



**INTERCONNECT COMMUNICATIONS**

A Telcordia Technologies Company

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# Spectrum for WiMAX in Europe

**The Search for a Home for the Next Generation of Wireless Broadband**



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## Introduction

The ubiquity and utility of WiFi hotspots in cafés, hotels, airports and similar such locations has led many in the ICT industry to the belief that a higher capacity, longer range, more flexible wireless broadband delivery technology is a critical step in delivering the Information Society objectives so favoured by policymakers and visionaries. To this end, companies and research establishments from around the world have been working to produce a next generation WiFi standard. The result is 'Worldwide Interoperability for Microwave Access' or WiMAX.

WiMAX is a global term to represent a suite of technical standards more specifically referred to as 'IEEE 802.16'. These standards, brought together under the watchful eye of the WiMAX forum (<http://www.wimaxforum.org>), represent a series of point to multipoint technologies designed to deliver broadband data connections at up to 270 Mbps in each direction (though speeds of the order 10 Mbps are more common). WiMAX is one of the technologies being developed to service what are known as Metropolitan Area Networks (MANs) where wide areas are covered with a broadband service rather than just hotspots as is common with WiFi. It is worth noting that another standard, 802.20, is being developed to deal with truly mobile broadband data delivery.

One of the advantages that WiFi equipment manufacturers have enjoyed is that the frequency band in which the services can operate is (with one or two minor exceptions) largely harmonised across Europe and - indeed - across the world. This allows manufacturers enormous economies of scale. From the regulators' standpoint, where spectrum is used by equipment that is likely to migrate across international borders, having spectrum allocations which are harmonised within a region means that the likelihood of interference from such equipment is minimised. Thus, whilst all radio equipment can in theory be tuned to operate on any specific frequency, having homogeneous, contiguous and harmonised spectrum allocations is highly desirable.

However, unlike WiFi which operates in spectrum which has been made licence exempt by many regulators, WiMAX is mainly intended to operate in spectrum which is licensed – the difference being that operating in licensed spectrum gives WiMAX services some certainty over the level of interference they will suffer. WiMAX (in particular variant 802.16e) could share spectrum at 2.4 and 5.8 GHz with WiFi services but, in order to achieve the maximum benefit from the new technology, licensed spectrum is clearly important.

Further, to achieve the 50km non-line-of-sight ranges which are being talked about for WiMAX services, significantly more transmitter power is required than is normally allowed in licence-exempt spectrum. This also causes difficulties if higher-power

WiMAX services operate in the same spectrum as licence-exempt WiFi, Bluetooth and other services, such that the interference from WiMAX would block out the use of the spectrum for other technologies. This is already a problem in some areas where higher-power WiFi services are licensed in the 2.4 GHz band.

Given the increasing demand for wireless services from many industrial sectors (such as cellular, fixed wireless access, broadcasting, transport, government and defence), licensed spectrum is at a premium with large sums being paid at auctions for access to the decreasing pool of this limited resource. This document, therefore, explores the spectrum being considered for the licensing of WiMAX services in Europe with a view to understanding the likelihood of such spectrum being made available.

	WiFi	WiMAX
Standards	802.11	802.16
Frequency Bands	2.4 - 2.4835 GHz (802.11b/g)	2 - 11 GHz (802.16a)
	5.15 - 5.35 and 5.47 - 5.725 GHz (802.11a)	10 - 66 GHz (802.16c)
Channel Bandwidth	20 MHz	1.75, 3.5, 5.5, 7, 10, 20 MHz
Throughput (in 20MHz bandwidth)	11 Mbps (802.11b)	Up to 70 Mbps (802.16a)
	54 Mbps (802.11a/g)	Up to 124 Mbps (802.16c)
Range	~100 metres	~10km line of sight
		~4km non line of sight

*Essential Characteristics - WiFi and WiMAX*

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## Spectrum for WiMAX in Europe

WiMAX is designed to operate in the frequency range 2 to 66 GHz, however, most interest is focussing on the 2 to 6 GHz range where portable and even potentially mobile operation is possible.

