Synchronization of Optimization Parameters between Different Technologies

Optimization parameters can be connected between different radio network technologies, different frequency bands or different carriers. For example, a triple band shared antenna with operating frequencies in the GSM900, GSM1800 and UMTS band can have different remote electrical tilts for each band, while the mechanical tilt of the antenna of course remains the same. This is obvious as the antenna is incorporated into a single physical aperture.

An example for different synchronizations between GSM900, GSM1800 and multi carrier UMTS is shown in the figure below:



The example shows that the azimuth between the different technologies, frequency bands and carriers is usually the same. The same applies to the mechanical tilt, as long as the antenna is a single physical entity. The remote electrical tilt however might be completely different, and variable in each band, frequency, technology. The same applies to the pilot power values.

Use of Synchronizations in the Optimization

The aim of the synchronization of the different parameters is to ensure that the right connections are set between the individual values. For example, the remote electrical tilt can be changed individually for the 900MHz band and the 1800MHz band, while the mechanical tilt is the same.

Furthermore, in cases where shared multi band antennas with remote electrical tilts are used, different antenna pattern apply to the different frequency bands and technologies. This needs to be taken into account in the joint optimization of multiple systems.

Generating Synchronization Files

ASSET Design allows two different modes for the synchronization of multi band antennas and multi technology systems.

Automatic Generation of Synchronization Files

In order to automatically create synchronizations between different networks, please enable the *Automatically create multiband parameter synchronizations for aligned antennas* checkbox in the project settings.

ASSET Design then automatically creates synchronizations of the individual multi-band and multi technology sectors if the antennas are co-located and both the mechanical tilt and the azimuths are the same (with minor tolerances to consider rounding errors).

In order to save these parameter synchronization settings:

From the **File** menu, click *Create parameter synchronization template*.

With this, the actual settings are stored in a .ParamSync file for further manual modifications, or reuse in other projects.

Add Synchronization Parameters in ASSET Design

Additional synchronization parameters can be added in the **Optimization Ranges** screen of the user interface:

- Select the cells for which you want to change synchronization parameters.

  Note: Cell parameters can only be synchronized if cells are on the same site, have the same azimuth, tilt, height and antenna.

- Press the **Add synchronizations** button.
- On the left hand side of the pop-up window you see the groups of cells that can be synchronized. On the right hand side you can add additional parameter synchronizations to the existing ones. To remove a parameter synchronization from a cell you have to manually edit the paramsync file which is described below.

Manual Generation of Synchronization Files

To enable synchronization between the different multi bands, frequencies and technology transmitters, a synchronization file needs to be generated.

To do this, follow the steps below:

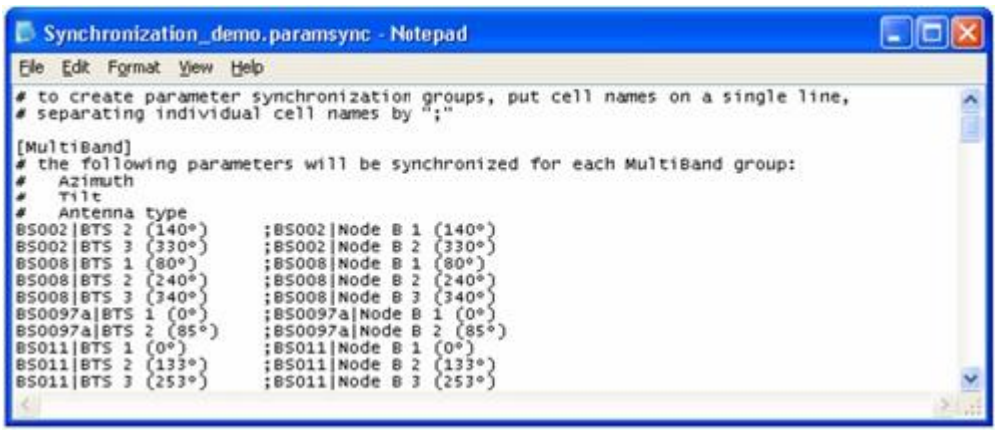
1. From the **File** menu, click *Create parameter synchronization template*.

   ASSET Design will then create a ".ParamSync template" file that includes a list of the transmitters in the actual project. The paramsync template also includes the instructions of how to edit the file in order to generate the synchronization between the different parameters.

2. Open the paramsync-file with a text editor.

3. The paramsync-file allows the synchronization of multi-band and multi-carrier technologies. For example, a multi-band antenna is modeled with synchronizations of the antenna azimuth, the mechanical antenna tilt and the antenna type itself. This means that in case a multi-band antenna is shared between different radio technologies, the antenna azimuth, the mechanical tilt and the antenna type itself will always be identical for both technologies or bands.

   To ensure the synchronization between these bands, the transmitters have to be brought into a single line in the paramsync-file, separated by a ";". An example is shown in the figure below.



4. After the synchronizations are defined, the file needs to be stored as .paramsync file.

5. To use the parameter synchronizations in the optimization of the multi-system, multi-band, multi-carrier networks, use the **ParamSync file (optional)** input box in the **Project Settings** screen of the user interface.

Manual Merging of Sites

The section [Sites] can be used to manually merge sites. The steps are similar to the steps in paragraph "manual generation of synchronization files" above. Instead of cell names the site names of the sites that shall be merged have to be brought into a single line in the paramsync-file, separated by a ";". ASSET Design can then synchronize parameters of cells on the merged sites.

13 Optimization Guidelines

This chapter offers guidelines and examples around optimization weights, clutter-dependent weights and optimizations with measurements.

Optimization Weight Examples

For each individual optimization target, a relative weight must be applied. These weights define the importance of the optimization target. A target with zero weight will not contribute to the optimization, only the according analysis will be reported.

The total optimization target results as the weighted addition of the individual targets. To be able to accurately add different targets, the target function values are normalized by the maximum possible target function value before multiplied by their weights and added together. The maximum target function value depends on the selected weighting methods (global only, clutter-dependent, traffic map weighting).

Target Function Weights

The total objective is calculated as the sum of the individual weighted target contributions. Each target contribution is calculated as the normalized contribution (in the range 0.0 .. 1.0) multiplied by the target's weighting factor.

objective = sum target_contribution = sum (normalized_target_contribution * target_weight)

The normalization of the individual targets ensures that all targets are treated equally and independent of the kind of the target, clutter-dependent weighting, or traffic weighting.

For example (if no additional clutter based or traffic map weighting is applied):

- The normalized contribution for 12 km^2 out of 20 km^2 is 0.6
- The normalized contribution for 1400 out of 2000 served users is 0.7

If the target function weights for both targets are 1.0, the total objective is 1.0 * 0.6 + 1.0 * 0.7 = 1.3. This means that both targets have (roughly) the same importance for the optimization. The maximum possible objective for this scenario is 2.0.

Notes:

- The normalization is done on the target function's absolute maximum, i.e. the situation where all pixels are covered or all users are served. This might not be possible in the scenario, that is, a normalized contribution of 1.0 might not be reachable in all cases.
- Assigning the same weight to several target functions does not necessarily mean that these will be equally important for the optimization. If for example two coverage targets are applied to the same network with thresholds of -84 dBm and -54 dBm and the same weight of 1.0, the effective weight for the optimization can be different. We assume that the potential optimization gain for coverage @ -84 dBm is from 70% (initial) to 90% (optimized), while the potential gain for coverage @ -54 dBm is just from 2% to 3% in very small regions next to the site locations.

  In this case it is obvious that the -84 dBm target will effectively be more important for the optimization as the average gain for a parameter modification is higher for this threshold.

For each individual optimization objective, target weights can be applied. These weights represent the importance of the optimization target as overall objective for the optimization process. The weights are applied to each single grid cell that can be gained. A weight of 0 means that the performance measure is not considered in the total optimization target.

The total optimization target results as the superposition (weighted addition) of the individual targets.

Total optimization target =

= "Area fulfilling coverage requirement [km²]" x "weight for coverage"

+ "Area fulfilling difference between 1st-2nd best pilot [km²]" x "weight for 1st-2nd best pilot"

+ "Area fulfilling difference between 1st-Nth best pilot [km²]" x "weight for 1st-Nth best pilot"

+ "Area fulfilling Ec/Io requirement [km²]" x "weight for Ec/Io requirement"

The overall objective of the optimization is to maximize the total optimization target.

Example 1

Area fulfilling coverage requirement: weight=1

Area fulfilling 1st-2nd best pilot requirement: weight=0

Area fulfilling 1st-Nth best pilot requirement: weight=0

Area fulfilling Ec/Io requirement: weight=0

Result: only the coverage target is considered in the optimization

Example 2

Area fulfilling coverage requirement: weight=0

Area fulfilling 1st-2nd best pilot requirement: weight=1

Area fulfilling 1st-Nth best pilot requirement: weight=0

Area fulfilling Ec/Io requirement: weight=0

Result: only the difference between 1st-2nd best pilot target is considered in the optimization

Example 3

Area fulfilling coverage requirement: weight=0

Area fulfilling 1st-2nd best pilot requirement: weight=0

Area fulfilling 1st-Nth best pilot requirement: weight=0

Area fulfilling Ec/Io requirement: weight=1

Result: only the received Ec/Io target is considered in the optimization

The high flexibility of the weighting mechanism allows the user to optimize for a wide range of optimization objectives.

Clutter-based and Traffic Map Weighting

In addition to the overall optimization weights, individual weights for each objective can be defined for each clutter class.

Clutter based weights or traffic map weighting can be used to adjust the importance of single pixels depending on their location, for example the main weight can be directed to the city center.

Thus the following scenarios are equal:

- no special weighting
- all clutter weights 1.0
- all clutter weights 2.0
- a traffic map with constant value 1.0
- a traffic map with constant value 0.001
- all clutter weights 0.5 + a traffic map with constant value of 20.0

In addition, the following scenarios are equal:

- clutter 0 -> 0.5, clutter 1 -> 1.0
- clutter 0 -> 1.0, clutter 2 -> 2.0
- clutter 0 -> 2.0, clutter 2 -> 4.0

Note: Due to the normalization the unit of the traffic map does not matter for the weighting process, only the relative difference of a pixel's value compared to the other pixels values is relevant, i.e. linear scaling of the traffic map does not influence traffic map WEIGHTING. Please note that it DOES INFLUENCE the cell's captured traffic and thus the total traffic limits.

For further description see Clutter-dependent Optimization Weights on page 154.

Traffic Limits

Traffic weighting is described above, as it is similar to the clutter-dependent weighting.

On top of the traffic weighting, traffic limits can be used to ensure that the cell radius will not become too large, or too small, avoiding overloaded and empty sectors.

Traffic map weighting is applied in a form that a cell with excessive traffic is assigned an appropriate degradation factor. The pixels in the cell's footprint are weighted by this factor in addition to clutter and traffic map weighting factors. Excessive traffic means that the cumulated traffic over the cell's best server footprint is larger than the maximum captured traffic.

A detailed description of the consideration of maximum traffic limits for each sector in the network is defined in the Network/Service Settings on page 29.

Combination of Weighting Mechanisms

The different weighting mechanisms are combined multiplicatively, with the important difference that clutter, traffic map and captured traffic weighting are applied before normalization and the target function's weight is applied after the normalization.

This gives the relation initially stated:

objective = sum (target_contribution) for all target functions

*= sum (normalized_target_contribution * target_weight) for all target functions*

For pixel targets the normalized target contribution is:

*normalized_target_contribution = Normalize(Sum (clutter_weight * traffic_map_weight * degradation_factor) for all covered pixels)*

which is roughly equal to:

normalized_target_contribution =

*Sum (clutter_weight * traffic_map_weight * degradation_factor) for all pixels satisfying requirements /*

*Sum (clutter_weight * traffic_map_weight) for all pixels*

For traffic simulation target the normalized target contribution is:

*normalized_target_contribution = Normalize(Sum (user_weight * clutter_weight) for all served users)*

which is roughly equal to:

normalized_target_contribution =

*Sum (user_weight * clutter_weight) for all served users /*

*Sum (user_weight * clutter_weight) for all users*

The individual user's weight is either 1 for the number of served users target, or the bit rate for the throughput target.

Clutter-dependent Optimization Weights

Use this section to define clutter-dependent weight factors for the combination of the individual optimization targets specified in the Optimization Target screen. The option of clutter-dependent weight factors can be enabled for each of the optimization targets individually. This can be done by enabling the check box 'Apply clutter weight factor' in the Optimization Target screen.

Using Zone Files

The zone file format is identical to the clutter file format. Zone files cannot yet be exported from ASSET.

Combination of Global and Clutter-dependent Optimization Weights

Global optimization weights and clutter-dependent optimization weights can be combined for each individual optimization objective. A global weight higher than zero is required to consider the optimization target. The individual importance of different areas can then be defined by clutter-dependent weighting factors.

Some examples for the clutter-dependent optimization weights are provided below.

Example 1

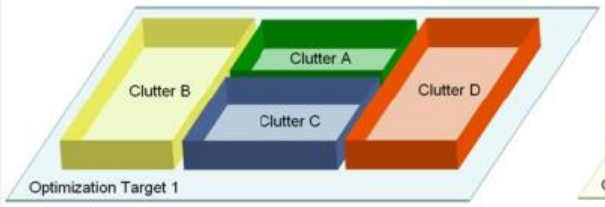
Optimization Target 1, for example, Coverage = *do not* use clutter-dependent weighting, global weight = 1

Optimization Target 2, for example, Difference 1st-Nth pilot = use clutter-dependent weighting, global weight = 1

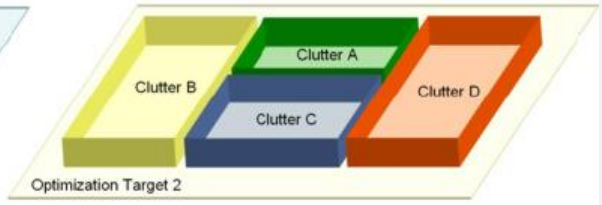
The clutter weights for the individual optimization targets are shown in the table below:

Optimization Target 1	Optimization Target 2
"global" weight = 1	"global" weight = 1
clutter-dependent weighting: **Disabled**	clutter-dependent weighting: **Enabled**
Clutter A = 1 Clutter B = 1 Clutter C = 1 Clutter D = 1	Clutter A = 1 Clutter B = 1 Clutter C = 1 Clutter D = 1

Result:



Clutter dependent weighting for optimization target 1



Clutter dependent weighting for optimization target 2

For Optimization Target 1, the clutter-dependent weighting is disabled. Hence, it does not matter which weights are set for the clutter types, the overall weight will be "1".

For Optimization Target 2, the clutter-dependent weighting is enabled. Hence, the importance will be based on the clutter-dependent weighting combined with the "global" weight for this optimization target.

If all clutter types have the same weight, there is no impact on the different optimization weights due to the clutter-dependent weighting.

Furthermore the global weight for both optimization targets is the same. This means that the importance of the two optimization targets is the same for all clutter types, i.e. areas.

In practical terms, this means (with coverage and quality as the optimization targets) that an additional 1km² in coverage is of the same value as an additional 1km² fulfilling the quality requirements.

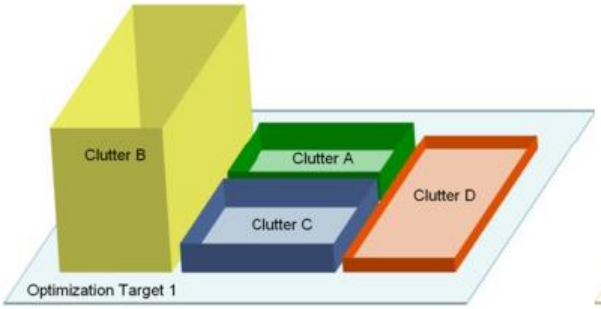
Example 2

Optimization Target 1, for example, Coverage = use clutter-dependent weighting, weight = 1

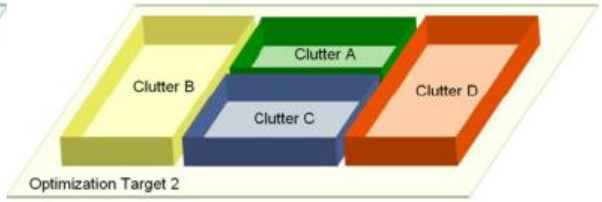
Optimization Target 2, for example, Diff 1st-Nth pilot = *do not* use clutter-dependent weighting, weight = 0 The clutter weights for the individual optimization targets are shown in the table below:

Optimization Target 1	Optimization Target 2
"global" weight = 1	"global" weight = 0
clutter-dependent weighting: **Enabled**	clutter-dependent weighting: **Disabled**
Clutter A = 1 Clutter B = 5 Clutter C = 1 Clutter D = 0.5	Clutter A = 1 Clutter B = 1 Clutter C = 1 Clutter D = 1

Result:



Clutter dependent weighting for optimization target 1



Clutter dependent weighting for optimization target 2

For Optimization Target 1, the clutter-dependent weighting is enabled. Hence, the importance of the individual areas will be based on the clutter-dependent weights defined for the clutter. The global weight is "1" and hence the overall multiplier for the clutter weights is "1".

For Optimization Target 2, the clutter-dependent weighting is disabled. Hence, the importance will be based on the global weight. Since this global weight is "0", the contribution of

Optimization Target 2 for any point in the optimization area is "0". This means that optimization target 2 is not considered at all in the optimization.

The optimization will hence only focus on optimization target 1. With the enabled clutter-dependent weighting we can see that the area described by Clutter B is 5-times more important than Clutter A and Clutter C and 10-times more important than Clutter D.

In practical terms, this means (with coverage and quality as the optimization targets) that only coverage is of importance in this example. An additional 1km^2 in coverage in Clutter B is 5-times the value as an additional 1km^2 in coverage in Clutter A+C , and 10- times the value for the same comparison with Clutter D.

Note: The global optimization weight is a multiplier to the normalized clutter based weighting factors. Hence, if the global weight for a particular optimization target is "0", the overall weighting for this optimization target will be zero independent of the clutter settings. This means that the target will not be considered in the optimization process at all.

