A Study from
the UMTS Forum

Thriving in harmony

Frequency harmonisation: the better choice for Europe

November 2006

UMTS Forum

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[1] Can be considered a stand-alone summary of the study.

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Abstract: This study undertaken by Booz Allen Hamilton, on behalf of the UMTS Forum, considers the impact on mobile consumers and the overall industry ecosystem of two alternative spectrum management scenarios for wide area communications. Firstly, continuation of the current harmonised approach, which is based on internationally agreed band plans using a designated group of technology standards. Secondly, the liberalised scenario, which advocates flexibility through generalised technology neutrality.

The report concludes, through qualitative and quantitative analysis, that consumers and the overall industry ecosystem are best served through continuation of the current harmonised approach. The qualitative analysis demonstrates that in a harmonised environment consumers benefit from the increased penetration of end-user services due to the speed of innovation and network effects (i.e. Metcalfe's Law); while the industry ecosystem benefits from the improved cost structure provided by the large market size, and scale effects resulting from a harmonised environment. Finally, the quantitative analysis suggests that spectrum harmonisation will benefit end-users through greater usage of end-user services, at lower ARPU, with a larger consumer surplus.

This study represents the results of the work undertaken by the original author, Booz Allen Hamilton, and has been subject to formal approval in the UMTS Forum. Thus, most manufacturers and operators within the UMTS Forum support the findings and conclusions in the report. Even though supporting spectrum harmonisation in many markets for the economies of scale it offers to the industry, Alcatel, Lucent and Nortel disagree with some of the key aspects and conclusions of this study. Furthermore, the National Administrations that are members of the UMTS Forum cannot be bound by the views, conclusions and recommendations expressed in this report. While all possible care has been taken to ensure that the information in this report is accurate, no warranty of any kind can be given with regard to this material. Neither the UMTS Forum nor Booz Allen Hamilton shall be liable for any errors contained in this report or for incidental consequential damages in connection with the use of the material.

1. Introduction

This study addresses the current debate around the most appropriate spectrum use proposition for wide area mobile communications. It considers the relative merits of the two alternative spectrum usage scenarios: continuation of the current harmonised spectrum regime, or the introduction of a more liberalised approach to spectrum management. The European market (EU-15) is used as the basis of the assessment.

Harmonisation in this study means defining technical conditions, including spectrum, band plan and technology, at a global and regional level, to ensure efficient spectrum use, seamless services over wide areas including roaming, system co-existence and global circulation of user equipments across borders. It is assumed that service flexibility can be provided through access agnostic converged core network architectures. Whereas, liberalisation refers to a spectrum use proposition of generalised technology neutrality with limited or no preconditions enabling so-called spectrum flexibility in support of new market entrants.

To date, a harmonised approach to spectrum management has been a key success factor in the development of the GSM/UMTS family within Europe and the world. In the US, the market has gradually consolidated and partially harmonised due to market forces alone, even in the context of a liberal spectrum regulation approach. Other nations such as Australia and Canada are less liberalised than the US is today and are in the process of considering the effects of change to their own spectrum regulatory schemes (e.g., in terms of interference potential for new or existing systems[2].)

While data for the United States is used in several instances to represent a liberalised spectrum management regime, it should be noted that this only serves to illustrate certain effects described in this study. We acknowledge that other factors may also have contributed to the overall market development and therefore have refrained from using such data directly in the quantitative analysis.

On behalf of the UMTS Forum, Booz Allen Hamilton has undertaken an economic analysis of the impacts of liberalisation versus harmonisation in spectrum regulation. This study contributes to the spectrum regulation debate, which has been addressed by multiple studies in recent years, is a key component of the i2010 Initiative, and was the subject of two key EC Communications over the past year[3]. The report considers how alternative spectrum use propositions, specifically, harmonised and liberalised propositions, would impact telecom consumers and the telecoms industry ecosystem over time in Europe.

A simulation model is used to determine the financial impact of the two spectrum management models, which reflects the qualitative consumer and ecosystem assessment, the balance of supply and demand as well as benchmarks to illustrate the overall financial results for a period of 15 years. The analysis is focused on wide area communications scenarios, and does not propose a one size fits all approach to spectrum management, recognising that in other contexts different conclusions could be drawn.

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2 Australian Communications Authority, *Vision 20/20: Future Scenarios for the Communications Industry – Implications for Regulation*, Final Report, April 2005 and *Spectrum Management and Telecommunications Policy, A Spectrum Policy Framework for Canada* (2002 Revised Edition)

3 EC COM(2005) 411: *A forward-looking Radio Spectrum Policy for the European Union: Second Annual Report*, June 2005 and EC COM(2006) 334: *On the Review of the EU Regulatory Framework for Electronic Communications Networks and Services*, June 2006

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II. Executive Summary and Recommendations

To summarise, the analysis demonstrates a tangible, multi-faceted upside in favour of harmonised spectrum use propositions. The review of customer benefit, industry ecosystem evolution, and resulting financial impact suggests that, in the wide area mobile communications scenarios analysed across the EU and worldwide, a harmonised spectrum use proposition provides the greatest overall benefit to consumers and also to industry.

While there are clearly many factors influencing consumer value-add and industry ecosystem, such that isolating the contribution of the spectrum regulation approach in a precise manner is challenging, Booz Allen Hamilton has applied a logical and objective approach to systematically analyse and compare the alternative spectrum use proposition scenarios.

The study qualitatively considers the impact of the alternative scenarios on consumers by assessing factors such as innovation, service continuity and penetration. The industry ecosystem is analysed by evaluating the impact of a number of key factors on the overall industry cost structure, including: industry scale, interference management, industry stability and competition.

The financial assessment is undertaken using a simulation model, which determines the overall industry financial impact by balancing the cost structure of each scenario to the market environment using an established mobile industry demand curve. The analysis considers the impact of the alternative scenarios, and associated value capture, across each of the key elements of the value chain.

