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DEVELOPMENT OF SPECTRUM REQUIREMENT FORECASTS FOR IMT-2000 AND SYSTEMS BEYOND IMT-2000 (IMT-ADVANCED)

UMTS Forum represents a significant group of spectrum users, which are directly interested in the development of public mobile networks, including UMTS/IMT-2000 and, especially, the related spectrum topics. The UMTS Forum gathers all the kinds of players involved in third generation mobile systems, including equipment manufacturers, operators, administrations, service providers and software developers.

In order to actively participate in the discussion on WRC-07 agenda item 1.4. and the related spectrum demand for IMT-Advanced, UMTS Forum ordered a study on the future spectrum requirements for IMT-Advanced from Analysys Consulting Limited. The purpose of this study is to support the spectrum discussion by providing an estimate of the possible spectrum demand using two market studies that have been contributed to the ITU-R by UMTS Forum and CEPT. The methodology in this study is different from the ITU-R methodology as our purpose is to provide complementary results to other estimates of the spectrum demand in the future.

The executive summary of the study is available on the next pages and the whole report is attached to this contribution. A block diagram illustrating the methodology used in this study is included as Annex.

Executive summary

Introduction

This report has been prepared by Analysys Consulting Ltd. (Analysys) on behalf of the UMTS Forum to develop spectrum forecasts for IMT-2000 and systems beyond IMT-2000, to support the UMTS Forum's contribution to preparations for the World Radiocommunication Conference in 2007 (WRC-07).

The European cellular market is currently implementing UMTS networks and services. Beyond this, the industry is already looking ahead towards the future (the systems beyond IMT-2000[1]). One of the key questions for cellular operators and regulators alike is what will be the spectrum requirements for these services in the future?

The future spectrum requirements are highly dependent on the future demand for cellular services and the traffic they generate. The UMTS Forum and the European Commission (EC) have commissioned studies to investigate the future demand for these services and the resulting traffic generated. These studies are the *Magic mobile future 2010-2020* and *The demand for future mobile communications markets and services in Europe (FMS)* respectively, both of which were published in April 2005.

The objective of the present study is to calculate the future demand for spectrum from IMT-2000 and systems beyond IMT-2000, up until 2020, using the traffic profiles forecast in the *Magic mobile future* and *FMS* studies mentioned above. Our methodology is based on the approach used for quantifying future spectrum demand for cellular services during Analysys's recent study for the Independent Audit of Spectrum Holdings (IASH) in the UK.[2]

Description of the traffic forecasts

The *Magic mobile future* study forecasts traffic for just one of the three scenarios developed in the study, namely "Scenario 2: Balanced, broad-based growth". Exhibit 0.1 below shows the traffic forecasts for this study.

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[1] Also known as IMT-Advanced.

[2] See www.spectrumaudit.org.uk or www.analysys.com for further details of this study.

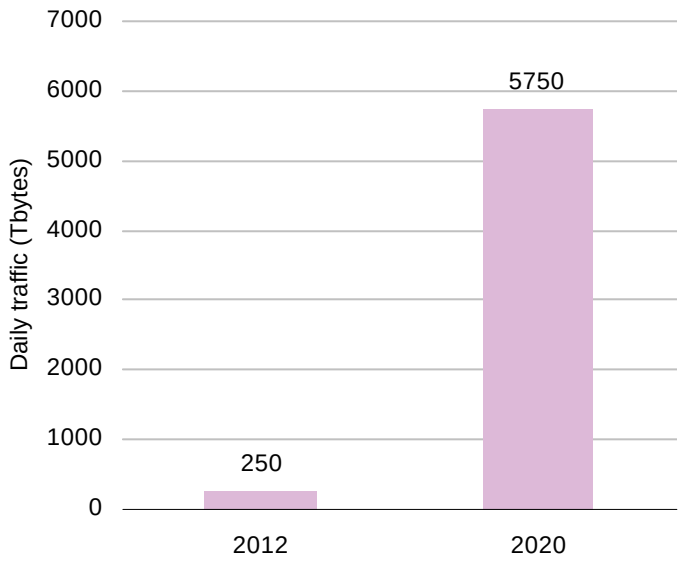


Exhibit 0.1: *Magic mobile future forecast of daily traffic for a representative European country [Source: Magic mobile future, 2005]*

The *FMS* study contains forecasts for three scenarios: "smooth development", "economic stagnation" and "constant change". The majority of the 43 respondents to the study considered the "constant change" scenario as the most plausible, which was later chosen as the basis of the market input from the European Conference of Postal and Telecommunications Administrations (CEPT) to the International Telecommunications Union (ITU-R). Exhibit 0.2 contains traffic forecasts for each of these scenarios.