There are three main bands being considered for WiMAX implementation in Europe (indeed the same bands are being considered worldwide): 2.5 GHz, 3.5 GHz and the lower part of the 5 GHz range. In addition, there are further bands which are being considered by the WiMAX forum but for which the regulatory hurdles are greater and as such are longer term destinations: 2.3 GHz, 2.8 GHz, 3.3 GHz and upper 5 GHz.

The position with respect to the availability of this spectrum in Europe varies from country to country making it difficult to see how any pan-European decision could be taken on an allocation. Here we look at the availability of these various bands under consideration.

### **2.3 GHz (2300 – 2500 MHz)**

This band (which is similar to the US WCS band which is 2305 – 2320 MHz / 2345 – 2360 MHz) includes the current licence-exempt WiFi band (2400 – 2483.5 MHz) and so around half of it could already be used, licence exempt, subject to agreement by national administrations on power levels. However, the licence exempt-part of the band is already congested in many parts of Europe, especially in urban areas, and so may not be of particular benefit for operators, though domestic use might be appropriate.

The lower part of this band (2300 – 2400 MHz) is allocated in Europe to various Fixed and Mobile services and also to radio amateurs, radars (usually Government), programme making and various other users. As such usage tends to be national in nature with different allocations (if there is any allocation at all) being available in each country, this band is unlikely to be harmonised across Europe. This makes it an unattractive band for widespread manufacture, though localised national licenses may be offered.

### **2.5 GHz (2500 – 2690 MHz)**

In Europe this band is designated as a '3G expansion band' with the intention of making it available for additional (UMTS-based) 3G cellular services. Some of the more enlightened regulators (including the UK) are considering making the award of this spectrum technology neutral, opening up the possibility that it could be used

for WiMAX services. There is, however, likely to be stiff commercial competition for the spectrum from other technologies including (of course) 3G as well as mobile television (DVB-H) providers, fixed wireless access (using non-WiMAX technologies) and wireless cable operators, who all no doubt see lucrative potential markets for their services. Should multiple technologies be licensed in this band, there will no doubt be a requirement either to establish spectrum trading-style 'spectrum rights' which define power and interference levels, or for lengthy sharing studies to ensure compatibility between services.

### **2.8 GHz (2700 – 2900 MHz)**

This spectrum is heavily used in Europe for aeronautical radar services. Sharing of the spectrum between radar and many other services has been contemplated and various studies undertaken. None of these, however, has conclusively shown that there would be a sufficiently low impact on the safety-of-life services that the radars support for this band to be able to be shared with any other service, let alone something as high density as WiMAX.

Whilst individual countries could license this spectrum for WiMAX services should they wish to do so, it would be on a Non-Interference Basis and in particular would have to ensure protection of all existing radar services not only in the country concerned, but also in neighbouring territories. It therefore seems unlikely that this band would be licensed for WiMAX, or for that matter, any other service.

### **3.3 GHz (3300 – 3400 MHz)**

This band is commonly reserved for military services, and it is unlikely that the military would be willing to share with commercial users in this band in the near future, except, possibly, in countries where such services do not exist. Even then, countries using the band for military services are unlikely to want to allow their neighbours to allow non-military services to operate in the band, further restricting the likelihood of this band becoming widely available for WiMAX services.

### **3.5 GHz (3400 – 3600 MHz)**

This band is primarily allocated to radiolocation (radar and navigation) services, though many countries have, or are intending to open up some of this spectrum for broadband fixed wireless access (BFWA) services on a licensed basis.

The UK has already licensed an operator (Pacific Century CyberWorks, based in Hong Kong) who is providing commercial services in some areas in 2 x 20 MHz of spectrum in this band. However, despite the fact that the spectrum they have is clearly paired, instead of choosing WiMAX they have chosen to go with TD-CDMA, a

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UMTS variant. It is possible that the use of a TDD technology offers better spectral efficiency when dealing with the asymmetric nature of Internet traffic.

Other countries may follow suit and offer licensed spectrum in this band but there is no guarantee and presently no sign of any pan-European harmonisation.