Table 1: Overview of Mobile Industry Value Chain Elements Considered in the Analysis

Consumer	• Determines the overall value of the eco-system through usage, price-paid and penetration
Network Operator	• Value captured by operators to provide services to end-users, either directly, or via indirect channels (e.g. MVNOs and service providers) • Only the network environment is considered, as the focus of the study is the radio layer
Licences	• Value of spectrum captured by governments • Licences are considered to apply in both scenarios
Interconnect	• Value associated with transit of traffic and termination of traffic on non-mobile networks
Terminals	• Value of end-user terminals, captured by terminal vendors
Infrastructure	• Value of network infrastructure, captured by network infrastructure vendors
IPR	• Mechanism to recuperate R&D investments - either captured via IPR royalties or infrastructure/terminal sales for traditional manufacturers

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A. Positive Qualitative Impact of Harmonised Spectrum Use Propositions on Consumers and Industry Ecosystem

In terms of benefiting **Consumers**, a standardised radio services environment will ensure a stable usage environment whereby end-user services subscribed to are delivered in a seamless, reliable manner with minimal disruption due to interference.

At the same time harmonisation creates a scalable platform which in turn attracts innovation focus: Innovators choose to deploy their end-user services in the environment which has the greatest user penetration. Therefore, harmonisation will typically achieve greater levels of service innovation, for example, within the GSM core network domain the deployment of SMS and pre-paid services illustrate the contribution of innovators in a harmonised environment.

Clearly the introduction of a service may initially take longer, as the radio service standardisation and spectrum harmonisation process takes longer. However, the effect of a delayed launch period is compensated for by a typically faster penetration of a larger user base with a greater networking effect – harmonised spectrum use propositions create markets with earlier and more pronounced penetration tipping points.

In addition, a standardised radio services environment will ease the introduction of new end-user services on a broader, ideally global, scale, allowing users to roam and use their communications service abroad, thereby increasing utility, penetration and usage.

Most importantly, higher resulting coverage will increase the ubiquity and accessibility of end-user services providing the maximum benefits of convergence to the entire public, regardless of their level of mobility. As a result, consumers clearly benefit from harmonised spectrum use propositions.

Following this consumer impact assessment, Booz Allen Hamilton has assessed the industry ecosystem, and the impact of alternative scenarios on the industry cost structure. The implications of the industry eco-system on end-users, for each scenario, are discussed in the economic assessment.

With a harmonised approach, the **Industry Ecosystem** is driven towards higher efficiency along multiple dimensions.

Firstly, requiring the use of designated standards creates an increased certainty of approach and potential for sustained growth which drives investor confidence allowing industry to more systematically apportion R&D investment, and undertake subsequent production at lower costs.

In addition, technology markets have greater scale hence unit production costs of a harmonised scenario are lower, which is a benefit that can be passed on to providers and ultimately to consumers.

IPR policies also have an impact on unit cost; however, the analysis indicates the comparative pricing effect is largely neutral since such costs also arise in the liberalised scenario. If anything, empirical evidence suggests that, when spread across large markets relying on open standards, IPR royalties may be lower than in niche markets served by small or exclusive pools of IPR providers.

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Lower production costs do not necessarily generate lower prices. In both scenarios (liberalised and harmonised) competitive market dynamics ensure that equilibrium is achieved between supply and demand. In the harmonised case it is assumed that competitive and efficient sub-markets are created to satisfy radio service supply through a layered architecture with open and clearly defined interfaces. In such markets technology competition is strong, with a broad choice of device and service offerings across multiple platforms. Likewise, prices are consistent with market dynamics and new competitors within the harmonised environment continually challenge existing price levels through competitive activity. Accordingly, Booz Allen Hamilton believes that the current levels of competition evident within the industry eco-system support the view that a harmonised environment will continue to facilitate the development of efficient, innovative, low-cost supplier markets.

B. Overall Market Evolution Scenarios Converge – Harmonisation Exhibits Faster Penetration

Integrating the above analysis results into an overall industry **Evolution Scenario**, demonstrates that the liberalised scenario may allow radio services in the market more quickly as the time required to build to a standard or harmonise spectrum is avoided. However, once products are actually launched, harmonised radio services will allow more rapid end-user service penetration due to market scale, broad compatibility and interoperability. Therefore Booz Allen Hamilton's modeling considered a delay in innovation time as part of the sensitivity analysis.

C. Harmonised Spectrum Use Propositions Create Higher Value and are More Cost Efficient

To analyse the financial impact of applying a harmonised versus a liberalised approach to spectrum use propositions, Booz Allen Hamilton has developed the Extended Impact Simulation Model (EISM). It models the entire industry value chain, and its value creation over a 15 year period, across the major 15 West European countries (EU-15).

The study does not consider a specific industry roadmap, or make any assumptions regarding the benefits of specific technologies in either scenario, it considers each scenario to contain a portfolio of technologies.

The harmonised scenario is the base case for the analysis, which is a realistic industry scenario based on widely accepted industry figures for penetration and usage. To assess the liberalised case, each value chain segment has been subjected to a change in development in line with the above analysis. The model then calculates a new evolution of the industry eco-system year by year, balancing demand and supply using mobile industry demand curves.

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The results of the economic analysis are shown below:

Table 2: Results of Economic Scenario Modeling (Impact Compared with Harmonised Basecase)

	Consumer Indices				Industry/Consumer Ecosystem Indicators		
	Usage/ Sub[1]	ARPU[1]	Penetration[1]	Consumer Surplus[2]	Consumer Revenue[1]	Industry Usage[4]	Industry Cost[5]
Liberalised Case (Variation in absolute terms compared with Harmonised Case)	-3%	7%	-5%	-€244 bn (-5%)[3]	2%	-7%	17%
Liberalised Case (Variation in growth from 2006 compared with Harmonised Case)	-3%	10%	-37%	-€244 bn (-5%)[3]	3%	-7%	23%

(1) Note: Percentage change compared with harmonised basecase by 2021
2) Note: Consumer Surplus shows the cumulative change in consumer surplus compared with basecase over 15 years 2006-2021)
(3) Note: Consumer Surplus as percentage of scenario consumer revenue over 15 years (2006-2021)
(4) Note: !ndustry usage shows the percentage change in mobile industry traffic level, in the EU-15 by 2021, compared with the harmonised basecase
(5) Note: Industry cost shows the percentage change in mobile industry cost level, in the EU-15 by 2021, compared with the harmonised basecase

The model suggests that 15 years after deploying a liberalised spectrum use proposition the industry would see 3% less usage per subscriber, 5% less end-user service penetration with a 7% higher ARPU, and an overall loss in consumer surplus of €244 bn compared with the harmonised case. In other words, continuation of the harmonised approach within Western Europe will allow more consumers to use services more often, while paying less in total, i.e. have €244 bn more discretionary budget.