	Smooth development (millions of mins of 1Mbit/s)	*Economic stagnation (millions of mins of 1Mbit/s)*	*Constant change (millions of mins of 1Mbit/s)*
2010	27 400	21 236	27 554
2015	137 141	15 210	111 426
2020	918 026	56 709	332 630

Exhibit 0.2: *FMS traffic forecasts by scenario [Source: FMS, 2005]*

Spectrum forecast methodology

In order to develop an understanding of how demand of cellular spectrum will evolve over the next 15 years, the study takes the perspective of a mobile network operator (MNO). In the event of traffic increasing on its network in the future, an MNO faces a trade-off between trying to obtain more spectrum and deploying more carriers, or deploying additional sites in order to increase capacity. We assume that if the MNO can achieve a certain threshold of cost savings through obtaining additional spectrum, then the operator will seek to obtain it. Therefore, in order to calculate the demand for spectrum, we have developed a cost model for an MNO's network to compare the differences in cost incurred when it has different quantities of spectrum available.

An overview of our modelling approach is displayed in the Annex. This methodology is based on the approach used for quantifying future spectrum demand for cellular services during Analysys's recent study for the IASH in the UK.

To model future spectrum demand, we need to make an assumption about the cost threshold at which operators would demand more spectrum – essentially, what the value of spectrum increment, e.g. 2×5MHz, will be in the future.

The report also includes an overview of the current methodology used by the ITU-R and discusses the differences between the two approaches.

Scenarios

We have used the *Magic mobile future* forecasts and the three scenarios in the *FMS* study ("constant change", "smooth development" and "economic stagnation") as our base-case scenarios. We have then run a number of scenarios, as outlined below:

- **Busy hour** – The base case for the proportion of daily traffic that falls in the busy hour is set to be 7.5%. However, we have also assessed the impact of using 10% as a high scenario.
- **Improvements in spectral efficiency** – In our base case, we have assumed that, in 2020, the improvement in spectral efficiency will be ten times that of UMTS technology today; however, we have also run low and high scenarios where this figure is five times and twenty times respectively.
- **Cost-saving threshold** – We have assumed the cost-saving threshold in our base case to be EUR7.5 million per 2×5MHz in 2005. This value was used by Analysys in its recent study for the IASH in the UK. This value was chosen to be representative for a Western-European country. However, we have also included scenarios in which this threshold is EUR3 million and EUR15 million.
- **Non-IMT-2000/systems beyond IMT-2000 traffic (*FMS* study only)** – In our base case, we have assumed that, in 2005, 50% of the traffic projected in the *FMS* study is carried over IMT-2000/systems beyond IMT-2000 networks and that this rises to 70% in 2020. This assumption was agreed in discussions with the UMTS Forum. We have also calculated spectrum demand for the case where the traffic carried over cellular networks remains at 50% until 2020.

Spectrum-requirement forecasts

Using the traffic profiles with our base-case assumptions, the total spectrum forecasts calculated, including existing spectrum used for mobile services, are given in Exhibit 0.3 below.