Example 3

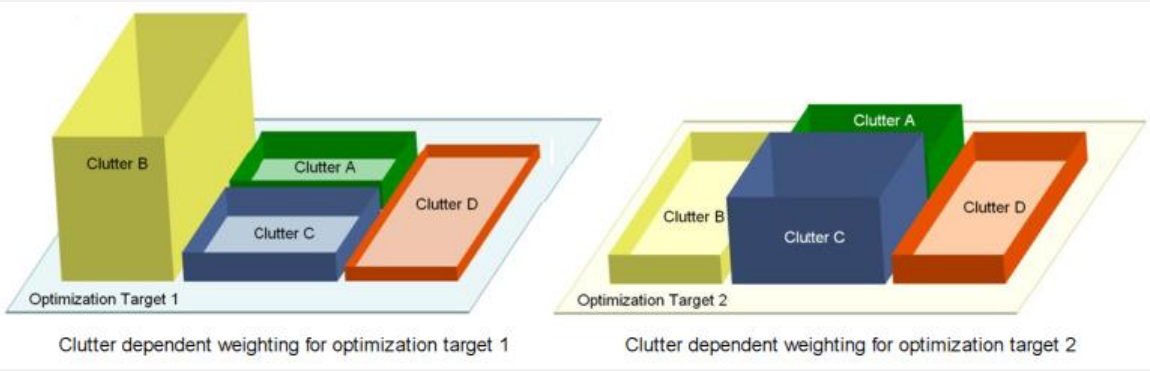
Optimization Target 1, for example, Coverage = do use clutter-dependent weighting, weight = 1

Optimization Target 2, for example, Diff 1st-Nth pilot = *do not* use clutter-dependent weighting, weight = 1

The clutter weights for the individual optimization targets are shown in the table below:

Optimization Target 1	Optimization Target 2
"global" weight = 1	"global" weight = 1
clutter-dependent weighting: **Enabled**	clutter-dependent weighting: **Disabled**
Clutter A = 1 Clutter B = 5 Clutter C = 1 Clutter D = 0.5	Clutter A = 2 Clutter B = 1 Clutter C = 3 Clutter D = 1

Result:



Clutter dependent weighting for optimization target 1 — Clutter dependent weighting for optimization target 2

For Optimization Target 1 the clutter-dependent weighting is enabled. Hence, the importance of the individual areas will be based on the clutter-dependent weights defined for the clutter. The global weight is "1" and hence the overall multiplier for the clutter weights is "1".

For Optimization Target 2 the clutter-dependent weighting is disabled. Hence, the importance will be based on the global weight. Since this global weight is "1", the contribution of optimization target 2 for any point in the optimization area is "1".

The optimization will hence focus on different levels optimization target 1, while the importance of the optimization target 2 remains the same throughout the optimization area (due to the fact that the different clutter weighting for optimization targets is not enabled).

Note: Even though the clutter-dependent weighting for optimization target 2 shows different values, it is DISABLED and hence the overall optimization weight for this target is given by the global weight only!

In practical terms, this means that the importance of a single optimization target can be modified for each clutter type. This clutter-dependent relative weighting of various targets provides great value.

Considering the cost and time limitations, clutter (area) based weighting becomes even more important. Assume that Clutter B describes an urban area, while the other clutter types describe suburban, rural and park areas. Furthermore, assume that depending on the different clutter types we have different traffic density distributions or ARPUs (which are nothing else than the different weights for different clutter types set above) and different costs for the implementation of parameter modifications. This is indicated in the table below:

Clutter type	Traffic density (or ARPU)	Costs for modifications
Urban	high (5 units = weight)	high (3 units)
Suburban	low (1 unit = weight)	high (3 units)
Park	low (0.5 unit = weight)	medium (2 units)
Rural	low (1 unit = weight)	low (1 unit)

In the case where the optimization budget is limited, cheaper modifications will be prioritized if the same area can be gained. However, this does not necessarily mean that they are then the most cost effective modifications. The most cost effective modification has to consider the value of the modification, e.g. how much more traffic can be served within the gained area by doing this modification. Another possible measure would be the average revenue per user, ARPU. Therefore, a more expensive parameter change can pay off if the additional area is worth the additional effort - compared to the area and the traffic that can be gained by the cheaper modification.

In the example above, a single modification in an urban environment would pay off compared to a cheaper modification in a rural environment if they can both gain the same area, even though the cheaper parameter modification costs only 1/3! The reason is that the rural return of investment would be 1/3, while the urban investment - if possible within the total budget - will deliver 5 units in terms of gained traffic. The more expensive modification therefore brings more income and hence is the preferable solution for this particular situation.

Example 4

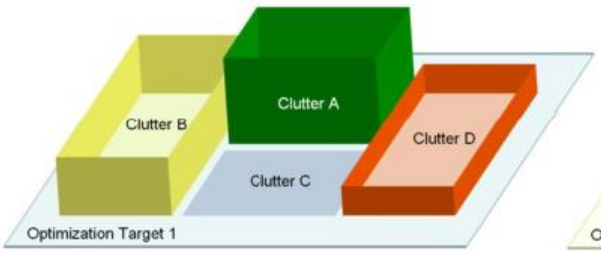
Optimization Target 1, for example, Coverage = use clutter-dependent weighting, weight = 1

Optimization Target 2, for example, Diff 1st-Nth pilot = use clutter-dependent weighting, weight = 2

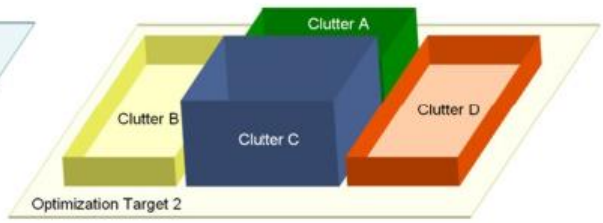
The clutter weights for the individual optimization targets are shown in the table below:

Optimization Target 1	Optimization Target 2
"global" weight = 1	"global" weight = 2
clutter-dependent weighting: **Enabled**	clutter-dependent weighting: **Enabled**
Clutter A = 3 Clutter B = 2 Clutter C = 0 Clutter D = 1	Clutter A = 2 Clutter B = 3 Clutter C = 1 Clutter D = 1

Result:



Clutter dependent weighting for optimization target 1



Clutter dependent weighting for optimization target 2

For Optimization Target 1, the clutter-dependent weighting is enabled. Hence, the importance of the individual areas will be based on the clutter-dependent weights defined for the clutter. The global weight is "1" and hence the overall multiplier for the clutter weights is "1".

Note: The clutter weight for Clutter C is "0". Since the clutter weight is a multiplier to the contribution of Optimization Target 1 this means that the area described by Clutter C does not deliver any value. This area is hence NOT considered in the optimization. A practical example for this would be that Clutter C describes a lake or a restricted area, where it is of no interest to provide coverage.

For Optimization Target 2, the clutter-dependent weighting is enabled as well. Hence, the importance will be based on the global weight times the clutter weighting factors.

Example 5

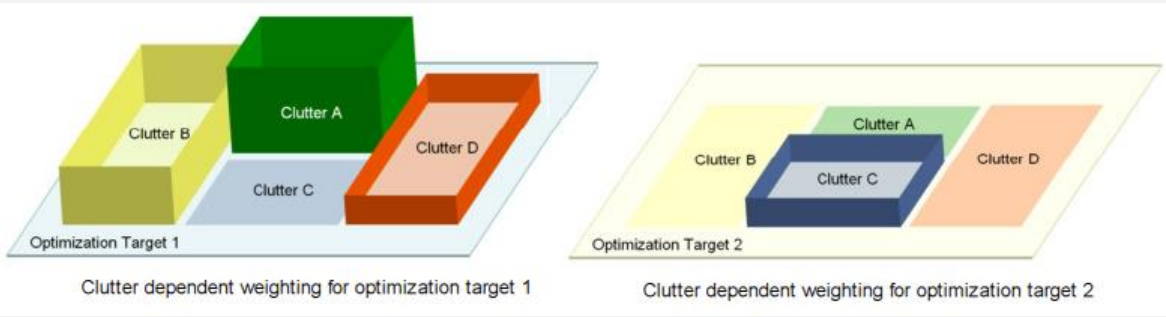
Optimization Target 1, for example, Coverage = use clutter-dependent weighting, weight = 1

Optimization Target 2, for example, Diff 1st-Nth pilot = use clutter-dependent weighting, weight = 1

The clutter weights for the individual optimization targets are shown in the table below:

Optimization Target 1	Optimization Target 2
"global" weight = 1	"global" weight = 1
clutter-dependent weighting: **Enabled**	clutter-dependent weighting: **Enabled**
Clutter A = 3 Clutter B = 2 Clutter C = 0 Clutter D = 1	Clutter A = 0 Clutter B = 0 Clutter C = 1 Clutter D = 0

Result:



For Optimization Target 1, the clutter-dependent weighting is enabled. Hence, the importance of the individual areas will be based on the clutter-dependent weights defined for the clutter. The global weight is "1".

Note: The clutter weight for Clutter C is "0". Since the clutter weight is a multiplier to the contribution of optimization target 1 this means that the area described by Clutter C does not deliver any value. This area is hence NOT considered in the optimization. A practical example for this would be that Clutter C describes a lake or a restricted area, where it is of no interest to provide coverage.

For Optimization Target 2, the clutter-dependent weighting is enabled as well. Hence, the importance will be based on the global weight times the clutter weighting factors. Since all (beside Clutter C) clutter-dependent weights are "0", this optimization target will only be considered in Clutter C and nowhere else.

In practical terms, this means that while optimization target 1 is important everywhere besides Clutter C, optimization target 2 is *only* considered in Clutter C.

Optimization with Measurements

ASSET Design supports not only prediction based but also measurement based target functions. This topic describes how to use measurements in the optimization process. Measurements are supported for GSM, UMTS, CDMA2000, and LTE.

Using Measurements

Measurements are used in ASSET Design by creating a measurement environment. A measurement environment is similar to an optimization environment with two major differences:

- Measurement environments contain pathloss files based on measurements while optimization environments contain pathloss files based on predictions.
- Measurement environments can only be used in combination with an optimization environment.

Measurement environments are used in ASSET Design by assigning them to individual target functions. The analysis for this target will hence be done with the measurement-based pathlosses rather than the prediction-based pathlosses. This allows maximum flexibility to combine different target functions for measurements and predictions with individual weights.

Prerequisites

A suitable ASSET project with measurement data is required to use measurements in ASSET Design. The transmitter settings in the project must accurately reflect the status of the network at the time the measurements have been done. In particular the following parameters must be as exact as possible in the ASSET project:

- Mechanical settings (tilt, azimuth, antenna pattern, and so on)
- Power settings (pilot power, total transmit power, and so on)
- Scrambling codes (UMTS) and Cell IDs of the cells

Caution: The ASSET project that is used to create the measurement environment must reflect the network configuration during the measurement as accurately as possible.

Usually the same project should be used to create the measurement environment and the optimization environment and this project should contain the network parameters used during the measurement (azimuths, tilts, antenna patterns, pilot powers, loads, and so on).

If this is not possible, for example if parameters have been modified since the measurement was done and these parameter changes have to be considered in the optimization, two ASSET projects have to be used:

- One ASSET project with the network configuration during the measurement to create the measurement environment.
- One ASSET project with the current network configuration to create the optimization environment.

Quality of Measurements

A general rule when using measurements in optimizations is: "the better the quality of measurements, the better the quality of the optimized network configuration".

Please consider the following rules when using measurements in optimizations:

- The measurements should have a sufficient number of samples that are dense enough and regularly distributed around the transmitters of interest. There should not be large uncovered areas (for example parks that could not be covered with drive tests) that are of interest for the operator.
- The measurements should have as many servers per sample as possible. To allow ASSET Design to improve the network, the information on alternative servers is vital. Measurements with only one server can be used to verify certain requirements, but the value for optimizations is limited.
- The measurements should be carried out with constant pilot powers and constant total powers (loads), otherwise the calculated pathloss matrices might not be accurately enough for the optimization process.

If one or more of these conditions is not met, it is highly likely that the optimization will not produce optimal results. Therefore, if the appropriate data is not available it might be better to, for example, refrain from using Ec/Io or C/I targets in the process and concentrate on coverage only.

Creation of Measurement Environments

The generation of measurement environments must be done with a separate tool Measurement Converter on page 193 that can load measurement files in text format.

Similar to the optimization environment (containing network data, transmitter data and prediction based pathloss matrices), a measurement environment contains propagation data calculated from measurements. The Measurement converter performs analysis and pre-processing, and subsequently writes all required data for ASSET Design into files in a user specified location.

If multiple test mobile or scanner data files need to be used in ASSET Design, repeat the export process and select a different measurement environment (that is, different .cme files) each. For more detailed information about the export of measurement environments, see Creating a Measurement Environment on page 18.

Using Measurements in the Optimization

Both an optimization environment and a measurement environment are required to utilize measurements in ASSET Design. The optimization environment contains all relevant network and transmitter parameters as well as the prediction based pathloss files. If you do not need to use measurements, the optimization environment alone is sufficient.

Multiple measurement environments can be used together with a single optimization environment. A measurement environment usually contains one set of test mobile or scanner data, hence several measurement data sets can be used simultaneously in one optimization run.

Please note that the ASSET project used for generating the optimization environment can be different from the project used for generating the measurement environment. However, parameter deviations (azimuth, tilt, powers) should not be too large to ensure the measurements are usable.

Use the measurement data instead of the predicted pathloss matrices by selecting the appropriate measurement environment for a target function (see Saving and Loading Target Function Settings on page 71). This allows to combine measurement based targets functions and prediction based target functions.

In fact it is recommended to use a **combination** of measurements and predictions whenever possible. This might for example be useful if the distribution of measurements is not dense enough. The optimization process might tend to focus on areas with measurements when optimizing for measurements only. This can be prevented by optimizing on both measurements and predictions.

Example

Create two coverage and two Ec/Io target functions to consider both predictions and measurements:

Coverage-P	weight 1.0	(no measurement environment)
Coverage-M	weight 0.5	D:\Data\DemoMeasurementEnvironment.cme
Ec/Io-P	weight 0.5	(no measurement environment)
Ec/Io-M	weight 0.25	D:\Data\DemoMeasurementEnvironment.cme

This example demonstrates how to optimize for coverage and Ec/Io (balanced 2:1), both based on predictions and measurements (balanced 2:1).

Using multiple measurement environments is possible by applying several targets and selecting another measurement environment for each target.

Example

Create two target functions to consider both coverage based on predictions and coverage based on measurements:

Coverage-P	weight 1.0	(no measurement environment)
Coverage-M1	weight 0.5	D:\Data\DemoMeasurementEnvironment1.cme
Coverage-M2	weight 0.5	D:\Data\DemoMeasurementEnvironment2.cme
Coverage-M3	weight 0.5	D:\Data\DemoMeasurementEnvironment3.cme

For clear identification of prediction and measurement targets in the optimization report and in Inspector it is recommended to assign appropriate target function names.

Consistent with all other target functions, each target objective is normalized by its maximum value. Thus, the target objective of a measurement based target will be normalized by the area of the optimization polygon in the same way as a prediction based target.

Please refer to Defining Targets on page 59 for more detailed information on target functions.

Useful Guidelines

You can increase the potential of achieving optimum optimization results if you follow these guidelines:

- Measurement based estimations of coverage and Ec/Io are only reliable if changes to the network configuration are not extensive. If, for example, a far-off transmitter is turned in the direction of a pixel and this transmitter was not part of any measurement sample, the increase of interference on the pixel cannot be correctly simulated.
- It is therefore crucial to limit parameter changes allowed in ASSET Design to small ranges. A good starting point is to set mechanical tilt ranges of ±2° and mechanical azimuth ranges of ±10°.
- The cell loads (total transmit powers) of the transmitters must be kept constant during the measurements. Otherwise Ec/Io target function cannot be used or is likely to be unreliable.
- The total transmit powers during the measurement should be as low as possible to get a high number of detected servers. High total transmit powers reduce the number of detectable servers due to the limited detection sensitivity of scanners.
- The better the required minimum Eb/Nt of the scanner, the more servers can be detected. More detected servers will generate better results. Excellent Eb/Nt values of scanners are 3dB or less.

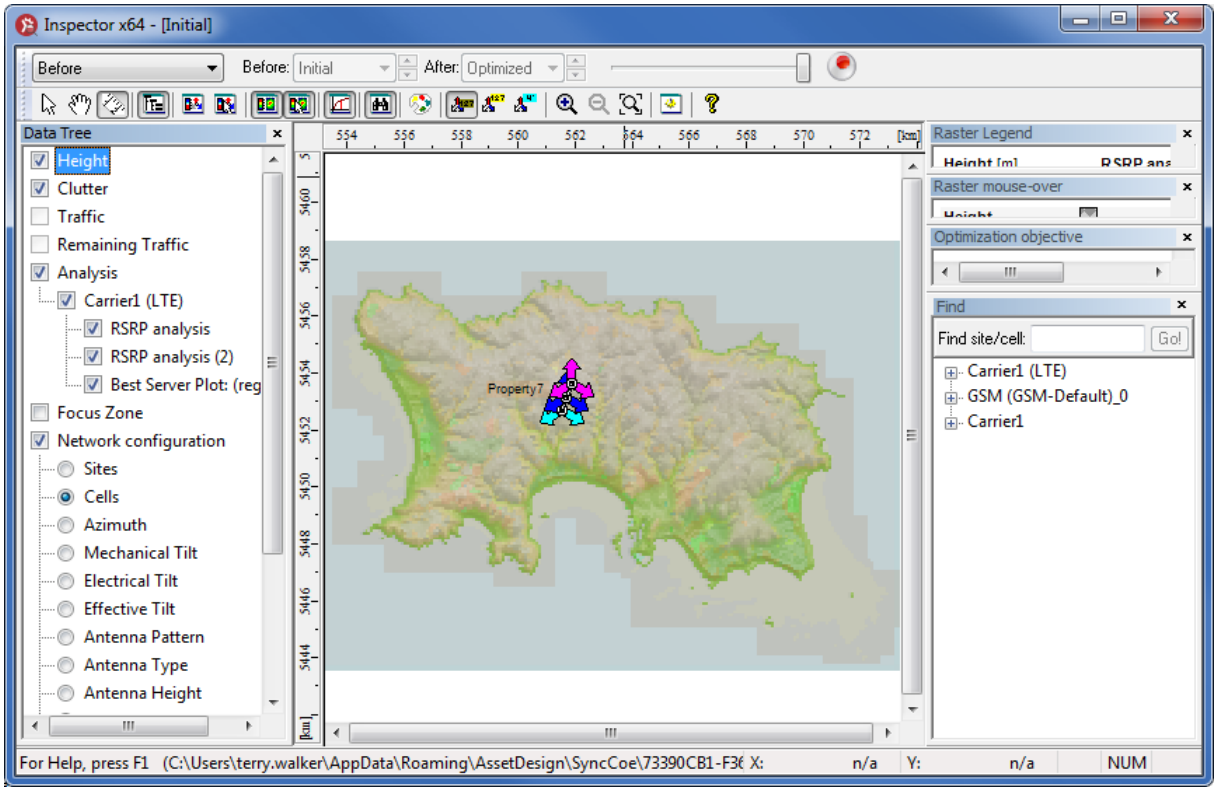
- Use prediction based targets as well as measurement based target functions in ASSET Design to avoid degraded network quality in areas without measurements. A suggested starting point uses weights 1:1 for measurements:predictions.
- Assign easily identifiable names to the individual target functions for better identification in ASSET Design reports and Inspector.

14 Inspector

Inspector allows a fast and efficient analysis of the modifications that have been made during the optimization. Each implementation plan step can be shown.

It also allows the visualization of different parameter values as well as predictions and maps. This can be done jointly for multiple networks, carriers and frequency bands.

Inspector includes a number of tool windows that help to display the individual changes and parameters.



Example of Inspector user interface

Overview of Inspector

This section gives an overview over the functions and benefits of Inspector.