By considering the impact of liberalisation on mobile industry growth from 2006, it can be seen that the growth in end-user service penetration is 37% higher in the harmonised case.

Booz Allen Hamilton also modelled the above liberalised case with a delay applied to the introduction of new end-user services. A typical delay of 9 months was assumed, resulting in further upside in favour of harmonisation, including: 8% more usage per subscriber, and 4% higher mobile industry revenue compared with the liberalised case by 2021 within the EU-15.

All in all, the analysis indicates that more value will be realised through continuation of the harmonised spectrum policy compared with the introduction of a more liberalised approach.

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D. Recommendation: Retain Harmonised Spectrum Use Propositions

For all of the above factors Booz Allen Hamilton's study concludes that European policy makers are well advised to continue along the successful route of harmonisation that has been established under GSM. Despite the commendable efforts of reformers to argue to the contrary, ***this study indicates that the optimal method for ensuring consumer satisfaction and efficient markets has not been nor will be tied to liberalisation***. This view is based on the tangible qualitative and financial advantages for consumers and the overall industry ecosystem.

According to the results, there are many other significant factors, specifically the availability of attractive and compelling service propositions that will have far more impact on the market and benefit to consumers than a change to spectrum use proposition. Moreover these benefits could be realised within the current harmonised environment, without the notable risk of false starts within the industry.

Any new service propositions will most likely benefit from a harmonised environment where consistent access to reliably managed spectrum, through an internationally agreed band-plan, will continue to drive success in the market well beyond 2010.

In summary, regulators should turn their attention from arguing for or against harmonisation versus liberalising spectrum use propositions, and rather trigger a comprehensive debate as to how the adoption of wireless broadband services could further be stimulated as demonstrated in many Asian countries, e.g. in Korea and Japan.

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III. Background and Perspective on Current Debate

This analysis considers the development of technology over time and the long-term impact of alternative use propositions rather than an anticipated end-state, thereby recognising that the global development of information-communications is a constant, rapidly changing evolution. Clearly, this market has been in the focus of regulatory attention due to both the success of mobile communications and the high prices for 3G licenses.

Definitions

Per table 3 below, alternative spectrum use propositions have been defined to undertake the analysis.

Table 3: Overview of Alternative Spectrum Use Propositions

Harmonisation	• Pro-active regulatory approach to manage access to spectrum bands with defined requirements • Dedicated bands linked to defined radio services nationally, regionally or globally • Designated group of technology standards required for the use of a particular band globally or at least regionally
Liberalisation	• Reactive, market-driven approach to spectrum management • Spectrum is liberally licensed to users with little or no preconditions • Technology agnostic: freedom on technology within interference limits – "generalised technology neutrality" (nationally or regionally)

The harmonised approach is characterised by pro-active regulation, conforming to specified international standards (e.g. IMT-2000 at ITU-R). Whereas the liberalised scenario follows a technology agnostic approach, with spectrum licensed to operators with limited or no preconditions, other than minimal interference limits. In the US for example, multiple radio service technologies (e.g., TDMA, GSM, CDMA, W-CDMA) compete in the same spectrum band and only have to obey certain interference limitations, thus leaving it to the industry to develop reasonable co-existence rules.

Harmonisation Objectives

The five main objectives of spectrum harmonisation are:

- **Sufficient:** Licences allocate enough spectrum to a single operator to enable the deployment of high bandwidth applications
- **Contiguous:** Contiguous frequency blocks allocated to an operator to enable efficient deployment of multiple services through effective channelisation of the available spectrum
- **Homogeneous:** A frequency band only supports a group of designated technology standards
- **Ubiquitous:** Internationally agreed band plan, with the same group of designated technology standards deployed in the same frequency band across countries, regions, globally to enable roaming, global circulation of devices and interoperability
- **Efficient:** Spectrum allocation provides the maximum capacity, includes minimising guard bands and reducing the effects of harmful interference

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Regulatory Approach

Each of the two regulatory models has its unique set of guiding principles and motivations. The regulatory approach in the liberalised spectrum use proposition is based on the overarching assumption that market forces are the best means for determining the most appropriate radio service, which is typically guided by three principles:

- Reducing barriers to entry to encourage innovation
- Technology neutrality to deliver fast time-to-market for new radio services
- Asymmetric regulation to stimulate new market entrants
  (asymmetric regulation is optional, as it is not only linked to liberalisation)

Technology neutrality, i.e., the availability of spectrum to competing radio technology standards is often seen as the major differentiator.

In contrast, the harmonised regulatory approach assumes that spectrum is a scarce resource that must be proactively managed by direct regulatory oversight to ensure efficiency of use, organised market development, and benefit (or lack of harm) to consumers. Its fundamental principles are:

- Co-operation between all elements of the value chain to enhance end-user experience and maximise the mobile utility
- Technology standardisation allowing the rapid proliferation of innovation
- Harmonised Spectrum bands dedicated to specific international technology standards to facilitate global circulation of devices, interoperability and roaming

Relevance

Why is this topic relevant now? Locally, nationally and globally, new spectrum users are keen to enter the market, which regulators wish to support through increased flexibility and reduced barriers to entry (e.g. the WAPECS model[4]). It is also argued that the effects of industry convergence create a more access agnostic environment, where access technologies have a less significant role in the overall eco-system.

Furthermore, innovation is an important topic across the EU regulatory environment, motivated originally by the Lisbon agenda and now addressed through the i2010 initiative[5].

Worldwide spectrum harmonisation is still facing important challenges, (e.g., harmonising usage of IMT bands), which national governments, the EC[6], and international organisations such as the ITU and CEPT are working to resolve with consideration of how the European and global spectrum management environment should be shaped going forward to achieve maximum benefit.