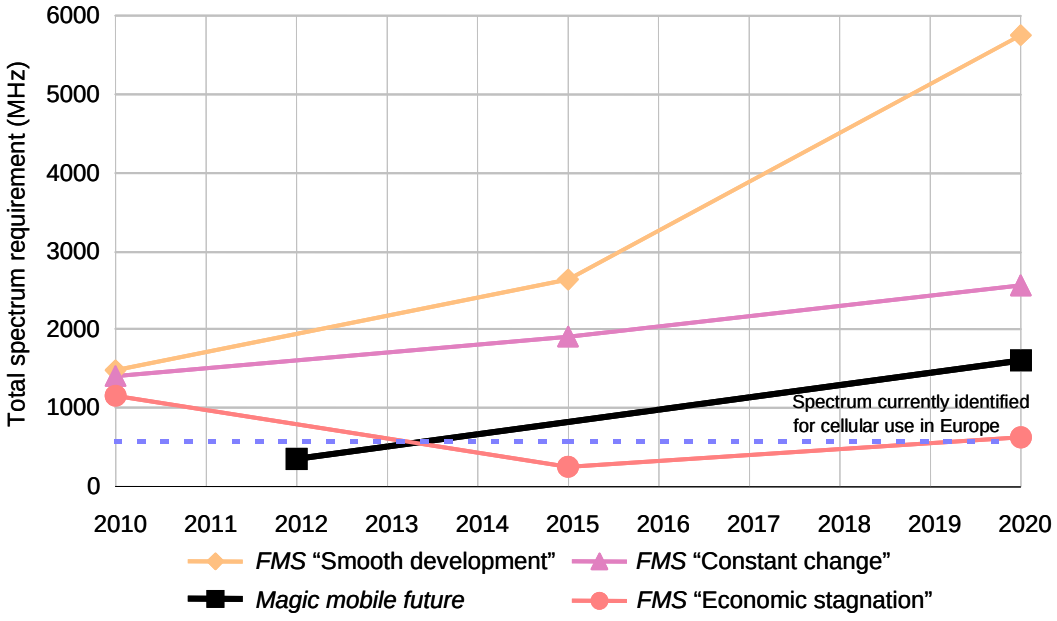


Exhibit 0.3: *Spectrum requirements calculated using the spectrum forecasts[3] in Europe [Source: Analysys, Magic mobile future, FMS, 2005]*

The *FMS* scenario for "constant change" has significantly higher spectrum demand between 2010–2020 than the *Magic mobile future* study. This is due to the fact that the *FMS* study assumes higher growth in traffic earlier than the *Magic mobile future* study. The *FMS* scenario for "constant change" yields a spectrum demand in 2020 that is 50% greater than the *Magic mobile future* forecast. Meanwhile, using the "smooth development" scenario results in a forecast requirement in 2020 that is more than three times as large as the *Magic mobile future* forecast.

In the "economic stagnation" scenario, there is a substantial reduction in spectrum between 2010 and 2015, before increasing again by 2020 to 640MHz. This is because, after some sharp increases in traffic in the years before 2010, the volume then decreases due to the onset of a period of economic decline. Note that, even though in the "economic stagnation" scenario we assume that operators continue to build out their networks and invest in more spectrally efficient technologies (e.g. systems beyond IMT-2000), this may not occur in practice, in which case the spectrum demand in this scenario will be higher.

Our scenarios have also illustrated a number of factors that may influence these spectrum requirements:

- **The busy-hour assumption –** If the busy-hour assumption is increased from 7.5% to 10%, then the spectrum requirements in 2020 rise from 1.6GHz to 1.9GHz (20%) when using the *Magic mobile future* traffic forecast, and increase from 2.6GHz to 2.9GHz (13%) when

[3] The spectrum currently identified for cellular use is 585MHz and includes the 900MHz and 1800MHz GSM bands, the 2GHz UMTS band (including the band that is currently used for DECT), and the 2.5GHz expansion band.

using the *FMS* "constant change" traffic forecast. Offering a service mix and pricing that results in a situation where the traffic is distributed as evenly as possible over the day would help to minimise the spectrum requirement.

- **Improvement in spectral efficiency –** If the assumed improvement in spectral efficiency, which is already substantial, is assumed to be even greater (e.g. doubled by 2020), then the spectrum requirements in 2020 would be reduced. Consequently, the spectrum requirements fall from 1.6GHz to 1.0GHz (40%) when using the *Magic mobile future* traffic forecast, and from 2.6GHz to 1.6GHz (38%) when using the *FMS* "constant change" traffic forecast. This underlines the requirement for the development of new, more spectrum-efficient technologies.
- **Cost-saving threshold –** If the cost-saving threshold assumption is reduced from EUR7.5 million to EUR3 million, then the spectrum demand in 2020 increases from 1.6GHz to 2.2GHz (40%) when using the *Magic mobile future* traffic forecast, and from 2.6GHz to 3.2GHz (25%) when using the *FMS* "constant change" traffic forecast. Similarly, if this assumption is increased to EUR15 million, then the spectrum demand in 2020 decreases from 1.6GHz to 1.3GHz (20%) when using the *Magic mobile future* traffic forecasts, and from 2.6GHz to 1.9GHz (25%) when using the *FMS* "constant change" traffic forecast.
- **The traffic assumptions applied to the *FMS* study traffic forecasts –** If the proportion of overall mobile traffic that is assumed to be served via IMT-2000 or systems beyond IMT-2000 remains at 50% until 2020, then the cellular spectrum requirement in 2020 decreases from 2.6GHz to 1.9GHz (25%) by 2020. If this were to occur, more spectrum would need to be allocated to other technologies (e.g. WLANs).

Conclusions

Both market studies used as inputs to these calculations predict significant growth in mobile traffic until year 2020. Our results suggest that if these traffic projections were realised, the spectrum requirements for cellular services would be much higher than the amount of spectrum currently allocated for cellular use in Europe.[4]

Using the traffic profile forecasts in the *Magic mobile future* study, we calculate that, in our base case, the total demand for cellular spectrum will be 1.6GHz by 2020.

Using the traffic forecasts from the "constant change" scenario in the *FMS* study (the scenario that was used in CEPT's contribution to the ITU-R as European Market Data), we calculate the total demand to be 2.6GHz by 2020.

