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COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

COMMISSION IMPLEMENTING DECISION

on the harmonisation of the paired frequency bands 1920-1980 MHz and 2110-2170 MHz for terrestrial systems capable of providing electronic communication services in the Union

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1. BACKGROUND, CONTEXT AND CONSULTATION

This Staff Working Paper presents the impact assessment of the Commission's proposal on the Commission Decision on the "Harmonisation of the paired frequency bands 1920-1980 MHz and 2110-2170 MHz for terrestrial systems capable of providing electronic communication services in the European Union". The main aim of this initiative is to outline the possible introduction of EU-wide technical harmonisation conditions for a portion of the 2 GHz band allocated for terrestrial transmission, which comprises the frequency ranges 1900-1980 MHz, 2010-2025 MHz, and 2110-2170 MHz.

1.1. Background and context

Nature of radio spectrum

All wireless equipment and services must transmit and receive information via the radio spectrum. The part of spectrum which is typically covered are the electromagnetic frequencies between 9 kHz (kiloHertz) and 3000 GHz (gigaHertz) corresponding to radio wavelengths from thousands of kilometres to under one millimetre.

Radio spectrum is therefore an essential resource for many commercial services: mobile, satellite and fixed wireless communications, TV and radio broadcasting, transport, navigation systems (GPS/Galileo), and many other applications (medical equipment, alarms, remote controls, hearing aids, microphones, etc.). Radio technology supports public services such as defence, security/safety and scientific activities (e.g. meteorology, Earth observation and monitoring, radio astronomy and space research).

As a measure of the importance of these wireless applications and services to society and the economy, access to radio spectrum has become an essential enabler for economic recovery and growth, to ensure high-quality jobs and long term EU competitiveness, and to bridge the digital divide. Given that radio spectrum is scarce in the sense that there is a fixed amount that can be used, the manner in which it is allocated and then authorised for use in the Member States is therefore an issue of crucial economic and social importance, with a direct impact on the development of the internal market.

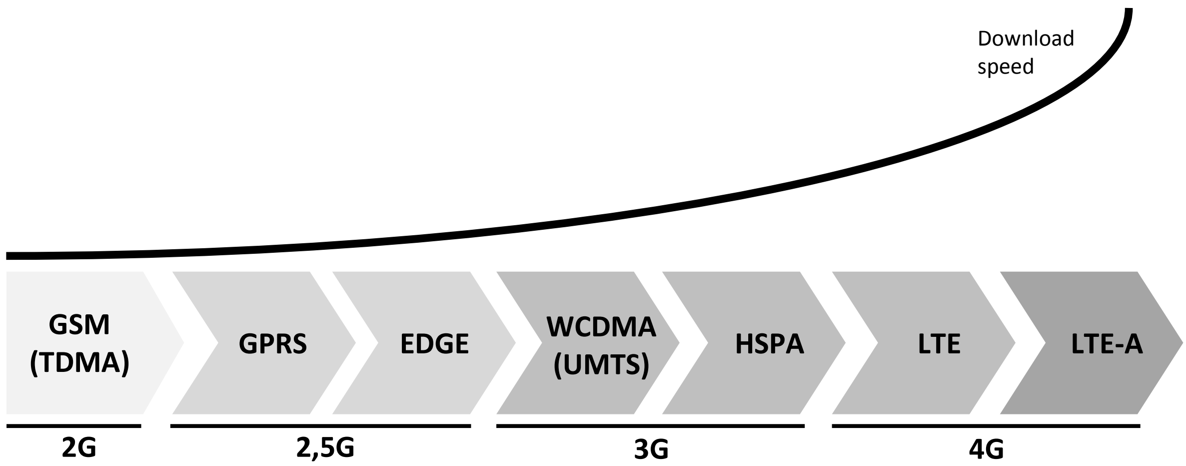
The physical characteristics of spectrum changes over the frequency bands and certain parts of the spectrum are less suited for some applications or users due to those differing characteristics. Typically, the higher the frequency band the more difficult it is for signals to travel over distance or penetrate into buildings. It has to be recognised that the frequency band that is allocated has a large impact on the costs associated with an application or service, especially in the case of mass market services where coverage, network capacity as well as operational costs are important. The bands between 300 MHz and 3 GHz are considered to be the most valuable part of spectrum in terms of combining good propagation characteristics with sufficient transmission capacity. Therefore these bands are subject to a higher demand inducing scarcity of radio resources.

Radio spectrum is a medium shared by multiple users, who may affect each other's operations. This is called interference and results in a limitation of available spectrum resources at a given moment and location. Interference between different signals on the same or adjoining frequencies is particularly critical when spectrum bands are crowded due to high demand. The nature and extent of such interference change according to the frequency band and the power level at which signals are transmitted. Interference can degrade or completely block radio signals, in which case it becomes harmful interference. The presence of harmful interference reduces or nullifies the efficient use of spectrum. However, in a number of cases an application can to a certain extent tolerate interference without significantly degrading the underlying service quality. Hence, the impact of interference on a service needs to be considered on a case by case basis. Interference is a key parameter for users of spectrum, as it determines the viability of a wireless application (with respect to quality of service). Since interference can be mitigated in many cases by technical means, in these cases interference translates into costs.

Another characteristic of radio spectrum is that radio emissions do not stop at borders. As a consequence interference is an important issue not just within a Member State but also between Member States as well as with third countries, which necessitate bilateral and/or EU level negotiations with third countries depending on the circumstances.

The use of successive mobile standards in Europe

In order to develop the internal market in networks and services, but also to overcome the risk of interference between different systems referred to above, the EU has relied on a series of mobile standards. The breakthrough came with the Global System for Mobile Communications – Groupe Special Mobile (GSM) – which was developed by the European Telecommunications Standards Institute (ETSI) as a replacement of the first generation analogue cellular networks. The GSM standard evolved into GPRS and further EDGE that allowed for packet radio internet access, where the user was typically charged based on volume of data consumed, in contrast to circuit switch data, which is typically billed per minute of connection time. The further evolution of the GSM standard to a third generation of mobile systems (UMTS, HSPA) allowed for greater speeds, lower latency and better quality connections. This, as well as the widespread availability and affordability of smartphones drove a major expansion in application, content and services, fuelling the demand for additional spectrum. This is developing further with the arrival of the fourthe generation (4G) of mobile standards, most notable the "Long Term Evolution" or LTE family of standards.



Spectrum 'crunch' for wireless broadband

The world-wide explosion of wireless data traffic with the progress in deployment of broadband technologies, the penetration of smart phones and the development of over-the-top applications (video, social networks, etc.) as well as the growing fixed-mobile convergence impose on regulators the urgent need for action to assess spectrum availability and use and identify new bands for wireless broadband. In 2011, 488 million smart phones (including laptops and tablets) were sold, which exceeds the number of Personal Computers' purchased in the same period (415 million).[1] The highest growth rate in the EU broadband market is in mobile broadband where take-up increased by 115% in the last year.[2] Such a strong increase if not accompanied by the availability of sufficient spectrum resources, risks limiting the ability of wireless operators to satisfy the traffic demand.

Back in 2006, the ITU estimated the future spectrum bandwidth requirements for third generation (3G) and fourth generation (4G) mobile communications (to which, respectively, UMTS and LTE belong, amongst others) as amounting to between 1280 and 1720 MHz in 2020 for the commercial mobile industry (including spectrum already in use, or planned to be used at that time for such systems), inter alia also for region 1 including Europe[3].

The multiannual Radio Spectrum Policy Programme (RSPP)[4] which was adopted on 14 March 2012 obliges EU Member States and the Commission to identify at least 1200 MHz of suitable spectrum for wireless broadband relying on the EU-level inventory process to match spectrum demand and supply in the range 400 MHz-6 GHz.. One possible tool to meet this objective is to introduce flexibility in existing spectrum bands so that they can be re-farmed for advanced wireless broadband technologies. In the USA also, following the adoption of a National Broadband plan of 2010, efforts are ongoing on the release or repurposing of several hundreds of MHz of spectrum for wireless broadband.

Flexibility of spectrum use – liberalisation and harmonisation

Since the expiry of the UMTS Decision, the terrestrial 2 GHz band has been identified as one of the bands where the Commission, in close cooperation with Member States, should apply technology neutrality[5] and service neutrality[6] as laid down in the Wireless Access Policy for Electronic Communications Services (WAPECS) concept [7] [8] in order to ensure *flexibility of spectrum use*. Flexibility of spectrum use in certain frequency bands can be mandated at EU level and then implemented at national level by technology and service-neutral allocations in the national frequency plans, which result in spectrum authorisations that allow spectrum users to avail themselves of a wider choice of technologies in order to deploy better and more innovative services and match market demand.

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1 Focus Magazine (7/2012), http://www.focus.de/digital/internet/netzoekonomie-blog/smartphones-nokia-und-microsoft-fallen-gegen-apple-und-google-weiter-zurueck_aid_713839.html

2 Jan 2009 to Jan 2010, See *Europe's Digital Competitiveness Report*, 2010. Mobile data volumes have corresponding large increases with, for example, OFCOM estimating a UK volume growth of 2300% in the past 2 years.

3 see ITU Report ITU-R M.2078

4 Decision 243/2012/EU of the European Parliament and the Council.

5 **Technology Neutrality:** As part of the flexibility principle, technology neutrality allows the deployment of any technology in a specific frequency band that has been identified for such use. However, there can be restrictions that need to be justified by the need to avoid harmful interference (for example by imposing emission masks and power levels), to ensure the protection of public health by limiting public exposure to electromagnetic fields, to ensure the proper functioning of services through an adequate level of technical quality of service, to ensure proper sharing of spectrum, to safeguard efficient use of spectrum, or to fulfil a general interest objective in conformity with Community law.

6 **Service Neutrality**: As part of the flexibility principle, service neutrality allows the provision of any service in a specific frequency band that has been identified for such use. However, for safety of life reasons a frequency band may be allocated exclusively for one particular service. Furthermore, a specific service may be made obligatory (without excluding other services) in justified cases, such as the promotion of social, regional or territorial cohesion, the avoidance of inefficient use of radio frequencies or the promotion of cultural and linguistic diversity and media pluralism.

7 RSPG Opinion of 23 November 2005 on Wireless Access Policy for Electronic Communications Services (WAPECS)

8 Commission Communication COM(2007)50 of 8 February 2007 on "Rapid access to spectrum for wireless electronic communications services through more flexibility"

The introduction of flexibility of use in a given frequency band is often referred to as the *'liberalisation'* of this band, which is somewhat different from the original liberalisation of telecommunications in the 1990s. The imposition of specific standards, such a those explained above, was essential at an earlier stage in the development of the internal market for mobile services, but the economic and regulatory context in the EU has changed significantly over the last ten years. For example the 900 MHz band, which had been used exclusively for GSM for many years, was liberalised in 2009 by virtue of a Commission Decision[9] to allow use of a family of mobile standards compatible with GSM (such as UMTS or LTE). However, opening a frequency band for further technologies and innovative services necessitates the imposition of common technical conditions on spectrum users at EU level in order to avoid harmful interference between different users within the band or in adjacent bands and to develop the internal market. The application of such a set of technical conditions is referred to as the *'harmonised use'* (or *'harmonisation'*) of the band. Therefore, introducing flexibility goes hand in hand with adopting common least restrictive technical harmonisation measures leading to the *"harmonised liberalisation"* of a frequency band. This initiative aims at the harmonised liberalisation of the terrestrial 2 GHz band.

<u>Legal context</u>

The Radio Spectrum Decision (676/2002/EC) adopted in 2002 provides the legal basis to harmonise at European level the use of certain frequency bands for a specific application – such as electronic communications services – thus creating common usage in the EU based on common technical requirements, and fostering the internal market. The Radio Spectrum Decision gives powers to the Commission to adopt technical harmonisation measures for a frequency band in the form of Commission Implementing Decisions subject to the comitology procedure and on the basis of a prior mandate to CEPT to develop the underlying technical conditions in the form of a CEPT report to the Commission. Commission Implementing Decisions apply directly to all Member States and address spectrum designation and availability but not the spectrum assignment or licensing procedures which remain in the competence of Member States.

Radio spectrum policy and management, as they apply to electronic communications, are dealt with by the Framework Directive 2002/21/EC and the Authorisation Directive 2002/20/EC, amended by Directive 2009/140/EC. The revised regulatory framework for electronic communications of 2009 introduced regulatory amendments to ensure flexible and efficient use of spectrum, reduce rigidity in spectrum management and put in place measures to facilitate access to spectrum. Flexible use of spectrum and limited harmonisation of authorisations have been strengthened through the enhancement of the principles of technology neutrality and service neutrality.

In particular, Article 9a of the Framework Directive allows licences holders to request an adaptation of their existing rights to benefit from technology and service neutrality until 24 May 2016 – the date after which the technology and service neutrality principles automatically apply to all existing rights in the domain of electronic communications services. This date implies a non-coordinated transition to generic technology and service neutrality which may fall short of technical harmonisation so that new services and the new technologies they operate on can benefit from the internal market economies of scale. Therefore, the harmonised use of liberalised bands also after 2016 remains crucial. Regarding this political initiative, the need for a harmonised liberalisation of the terrestrial 2 GHz band was already identified in the WAPECS approach in 2007, and its envisaged implementation at

[9] Commission Decision 2009/766/EC, amended by Commission Decision 2011/251/EU.

an earlier deadline (around 2013) is justified by solid socio-economic analysis, evidence of spectrum (non-)use and broad stakeholder support.

Furthermore, Directive 2002/77/EC (the "Competition" Directive) also aims at eliminating special and exclusive rights in the use of frequencies and requires that assignment of spectrum be based on objective, transparent, non-discriminatory and proportional criteria. (The latter criteria are also stipulated in the Framework and Authorisation Directive.) The R&TTE Directive 1999/5/EC governs the introduction, free movement and deployment of radio equipment and telecommunications terminal equipment within the internal market, and the fulfilment of essential requirements, such as the avoidance of harmful interference.

Finally, the RSPP reinforces the policy principles of technology and service neutrality in licences, the harmonised use of radio frequencies as well as the promotion of wireless broadband by fostering flexible and innovative spectrum use.

The specific situation of the terrestrial 2 GHz band

In 1998 the European Parliament and the Council adopted the UMTS Decision[10,] which stipulated that Member States should take all actions necessary in order to allow the coordinated and progressive introduction of the UMTS[11] services on their territory by 1 January 2002 at the latest and, in particular, to establish an authorisation system for UMTS no later than 1 January 2000. The Decision applied to the bands 1900-1980 MHz, 2010-2025 MHz, 2110-2170 MHz (hereinafter: the "terrestrial 2 GHz band").

The UMTS Decision did not include any technical harmonisation parameters and the guiding technical conditions were set through a mandate to the European Conference of Postal and Telecommunications Administrations (CEPT) – an international organisation where policy makers and regulators from 48 countries across Europe collaborate to coordinate telecommunication, radio spectrum and postal regulations. Following this mandate a decision by CEPT was developed specifying technical requirements to follow in these bands. Such decisions are not legally binding, but rely on a voluntary implementation by CEPT members.

The UMTS Decision expired in 2003, by which time Member States had fulfilled their obligations as regards the roll-out of UMTS. As a result this band was de facto harmonised by licences that last 15-20 years and prescribe a specific technology – UMTS. Therefore, the terrestrial 2 GHz band is still assigned and used in Europe today to deploy UMTS networks.

The terrestrial 2 GHz band is currently divided into paired spectrum, also called Frequency Division Duplex (FDD) bands, and unpaired spectrum, also called Time Division Duplex (TDD) bands. More concretely, the 1920-1980 MHz band is paired with the 2110-2170 MHz band ("2 GHz paired bands") for the provision of FDD UMTS services and the 1900-1920 MHz and 2010-2025 MHz unpaired bands ("2 GHz unpaired bands") are used for the provision of TDD UMTS services.

Any mobile cellular system ensures communication in both directions simultaneously e.g. with either end being able to talk and listen as required. The different directions of transmissions are defined as follows:

- (1) Uplink – the transmission from the user equipment to the base station
- (2) Downlink – the transmission from the base station to the user equipment

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10 Decision No 99/128/EC of the European Parliament and of the Council on the coordinated introduction of a third-generation mobile and wireless communications system (UMTS) in the Community

11 Universal Mobile Telecommunications System (UMTS) is a third generation mobile cellular technology for networks based on the GSM standard.

- These links might carry different amounts of data. With FDD two different frequency channels are used for transmission and for reception, while with TDD the same frequency channel is used, with different time slots allotted for transmission and reception.

At the international level the terrestrial 2 GHz band had been identified as an IMT[12] band in the Radio Regulations[13] developed by the International Telecommunications Union, a UN body. Therefore, this band is being used for IMT services worldwide with FDD being the prevailing mode of operation.

In light of this situation, therefore, and pursuant to the Radio Spectrum Decision, in June 2009, the Commission issued a mandate to CEPT to conduct technical studies concerning the terrestrial 2 GHz band. The purpose of these studies was to contribute to the practical implementation of the WAPECS concept for the terrestrial 2 GHz band, by developing the least restrictive technical conditions necessary. In response to the mandate, CEPT developed its Report 39[14] containing least restrictive conditions for the use of the terrestrial 2 GHz band.

1.2. Consultation and expertise

1.2.1. Overview of main consultations of external stakeholders

The Commission launched a call to stakeholders for their views on the options for the possible introduction of harmonised technical conditions for the terrestrial 2 GHz band[15]. The closing date for comments was 27 January 2012. In total **26 contributions** were received to the public consultation. 5 national administrations representing Member States have responded. 15 companies and 2 industrial associations, most of them stakeholders from the mobile industry, have provided their views. In addition, 3 organisations affected by spectrum use in this band have given their input as well as one technical standardisation group.

The main contributors were current license holders i.e. mobile operators and they are the key stakeholders as their buy in is needed to implement options 2 and 3 (for the FDD bands) discussed later on. The responses received by this industry branch might be regarded as representative, since the association GSMA representing the mobile industry, together with a high number of individual contributions from mobile operators had been received. Another key stakeholder group consists of the equipment manufacturers, who had been surveyed in the context of the study by Helios in addition to the public consultation.