### **Lower 5 GHz (5150 – 5350 MHz and 5470 – 5725 MHz)**

This band was recently the subject of an European Union Decision (2005/213/EC) which made it available, licence exempt, for wireless access systems across Europe by 31 October 2005 subject to various restrictions on indoor and outdoor power levels and the use of polite protocols (such as listen-before-transmit and power level control).

As such, low power WiMAX services could use this frequency band subject to the restrictions in the decision, though for wider area services a licensed approach would be necessary. Given that this band is also used for radar and aeronautical navigation services and that, as a result of the EU decision, the band is likely to gradually fill with other WiFi type services, it is unlikely that licensed usage would be contemplated.

### **Upper 5 GHz (5725 – 5850 MHz)**

This is part of the ISM band where various low power devices already share spectrum on a licence-exempt basis with other services. If operated at low power, WiMAX equipment could use this frequency band, however there is pressure to allow higher powered services. No decision has yet been taken on whether or not such higher power usage might be authorised, either at a national or pan-European level.

### **TDD versus FDD**

It is obviously easier to find blocks of spectrum in which TDD services could operate due to the fact that no duplex-paired frequencies are required. In fact, within reason, TDD architectures could use any semi-contiguous available blocks of spectrum, subject to any tuning range limits on the equipment concerned. It is thus more likely that spectrum which could be used for TDD services might be licensed either nationally or regionally than FDD spectrum. As an example, if the 3400 – 3600 MHz band was to be opened up for WiMAX services, but the allocation in each country was different, a TDD solution which could use any frequency in this band would offer greater potential for operating within the available spectrum than an FDD solution where different countries might provide different duplex pairing and different paired frequency blocks.

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## Conclusion

A harmonised allocation for WiMAX services across Europe (and wider) would offer many benefits. Of the candidate bands available, however, few offer the true potential to deliver an appropriate regional solution. Sharing of licence-exempt bands, whether at low or higher transmitter powers is problematic for all users.

WiMAX operators are likely to be able to compete on even terms for spectrum in the 2.5 GHz band if such spectrum is licensed on a technology-neutral basis. Other than this, the most likely 'common' allocation across Europe is in the frequency range 3400 – 3600 MHz as many countries have already earmarked this band for broadband wireless access, although it is likely that the sections of this band that will be opened up would be different in each jurisdiction.



# About InterConnect Communications

**InterConnect Communications** is a wholly-owned subsidiary of Telcordia Technologies Inc., based in the United Kingdom, and a leading provider of consultancy services on spectrum and wireless technology issues. Operators, manufacturers or regulators considering the opportunities for WiMAX services in Europe and across the world seeking further information on the situation in a given country, region or standardisation or regulatory body will find InterConnect's global knowledge exceptionally advantageous in developing business plans, securing or licensing spectrum and in equipment type approval.

InterConnect consultants have completed major radio spectrum regulation, management and monitoring projects around the world, including the successful specification, tender adjudication and purchase of radio spectrum management and monitoring systems as well as institutional development, training and regulatory reform. The company has also produced a number of reports on Spectrum Management for national spectrum administrations, the European Commission (EC) and European Radiocommunications Office (ERO). Our multi-disciplined team of radio experts has extensive experience of the development and modernisation of radio spectrum management and spectrum monitoring organisations and systems including:

- the development and implementation of radio spectrum policies;
- the construction of a national radio frequency plans/tables, the planning of spectrum usage, and the assignment of frequencies for different services;
- the specification of spectrum management and monitoring systems including preparation of technical specifications and tender documentation, evaluation of offers, contract negotiation, project management of the procurement, installation and commissioning processes;
- the establishment and implementation of spectrum re-farming plans;
- institutional development including the production of processes to support new spectrum policies, regimes and systems;
- training on all matters concerning radio spectrum management, including the running of the popular TRMC Spectrum events.

For more details of InterConnect's radio spectrum services, please visit <http://www.icc-uk.com/spectrum.php> or e-mail John Berry, Director of Spectrum Services, at [johnberry@icc-uk.com](mailto:johnberry@icc-uk.com)



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