Launching Inspector

Inspector can be launched in different ways:

- From ASSET Design, using the **Visualize Results** button after an optimization has finished.
- From ASSET Design: from the **Tools** menu, click **Inspector**. You can then select an implementation plan index file (.cipi) from a previous optimization.
- From Windows Explorer, by double-clicking on an implementation plan index file (.cipi) in the result directory of a previous optimization.

Visualizations

Inspector allows a fast and efficient analysis of the modifications that have been made during the optimization. Each implementation plan step can be shown.

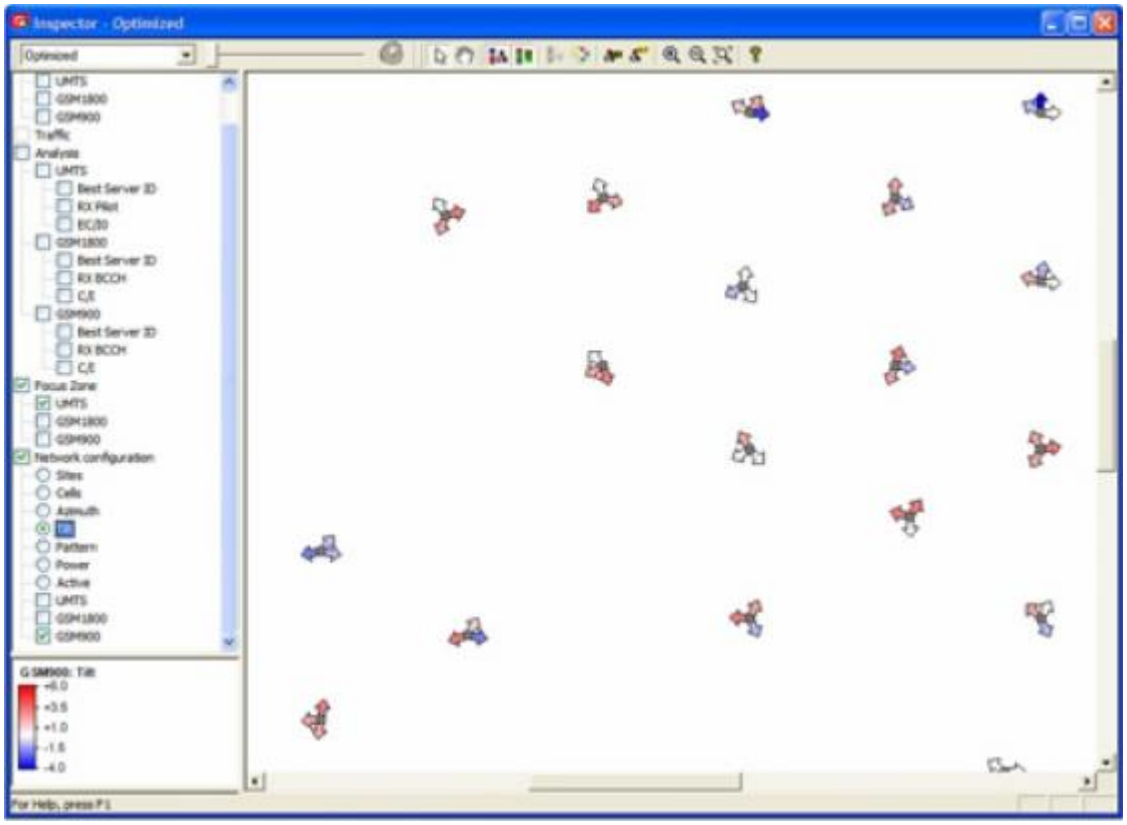
The parameter values that can be displayed include:

- Active and Inactive sites and cells
- Power levels
- Mechanical antenna tilts
- Electrical antenna tilts. The electrical tilts are currently represented by changes in the antenna pattern.
- The effective tilt. This is the combination of both the mechanical and the electrical tilt.
- Antenna pattern exchange
- Antenna azimuths

Each of the parameters and each analysis can be displayed in two different modes:

- As an absolute measure
- As the difference between two implementation plan steps

The advantages are that the individual sector specific parameters can be visualized and color coded. By doing so, antenna tilts can be represented by different colors in the Inspector, and the user can directly identify all the changes in the network. An example for Inspector is shown in the figure below:



Inspector also allows the visualization of different geo data, traffic and clutter maps, as well as various performance predictions. It can display the predictions before and after the optimization, as well as for each implementation plan step, and also show the difference between them.

For a detailed description, see Visualization Functionalities in Inspector on page 167.

Evaluating Parameters and Raster Plots

Inspector allows the visualization of different parameter values as well as predictions and maps. This can be done jointly for multiple networks, carriers and frequency bands.

Inspector includes a number of tool windows that help to display the individual changes and parameters efficiently. Details on these tool functionalities and specific settings are described in User Interface on page 174.

Visualization Functionalities in Inspector

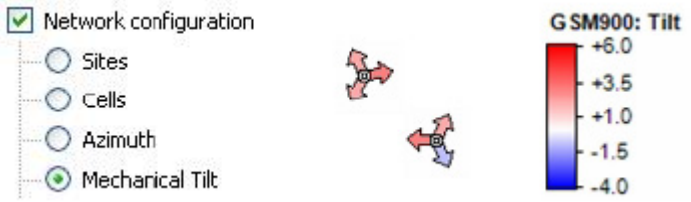
This section describes the different visualization functionalities in the Inspector.

Inspector allows a fast and efficient visualization of different plots. These are described in the following sub-sections.

Network Configuration

The *Network configuration* node in the tree structure allows you to select the network parameter to display in the map window.

Select the radio button of the parameter you want to show. The parameter values are displayed by means of color coded arrows for each individual sector. This allows a clear display of sector parameters such as antenna tilts and power levels on a per sector level. An example is shown in the picture below: the antenna tilt (mechanical tilt) is displayed for 6 sectors by means of different colors.



In the legend you find the different color coded tilt value. The legend can be adapted according to user requirements. This is done in the color editor of the Inspector. For details please see Color Editor on page 183.

Note: Please note that azimuth values are not color coded in the before or after visualization. In this case the sector arrows are displayed in the cell's footprint color if a best server plot for the network is visible, otherwise they are white.

Optimizable Parameters

These are parameters that can be assigned optimization ranges in ASSET Design. It is possible to view the parameter value for the initial and optimized state and for every implementation plan step if available. Available parameters are:

- Azimuth
- Mechanical Tilt
- Electrical Tilt
- Effective Tilt
- Antenna Pattern
- Antenna Type
- Power
- Active

Result Parameters

Result parameters are calculated during the optimization. They can be visualized for initial and optimized state and for every implementation plan step if available.

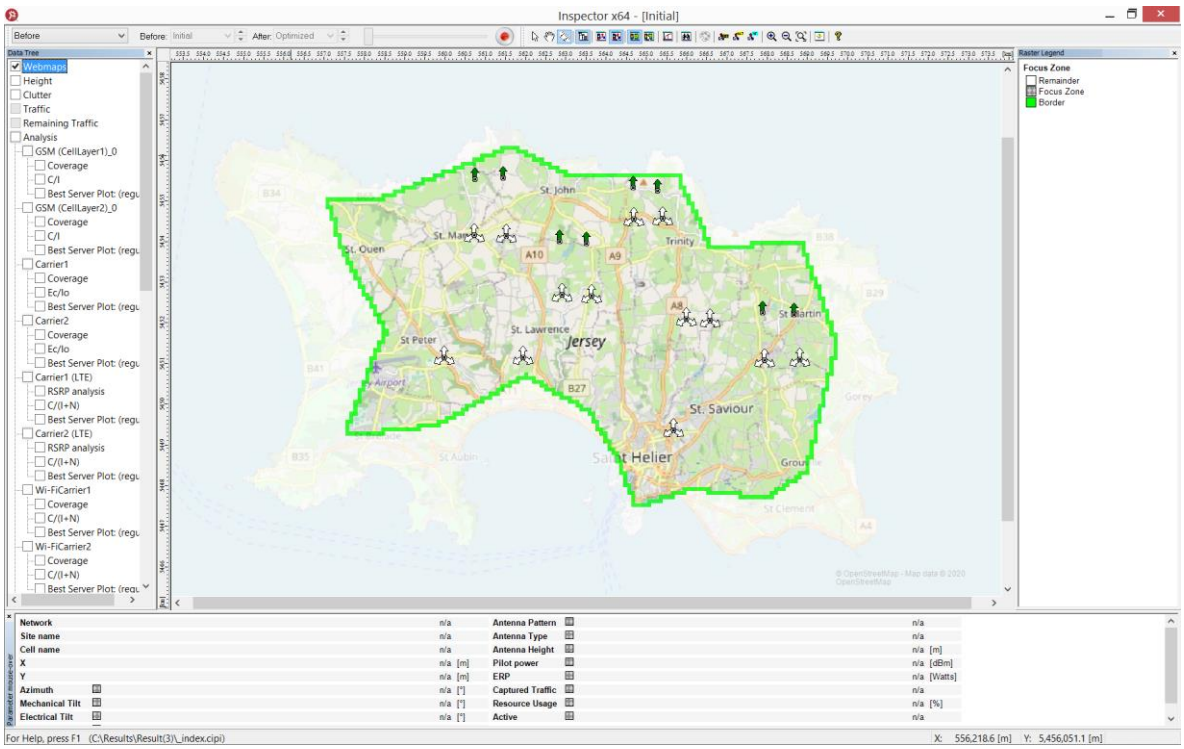
- Captured Traffic (only if a traffic map is available, the unit is the same as in the traffic map)
- Resource units (only if a traffic (density based) target is calculated, in percent of the cell's capability)

Webmaps

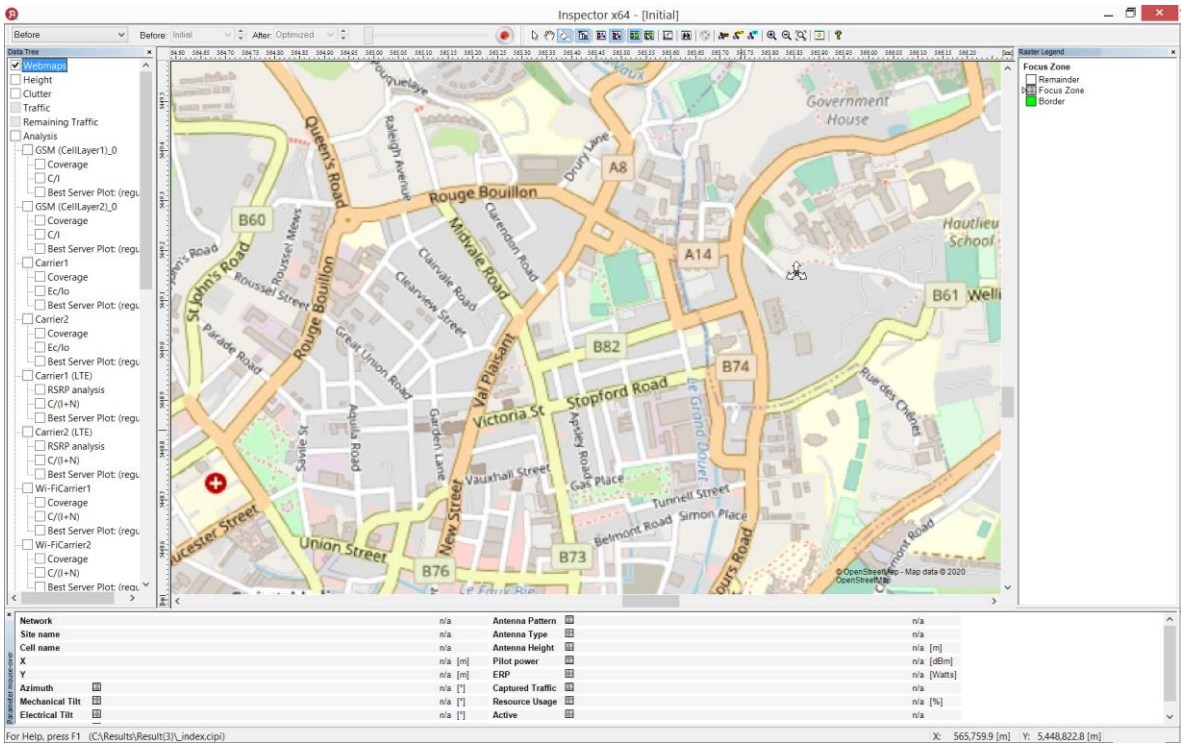
In Inspector, you can display OpenStreetMap data in the background layer of the view.

To do this, click the Webmaps node in the tree structure of the window.

This picture shows an example of a zoomed-out webmap:



This picture shows an example of a more detailed (zoomed-in) webmap:



Height, Clutter, Traffic and Zones

This table shows some of the options available in Inspector:

Setting or Option	Description for Requirement Values
Height	Displays the height information of the underlying ASSET project.
Clutter	Displays the clutter data for the different radio technologies and frequency bands used in the actual ASSET Design project. In the case where alternative clutter files are available to be used (see Project Settings on page 22), the alternative clutter data can be displayed. In this case, enable the checkbox of the clutter files that should be displayed.
Weighting Zones	Displays the zone files that were used to replace the clutter based weighting for one or multiple optimization targets.
Traffic	Enable this checkbox to display the traffic data for the different radio technologies and frequency bands used in the actual ASSET Design project. In case that multiple traffic maps are available, enable the checkbox of the traffic map that should be displayed. If the used traffic maps for the different networks are identical, ASSET Design will display only one single traffic map. If shared traffic has been used in a multi-network project, the remaining shared traffic of each network can be selected for display.

You can also:

- Use the slider control in Inspector's Toolbar to vary the transparency of the individual traffic maps. The legend colors of the map can be changed in the Color Editor.
- Use the context menu (right mouse button click) if you want to export the maps to image files or .bil files.

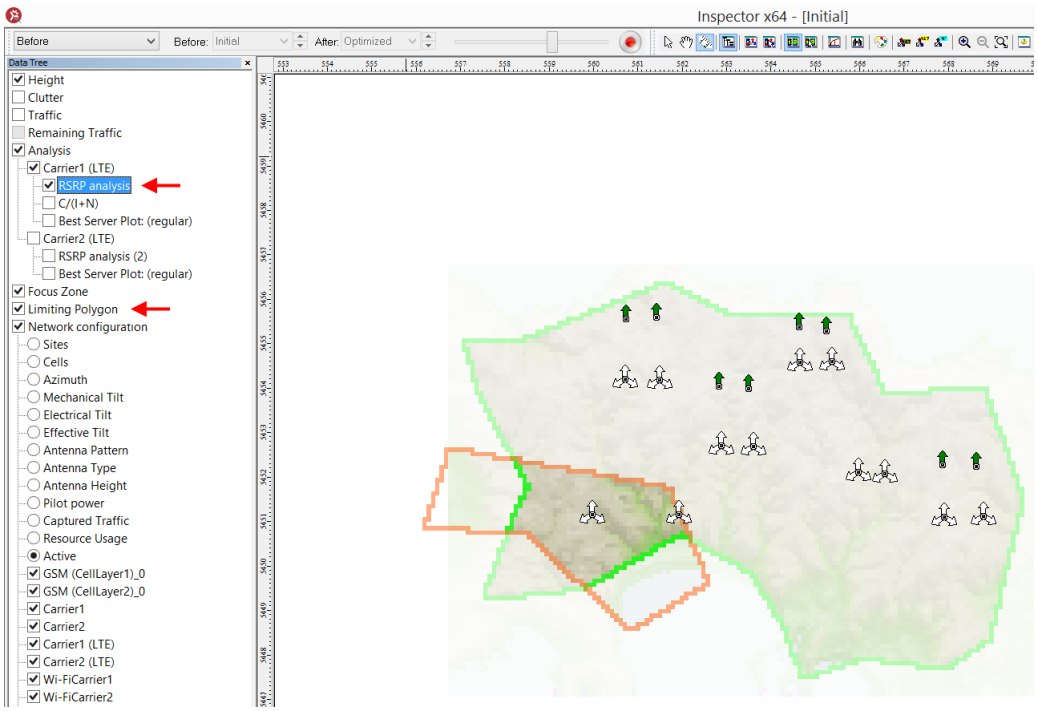
Optimization Area and Limiting Polygons

Inspector allows the display of the optimization area of the used project.

An optimization area can be displayed in different colors. These colors can be defined and changed in the Color Editor.

Limiting Polygons

If a limiting polygon has been associated with a target (see Targets - Using Limiting Polygons on page 67), the limiting polygon will be shown, as in this example:



Example of a limiting polygon displayed in Inspector

Note: If the checkboxes of multiple plots are currently selected in the data tree, it may be that the top-layer plot has a different limiting polygon associated with it, or none at all. Either way, you would not see the limiting polygon associated with the other (lower-layer) plot, even if that plot's checkbox is selected.

Prediction Plots and Performance Analysis

Inspector provides a very fast and efficient way of showing prediction plots and performance analysis.

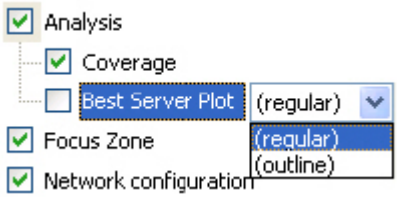
The analysis plots are grouped by the different technologies and frequency bands that are considered in the actual ASSET Design project. Enable the checkbox of the individual analysis plots that should be displayed.

Use the slider control in Inspector's Toolbar to vary the transparency of the individual analysis plots. The legend colors of the plots can be changed in the Color Editor.

Best server plots offer two different styles:

- **Regular** displays the best server footprint with one solid color per best server
- **Outline** displays only the cell borders per best server, pixels inside the same best server area are transparent. This allows to view an underlying analysis layer and the cell borders at the same time.

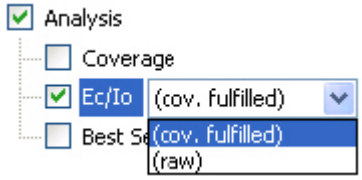
The display style can be changed for every best server plot individually in the tree view:



Target functions can be defined as a **coverage requirement to be fulfilled**, described more fully in Defining Targets on page 59. In this case the tree view offers the possibility to choose between two display options:

- **Cov. fulfilled**: Pixels not fulfilling the coverage requirement are transparent. This represents the target function as used in the optimization.
- **Raw**: The unconditioned target function values are displayed. In this case the observed area can be larger than the objective value used in the optimization.

The display style can be changed for plot with a coverage requirement in the tree view:

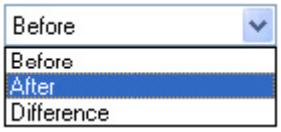


Note: The target function plot for capacity (density based) displays the maximum possible throughput in Mbit/s per pixel as given by the modulation settings. The plot does not consider the offered traffic from the traffic map.

Saving plots to files: Use the context menu entry Save raster map to file ... to select a file name where the selected plot shall be saved to. Five different Windows standard file formats are available (BMP, JPG, and others).