In parallel to the development of this staff working paper, discussions have been launched with Member States in the remit of the Radio Spectrum Committee on the CEPT report 39 and the content of potential technical harmonisation decision.

In addition to the public consultation organised specifically on the terrestrial 2 GHz band as described above, in the past several public consultations had been organised which are relevant in this context. To be highlighted are the public workshop[16] and public consultation[17]

12

13 See Radio Regulations 5.388A and B

14 Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for 2 GHz band, 25 June 2010

15 http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/activities/index_en.htm#2ghz_consultation

16 http://ec.europa.eu/information_society/policy/ecomm/doc/library/public_consult/review/601_08_workshop_agenda_24jan.pdf

17 http://ec.europa.eu/information_society/policy/ecomm/library/public_consult/review/index_en.htm

foregoing the review of Framework Directive[18]. These public consultations covered the aspects of technology and service neutrality. Also preceding this review, the Commission had drafted a Communication on the WAPECS concept, which took utmost account of the RSPG Opinion[19] on this subject. The RSPG Opinion was put to public consultation before its finalisation.[20] Moreover the CEPT report 39 setting out technical conditions was also subject to a public consultation organised by the CEPT[21] to which inter alia 19 Member States had replied.

1.2.2. Internal consultations

Regarding internal consultations, other services of the Commission with a policy interest in the subjects involved have been associated in the development of this analysis. An Impact Assessment Steering Group including all relevant services was established, and met on 17 February 2012 to discuss a draft version of the impact assessment. After this meeting, further remarks had been received, which were incorporated into this draft staff working paper. The updated version had been circulated then for further comments. A second IASG was held on 28 March, where final comments from other services of the Commission. Together with other units in DG INFSO, DG ENTR, DG COMP, the Legal Service and the Secretariat General were represented at the meetings or have contributed with comments to the development of this impact assessment.

1.2.3. Main conclusions from the consultative process

It can be concluded that while harmonised liberalisation of the paired spectrum, in particular for technologies of the IMT[22] family (such as LTE[23]), has received strong support, the options for the unpaired sub-bands highlighted by the Commission in its call for public consultation have not found broad support. A number of stakeholders raised alternative options for the unpaired sub-bands in addition to the options above. The views of the stakeholders with respect to the specific Commission's proposal in the questionnaire, together with alternative uses proposed, are summarized in the tables under Annex 1.

The overwhelming majority of respondents to the public consultation supported the harmonised liberalisation of the 2 GHz paired bands while protecting existing investments and operations. In this regard, the main aim seems to be the introduction of LTE in the paired spectrum in the short and mid term. Several stakeholders took the view that a harmonisation decision on the 2 GHz unpaired bands should be preceded by more extensive analysis of different alternative options – also in the outcome of the work of CEPT – and rely on broad consensus by stakeholders.

The most widely debated points related to the scenarios for the unpaired sub-bands highlighted by the Commission in its call for public consultation (these are discussed later on under option 2). The majority of stakeholders argued that neither these scenarios nor the additional (shared) introduction of machine-to-machine (M2M) communications under the low-power scenario in these sub-bands would stimulate market demand and create an

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18 Directive 2009/140/EC of the European Parliament and of the Council of 25 November 2009 http://ec.europa.eu/information_society/policy/ecomm/eu-rules/index_en.htm

19 http://rspg.groups.eu.int/_documents/documents/opinions/rspg05_102_op_wapecs.pdf

20 http://rspg.groups.eu.int/consultations/responses_wapecs/index_en.htm

21 www.CEPT.org, working group PT1

22 International Mobile Telecommunications

23 Long term Evolution (LTE) is a standard for wireless data communications technology and an evolution of the GSM/UMTS standards. The goal of LTE is to increase the capacity and speed of wireless data networks using new Digital Signal Processing techniques and modulations that were developed around the turn of the millennium. Its wireless interface is incompatible with 2G and 3G networks, so that it must be operated on a separate wireless spectrum.

ecosystem and economies of scale. Furthermore, several respondents considered some possibilities to provide electronic communication services (ECS) in the unpaired bands already possible also under the current regulatory framework – so no regulatory intervention is needed.

A number of respondents have proposed alternatives for use of the unpaired spectrum. These include pairing the unpaired sub-bands mutually or with other portions of spectrum (below 3 GHz), uplink-only use, use for broadband public protection and disaster relief (PPDR)[24], use for DECT[25] systems, use for Direct-Air-to-Ground-Communications (DA2GC)[26], use for equipment for programme making and special events (such as wireless cameras)[27], use for short-range devices, use for backhaul relay[28] links of mobile networks, or use for equipment complying with the IEEE 802.20 mobile internet standard.

Several respondents supported spectrum sharing and/or spectrum trading[29], mainly on a commercial basis, as means to facilitate the aggregation of bandwidth available to operators thus overcoming issues related to the fragmentation of spectrum holdings in each unpaired sub-band.

It has also been suggested that both unpaired sub-bands be treated differently upon harmonisation since they have different technical constraints and bandwidth.

Some respondents have raised concerns regarding interference to services in adjacent bands, notably DECT below 1900 MHz and mobile satellite systems (MSS) below 2010 MHz or to satellite-based earth exploration and other services which are adjacent or partly co-allocated in some sub-bands of the terrestrial 2 GHz band.

The clear lack of consensus around any option for using the unpaired spectrum across different stakeholder domains appears to necessitate further studies for these sub-bands. While license holders from the mobile industry claim more spectrum to ensure pairing the current TDD sub-bands and make them usable without technical constraints for any type of cellular networks, also other alternative options may be viable, including mutual pairing of the unpaired sub-bands while leaving a guard band to adjacent DECT systems below 1900 MHz. Further options for the unpaired spectrum deserving scrutiny are PPDR, DECT and DA2GC. It can be also stressed that the work done in CEPT has received a lot of attention regarding the search of possible options for the unpaired spectrum.

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[24] Public protection (PP) radiocommunications: Radiocommunications used by responsible agencies and organizations dealing with maintenance of law and order, protection of life and property, and emergency situations. Disaster relief (DR) radiocommunications: Radiocommunications used by agencies and organizations dealing with a serious disruption of the functioning of society, posing a significant, widespread threat to human life, health, property or the environment, whether caused by accident, nature or human activity, and whether developing suddenly or as a result of complex, long-term processes.

[25] DECT (Digital Enhanced Cordless Telecommunications) technology is widely used for residential and business cordless phone communications. Designed for short-range use as an access mechanism to the main networks, DECT technology offers cordless voice, fax, data and multimedia communications, wireless local area networks. This is the major technology used for cordless phones.

[26] communication between aircrafts and ground stations for offering mobile broadband access in planes

[27] Programme Making: radio applications used in the making of a programme for broadcast, the making of a film, presentation, advertisement or audio or video recordings, and the staging or performance of an entertainment, sporting or other public event. Special Events**:** radio applications used for an occurrence of limited duration, typically between one day and a few weeks, which take place in specifically defined locations. Examples include large cultural, sport events (football matches, Tour de France etc.), entertainment, religious and other festivals, conferences and trade fairs. In the entertainment industry, theatrical productions may run for considerably longer.

[28] These are wireless connections between base stations within the mobile infrastructure networks

[29] Spectrum trading permits license holders to buy, sell and lease their spectrum to other users.

On the other hand, a broad consensus exists around the harmonised liberalisation of the paired spectrum in order to enable technology and service neutrality in these sub-bands and establish legal certainty in their future use.

2. PROBLEM DEFINITION

2.1. General problems identified in the IA on the RSPP applicable to the terrestrial 2 GHz band

Spectrum for wireless broadband is becoming scarce as demand for wireless data traffic increases tremendously. Scarcity can also be induced or amplified by inefficient management of spectrum (a regulatory issue), particularly when management models have been developed in a time of less demand and less scarcity, or by inefficient technical usage of spectrum (a technical issue).

In the Impact Assessment[30] of the Radio Spectrum Policy Programme[31], which outlines EU spectrum policy objectives for the next years, 2 general problems have been identified which also apply to this initiative:

- Suboptimal use of spectrum with regard to the potential economic, social and environmental benefits – in this regard, in particular the non-use of the 2 GHz unpaired spectrums hampers the materialisation of additional socio-economic benefits
- A mismatch between the growing demand for new wireless services and available spectrum resources – in this regard, the harmonised liberalisation of the terrestrial 2 GHz band spectrum would enhance its efficient use by allowing more efficient innovative technologies, which also facilitate the provision of broadband services

2.2. Specific problems in the use of the terrestrial 2 GHz band

Technology-centric authorisation

Based on information provided by Member States within the Radio Spectrum Committee or contained in the ECO Report[32] on the licensing of 'Mobile bands' in CEPT countries it can be concluded that in most EU Member States the licenses granted for the terrestrial 2 GHz band are currently limited to UMTS/IMT-2000 technology. Deployment of innovative wireless services and technologies is hampered by the reservation of this band for a narrow set of services. Such a restriction prevents the spectrum user (network operator) from making timely decisions on how to use available spectrum, in direct response to market demand and new technology opportunities. Both the study by Helios and stakeholder feedback assert the interest in liberalising the terrestrial 2 GHz band for the deployment of more advanced mobile technologies such as LTE.

Risk of uncoordinated liberalisation

The Framework Directive requires the application of the principles of service and technology neutrality for EU harmonised bands as of 25 May 2016 at the latest. In the lack of any EU-level action, this would introduce flexibility of use, including in the terrestrial 2 GHz band, however, the coordinated implementation of technology and service neutrality is not guaranteed as technical conditions remain undefined (in regulatory context) across the EU.

30 SEC(2010)1034 http://ec.europa.eu/governance/impact/ia_carried_out/docs/ia_2010/sec_2010_1034_en.pdf

31 COM (2010)0471 http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/documents/legislation/index_en.htm#rspp_proposal

32 ECO report 03 on the licensing of "mobile bands" in CEPT of 17/8/2011 (updated on 12/1/2012)

The lack of common technical conditions is likely to result in fragmentation of the internal market and in a lack of interoperability of equipment. Regarding the terrestrial 2 GHz band, this could be enhanced by potential discrepancies in current licences' conditions regarding the spectrum holdings per operator (typically in 2 x 15 MHz blocks for the FDD bands and 1 x 5 MHz block for the TDD bands) or the expiry deadlines (mostly in the period 2017 - 2026). Several Member States have already liberalised use of the terrestrial 2 GHz band for technologies other than UMTS/IMT-2000 (Sweden, Germany, Netherlands).

Technical restrictions on the 2 GHz unpaired bands

A key limitation on the use of the TDD bands is that they are too narrow to accommodate multiple broadband channels (of at least 10 MHz with LTE), while ensuring smooth co-existence of multiple operators. In fact, they are typically partitioned in 5 MHz blocks between multiple operators whereas co-existence challenges between different (uncoordinated) TDD networks result in restrictions on cell coverage (reduced transmission power levels) or usable bandwidth (need for guard bands). Specifically, the band 2010-2025 MHz is unlikely to be usable by more than one operator for wireless broadband in the long-term due to its overall bandwidth of nearly 15 MHz, which may be further reduced due to the need for guard bands to avoid interference to services in adjacent bands. Even if the spectrum in each TDD band is pooled to serve one operator or be used by one shared network, the overall amount of spectrum in each TDD band is too small to generate economies of scale compared for example to the 2 GHz paired bands.

Furthermore, the 1900 – 1920 MHz TDD band is adjacent to the band 1880-1900 MHz which is used across Europe for DECT services[33]. DECT services have ‘priority over other services in the same band, and are protected in the designated band’. The band is also adjacent to the FDD uplink band 1920-1980 MHz, which is intensively used in the wake of significant investments by network operators across the EU. This would in general require guard bands on both sides of this TDD band thus severely limiting the amount of usable spectrum. The 1900-1920 MHz band has not been used except in the Czech Republic (see Annex 2 for a detailed description), where one operator took a commercial decision to deploy a network as an alternative to ADSL for broadband access; however this operator has recently announced the closure of its TDD network and the migration of its users to the operator’s FDD network. Given that the 2010-2025 MHz band is partially not assigned in the EU and wherever assigned not used either, the unpaired 2 GHz spectrum remains a locked asset.

The typical view of technical conditions specified in CEPT report 39, in particular the in-band power limits, is that they are too restrictive to be useful (i.e. would result in restricted cell site coverage) but necessary to protect the heavily used adjacent FDD spectrum. Less restrictive in-band power limits may result in increased interference into the FDD bands and/or additional costs to mitigate interference (e.g. filters) but could potentially enable wider range of technologies and services. Overall it was considered that the conclusions of CEPT report 39 would potentially inhibit emergent technologies in the unpaired TDD bands since the interference situation would not improve even if new technologies are used (e.g. LTE).

The survey of license holders conducted by Helios[34] concluded that, in the future, the 2 GHz FDD and TDD bands are intended to be used as additional network capacity to support existing services i.e. mobile broadband and voice. However, the information gathered on the

[33] As per Council Directive 91/287/EEC and ERC DEC (94)03

[34] See page 13 of study undertaken for the Commission called "Support the 2 GHz Impact Assessment – Final Report" by Helios http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/_document_storage/studies/2ghz/support2ghz_ia_final_report.pdf

current usage of the terrestrial 2 GHz band revealed that only 17,6% of the responding license holders had plans to utilise the TDD spectrum in the near future. Since only a limited number of license holders had responded to the survey, these figures above might not even be representative for the EU. However they provide a good indication on the persistent underutilisation of the unpaired 2 GHz spectrum.

RSPG view

The underutilisation of the TDD bands in the terrestrial 2 GHz band has been confirmed by the Radio Spectrum Policy Group (RSPG), which is an advisory body to the European Commission consisting of high level experts from the different Member States on radio spectrum. This group recently published a report on Improving Broadband Coverage[35] which sets out some of the key issues EU Member States face in providing high speed broadband services to all citizens and consumers. According to this report the reason for the underutilisation of the unpaired 2 GHz spectrum is that the size of the bands being harmonised/licensed is not compatible with mobile broadband systems and may not have been sufficient for significant market penetration when compared to the resources necessary for operators to invest in that band and that the restrictions on coexistence with adjacent users may have proved too difficult to overcome in the case of the 1900-1920 MHz band. So the RSPG points to a regulatory failure due to overly restrictive technical conditions.

Furthermore the RSPG reports that research and development of mobile technology suitable to use the terrestrial 2 GHz band was clearly focussed on UMTS-FDD services after 2000. This meant that there was relatively little initial development of UMTS-TDD services in most areas. As a result there is a trend for a continuing focus by industry on developing FDD-based technology. The RSPG considers that despite similar regulatory conditions, one market has largely succeeded in the terrestrial 2 GHz paired bands whereas the other market has, to date, failed to emerge in the unpaired bands. The RSPG suggests that the emergence of such a market could not take place without sufficient interest and involvement from a large number of industry players. The above indicates a *market failure* in the unpaired bands of the terrestrial 2 GHz band.

The RSPG report then concludes that it may therefore be appropriate to investigate what demand exists for services that could use this spectrum and suitable conditions to ensure an effective usage of these bands and to develop effective related harmonised conditions. Both the responses gathered in the survey from license holder, manufacturers and the RSPG report show that a market failure exists due to lack of a business case or strong market demand for delivering services using the TDD bands, since currently there is still a potential of increasing the utilisation of other available bands to deliver mobile services more economically.

In summary, the *specific problems* that the initiative addresses relate to:

1. Deployment of innovative wireless services and technologies is hampered by the technology-centric designation and assignment of the terrestrial 2 GHz band (1900-1980 MHz, 2010-2025 MHz and 2110-2170 MHz), namely for UMTS. Even if this designation has expired, legal uncertainty remains for the long term use of this band at European level given that licenses are still limited to UMTS.

2. Some Member States are already introducing technology and service neutrality in the licences of mobile network operators. Given the fact that some Member States are faster than others in introducing flexibility and more importantly in the absence

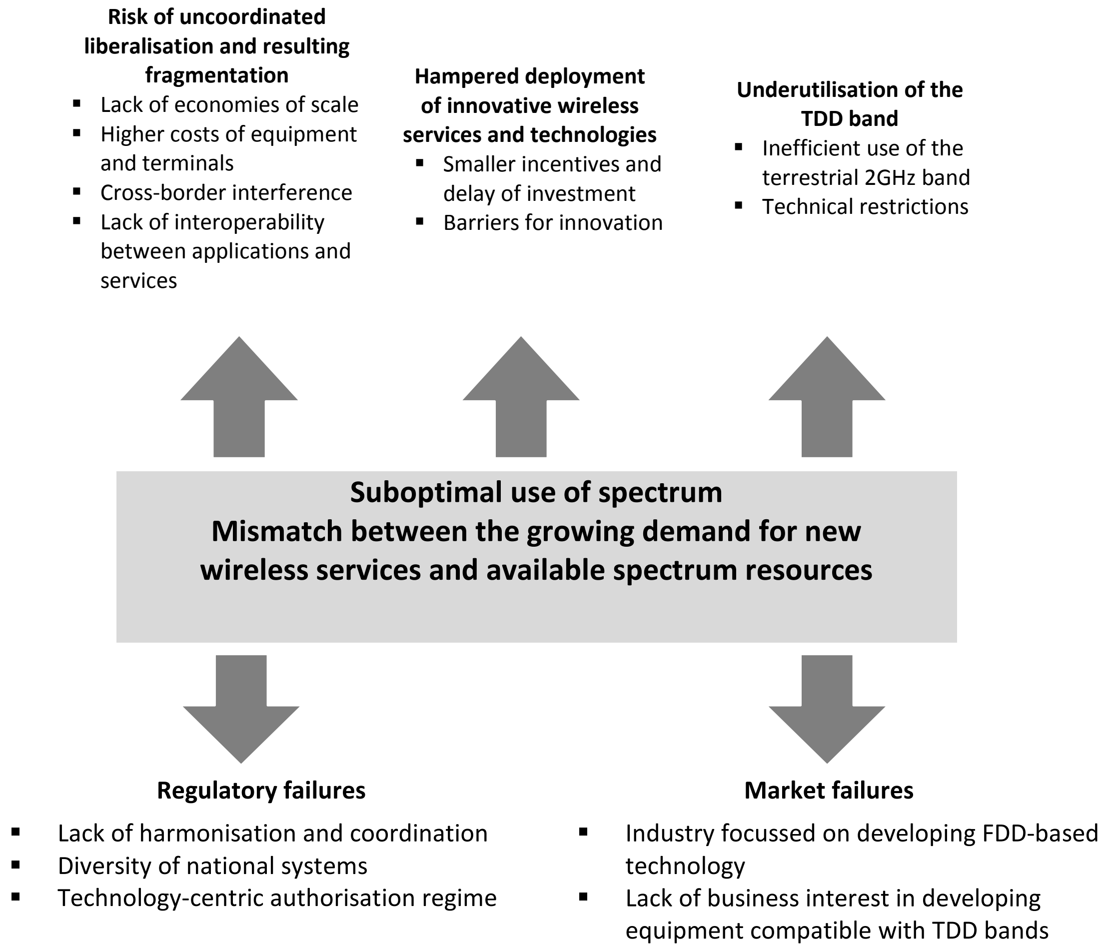
[35] RSPG 11-393 http://rspg.groups.eu.int/_documents/documents/meeting/rspg26/rspg11_393_report_imp_broad_cov.pdf

of binding common technical conditions for the introduction of technology and service neutrality this would lead to continuous fragmentation of the use of the terrestrial 2 GHz band within the EU.