The current status of the harmonisation discussion is clearly illustrated in the figure below, which shows how the 2GHz IMT-2000 band, which was identified on a global basis, is harmonised in all countries and regions except the more liberalised US market.

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4 RSPG Opinion on *Wireless Access Platforms for Electronic Communications Services (WAPECS)*, November 2005

5 EC COM(2006) 215: *i2010 – First Annual Report on the European Information Society*, May 2006

6 RSD 676/2002/EC March 2002 and Chairman's Summary Report, 16th Radio Spectrum Committee Meeting, Brussels, 5 July 2006

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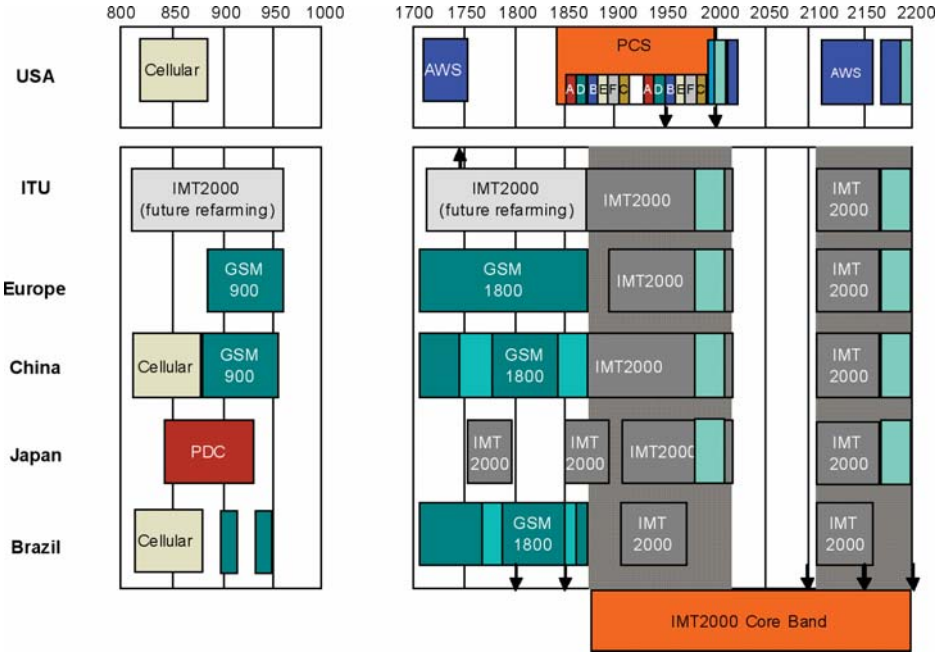
Figure 1: Spectrum use across the IMT Spectrum Bands



UMTS Forum, December 2005

Summary of Regulatory Positions

In general, worldwide regulatory trends over the past ten years have shifted from strict control (e.g., block allocation and licensing) to liberalisation activities in certain frequencies and areas (e.g., open availability of spectrum under a "commons" model or development of other flexible use scenarios such as WAPECS); based on the theory of stimulating competition and providing innovation-driven economic benefit.

At the same time, there is an emerging view that liberalisation may not be the driver for current economic benefits, nor will it realise the desired future economic benefits. Within the EU, the debate is considering the relative merits of harmonisation and whether a more liberalised approach could address some of the concerns that harmonisation creates unnecessary restriction. It is now at the point where the debate must be resolved and reflected concretely in current legislation and policy making.

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The table below summarises the main points of the spectrum strategy debate.

Table 4: Overview of arguments related to the use of Harmonised Spectrum Use Propositions

Benefits	Concerns
• Minimises harmful interference and promotes spectrum efficiency and so increases spectrum use and competition • Allows for global circulation (mobility of terminals) and roaming • Creates large equipment markets • Promotes price competition between suppliers • Ensures radio service penetration and interoperability between terminals and other networks – the "network effect" • Promotes independent competition between market players at every layer of the architecture (network, end-user services and application suppliers) • Allows more dynamic growth trajectory in the introduction of new end-user services • Focuses R&D investment due to stable environment	• Restrictions on use (or trade) of underused spectrum for alternative uses • Restrictions on the ability to re-farm spectrum • Insufficient spectrum allocated to some end-user services • Delays caused by time to agree harmonisation measures • Restrictions on the use of equipment developed elsewhere, which may be cheaper or have greater functionality • Less innovation and lock-in to a potentially inferior mandated standard • Delays in the introduction of new end-user services and equipment due to the time to agree standards and agree harmonisation measures • Less flexibility in support of spectrum access for new market entrants

Source: Indepen and Aegis study and the Booz Allen Hamilton harmonisation study

This report provides an end-to-end view on this complex debate and is aimed at assisting the regulatory process with a differing perspective to that of liberalisation as a key driver for continued European market success and prosperity.

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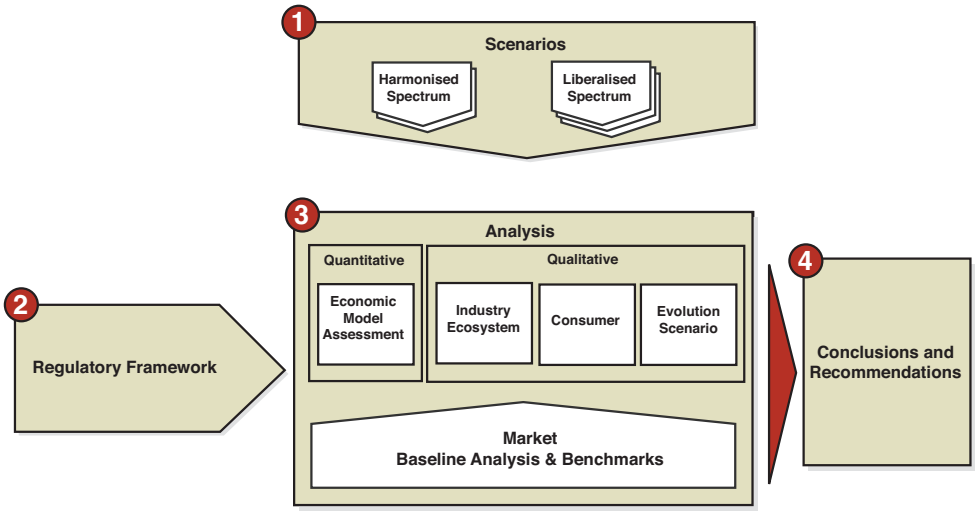
IV. Spectrum Use Proposition Analysis and Results

Supporters in favour of liberalisation argue that the costs of harmonisation outweigh its benefits. This study offers a contrary view: Harmonisation realises greater end-user benefits by maximising the impact of innovation – through the greater diffusion capabilities of standardised platforms, increased investment levels and greater end-user service penetration. Concurrently harmonisation will maintain a lower cost structure ensuring more attractive price levels and greater usage.