Before, After and Difference Plots

Inspector allows the very quick and simple comparison of the parameter values as well as the prediction and analysis plots before and after the optimization. In order to make this quick comparison, please select one of the three options in the selection box in the Inspector tool bar:



Before: Select this option to view the parameter values and the prediction plots selected in the *Before* selection box. If no implementation plan has been computed, this is the network configuration before the optimization with ASSET Design, otherwise the selected implementation plan step is displayed. For details on implementation plan steps, see Implementation Plan in Inspector on page 172.

After: Select this option to view the parameter values and the prediction plots selected in the *After* selection box. If no implementation plan has been computed, this is the network configuration after the optimization with ASSET Design, otherwise the selected implementation plan step is displayed. For details on implementation plan steps, see Implementation Plan in Inspector on page 172.

Difference: Select this option to view the parameter values and the prediction plots as a difference of the network states specified in the *Before* and *After* selection boxes.

Note: In order to allow fast switching between the *Before* and the *After* network configurations, Inspector provides hot-keys to switch between the different network configurations:

"1" ... Before

"2" ... After

"3" ... Difference

Implementation Plan in Inspector

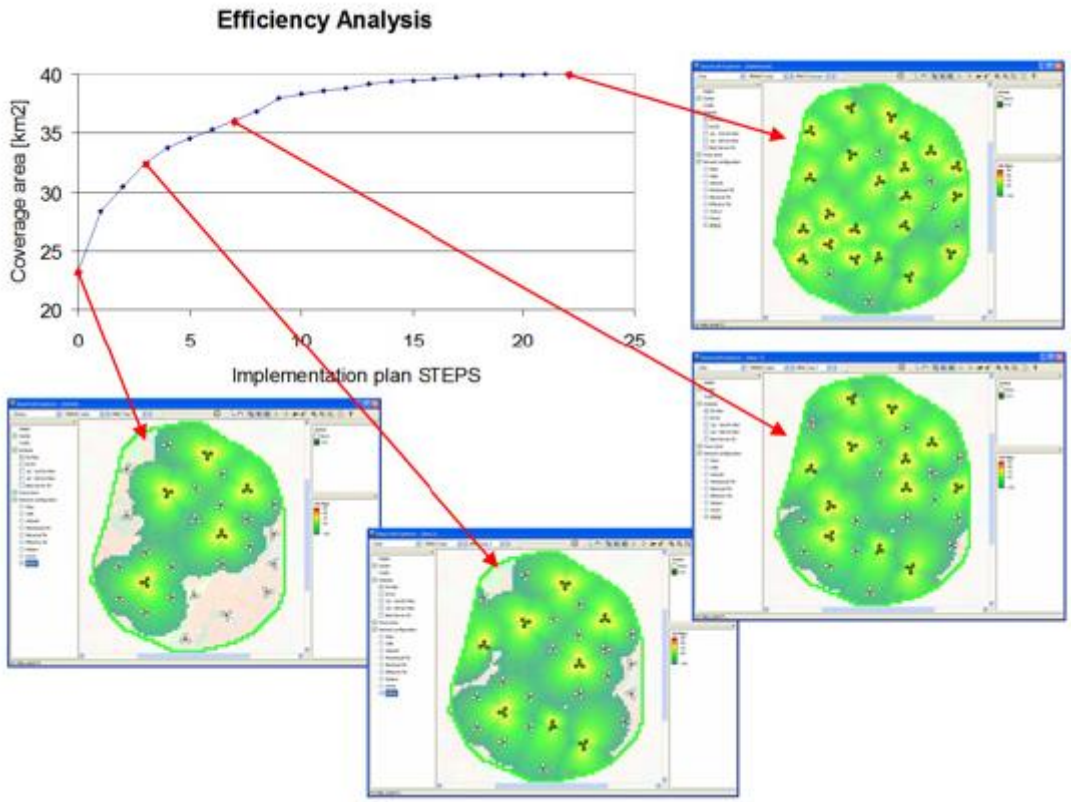
This section describes the visualization of the implementation plan in the Inspector.

Note: In order to be able to display the plots for the individual implementation plan steps, the associated checkbox in the Optimization Options needs to be enabled in ASSET Design.

The Inspector allows a fast iteration through the implementation plan steps. This means that for each step the changed parameters as well as the improved prediction plots can be displayed for the individual networks and technologies.

Improvements up to a Specific Point in the Implementation Plan

The picture below shows an example of how the impact of the different steps in the implementation plan can be visualized:



Inspector allows the step-by-step visualization of the different modifications done in the network. This can be used to investigate the most cost efficient parameter modifications and compare them with practical engineering rules.

The selection of the implementation plan step to be shown is done with the main selection box (Before/After/Difference) and the two implementation plan selection boxes *Before* and *After*.

- When **Before** is selected in the main selection box, the implementation plan step in the *Before* selection box is shown. Please note that the allowed range for this selection box is from the initial up to the step before the last step. To visualize the last (optimized) configuration, use *After* in the main selection box.
- When **After** is selected in the main selection box, the implementation plan step in the *After* selection box is shown. Please note that the allowed range for this selection box is from one step after the initial step up to the last (optimized) step. To visualize the first (initial) configuration, use *Before* in the main selection box.
- When **Difference** is selected in the main selection box, the difference of the parameter values and prediction plots is shown. The Analysis window shows the CDF or PDF curves for both states in this case.

Note: In order to allow fast switching between implementation steps, various hot keys are available, for example:

Page Up/Page Down ... move to next/previous step

Ctrl-'-Home/Ctrl-'-End ... display first/last implementation plan step

Getting to the desired Implementation Plan step, for example the one with the best trade-off in cost and coverage, may be by using the Optimization Objective Window on page 181.

Analysis of Differences in Individual Steps

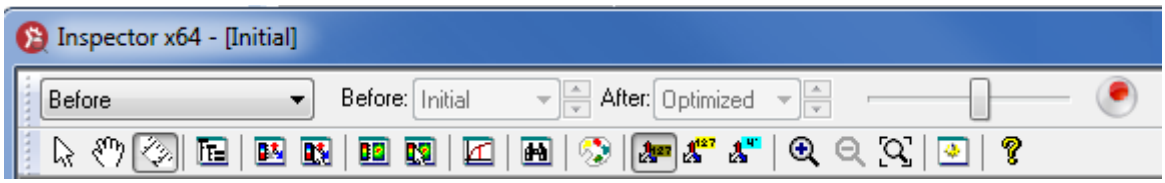
Further to the analysis of the improvements for the implementation plan, Inspector also allows the direct analysis of the effect of a specific implementation plan step. To do so, the difference mode needs to be enabled by selecting *Difference* in the main selection box. The user can then define the *Before* and *After* steps that should be compared in the difference analysis.

User Interface

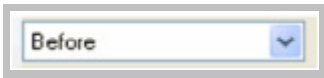
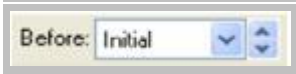
This section describes the different windows and tools in Inspector.

Toolbar

Inspector provides a number of functionalities to simplify the comparison of different network configurations before and after the optimization, as well as the difference of both. These tools are accessible via the Inspector toolbar:



This table describes each item on the toolbar:

Item on Toolbar	Description
	**Main selection box**: Use this selection box to choose the display of the individual network states Before, After and Difference. This allows the user to display both the parameter values as well as the prediction and analysis plots of the individual network states. **Note**: In order to allow a very fast switch between the initial and the optimized network configuration, Inspector provides hot-keys to switch between the different network configurations: "1" ... Initial "2" ... Optimized "3" ... Difference
	**Implementation plan - Before**: Use this selection box to choose the implementation plan step that is displayed in the *Before* state. By default, this is the initial network configuration. However, in order to compare different network implementation steps and their effectiveness, the *Before* step can be set to any step in the implementation plan (except for the optimized state). For details on how the different steps can be displayed, see Implementation Plan in Inspector on page 172. To be able to display the plots for the individual implementation plan steps (and not only the initial and the optimized step), the associated checkbox in the Optimization Options needs to be enabled.
	**Implementation plan - After**: Use this selection box to choose the implementation plan step that is displayed in the *After* state. By default this is the final optimized network configuration. However, in order to compare different network implementation steps and their effectiveness, the *After* step can be set to any step in the implementation plan (except for the initial state). For details on how the different steps can be displayed, see Implementation Plan in Inspector on page 172. To be able to display the plots for the individual implementation plan steps (and not only the initial and the optimized step), the associated checkbox in the Optimization Options needs to be enabled.

Item on Toolbar	Description
	**Transparency control**: Use the slide control bar to define the transparency of the individual maps and analysis plots. In order to modify the transparency of the individual plots, the specific map or plot needs to be selected in the project tree.
	**Site perspective**: Use the site perspective tool to define the perspective view of the individual sectors. This functionality enables the perspective site and sector view in the case where multiple parameters have to be displayed for a co-located antenna. For example, with the perspective function it is possible to display multiple co-located sectors that share the same physical antenna, but use different electrical antenna tilts.
	**Selection**: Use the selection tool as default selection tool. When the selection arrow is activated, it can also be used as a zooming tool. Click and hold the left mouse button while dragging to define the zone that should be displayed on the map. Click and hold the middle mouse button while dragging to pan the map window.
	**Pan**: Use the pan tool to move the visible part of the map in Inspector.
	**Toggle data tree window**: Use this button to switch the data tree window on and off.
	**Toggle parameter legend**: Use this button to switch the parameter legend window on and off. The parameter legend window will then display the legends for the parameters that are actually displayed. In the case where parameters for multiple networks are displayed, the legends for the different technologies and frequency bands are displayed as well.
	**Toggle parameter mouse over window**: Use this button to switch the parameter mouse over window on and off. The parameter mouse over window will then display the parameter values for the different sectors where the mouse cursor is currently located.
	**Toggle raster legend**: Use this button to switch the raster legend window on and off. The raster legend window will then display the legends for the different raster plots (maps and analysis) that are actually selected. In the case where multiple raster plots are selected, the legends for the different plots are displayed individually as well.
	**Toggle raster mouse over window**: Use this button to switch the raster mouse over window on and off. The raster mouse over window will then display the raster values for the individual pixels where the mouse cursor is currently over. In the case where multiple raster layers are selected, all selected raster values are displayed in the raster mouse over window.
	**Toggle optimization objective window**: Use this button to switch the optimization objective window on and off. The window will display the objective plots for for the different target functions associated with raster plots that are actually selected. In the case where multiple raster plots are selected, the objective plots for their target functions - if available - are displayed individually as well.
	**Toggle find window**: Use this button to turn the find site and sector window on and off.
	**Color editor**: Use the color editor to view and modify the color settings for the individual maps, plots and parameter values in Inspector. In order to do so for a particular parameter or plot, this parameter or plot needs to be selected in the project tree. Alternatively you can double click on a legend to edit the color palette. For additional information, see Color Editor on page 183.
	**Site labels**: Use this button to turn the display of the site labels on and off.
	**Sector labels**: Use this button to turn the display of the sector labels on and off.
	**Parameter labels**: Use this button to turn the display of the parameter labels on and off. Parameter labels will be displayed alternatively to the sector labels.

Item on Toolbar	Description
	**Zoom in**: Click this button to zoom in by 15%
	**Zoom out**: Click this button to zoom out by 15%
	**Zoom to fit**: Click this button to zoom so that the area surrounding all sites considered in the actual ASSET Design project is displayed within the map window.
	**Settings**: Use this functionality to define, load and save settings for the visualization in Inspector.
	**About**: Click this button the view information about the current Inspector version.

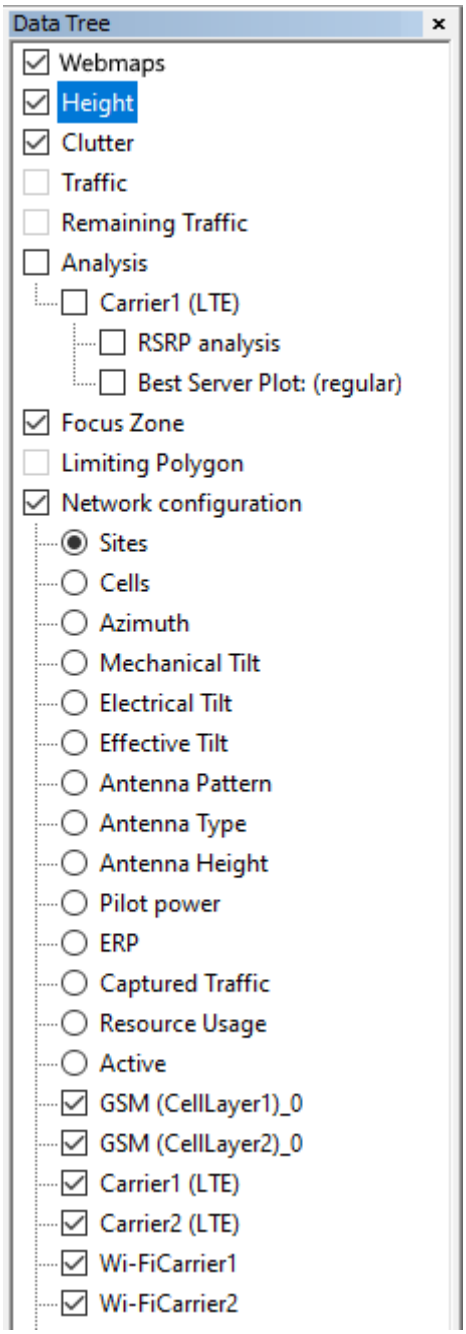
Data Tree Window

The project data tree window in Inspector provides a full list of all parameter and raster data available. This includes:

- Webmap data
- Height data
- Clutter data
- Traffic data
- Focus Zone (optimization area)
- Network analysis, such as prediction plots
- Network configuration, such as transmitter parameters

To show or hide this window, use the  button in the toolbar.

Data Tree Window:



The plot in the top-most position of the project tree is in the background of the layer hierarchy. For instance, in the project tree on the left, the UMTS clutter is displayed in the lowest position. In front of that, the UMTS RX Pilot layer is displayed. For each of the layers the transparency can be defined separately.

The project tree also displays the available technologies within the ASSET Design project.

The user can then select the parameters or analysis plots to be displayed in the main window of Inspector.

For more detailed descriptions of the individual visualization possibilities, see Visualization Functionalities in Inspector on page 167.

Context Menu Entries:

Display legend: Show or hide the legend in the raster legend window.

Display mouse-over: Show or hide the mouse over value in the raster mouse over legend window.

Display optimization objective plot: Show or hide the target function objective plot in the target function objective plot window.

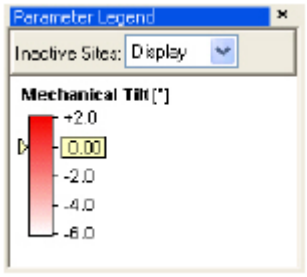
Edit colors: Opens the color editor for the selected legend. See Color Editor on page 183.

Display analysis: Opens analysis window for selected raster map or network parameter. See Statistical Analysis on page 184.

Display optimization objective analysis: Opens optimization objective analysis window for selected raster map. See Optimization Objective Analysis on page 188.

Parameter Legend Window

The parameter legend displays the color legend for the currently displayed network configuration parameter. Multiple legends are displayed if more than one network is currently visible. The color code can be configured with the color editor by double clicking on the legend. See Color Editor on page 183.



Inactive Sites: Use this to define how inactive sites are to be displayed. The options include:

- Display ... inactive sites are displayed the same way as active sites
- Outline ... the sectors of inactive sites are shown transparently
- Hide Cells ... the arrows for the sectors of inactive sites are not shown at all, only the site's circular symbol is drawn
- Hide ... inactive sites are not displayed at all

Context Menu Entries:

- **Hide this**: Hides the selected legend
- **Edit colors**: Opens the color editor for the selected legend.
- **Display mouse-over**: Show or hide the mouse over value in the raster mouse over legend window

Map Window

This section discusses some additional features and functions.

Note: For a description of the different data types in the map window, see Visualization Functionalities in Inspector on page 167.

Mouse Over Features:

Moving the mouse cursor over a pixel or antenna symbol, specific information can be displayed. This functionality can be turned on and off.

- Mouse Over functionalities for raster information:

  The actual values for different rasters can be displayed. The individual plot layers can be turned on and off independently as described in Raster Mouse Over Window on page 180.

- Mouse Over functionalities for parameter values:

  Once the mouse is moved over a sector symbol, the sector specific parameter values can be displayed, such as:

  - Sector technology
  - Site and Sector (Cell) name

- Coordinates
- Antenna pattern and azimuth
- Mechanical, electrical and effective antenna tilt
- Activation status and power (pilot) values

If more than one sector is below the mouse cursor, the tab key can be used to select between those sectors.

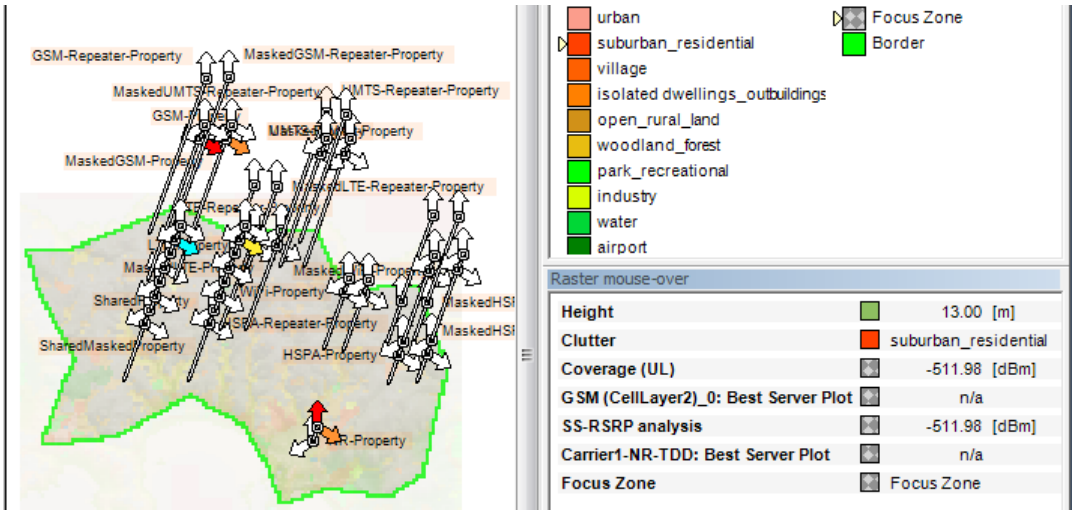
Note: By clicking on an individual sector (rather than just moving the mouse cursor over it) the information of this sector is locked until something else is selected with the mouse. Click on the map or background to release the sector lock.

Other Useful Information:

- To disable the Perspective View, double-click on the  icon in the toolbar.
- To Zoom In and Zoom Out you can turn the mouse wheel.
- To Pan the map area, you can use the middle mouse button (or mouse wheel).
- To Zoom to Fit, double-click the mouse wheel.
- The context menu in the map window offers various functions as an alternative to toolbar buttons.