3. The 2 GHz unpaired (TDD) bands (1900-1920 MHz and 2010-2025 MHz) are not used in all Member States which results in inefficient radio spectrum use of the terrestrial 2 GHz band and contrasts the overall demand for spectrum due to explosion of wireless traffic.

Therefore, while the first two specific issues are common to both the FDD and TDD bands, the third specific problem applies only to the TDD bands. **The underutilisation of the TDD bands has two major causes**. One is the *regulatory failure* due to the outdated regulatory set-up imposing technical coexistence issues with adjacent bands – in particular the DECT and FDD uplink bands – and hampering the utilisation of the TDD bands for ECS in the long term. The second driver is a *market failure* due to the continuing focus by industry on developing FDD-based technology and the persistent lack of business interest in developing TDD equipment.

Problem tree



2.3. The EU dimension

Spectrum management is still largely a Member State competence, which should however be exercised in compliance with EU law. While the need of a certain level of coordination at EU level is generally acknowledged, this raises the question of why and to what extent specific EU actions on spectrum adds value.

According to the RSPG opinion on the RSPP[36], spectrum is a national resource which should be managed in a coordinated manner by EU Member States in conjunction with the European Commission, within the international regulatory context. Part of spectrum is used for activities outside the competence of the EU including defence and security. However, there is also a coordinated "EU spectrum space" which includes a large corpus of Commission decisions which have been adopted pursuant to the Radio Spectrum Decision and which harmonise the technical conditions for the use of the radio spectrum in the EU.

Moreover, the regulatory framework for the electronic communications, and in particular the Authorisation Directive 2002/20/EC and the Framework Directive 2002/21/EC lay down specific rules regarding spectrum allocations and the issuance of rights of use of spectrum for electronic communications. These strengthen in particular the principles of technology and service neutrality.

Added value of EU coordination for the terrestrial 2 GHz band

The RSPP sets as policy objectives, amongst others, the need to encourage the efficient management and use of spectrum, to allocate sufficient and appropriate spectrum in a timely manner to support EU policy objectives and best meet the increasing demand for wireless data traffic, and to promote innovation and investment through enhanced flexibility in the use of spectrum through a consistent application in the EU of the principles of technology and service neutrality.

- Certain uses of radio spectrum such as for public safety services vary greatly amongst Member States. Spectrum management therefore needs to be differentiated to take into account the specific national conditions. Due to different size and population of a country and different geographical topology, the business case to invest in new spectrum or in the deployment of more efficient technologies might also significantly differ across the EU.

However, the drawback of a purely national approach by the Member States is that the development of a co-ordinated internal market in wireless equipment and services remains limited. According to a study conducted in 2004, even if Member States individually took the most appropriate action to modernise their spectrum management, the effect would be that Europe would fail to realise 30% of the potential benefits unless the EU coordinated its efforts.[37] There is a high potential for added value in attaining more efficiency in the use of radio spectrum within the European Union by addressing following potential drawbacks of a unilateral or uncoordinated approach by Member States:

- Lack of EU coordination may result in *cross border interference* preventing Member States from allocating radio spectrum to its best use and hampering user experience and consumer benefits; the introduction of harmonised technical conditions facilitates interference minimisation between different technologies in adjacent bands and across borders.

- *Interoperability of applications and services* would be endangered across borders – the incoherent use of a given frequency band in different Member States will entail significant extra equipment costs and result in a fragmented internal market industry; it will also cause a higher administrative burden in following applicable spectrum regulations.

[36] http://rspg.groups.eu.int/_documents/documents/opinions/rspg10_330_rspp_opinion.pdf

[37] Analysys et al, Study on Conditions and Options in Introducing Secondary Trading of Radio Spectrum in the European Community, Final Report for the European Commission, available at http://ec.europa.eu/information_society/policy/radio_spectrum/activities/studies/index_en.htm

- It might lead to a missed opportunity in boosting the *innovation potential* at European level and in addressing potential bottlenecks relating to radio spectrum which could create a significant barrier to entry to innovative services and applications. This risk is high if radio spectrum is reserved for one *specific technology* (such as UMTS in the terrestrial 2 GHz band) and no clear framework exists which would allow for a coordinated technology development.
- In addition to the aforementioned general considerations applicable to the advantages of harmonised liberalisation of terrestrial 2 GHz band, the importance of timely EU-level action i.e. before the 2016 deadline of the Framework Directive should be underscored in order to fully realise the socio-economic potential of the measure as recommended in the study by Helios and to also reap the benefits of harmonised technical conditions, which would not be available in the absence of EU coordination, even after the 2016 deadline. In general, the absence of EU coordination for the harmonised liberalisation of a particular frequency band under the current regulatory framework imposes the risk of fragmented and incoherent technical conditions across the EU – even under the principles of technology and service neutrality – thus resulting in potential interference, higher cost of consumer equipment and less innovation.

Commission Implementing Acts vs. 'soft' regulation

- CEPT/ECC Decisions already act as soft law in CEPT counties including all EU Member States. In particular, the CEPT/ECC Decision ECC/DEC/(06)01[38] has been adopted to promote the use of the whole terrestrial 2 GHz band for UMTS based on channelling arrangements and is currently in the process of review. CEPT/ECC Decisions are not mandatory while defining technical and regulatory conditions. Therefore, there is no added value of a stand-alone Commission Recommendation on the harmonised liberalisation of the terrestrial 2 GHz band at EU level. Only a mandatory Commission Implementing Act under the Radio Spectrum Decision would create regulatory certainty in using the band according to agreed uses and technical harmonisation conditions developed through a Mandate to CEPT.

3. OBJECTIVES PURSUED BY THE POLICY INITIATIVE

In line with the objectives set in the Radio Spectrum Decision as well as in the Radio Spectrum Policy Programme *the general objective* for this policy initiative – in response to the two general problems identified above – is to promote a more efficient use of spectrum and to promote competition and innovation in the terrestrial 2 GHz band while ensuring that harmful interference is avoided.

Complementary to the general objective, the following *specific objectives* are set to address the three specific problems identified above:

1. To allow and stimulate the deployment of innovative wireless services and technologies for equipment, services and/or networks by promoting regulatory certainty at a European level in the terrestrial 2 GHz band.

2. To contribute to the development of the internal market by avoiding fragmentation at EU level in the use of the terrestrial 2 GHz band.

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38 ECC Decision of 24 March 2006 on the harmonised utilisation of spectrum for terrestrial IMT-2000/UMTS systems operating within the bands 1900-1980 MHz, 2010-2025 MHz and 2110-2170 MHz

3. To allow for utilisation of the TDD sub-bands that is most beneficial from an economic, social and environmental point of view by helping to overcome the regulatory and market failure resulting in underutilisation of the TDD bands.
4. Moreover, the objectives of this policy initiative will contribute to achieving the goals of the Europe 2020 Strategy and the Digital Agenda for Europe – *"to deliver sustainable economic and social benefits from a Digital Single Market based on fast and ultra fast internet and interoperable applications, with broadband access for all by 2013, access for all to much higher internet speeds (30 Mbps or above) by 2020, and 50% or more of European households subscribing to internet connections above 100 Mbps"*[39].

4. POLICY OPTIONS

The following options have been identified for this initiative:

Option 1: Baseline scenario/No regulatory change

This scenario assumes that current terrestrial 2 GHz licence conditions will not change, therefore the usage of the terrestrial 2 GHz band may not change at least in the short term (2-3 years). A major milestone in this scenario is the introduction of technological and service neutrality for existing rights of use (granted before 25 May 2011) as of 25 May 2016 by virtue of the Framework Directive. Moreover, even though earlier liberalisation of conditions might be triggered by holders of rights of use that expire after this date pursuant to Article 9a(1) of the Framework Directive, this process is not coordinated at EU level while national regulatory authorities are entitled to refuse with proper justification to grant more flexible rights before 25 May 2016. Finally, the Framework Directive does not provide for harmonisation of the technical conditions upon liberalising the terrestrial 2 GHz band. Voluntary coordination between EU Member States would be the only way to ensure regulatory and technical coherence of measures and hence the technical conditions set in CEPT report 39 will be applicable only on a voluntary basis and act as soft regulation.

Therefore, Member States advance with liberalisation at an uneven pace – use of the FDD bands would be based on UMTS while in a few Member States licences have been made flexible to also include LTE. Transition from UMTS to more advanced technologies such as LTE takes place in an uncoordinated way at European level. The 2 GHz paired bands continue to be used extensively, while the 2 GHz unpaired bands remain underutilised. As confirmed by the Helios study, only with LTE equipment would TDD and FDD band support be cost-effectively integrated on one chip and facilitate take-up of the 2 GHz TDD spectrum, in the case mobile operators develop a business case.

Stakeholders have not seen added value in this option but rather preferred a harmonised regulatory approach at EU level regarding the whole terrestrial 2 GHz band.

Option 2: Harmonised liberalisation of the whole terrestrial 2 GHz band under the technology and service neutrality principle, with a mandatory EU wide allocation established by an EC Implementing Decision on the basis of the Radio Spectrum Decision.

This option would lead to the technical harmonisation and liberalised usage of the whole terrestrial 2 GHz band at an early deadline around 2013 through an EC Implementing Decision. Liberalisation implies that the technology would not be specified and would be open to all systems capable of providing electronic communication services. Based on already available technical parameters defined at CEPT – such as Block Edge Masks which limit

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radiated power levels – the use of the terrestrial 2 GHz band would also be technically harmonised at EU level. CEPT has developed the technical parameters to be included in the Commission Implementing Decisions following a mandate by the Commission pursuant to the Radio Spectrum Decision.

By introducing flexibility of technology choice under harmonised conditions across the EU, access to the terrestrial 2 GHz spectrum for innovative and more efficient technologies such as LTE is facilitated and the internal market is promoted. In the FDD bands the existing service operators could continue to use the paired bands for the provision of electronic communication services but would avail themselves of the possibility to deploy technologies other than UMTS.

Three scenarios for the TDD bands

Since the TDD bands are currently not used for the provision of electronic communications services under the current licences, a key consideration is to create harmonised technical conditions which promote their utilisation. Therefore, in the public consultation the Commission proposed the following two scenarios recommended by the Helios study to stimulate take-up of the TDD bands by overcoming the basic limitation of their use – the risk of harmful interference between adjacent TDD operators or from the lower (1900-1920 MHz) TDD band into the adjacent DECT and FDD uplink bands. They were:

(1) Use for low-power TDD radio access networks for the provision of ECS like in the FDD bands.

(2) Use for downlink-only services to support asymmetric data transfer

As a 3rd possible scenario, the 2 GHz unpaired bands could be used for uplink, paired with a downlink in another band. This scenario resolves interference issues however, it is important to note that, at present, there is no straightforward option for a paired downlink band. Therefore, this scenario was not proposed for public consultation. In the case of pairing additional (doubled) wide-area network capacity can be provided by transforming each 5 MHz TDD channel into paired (2 x) 5 MHz FDD channel.

In the first scenario, it is assumed that there is wide-spread implementation of femto cells[40], with limited coverage, including areas with existing (wide-area) network coverage. At the same time the limitation of use to electronic communications services under the technical conditions developed by CEPT would also result in a limited scope for shared use (not conducive e.g. to internet of things).

[40] Femto cells or femtocells are small cellular telecommunications base stations that can be installed in residential or business environments either as single stand-alone items or in clusters to provide improved cellular coverage within a building. It is widely known that cellular coverage, especially for data transmission where good signal strengths are needed and is not as good within buildings. By using a small internal base station - femtocell (femto cell), the cellular performance can be improved along with the possible provision of additional services.
In order to link the femtocells with the main core network, the mobile backhaul scheme uses the user's DSL or other Internet link. This provides a cost effective and widely available data link for the femtocells that can be used as a standard for all applications.
There are many advantages for the deployment of femtocells to both the user and the mobile network operator. For the user, the use of a femto cell within the home enables far better coverage to be enjoyed along with the possible provision of additional services, possible cost benefits, and the use of a single number for both home and mobile applications. For the network operator, the use of femtocells provides a very cost effective means of improving coverage, along with linking users to their network, and providing additional revenue from the provision of additional services.

- In the second scenario the TDD bands are used for downlink-only services to support asymmetric data transfer (e.g. file downloads), which provides additional downlink network capacity which is particularly suited where a number of users within a cell range request the same content. Such content could include both real-time and non-real time data including common audio or video data, common web-sites, application updates, and push[41] data services. Asymmetric data transfer could be implemented on a per operator basis using their existing spectrum or across multiple operators sharing pooled spectrum. The delivery of common content via a downlink only network reduces the load on the original network by a factor equal to the number of users who are requesting the data in question.
- Both scenarios (1) and (2) would allow uncoordinated use between multiple coexisting operators, which does not put major limitations on the available spectrum per operator.

During the public consultation stakeholders generally rejected scenarios (1) and (2) as missing the business case due to the lack of market demand (for low-power or downlink-only services). They were also considered possible under the current licences. Scenario (3) was favoured by mobile operators, which however could not suggest viable options for the pairing bands which could be made available in the short to medium term. The proposals for pairing bands either included bands which do not allow the deployment of high-density mobile networks or necessitated major decisions at ITU level.

Option 3: Harmonised liberalisation of the 2 GHz paired bands only, under the technology and service neutrality principle with a mandatory EU wide allocation established by an EC Implementing Decision on the basis of the Radio Spectrum Decision

This option is would lead to the technical harmonisation and liberalised usage of the 2 GHz paired bands only, in the same way as under Option 2, i.e. with an early deadline around 2013 through an EC Implementing Decision.

During the public consultation stakeholders outside the mobile sector strongly favoured different alternative options for using the TDD bands other than mobile communications services. There was no distinct usage scenario but a rather heterogeneous set of proposed alternatives. Therefore, for the TDD bands under this option, no decision would take place at this moment, but the Commission would engage in further study and investigation of how to use the 2 GHz unpaired bands in the best possible way, primarily for services other than ECS. The Commission would need to launch a specific mandate to CEPT to develop technical studies specifically on other use of the 2 GHz unpaired bands. The objective would be to identify all technically feasible options for the use of this band and the respective technical conditions avoid harmful interference and ensure co-existence.

Potential uses which had not been investigated in detail but emerged through the public consultation could be for Public Protection and Disaster Relief (PPDR), DECT, short range devices or Direct-Air-to-Ground-Communications. Probably each of these uses would not be sufficient to fulfil spectrum efficiency objectives and they would not be compatible with each other. Therefore possibilities for shared use of the TDD bands would need to be investigated. following the results of CEPT mandate, the Commission may decide to adopt another Implementing Decision for the 2 GHz unpaired bands taking into account the impact on existing licenses.

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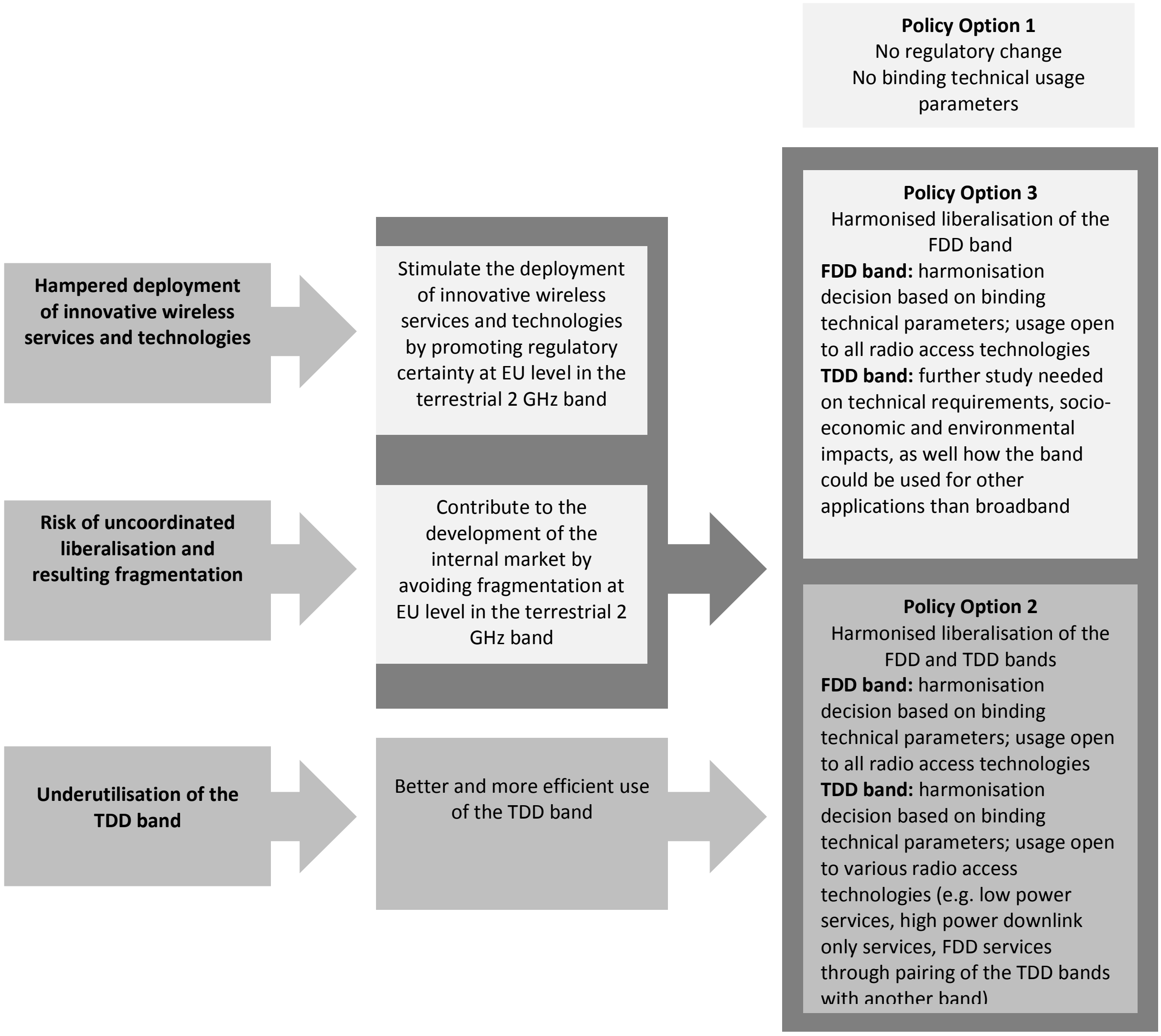
41 Push services are often based on information preferences expressed in advance. A client might "subscribe" to various information "channels". Whenever new content is available on one of those channels, the server pushes the information out to users.

