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| **Radiocommunication Study Groups** |  |
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| User guide for the IMT spectrum requirementestimation tool |

# 1 Introduction

In the following, the tool for the implementation of the methodology to determine global spectrum requirements for IMT in Recommendation ITU-R M.1768-1 is presented[[1]](#footnote-1). This methodology and tool could also be used to estimate the total IMT spectrum requirements of a specific country if all the input parameter values are specified (as described in the methodology itself).

2 Methodology flow and calculation steps

Use of the software tool

The methodology of estimating the spectrum requirements for IMT is implemented in MS Excel as a Spectrum Calculator tool to facilitate its use. The tool is available on the ITU-R WP 5D web-page for users with TIES accounts.

The tool consists of 27 worksheets and seven modules of macros. The worksheets present input parameter values, intermediate calculation results obtained from worksheet calculations and macro calculations, and the final spectrum requirements. The tool is executed from its opening sheet called “Main”, which is the core of the tool.

Figure 1 shows the relationship between the methodology flow chart and the corresponding worksheets in the “Spectrum Calculator” tool as well as the different input parameters to the methodology calculation steps. The worksheets with a grey background colour in Figure 1 denote the locations in the tool where the input parameter values are inserted. The worksheets with a white background colour in Figure 1 are where the actual calculation is implemented including intermediate calculation results.

Figure 1

Input parameters, methodology flow chart and corresponding worksheets
in the “Spectrum Calculator” tool



A graphical description of the functioning of the tool is summarized in the attachment below.



In the following sub-sections, a quick guide to the spectrum requirement estimation tool and its use is presented.

1) Enable macros

Macros need to be enabled in order to run the calculations. Many of the calculation algorithms are implemented with macros including for example, traffic calculation and distribution, and capacity calculation which correspond to Steps 2-5 in Figure 1.

2) Ensure that all required input parameter values are inserted into correct worksheets in the tool

The spectrum requirement estimation methodology uses a number of market/traffic and radio‑related input parameters that need specific values in the calculation. Before using the tool, all relevant input parameter values need to be inserted into the relevant worksheets of the tool. Market/Traffic related input parameters are inserted into worksheets “Market-Setting”, “RATG‑DistRatio-Input”, “SE-Input” and “SCategory-Input”. Radio-related input parameters are inserted into worksheets “Main”, “RATG1&2Def-Input”, “RATGEff-Input” and “RATG3&4 Def‑Input”.

3) Press “Run All” button in the front sheet “Main”

The tool is run by using the “Run All” button in the front sheet “Main” which conducts the following calculation steps:

– resets old values;

– reads input parameter values and calculates overall traffic demand (Steps 2-3 in Figure 1);

– distributes traffic to the different RATGs (Radio Access Technology Group) and radio environments (Step 4);

– calculates distributed traffic of RATGs 1 and 2 (Step 4);

– calculates required capacity for reservation-based and packet-based traffic for
 RATGs 1 and 2 (Step 5);

– calculates intermediate spectrum requirements (Step 6); and

– applies necessary adjustment to obtain the final spectrum requirement estimates for
IMT systems in 2020 (Steps 7-9).

4) Final results: spectrum requirements of RATG 1 and RATG 2 in 2020

After the calculations are done using the “Run All” button in the opening sheet (“Main”), the final spectrum requirements of RATG 1 and RATG 2 in 2020 are shown in the “Output” box below the calculation buttons. The final spectrum requirements are calculated in the last worksheet “Adjs&AggSpectrum” from which they are copied to the “Main” sheet.

5) Separate calculations need to be run for different settings

The calculations will need to be run separately for lower and higher user density settings. For separate calculations, the appropriate market setting parameters in the worksheet “Market-Setting” need to be changed.

# 3 Sensitivities related to the application of the methodology

The tool consists of two parts:

– a framework for the input parameters (market, service category, radio and other parameters) used in the methodology which are based on the year 2020;

– the methodology itself (the validity of which is not limited in time).

As a consequence, the tool provides an estimate of spectrum requirements for the year 2020.

It should be recognised that methodology is general in nature and that the chosen values for a number of the input parameters are interdependent. Therefore the spectrum requirements output from the tool are sensitive to the resultant changes to these parameters. It should further be noted that there are a range of other factors in relation to the methodology itself that could have an impact on spectrum requirements. The tool should be employed with this in mind.

## 3.1 Examples of input parameter sensitivities

The following input parameters to the tool are examples that have been identified as being particularly sensitive in terms of impact on the spectrum requirement calculation:

• Different values for the application data rate, population coverage percentage, area spectral efficiency, and cell area (of a given radio environment) could change the dominant radio environment and teledensity combination that gives the largest spectrum requirements and therefore change the overall spectrum requirements. It should be noted that some of these parameters are interrelated and therefore have to be carefully chosen.

• Half of the service categories are assumed to be delivered via reservation-based transmission scheme. However, some of these service categories might be delivered through packet-switched transmission scheme depending on their required QoS.

## 3.2 Sensitivities in the methodology itself

The following are examples of the sensitivities in the methodology:

• The methodology is not designed to calculate the individual spectrum requirements for specific frequency ranges, and consequently the modelled cell areas across different cell types do not vary with frequency band.

• In real deployments, cell sizes would be determined as a function of the entire area that operators are required to cover while designing to achieve efficient network topology. The methodology however does the reverse, i.e., fixed cell sizes are initially given as input parameters.

• The methodology does not consider the fine-grained local spatial and temporal distribution of traffic demand, which means it does not reflect peak traffic demand.

• The manner in which spectrum is assumed to be shared among the different cell layers would impact the estimated total spectrum requirements.

## 3.3 Other factors not considered by the methodology

Following are some other factors not considered that are nonetheless relevant and that have an impact on spectrum requirements:

* Economic factors, such as operators’ decision on RAT group choices and network deployment architecture considering their cost, are not considered in the tool nor in the methodology.

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1. The user guide also contains a section that identifies sensitivities related to the application of the methodology, which should be kept in mind when using the tool. [↑](#footnote-ref-1)