Parameter Mouse Over Window

The parameter mouse over window displays the parameter values for a selected sector or the sector below the mouse cursor. The visibility of parameters can be configured individually in the context menu:



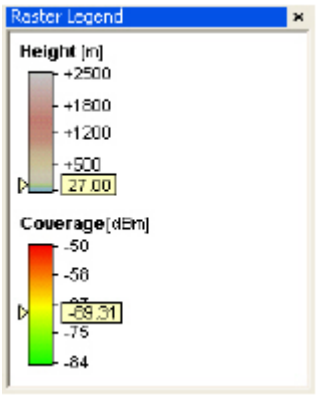
Context Menu Entries:

- **Hide this**: Hides the selected parameter
- **<parameter name>**: Shows or hides the corresponding parameter

Raster Legend Window

The raster legend window displays legends for the active raster plots. Individual legends can be turned on and off independently, the color code for every legend can be configured with the color editor by double clicking on the legend. See Color Editor.

Note: Legends can only be displayed for visible plot layers, they are automatically hidden if a layer is turned off.



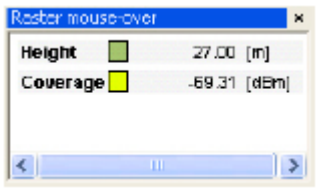
Context Menu Entries:

- **Hide this**: Hides the selected legend
- **Edit colors**: Opens the color editor for the selected legend.
- **Display mouse-over**: Show or hide the mouse over value in the raster mouse over legend window
- **Display optimization objective plot**: Show or hide the target function objective plot in the target function objective plot window
- **<plot name>**: Shows or hides the corresponding legend

Raster Mouse Over Window

The raster mouse over window displays mouse over values for the active raster plots. The visibility of parameters can be configured individually in the context menu.

Note: Mouse over values can only be displayed for visible plot layers, they are automatically hidden if a layer is turned off.



Context Menu Entries:

- **Hide this**: Hides the selected parameter
- **Display legend**: Show or hide the legend in the raster legend window

- **Display optimization objective plot**: Show or hide the target function objective plot in the target function objective plot window
- **<plot name>**: Shows or hides the corresponding plot

Optimization Objective Window

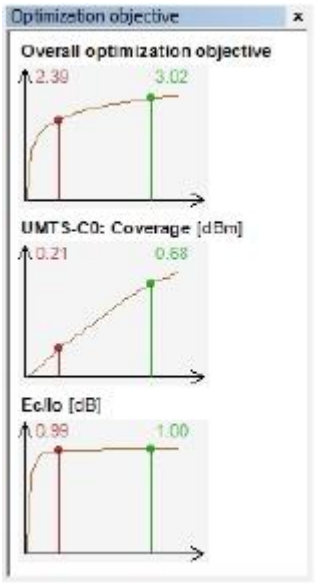
The optimization objective window displays target function objective plots for the active raster plots where feasible (for example, best server plots are not the direct result of a target function, thus they possess no objective plot). The visibility of individual plots can be configured individually in the context menu.

Note: Optimization objective analysis is only available if an implementation plan has been calculated.

One or two marker lines indicate the Implementation Plan step currently displayed, in red if "*Before*" is currently displayed, in green for "*After*", or both, if "*Difference*" is displayed (see Implementation Plan selection boxes in Toolbar on page 174).

Double-clicking on a plot (or using the context menu, see below) brings up an analysis window for the respective plot. See Optimization Objective Analysis on page 188.

Note: Optimization objective plots can only be displayed for visible plot layers, they are automatically hidden if a layer is turned off.

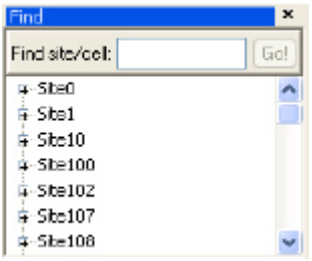


Context Menu Entries:

- **Hide this**: Hides the selected plot
- **Display analysis**: Show analysis window for selected plot
- **<plot name>**—: Shows or hides the corresponding plot

Find Window

This window allows to locate sites or sectors in the map view. Simply type the name of a site or sector in the edit control and press return or the *Go!* button. Double clicking a site or sector will center that site/sector in the main view port. The context menu offers these functions as well.



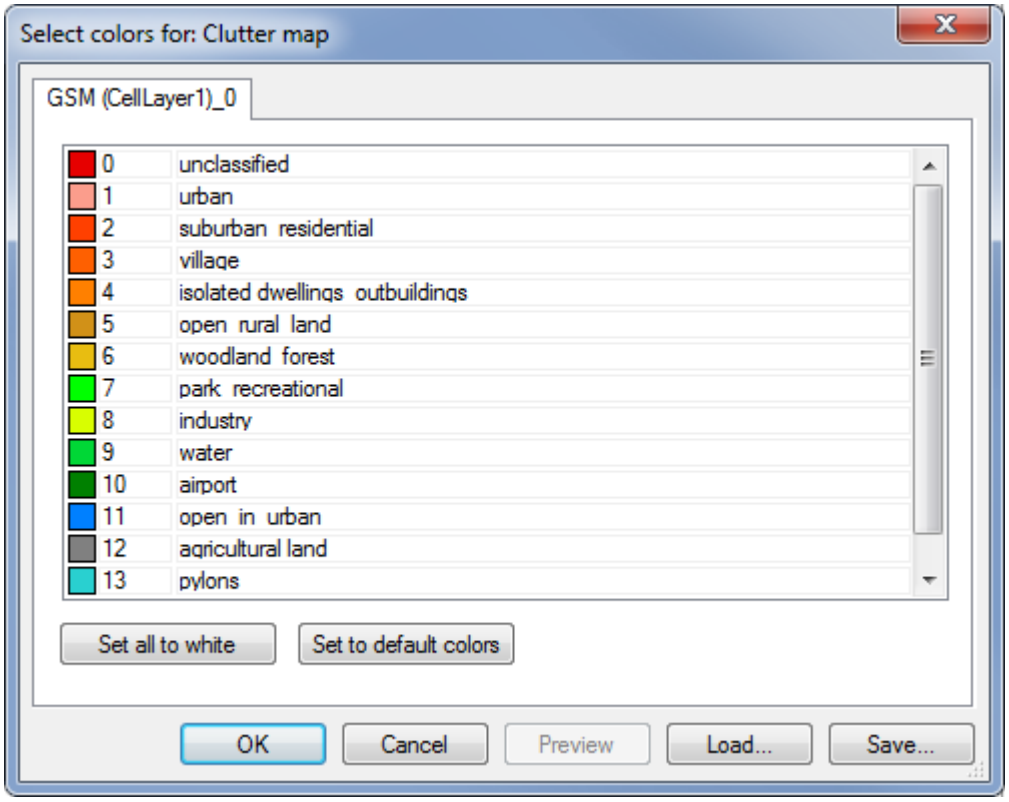
Note: Sometimes it is difficult or impossible to locate a sector if it is partially or totally hidden by other sectors. In this case zoom to an appropriate zoom level in any map region and use the *Go!* button to center the map window on the site of interest.

Context Menu Entries:

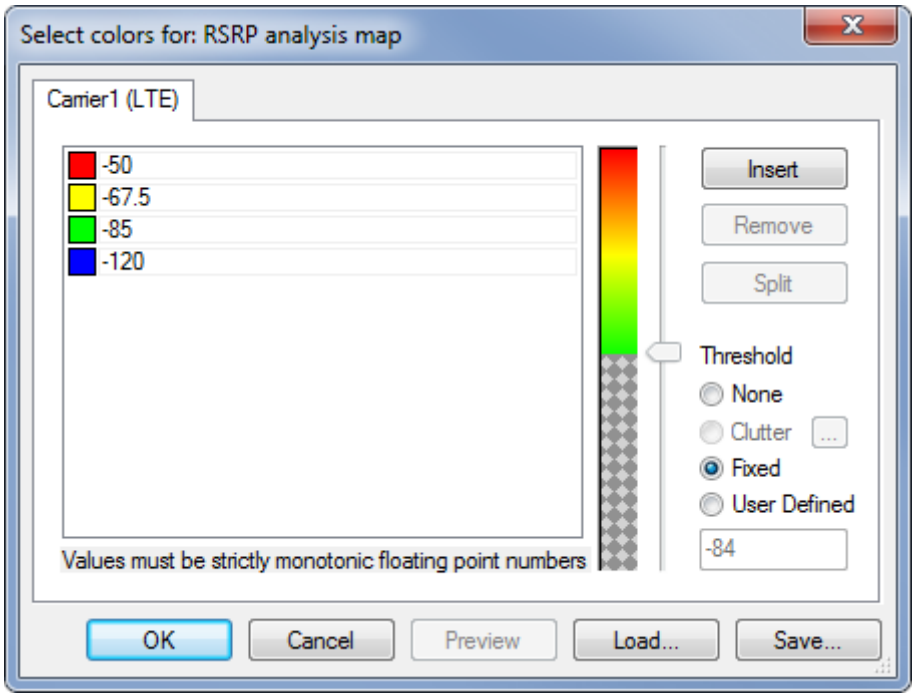
- **Display site**: Display the site. If it is not visible in the map window, the viewing rectangle is moved to the site. Note that the site is not highlighted with this function.
- **Display cell**: Display and select the cell. It starts blinking in the map window and the parameter legend and mouse over display the values of this sector regardless of the mouse cursor position. Click into the map window to undo the selection.
- **Hide inactive cells**: Do not display inactive cells (for the current implementation plan step) in the site list.
- **Hide sites with no active cells**: Do not display sites without active cells (for the current implementation plan step) in the list.
- **Hide this network**: Disable visualization of the selected sector's network. Please note that this is equivalent to disabling the network in the data tree.
- **Collapse all**: Collapse all tree items.
- **Expand this network**: Expand the tree items for the current network.
- **Expand all**: Expand all tree items.

Color Editor

For items such as Best Server Plots and Clutter, these contain discrete values and you can assign a color to each value. You can quickly change the color scheme for discrete values, because values can either be 'all set to white' or 'reset to their default colors'. This enables you to easily highlight a single value in the visualization and afterwards switch back to the default colors. Here is an example:



For items such as the Target Plots, Network Configuration Parameters and Heights, the Color Editor allows you to define the color palette and the thresholds individually for every target plot and parameter type. The target plots hold continuous values, for which you can set color gradients for coverage, interference, and so on. Here is an example:



This form of the color editor requires more explanation, as described in this table:

Option	Description
Levels	A list of parameter levels can be entered in the list window. Use the button *Insert* and *Remove* to add or delete levels. Please note that the list of values has to increase monotonically, i.e. every value has to be larger than the value below.
Colors	Every level can be assigned one or two colors. If one color is assigned, the color palette is interpolated smoothly between the assigned colors. If two colors are assigned using the **Split** button, the color interpolation is punctuated and the palette jumps from the first to the second color at the according level as shown for -80 dBm in the screenshot above. This feature can be used to highlight certain requirements without the need to define two levels.
Insert	Inserts a new level above the currently selected value.
Remove	Removes the selected level.
Split / Unsplit	Splits the current level (i.e. allows the assignment of two colors) or removes the splitting.
Threshold	It is possible to specify a threshold for the legend. Values below this threshold are displayed transparent as indicated in the palette preview. This feature allows the fast visualization of different requirements without the need to change the color assignment. • **None**: No threshold is used, all values of the plot are displayed with the standard color interpolation. Values below/above the first/last color level are clipped and displayed with the first/last color. • **Clutter**: If the optimization uses clutter-dependent thresholds, these thresholds can be used for the visualization. The text uses clutter thresholds is displayed in the legends to indicate that pixel depending thresholds are used. The ellipsis button … allows to view the current settings. For every pixel the threshold is determined as given from the clutter, values below the pixel based threshold are displayed transparent. • **Fixed**: If the optimization uses a fixed threshold (not depending on clutter classes) this threshold can be used for the visualization. • **User defined**: A user defined threshold can be entered or selected with the slider.
Preview	The changes can be previewed in the map window using this button.
Load	Allows to load the palette from a .pal file. Color palettes can also be loaded from ASSET palette .stt files.
Save	Allows to save the palette to a .pal file.

Statistical Analysis

This section describes the statistics functionality of Inspector.

This enables you to analyze statistics for:

- **Plot Analysis**: floating point raster analysis, such as RX coverage, C/I, Ec/Io
- **Parameter Analysis**: floating point based parameter data
- **Optimization Objective Analysis**: target function objective plots

The three respective analysis windows handle similarly, as described in the following sections.

Plot Analysis

This section describes the statistics functionality relating to raster plots.

Overview

Inspector enables you to analyze statistics for every floating point raster analysis, such as RX coverage, C/I, Ec/Io, and so on. The statistics can be viewed as CDF (cumulative distribution function) or PDF (probability density function) scaled in km² or % of the optimization area.

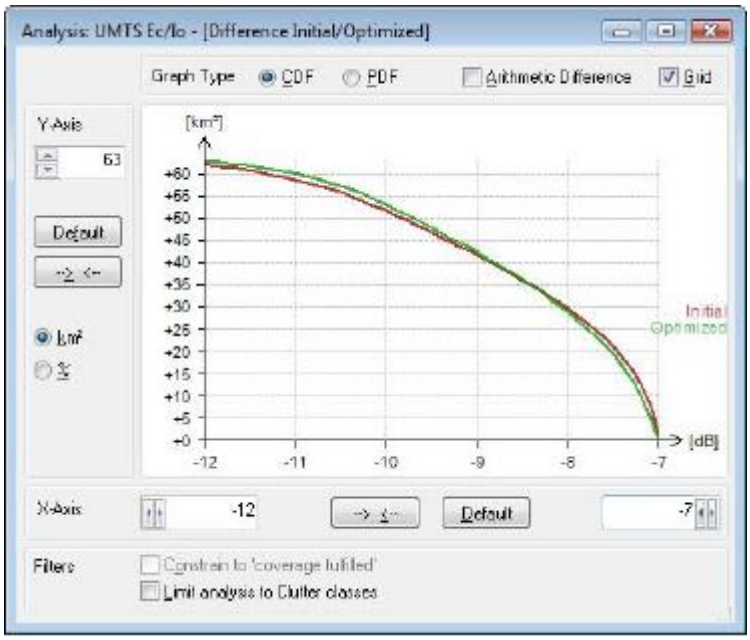
Depending on the currently shown state (B*efore*, A*fter*, D*ifference*), the analysis for the selected state or for both states is displayed as follows:

- Selected state - *Before*: **red** line
- Selected state - *After*: **green** line
- Both states: - **red** and **green** (two lines)

Also see Mouse Tracking and Clipboard Functions on page 189.

Analysis Window for Plot Analysis

The analysis window for a result plot can be opened by double clicking on the corresponding item in the tree view, with the context menu entry *Display Analysis*, or with the hot key *Ctrl+A*.



Option	Description
Graph Type	Either the CDF (cumulative distribution function) or the PDF (probability density function) can be displayed for the selected plot.
Grid	This checkbox turns on horizontal and vertical grid lines.
Arithmetic Difference	This checkbox may be used to display an arithmetic difference graph in *Difference* mode (see Implementation Plan selection boxes in Toolbar on page 174), instead of showing *Before* and *After* graphs.
Y-Axis:	The y-axis can be scaled in km² or percent of the optimization area. Please note that the analysis is restricted to the optimization area in both cases.

Option	Description
Plot area	The plot area displays one (B*efore*, A*fter*) or two (*Difference*) graphs of the evaluated analysis. Mouse tracking is available, the current x- and y-values are displayed next to the axes.
X-Axis min and max	These edit controls allow manual scaling of the horizontal axis.
Y-Axis max	This edit control allows manual scaling of the vertical axis upper limit.
Auto scale	This button (--> <--) under the x-axis automatically scales the horizontal axis to the x-range of values in the current plot. The corresponding button next to the y-axis automatically scales the vertical axis to the y-range of values in the current plot.
Default	These buttons scale the horizontal or vertical axis, respectively, to the default range for the selected plot type.
Filters	**Constrain to coverage fulfilled**: This option constrains the set of analyzed pixels establishing the statistics to those exceeding the corresponding coverage threshold. **Limit analysis to clutter classes**: If this option is selected, a list of classes of the clutter file or a zone file is shown. Select or deselect them to limit the analysis to the selected clutter classes. By this, the entire statistics are based on the combined area of the selected clutter classes. As an example, this means that 100% area in the CDF is the combined area of the selected clutter classes only and not the total area of the optimization area any more. If the clutter file or a zone file shall be used, it can be selected with the drop-down menu next to the check box.

Note: The target function plot for capacity (density based) displays the maximum possible throughput in Mbit/s per pixel as given by the modulation settings. The plot does not consider the offered traffic from the traffic map.

Parameter Analysis

This section describes the statistics functionality relating to parameters.

Overview

Inspector enables you to analyze statistics for every floating point parameter, such as Power, Tilt, and so on. The statistics can be viewed as cumulative, or density plot scaled in numbers of cells or % of all cells. In density mode, a graph shows how many cells have the value at the respective X-axis position for the parameter the window is associated with. In cumulative mode, it shows how many cells have this or a smaller value. Note that in density mode, a bar chart is used as graph for better clarity.

Depending on the currently shown state (B*efore*, A*fter*, D*ifference*), the analysis for the selected state or for both states is displayed as follows:

- Selected state - *Before*: **red** line
- Selected state - *After*: **green** line
- Both states: - **red** and **green** (two lines)

Also see Mouse Tracking and Clipboard Functions on page 189.

Available Parameters

Various cell parameters can be analyzed by Inspector.

Optimizable Parameters

These are parameters that can be assigned optimization ranges in ASSET Design. It is possible to view the parameter value for the initial and optimized state and for every implementation plan step if available. Available parameters are:

- Azimuth
- Mechanical Tilt
- Electrical Tilt
- Effective Tilt
- Power

Result Parameters

Result parameters are calculated during the optimization. They can be visualized for initial and optimized state and for every implementation plan step if available. Available parameters are:

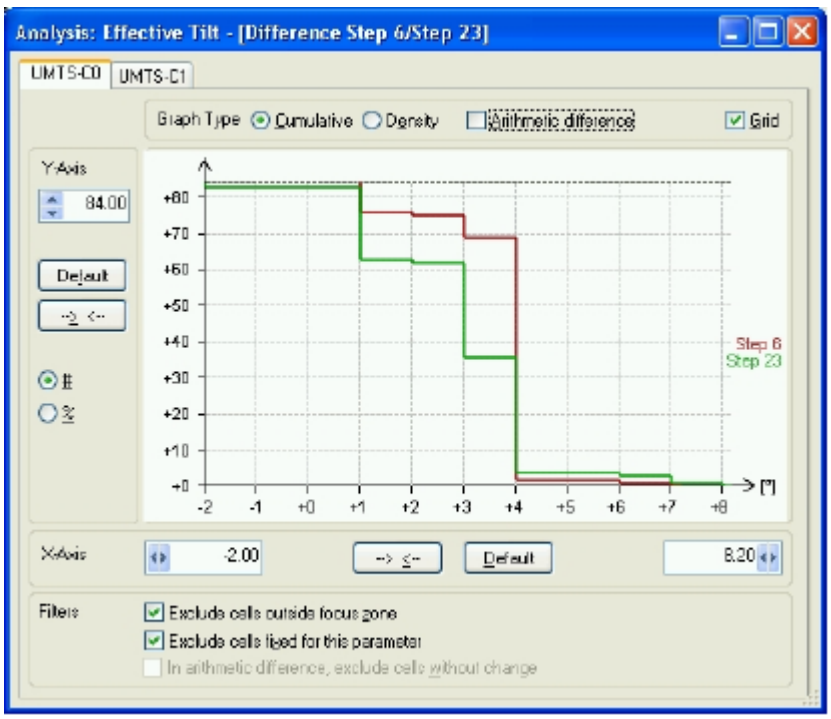
- Captured Traffic

  (only if a traffic map is available, where the unit is the same as in the traffic map)
- Resource units

  (only if a density-based traffic target is calculated, as a percentage of the cell's capability)

Analysis Window for Parameter Analysis

The analysis window for a result plot can be opened by double-clicking on the corresponding item in the tree view, with the context menu entry *Display Analysis*, or with the hot key *Ctrl+A*.