The aforementioned 3 options, including the scenarios under Option 2, constitute an exhaustive list of alternatives taking into account the current licensing regime and the status-quo of usage of the terrestrial 2 GHz band. They address to a different degree the policy objectives of this initiative.

The dependencies between problems, objectives and policy options are visualised below in support of the intervention logic of the initiative.



5. ASSESSMENT OF THE IMPACT OF OPTIONS

5.1. Assessment of options as regards their socio-economic and environmental impact

Assessing environmental impact

There are growing environmental impacts due to the increase in the demand for wireless services. Global mobile data traffic will grow 18-fold by 2016, by which date the number of connected devices will exceed the population of the world, Cisco predicted recently.[42]

Between 2009 and 2014, demand for transmitted data over some form of wireless network (nominally mobile) has been estimated in Western Europe to increase by 37 times in

[42] http://www.totaltele.com/view.aspx?ID=471255

volume[43], as against traditional transmitted data volume increases of approximately a factor of 10 every 5 years. The latter rate corresponds to an increase of the associated energy consumption by approximately 16-20 % per year[44] if accounting for increases in energy efficiency is included. Such impacts on the energy consumption and greenhouse gas emissions tend to increase as the transmission efficiency declines, i.e. generally with higher frequency, when considering the network node density. In consequence, electronic communication networks are an increasing part of the ICT energy budget. The total ICT budget is estimated at between 3% and 6% of total energy consumption and a corresponding percentage of the world-wide CO_2 emissions, which is comparable with the airline industry. [45] In the context of roll-out of LTE with its forecast of high density of base stations another element to take into account are the resources needed for building the network infrastructure and the wireless devices for the consumers.

Nevertheless, the environmental impact of the options of this initiative, be it under the baseline scenario or with coordinated liberalisation and harmonisation of the terrestrial 2 GHz band partly or as a whole, is limited and depends on the additional network capacity that is generated. Compared to the overall network capacity, the additionally generated network capacity even in the most optimistic case (Option (2)) is relatively limited, therefore environmental impacts are assumed to be also relatively small as regards energy consumption.

As regards resource efficiency, with a new technology being put in place, the shift to LTE and other technologies means that new handsets are necessary to operate the new technologies. Especially in relation to some raw materials and components used in mobile phones and smart phones this can prove resource intensive. However, again, in the terrestrial 2 GHz band in which (at least in the FDD part) technological change takes place and will take place at national level with or without regulatory action, the impact on the environment of the liberalisation and harmonisation of the terrestrial 2 GHz band is still limited.

5.1.1. Option 1: Baseline scenario

The 2 GHz paired bands will continue to be used for the core mobile and data services provided by MNOs. This was confirmed through the survey responses received for the Helios study and also in the public consultation organised by the Commission. The Framework Directive already allows Member States to introduce technology and service neutrality in existing rights of use upon request by operators in the time frame until 25 May 2016, but mandates so only after this date. Operators may decide to migrate to a more efficient technology (e.g. LTE) in the 2 GHz paired bands in order to enhance their network capacity and respond to increase of demand.

The bands and technologies highlighted in grey in the table below shows the current network capacity for mobile and data services and in which bands which technologies are used in general. The bands and technologies highlighted in black are those which could become systematically available under the other options considered in this impact assessment.

Frequency Band	**GSM**	**UMTS**	**LTE**	**WIMAX**
800 MHz (FDD)				

43 Cisco, 2010

44 SCF Associate Ltd estimates, assuming an energy efficiency increase of 30% every two years with new network equipment installation made to increase network capacity.

45 Forge (2007) examines the ICT life cycle in terms of greenhouse gas emissions, power consumption, waste recycling and impacts of operating system change on the environment.; see also SCF study Perspectives on the value of shared spectrum access

900 MHz (FDD)		[46]		
1800 MHz (FDD)		[xlii]		
2100 MHz (FDD)				
2100 MHz (TDD)		[47]		
2600 MHz (FDD)				
2600 MHz (TDD)				
3400- 3600 MHz				
3600-3800 MHz				

As can be seen from the table above, the additional network capacity that could be provided through liberalisation of the terrestrial 2 GHz band represents a limited amount of the overall spectrum assets, which may be available to an operator. Moreover, while all frequency bands depicted above are important for achieving the broadband targets of the Digital Agenda for Europe[48], the contribution through liberalising the 2 GHz paired bands would have relatively slow effect on the overall network capacity of mobile operators to deploy next-generation broadband technologies since UMTS technology already offers broadband services while green field bands (like 800 MHz) or bands traditionally used for voice services (2G) would be exploited first by operators.

Incoherent liberalisation

Despite the fact that early liberalisation might take place before 2016 pursuant to the Framework Directive based on voluntary action, this process is neither coordinated nor harmonised across Europe. Without an accompanying harmonisation measure, early liberalisation would be hindered due to the lack of legal certainty over the *applicable technical conditions*. This means that Member States could set up the technical conditions themselves, or coordinate it on a voluntary basis i.e. based on CEPT report 39. This could ensure interoperability throughout the EU, but does not provide the legal certainty of a Commission Decision as it relies on a voluntary implementation of the technical conditions developed by CEPT. Only legally binding harmonisation measures would accelerate a uniform liberalisation process across the EU which would materialise the benefits of harmonised liberalisation of the terrestrial 2 GHz band. Furthermore, the *differentiated treatment* by NRAs of license holders requesting liberalised use of the 2 GHz paired bands until the deadline of 25 May 2016, which will depend on the competitive situation at national level, the remaining duration of their licences and the resulting risk of harmful interference, may lead only to partial liberalisation of the licenses, subject to the NRAs' discretion. Altogether, depending on the pace of implementation at national level, the potential benefits of action, shown under Option 2 are partially lost (namely the producer and consumer surplus

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46 It is feasible that operators may forego the interim step and migrate directly from GSM to LTE.

47 In the baseline scenario it is only small amount of use would take place based on limited use of IMB and small TDD networks already implemented in a few European countries (e.g. Czech Republic, Slovakia, and Romania). However, major use of the band would only take place following liberalisation and the use of LTE

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for the years 2013, 2014, 2015 and partially 2016). This could represent a significant opportunity cost compared to an earlier liberalisation, which cannot be quantified due to the inherent timing uncertainties in this scenario.

Due to the lack of binding technical requirements at EU level and the resulting market fragmentation, the environment for investment would be less attractive to technology and service providers. This in return would impact on the speed of equipment development and likely result in a missed opportunity to create economies of scale for new services in a consolidated internal market. Therefore, stakeholders have generally supported EU level action during the public consultation.

Integrated Mobile Broadcast (IMB)

The use of the 2 GHz unpaired band in the baseline scenario is driven by existing licence terms – mainly restricted to UMTS[49]. One possible application under this scenario would be to offer Integrated Mobile Broadcast services[50] in the 2 GHz unpaired (TDD) bands. While use of IMB is already permitted within existing licence terms, there are some restrictions – (i) the downlink-only nature of the service means that it cannot be used in the 5 MHz block immediately adjacent to 1920 MHz due to the need for a guard-band with the FDD uplink band; (ii) it requires all operators with spectrum in the band to agree to use IMB, otherwise power levels will be severely restricted; (iii) available bandwidth and power levels may be further limited in order to prevent interference into the neighbouring DECT band at 1880-1900 MHz. In theory, the whole of the band 2010-2025 MHz could be used for IMB services. Due to costs of upgrading handsets and the lack of market for a downlink-only/broadcast service – as also confirmed in the public consultation – using the TDD bands it is likely that there will be only a very small amount of use of the TDD bands based on IMB in the future.

Socio-economic impact

Whilst, in theory, it would be possible for each operator to take a stand alone decision as to what new service to implement, there are clearly technical impediments which would restrict flexibility in the case where operators wished to go different ways. For example, an operator could not introduce IMB services in spectrum adjacent to another operator who wished to offer mobile TDD services due to the high levels of interference into the TDD service. It seems very unlikely that operators in adjacent spectrum blocks would have the freedom to provide services independently. In practical terms, this means that all operators in a specific block of 5 MHz in the 2 GHz unpaired band would need to offer the same services and possibly align timeslots between uplink and downlink with TDD.

A similar situation occurs in cross-border instances. If an operator on one side of a border had a high power IMB network, it would be unfeasible for an operator on the other side of the border to operate a TDD network in the vicinity of the border. It is likely that cross-border coordination agreements would not overcome these issues without severely restricting the operation of services on both sides of a border.

In view of the above, an operator would be confronted with lack of flexibility to select a technology solution independent of other operators and neighbouring countries. The consequence is that first movers in using the bands will set a precedent for the overall use of the band. It is, however, feasible that the services operated in the 1900 – 1920 MHz band could differ from that in the 2010 – 2025 MHz band providing a modicum of flexibility.

[49] See also the Table in Annex 2.

[50] Integrated Mobile Broadcast (IMB) technology enables spectrally efficient delivery of Broadcast services using TDD radio techniques and is part of the applicable standard. Therefore IMB could be deployed under the current regulatory framework in the TDD bands.

The above illustrates well that it is very likely that the 2 GHz unpaired band would remain underutilised rather than contributing to operators' network capacity as the problems described above would not be solved without regulatory action. This would result in a lost benefit, an opportunity cost of not achieving socio-economic benefits from the use of this spectrum, such as enabling new services to be provided, alleviating network capacity constraints in relation to the delivery of existing services; or the more efficient delivery of existing services.

The benefits to society include additional consumer surplus[51] that is generated from increased data consumption as well as increased producer surplus[52] generated from providing the additional network capacity at lower cost than it would otherwise have been provided. In case that the terrestrial 2 GHz band remains underutilised these benefits to stakeholders like mobile network operators and consumers could not be realised to their full potential.

5.1.2. Option 2: Harmonised liberalisation of the whole terrestrial 2 GHz band under the technology and service neutrality principle, with a mandatory EU wide allocation established by an EC Implementing Decision on the basis of the Radio Spectrum Decision.

<u>Impact of coherent liberalisation in general</u>

Applying the service and technology neutrality principles to the terrestrial 2 GHz band means that only the minimum technical requirements are defined which aim at avoiding harmful interference without imposing a specific technology. Therefore, this leads to more flexibility as to how the frequency bands are used and allows more technologies and applications to compete and innovate, thus improving spectrum utilisation and overcoming potential mismatch between demand and supply.

The review of the telecom package in 2009 was accompanied by an impact assessment[53]. The table below provides a summary on main likely impacts and risks identified in the impact assessment and arising from further coordination in spectrum trading and strengthening flexibility of radio spectrum use compared to a no regulatory changes policy at that time. The signs represent a scale of possible impacts vis-à-vis the “no change scenario”: **+** positive impact**, O** neutral impact, **−** negative impact. This is relevant for the terrestrial 2 GHz band since this is the last band identified as a WAPECS band where application of the technology and service neutrality principle is still outstanding.

51 Consumer welfare or surplus generated when there is a difference between the price that consumers pay for something compared to the price they would have been willing to pay. This could either be generated due to 1) a reduction in the price of a product/service in order to stimulate increased demand (i.e. a move down the demand curve) or due to an increase in demand meaning that a consumer’s willingness to pay increases and more consumers will buy the product/service at the current pricing level (i.e. the demand curve itself moves).

52 Producer surplus is the difference between the amount that is charged for the product/service compared to the cost of providing the service i.e. it can be thought of as the producer’s profit.

53 See SEC(2007) 1472/3 Accompanying document to the Commission proposal for a Directive of the European Parliament and the Council amending European Parliament and Council Directives 2002/19/EC, 2002/20/EC and 202/21/EC; Commission proposal for a Directive of the European Parliament and the Council amending European Parliament and Council Directives 2002/22/EC and 2002/58/EC; Commission proposal for a Regulation of the European Parliament and the Council establishing the European Electronic Communications Markets Authority {COM(2007)697, COM(2007)698, COM(2007)699, SEC(2007)1473}

Compared to the original table in the impact assessment above, in the table below only the aspects relevant for liberalisation in the terrestrial 2 GHz band are highlighted and those relevant for trading have been left out as these are not relevant to this discussion.

Summary on the main impacts and risks

IMPACTS AND RISKS	**Introduce the principle of technology and service neutrality**	**No change**
	ECONOMIC	
Investment and innovation	**+** More flexible and co-ordinated spectrum management will significantly encourage investment and innovation.	Does not facilitate cross-border investment and deployment of new innovative cross-border services. Differences in regulation do not particularly encourage operators to invest in other Member States.
Internal market, regulatory consistency	**+** Improvements removing the current fragmentation in national spectrum policies – through strengthened co-ordination mechanisms. More opportunities for development or cross-border or pan-European services using frequencies.	Inconsistent application of rules, slow progress based on voluntary co-ordination with lengthy and cumbersome procedures, risk of increasing differences between MS. Slow deployment of cross-border services.
EU competitiveness	**+/O** More flexibility should strengthen competitiveness of the mobile/wireless industry.	Risk of gradual erosion of the mobile/wireless industry's competitiveness vis-à-vis the rest of the world. Economies of scale and scope harder to achieve for mobile/wireless operators, slower uptake of cross-border services.
Economic operators' costs and benefits	**+/−** More opportunities for mobile operators to respond to changes in market demand which can lead to increased revenues at a cost of roll out of new technology networks	High barriers of entry for new technologies, impact varies by national spectrum regime.
Consumer benefits	**+** More choice, more services, lower cost	Same choices as today, big differences between MS as regards service offerings and prices (not justified by differences in the underlying costs)
Overall economic growth	**+/O** Economic modelling using scenarios shows that more flexible and co-ordinated spectrum management (including the introduction of spectrum trading) has a significant and positive impact on GDP growth (the difference between the best-case and the worst-case scenario would be approx. 0.1% of the annual GDP growth)	Slower GDP growth than in Option 1
SOCIAL		
Social and digital inclusion	**+/O** Impact will depend on other factors, such as the future universal service concept. Positive impact of co-ordination on regulatory consistency should have positive effect on digital inclusion across the EU. More choice and cheaper wireless services should contribute to social inclusion and bridging the digital gap between regions.	Impact will depend on other factors, such as the future universal service concept. Wireless services generally less affordable and less available across the EU than in Option 1. However, big differences between MS can be expected.
Employment and labour market	**+/O** Difficult to predict the outcome. Scenario modelling shows a positive impact on employment in knowledge industries. Positive spill-over effects to other sectors can be expected. Negative employment effect for market players who will not adapt to the change.	Only limited spill-over effects can be expected due to slower deployment of new wireless technologies and services.

Impact of technical harmonisation in general

Flexibility by itself is not sufficient if introduced in a fragmented manner. Harmonisation of technical conditions at EU level is the way to overcome such fragmentation. Moreover harmonisation would reduce the risk of interference. Other likely impacts of harmonisation in broad terms are enhanced competition, innovative products and technologies, lower cost for consumers through economies of scale and contribution to economic growth. The technical harmonisation leads to regulatory certainty as regards the use of both the paired and unpaired spectrum of the terrestrial 2 GHz band. Legal certainty leads to a secure business environment for investment in the terrestrial 2 GHz band. Furthermore, technical harmonisation allows for a coordinated and smooth transition to more advanced technologies.

As regards competition, harmonisation to assist flexibility in the terrestrial 2 GHz band would not lead to new entrants as existing license holders would continue to use the allocated and assigned radio spectrum. Only the licensing conditions would change, not limiting the license to the deployment of UMTS. However, this measure can encourage competition between the existing market players through a greater freedom to choose services and technologies. Those mobile operators who endorse and deploy more efficient technologies would have a better possibility to react to changes in market demand and to satisfy demand, compared to those who do not move to more efficient technologies. Therefore the more technologically advanced mobile operators would have a comparative advantage to those following technology trends more slowly.

Model and assumptions for the quantification of the socio-economic impact of a liberalised harmonisation of the terrestrial 2 GHz band

The additional flexibility offered by the liberalisation of the bands would be the use of alternative technologies in both the TDD and FDD bands (e.g. TD-LTE and FD-LTE). One of the benefits in the particular case of LTE is that the core of LTE remains around 90% common between the FDD and TDD variants and it is apparent that chipset manufacturers have the possibility to integrate both the FDD and TDD capability in one chip. However, the use of this capability requires the selection of the RF (radio frequency) components dedicated to each mode within a handset.