Overview

This study directly compares the two spectrum usage propositions and their impact on the industry eco-system, consumer and financial dimensions – the harmonised base case, and a liberalised case (which includes a sensitivity analysis on innovation delay) – to allow for direct, side-by-side comparison of these elements.

Figure 2: Analysis Framework for the Study



A. Consumer Impact

In performing the study Booz Allen Hamilton was cognisant of the fact that, from a regulatory and policy making perspective, consumers (those least able to affect the upstream components of the value chain) must always be of paramount concern. The results of the consumer analysis show three key areas of value creation.

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Table 5: Consumer Impact of Harmonisation

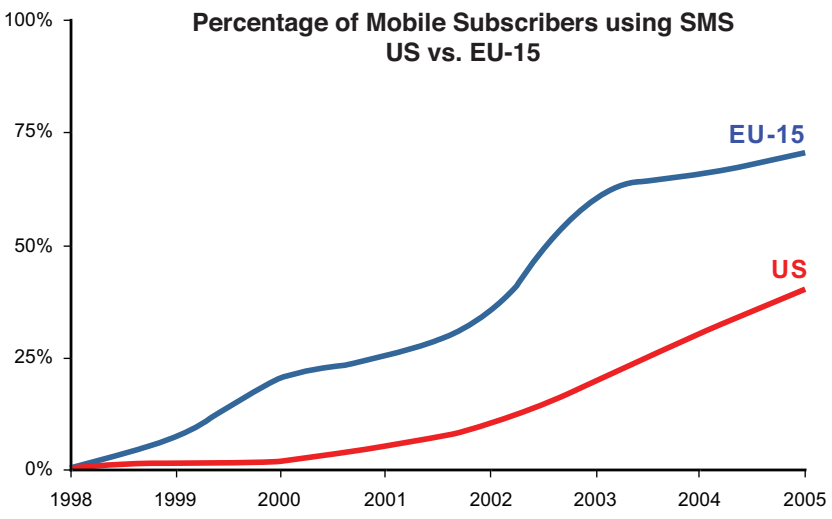
Area	Impact	Financial Model Inputs
Innovation	• Creating a larger platform for service innovation • Increasing usage attractiveness through network effect	• End-user environment modelled by applying an industry demand curve • Sensitivity analysis considering the impact of innovation delay
Radio Service Continuity and Compatibility	• Allowing a better service experience across country borders, e.g. roaming • Global circulation of handsets	
Penetration	• Accelerating penetration after the initial standardisation and launch phase	

Source: Summary of findings from consumer analysis, Booz Allen Hamilton

Innovation: Harmonisation maximises the impact of innovation in two ways:
(i) encouraging the diffusion of new end-user services across multiple markets – reducing the implementation time of new end-user services (e.g., pre-paid services)
(ii) the "network effect" (Metcalfe's Law)[7] indicates that the number of users determines the overall value of the system. A seamless radio environment with a large number of users facilitates the rapid penetration of innovative end-user services (e.g., SMS growth) and creates superior incentives for innovators to interface to harmonised radio services. This has specifically created very dynamic, innovative handset markets.

The rapid adoption of SMS in Europe compared with the US illustrates how the network effect drives use of innovative end-user services. Delays in introducing the inter-standard SMS and the lower overall penetration of mobile in the US market inhibited the growth of the SMS service.

Figure 3: Innovation Example – SMS Penetration



Source: IDC, Forrester, Booz Allen Hamilton analysis

[6] Metcalfe's Law and Legacy, first published in Forbes ASAP, September 13, 1993

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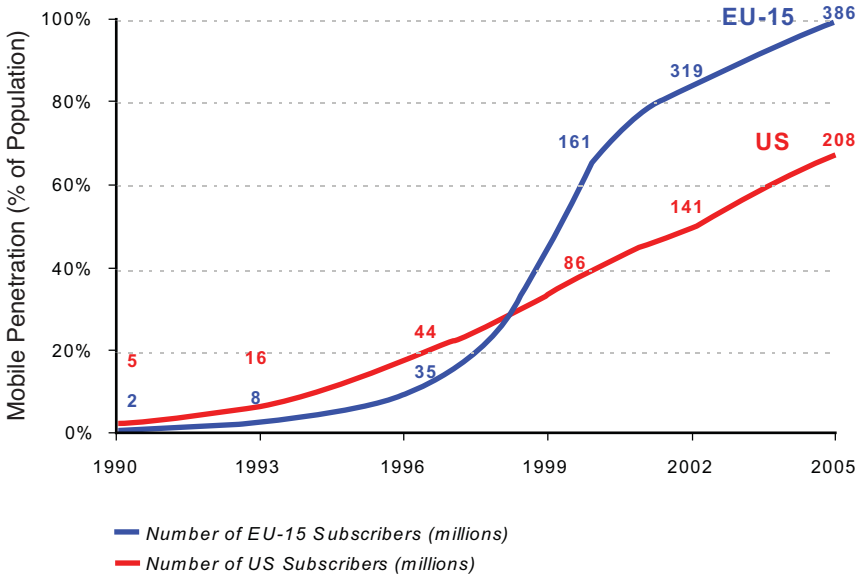
Radio Service Continuity and Compatibility: The use of internationally standardised technologies facilitates global circulation of handsets and international roaming. For example, two thirds of the world's population currently live within GSM coverage[8]. Most of the countries with GSM deployed have roaming agreements in place and allow internationally seamless use. In addition to benefiting highly-mobile customers, which is an increasing portion of the mobile subscriber base (currently 40% of subscribers in Europe roam on other operators' networks[9]), this global compatibility leverages considerable economies of scale by limiting the engineering and production costs for multiple country or region-specific terminals and equipment versus worldwide product offerings. This effect serves to drive down costs for all end users.