Option	Description
Graph Type	Either cumulative or density representation can be used for the selected plot.
Grid	This checkbox turns on horizontal and vertical grid lines.
Arithmetic Difference	This checkbox may be used to display an arithmetic difference graph in *Difference* mode (see Implementation Plan selection boxes in Toolbar on page 174), instead of showing *Before* and *After* graphs.
Y-Axis:	The y-axis can be scaled in km^2 or percent of the optimization area. Please note that the analysis is restricted to the optimization area in both cases.
Plot area	The plot area displays one (B*efore*, A*fter*) or two (*Difference*) graphs of the evaluated analysis. Mouse tracking is available, the current x- and y-values are displayed next to the axes.
X-Axis min and max	These edit controls allow manual scaling of the horizontal axis.
Y-Axis max	This edit control allows manual scaling of the vertical axis upper limit.
Auto scale	This button (--> <--) under the x-axis automatically scales the horizontal axis to the x-range of values in the current plot. The corresponding button next to the y-axis automatically scales the vertical axis to the y-range of values in the current plot.
Default	These buttons scale the horizontal or vertical axis, respectively, to the default range for the selected plot type.
Filters	Allows exclusion, as far as the statistical graphs are concerned, of cells which are outside the optimization area, and/or cells which were not changed by optimization, and/or (in "*Difference*" mode only) cells which have not changed.

Optimization Objective Analysis

This section describes the statistics functionality relating to target function optimization objective plots.

Overview

Inspector enable you to display target function optimization objective plots in detail.

Depending on the currently shown state (*Before*, *After*, or *Difference*) the analysis shows the position of the currently displayed Implementation Plan step, or steps, as follows:

- *Before*: **red** line
- *After*: **green** line

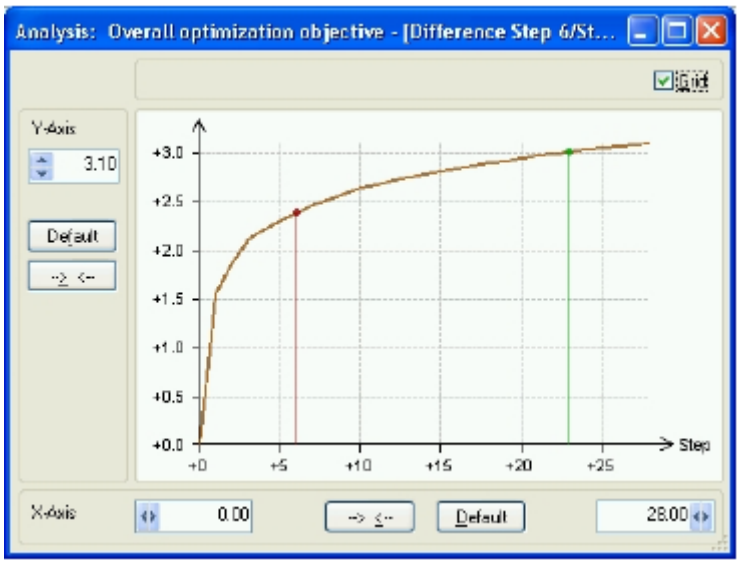
It is possible to change the currently displayed Implementation Plan step, not only by using the toolbar (see Implementation Plan selection boxes in Toolbar on page 174), but also using the mouse to drag said lines to the desired location, that is, the Implementation Plan step number.

Note: Optimization objective analysis is only available if an implementation plan has been calculated.

Also see Mouse Tracking and Clipboard Functions on page 189.

Analysis Window for Optimization Objective Analysis

The analysis window for a result plot can be opened by double-clicking on the corresponding item in the tree view, with the context menu entry *Display optimization objective plot*, or with the hot key *Ctrl+O*.



Option	Description
Grid	This checkbox turns on horizontal and vertical grid lines.
Plot area	The plot area displays the optimization objective plot, plus one (before, after) or two (difference) lines showing the respective position(s) of the displayed Implementation Plan step(s).
X-Axis min and max	These edit controls allow manual scaling of the horizontal axis.
Y-Axis max	This edit control allows manual scaling of the vertical axis upper limit.
Auto scale	This button (--> <--) near the x-axis automatically scales the horizontal axis to the x-range of values in the current plot, the corresponding button close to the y-axis automatically scales the vertical axis to the y-range of values in the current plot.
Default	These buttons scale the horizontal or vertical axis, respectively, to the default range for the selected plot type.

Mouse Tracking and Clipboard Functions

In relation to the Analysis Windows, there are some common functions available.

Mouse Tracking

When moving the mouse cursor into the plot area, a vertical marker and one or two horizontal markers (depending on the number of active graphs) are automatically displayed and labeled with the corresponding x- and y-values.

If a more detailed analysis for certain x-values is required, it is possible to lock the marker by clicking into the plot area with the left mouse button.

Two operation modes are possible depending on the number of graphs:

- If one graph is displayed (*Before* or *After*), the marker is fixed to the current x-value. A second click unlocks the marker.
- If two graphs are displayed (*Difference*), the marker for the graph closest to the mouse cursor is locked, the marker for the other graph can now be moved. Subsequent mouse clicks lock or unlock the marker for the graph closest to the mouse cursor. By locking one marker and moving the other marker, the statistics can be evaluated relatively to each other very comfortably. Locking both graphs provides an easy way to read out certain measurement points.

Clipboard

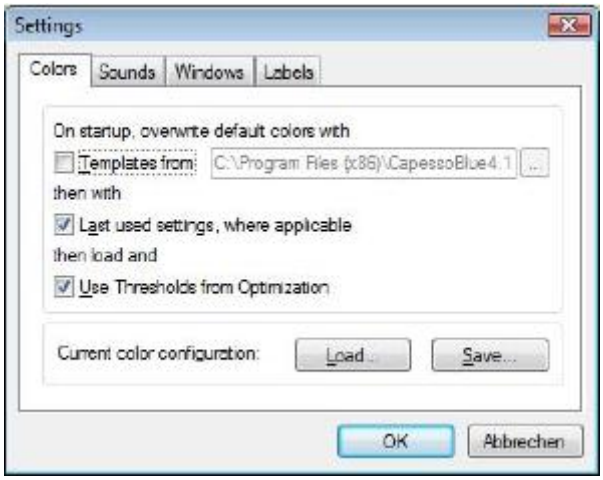
Right-click in the diagram area to access additional functions:

- **Copy chart graphics to clipboard**: Places the chart in bitmap form into the clipboard.
- **Copy graph values to clipboard**: Places the data values in tab-separated text into the clipboard. The data can be copied into a text editor or Microsoft Excel for further analysis.

Settings and Hotkeys

Settings

To open the **Settings** dialog box, from the in the Inspector toolbar, click the  button.



Colors

- **Load template from**: If this box is checked, an alternate color configuration file can be specified to override the default color settings. Please use the file DefaultColors.pal as a template for your own settings, the best way to manage user defined color schemes is to save the individual color palettes in the color editor and merge those files into a copy of DefaultColors.pal with a text editor.
- **Last used settings**: Check this option to reload the color settings from your last session. If the option is unchecked, Inspector uses the default colors every time it is launched.
- **Use Thresholds from Optimization**: Check this option to use the threshold values for with color settings as used by the optimization. If the option is unchecked, Inspector uses the thresholds used last (see above), or the default threshold settings.

Sounds

- **Moving mouse over cells**: Enables a click sound when the mouse cursor enters the area of a cell arrow symbol (and hence the parameter mouse over displays new values).
- **Clicking in cells**: Enables a click sound when clicking on a cell to select it (and hence the parameter mouse over is locked to this cell).

Windows

- **Auto toggle legend panes**: Automatically removes empty legend windows. If this option is unchecked, empty legend windows are not removed automatically but stay open, causing fewer re¬draw operations of the map area.
- **Display title caption for docking panes**: If this option is checked, the docking window title bar will show the window's name instead of the default grip area.
- **Display implementation plan step shown last**: If this option is checked, the current implementation plan step is saved when closing Inspector and is restored when re-starting it with the same project. If the option is not checked, Inspector always starts with the initial/last implementation plan steps.

Labels

Modify the sizes of labels of sites, cells, and graphs.

Hotkeys

These tables list the hotkeys that can be used in Inspector:

Hotkeys	Description
F1	Display Help.
1	Display the parameters and raster plots of the network configuration selected by the *Before* list box.
2	Display the parameters and raster plots of the network configuration selected by the *After* list box.
3	Display the parameters and raster plots as difference measures of *After* minus *Before* network configurations.
Ctrl+Home	Display the Initial (the very first) Implementation Plan Step .
Ctrl+End	Display the Optimized (the last) Implementation Plan Step.
Page Up or Page Down	Cycle through Implementation Plan Steps for currently selected category (*Before*, *After*). If category *Difference* is chosen, the *Before* selection is modified.
Shift+Page Up or Shift+Page Down	Step through category currently not selected (if *Before* is selected, steps through *After* and vice versa). If category *Difference* is chosen, the *After* selection is modified.
Space	Disables/enables item currently selected in tree view (if any), independent of which window has input focus.
+	Zoom In when the map is selected in the main Inspector window.
-	Zoom Out when the map is selected in the main Inspector window.
*	Zoom to fit the entire optimization area into the visualization window, when the map is selected in the main Inspector window.
S	Switch the Site labels ON and OFF.
C	Switch the Cell labels ON and OFF.

Hotkeys	Description
T	Switch the Tree pane ON and OFF.
R	Switch the Raster pane ON and OFF.
Shift+R	Switch the Raster mouse-over pane ON and OFF.
P	Switch the Network parameter pane ON and OFF.
Shift+P	Switch the Network parameter mouse-over pane ON and OFF.
O	Switch the Target Function Objective pane ON and OFF.
F	Switch the Find Site/Cell pane ON and OFF.
Ctrl+F	Search for a site/cell using the Find Site/Cell pane.
Ctrl+Ins	Copy current map view (zoom factor + bounding rectangle) to clipboard.
Shift+Ins	Paste current map view (zoom factor + bounding rectangle) from clipboard.
Ctrl+Shift+A	HIDE or SHOW all open analysis window.
Alt+O or ?	Open Settings (Options) dialog.
A	Show the 'About' box.

For Selected Tree Items:

Hotkeys	Description
Ctrl+L	Toggle legend.
Ctrl+C	Edit colors.
Ctrl+M	Display in mouse-over.
Ctrl+A	Display Analysis window.
Ctrl+O	Display Target Function Objective analysis window.
Shift+O	Display in Target Function Objective pane.
"," or "."	Transparency.
Space	Check/uncheck.

When Mouse is Over a Cell:

Hotkeys	Description
Tab	Cycle through all cells at current mouse position.

Note: Available shortcuts are quoted in the status line of Inspector.

15 Measurement Converter

Overview of Measurement Converter

The ASSET Design Measurement Converter is a standalone tool to generate pathloss files based on measurement data. The measurement data will be read from text files in *.csv format. As long as the measurement files comply with some basic formatting rules, it does not matter what the source of the data is. It can be scanner data, test mobile data, mobile reports, or other measured data from the mobile radio network.

ASSET Design currently supports GSM, UMTS, and LTE measurement data.

Source Data

Optimization environment

- Select the optimization environment that was exported from the ASSET project representing the network configuration at the time the measurements were conducted. Use the **Open File** button to browse to and select the according .coe file.
- The **Cell identifier** column defines which column of the cell table of the project to use for cell identification. If the project contains custom columns these can also be selected in the drop-down menu. Select the column which corresponds to the column in the measurement file that identifies the server for each measurement.

Note:

- For GSM networks, it is possible to select *BCCH + BSIC* as cell identifier. In this case, the measurement file must contain separate columns for the BCCH and for the BSIC information.
- For LTE networks, two of the options need clarification: *SRCID* corresponds to the 'Identity' parameter from ASSET, whereas *CELL_ID* corresponds to the 'Cell Name' from ASSET.

- *Technology* selection: If the optimization environment includes networks of multiple technologies, one has to be selected first with the **Technology** drop-down menu. If there is only a single column in the optimization environment available for cell identification, the Cell identifier column selection will not be shown.
- *Network* selection: Shows a list of frequency bands for GSM and a list of carriers for UMTS/LTE. Only cells for the chosen option will be used for the conversion.

Optimization environment projection

- The coordinate system that was used for the projection to export the ASSET project to the optimization environment (geo data, site locations, and so on) needs to be metric and rectangular (northing/easting). The same projection must be selected here to accurately project the measurement points onto the analysis area.
- The **Environment coordinate system information** box provides details of the coordinate system string used in the ASSET project. This can give you a hint to find the correct projection.
- If the optimization environment contains an EPSG code, it will automatically be used to select the correct projection.

- If an optimization environment with the same coordinate system information has already been successfully used before, this projection will be loaded automatically. If a corresponding projection was found and applied, "*Settings loaded!*" will be displayed.
- Use the **Browse**  button to open a dialog box for searching the correct projection.
- Use the **Search terms** field to provide a name (or a part of it) of a projection to search for. Press **Enter** or click the **Search** button to start searching. The category and the name of all known projection systems are compared with the search term. Matches are displayed in the list below.
  - The *Projection category* is the geographical region or the basic projection system (e.g. UTM based on WGS 1984 ellipsoid).
  - The *Projection* is the actual used system (the name) or the zone (e.g. the UTM zone).
- If the projection cannot be found, new projection systems can be defined. They will be stored in a user-specific file and automatically be loaded next time the Measurement Converter is started. Use the **Add projection** button to define a new projection system.
  - Provide a category and a name in the corresponding fields.

    Note: The category and the name must be unique, otherwise the new projection cannot be added.
  - The new projection system is defined by providing a Proj4-string. Proj4-strings are a simple method to identify projection systems, which can be found online. Copy and paste the corresponding string to the *Proj4 string* field.
  - If the projection defined by the Proj4-string does not yet exist and the Proj4-string is valid, the new projection can be added with the button *Add projection to list*.

Measurement file

- Use the **Open File** button to browse to and select one or more measurement data input files.

  The default location for measurement environments is a sub-folder *Measurements* in the corresponding optimization environment.
- If more than one measurement file is selected make sure that the files use the same projection and contain the same columns. For a description of the file and data format, see File Format of the Measurement Data on page 202.

Select Columns

Opens a dialog box to identify key columns of the measurement file. See Measurement File Column Selection on page 197.

Converted Data

Generate environment

Select this option and use the **File Open** dialog box to define the .cme file where the measurement environment will be stored.

The measurement input data will be used to calculate pathloss matrices for the cells and write them to the measurement environment. For an overview about measurement environments, see Optimizing with Measurements on page 196.

Generate traffic map

Select this option to create a user-density traffic map from the measurement data. The file name is automatically defined when a measurement file is selected.

The default location for the traffic map is the traffic data folder of the selected optimization environment.

The traffic map is created in two file formats:

- Bil-file format for use in ASSET Design
- Tri-file format for use in ASSET

Tip: To ensure you have a large enough sample size, it is recommended that you only use traffic maps created with measurements from mobile reports.

Maximum pathloss radius

This is the maximum distance in meters of measurement samples from their server to be considered for the averaging and conversion to pathloss matrices.

If the distance between a measurement sample and the corresponding server is greater than this radius, then sample will be ignored.

Start Measurement conversion

Click the **Start Measurement** button to load the input file, process the data samples, and write the converted pathloss files. For each conversion a new tab (worksheet) will open.

Status

Status line: Describes the action currently in progress (reading input file, converting data, and so on).

Progress bar: Shows the progress of the current action.

Information window: Displays additional information like statistics or error messages.

Conversion of Measurements to Pathloss Data

Measurements are converted to pathloss data as follows:

1. The measurement samples within a pixel of a certain size are averaged for each cell separately. The pixel size is defined by the resolution of the optimization environment.
2. Some basic checks are done to remove unreliable samples. The maximum distance from the server is checked with the number defined in the input field described above. Feasibility checks will rule out samples whose received power is outside a certain confidence interval.
3. Measurements with repeaters are assigned to the donor or the repeater. Because donor and repeater have the same cell ID, a range check is used to assign the measurements to the donor or the repeater whatever is closer.
4. Measurements from secondary antennas are assigned to the primary antenna. No pathloss files are created for secondary antennas.

   Important: We recommend that you do not optimize secondary antennas, as the antenna masking of areas actually served by secondary antennas will be wrong.

5. For each pixel where samples are available, the pathloss to each measured server is calculated from the averaged received power using the parameters of the server cell (transmit power, transmit losses, and so on).
6. The calculated pathloss values are then written to pathloss files, one for each measured cell. These pathloss files will contain masked pathloss data.

Conversion of Measurements to a Traffic Map

For each pixel of the optimization area, the number of measurement points falling in this pixel is counted (where each row of the measurement file is one measurement point).

After the accumulation for each pixel, this number is divided by the pixel's size and written to the traffic map. The resulting data is a user density map in users/km^2.

Optimizing with Measurements

ASSET Design can use prediction-based pathloss data or measurement-based pathloss data for the analysis of one target functions (for example, the calculation of received power, signal to noise ratio, and so on). If you want to use measurement-based pathloss data, you need a measurement environment as well as the optimization environment:

- The optimization environment contains pathloss files produced by prediction models.
- The measurement environment contains pathloss files calculated from measurements.

> **Note:** A measurement environment needs a corresponding optimization environment, and cannot be used standalone.

The Measurement Converter can generate a measurement environment from an optimization environment and a measurement data file. Multiple measurement environments can also be generated from the same optimization environment and multiple data files.

Using Measurement Environments in ASSET Design

After having added a target function, use the **File Open** button in the Measurement environment section of the target function **Options** to select the .cme file of the measurement environment.

If multiple measurement files have been converted to measurement environments, add multiple targets and assign one measurement environment each. Using the same weights for these target functions will equally balance the impact of the measurements on the total objective. By using different weights, certain measurements can be prioritized over others.

Donor and repeater cells should not be optimized. The donor cell has a combined pathloss of donor and repeater while the repeater has no pathloss data.

Measurement conversion for splitters is currently not supported.