The cost of an RF frontend in a handset increases with the number of different bands and technologies that need to be supported. Cost reductions due to economies of scale can be achieved if the number of handsets sold is sufficiently high. Feedback from equipment manufacturers collected in the survey of the study is that handsets supporting both TD-LTE and FD-LTE are feasible and can be built at a reasonable cost if there is sufficient demand[54]. This is where the proactive harmonisation of spectrum bands may stimulate the production of equipment, where the additional costs (in handset terms) for the incorporation of the TDD functionality can be significantly reduced so that integrated handsets become available at a comparable price level to that of today's handsets only supporting FDD. Similarly, base stations equipment manufacturers already have the capability to offer TD-LTE on the same baseband unit as FD-LTE subject to the demand for its use.

Therefore the study made assumptions as regards the evolution of handset capabilities in coping with the different technologies in line with the findings above. Handset capabilities assumptions show what percentages of the devices on the market in a given year are able to cope with a given technology:

[54] There is also evidence to suggest that the cost of RF components (of a similar complexity) decreases over time. The RF bill of materials costs for a tri-band phone was ~$12 in 2003, while for a similar volume of units the bill of materials for a quad-band phone in 2006 was ~$6.

	2010	2011	2012	2013	2014	2015	2016
GSM	100%	100%	100%	100%	100%	100%	100%
UMTS	90%	93%	96%	99%	100%	100%	100%
LTE	0%	10%	30%	50%	70%	90%	100%

The assumption is that as of 2016 all handsets on the market will be able to deliver several technologies, namely GSM, UMTS and LTE, in both the FDD and TDD part of the terrestrial 2 GHz band.

The study contracted by the Commission carried out a cost benefit analysis (CBA) on what added value the harmonised liberalisation of the terrestrial 2 GHz band would bring, assuming 4 different scenarios for the potential use of the TDD bands for ECS. These scenarios were compared to the baseline scenario under option 1. The mobile network operators (MNOs) have licenses for different frequency bands and use different technologies to provide mobile voice and mobile broadband services. As demand for these services grow, MNOs can meet the demand through the use of spare network capacity within existing spectrum, through the allocation of new spectrum, and/or the implementation of new technologies. The Cost Benefit Analysis estimates the additional network capacity that could be created in the FDD and TDD bands if liberalisation and harmonisation took place compared to a no regulatory change scenario. For the FDD bands the assumption is that MNOs would switch from UMTS to LTE in the first instance following liberalisation to achieve greater spectrum efficiency and network capacity. The different uses of the TDD bands create additional network capacity to provide mobile voice and broadband data services similar to those currently provided today. The additional network capacity gained in the FDD and TDD bands creates the possibility to deliver additional services, which can lead to increases in producer surplus and consumer surplus. Beyond these economic benefits the availability of additional services creates also social benefits as more and more consumers can benefit from better quality and more divers choice of electronic communication and wireless broadband services.

On this basis the CBA calculates the net present value of increases in consumer and producer surplus over the next 10 years, assuming liberalisation entering into force in 2013. The model, given that it provides a simplified picture of the reality, has therefore its limitations. The model used in the study has considered consumer prices for the transmission of 1 MB as constant. With likely economies of scale, however, consumer prices are expected to decrease over time. Therefore the figures for consumer surplus are considered to be underestimated in the study. On the other hand, the results for benefits, in particular producer surplus, seem to be overestimated. The model assumes that all necessary investments in both the FDD and TDD bands for the roll-out of the network would take place. However, mobile operators are cautious as regards the TDD bands and several have indicated in the public consultation that they don't see a business case for providing services in the TDD bands even if liberalised. In Annex 3 the main assumptions made in the study are listed and explained in detail.

Socio-economic impacts

In case the TDD bands were used for ECS depending on the type of usage (i.e. low power usage or downlink only usage with asymmetric data transfer, or pairing of the TDD bands with another band to provide FDD type services) harmonised liberalisation of the terrestrial 2 GHz bands could yield significant economic benefits up to 1,138 M€ Net Present Value (NPV) over the analysis period (2011 to 2021). Additional cell site costs would amount up to 295M€. This is the amount what MNOs would need to invest upfront in the use of the terrestrial 2 GHz band to be able to achieve the net benefits indicated above. The Break Even

Point (BEP) - the point in time as of which the benefits outweigh the costs - would be achieved in 2013, the year liberalisation is assumed to be implemented.

The CBA model assumes that mobile operators will offer LTE services in the TDD bands right away after liberalisation in 2013, while they will need 3 years to roll out LTE in the FDD bands. In case this assumption is modified so that in both the paired and unpaired radio spectrum LTE is delivered as of 2016, the maximum achievable net present value decreases to 976 M€. However, in case downlink only services are provided in the TDD bands the net present value shrinks to 73 M€ for the period 2011-2021, since a substantial part of the benefits are offset to later years following the analysis period.

If the TDD bands were paired with another band to provide FDD services the cost-benefit analysis shows that compared to the baseline scenario under option 1 an economic benefit of 341M€ NPV could be reaped over the analysis period. Additional cell site costs amount to 186 M€ NPV. In case it is assumed that both the paired and unpaired radio spectrum LTE is delivered as of 2016, the net present value decreases to 235 M€ for the period 2011- 2021.

The use of the 2 GHz TDD bands to provide ECS in the form of *low power TDD* for indoor/home use or downlink only services has a significant impact on the network capacity with up to 35% increase in utilised network capacity towards the end of the analysis period. An immediate increase in network capacity is realised as common content is pushed to users via a downlink only channel. This increase in network capacity continues to grow as overall demand increases and more and more common data content is provided in this manner. As a result significant economic and social benefits are possible with respect to the baseline.

Among the scenarios to use the TDD bands to provide ECS, *downlink only services* also offer a great potential for additional social benefits. This is based on the fact that this scenario potentially enables the delivery of high bandwidth broadcast applications which are currently not cost-effective using the current FDD bands. This in turn may stimulate the market for the development of a new range of desirable services and applications providing perceived benefits to consumers that would otherwise not be possible. However, these additional benefits are dependent on a market being found for a particular broadcast service or application.

NPV comparison of the scenarios under Option 2

Description and main assumptions	**NPV 2011-2021**
Operators roll out LTE on the TDD band in 2013 and on the FDD band in 2016	€1,138M
Operators roll out LTE on the TDD and FDD bands in 2016	€976M
Provision of downlink-only services in the TDD band	€73M
TDD band paired with another band to provide FDD services (roll-out in 2013)	€341M
TDD band paired with another band to provide FDD services (roll-out in 2016)	€235M

<u>Uncertainties related to Option 2</u>

The above figures are subject to uncertainty factors highlighted in the study by Helios as well as in the public consultation.

As regards the net benefits that can be achieved through the *low power usage* of the unpaired bands the main reason is that – while several stakeholders consider this usage to be possible already today under the current licensing regime – no market demand and no ecosystem have emerged. It has been claimed that guard bands may be necessary on both sides of the spectrum band to protect adjacent services. In particular, mobile operators did not support such low power usage because in their view the market does not demand services that are specifically low power, and there are no services that can inherently only be delivered using low power infrastructure.

Regarding *integration of both duplex modes* (FDD and TDD) in handsets, this becomes more straightforward under LTE technology and remains more costly for UMTS and potentially WIMAX (current implementations rely on external 'dongles' to access IMB services). The CBA model assumes that as of 2016 all handsets on the market will be able to deliver several technologies, namely GSM, UMTS and LTE, in both the FDD and TDD part of the terrestrial 2 GHz band. This assumption of the study however, does not seem to be realistic. Generally the more bands need to be served and the more technologies there are to serve, the more costly the devices get. The feedback received in the public consultation contradicts the assumption above, as the operation in the small TDD bands is considered costly compared to its size and therefore the potential network capacity that could be provided in these band. Recent predictions show lower rates of market share growth in handsets capable to deal with LTE. Furthermore the mobile industry estimates that a market demand for a handset delivering LTE only on a FDD basis will be significantly higher than for devices delivering LTE technology on both FDD and TDD basis.

As regards *downlink-only use*, while there may be a small amount of use of IMB, it is assumed that if the band is harmonised to facilitate downlink only to allow the use of LTE operators will mainly wait until the availability of the LTE based EMBS. Even if in theory downlink only services seem worthwhile to implement, the public consultation has confirmed the lack of applicability of this possibility to the lower unpaired sub-band. Only a few stakeholders backed such services, mainly in the sub-band 2010-2025 MHz. This does however seem to be in contrast with the trend that exploding data traffic largely attributed to video applications such as video on demand and IPTV[55]. In particular, mobile operators and equipment manufacturers considered other bands more suitable for these types of services and questioned their take-up in additionally dedicated spectrum bands.

Other barriers preventing the successful realisation of the use of the TDD bands for ECS are:

- The uncertainty over a market for the delivery of broadcast or downlink only service over the TDD bands as broadly indicated in the public consultations.
- The possible need for MNOs with existing TDD licences to engage in national or Europe wide spectrum trading or spectrum pooling arrangements in order to make enough spectrum available to implement e.g. IMB/eMBMS downlink technologies and services.
- The risk of interference at the 1920 MHz spectrum boundary between high-power DL-only transmitters and the FDD uplink (receiving FDD base stations). On the other hand, low-power DL-only services would not create strong market demand. This makes the DL-only scenario suitable only for the upper unpaired sub-band (2010-2025 MHz).

[55] Television provided over the internet

Sharing spectrum on a contractual basis could lead to collusive outcomes and anticompetitive foreclosures through increasing commonality of costs and/or if they involve the exchange of commercially sensitive information. Compliance of spectrum sharing agreements with competition law cannot be assumed in general (although spectrum sharing agreements can also not be judged as restricting competition in general).

Regarding *Machine to Machine (M2M)* communications under the low-power scenario, in particular the mobile operators considered that M2M are delivered over mobile networks in other bands and no additional and dedicated spectrum is needed in the unpaired spectrum where mobile applications have not taken up.

Regarding *pairing TDD spectrum* with other external bands, which was suggested by stakeholders from the mobile or DECT domain during the public consultation to eliminate the major interference issues at the 1900 MHz and 1920 MHz frequency borders of the lower TDD band, this would delay utilisation by many years, because such external bands have not been identified, yet. The mobile market has global implications and manufacturers as well as operators are looking for global allocations. New spectrum bands to be allocated at global level to mobile broadband will be discussed at the next World Radio Conference organised by the ITU in 2015. Any progress before then is unlikely. Also, according to past experience, it would take at least another three years for equipment to be developed and to become available. EU pairings in theory may be possible beforehand, e.g. with spectrum at 1.5 GHz band, but this does not change the intrinsic fault of the unpaired sub-bands, namely that with 20 MHz and 15 MHz respectively, the unpaired sub-bands at 2 GHz are basically too narrow for more than one (maximum 2) operators providing broadband services. So the unpaired bands if used for electronic communication services would always remain a niche band with limited economies of scale.

The considerations above give rise to considerable uncertainty in the market viability of Option 2 and thus undermine the socio-economic benefits attached to it in the outcome of the comprehensive cost-benefit analysis in the study by Helios.

5.1.3. Option 3: Harmonised liberalisation of the 2 GHz paired bands only, under the technology and service neutrality principle with a mandatory EU wide allocation established by an EC Implementing Decision on the basis of the Radio Spectrum Decision

Separate approach for the TDD bands

This option introduces, however, a cautious approach as regards the TDD bands as it does not suggest their harmonised liberalisation for use for electronic communication services, but could allow for applications other than mobile communications. This would need to be investigated further. The weakness of the outdated regulatory set-up, which hampers the utilisation of the TDD bands for ECS, as well as the potential interference issues presented above could be overcome by allocating the TDD bands to other applications, which are less prone to interference but have the potential to generate significant socio-economic benefits.

Furthermore, this option offers the possibility to introduce *shared use* by several alternative applications to ensure utilisation of the unpaired bands. Shared use is very much dependent on the technical conditions that are set for the frequency band in question and on the type of assignment method (license-exempt, individual licence with shared access, exclusive individual licence). Therefore it is a major aspect to examine further in technical studies. The alternative proposals received in the public consultations which can be considered in this scenario include ad-hoc PPDR, PMSE, short-range devices or Direct-Air-To-Ground communications.

The drawback of this option is that the TDD band would continue to be underutilised for some time until harmonised conditions are adopted (probably until 2014), while the advantage is that it is more likely that on mid term the most beneficial option for usage is found. Without modifying the conditions for use of the TDD bands the underutilisation of the TDD bands continues. This leads to an opportunity cost since benefits are lost that could be achieved in the TDD bands as shown in Option 2. The net present value (NPV) of the possibilities for utilising the TDD bands for ECS and therefore the opportunity cost if these scenarios are not implemented is highly sensitive to the effective liberalisation date. Generally, a delay in implementation leads to significantly lower NPV under Option 2.

Such an opportunity cost of not using the TDD bands for ECS can be offset by future benefits of allocating this band to other applications at a later stage, when the technical conditions are fully developed. Under option 2 we have discussed the weaknesses of the analysis and CBA model. It has become clear that benefits were too optimistically calculated as regards the development of market penetration of handsets capable to serve LTE both on a FDD and TDD basis. This is due mainly to the lack of availability of RF chipsets. Due to the fragmentation of LTE frequency bands in the EU and worldwide and the limited possibility to produce multi-RF chipsets, RF chipset manufacturers would set higher priority to bands where ecosystems are developing the fastest. The 2 GHz unpaired band will not be given a high priority due to its limited bandwidth.

What is also apparent is that mobile operators don't believe in a market growth of handsets which can deal with both FDD and TDD technology in the 2 GHz band, but rather believe in take up of handsets which serve only the FDD component in the 2 GHz band, at least in the medium term.

On the other hand, there is no objective reason to postpone a decision on the FDD part of the 2 GHz band – the sooner a harmonised liberalisation is implemented the higher the estimated net benefits (shown below) are. Therefore, there is reasonable ground for separating regulatory action for the FDD and TDD bands in the terrestrial 2 GHz band.

Socio-economic impact resulting from the FDD bands

For the FDD bands this option offers the same benefits of harmonisation and liberalisation as option 2. If the 2 GHz paired bands alone were harmonised, the net economic benefit that could be achieved relative to the baseline scenario amounts to 135 M€ if liberalisation was implemented in 2013. A delay of implementation of 3 years would reduce the net benefits to 108 M€ (i.e. by 27 M€).

NPV for the FDD bands under Option 3

Description and main assumptions	**NPV 2011-2021**
Operators roll out LTE in the FDD bands in 2013	€135M
Operators roll out LTE in the FDD bands in 2016	€108M

The mobile operators would need to invest a significant amount beforehand, estimations range from 187 M€ to 295 M€ depending on how the unpaired part of the terrestrial 2 GHz band would be used- to roll out the infrastructure needed for LTE in both the FDD and TDD bands. Mobile operators have supported a harmonisation and liberalisation of the FDD bands in the terrestrial 2 GHz band, so mobile operators see a business case for deploying LTE in the FDD bands. However, whether the mobile operators are willing to make such an upfront investment in the 2 GHz TDD bands, in which up to now no business case developed, is questionable.

Such an investment is perceived as too risky given the history of little use of the unpaired bands. This is confirmed by the public consultation.

Administrative impact due to separate approach for the TDD bands

While option 2 could be realised within the current spectrum assignments, any other usage scenario highlighted under option 3 for the TDD bands would necessitate refarming[56] or re-allocation of radio spectrum. As the TDD bands are unused, virtually no legacy equipment would need to be exchanged or discarded. However it is difficult to estimate how costly it would be to take back licenses from mobile network operators. Experience from the past with refarming of other bands does not represent a sound basis for comparison, since these bands had been heavily used and therefore a significant value was attached to radio spectrum. At the same time, even if the licensed radio spectrum in the TDD bands is not used and the economic value of these bands is limited, mobile network operators might not be willing to give these back given the existing spectrum scarcity and because of concerns that FDD bands could be interfered from the adjacent TDD bands.

Re-farming might also trigger some administrative work for both mobile network operators and national administrations as they would need to handle the implementation of refarming and bear implementation costs. Therefore a significant uncertainty exists as regards implementation costs.

It is difficult to argue on a quantitative basis on the potential economic impact of allocating the TDD bands to other applications. Benefits of future action cannot be estimated today, since CEPT studies have not been conducted yet on how the technical conditions would look like if the TDD bands were used for other applications than for ECS. Without such studies however, no quantification can take place in economic terms as key inputs and assumptions with regard to the amount of spectrum that can be actually used are unclear. Therefore it cannot be calculated what the quantity of possible services provided would be, which would be a necessary input for the quantification of the producer and consumer surplus.

As a conclusion it is too premature assess at this point the impact of the TDD bands if other applications than ECS are considered to use this band. There are no particular risks or costs linked to the fact that under this option the unpaired spectrum bands are tackled separately from the paired ones.

5.2. Comparison of options

Problem-solving

Both Options 2 and 3 indicate that harmonisation of the FDD bands creates a net socio-economic benefit compared to the baseline scenario and is therefore worthwhile to implement. Moreover, the public consultation has shown that there is strong support for the view that liberalisation and harmonisation is necessary in the FDD bands.

Description of the policy option and main assumptions	**Net Present Value (NPV) 2011-2021**
Policy option 1	
No regulatory action	-

56 Spectrum refarming (or re-allocation and/or re-assignment of spectrum) refers to the process of changing the allowed uses of specific radio frequency bands and sub-bands.

Policy option 2	
Operators roll out LTE on the TDD band in 2013 and on the FDD band in 2016	€1,138M
Operators roll out LTE on the TDD and FDD bands in 2016	€976M
Provision of downlink-only services in the TDD band	€73M
TDD band paired with another band to provide FDD services (roll-out in 2013)	€341M
TDD band paired with another band to provide FDD services (roll-out in 2016)	€235M
Policy option 3	
Harmonised liberalisation of the FDD band only (as of 2013)	€135M
Harmonised liberalisation of the FDD band only (as of 2016)	€108M

The harmonised liberalisation of the paired sub-bands of the terrestrial 2 GHz band under Options 2 or 3 addresses both specific problems identified for the FDD bands in section 2.2 of this impact assessment (specific problems 1 and 2). It is unlikely that the problem of underutilisation of the unpaired bands could be solved by the implementation of Option 2.