Penetration: The greater utility offered by innovation and service continuity clearly drives increased penetration of end-user services. The US market originated from a harmonised first generation (analogue) mobile technology environment, while in Europe many different analogue technologies were in use. However, over time the US chose a liberalised approach, while Europe developed a harmonised environment with the introduction of GSM. As a result, the benefits of innovation and industry scale soon allowed penetration levels within Europe to overtake those of the US market.

Figure 4: Mobile Subscriber Penetration Evolution



Source: Merrill Lynch, Wireless Matrix, Ofcom, CTIA

While there is a clear and comparable subscriber penetration advantage in the harmonised European market compared with the liberalised US environment, it should be acknowledged that the US market has demonstrably higher consumption per subscriber and ARPU levels than Europe. However, in our opinion these specific market indicators (consumption per subscriber and ARPU) cannot be directly compared as they are influenced by other market factors not related to spectrum policy, e.g., called-party-pays and flat-rate pricing.

8 Source: Ericsson, 2005
9 Source: Informa Telecoms & Media, 2005

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B. Industry Eco-System Impact

This section of the analysis considers the industry eco-system and its potential effects on the overall value chain. It incorporates the complete supply chain for mobile wide area network services, i.e. service operators, handset and equipment suppliers, auxiliary suppliers, license providers (the government) and IPR owners. Four main observations emerge:

Table 6: Industry Impact of Harmonisation

Area	Impact	Financial Model Inputs
Stability	• Longer-term and sustained investment levels centred in the EU economy	• Effect captured in the supplier scale effects below
Supplier Scale	• Lower cost terminals and infrastructure due to industry scale effects	• Liberalisation increases terminal costs by 25% due to reduced scale • Liberalisation increases radio infrastructure cost by 10%
Interference Management Costs	• Reduced costs in infrastructure • Reduced operator network OPEX	• Liberalisation increases the radio infrastructure cost by 20% and handset cost by 5% • Liberalisation increases the network operator cost structure by 15%
Competition	• Ensures market efficiency by encouraging independent competition between market players at every layer of the architecture	• In the liberalisation case, competition is primarily supported through competition between radio platforms

Source: Summary of findings from eco-system analysis, Booz Allen Hamilton

The study considers that standardised industry roadmaps are able to leverage the full benefits of technology evolution. Technology disruptions that occur in the broader industry eco-system should be equally accessible to the standards organisations. Evidence suggests that this occurs within international standards (e.g. GSM roadmap has adopted the W-CDMA air interface technology for UMTS). As such, no technical advantage (e.g., capacity or throughput) is foreseen through either spectrum use proposition.

Stability: A harmonised spectrum use proposition will favour a standardised technology environment, which in turn will stimulate investment, particularly in terms of R&D. In general, supply is more efficient in large and mostly unified markets to allow for volume sales and scale effects, and hence suppliers typically invest greater resource to address such markets rather than smaller niches. Likewise, large-scale markets tend to allow for size and regional diversification that also attract investment. The existence of increased investment supports

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innovation which in turn carries forward the objectives of the Lisbon agenda and the associated i2010 initiative, which are aimed at fostering growth and jobs in the information society and media industries within Europe to ensure continued European competitiveness in global technology.

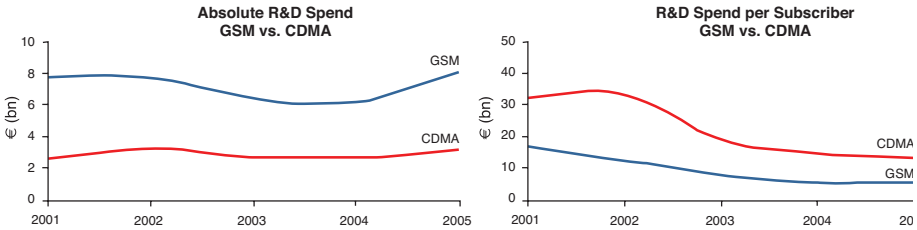
The international technology standards associated with a harmonised approach to spectrum management encourage a higher level of R&D investment due to the increased stability, predictable demand and overall industry scale. At the same time, the greater size of the market in the harmonised environment increases efficiencies as lower R&D investment is required on a per subscriber basis.

NEXTEL Case Study

The example of NEXTEL in the US, demonstrates the negative impact of improper interference management, where liberalisation allowed the deployment of incompatible radio services.

The US Federal Communications Commission (FCC) allowed Nextel to deploy a cellular-like service on the 800 MHz band interleaved with SMR bands used by surface movement radars. The high power transmissions by Nextel and other operators caused significant harmful interference for several years with commercial and government SMR users. As a result the FCC was required to order a comprehensive band restructuring. This has resulted in tremendous monetary and opportunity costs to the public, consumers and government – including the regulators themselves – to resolve. The equipment retuning and replacement cost may be up to $2bn.

Figure 5: R&D investment in GSM-/UMTS-family (GSM) compared with cdmaOne-/cdma2000-family (CDMA)



Source: IDC, GSM Association, CSFB, Booz Allen Hamilton analysis

Supplier Scale: The benefits (scale effects) of a large market will drive down handset and infrastructure costs. In terms of handsets, the average wholesale selling price is currently 25% lower for GSM than cdma2000, this difference is continuing to widen as more countries are adopting the GSM standard. The costs associated with deploying and maintaining radio systems is lower on average for GSM compared with cdma2000. In fact, both supplier scale and market predictability are reducing production costs for suppliers.