In any case, it is recommended to carefully combine targets with measurement-based targets with prediction-based targets. The surface density of the measurement points is often much weaker than the predictions of propagation models. The exclusive use of measurement-based targets would perhaps focus the optimization gain too much on areas where enough measurement samples are available and ignore other areas, and this may not meet the needs of the network operator. This can be mitigated by combining the two types of target.

More information can be found in Optimization with Measurements on page 160.

Ensuring the Quality of the Measurements

Follow these guidelines to ensure the measurements are the best possible quality:

- The more measurement samples the better. The points should be dense enough and regularly distributed over the area of interest.
- Each cell of the optimization area should be measured.
- The measurement samples should contain as many servers as possible to be able to accurately calculate interference contributions in the analysis.
- The ASSET project that you use must accurately represent the network configuration at the time of the measurements, otherwise the generated pathloss files might be unreliable and hence optimization results might suffer.

  For example, the downlink traffic power parameters in ASSET used for the interference calculations should be set to realistic values and reflect the real situation in the network as accurately as possible.

Measurement File Column Selection

Auto-select

Use the **Auto-select** button to automatically map the columns of the measurement file to according transmitter/cell parameters. The function scans the header row of the measurement file for keywords such as longitude, latitude, cellid, cell_id, scrambling, rscp, rxpower, rx_power, rsrp, etc., and tries to map them to the matching parameters.

Important:

- If the order of the columns does not match the order of server 1..N or the naming does not match the naming convention given above, the automatic mapping might fail or assign wrong columns. Do a manual selection in this case.
- Always verify the mapping after using the automatic mapping function. Invalid column mapping might lead to an unusable quality of the measurement environment and bad optimization results.

Longitude / X

Select the column that contains the longitude information.

Latitude / Y

Select the column that contains the latitude information.

First Cell Identifier

Select the column that contains the cell identifier information of the first server. If, for GSM, *BCCH + BSIC* has been selected as cell identifier column from the optimization environment, both the *First BCCH* and *First BSIC* must be mapped here rather than First cell identifier.

First Received Power

Select the column that contains the received power values of the first server.

First C/I

Select the column that contains the received C/I values of the first server. This column is optional and can be omitted if for example the measurements don't contain C/I information.

Important: Each row is a measurement at one particular position and can contain several measured servers. The column selection will identify a certain structure of the sequence of the cell identifier and received power columns for server 1, server 2, and so on. It is required that this sequence of columns is identical for the servers, and that all columns of server 2 are after the columns of server 1, and so on.

For more details on the columns of the measurement file, see File Format of the Measurement Data on page 202.

After having selected the longitude, latitude, first cell ID, and first RX power columns, the tool will identify as many (cell-ID / RX-power) pairs as possible. The cell ID and RX power columns of the other servers have to be identical to those of the first server but with ascending numbers (e.g. "cellID_1", "cellID_2", ...).

All columns of server 1 must be grouped together, succeeded by all columns of server 2, and so on, hence the columns of a server are forming a group. The group sizes must be identical for all servers. The position of cell ID and RX power within each group must be identical. The number of identified groups defines the maximum number of measured servers per location.

In the case that all cell IDs of the servers are grouped together in one column, all RX-power values are grouped together in one column, and so on, select the **Separate multiple values per measurement column** option.

If the measurements include C/I values and the C/I column has been selected, the Measurement Converter will compare the C/I measurements against the corresponding C/I values that have been calculated using the cell parameters of the optimization environment and the pathlosses calculated from the received power values. The statistics at the end of the conversion process will then include the standard deviation of the measured and the calculated C/I. The C/I columns of the measurement file are only used for these statistics, not for calculating any other data like interference matrices.

C/I measurements are handled differently depending on technology:

- For UMTS and CDMA2000, the C/I measurements must be Ec/Io values
- For LTE, the C/I measurements must be RSRQ values
- For GSM, C/I measurements are ignored

Filter

Optionally a filter column with corresponding filter values can be defined. The measurement converter will only consider measurements that fulfill the filter criteria. The longitude and latitude column cannot be used to filter measurements. Valid filter values have to be entered one per line and can include numbers (such as channel numbers) or text (such as Cell IDs). It is even possible to define ranges of valid values with the syntax [min, max]. For example, you could consider only measurements with a certain C/I level: [-20.5, 100].

Separate multiple values per measurement column by

If the values for cell ID, RX-power, and so on, of all servers are grouped together in one column each, then select this option. Those grouped values shall be surrounded by quotation marks and separated from each other with either comma, tab stop, or semicolon. Select that separator from the drop-down list next to the check box.

Note: The number of values in each such group is the number of measured servers for that location. It must be identical for the columns cell ID, RX-power, and C/I within one row.

Status

Shows if all columns have been selected properly or if selections are missing. Also displays the detected size of the groups and the max. number of measured servers (as explained above).

Conversion Statistics

After a successful conversion or traffic map creation some statistics are presented in the information window and also in the **Conversion Results** dialog box that is opened automatically. These statistics provide some insights regarding the quantity and quality of the measurements, and the results of the swapped feeder analysis.

If a conversion or traffic map creation fails, some of the statistics can still be available to help you find the reason why they failed.

General Statistics

Conversion completed in:

Runtime of the conversion.

Measurement file lines read:

Count of lines read from the measurement file, and count of lines that had invalid coordinates. A large count of invalid coordinates can indicate bad measurement data or that a wrong optimization environment projection has been chosen.

Measurement Environment Statistics

Cells with measurements:

The count of cells with available measurements, and the total count of measurements.

Used measurements:

- Total: Total count of measurements.
- Used: Count of measurements that were used to create the measurement pathloss files.
- Unknown: Count of measurement belonging to cells that are not part of the source environment.
- Out of range: Count of measurements that where outside the given maximum pathloss radius.
- Ambiguous: Count of measurements that were in range of multiple cells using their cell identifier (e.g. same scrambling code or same physical cell ID). A possible reason for a high number of ambiguous measurements can be that cells on different carriers (multi-carrier network) but on the same transmitter or site use the same cell identifier in the ASSET project. In such a case, export only a single carrier to the optimization environment, or correct the wrong cell identifiers in the ASSET project.

Used measurement points:

Count of valid coordinates (lines in measurement file).

Valid samples:

Count of measurements that had valid data. Invalid data examples are empty cell identifier columns, or non-number values in received power columns.

Average number of servers per measurement point:

This is the number of measured servers per measurement point averaged over all measurement points. A value of 1 indicates single server measurements which should only be used for coverage analyses. The higher this number the better can inter-cell interference be considered, e.g. for SINR analyses.

Average number of servers per pixel:

This is the number of measured servers per pixel averaged over all pixels. A value of 1 or close to 1 means that only a single server was measured in most of the pixels. Reliable optimizations are unlikely in this case. Depending on the environment, the average number of servers should at least be 3.

Standard deviation of C/I:

The measured C/I samples (Ec/Io for UMTS or CDMA2000, RSRQ for LTE) are compared to the reproduced C/I of the server for the pixel. The reproduced C/I of a server for a pixel is calculated using the cell parameters from the optimization environment (pilot powers, traffic powers, etc.) and the pathloss calculated from the received power samples in the pixel from the server. The displayed parameter is the standard deviation of all measured C/I samples and the reproduced C/I values averaged over all pixels and the strongest 6 servers.

This statistical parameter reflects the accuracy of the down-link traffic power cell parameter in the optimization environment. This power is crucial for accurate C/I optimizations. If the standard deviation is high (e.g. 7–10dB or more) then C/I optimizations should only be done with care.

Average RX power reproduction confidence:

All received power samples for a particular server within a pixel are compared to the average received power from that server in that pixel. The percentage of those that are deviating less than 1dB from the average is calculated. This percentage is finally averaged over all servers and all pixels.

Pathloss area with measurements:

How much area in % of a pathloss file consists of pixels with valid measurements, and thus has a valid pathloss value. Low numbers indicate that not enough measurements were available.

Measurements per pathloss file:

How many measurements were used to create a pathloss file.

Measurements ignored due to extreme values:

Measurements with very high or very low received power values, or measurements that diverged too far from the average value. These values are likely to be invalid and are ignored.

Number of pixels with measurements:

How many pixels of the optimization contain one or more measurements samples.

Traffic Map Statistics

Coordinates outside the traffic map

The count of measurement lines that had coordinates outside of the traffic map. The traffic map is automatically set to the size of the optimization area, plus a few pixels of margin for coarser resolution optimizations.

A large number of such coordinates can be the result of the measurement file simply covering a larger area, the measurement file not actually covering the optimization area, or an invalid environment projection.

Traffic map area

Total area of the traffic map, and the area of the traffic map where users (= rows in the measurement file) were found.

Users in traffic map area

Total count of users (= rows in the measurement file) that had valid coordinates and are within the traffic map area.

Repeater Details

If the environment contains repeaters, all measurements are added to the donor, as the donor and its repeaters use the same identifier.

In the **Repeater details** pane you can view all donors with measurements and the repeaters which belong to them.

Important: We recommend that these donors are not optimized, as their pathloss files also include their repeaters' areas, and parameter changes would invalidate the antenna masking.

Swapped Feeder Analysis

In the **Conversion Results** dialog box, underneath the **Statistics** chart, you can view a summary of the number of detected swapped feeders.

Click the **Swapped feeder details** button to switch between a chart and a more detailed swapped feeder analysis.

The swapped feeder analysis details show the list of cells (grouped by site) that may have a wrong feeder connected, along with the reliability of the incorrect feeder detection (from 0 to 100%) for each cell, and the cell that is most likely connected to that feeder.

The potential swapped feeder is derived as follows:

- The swapped feeder analysis evaluates the angles of the antennas of sites to the pixels of the measurements
- If the measurements indicate a certain cell as the best server for a pixel, the other antennas of the same site are checked
- If the main beam of another antenna is closer to the pixel as the best server (in the angular domain), the other cell adds to the statistics as potential swapped feeder
- After all pixels have been analyzed, the statistics are searched for cells that have been detected as swapped feeders frequently

The reliability of the incorrect feeder detection is calculated as a ratio of the number of times a cell has been detected as swapped feeder to the number of times a cell has been detected as correct feeder.

Additionally, the statistics are weighted by the received power (in dBm), because stronger received cells provide more accurate results than weaker cells.

The Accuracy of the Detection

The swapped feeder detection works best in cases where all cells are surrounded by a large number of measurements with clear best server structures.

In some cases, the detection algorithm might provide false positive results (in other words, swapped feeders are detected even though the feeders are connected correctly):

Reason	Description
Drive test measurements	Drive tests are often done only on main roads, and thus might not provide enough spatial distribution for accurate swapped feeder detection for some of the cells.
Only a few measurements points are available for some cells	If these measurements are not located near the main beam of the antenna, the swapped feeder detection algorithm might assign them to a different cell by mistake which can lead to a false positive result.
Measurement points are concentrated in small areas	If measurements are available only in a small area or only for a small part of the optimization polygon, the swapped feeder detection might not be accurate for cells that are distant to the measurements. The reason is that for these cells the measurements are seen only in a small angular range. The assignment of measurements to cells is based on a minimum angle search, and thus the swapped feeder detection algorithm cannot work properly.
Cells close to the border of the optimization polygon	Measurements are only processed within the optimization polygon. Cells close to the border of that polygon are therefore not entirely surrounded by measurements. That can result in inaccurate swapped feeder detection results.
Incorrect network configuration parameters	If the configuration parameters of the cells in the optimization environment (exported from the planning tool) are incorrect (e.g. wrong azimuth settings of the transmitters/cells), the swapped feeder detection algorithm might return false positive results. If many swapped feeders are detected, it is therefore recommended to check the planning tool project for incorrect site/ transmitter/cell configuration parameters, in particular the azimuth settings.

File Format of the Measurement Data

The measurement data input file should follow these formatting rules:

- It must be an ASCII character text file, organized in columns and rows as character separated values (csv).
- The separator is detected automatically and can be the tab stop character, comma, or semicolon.
- The first line is a header line and contains the name of the columns. Empty columns are not allowed in the header line.
- All rows following the header line are interpreted as data rows. Data rows do not have to have the same number of columns as defined by the header line, reading of data rows stops at the end of line anyway.

  In any case, not more than the number of servers defined by the header line are read from data rows, where remaining columns will be ignored.
- All columns must have unique names.
- Associated columns (for example, first received power, second received power, and so on) are characterized by identical names and ascending numbers following the name.
- The user has to select the column name identifying (i) the cell ID of the measured server, and (ii) the received power from this server (see Measurement File Column Selection on page 197). The tool will try to detect as many cell ID/server pairs as possible in the header line.
- The maximum number of measured servers in following data rows is defined by the number of detected servers in the header line.

- Optionally, a C/I column can be selected if existing. In this case, Measurement Converter will display the standard deviation of measured vs. calculated C/I.

Important: The coordinates of the measurement points in the data file must be given in the WGS 84 world coordinate system (longitude and latitude).

Column Description

This table describes the file and data format of the measurements:

Column	Description	
Longitude	WGS 84 coordinates of the longitude	
Latitude	WGS 84 coordinates of the latitude	
...	Some columns which are ignored (optional)	
...	Columns with server 1 parameters (optional)	Group 1 = first server
Cell ID 1	Cell ID of first server	
...	Columns with server 1parameters (optional)	
RX power 1	Received power from first server	
C/I 1	C/I of first server (optional)	
...	Columns with server 2 parameters (optional)	Group 2 = second server
Cell ID 2	Cell ID of second server	
...	Columns with server 2 parameters (optional)	
RX power 2	Received power from second server	
C/I 2	C/I of second server (optional)	
...	...	...

All parameters of a server (cell ID, received power, and other columns) must be grouped together.

The position of cell ID, received power, and optionally C/I within each group must be identical from group to group, also the number of columns of each group must be identical. The group of server 2 must follow the group of server 1, server 3 must follow server 2, and so on. The number of servers is not limited in a row. The number of rows is only limited by practical reasons like memory usage or time to read and convert the data.

Example of valid file:

Long	Lat	Time	CellID_1	EcIo_1	RSCP_1	CellID_2	EcIo_2	RSCP_2	...

Example of invalid file:

Long	Lat	Time	CellID_1	CellID_2	EcIo_1	EcIo_2	RSCP_1	RSCP_2	...

Multiple values per measurement column

As an alternative to the format described above, the values for cell ID, received power, and C/I can be grouped together for all servers of one measurement point (one row of the measurement data file).

The file will thus consist of only a single column each for cell ID, received power, and C/I. For each measurement point a different number of servers can be realized by having a different number of values grouped together in each of these columns.

Those values must be surrounded by quotation marks and separated from each other by comma, tab stop, or semicolon. For example:

"156,163,171" <tab stop> "-98.3,-101.8,-102.1" ...

16 Incident Reports

Incident reports are compressed archive files containing information required to analyze or reproduce software behavior at your software vendor.

Two different incident report formats are available:

Report Format	Includes
Small	All textual data, optimization ranges and settings, log files, but not excessive binary data.
Large	All textual data, optimization ranges and settings, log files, binary data for path losses, elevation angles, traffic maps, and so on.

Incident reports are automatically generated after serious errors, but you can also generate them manually. They are stored in the ASSET Design temp directory for further submission and have to be deleted manually.

This describes how to:

- Generate incident reports manually
- Manage incident reports, including how to submit them

Manually Creating Incident Reports

You can generate incident reports in a number of ways:

- In ASSET Design, from the **Tools** menu, click **Generate Incident Report**.

  This option automatically adds the data loaded in ASSET Design to the report.

- From the **Start** menu, point to **Program Files**, **TEOCO**, **ASSET Design** and click **Create Incident Report**.

  This option opens the **Incident Report Generator**, and enables you to add user defined data to the incident report.

  You can add and delete files or folders.

  The Incident Report Generator supports several pre-defined files that are automatically handled correctly. If you add these file types, the directories associated to the files are automatically added to the report.

File Type	Description
Optimization Environment (.coe)	The corresponding Optimization Environment directory is automatically added.
Measurement Environment (.cme)	The corresponding Measurement Environment directory is automatically added.
Optimized Network (.con)	Other files or directories can be added as required to provide suitable information to the support.

  In some situations, Support may request additional information and provide you with arguments that can be entered or copied into the corresponding field.

Important: In the very rare instance that an error occurs when the incident report is being generated, you should:

- Submit the log file instead by clicking the appropriate button in the Incident Report Generator

  - or -

- Email a screenshot with a detailed problem description to Support

Managing Incident Reports

Incident reports are stored in the temporary optimization folder. By default, this is located at C:\Windows\Temp\C3G, but you can change this location in the ASSET Design Options.

You can use the **Incident Report Manager** to submit or delete reports.

To open the Incident Report Manager:

From the **ASSET Design Tools** menu, click **Incident Report Manager**.

- or

From the **Start** menu, point to **Program Files**, **TEOCO**, **ASSET Design** and then click **Manage Incident Reports**.

Tip: The Incident Report Manager opens automatically after a report has been created.

The Incident Report Manager automatically scans the temporary optimization folder for reports and displays them in a structured, sorted list.

Tip: If you want to manage the reports in a folder other than the temporary optimization folder, see Using Alternative Folders on page 206.

Using Alternative Folders

You may need to manage reports that are located in a folder other than the temporary optimization folder, for example when:

- The temporary optimization folder has been changed, and you need to manage or submit reports in the previous folder
- You need to manage or submit reports:
  - On a different machine
  - On an external drive or a backup directory

To use an alternative folder:

1. Click the **Select Source Directory** button.
2. Locate the report that you want to use and click **OK**.

   The Incident Report Manager automatically enumerates the new folder and displays the associated reports in the tree view.

Submitting Incident Reports

In the **Incident Report Manager**, you can submit reports to share them with Support and others.

To do this:

1. Select the required report.

   For more information on report types, see Which Report Type Should You Submit? on page 207.

2. Click the required Send report option, depending on how you want to send it:
   - **Send report via email**: Report Manager uses your default e-mail application to send the report.
   - **Send report via ftp**: Report Manager uses an integrated FTP client to upload the report to Support.

   Note: The FTP client uses passive mode, proxy support is not available.

3. When prompted, provide the additional information:
   - Your name.
   - Your company.
   - A reply e-mail address (important when using the FTP option).
   - A problem description. Please provide as much information as possible to help with the analysis and reproduction of your problem.

Which Report Type Should You Submit?

When considering which report type you submit, you should bear in mind that the data required to analyze software behavior varies from situation to situation. As a general rule you should provide as much information as possible, while ensuring that the amount of data you choose can be submitted successfully via FTP or e-mail:

- Large reports of 3 MB or less can be submitted via email
- Large reports between 3 MB and 50 MB should be transferred by FTP
- If the report size exceeds 50 MB, you should submit the small report

Notes:

- Incident report files are stored as plain files on your hard disk, you can copy them to other media such as CDs or flash memory devices.
- If the analysis of the small report reveals that the large report is required, Support will request the large report.

Deleting Incident Reports

To delete one or more reports:

1. Select the required reports.
2. Click the **Delete** button.

Warning: Reports should be deleted with care; do not delete reports associated with pending support requests.

17 Licensing Information

Licensing Information

ASSET Design uses the CodeMeter UFC (Universal Firmcode) licensing system. This system can use both dongles and software licenses (the previous system, used for versions up to 9.1.1, only used dongles).