On the other hand, as explained in the previous section, significant uncertainty exists as regards the viability and feasibility of the use of the TDD bands for ECS. The CBA model assumes that MNOs would see a business case for such usage of the TDD bands and would be willing to implement these usage possibilities under Option 2. The CBA calculated for potential ECS use of the TDD bands foresees significant increase in producer surplus, meaning additional profit to MNOs, compared to relatively small increase in consumer surplus. However, the public consultation indicates that MNOs have marginal economic interest in the use of the TDD bands.

Furthermore, the current licensing structure as well as the technological development (e.g. for RF handsets) would lead to significant delays in the availability of mobile services in the unpaired bands compared to the assumptions of their rollout by 2013 under Option 2.

From the consumers' point of view, the CBA has identified added value in the form of consumer surplus, with the consumption of more services due to an augmented ability of the MNO to satisfy more demand to deliver existing mobile voice and broadband data services. However, if it is unlikely from the MNOs perspective that the TDD bands were used for ECS in the future, only a portion of the estimated consumer surplus could be realised with the liberalisation of the FDD bands. There are also other applications that could use the TDD bands, e.g. broadband public protection and disaster relief (PPDR) services or wireless short range communications like DECT or WiFi, which could generate significant benefits to the society and could outperform the probable added value of the use of the TDD bands for ECS. In the absence of concrete technical conditions which set operational limitations and translate into costs, a reasonable quantification of economic impact of potential other uses for the TDD bands cannot be undertaken at this point in time.

As regards the implementation of Option 2 there may not be an economically viable case for using the 2 GHz TDD bands to provide additional network capacity in all Member States. Therefore liberalisation of the 2 GHz band may result in little or no primary economic benefits in these countries (see in more detail in Annex 3 under the results of the sensitivity analysis). Nevertheless considering countries where there are a high number of subscribers, an early liberalisation is required to maximise the potential economic benefits in line with the increasing demand for mobile broadband services.

Option 3 would address all 3 specific problems, either directly through the harmonised liberalisation of the paired bands, or indirectly through a more thorough investigation of what applications to allocate the unpaired bands for, in line with the majority of views during the public consultation. While Option 2 addresses the problems for the paired bands, the 3rd specific problem for the TDD bands driven by regulatory failure (outdated regulatory set-up) is not solved and interference from services provided in adjacent bands is not avoided. Option 3 provides the possibility to address the major drawback of using the TDD bands – the potential of harmful interference – better than the other options at stake.

Impact on competition

A harmonised liberalisation of the 2 GHz band implies a shift from the only mature broadband technology today (UMTS/HSPA -3G) to emerging, more spectrum-efficient broadband technologies (e.g. LTE - 4G). Such a change is unlikely to trigger competitive distortions for the following reasons:

(i) all operators in Europe that have 2 GHz spectrum would also have either greenfield spectrum, where there is no existing use or legacy to take into account (800/2600 MHz) or 1800 MHz spectrum to deploy broadband first so that any competitive distortion will already have been addressed in that context.

(ii) broadband is already possible at 2 GHz today with UMTS and operators are likely to phase out this mature technology at a later stage, well after investments in other more attractive bands have been made. New technologies will bring more dramatic efficiency gains in other bands while the improvement of user experience with broadband services at 2 GHz will remain marginal. Therefore, the impact on competition in the wireless (mainly mobile) broadband markets in the mid-term will be limited compared to the developments in competing harmonised spectrum bands at EU level.

In general, the impact of a spectrum asset on competition for the provision of ECS must be evaluated in a holistic way taking into account all spectrum holdings of operators (regarding frequency position and spectrum amount) on a particular market. It is the spectrum mix, which finally determines the competitive situation of an operator, since different bands have different levels of ecosystem development as well as propagation and capacity characteristics.

Liberalisation of the bands and harmonisation of technical conditions can provide for higher economies of scale, stronger incentives for investment and innovation, as well as cross-border interoperability between applications and services. The lack of additional barriers and stronger coordination in the market should have a positive impact on competitiveness of the mobile/wireless industry.

The implementation of Option 3 in relation to the unpaired bands could also potentially have an impact on competitiveness of businesses other than the mobile network operators and manufacturers. However, at this stage it cannot be determined what the unpaired 2 GHz band could be best used for and therefore implications on the economy and the competitiveness cannot be specified for this part of the 2 GHz band at this stage. Nevertheless, under option 3 there is a better potential to ensure usage of the unpaired bands, e.g. by sharing this band between different applications.

In addition, the table below compares and summarises differences between the policy options in qualitative terms.

Policy Option	Pros	Cons
1. Baseline	For FDD bands: no regulatory action at EU level gives the Member States more freedom to act according to national specificities. For TDD bands it is certain that no harmful interference is caused to adjacent FDD bands as this band is underutilised/ unused. The TDD bands would need to be refarmed from current license holders to allow other applications to use these bands as currently licensed for. This cost is avoided in a no change scenario. Significant differences exist of added value of a liberalised harmonisation at Member States level.	For FDD bands: Technological change is carried out in an uncoordinated manner throughout the Member States with diverging speed and timing. Flexibility is not granted to the MNOs/ to the market to migrate to more efficient technologies as need arises. A rigid regulatory approach in the usage of the terrestrial 2 GHz band limits the ability of the market to react to changes in demand. This poses an additional network capacity constraint on the MNOs, while demand for wireless services is estimated to explode the next years due to new services requiring more and more data traffic. For TDD bands: A significant number of applications could potentially use the TDD bands while current license holders only hoard the spectrum without using it. This is not an efficient usage of a scarce resource and is a lost opportunity to society and the economy.
2a. Harmonised liberalisation of the whole terrestrial 2 GHz – *FDD bands*	Legal certainty is provided to stakeholders at European level. This ensures an appropriate climate for further investment and provides the necessary flexibility of MNOs to migrate to more efficient technologies according to market demand. As additional network capacity is made available through the technological change, more demand for mobile voice and broadband data services can be satisfied benefiting both the European economy and society. A European approach supports an internal market, helps to achieve economies of scale and to bring down equipment costs.	Since the paired part of the terrestrial 2 GHz band is only one of the many bands available to MNOs and represents only a small proportion of total network capacity, regulatory action does have a significant but still relatively limited effect on the overall network capacity of MNOs to meet demand and on economies of scale and cost of equipment. Also some parts of the handset (i.e. the radio frequency component) become more costly with the number of frequency bands and technologies to be supported.

2b. Harmonised liberalisation of the whole terrestrial 2 GHz – *TDD bands: low power, downlink- only or pairing*	The use of the TDD bands for ECS supports core MNO services. Lower power usage could support M2M communications means synchronisation of transmission would not necessarily be required and therefore the risk of harmful interference is reduced. The provision of downlink only services potentially enables a new suite of high bandwidth broadcast applications that cannot be cost-effectively delivered over current FDD bands. The value for these services may be perceived by consumers as higher than current voice and data services potentially resulting in higher producer and consumer surpluses than calculated in the CBA. Additional spectrum efficiency gained from providing common downlink only service to multiple operators through spectrum pooling and sharing i.e. a greater number of users make use of common content.	Low power usage is possible today is to some extent is already deployed today in Member States, while for the cost-benefit analysis it was assumed that this was not the case. Therefore the calculation of achievable additional economic benefit compared to the baseline scenario seems too optimistic. It may require Europe wide spectrum pooling or spectrum trading to realise sufficient spectrum for feasible implementation of downlink only services supporting high bandwidth broadcast applications which could result in additional costs or delays in implementation. Furthermore, additional handset modifications may be required to support push services that require handsets to cache data transmitted over 2 GHz TDD bands. In case of pairing the TDD bands identifying a suitable band to pair with is not straightforward and has already been subject to much discussion with no agreement reached.

		For the allocation of an additional band to pair the TDD bands with, agreement is likely to be needed also at international level (i.e. at the next World Radio Conference organised by the ITU, an UN body, in 2015). This suggests that such a band could become available only on the long term and would render the TDD bands underutilised or unused for a long period of time. The regulatory failure resulting from an outdated regulatory set-up is not solved and interference from services provided in adjacent bands is not avoided. The costs for acquiring the paired spectrum are not taken into account in the CBA but could be significant and would need to be considered on a case by case basis. The TDD band remains still underutilised/ unused for the time being until further investigations are not carried out. This represents an opportunity cost. A significant number of applications could potentially use the TDD bands while current license holders are likely to continue to only hoard the spectrum without using it.
3. Harmonised liberalisation of the 2 GHz FDD bands only, no action for the TDD bands.	For the paired bands the benefits outlined under option 2 as regards a harmonised liberalisation are achieved. Supports core MNO services but without the potential reduction in service quality. All problems identified in the problem definition are either solved directly, or are addressed in the course of further study for the TDD bands It is very likely that allocation of the unpaired bands to other applications would result in usage of the TDD bands.	The TDD band remains still underutilised/ unused for the time being until further investigations are not carried out. This represents an opportunity cost. Implementation costs in the form of re-farming costs will need to be born.

5.3. Assessing administrative burden

The initiative which this impact assessment accompanies is a Commission Implementing Decision. The processes to develop and agree on an Implementing Decision are based on the Radio Spectrum Decision. It is very closely linked to the WAPECS initiative and as such does not constitute a measure which would trigger new information requirements. The same reporting requirements would apply as regards the terrestrial 2 GHz band as now. These would relate to the implementation of the Commission Decision (2007/344/EC), which establishes a European portal for public access to information about spectrum use in Europe (see www.efis.dk). Also at national level no additional information requirements are necessary to implement this initiative.

Therefore this initiative is considered to be neutral as regards administrative burden since it neither saves nor creates additional administrative costs to Member States and mobile operators.

5.4. Conclusions

Option 2 shows the potential that can be achieved in socio-economic benefits in case regulatory action on harmonised liberalisation of the whole terrestrial 2 GHz band is accompanied by common action from market players, mainly mobile network operators and equipment manufacturers. For the 2 GHz paired bands (1920-1980 MHz and 2110-2170 MHz) such common action is very likely and confirmed through the contributions to the public consultation organised on this subject.

However, for the 2 GHz unpaired bands (1900-1920 MHz and 2010-2025 MHz) even if the regulatory restrictions are removed a significant uncertainty exists, whether manufacturers would develop the necessary equipment that would serve also the TDD sub-bands of the terrestrial 2 GHz band. Moreover, mobile network operators who have obtained licences for the unpaired bands maintain the position that there is hardly any business case to provide wireless broadband services in the TDD bands.

Option 3 shows the socio-economic benefits that are likely to be achieved in the **paired** spectrum and opens the possibility to use the **unpaired** spectrum of the terrestrial 2 GHz band in an alternative manner, namely for services other than electronic communication services. Given the barriers and uncertainties elaborated above that are likely also in the future to hamper the use of the TDD bands for broadband electronic communication services, an alternative usage of the unpaired bands looks more promising even if it necessitates further technical investigation on the subject as well as implementation delay.

Concluding the analysis above the option suggested to be implemented is **Option 3**.

6. EVALUATION AND MONITORING

Access to information about how spectrum is used is crucial for regulators and stakeholders alike. First requirements at EU level to make such information available can be found in the Radio Spectrum Decision (767/2002/EC) and in a specific Commission Decision (2007/344/EC), which establishes a European portal for public access to information about spectrum use in Europe (see www.efis.dk). The information collected in this context gives a good picture of how spectrum is allocated and designated at national level; however it fails to convey how the spectrum is actually being used.

In order to be able to assess in more detail how the high value spectrum is actually used and which parts of it could be used more efficiently so as to accommodate demand for services of high socio-economic value, Article 9 of the Radio Spectrum Policy Programme establishes an inventory of spectrum use examining both commercial and public use of spectrum, in particular for those services, which could operate in the frequency range from 400 MHz to 6 GHz.

The inventory has the objective to allow identification of spectrum bands where efficiency of existing spectrum use could be improved in order to accommodate spectrum demand in support of Union policies, promote innovation and enhance competition.

To achieve the objectives, the Commission shall adopt implementing acts assisted by the Radio Spectrum Committee (RSC). The implementing acts will cover a) practical modalities and uniform formats for the collection and provision of data by the Member States to the Commission on the existing uses of spectrum and b) a methodology for an analysis of technology trends, future needs and demand for spectrum in Union policy.

The inventory will provide the methodology and tools to evaluate and monitor how radio spectrum is actually used at European level, ensuring consistency throughout the EU. Since the 2 GHz band falls within the scope of the inventory established by the RSPP, the initiative that is accompanied by this impact assessment will be incorporated into the inventory of radio spectrum use.

Beyond the inventory there are a number of indicators which could serve for monitoring purposes, as follows:

1. By Member State number of mobile network operators/ other users actually using the unpaired terrestrial 2 GHz band

2. Number of mobile network operators who have migrated to more efficient technologies than UMTS in the paired terrestrial 2 GHz band by Member State (alternatively: number of licences which have been changed to respect the technology and service neutrality principles and number of operators who actually offer fourth generation services)

3. Aggregated number of base stations at national level in a Member State for the terrestrial 2 GHz band (FDD and /or TDD)

4. Aggregated level of traffic at national level in a Member State in the terrestrial 2 GHz band (FDD and /or TDD)

5. In relation to devices: how many models are on the market, which are capable of serving several technologies and radio spectrum bands, including LTE in the terrestrial 2 GHz band? What is their market share compared to devices which do not allow for the usage of the terrestrial 2 GHz band?

7. ANNEX 1: RESULTS OF THE PUBLIC CONSULTATION

The views of stakeholders with respect to the specific Commission's proposals in the questionnaire are summarized in the table below.

Proposal	Explicit support	Explicit opposition	Comments
Harmonised liberalisation of the band, i.e. service and technology neutrality under harmonised technical conditions	*Paired spectrum only*: Huawei (list of standards), IPWireless*, PTS, GSMA, France, Deutsche Telekom* Hutchison*, Denmark, a confidential respondent, Nokia-NSN, SFR, WIND, Vodafone, Telefonica	DLR, GRAF, DECT Forum, ETSI TC DECT	* These respondents have expressed concerns about potential interference between different technologies or about the retro-active impact of harmonisation on existing licence conditions. Ericsson, GSMA, Nokia-NSN, SFR, WIND expressed support for an IMT liberalisation path
Low-power scenario in the unpaired spectrum	COIT, Hutchison (*maybe*, only upper band), Nokia-NSN, *WIND (2nd best solution)*	ITAS, Qualcomm, DECT Forum, Ericsson, Huawei, GSMA, Deutsche Telekom, Hutchison (only lower band), a confidential respondent, Germany, France, Denmark, Telecom Italia, SFR	Overall lack of support
Downlink-only scenario for the unpaired spectrum	IPWireless, PTS (local markets), Hutchison (*maybe*, only upper band)	ITAS, Qualcomm, DECT Forum, Ericsson, Huawei, GSMA, Deutsche Telekom, a confidential respondent, Hutchison (only lower band), Germany, France, Denmark, Nokia-NSN, Telecom Italia, SFR, WIND, Vodafone	Overall lack of support Concerns by one stakeholder on interference with ground components of mobile satellite systems
Hybrid use of both unpaired sub-band,	IPWireless (*maybe*), Nokia-NSN (*maybe*)	ITAS, Qualcomm, DECT Forum,	Overall lack of support.

according to both proposed scenarios i.e. a different scenario in each sub-band		Ericsson, Huawei, GSMA, Deutsche Telekom, a confidential respondent, Germany, Denmark, France, Telecom Italia, SFR, Vodafone	However, different harmonisation measures per unpaired sub-band suggested (France)
Spectrum trading/sharing	Telenor, IPWireless, Nokia-NSN, WIND, Vodafone, Telefonica, Huawei		Overall support for such measures in the unpaired spectrum
M2M (Machine to Machine Communication) in unpaired spectrum – shared under the low-power scenario	COIT	ITAS, Qualcomm, Ericsson, Telenor, GSMA, IPwireless, France, Deutsche Telekom, a confidential respondent, Hutchison, Germany, Denmark, France, Telecom Italia, WIND, Vodafone	Overall lack of support More precise description of use case required by some stakeholders
Harmonisation of the paired spectrum only; postponement of a decision on unpaired spectrum	Qualcomm, Telenor, GSMA, France Germany, Denmark, Vodafone, Telefonica		Overall support

Mobile broadband options	**Explicit support**	**Explicit opposition**	**Challenges**
Mutual pairing of both unpaired sub-bands – 2x15 MHz	(DECT Forum, Vodafone, Nokia-NSN)	(Deutsche Telekom)	None, protection of adjacent DECT bands favoured
Pairing with additional bands: 1900-1920 with 2090-2110 MHz and 2010-2025 with 2200-2215 MHz	(Telenor[57], GSMA, Telecom Italia, SFR, VF[58], Telefonica, Hutchson, a confidential respondent)		Sharing conditions with other existing applications to be studied. Potential issues with international regulations (ITU Radio Regulations). A new band channel plan proposed by a

[57] No bands specified
[58] Only 1900-1920 MHz with 2090-2110 MHz mentioned

			confidential respondent.
Backhaul wireless relay	(COIT, a confidential respondent)		Specified by the applicable standard
Uplink only	(Finland, DECT Forum, Ericsson)		Related to pairing options, where the unpaired spectrum is used in the uplink
Use for systems compliant with the mobile internet standard IEEE 802.20 – packet-based air interface for IP services	(ITAS)		Mobile Broadband Wireless Access[59]
Alternative options for the unpaired sub-bands			
Broadband public protection and disaster relief (PPDR) - paired	(France, IP Wireless)		
DECT	(France, DECT Forum)		
Direct-Air-to-Ground-Communications (DA2GC) - paired	(Germany, France, Deutsche Telekom)		Fragmentation of the unpaired spectrum possible, since 2x10 MHz needed
Conduct technical studies at CEPT in order to find an appropriate option	(Qualcomm, GSMA)		More respondents have implicitly supported this option
Collective use[60] – femtocells / Internet of Things / Machine to Machine communications (M2M)	(COIT)		Collective unlicensed use for different applications
Programme Making and Special Events (PMSE)	(Germany, France)		Such as wireless cameras
Short-Range Devices	(France)		

59 http://ieee802.org/20/

60 Collective Use of Spectrum (CUS) allows an undetermined number of independent users to access spectrum in the same range of frequencies at the same time and in a particular geographic area under a well-defined set of conditions. It complements the concept of individual rights of use where only one user holds the right to use a specific part of the spectrum.