Interference Management Costs: A liberalised approach to spectrum management will increase these costs, which are incurred by network operators to purchase equipment and services to address interference but which ultimately must be passed on to consumers in the form of higher prices for the same services (i.e., no value-add for innovation, rather the cost to restore services already planned and developed). Such expenditure is necessary to reduce the effects of harmful interference of different radio systems in the same band (e.g., increased radio planning effort, increased cost of specially designed filters).

Competition: Clearly, greater supplier scale and lower market risk will only provide lower end-customer prices in case of an efficient supply market. Technology standardisation stimulates competition and encourages industry efficiency by creating a layered (horizontal) architecture based on open interfaces which allows multiple technology providers access to a common standard rather than multiple proprietary ones. The standardisation of interfaces creates a range of efficient submarkets:

- Broader supplier markets – realising additional competition based on standardised interfaces, enabling new suppliers with potentially superior technology to bring down price – e.g., GSM and W-CDMA handsets, which benefit from multiple manufacturers worldwide as opposed to iDEN handsets made by one manufacturer.

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- Transparent and synergetic Business Process Outsourcing markets allow for increased efficiency through sharing of local assets in a harmonised environment such as in Europe where there is one standard versus the US where there are three. In a standardised technology environment there is evidence of this benefit in the sharing of radio infrastructure: including sites, masts, antenna systems and even base stations.
- Standardised radio services facilitate the development of alternative market channels – standardised interfaces support a broader range of service providers and MVNOs, which face challenges in an environment where handset supply and interface points are not standardised.

US Case Study

The 1996 telecommunications act passed by the US congress was intended to facilitate competition in the US telecoms market through, for example, asymmetric regulation amongst other spectrum management policies. This achieved a temporary spike in the number of asset-based service providers owning spectrum. However, over time the number of carriers has reduced leaving four carriers as of today (Sprint/Nextel, T-Mobile, Cingular and Verizon), with three technology standards GSM, CDMA and iDEN.

C. Evolution Scenario

As a result of the above discussion, the harmonised approach initially requires more time to implement new radio services due to the time needed to standardise technologies and harmonise spectrum. However, the resulting fragmentation of radio services under multiple unco-ordinated equipment and service providers reduces end-user services take-up and penetration (as illustrated in this study). Although in such a case the innovation time can be more rapid than in the harmonised case.

In the long-run, market forces may dictate that the liberalised case also results in a consolidation of operators and standards, which is the situation that has emerged in the US. Thus while it can be argued that market dynamics mean that liberalisation and harmonisation regulatory approaches may achieve very similar end-states in terms of the overall market structure, the route of liberalisation clearly introduces additional delay and transaction costs across all elements of the value chain – including consumers – to eventually reach the same results.

The economic modeling considers the effect of innovation delay by carrying out a sensitivity analysis on the results of the liberalised case. The sensitivity analysis applies an innovation delay to the penetration rate of new end-user services.

D. Economic Benefits of a Harmonised Approach

Booz Allen Hamilton has undertaken an overall economic benefit analysis designed to directly compare the two possible spectrum management approaches. The analysis demonstrates the economic impact over time of deploying new radio services based on a harmonised approach compared with a liberalised model.

The analysis uses a detailed Economic Impact Simulation Model (EISM) mirroring the effects of the two industry spectrum use propositions on the overall cost structure. The model contains the key financial parameters for each industry value chain segment and evolves these over time, using industry benchmarks, and market data as a baseline.

The model simulates the different industry scenarios by allowing any parameter to be separately adjusted in line with the expected industry conditions. The model will, through a number of iterations, balance industry demand (consumption) with the overall cost structure. The model then provides the equilibrium value for all the key parameters for each year over the 15 year analysis period. The final parameter results are then processed to determine the consumer surplus.

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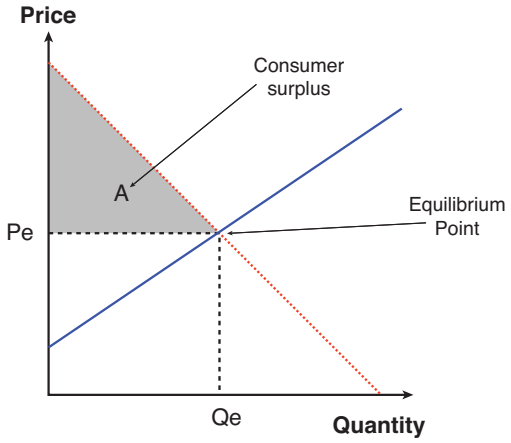
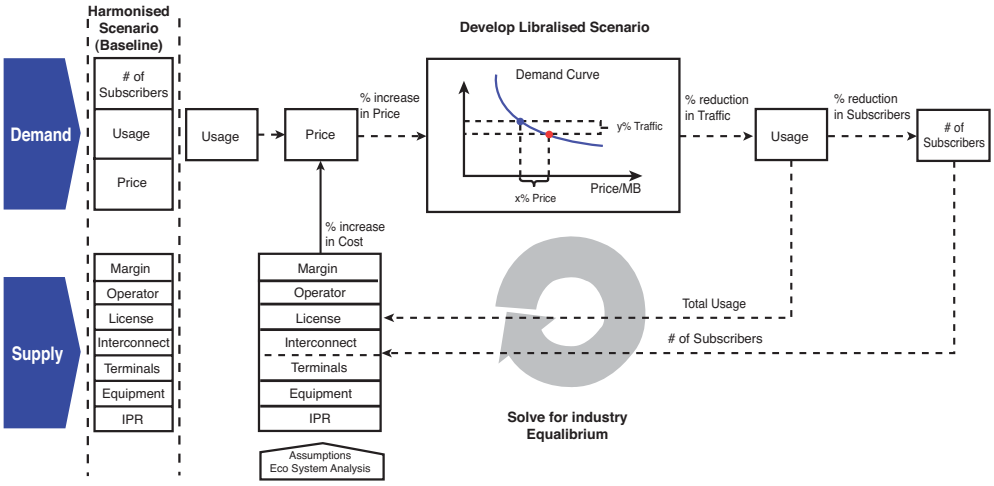
The consumer surplus is the difference between the price consumers are willing to pay (or reservation price) and the actual price paid. If a consumer is willing to pay more than the actual price, their benefit in a transaction is how much they saved. The aggregate consumers' surplus is the sum of the consumer's surplus for each individual consumer. This is represented on the supply and demand diagram (Figure 6) by area A. The model provides the change in consumer surplus as an output of the model by comparing the consumer surplus for the liberalised and harmonised cases.