The UFC licenses require CodeMeter runtime 6.50c or later on both clients and servers. The ASSET Design installation includes the updated CodeMeter runtime. A standalone runtime (for example if you are using a CodeMeter license server) can be downloaded here: https://www.wibu.com/downloads-user-software.html

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Important:

- ASSET Design versions from 9.1.2 onwards need the new UFC dongles or UFC software licenses.
- ASSET Design older versions up to and including 9.1.1 need the old dongle-only licenses.
- The new licenses are not compatible with the old ones, so existing dongles cannot be reused for new UFC licenses.
- If you want to partially or fully switch your existing licenses, please contact TEOCO Product Support (global.ran.support@teoco.com).

Details for UFC Dongles

- Dongles can be used as before (for example, moving dongles between different machines).
- After updating a license, you will need to create another license request before getting any further license updates. You can either do this after installing the update or when you need the next update*.

Details for UFC Software Licenses

- Software licenses are bound to a machine and its hardware. Minor changes are possible, but major ones will break the software license.
- Software licenses can be bound to virtual machines and their host. However, please note that:
  - Changes to the virtual or the host machine can break the software license.
  - Moving a virtual machine to a different host will break the license.
  - The use of virtual machine licenses may require approval by TEOCO.
- Customers need to create an empty license container. This is done by installing the CodeMeter runtime and using a container template file sent by TEOCO. When this is installed, you will need to create a license request. See Obtaining a License on page 210.
- After updating a license, you will need to create another license request before getting any further license updates. You can either do this after installing the update or when you need the next update*.
- Broken licenses may be repaired by undoing the changes that broke them. If the license can’t be repaired this way, a new empty license container needs to be created, and it will require a new license.

* This extra step is currently necessary, but there is a strong chance that a newer CodeMeter version may remove this step in the near future.

License Installation and Updating

For information on installation and updating of licenses, see Obtaining a License on page 210.

Obtaining a License

Please refer to the preceding section ('Licensing Information') before reading these steps.

Dongle License

To obtain a dongle with an ASSET Design license please contact TEOCO Product Support (global.ran.support@teoco.com).

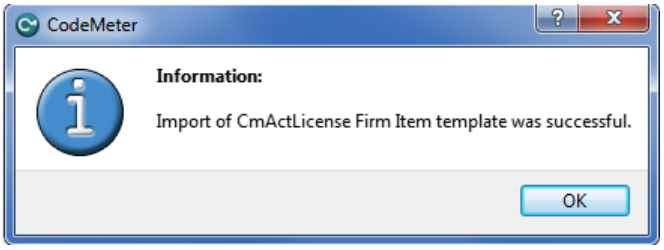
Software License

Please contact TEOCO Product Support (global.ran.support@teoco.com) if you need any assistance with the procedures below.

Initial Process (Creating a CodeMeter License Container)

1. Contact TEOCO Product Support to request a software license template file (***.WibuCmLIF**).
2. Install ASSET Design (this also installs the updated CodeMeter runtime 6.50c).
3. Double-click the ***.WibuCmLIF** file.

   A message confirms that the CodeMeter container template file import is successful:



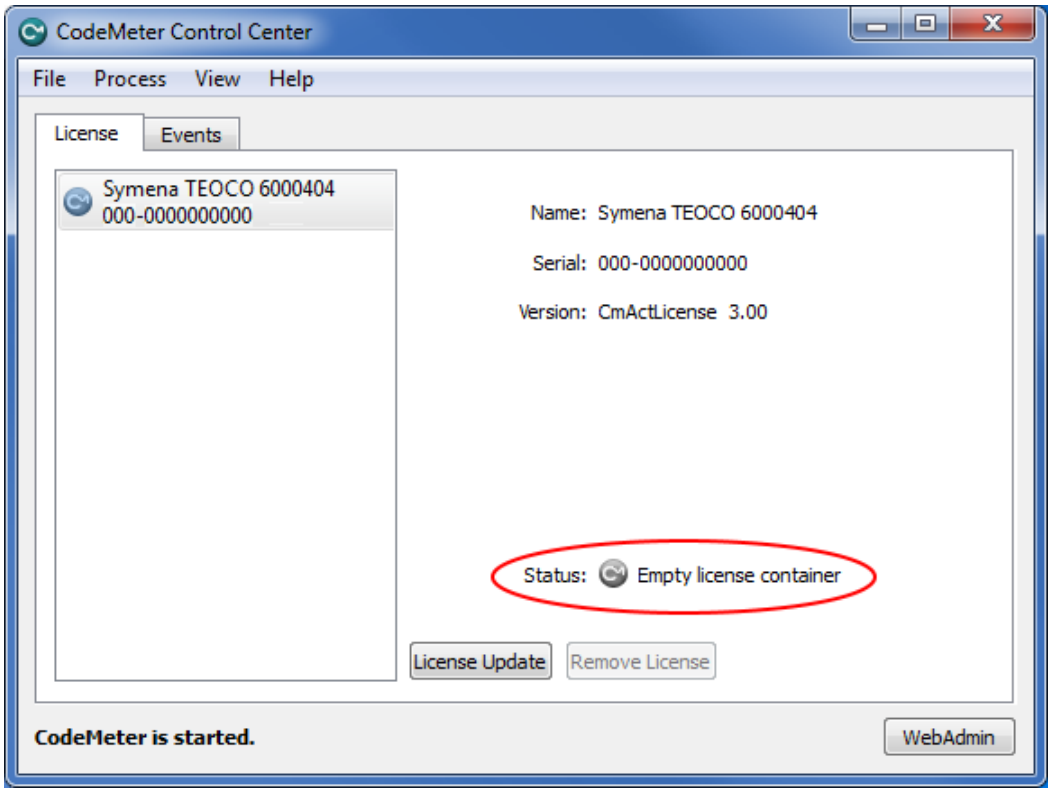
4. Click **OK**.
5. Create & send us a license request as described in Creating a License Request on page 211.

Creating a License Request

This is required to initialize a software license after creating an empty software license container.

(It is also currently required after each subsequent license update/activation, but this may not be necessary in a future version of CodeMeter.)

1. If it is not already started, start the CodeMeter Control Center from the task bar  .
2. Select the empty license container on the License tab:



3. Click **License Update**.

   If you are asked to choose a vendor, select 'Symena Universal Firmcode 6000404'.
4. The CmFAS Assistant appears. Click **Next**.
5. Select **Create license request**, and click **Next**.
6. Select a storage location for the ***.WibuCmRaC** file, and click **Commit**.
7. Click **Finish**.
8. Send a copy of the ***.WibuCmRaC** file to TEOCO Product Support.

   This license request file holds information on your license container and allows us to create license updates.
9. You will receive a license file (***.syl**) from TEOCO Product Support.
10. Save the file and update the license. See Updating or Activating License Files on page 213.

License Manager

The License Manager enables you to apply license files to a dongle or a software license.

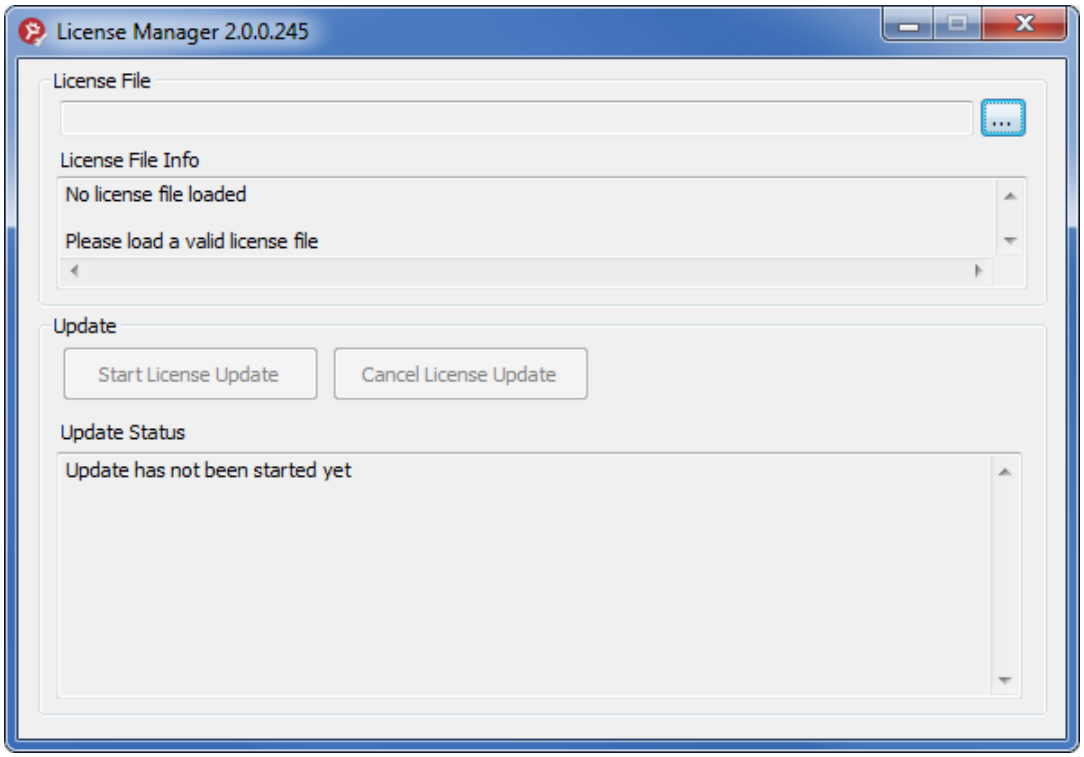
Notes:

- Dongles or software licenses connected to remote computers can be also updated, if:
  - The remote computer is configured as a CodeMeter license server
  - The dongles or software licenses on the remote computer are network licenses
- Local software or dongle licenses (also known as 'workstation licenses') on remote computers cannot be updated. A local license can only be updated directly on the computer.
- License update files (also known as activation files) are now provided as *.syl files, which can contain a series of older updates and the most current update. The License Manager will try to install all updates beginning with the oldest. This ensures that software or dongle licenses are always kept up-to-date and you do not need to worry about applying updates in a specific order.

To open the License Manager:

From the **Start** menu, point to **Programs**, **TEOCO**, **ASSET Design**, and then click **License Manager**.

This picture shows an example:



Updating or Activating License Files

To update or activate a license file:

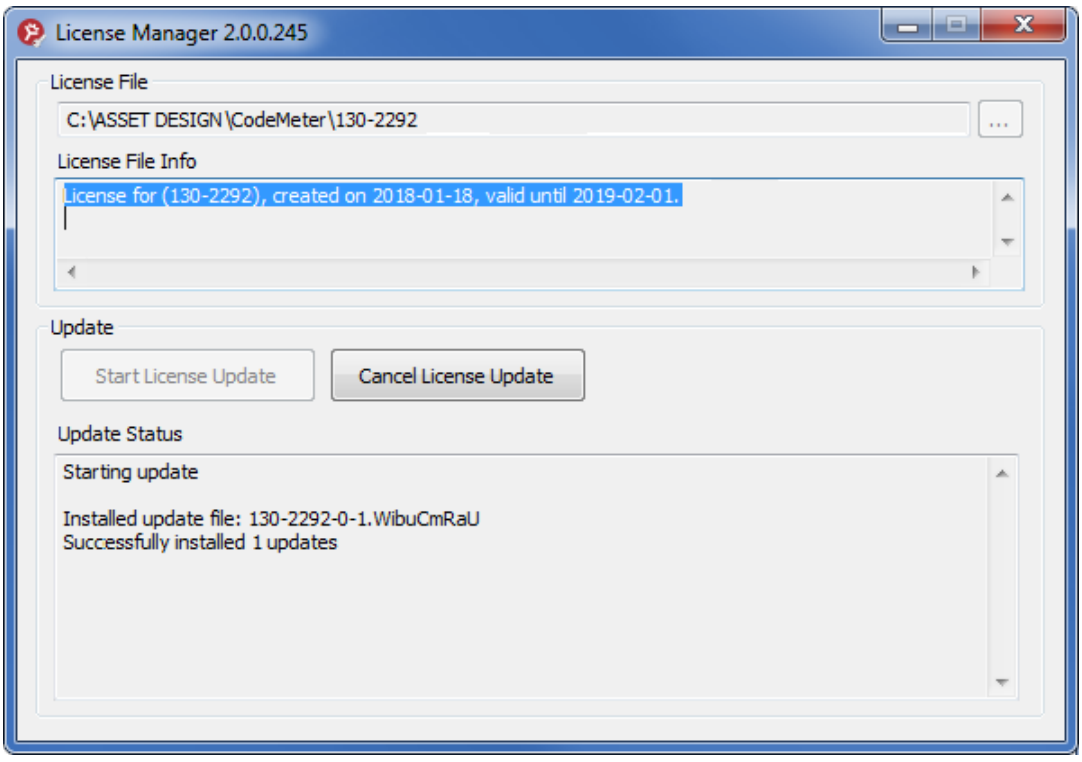
1. In the License Manager, click the **Browse** button [...] and select the ASSET Design license file that you want to apply.
2. Click the **Start License Update** button to apply the license.

   Tip: You can view information about the currently-loaded license file under *License File Info*.

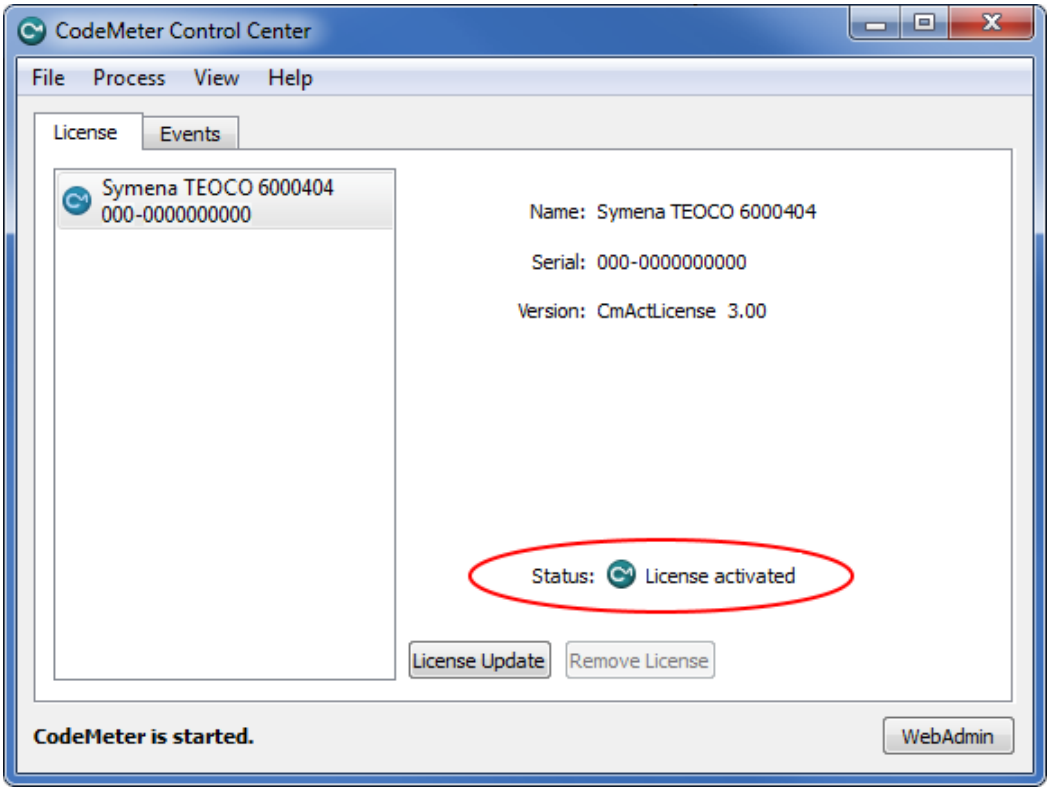
3. When a valid license file is loaded, the **Start License Update** button is enabled. Click it again to start the update.

   Note: The **Cancel License Update** button enables you to stop the license update while it is running, for example if it takes too long for network licenses.

4. When the update has finished, the status of the update is displayed in the **Update Status** pane:
   - If it is successful, the number of applied updates is shown, as in this example:



In the CodeMeter Control Center you can check the license status, especially after a license activation, as in this example:



- If it is unsuccessful, the reason will be shown in the error message.

18 Third Party Licence Information

These licenses are used by ASSET Design and the supporting tools:

Library	License	Source
Resizable Lib	Artistic Library	https://www.codeproject.com/
7Zip	GNU LGPL	http://www.7-zip.org/
DotSpatial	GNU LGPL	https://github.com/DotSpatial/DotSpatial
GEOS	GNU LGPL	http://trac.osgeo.org/geos/

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Version 3, 29 June 2007

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An “Application” is any work that makes use of an interface provided by the Library, but which is not otherwise based on the Library. Defining a subclass of a class defined by the Library is deemed a mode of using an interface provided by the Library.

A “Combined Work” is a work produced by combining or linking an Application with the Library. The particular version of the Library with which the Combined Work was made is also called the “Linked Version”.

The “Minimal Corresponding Source” for a Combined Work means the Corresponding Source for the Combined Work, excluding any source code for portions of the Combined Work that, considered in isolation, are based on the Application, and not on the Linked Version.

The “Corresponding Application Code” for a Combined Work means the object code and/or source code for the Application, including any data and utility programs needed for reproducing the Combined Work from the Application, but excluding the System Libraries of the Combined Work.

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   You may convey a covered work under sections 3 and 4 of this License without being bound by section 3 of the GNU GPL.

2. **Conveying Modified Versions.**

   If you modify a copy of the Library, and, in your modifications, a facility refers to a function or data to be supplied by an Application that uses the facility (other than as an argument passed when the facility is invoked), then you may convey a copy of the modified version:

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b) under the GNU GPL, with none of the additional permissions of this License applicable to that copy.

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   The object code form of an Application may incorporate material from a header file that is part of the Library. You may convey such object code under terms of your choice, provided that, if the incorporated material is not limited to numerical parameters, data structure layouts and accessors, or small macros, inline functions and templates (ten or fewer lines in length), you do both of the following:

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   b) Accompany the Combined Work with a copy of the GNU GPL and this license document.

   c) For a Combined Work that displays copyright notices during execution, include the copyright notice for the Library among these notices, as well as a reference directing the user to the copies of the GNU GPL and this license document.

   d) Do one of the following:

   0) Convey the Minimal Corresponding Source under the terms of this License, and the Corresponding Application Code in a form suitable for, and under terms that permit, the user to recombine or relink the Application with a modified version of the Linked Version to produce a modified Combined Work, in the manner specified by section 6 of the GNU GPL for conveying Corresponding Source.

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5. **Combined Libraries.**

   You may place library facilities that are a work based on the Library side by side in a single library together with other library facilities that are not Applications and are not covered by this License, and convey such a combined library under terms of your choice, if you do both of the following:

   a) Accompany the combined library with a copy of the same work based on the Library, uncombined with any other library facilities, conveyed under the terms of this License.

b) Give prominent notice with the combined library that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.

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The Artistic License

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The End

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