8. ANNEX 2: ASSIGNMENTS AT NATIONAL LEVEL OF THE UNPAIRED TERRESTRIAL 2 GHZ BANDS

	1900-1920 MHz			2010-2025 MHz		
LICENCES	**assigned / technology**	**Year of expiry**	**used**	**assigned / technology**	**Year of expiry**	**used**
Austria	UMTS	2020	NO	UMTS (5 MHz)	2020	NO
Belgium	IMT2000	2021	NO INFO	NO	n.a.	NO
Bulgaria	NO INFO			UMTS*	2015-2025*	NO INFO
Cyprus	UMTS (10 MHz)	2023-24*	NO	NO	n.a.	NO
Czech Republic	UMTS	2022-25*	YES (1xMNO)	NO	n.a.	NO
Denmark	UMTS	2021	NO INFO	NO(NEUTRAL)	n.a.	NO
Estonia	UMTS/IMT	2012-17	NO	NO(IMT)	n.a.	NO
Finland	UMTS	2019*	NO INFO	NO	n.a.	NO
France	UMTS (15 MHz)	2021-22	NO INFO	NO	n.a.	NO
Germany	NEUTRAL	2020	NO	NEUTRAL	2025	NO
Greece	NO INFO			NO INFO		
Hungary	IMT2000/UMTS	2019*	NO	NO(IMT2000/UMTS)	n.a.	NO
Ireland	IMT2000/UMTS (10MHz)	2022	NO	NO	n.a.	NO
Italy	IMT	2021	NO INFO	NO	n.a.	NO
Latvia	IMT2000/UMTS (15MHz)	2017-20	NO	NO	n.a.	NO
Lithuania	RESERVED*	n.a.	NO INFO	RESERVED*	n.a.	NO INFO
Luxembourg	UMTS	2017-23*	NO	NO (UMTS)	n.a.	NO
Malta	UMTS (15 MHz)	2020-22*	NO INFO	NO	n.a.	NO

Netherlands	NEUTRAL/request (15 MHz)	2016	NO	NEUTRAL/request (5 MHz)	2016	NO
Poland	UMTS*	2023*	NO INFO	NO INFO		
Portugal	UMTS*	2016*	NO INFO	NO*	n.a.	NO
Romania	UMTS*	2020-22*	NO INFO	NO INFO		
Slovakia	UMTS (15 MHz)*	2022-26*	NO INFO	NO INFO		
Slovenia	UMTS (15 MHz)	2016-21*	NO INFO	NO(UMTS)	n.a.	NO INFO
Spain	UMTS*	2020*	NO INFO	NO INFO		
Sweden	NEUTRAL (15 MHz)	2025*	NO	NO (NEUTRAL)	n.a.	NO
United Kingdom	UMTS*	2021*	NO INFO	NO INFO		

* Based on information from the ECO report 03 on the licensing of "mobile bands" in CEPT (12/1/2012)

9. ANNEX 3: ASSUMPTIONS AND PARAMETERS OF THE MODEL USED TO CALCULATE THE NET ECONOMIC BENEFITS UNDER POLICY OPTION 2 AND 3

In order to assess the impact of a harmonised liberalisation of the paired (FDD) and unpaired (TDD) terrestrial 2 GHz band, it is assumed that the unpaired bands would be used to provide electronic communication services. The model first estimates the performance of a representative network in the baseline scenario and then modifies the network to determine the difference in the resulting network capacity and cost in the other scenarios.

9.1. Inputs

Examining the impact of the policy options in Member States requires flexibility of the adopted model. This is achieved by taking a number of inputs which are then used to assess network capacity.

Table 9-1: Variable inputs to the cost and capacity model

Input	Description
Amount of spectrum in each available band	This can be set to represent any particular operator in any given country. For the purposes of the baseline scenario, it has been assumed that there are [n] operators and that every band is available (or will become so) over the period of the model such that the operator in question has access to: 2 x 30/[n] MHz in the 800 MHz band 2 x 35/[n] MHz in the 900 MHz band 2 x 75/[n] MHz in the 1800 MHz band 2 x 60/[n] MHz in the 2 GHz FDD band 15/[n] + 20/[n] MHz in the 2 GHz TDD bands 2 x 70/[n] MHz in the 2600 MHz FDD band 50/[n] MHz in the 2600 MHz TDD band
Use of different technologies.	It is assumed that, for those bands which can support multiple technologies (e.g. 900 MHz), over a period of time, some spectrum is re-farmed from the existing technology to a (newer) alternative. Roll-out of new technologies does not occur until sufficient spectrum has been released to enable it. In newer bands (e.g. 2600 MHz), a roll-out of technology over time is assumed. The speed and timing of roll-out can be varied.
Number of cell sites deployed	The total number of cell sites used by an operator is broken down into Femto, Pico and Micro/Macro cells. The overall number of sites is assumed to grow over the period of the model. It is assumed that older technologies (e.g. GSM 900/GSM 1800) are installed on the majority of sites and that these sites are re-used for newer technology as it is rolled out rather than additional new sites being developed.

Spectrum efficiency of different technologies	In order to assess the capacity which the network can produce, the spectrum efficiency of each technology (in Bits/sec/Hz) is required. This is based on the following averages: 0.17 Bits/sec/Hz/cell for GSM[61] 0.51 Bits/sec/Hz/cell for UMTS 1.28 Bits/sec/Hz/cell for LTE[62]
Network utilisation	The model calculates the total network capacity. However the MNO infrastructures are built to meet the peaks in demand; therefore not every cell will be used to its full capacity, nor will it be fully utilised every hour of the day. To reflect this, and based on discussions with MNOs, a factor of 20% has been applied to the total network capacity generated to represent the capacity actually available for consumption as opposed to the theoretical maximum capacity generated assuming a constant 24/7 demand. However, we also look at the impact of using lower (10%) and higher (30%) utilisations in the sensitivity analysis.
Type of capacity	Most technologies deliver unicast data connectivity; however one scenario considers the use of broadcast (IMB/EMBS) technology which delivers multicast capability.
Handset capability	Whilst networks can be developed using specific technologies, the capacity which that network generates cannot be used until it can be consumed in user terminals (e.g. handsets). As such, account is taken of the proportion of handsets in any given year which are capable of using the available network technologies. Handset capabilities are considered on a per technology basis only i.e. they are assumed to support all frequencies considered in the CBA. The new technologies will be included in handsets by the manufacturers as part of their overall product development roadmap.

9.2. Estimating capacity

Total network capacity is calculated as the sum of the capacity produced by each cell, of each technology type, in each band, as modified by the utilisation factor.

Key assumptions:

No specific account has been taken of the utilisation of the network for the delivery of voice calls. Where mobile penetration has reached 100% (as it has over most of Europe), the load on the network due to voice calls is relatively constant (in data bandwidth terms) over the period of the model. This represents a base load on the network which becomes a smaller proportion of overall network traffic as data usage grows. Whilst the inclusion of voice traffic would be important for calculating differentials in pricing, it is reasonable to assume that any growth in network capacity will be used for delivering enhanced data connectivity and not additional voice capacity and given that the model is comparing the network year-on-year, voice can safely be treated as a fixed data load.

[61] "Edge – Enhanced data rates for GSM evolution", Anders Furuskär, Jonas Näslund and Håkan Olofsson, Ericsson, 1999

[62] "4G Capacity Gains, Report for Ofcom", http://bit.ly/j8uGyU

No additional spectrum becomes available to MNOs during the period of the analysis, outside of those already considered in this study[63].

The UMTS TDD bands will eventually be used in the "Do Nothing" reference case but only after all other options for capacity increase with FDD bands has been exhausted. It is therefore assumed that full use of the UMTS TDD bands would only happen at a much later date outside of the time duration of the CBA. Within the time duration of the CBA only limited use will be made of the UMTS TDD bands in the "Do Nothing" case based on some IMB implementations and small TDD networks currently implemented in Eastern Europe.

The network capacity is calculated individually for femto cells (Group I), pico cells (Group II) and macro/micro cells (Group III). The current cell site populations are: femto cells: 0; pico cells: 3,000; macro/micro cells: 7,000. The number of both pico and macro/micro cells increase by 2% each year.

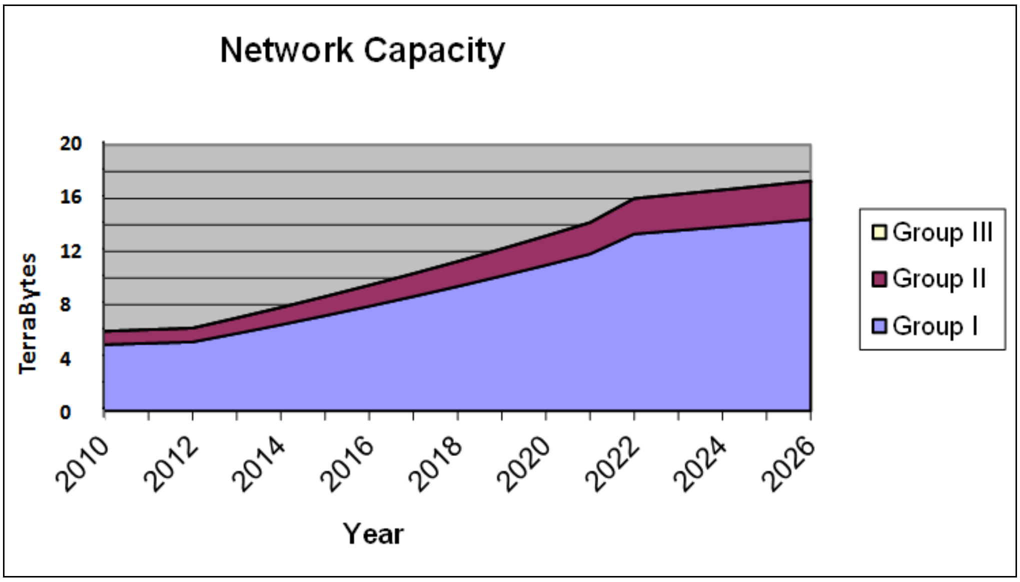
Femto cells will only exhibit a significant uptake within the context of low power TDD services and in this scenario they will increase to 1,085,856 by 2021 based on a market study carried out by the femto forum.

A separate network utilisation figure of 2% was applied to the use of femto cells . This value was chosen to be 1/10th of the utilisation of the rest of the network to reflect the fact that the amount of time a femto cell was likely to be in use during a day is less than macro or micro cells.

In case that the TDD bands were used for asymmetric downlink only services it was assumed that on average 4 users in each FDD cell would be using common content that could then be delivered via the 2 GHz TDD cell. Therefore, each 1 MB of capacity provided by the 2 GHz TDD cells results in a capacity increase equivalent to 4 MB across the network.

Figure 0-1 below, illustrates an example output of the network capacity model. The total capacity is shown per cell type (group I being macro/micro cells, group II being pico cells and group III being femto cells which are not widely used in this particular example).

Figure 0-1: Example network capacity calculation



63 Whilst this is unlikely to represent actuality, additional spectrum will impact equally across all scenarios. Though this may change the absolute value of the results, it will not impact the relative assessment of options.

9.3. Calculating costs

The cost of infrastructure and equipment required to increase the MNO network capacity in any given year was calculated taking into account the following inputs:

Cell site costs

Number of new cell sites;

Number of sites that will be upgraded and the new technology that will be implemented.

Backhaul costs

Cost to increase backhaul capacity where current cell site thresholds are exceeded[64].

Additional key assumptions that were made in calculating costs are as follows:

The main sources of cost are in the implementation of new cell sites or upgrading equipment at existing cell sites, and backhaul. All other costs (such as base station controllers, mobile switching centres, and so forth) are considered an order of magnitude lower given the smaller number of upgrades and changes that will be required to those network elements than to cell-sites and backhaul. In addition it is assumed that operating costs remain the same in the baseline and all other scenarios and can therefore be ignored.

Femto cells are assumed to utilise existing backhaul infrastructure (e.g. local ADSL connections) and therefore backhaul costs are only applied to pico and macro/micro cells.

IMB and EMBS will use satellite links for backhaul rather than fixed point-to-point links. Satellite links are a cost efficient way of delivering common content to multiple cell site locations.

Although there is a cost associated with the production and distribution of handsets with new capabilities (i.e. supporting new technologies or with new filters) it is assumed that these costs are largely the same in both the reference case and the scenario under investigation. These costs can therefore be ignored when considering the difference in cost between the reference case and any particular scenario. For example, based on the feedback received from equipment manufacturers during the survey it is assumed that new handsets entering the market will include multi-mode, multi-band chipsets that are UMTS FDD, FD-LTE and TD-LTE capable; the costs of implementing RF components in a handset is minimal and that timing of any policy decision will not greatly impact the market penetration of new devices.

No costs have been included for any equipment external to the handset required to utilise a frequency/technology/service. It is assumed that external equipment is only required in the case of IMB where the UMTS TDD technology is implemented in a USB dongle which is attached to a handset. However, due to the relatively small amount of IMB usage assumed in both the baseline and the other scenarios this additional cost is assumed to be marginal and not significant to the overall outcome.

Any costs associated with realising the pairing of spectrum (for scenario 2.3) are not taken into account but could potentially be significant and would need to be considered on a case by case basis.

Within each scenario the MNOs will use the available frequency bands in the same way (i.e. the use of the bands is harmonised; no standalone decisions will be made; all operators will assume the same option collectively). Therefore any additional costs associated with coordinating use of the bands in the case of non-harmonised use are not considered.

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[64] Note that it is assumed that femto cells require no (network provided) backhaul as they are connected to the user's own Internet connection.

The cost figures are assumed constant for the duration of the analysis period and are based on current costs.

9.4. Calculating demand

The demand for mobile broadband data was derived from predictions made in various widely recognised industry reports[65] [66]. In particular the current global demand for mobile data is 240,000 Terabytes per month according to Cisco's 2011 white paper on traffic growth. The paper reports high growth in the immediate term with 150% growth set for this year. The annual growth steadily declines reaching 56% for 2015, its final year of forecast.

In addition the following key assumptions relating to demand were made:

The demand curve is assumed to represent exogenous demand (i.e. the level of demand if there were no capacity constraints).

The demand curve assumes demand for data associated with M2M applications as well as user orientated applications and services.

This forecast trend is extended beyond 2015 (based on professional judgement) with a continuing decline in annual growth reaching a steady continuous 5% growth from 2020 onwards.

A country specific demand trend is derived from the above global trend on the basis of population. In turn, the specific demand for a single MNO is obtained by dividing by the total number of MNOs in the country assuming each has an equal share of the market.

Different data demand growth predictions were also investigated in the sensitivity analysis.

9.5. Additional high-level assumptions

The table below describes the additional high level assumptions made in the cost-benefit analysis.

Table 9-2: Key CBA input assumptions

CBA Parameter	Assumption	Note
Cash flows	Nominal cash flows	The cash flows used in the CBA are not adjusted for inflation
Time duration of analysis	10 years (2011 to 2021)	The analysis is restricted to 10 years because it is difficult to predict technology and market developments and MNO plans beyond this time frame.
Date of liberalisation (2 GHz bands)	2013	This is the date that liberalisation is assumed to be implemented in the 2 GHz (FDD and TDD bands). (Note that the process of liberalisation may begin before this date.) Any rollout of new technology enabled by liberalisation is assumed to start in the year before the liberalisation but accelerate following liberalisation. The impact of changing the liberalisation date to 2015 and 2017 is also investigated in the

[65] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010–2015, Cisco Whitepaper, February 2011

[66] Wireless network traffic 2010–2015: forecasts and analysis, Analysys Mason, July 2010

CBA Parameter	Assumption	Note
		sensitivity analysis.
Date of liberalisation (other bands used by MNOs)	2013	This is the date that liberalisation is assumed to be implemented to other (non 2 GHz bands) that are used by MNOs to deliver mobile voice and broadband data services). Any rollout of new technology enabled by liberalisation is assumed to start in the year before the liberalisation but accelerate following liberalisation. This date is applied in the same way in both the reference baseline as well as the scenarios under investigation.
Discount rate (for nominal cash flows)	10%	The discount rate reflects how the cash flows are valued over time and in particular reflects the expected rate of return for an investment from a commercial point of view. Source figures [67] [68] [69] suggest values ranging from 3.5% for a rate of return to reflect society's value of the benefits, 5% for the opportunity cost of capital (the likely return for an alternative investment of the capital) to 11.5% for a rate of return expected by a commercial organisation in the mobile sector. For investments that are considered risky higher discount figure may also be used. It is noted that these discount rates are for real cash flows and the CBA is conducted for nominal cash flows. These figures are therefore used to provide an indicative range of discount rates. For the purposes of this analysis we have chosen 10% as an appropriate commercial discount rate for the mobile sector but we also look at the impact of changing this to 5% and 15% in the sensitivity analysis.
Price of data	€0.013 per MB	The price the user pays for consuming data is based on research conducted into typical current data price plans offered by operators in Europe, an Ofcom UK market assessment [70] and a report on European data roaming prices[71]. It is assumed that price paid by consumers for the additional capacity is set based on the general demand for mobile broadband data. The research

67 Application of spectrum liberalisation and trading to the mobile sector - A further consultation, Ofcom, February 2009

68 The Green Book, HM Treasury (http://www.hm-treasury.gov.uk/data_greenbook_index.htm)

69 http://ec.europa.eu/regional_policy/sources/docoffic/2007/working/wd4_cost_en.pdf

70 Mostly Mobile, Ofcom's mobile sector assessment, Second consultation, July 2009

71 International Roaming BEREC Benchmark Data Report, Body of European Regulator for Electronic Communications

		indicated that the current price levels are in the range €0.013 to €0.13 per MB with prices generally falling year on year, although with demand for data expected to increase rapidly in the coming years it is assumed that we are currently approaching a price equilibrium point where the price will stabilise. It is likely that the price of data will continue to change over time and also for different types of services. However, it is difficult to predict this trend within any certainty. Therefore for simplicity of analysis the price has been kept constant at the bottom of the currently established price range but we also look at the impact of increasing this value in the sensitivity analysis.
Price elasticity of demand	-1.0	The price elasticity represents the responsiveness of changes in demand to percentage changes in price (price elasticity = % change in demand / % change in price). The value chosen was taken from the reference literature sources [72] [73] that most closely match the scenarios under investigation in this CBA. The value was derived through historical analysis in the mobile market and applying assumptions as to how it would change in the future. Like the unit price of data the actual price elasticity is likely to vary with time and for different types of services. New services may be considered as luxury goods attracting higher prices and higher (magnitude) price elasticities. Therefore for simplicity of analysis the price elasticity has been kept constant but we also look at the impact of the price elasticity increasing to -0.5 or decreasing to -1.5 in the sensitivity analysis. The range of the increase or decrease was set based on the typical range of price elasticities observed during the research.
Country type under analysis	UK - high number of cell sites and subscribers	The UK had the widest range of data (price, number of subscribers, number of operators, number of cell sites, costs) readily available to the project team and therefore was selected as the reference country on which to carry out the initial analysis. However, other European countries (characterised in terms of number of subscribers and cell sites) were also investigated in the sensitivity analysis through additional case studies based on data obtained for Romania, the Netherlands and Slovakia.