Figure 6: Consumer Surplus Illustration



For the liberalised case, the model parameters are defined in line with the qualitative assessment, e.g., by introducing higher industry cost as discussed above. Clearly, changes in the supply side will also affect the demand side (consumption) as an increase in industry cost will drive up prices and hence reduce consumption. The model can predict such a change, using demand curves for the European mobile market. The model will also "feed back" changes in demand into the industry cost, e.g., lower consumption implies a reduced need for capacity upgrades. The resulting demand-supply feedback loops are closed after every year and brought to equilibrium.

Figure 7: Extended Intelligent Simulation Methodology



The model employs an elasticity curve for the Western European market (see Figure 8), to determine the impact of changing price structure on consumption and penetration levels. The revenue per minute is determined by the industry cost structure and margin of the industry scenario. The impact of the liberalised scenario is established by calculating the change in usage based on the change in price from the industry demand curve.

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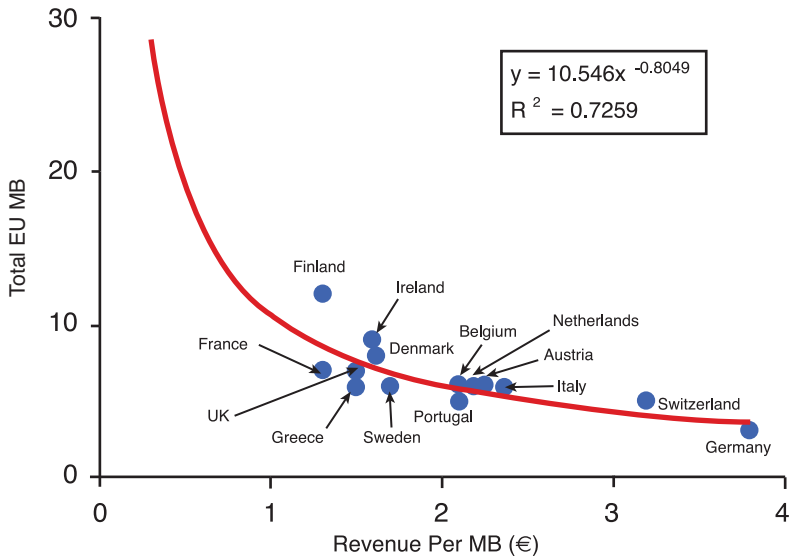
Figure 8: Normalised Demand Curve – European Markets



Note: Total EU MB – Total traffic consumption in the EU-15, including normalised voice. Revenue per MB in $/MB. Based on European Regulatory Analysis [IDC and Booz Allen Hamilton Analysis]

The resulting mobile market indicators are compared below for the two scenarios.

Table 7: Mobile Market Indicators (selected years)

	2006	2010	2014	2018	2021
Harmonised Scenario (Base Case)					
Usage/Sub (MB/Yr)	240	1,405	8,221	48,111	181,032
Subscribers (Mio)	406	423	437	452	463
ARPU (€/Yr)	273	388	515	683	844
Liberalised Scenario					
Usage/Sub (MB/Yr)	240	1,388	8,056	46,915	176,131
Subscribers (Mio)	406	414	422	433	442
ARPU (€/Yr)	273	400	540	724	900

Source: Booz Allen Hamilton analysis

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The overall summary of results is shown below.

Table 8: Results of Economic Scenario Modeling (Impact Compared with Harmonised Basecase)

	Consumer Indices				Industry/Consumer Ecosystem Indicators		
	Usage/ Sub[1]	ARPU[1]	Penetration[1]	Consumer Surplus[2]	Consumer Revenue[1]	Industry Usage[4]	Industry Cost[5]
Liberalised Case (Variation in absolute terms compared with Harmonised Case)	-3%	7%	-5%	-€244 bn (-5%)[3]	2%	-7%	17%
Liberalised Case (Variation in growth from 2006 compared with Harmonised Case)	-3%	10%	-37%	-€244 bn (-5%)[3]	3%	-7%	23%

(1) Note: Percentage change compared with harmonised basecase by 2021
2) Note: Consumer Surplus shows the cumulative change in consumer surplus compared with basecase over 15 years 2006-2021)
(3) Note: Consumer Surplus as percentage of scenario consumer revenue over 15 years (2006-2021)
(4) Note: Industry usage shows the percentage change in mobile industry traffic level, in the EU-15 by 2021, compared with the harmonised basecase
(5) Note: Industry cost shows the percentage change in mobile industry cost level, in the EU-15 by 2021, compared with the harmonised basecase

Using the parameters as summarised in table 6, the model shows that 15 years after deploying a liberalised spectrum use proposition the industry would see 3% less usage per subscriber, 5% less end-user service penetration with a 7% higher ARPU, and an overall loss in consumer surplus of €244 bn compared with the harmonised case. In other words, continuation of the harmonised approach within Western Europe will allow more consumers to use services more often, while paying less in total, i.e. have €244 bn more discretionary budget.

Booz Allen Hamilton also modelled the above liberalised case with a delay applied to the introduction of new end-user services. A delay of 9 months was assumed, resulting in further upside in favour of harmonisation, including: 8% greater usage per subscriber, and 4% higher mobile industry revenue compared with the liberalised case by 2021 within the EU-15.

By considering the impact of liberalisation on mobile industry growth from 2006, it can be seen that the growth in end-user service penetration is 37% higher in the harmonised case.

The analysis indicates that more value will be realised through continuation of the harmonised spectrum policy compared with the introduction of a more liberalised approach.

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UMTS Forum
Russell Square House
10-12 Russell Square
London
WC1B 5EE
United Kingdom

Tel +44 (0)20 7331 2020
Fax +44 (0)20 7331 2040
E-mail: info@umts-forum.org
www.umts-forum.org

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