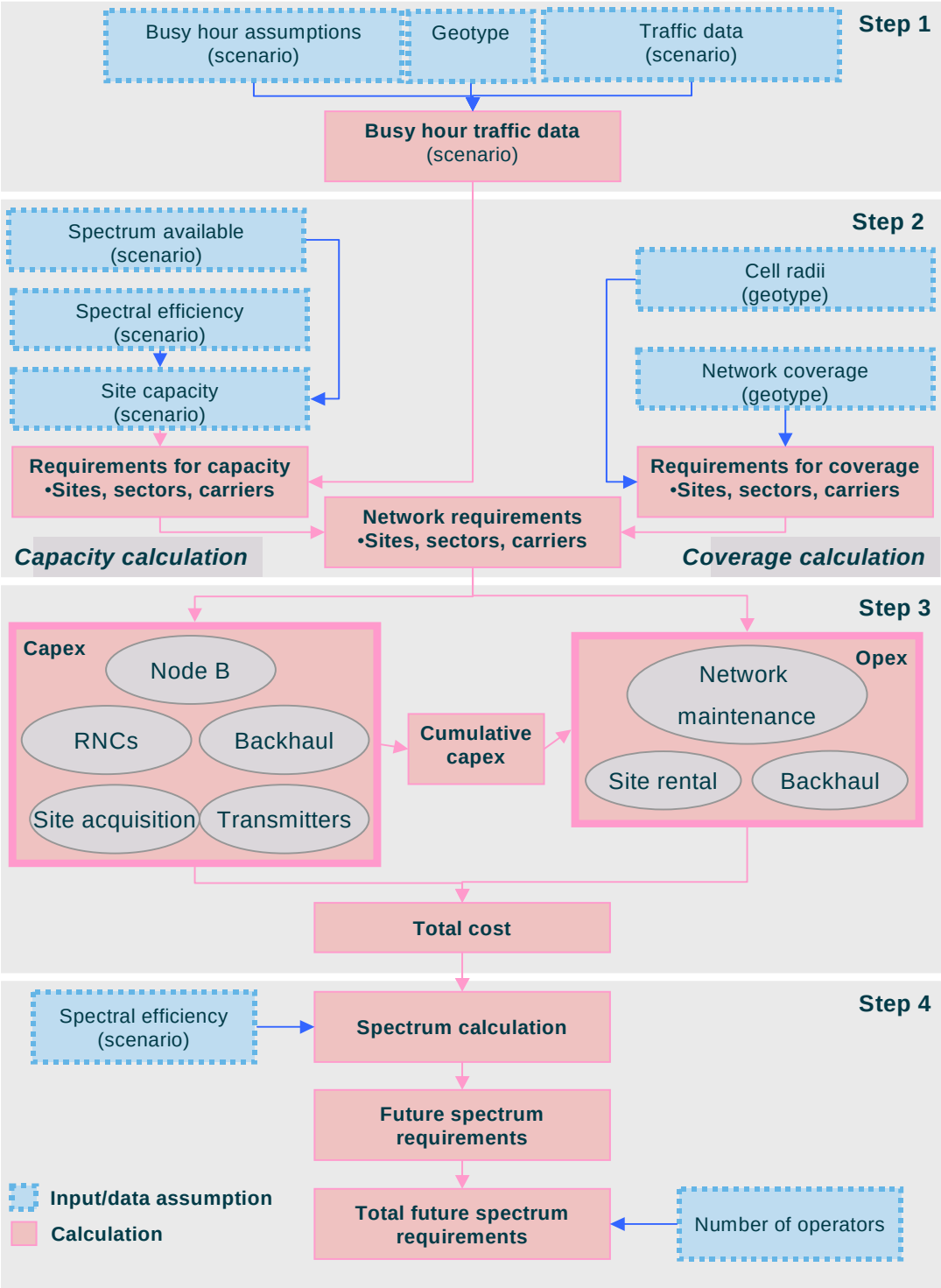
Finally, it should be noted that this study is based on the *Magic mobile future* traffic forecasts for a *representative* Western-European country and on *FMS* traffic forecasts for "EU25 plus accessions". Therefore, those Western-European countries with traffic demand and urban population density that are higher than average may require more spectrum than we have calculated in this study.

Attachment

"Final report for UMTS Forum11-01-0

[4] The spectrum currently identified for cellular use is 585MHz and includes the 900MHz and 1800MHz GSM bands, the 2GHz UMTS band (including the band that is currently used for DECT) and the 2.5GHz expansion band.

ANNEX



Calculation of an MNO's spectrum requirements [Source: Analysys, 2005