[72] Application of spectrum liberalisation and trading to the mobile sector - A further consultation, Ofcom, February 2009

[73] 'Economic impact of the use of radio spectrum in the UK', Report for Ofcom; Growitsch, C; Marcus, J Scott & Wernick, C (2010)

9.6. Additional key results of the sensitivity analysis

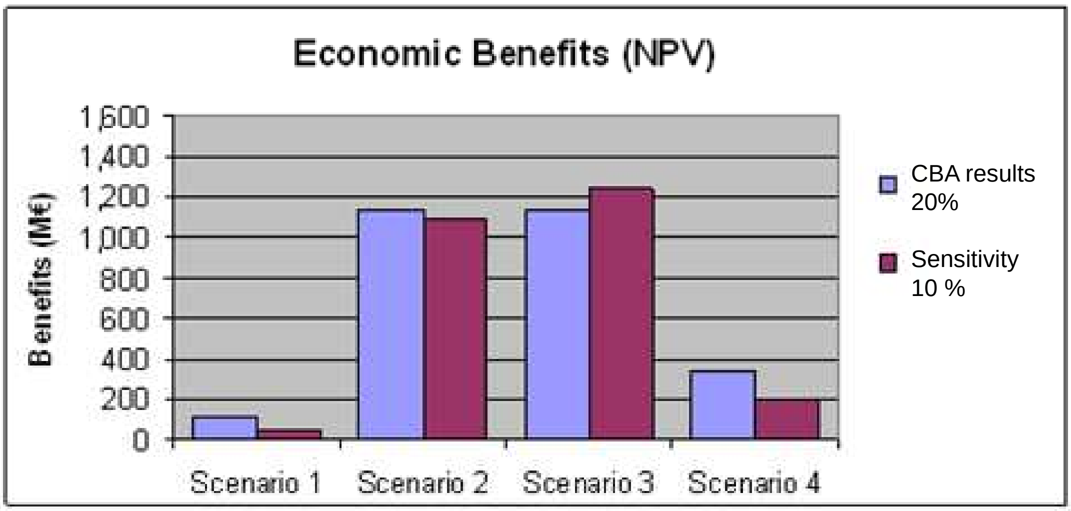
In order to investigate the impact of changes in assumed values on the CBA results, identify the assumptions that have the strongest impact on the results, as well as identify the ranges of assumptions for which the CBA analysis remains valid, a sensitivity analysis was conducted.

The following set of parameters has been examined:

- discount rate;
- network utilisation;
- unit price of data;
- timing of liberalisation in the 2 GHz band;
- price elasticity;
- data demand;
- infrastructure costs;
- number of operators;
- number of subscribers per cell using common content;
- different country case studies (i.e. number of cell sites and subscribers).

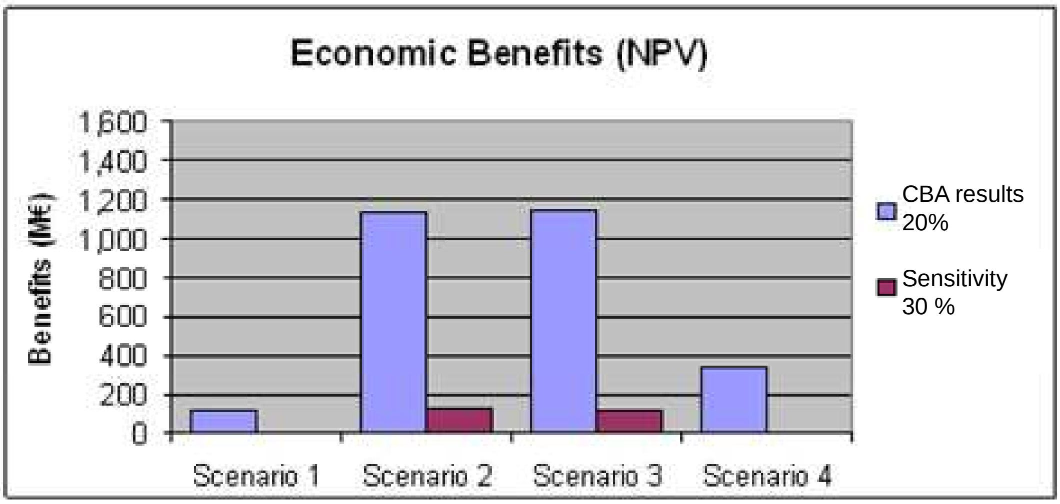
The network utilisation used in the CBA above was assumed to be 20%. The figures below illustrate the impact of using utilisation values of 10% and 30% respectively[74] The results show that network utilisation can have a significant impact on the CBA results as it plays a key role in determining whether the economic benefits are assessed within a capacity constrained or demand constrained environment. An increase in utilisation means that more of the increased demand can be met within the existing MNO infrastructure and other frequency bands i.e. the environment becomes demand constrained. There is therefore little benefit to be gained from increasing the capacity further using the 2 GHz TDD bands. A reduction in utilisation results in an environment which is increasingly capacity constrained and where less additional network capacity (and therefore benefit) is being realised for a given cost.

Figure 0-2: 10% network utilisation



[74] Note, that in scenario 2 the femto cell utilisation was also varied. It was assumed that the femto cell utilisation was 1/10th that of the utilisation of the wide area network.

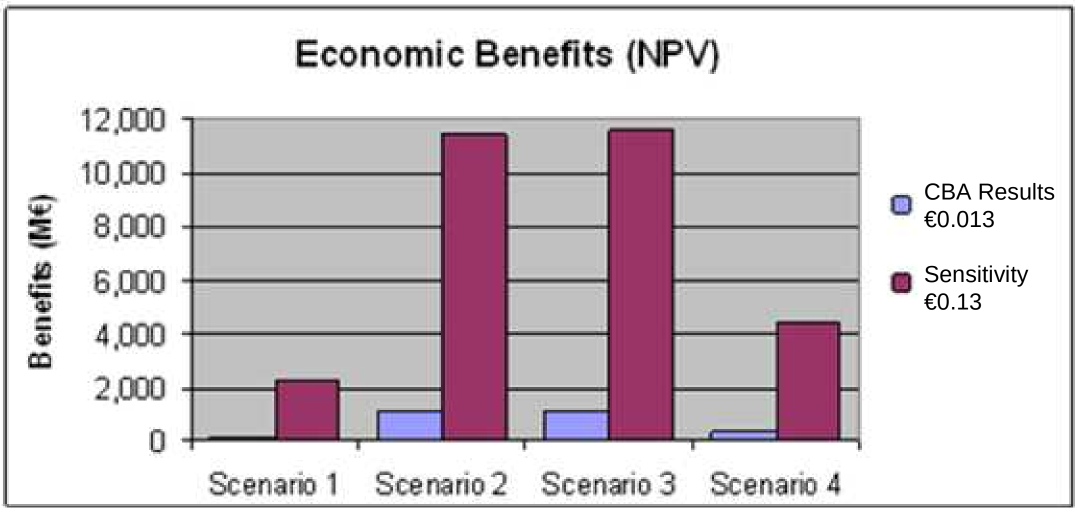
Figure 0-3: 30% network utilisation



Low power usage and downlink only services scenarios have the greatest economic benefits. However, it noted that scenario downlink only services is the only scenario whose NPV increases as the network utilisation is reduced to 10%. Scenario downlink only services is a cost efficient way of realising increases in network capacity on the assumption that there is common content required by users that can be delivered via downlink only services.

The data price used in the CBA above was assumed to be 0.013€ per MB. The reference data suggested typical current data prices were in the range 0.013€ to 0.13€. The figure below illustrates the impact of using 0.13€ per MB. This also illustrates the potential additional benefits that might arise if use of the 2 GHz TDD bands enabled new types of highly desirable services and applications. As expected the unit data price just scales the economic benefits. The data price is fundamental in setting the absolute value of the resulting economic benefits as it is a central part of the calculation of the consumer surplus as well as the additional revenue generated by the MNO from sale of the additional network capacity.

Figure 0-4: €0.13/MB unit data price



The implementation of liberalisation in the CBA above was assumed to be 2013. The figures below illustrate the impact of implementing[75] liberalisation in 2015 and 2017 respectively.

Figure 0-5: Liberalisation implemented in 2015

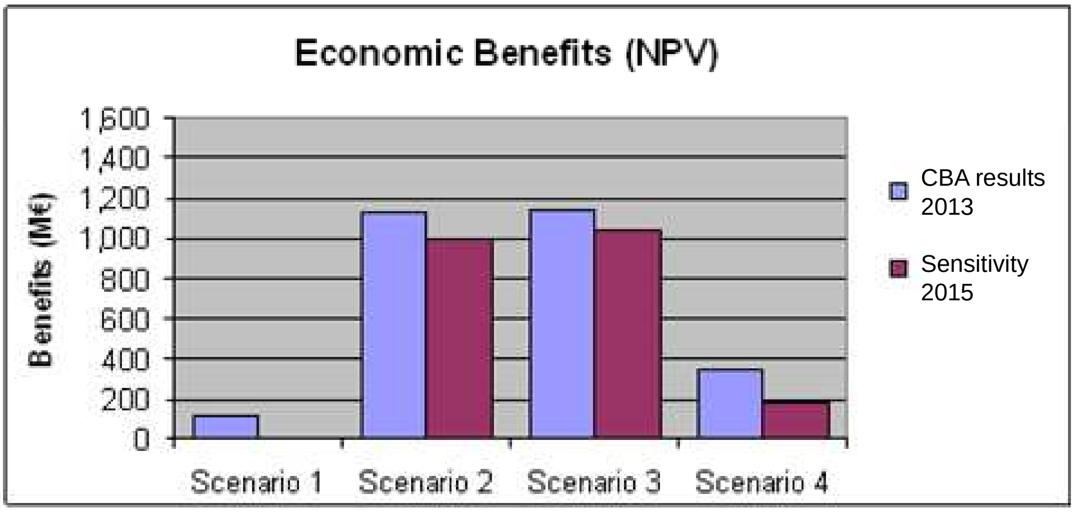
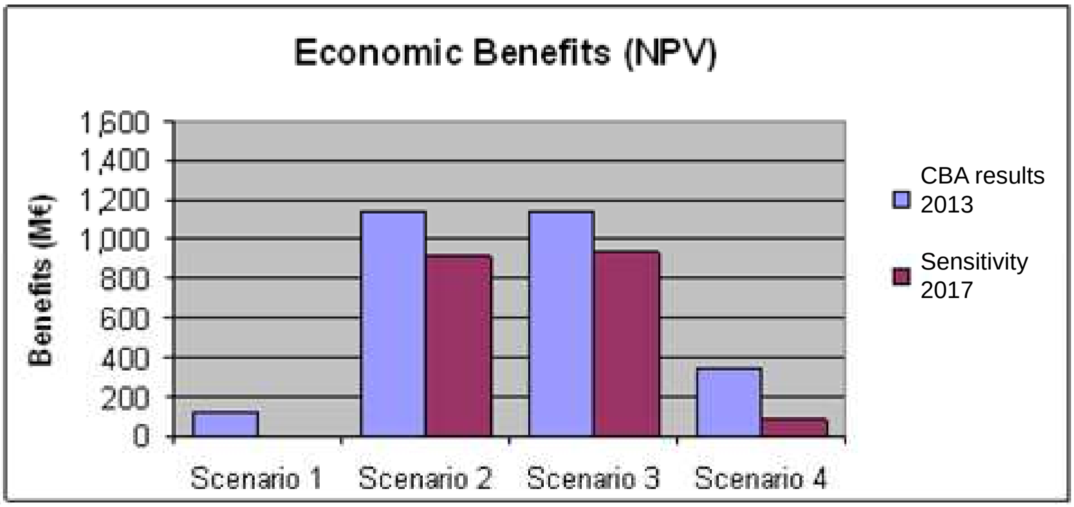


Figure 0-6: Liberalisation implemented in 2017



A later decision to liberalise will reduce the economic benefits generated by approximately 100M€ for each year of delay. It does not however affect the relative value between scenarios. The optimum liberalisation date is closely linked with the date of any transition between a demand constrained and network capacity constrained environment, and is therefore closely linked to the predicted increase in demand.

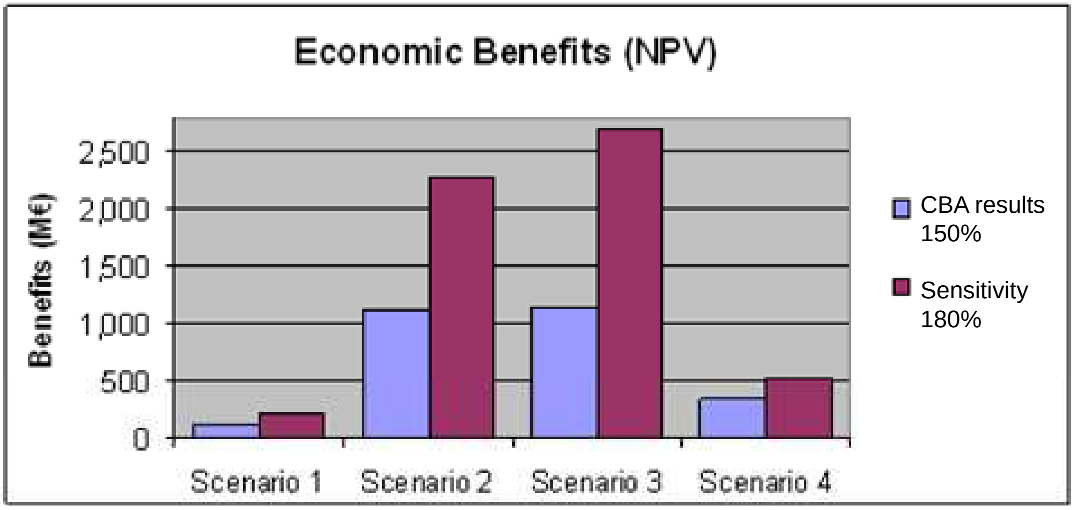
The price elasticity used in the CBA above was assumed to be constant at -1.0 throughout the analysis period. The results scale according to the price elasticity used. A decrease in the assumed elasticity results in increased economic benefits, and vice-versa.

The data demand is a key assumption which plays an important role on determining whether the economic benefits are assessed within the context of a network capacity constrained or demand constrained environment. It has a similar effect compared to that of network

[75] Note that the effects of liberalisation may begin before the implementation date, if it is known in advance that liberalisation will take place.

utilisation. A 180% annual growth of data demand has a substantial impact on the benefits, as illustrated in the figure below.

Figure 0-7: 180% annual growth of data demand



The magnitude of demand (reaching 839,000 TB per operator in 2021) is large enough that the percentage changes indicated above result in an increase of demand of 8,000 TB on the network. Increasing demand by such an amount significantly increases the economic benefits where the incremental value of any additional network capacity is significant. Conversely reducing the demand by such an amount eliminates the need for additional network capacity and thus the scenarios become indistinguishable from the baseline case.

9.7. Sensitivity of the results as regards the number of subscribers and number of cell sites in a Member State

The CBA above was performed for the UK which is assumed to be typical of a country with a large number of subscribers and cell sites (for a single operator) deployed across the coverage area. The sensitivity analysis below presents case studies for other European countries representative of the range of different types of countries found in Europe:

Romania - low number of subscribers relative to a high number of cell sites.

The Netherlands - high number of subscribers relative to a low number of cell sites.

Slovakia - low number of subscribers relative to a low number of cell sites

The number of subscribers and cell sites for each case study were scaled relatively to the UK case study according to country population and area respectively. The resultant case study range was examined:

Case study type				
	UK	**Romania**	**Netherlands**	**Slovakia**
Number of subscribers	High	Low	High	Low
Number of cell sites	High	High	Low	Low
Range of values (per operator)				
Subscribers	20,700,000	7,300,000	5,600,000	1,800,000

Femto cell sites	Scaled to population

The number of subscribers relative to the number of cell sites is a key assumption playing an important role in the determination of overall network demand and the relative infrastructure investment required in order to satisfy it. As a result, only the high-high and high-low case studies yield additional economic benefits across the scenarios relative to the baseline case where the terrestrial 2 GHz band continues to be used as it is today. However, it is noted that scenarios low power usage and downlink only services yield additional economic benefits in each of the type of country, even if these are only very small in the case of countries with low number of subscribers.

The table below categorises the Member States:

	Number of subscribers	
Number of cell sites	**High** (pop density > 110 per km^2)	**Low** (pop density ≤ 110 per km^2)
High (country area > 100,000 km^2)	UK, France, Germany, Italy, Poland	Romania, Bulgaria, Finland, Greece, Sweden, Spain
Low (country area ≤ 100,000 km^2)	Netherlands, Belgium, Czech Republic, Denmark, Luxembourg, Malta, Portugal	Slovakia, Austria, Cyprus, Estonia, Hungary, Ireland, Latvia, Lithuania, Slovenia

From the sensitivity results and table above it can be concluded that, although the economic benefits may differ significantly across Member States, the harmonised implementation of scenarios low power usage and downlink only services would result in economic benefits across the EU relative to the baseline scenario which assumes that no regulatory action is taken.